Liberty Utilities	SUBSTATION MAINTENANCE Procedure	Doc. # **SMP 400.06.2** Page 1 of 14
	SUBSTATION VISUAL AND OPERATIONAL (V&O) INSPECTION	Version 1.1 – 11/20/18

PURPOSE

This procedure describes the methods used to perform Visual and Operational (V&O) Inspections of electrical substations used in the distribution of electricity.

V&O Inspections, are performed with the apparatus in service, and are used to:

Verify the security of fences, gates etc. that prevent entry of the public, and provide a legal record of their inspection.

Detect any hazards to company employees or the public.

Verify that animal protection measures are present and in good condition.

Detect abnormal conditions before the apparatus is damaged or a customer outage occurs.

Collect data (counter readings, fault operations etc.) used to prioritize individual apparatus inspections.

Collect data (regulator travels, load readings, relay targets etc.) used for system operation purposes.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities

Substation and other Workers performing inspection and maintenance activities

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures

EP-14 Oil Filled Electrical Equipment Management

LU-EOP G022 Substation Security Entry, Notification, and Documentation

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Inspect-	An assessment of Liberty Utilities facilities for the purpose of determining the condition of the facility and any associated components.
System Operator-	An authorized person, who directs, controls, monitors, and operates the electric system and its associated apparatus.
Qualified Person-	A person knowledgeable in the construction and operation of electric power generation, transmission, substation, and/or distribution apparatus involved along with the associated hazards in specific duties pertaining to electric operations.
Qualified Worker-	Workers shall be trained in and familiar with the safety related work practices, safety procedures and other safety requirements that pertain to their respective job assignments. Workers shall also be trained in and familiar with any other safety practices, including applicable emergency procedures (such as pole top/bucket rescue). Qualified workers shall be trained and competent in:

- Skills and techniques necessary to distinguish exposed live parts.
- Determining nominal voltage of exposed live parts.

- Knowledge of minimum approach distances.

Proper use of precautionary techniques, use of PPE including insulating and shielding materials and properly rated insulated tools for working on or near energized parts of electrical equipment

SPCC- EPA's Spill Prevention, Control and Countermeasure Program

PROCEDURE CONTENTS

Table of Contents

1.0 Test Equipment Required.

1.1. Digital Multi-meter, IEC 1010-1 Cat. IV

1.1.1. Spare battery

1.2. Recloser Battery test meter with load test feature.

1.2.1. For Form 3 Recloser battery tests.

2.0 Materials Required.

2.1. Clipboard

2.2. Binoculars

2.3. Flashlight

2.4. Magnet for resetting drag hands

3.0 Initial Substation Entry

3.1 Refer to LU-EOP G022 Substation Security Entry, Notification, and Documentation Requirements

4.0 Inspect Yard

4.1 Perform an inspection for:

4.1.1 Alarms

4.1.2 Cut or removed ground grid or ground grid connections.

4.1.3 Obvious damage.

4.1.4 Security of gates, Control House, fence and locks.

4.1.5 Unusual noises.

5.0 Notify the System Operator

5.1 Inform them you are in the Station for a V&O Inspection and that you will be testing alarms.

5.2 Ask System Operator if any equipment has been tagged out or relays blocked.

6.0 Reporting and Correcting Problems and Discrepancies

6.1 Severe Trouble shall be reported to the Control Center and the person in charge of the substation immediately.

6.2.1 The employee shall secure the area and warn unauthorized people to stay clear of the danger.

6.2.2 A severe trouble condition is a situation that is hazardous to the system operation and/or Liberty Utilities employees or the public.

a.) See Trouble Reporting Appendix at the end of this document for additional information on trouble reporting.

6.3 Document all paint and preservation problems.

6.3.1 Rust, corrosion, or fading to the point where primer, or bare metal shows.

6.4 Problems and discrepancies found should be repaired during the V&O Inspection whenever possible.

6.5 Problems and discrepancies not corrected during the V&O Inspection shall be recorded as a note in the comment section of the Substation V&O Inspections Form.

6.5.1 The Supervisor reviewing the inspection form shall generate follow-up work.

6.6 Record findings in the comment section of the Substation V&O Inspections Form.

7.0 Control House

7.1 Check control house door locks working, secure, and in good condition.

7.2 Station Log Book

7.2.1 Enter date, time and employee names that are performing the V&O Inspection.

7.2.2 Check the Station Log Book for abnormal conditions that can be corrected during the V&O Inspection.

a.) After the V&O Inspection, record all abnormal problems found in the Log Book, with red pen, and whether they were corrected or not.

7.3 SPCC – SPCC locations only.

7.3.1 Verify SPCC Plan is available at the substation.

7.3.2 Verify SPCC notification list posted.

7.3.3 Check oil spill containment kits complete and in good condition.

7.4 Control Panels

7.4.1 Indicating Lights

a.) Check that the indicating lights on the control board are working.

b.) Check the available stock of spare bulbs; restock as necessary.

c.) Inspect rear of Control boards for any signs of overheating, burned wiring, moisture, etc.

7.5 Noises - Listen for any unusual noises from relays, modules, RAPRs, timer circuits etc.

7.6 Relay targets and alarms.

7.6.1 Record targets and alarms on the V&O Report and in the station log book.

a) List the apparatus affected indicating circuit designation, phase and type of relay or alarm.

7.6.2 Reset and report relay targets and alarms to the System Operator and your supervisor.

7.7 Reclosing Relays

7.7.1 Check that reclosing relays are in service.

a.) Record any reclosing relays that are off and tagged.

b.) Report any reclosing relays that are off and not tagged to the System Operator.

7.7.2 Verify mechanical reclosing relays are in the start or zero position.

7.8 Ground Trip Switches (cutouts)

7.8.1 Check that all ground trip relays are in service (ON).

a.) Record any ground trip switches that are off and tagged.

b.) Report any ground trip switches that are off and not tagged to the System Operator.

