
NAVY PUBLIC WORKS CENTER

NORFOLK, VIRGINIA

UTILITIES DEPARTMENT

STANDARD OPERATING PROCEDURE / JOB HAZARD ANALYSIS

TITLE

FAULT LOCATING A HIGH VOLTAGE CIRCUIT

PROCEDURE NUMBER

WC 622 HVE 011

DISTR:
601A
610
620
WC 622
WC 624

SIGNED:_____
(DATE)

APPROVED:_____
(DATE)

SAFETY PROFESSIONAL:_____
(DATE)

MANAGEMENT OFFICIAL:_____
(DATE)

DATE:_____ REVISION DATE:_____

FAULT LOCATING A HIGH VOLTAGE CIRCUIT

Purpose:
Procedure for locating a fault on a high voltage power cable.

Potential Energy Sources:
1. 34.5 kv equipment and cables.
2. 11.5 kv equipment and cables.
3. 4.16 kv equipment and cables.
4. Cable test and/or impulse generator test set.

Tools and PPE:
Tools: Biddle 0-30KV proof test/impulse generator test set, 3 KW (120 volt) power source, manhole hooks, portable gasoline powered manhole pump, Biddle magnetic impulse detector, power system one line diagrams, distribution system manhole prints, shotgun stick, and ground cables. PPE: Nomex coveralls, Nomex hood, insulating rubber gloves, insulating rubber sleeves, hard hat, safety shoes, safety glasses. The class of rubber gloves and sleeves will depend on the exposure voltage as per the following: Class 0 - up to 1,000 volts, Class 1 - up to 7,500 volts, Class 2 - up to 17,000 volts, Class 3 - up to 26,500 volts, Class 4 - up to 36,000 volts.

References:
1. PWC Occupational Safety and Health Program Manual, PWCNORVAINST 5100.33E
2. Occupational Safety and Health Standards for General Industry (29 CFR PART 1910): Subpart I, Personnel Protective Equipment; Subpart R, Electrical Power Generation / Transmission / Distribution;
   Subpart S, Electrical
3. NFPA 70 E, Approach Distances To Exposed Energized Electrical Conductors and Circuit Parts
4. ANSI C2-1987, National Electrical Safety Code
5. Electrical Transmission and Distribution Safety Manual, NAVFAC P-1060
6. US Corps of Engineers Safety and Health Requirements Manual
7. PWC, Code 600, Lockout and Tagout Procedure
8. PWC SOP# 600 HVE 6, PWC Switching or Breaker Operation
9. PWC Code 600 Outage Reporting Process

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Preliminary Preparations
1. Travel to affected substations and identify which circuit breaker(s) have tripped. Observe tripped substation breaker(s) protective relay targets to identify the faulted line. Communicate to operations personnel all information discovered at the substations, i.e. breakers tripped and targets down. Personnel in the substation will wear Nomex coveralls and safety shoes.

2. The command control center will review the updated power system one line to determine the system switching arrangement at the time of the fault. This information will then be transferred to the field personnel.

3. Personnel at the affected substation(s) will observe the station recording MWATT and recording MVAR charts to determine the magnitude of the fault. This information will be communicated to operations control personnel.

4. Using one line diagrams, and command control switching orders, transfer as many loads as possible to alternate feeders. Refer to SOP# 600 HVE 6, PWC Switching or Breaker Operation for procedure to open/close the switches or breakers. As per the Code 600 Outage Reporting Process, the operations control personnel will be informed of all switching. Personnel switching will wear listed PPE.

5. Using one line diagrams, and command control switching orders perform switching operations to isolate the faulted circuit section and restore power to as many loads as possible. Refer to SOP# 600 HVE 6, PWC Switching or Breaker Operation for procedure to open/close the switches or breakers. As per the Code 600 Outage Reporting Process, operations control personnel will be informed of all switching. Personnel switching will wear listed PPE.

6. Lockout and Tagout all devices that could possibly re-energize the isolated, faulted, circuit. Refer to PWC, Code 600, Lockout and Tagout Procedure. Test circuit to verify it has been deenergized. Before the circuit conductors are checked, test the high voltage tester on a known energized circuit to verify the tester is working. Test each deenergized circuit conductors separately, taking care not to cross phase during test. If voltage is detected, stop the test. If no voltage is indicated, retest the high voltage tester to re-verify it is working properly. Wear listed PPE to test the circuit.