7.9 Bus Transfer Schemes

7.9.1 Check both buses alive (load ammeters, bus voltmeters bus alive lights).

7.9.2 Check timers reset

7.9.3 Check that the sequence timers in normal position

7.9.4 Check transfer scheme auto

a.) Record any auto transfer switches that are manual or off and tagged.

b.) Report any auto transfer switches that are manual or off and not tagged to the System Operator.

7.9.5 Check tie breakers properly setup (setup varies by station scheme).

7.10 High Side Transfer Schemes

7.10.1 Check both lines alive (load ammeters, line alive lights).

7.10.2 Check timers reset

7.10.3 Check that the sequence timers in normal position

7.10.4 Check transfer scheme auto

a) Record any auto transfer switches that are manual or off, and tagged.

b) Report any auto transfer switches that are manual or off, and not tagged to the System Operator.

7.10.5 Check air break/circuit breaker/circuit switcher status (open or closed).

7.11 Annunciator and Alarm Test Switches

7.11.1 Annunciator panel

a.) Move toggle switches, which are not tagged, to the TEST position to check lights. This will send an alarm to the Control Center.

b.) To clear trouble condition, turn the toggle switch to the reset position, then back to ON. There may be multiple alarms, usually in transformer cabinets.

c.) Check with supervisor before testing any switches that are in the off position.

d.) Verify the System Operator received the alarms.

7.11.3 Repair of alarm conditions.

a.) Alarm conditions should be corrected during the V&O Inspection.

b.) If the alarm condition cannot be corrected during the V&O:

The alarm should be cleared by turning the annunciator switch to OFF.

The toggle should be tagged with the date, reason and inspectors name.

Both the System Operator and your supervisor should be notified that the alarm condition exists and the alarm point is off. Verify the System Operator received the alarm.

7.12 Tags and Clearance and Control switching forms and Supplies

7.12.1 Check the stock of Clearance and Control Tags.

a.) Restock as necessary.

7.12.2 Check the stock of Ground Device Identification Tickets (GDIT).

a.) Restock as necessary.

7.12.3 Check the stock of Filed Switching Order Pads

a.) Restock as necessary.

7.12.4 Check that pens (red and blue/black) and pencils are available with the logbook

a.) Restock as necessary.

7.13 Control House Heating and Lighting

7.13.1 Test control house lighting.

a.) Replace any defective bulbs, or ballasts or sockets.

7.13.2 Test emergency lighting.

a.) Replace batteries if needed

7.13.3 Inspect heaters, fans and thermostats for proper operation. Make sure fans are not broken or bound up and they are in good working order.

7.14 Station Service and Transfer Switch

7.14.1 Check transfer switch on preferred supply

7.14.2 Check transfer switch for damage or overheating.

7.14.3 Test and record preferred and alternate secondary voltages at transfer panel.

7.15 Check AC supply panels for:

7.15.1 Tripped circuit breakers.

7.15.2 Circuit breakers in the proper position.

7.16 Check DC Circuit Breaker of Fuse Panel

7.16.1 Check DC supply panels for:

a.) Tripped circuit breakers or blown fuses.

b.) Circuit breakers in the proper position.

7.17 Protective Grounds

7.17.1 Check that grounds in station are in sets of 3 and that they are hung up properly.

7.17.2 Check that the phase end and ground clamps are in good working order.

7.17.3 Lubricate as required.

7.17.4 Inspect for the cracked or cut insulation and broken conductor strands.

7.17.5 Replace or repair damaged protective grounds. Do not leave damaged grounds at the station.

7.18 Switch Sticks

7.18.1 Inspect Switch Sticks and Grounding Sticks. Test Results are stored on Common Drive and maintained yearly.

a.) Test locally using approved methods, test equipment and competent, trained personnel.

7.18.2 Inspect Switch Sticks and Grounding Sticks for surface contamination, damage and proper operation.

a.) Clean if necessary

7.18.3 Insure Switching and Grounding Sticks are stored properly.

7.19 Fire Equipment

7.19.1 Inspect fire extinguishers to be properly secured and in their marked locations.

7.19.2 Update inspection cards.

7.19.3 Record out of date fire extinguishers on the V&O and record for future replacement.

7.19.4 Discharged fire extinguishers shall be reported to the appropriate supervisor for recharging.

7.19.5 Discharged or partially discharged fire extinguisher shall be removed from the substation.

7.20 Phone Lists

7.20.1 Verify local and System Operator phone numbers are posted and correct.

7.20.2 Verify that the emergency telephone list is posted and clearly visible at each telephone location.

7.21 Cleanliness and General Condition -

7.21.1 Clean control house floors and sanitary facilities, empty wastebaskets and dust as necessary.

7.21.2 Inspect control house for water leaks.

7.21.3 Check for signs of animal entry into control house.

7.22 Turn on yard lights, so they can be checked during the Yard Inspection.

8.0 Yard Inspection

8.1 Unusual Noises

8.1.1 Be alert for arcing, gurgling and pinging noises which could indicate imminent and violent equipment failure.

8.2 Walk the perimeter fence and inspect:

8.2.1 Fence height ≥ 7' (fabric + barbed wire)

8.2.2 Barbed wire - Strands to be intact and tight.

8.2.3 Fence fabric - Holes or breaks in the chain link.

8.2.4 Fence Ties - Loose or missing fence tie wires.

8.2.4 Fence Erosion - Signs of erosion or digging under the fence.

a.) Space below fence should be less than 2 inches.

8.2.6 Grounding - Ground conductor and connections secure and connected at every other fence post. Posts on both sides of gates should be grounded.

8.2.7 Fence Posts – Sound, not rusted through at ground level and not been raised by frost.

8.3 Entrance Gates

8.3.1 Test gates for proper operation.

a.) Gates should swing easily out of the way.

8.3.2 When closed, the gates should by chained tightly, or locked, with minimal space.

a.) Gap between gate, leafs & fence < 4".

b.) Gap between gate, leafs < 4".

c.) Gap between gate and ground < 4".

8.3.3 Verify locking chains, hardware and locks present and in good condition.

8.4 Check Substation signs: (Refer to LU-ENG-SUB003)

8.4.1 Safety sign on main entrance gate.

8.4.2 Sign w/ substation name/designation and emergency contact phone number on/near main entrance gate.

8.4.3 Safety signs are on all perimeter sides of substation with 50' max. separation between signs.

8.4.2 Signs are easily readable (not faded, damaged or inside of fence fabric).

8.5 Substation yard security problems shall be corrected or reported immediately to supervisor.

8.6 Vandalism related problems should be specifically recorded as such, and reported to supervisor. Break-ins should be reported to local police.

8.7 Yard Lights

8.7.1 Check all yard lights working. (Yard lights should have been turned on during control house inspection.)

8.7.2 Repair broken bulbs, glass fixtures, spot light heads, or other lighting that needs attention.

a.) If work cannot be completed safely and while maintaining safe work clearances or if special equipment such as a bucket truck is needed, note on the V&O report.

8.8 Vegetation/Climbing Aids

8.8.1 Check for any growth of trees or vegetation in fence and gate areas that animals or people could use to climb over the fence.

a.) Cut or record for the Arborist to have removed.

8.8.2 Record vegetation growth within the substation that requires spraying or removal

8.8.3 Check for stored material (either side of fence)

8.8.4 Check for new or added structures/buildings, neighbors, fences, walls, etc., any other encroachments

8.9 Bus and structure.

8.9.1 Record missing or damaged animal protection devices.

8.9.2 Inspect insulators for:

a.) Broken, chipped or damaged skirts.

b.) Carbon tracking or flash over.

c.) Surface contamination (dirt, rust, salt spray etc.).

d.) Broken or damaged insulators should be recorded on V&O Report.

8.9.3 Broken porcelain should be picked up off the ground.

8.9.4 Visually inspect current and voltage transformers for damage or signs of overheating.

8.9.5 Visually inspect arresters for:

a.) Blown or damaged arresters

b.) Surface contamination

8.9.6 Visually inspect potheads and cable terminators for:

a.) Damage and leaking compound.

b.) Surface contamination

8.9.7 Report unusual noises immediately and record them on the V&O Report.

8.10 Structure and apparatus ground connections

8.10.1 Inspect for any cut, broken or missing ground connections to apparatus, structures and guy wires.

8.10.2 Inspect static wires and record any problems.

8.10.3 Visually Inspect Station Service Transformers for:

a.) Evidence of oil leaks on transformer tank, and on the ground.

b.) Bushing damage or surface contamination.

c.) Damaged or improperly closed primary fuses.
d.) Output Voltage if not previously measured at station service transfer switch.

8.11 Inspect equipment and structure foundations.
8.11.1 Large cracks.
8.11.2 Settling (not level).
8.11.3 Deterioration (large areas of surface erosion, stone showing).

8.12 Inspect Cableways
8.13 Damage, missing or broken cover sections and deterioration.
8.14 Inspect buildings junction boxes, structures etc. for overall paint condition
a.) Record items needing attention.

8.15 Clean up substation yard.
8.15.1 Remove broken porcelain, debris, and trash
8.15.2 If area requires major clean up or crushed stone requires leveling, note on V&O Report.
8.15.3 If equipment or materials are intentionally stored in the yard insure that they are neatly placed and not a hazard to personal, barricade area if necessary.

9.0 Oil Leak Reporting

9.1 Oil filled apparatus must be inspected for any signs of leaks.
9.1.1 The oil leak status shall be recorded for each piece of oil filled apparatus in substation that appears on inspection checklist. A sample list of such equipment:

- Station Transformer
- Circuit Breakers and Circuit reclosers
- Regulators
- Capacitors
- Reactors

9.1.2 Leaks from small apparatus that do not appear on inspection checklist should be recorded in comments section.

9.2 Oil Leak Status Codes
9.2.1 Oil leaks are categorized as follows:
a.) Clean - Apparatus is dry and shows no evidence of oil leaks.
b.) Repaired – A leak is found and repaired, note the repairs made.
c.) Weep - Anytime the external surface of a piece of apparatus is wet with oil. Note the location and, if possible, cause of the leak.

f.) Leak - Oil is running off or about to run off the external surface of containers or electrical apparatus. Required Action immediately contact supervisor and environmental program manager.

9.3 Leaks categorized as Leak require immediate action to stop the leak or contain the released oil

9.4 Leaks from PCB Equipment

9.4.1 If a leak is discovered from equipment classified as over 500 ppm PCB cleanup must begin within 48 hours (40 CFR 761.30(a)(1)(x).

9.4.2 The inspection records must also include:

a.) The location of the leak;

b.) The estimate of fluid released;

c.) The date and description of any cleanup, containment, repair or replacement;

d.) The results of any containment (for example, was containment successful or not).

e.) The daily inspection results required for uncorrected, active leaks (refer to Environmental Procedure EP-14).

f.) The records must be available for inspection by the EPA and must be maintained for at least three years after disposal of the equipment.

9.5 Load Reading

9.5.1 Record any load reading that is requested by engineering on a monthly basis. This will be saved in the public folder so engineering can access the data.

10.0 Apparatus Inspections

Refer to the V&O Inspection sections of the following SMP's for apparatus inspections. Apparatus inspections are not required to be performed as part of the substation V&O inspection. Apparatus V&O inspections have their own inspection cycles.

10.1 Circuit Breaker Inspection

10.1.1 Perform visual inspection of equipment:

A) Checking bushing condition for cracks and chips.

B) Painted surfaces for rust.

C) Overall breaker condition (leaning).

D) Foundation for exposed rocks and cracks.

E) Proper ground connections.

10.1.2 Check Position Indicator for visibility, color and matching to breaker status.

10.1.3 Check Spring (if available) to be in the full charged position with matching indicator.

10.1.4 Record any Reclosing relays that are off and tagged and check with system operator for SCADA tags.

10.1.5 Record any ground relays that are off and tagged and check with System Operator for SCADA tags.

10.1.6 Inspect Mechanical (69) Trip toggle switch for correct position. Should be in the normal position unless in abnormal state.