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7. All personnel working on the outage should review the power system one line diagram, and the distribution system manhole prints to determine what facilities are still without power and what the faulted circuit's cable routing is.

Locating the Fault

Note: All faults will not be the same. All the steps to locate a fault may not have to be followed. The fault may be located performing steps 1-7. Some faults may require a combination of the underground and the overhead procedures listed below.

8. Open all transformer primary switches on the isolated, faulted, circuit. The personnel should perform a quick check on transformer, transformer primary switch, primary switch fuses, and other equipment on site to determine if the fault is or is not located at that site.

Underground, Isolated, Faulted Circuit

9. Disconnect all lightning arresters on the isolated, faulted, circuit.

10. Pull all PT fuses on the isolated, faulted, circuit. Wear Nomex coveralls and insulating rubber gloves as a pre-caution.

11. Proof test the faulted circuit, one phase at a time, to determine the faulted phase(s). The tester(s) will wear insulating gloves, Nomex coveralls, safety shoes, safety glasses, and a hard hat.

12. Once the failed phase(s) has been identified, attach safety grounds to the non-faulted phases. To attach grounds, first connect one ground cable end to station ground, or a grounded structure, then attach the other end to a fiberglass shotgun stick and place the ground on the circuit using the shotgun stick. Follow Code 600's Lockout and Tagout Procedure concerning ground tags.

13. Connect the test set to the faulted phase and initiate impulse testing at 100% of cable voltage rating. The test set operator will observe the instrument at all times for safety and proper operation. The test set operator(s) will wear insulating gloves, Nomex coveralls, safety shoes, safety glasses, and a hard hat.
Non-essential personnel will stay clear of the testing area.

14. While the impulse tester is operating other personnel will visually and acoustically check all manholes the faulted circuit runs in for an impulse

"pop". The circuit inspectors need not wear any special PPE to perform the visual and audio checks, but if they are to touch anything then they are to wear insulating gloves, Nomex coveralls, safety shoes, safety glasses, and a hard hat.

15. If the visual and audio manhole checks fail to locate the fault, use a magnetic impulse detector to locate the fault. A change in direction on the impulse detector from one manhole to the next, adjacent, manhole will indicate the fault is between the two points. The fault point now has to be pinpointed. Depending on the circuit configuration at the location the fault can be at:

- either of the adjacent manholes
- the ductbank between the adjacent manholes
- on a lateral running out one of the adjacent manholes

(Note: the lateral will now have to be checked with the detector)

- on a lateral running to a facility transformer site
- in a facility transformer site

The magnetic impulse detector will wear insulating gloves, Nomex coveralls, safety shoes, safety glasses, and a hard hat.

16. Disconnect the impulse test set, and ground the faulted phase conductor(s). To attach grounds, first connect one ground cable end to station ground, or a grounded structure, then attach the other end to a fiberglass shotgun stick and place the ground on the circuit using the shotgun stick. Follow Code 600's Lockout and Tagout Procedure concerning ground tags.

Overhead, Isolated, Faulted Circuit

17. Drive along the overhead circuit and look for an obvious problem.

18. If the drive quick check does not reveal where the fault is, a more detailed inspection will be made. Use bucket trucks to check the overhead circuit pole by pole. If there are energized circuits on the pole line the bucket personnel will wear listed PPE.

19. If the detailed inspection does not find the fault, the next course of action will depend on the faulted circuit's voltage.
4160, 11500, 13200 - recluse the circuit and reinspect per 17 and/or 18
34500 - disconnect all lightning arresters and place a fault locator on the circuit and commence impulse testing to locate problem.

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20. Once the fault has been found, detach test unit and attach safety grounds to faulted circuit. To attach grounds, first connect one ground
cable end to station ground, or a grounded structure, then attach the other
stick and place the ground on the circuit using the shotgun stick. Follow Code 600's Lockout and Tagout Procedure concerning ground tags.

Fault Is Found

21. Notify maintenance personnel of exact fault location and turn over all Lockout Tag stubs/keys and Ground Tag stubs. Review a system power one line diagram with maintenance personnel to brief them on the switching which has occurred and the locations of all grounds. Notify operations control personnel of the fault location and what the problem is and the time the problem was found.

22. Return all test equipment to normal storage site.