10.1.7 Listen for abnormal humming or buzzing coming from the Breaker.

10.1.8 Inspect animal guards for good condition. Document any spots that are missing animal guards or need to be installed/replaced.

10.1.9 Check for breaker heater functionality. DO NOT TOUCH WITH BARE HANDS.

10.1.10 Record counter from relay control and update counter card with necessary information (targets and cause). Only update counter card when there is a change to the count number.

10.1.10 Record relay targets and reset.

10.1.11 Check indicator lights for open/closed status and replace bulb if needed.

10.1.12 Take voltage reading and perform a load test on the batteries through external or internal test when available. Loss of more than 3 Volts on load test is a Fail.

A) Record tests as PASS/FAIL on inspection sheet.

B) Failed battery load test should be replaced immediately.

10.1.13 Record breaker position as open or closed. Abnormal states should be reported to System operator or Supervisor.

10.1.14 Check and record oil level and document any leaks that are found. Refer to leak status 9.2.1 for leak categorization.

10.2 M.O.D and Switches

10.2.1 Inspect labeling for clear and correct labeling. Replace or add if safe to do so.

10.2.1 Check to make sure equipment is locked in the correct open or close state and the locks are in good working order.

10.2.2 Visually inspect all rods and linkage to insure they are attached and connected to the structure.

10.2.3 Ensure all switches are properly grounded and grounds have not frayed or detached.

10.2.4 Check motor cabinets heaters make sure they are functional if available.

10.2.5 Check indicator bulbs in motor cabinet or control house and replace if needed.

10.2.6 Record operation counter if available.

10.2.7 Check live line indication usually found inside control house when available. Replace bulb if needed.

10.2.8 Record the state of the switch (open/closed) and document if M.O.D is in abnormal configuration (Auto/Manual).

10.3 Transformer

10.3.1 Visually inspect bushing and arrestors for:

A) Cracks and chips.

B) Oil level if available.

C) Blown or disconnected arrestors.

10.3.2 Inspect tank grounds for any disconnected or missing copper.

10.3.3 Operate transformer fans or pumps and make sure each fan is operating correctly. Notify supervisor if fan does not operate.

10.3.4 Inspect transformer cabinet for:

A) Proper heater and thermostat function.

B) Cabinet vents are not blocked.

C) Annunciator is not in an alarming state. Report any alarms to System Operator and Supervisor.

10.3.5 Inspect pressure relief to make sure it has not blown or has broken off. If blown notify Supervisor immediately.

10.3.6 Listen for any abnormal buzzing or humming from the transformer.

10.3.7 Record nitrogen pressure + or – pressure is acceptable. 0 pressure may indicate a leak and should be addressed with nitrogen added into the system.

10.3.8 Record both the Max and instantaneous temperature of the top oil and the winding temperature where available. Reset drag hands with manually or with magnet.

10.3.9 Check and record oil level and document any leaks that are found. Refer to leak status 9.2.1 for leak categorization.

10.4 Voltage Regulators

10.4.1 Visually inspect bushing for cracks and chips.

10.4.2 Look for any missing or broken tank grounds.

10.4.3 Listen for any abnormal buzzing or humming from the regulator.

10.4.4 Inspect control box for any signs of rust, broken hinges or general damage.

10.4.5 Inspect arrestors for any signs of damage, cracks or porcelain. Record circuits and phases with porcelain arrestors for replacement.

10.4.6 Inspect animal guards for any damages and make note of any location that requires new or is missing an animal guard.

10.4.7 Record information from the regulator:

A) Voltage can be found navigating the control screen or by using a volt meter to read voltage on front of the control.

B) Operation counter can be found on control screen or directly on control

C) Record Low, Present, and High tap positions and reset drag hands.

D) Record oil level in sight glass if available.

E) Check if device is in auto or manual mode, if in manual call System Operator to make sure device is not supposed to be in abnormal condition.

F) Check if device is in internal or external power source. Should be set to internal for normal operations.

G) Check for oil color if available (Clear/Amber/Dark) and record any oil leaks.

10.5 <u>Batteries and Chargers</u>

10.5.1 Inspect each battery bank for a No smoking sign.

10.5.2 Check eyewash station for leakage and expired water.

10.5.3 Check vents are clear of debris and fan motors in working order.

10.5.4 Inspect flame arrestor caps for cracking or breaking. Record any damaged ones for replacement.

10.5.5 Inspect all external connects for signs of corrosion or heating.

10.5.6 Visually inspect battery cell internals for the following:

A) Plates buckling or warping.

B) Large buildup of sediment at bottom of cell.

C) Any acid leaking out of cells and falling into spill containment pads.

D) Proper liquid level in battery cells, if low fill with distilled water.

10.5.7 Inspect rack for good condition and proper grounding.

10.5.8 While charger is on record float voltage and load amp reading. If available check the positive and negative to ground indicator.

10.5.9 On pilot cell record the cell number with the cell voltage and cell temperature.

10.5.10 Turn off charger and record overall voltage.

10.6 <u>Capacitors</u>

10.6.1 If capacitor bank is controlled via Circuit Breaker please refer to 10.1 for inspection procedure.

10.6.2 Inspect capacitor bank for any bushing damage, all ground are properly connected and secure, and any animal guards are not missing. Note any spots that should have animal guards for future install.

10.6.3 Record the switch position (Open/Close).

10.6.4 Record counter from the switch position or control counter if available.

10.6.5 Record control operation if automatic or in manual. Call System operator if capacitor bank is in abnormal configuration.

10.6.6 If available check the controlling relay for accurate clock time and any alarms indicated. Record and report any alarms with the System Operator.

10.6.7 Visually inspect the capacitor bank for any bulging, oil leakage or blown fuses.

11.0 Final Checklist

11.1 Turnoff yard lights

11.2 Verify all abnormal conditions found are entered in station log book.

11.3 Call the System Operator and notify them that the V&O Inspection has been completed and you will be leaving the station.

a) Report any abnormal conditions, alarms or relay targets found.

11.4 Turn control house lights off, lock doors and check secure.

11.5 Re-arm security alarms.

11.6 Close and securely lock gate.

11.7 All V&O forms will be scanned to supervisor and saved on the common drive for review. (W:\ElectricOperations\Substation\SUBSTATION V&O INSPECTIONS)

12.0 Appendix A – Trouble Reporting

12.1 Trouble

12.1.1 The term trouble is defined as any condition which occurs on the equipment that has or could affect the ability of that equipment to perform its required function.

12.2 Severe Trouble

12.2.1 A severe trouble condition is a situation that is immediately hazardous to the system operation and/or personnel. These troubles are immediately reported to the System Operator and to the person in charge of the substation. The employee shall secure the area and warn unauthorized people to stay clear of the danger.

12.2.2 Examples of Severe Trouble

a) Dead station battery

b) Blown bushings or cable terminator

c) Downed live lines

d) Multiple broken support insulators

e) Electrical fires

f) Grounds cut in station

g) Loss of station service power

h) Broken pole or structure

i) Blown by pass/shunt arresters on regulators

j) Low oil levels

k) Unusual noises

12.3 Not Immediately Fixable Trouble

12.3.1 These troubles are reported to the System Operator and the person in charge of the substation. They shall also be noted on the V&O form and station logbook in red and scheduled for repair at a later date.

12.4 Examples of Not Immediately Fixable Trouble:

a) Surge Arrester blown

b) Broken operating rods on disconnects

c) Damaged bus support insulators

12.5 Fixable Trouble

12.5.1 Fixable items should be repaired as they are discovered during the V&O Inspection. This insures that the station is maintained in the best possible operating condition and prevents unnecessary return trips. The items fixed should be noted on the V&O Report and in the station logbook.

12.5.2 Examples of Fixable Trouble

a) Low Battery electrolyte

b) Replacing blown lamps

c) Installing missing covers

d) Installing signs

e) Installing new locks

f) Cleaning and repairing oil leaks

g) Changing recloser batteries

h) Replacing control fuses

I) Changing nitrogen bottles

j) Changing Silica Gel turned pink or white

13.0 Revision History

Date	Rev #	Description	Lead/Author
11/20/18	**1.1**	**Major update to include apparatus inspection and minor wording changes**	**Andrew Furtado**
04/01/2014	**1.0**	**Initial Version of document Update from National Grid document to be NH Specific**	**Robert J Johnson**

INTRODUCTION

This procedure describes the methods used to perform Visual and Operational, Thermographic, Mechanism, Diagnostic, and Acceptance Testing on all Circuits Breakers used in electrical substations.

PURPOSE

Scheduled equipment testing and inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used, to inspect and test Circuit Breakers.

ACCOUNTABILITY

Substation and Qualified Managers supervising inspection and maintenance activities

Substation and Qualified Workers performing inspection and maintenance activities

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures

LU SMP 499.10.2 Substation Work Area Identification Procedure

LU SMP 400.06.2 V&O Inspection Procedure

LU SMP 400.07.1 Thermographic Inspection

Substation Breaker/Recloser Testing Guidance Document

ANSI/NETA (MTS) Maintenance Testing Specifications 2019

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected and maintained.

Manufacturer's operating manuals for the specific test equipment to be used.

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procedures (such as pole top/bucket rescue). Qualified workers shall be trained and competent in:

- Skills and Techniques necessary to distinguish exposed live parts
- Determining nominal voltage of exposed live parts
- Knowledge of minimum approach distances
- Proper use of precautionary techniques, use of PPE including insulating and shielding materials and properly rated insulated tools for working on or near energized parts of electrical equipment

69 Switch- Switch turned off by operating the mechanical trip mechanism. This switch is in the closing circuit and prevents the breaker from being closed until it is reset.

Contact Erosion- During vacuum circuit breaker operation small amounts of metal are vaporized off of the contacts. A mark or measurement on the operating rod indicates when the erosion is sufficient to require the contacts (new vacuum bottle) to be changed.

PROCEDURE CONTENTS

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1.0 Test Equipment Required

1.1 V&O Inspection

1.1.1 Digital Multi-meter, ANSI Class IV

1.1.2 Spare battery for PTR and Relay

1.2 Major Maintenance

1.2.1 All of the above

1.2.2 Megger Megohmmeter

1.2.3 Contact Tester Microhmmeter

1.2.4 DC Hi-Pot Tester (Vacuum Bottle Only)

1.2.5 TTR

1.2.6 Micrometer

1.3 Acceptance Testing

1.3.1 All of the above

2.0 Materials Required

2.1 V&O Inspection

2.1.1 Inspection forms or software for digital forms

2.2 Major Maintenance

2.2.1 Substation computer with test equipment software

2.2.2 Report coversheet with nameplate data

2.2.3 PDF software for combining test reports

3.0 Unusual Hazards

All work should be performed by a qualified worker trained on substation safety and knowledgeable about all potential hazard and familiar with testing and maintenance procedures. Refer to LU-SMP 499.10.2 Substation Work Area Identification Procedure for identifying and setting testing area.

3.1 Electrical

Care should be taken when handling and operating on or inside Circuit Breakers. Units should be tested and grounded before any work starts. In-service units will have either 120v or 208v operating inside the controls and wiring. Make sure the manufacturer manual is referenced and voltage testing is made during any testing or troubleshooting.

Bench testing or acceptance testing units will have to have control power voltage backfeed to it. Be sure to wear all proper P.P.E. when handling and operating.

3.2 Mechanical

Circuit Breakers have many mechanical moving parts that can cause injury when not handled safely. Always make sure everyone is clear of all moving parts before operating. If the Circuit Breaker is equipped with a closing spring make sure the spring is de-energized before any work is started. This can be accomplished by removing control power and operating the breaker manually until the spring is completely de-energized.

4.0 Visual and Operational Inspection

4.1 Please refer to SMP 400.06.02 for all steps regarding V&O Inspection

5.0 Major Maintenance

5.1 Insulation testing

5.1.1 Using the Megohmmeter to test bushing, with the recloser in the open position to test bushing – ground and bushing – bushing (same phase). Document all test results using Liberty Utilities approved forms.

5.1.2 Test Lightning Arrestors for insulation breakdown.

5.2 Contact Testing

5.2.1 Use Microhmmeter for contact testing on each phase. Check the manufacturer's manual for specific tolerances if not available vacuum bottle results should be with 10% of each phase. Check for any significant contact erosion. Document all test results using Liberty Utilities approved forms.

5.3 Mechanical Check

5.3.1 Check all moving parts and lubricate as recommended by manufacturer

5.3.2 Operate the CB manually using the manual controls and 69 trip control.

5.3.3 Fully discharge the closing spring and manually charge.

5.3.4 Measure Contact wipe or contact wear as applicable. Use a caliper to check contact movement compared to recommended manufacturer standards. This is to inspect for any contact erosion.

5.3.5 Any distribution Breakers taken out of service should have stainless hardware replaced where needed as well as any tap connections cleaned and re-greased. Check with equipment manufacturer's manual for proper grease and lubrication recommendations.

5.4 TTR

5.4.1 Using TTR test the CTs if available at the current tap settings.

Document all test results using Liberty Utilities approved inspection forms.

6.0 Reporting

6.1 All testing should be reported and documented using Liberty Utilities approved inspection forms for Circuit Breakers.

6.2 All reports should be given to the Supervisor in a timely manner for review and recordkeeping. All reports should be saved in the proper testing folder on the (W) Drive.

7.0 Acceptance Testing

7.1 All above test should be completed for acceptance testing. This should be done to insure equipment is in good working condition after delivery from manufacturer. Any defects or issues should be brought to the attention of the Supervisor for immediate action.

7.2 DC Hipot testing

7.2.1 Check with manufacturer's manual before running test. When running this test it is considered a Go, No-go test. Only use for vacuum bottles when applicable.

8.0 Testing Schedule

8.1 To maintain proper working and functional equipment Liberty Utility has decided that all major maintenance should be performed on a 4 year cycle until such times where that needs to be changed.

8.2 If a miss operation under a fault condition occurred, basic testing should be performed on the breaker. This would include an insulation and contact test, and a control relay test.

Date	Rev #	Description	Lead/Author
4/01/2020	1.0	Creation of document for Liberty Utility System	Andrew Furtado

INTRODUCTION

This procedure describes the methods used to perform Visual and Operational, Thermographic, Mechanism, Diagnostic, and Acceptance Testing on Distribution Line Reclosers (Pole Top Reclosers).

PURPOSE

Equipment inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used, to inspect Distribution Line Reclosers (PTR).

ACCOUNTABILITY

Substation and other Managers supervising inspection and maintenance activities.

Substation and Qualified Workers performing inspection and maintenance activities.

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures

Liberty Utilities Overhead Construction Standards – Section 12 Protection

LU EOP D011 Inspection/Maintenance and Installation of Distribution Line Reclosers

LU SMP 499.10.2 Substation Work Area Identification Procedure

LU SMP 400.06.2 V&O Inspection Procedure

Substation Viper S – Specific Testing Guidance - Checklist

ANSI/NETA (MTS) Maintenance Testing Specifications 2019

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected and maintained.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Inspect-	An assessment of Liberty Utilities facilities for the purpose of determining the condition of the facility and any associated components.
System Operator-	An authorized person, who directs, controls, monitors, and operates the electric system and its associated apparatus.
Qualified Person-	A person knowledgeable in the construction and operation of electric power generation, transmission, substation, and/or distribution apparatus involved along with the associated hazards in specific duties pertaining to electric operations.
Qualified Worker-	Workers shall be trained in and familiar with the safety related work practices, safety procedures and other safety requirements that pertain to their respective job assignments. Workers shall also be trained in and

familiar with any other safety practices, including applicable emergency procedures (such as pole top/bucket rescue). Qualified workers shall be trained and competent in:

- Skills and Techniques necessary to distinguish exposed live parts
- Determining nominal voltage of exposed live parts
- Knowledge of minimum approach distances
- Proper use of precautionary techniques, use of PPE including insulating and shielding materials and properly rated insulated tools for working on or near energized parts of electrical equipment

69 Switch- Switch turned off by operating the mechanical trip mechanism. This switch is in the closing circuit and prevents the breaker from being closed until it is reset. On a distribution line recloser it is a yellow trip handle. To reset handle must be placed back to the normal position.

Contact Erosion- During vacuum circuit breaker operation small amounts of metal are vaporized off of the contacts. A mark or measurement on the operating rod indicates when the erosion is sufficient to require the contacts (new vacuum bottle) to be changed.

PROCEDURE CONTENTS

Table of Contents

1.0 Test Equipment Required

1.1 V&O Inspection

1.1.1 Digital Multi-meter, ANSI Class IV

1.1.2 Spare battery for PTR and Relay

1.2 Major Maintenance

1.2.1 All of the above

1.2.2 Megger Megohmmeter

1.2.3 Contact Tester Microhmmeter

1.2.4 DC Hi-Pot Tester (Vacuum Bottle Only)

1.2.5 TTR

1.2.6 Micrometer

1.3 Acceptance Testing

1.3.1 All of the above

2.0 Materials Required

2.1 V&O Inspection

2.1.1 Inspection forms or software for digital forms

2.2 Major Maintenance

2.2.1 Substation computer with test equipment software

2.2.2 Report coversheet with nameplate data

2.2.3 PDF software for combining test reports

3.0 Unusual Hazards

All work should be performed by a qualified worker trained on substation safety and knowledgeable about all potential hazard and familiar with testing and maintenance procedures. Refer to LU-SMP 499.10.2 Substation Work Area Identification Procedure Section 5.0 Temporary Testing Area prior to identifying and setting up testing area.

3.1 Electrical

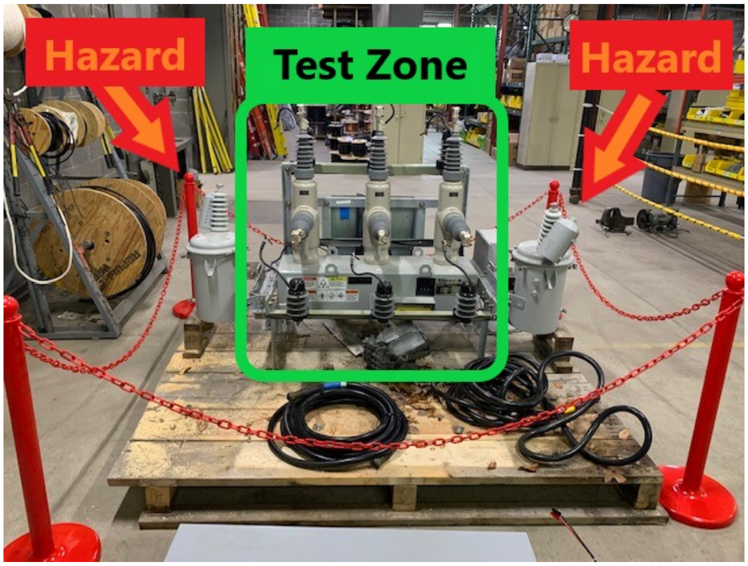
Care should be taken when handling and operating on or inside Distribution Line Reclosers. Units should be tested and grounded before any work starts. In-service units will have either 120v or 208v operating inside the controls and wiring. Make sure the manufacturer manual is referenced and voltage testing is made during any testing or troubleshooting. Bench testing or acceptance testing units will have to have control power voltage backfeed to it. Be sure to wear all proper P.P.E. when handling and operating test equipment and Distribution Line Recloser (PTR).

3.2 Mechanical

Distribution Line Reclosers have many mechanical moving parts that can cause injury when not handled safely. Always make sure everyone is clear of all moving parts before operating. If PTR is equipped with a closing spring make sure the spring is de-energized before any work is started. This can be accomplished by removing control power and operating the breaker manually until the spring is completely de-energized.

3.3 G&W Viper S w/PTs (Item ID 8830-9201974 or 9201971)

Refer to Liberty Utilities Overhead Construction Standards Section 12 – Protection Page numbers 12-338, 12-339, & 12-340 and G&W Installation, Operation, and Maintenance Instructions for Viper-S Solid Dielectric Recloser - GWI 531-I supplied with unit.



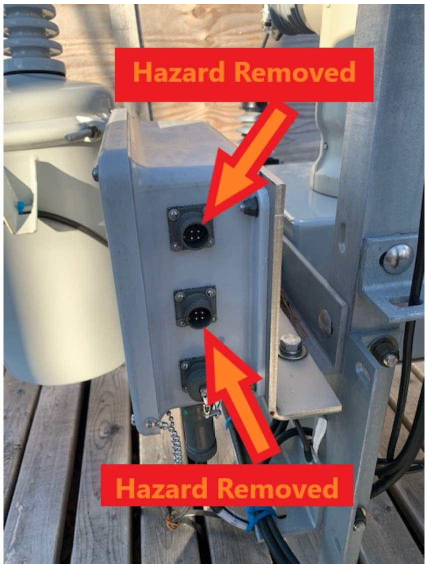
1- Identify all potential hazards in work area. Looking outside the equipment being worked on (as seen in figure above).

2- Review equipment manual for all hazards. All new equipment or equipment that workers are unfamiliar with should involve a safety stop to review its operations.

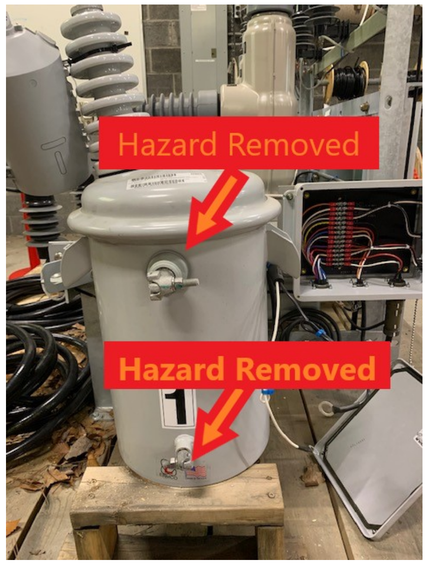
3- Review wiring diagram to determine what is going to be energized at the time of testing

4- Remove secondary connectors off of the junction box going to each transformer, should have the same look as pictured below.

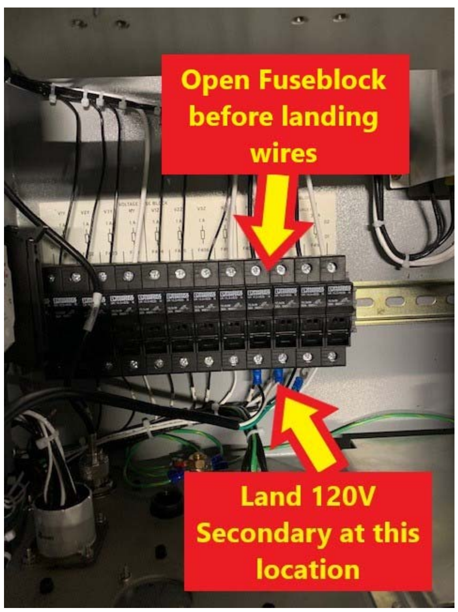
5- Disconnect the secondary connection on the Transformers they are located on the picture below. (This will create a visual air gap that will prevent any potential back feed when the control is energized).



See Note 4



See Note 5



6- Connect 120VAC power at terminal block and open fuseblocks as shown above

7- Begin test set up with safe work practices

3.4 G&W Viper S (Item ID 8830-9201979)

Refer to Liberty Utilities Overhead Construction Standards Section 12 – Protection Page numbers 12-338, 12-339, & 12-340 and G&W Installation, Operation, and Maintenance Instructions for Viper-S Solid Dielectric Recloser GWI - 531-I supplied with unit.

3.5 G&W Viper ST (Item ID 8830-9201982)

Refer to Liberty Utilities Overhead Construction Standards Section 12 – Protection Page numbers 12-341 & 12-342 and G&W Installation, Operation, and Maintenance Instructions for Viper-ST Solid Dielectric Recloser - GWI 531-8 supplied with unit.

4.0 Visual and Operational Inspection

4.1 Please refer to SMP 400.06.02 for all steps regarding V&O Inspection

5.0 Major Maintenance

5.1 Insulation testing

5.1.1 Using the Megohmmeter, with the recloser in the open position to test bushing – ground and bushing – bushing (same phase). Document all test results using Liberty Utilities approved forms.

5.1.2 Test Lightning Arrestors for insulation breakdown.

5.2 Contact Testing

5.2.1 Use Microhmmeter for contact testing on each phase. Check the manufacturer's manual for specific tolerances if not available vacuum bottle results should be with 10% of each phase. Check for any significant contact erosion. Document all test results using Liberty Utilities approved forms.

5.3 Mechanical Check

5.3.1 Check all moving parts and lubricate as recommended by manufacturer

5.3.2 Operate the PTR manually using the manual controls and 69 trip control.

5.3.3 Fully Discharge the closing spring and manually charge.

5.3.4 Measure Contact wipe or contact wear as applicable. Use a caliper to check contact movement compared to manufacturer standards. This is to inspect for any contact erosion.

5.3.5 All in-service distribution line reclosers should have stainless steel hardware replaced where needed as well as any tap connections cleaned and re-greased. Check with equipment manual for proper grease and lubrication recommendations.

5.4 TTR

5.4.1 Using TTR test the CTs if available at the current tap settings.
Document all test results using Liberty Utilities approved inspection forms.

6.0 Reporting

6.1 All testing should be reported and documented using Liberty Utilities approved inspection forms for Distribution Line Reclosers.

6.2 All reports should be given to the Supervisor in a timely manner for review and recordkeeping. All reports should be saved in the proper testing folder on the (W) Drive.

7.0 Acceptance Testing

7.1 All above test should be completed for acceptance testing. This should be done to insure equipment is in good working condition after delivery from manufacturer. Any defects or issues should be brought to the attention of the Supervisor for immediate action.

7.2 DC Hipot testing

7.2.1 Check with Manufacturer manual before running test. When running this test is it considered a Go, No-go test. Only use for vacuum bottles when applicable.

8.0 Testing Schedule

8.1 Pre-Installation, scheduled prior to putting unit into service.

8.2 To maintain proper working and functional equipment Liberty Utility has decided that all major maintenance should be performed on a 20 year cycle until such times where that needs to be changed.

8.3 If a miss operation under a fault condition occurred, basic testing should be performed on the breaker. This would include an insulation and contact test, and a control relay test. The distribution line recloser would need to be removed from service by the electric line department.

Date	Rev #	Description	Lead/Author
4/01/2020	1.0	Creation of document for Liberty Utilities System	Andrew Furtado

INTRODUCTION

This procedure describes the methods used to perform Visual and Operational, DGA and TCG, In Service, Diagnostic, Acceptance, Thermographic, and other inspections on large, power transformers used in electrical substations.

PURPOSE

Scheduled equipment inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used to inspect large power transformers.

ACCOUNTABILITY

Substation and other Managers supervising inspection and maintenance activities

Substation and Qualified Workers performing inspection and maintenance activities

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures

LU SMP 499.10.2 Substation Work Area Identification Procedure

LU SMP 400.06.2 V&O Inspection Procedure

LU SMP 400.07.1 Thermographic Inspection

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

DGA-	Dissolved Gas Analysis – Analysis of the gases in insulating oil. Used for early detection of transformer problems and after suspected internal faults. DGA tests can detect overheating, corona and arcing, seal failure and water.
Leakage Reactance-	Electrical test to determine winding distortion in transformers.
LTC-	Load Tap Changer – Tap changer capable of operation while the transformer is energized and under load. Operates automatically to compensate for changes in source voltage and load current to maintain constant voltage to customers.
DETC-	De-energized (No Load) Tap Changer – Tap changer that is only operated while the transformer is de-energized. Set at installation and rarely changed.
Oil Screen Test-	Laboratory test of transformer oil, usually a quart sample, for low dielectric, particles, contaminants, inhibiter, degradation, acids, PCB's and water.

Silica Gel-	Crystalline material capable of absorbing moisture. Used in free breathing transformers and tap changers to remove moisture from the air entering the oil space.
Surge Arrestor	Lightning arrester. Used to protect transformers and other equipment from high voltage transients caused by lightning and system disturbances.

PROCEDURE CONTENTS

Table of Contents

1.0 Test Equipment Required

1.1 V&O Inspection

1.1.1 Digital Multi-meter, ANSI Class IV

1.1.2 Spare battery for PTR and Relay

1.2 Major Maintenance

1.2.1 All of the above

1.2.2 Megger Megohmmeter

1.2.3 TTR

1.2.4 Omicron Testrano 600

1.2.5 Nitrogen Gas Bottle

1.2.6 Oil Dielectric Test Set

1.3 Acceptance Testing

1.3.1 All of the above

2.0 Materials Required

2.1 V&O Inspection

2.1.1 Inspection forms or software for digital forms

2.2 Major Maintenance

2.2.1 Substation computer with test equipment software

2.2.2 Report coversheet with nameplate data

2.2.3 PDF software for combining test reports

3.0 Unusual Hazards

All work should be performed by a qualified worker trained on substation safety and knowledgeable about all potential hazard and familiar with testing and maintenance procedures. Refer to LU-SMP 499.10.2 Substation Work Area Identification Procedure for identifying and setting testing area.

3.1 Fall Arrest Protection

3.1.1 Employees should be tied off on to ladder or using structure fall arrest device to avoid and prevent any accidental falls.

4.0 Visual and Operational Inspection

4.1 Please refer to SMP 400.06.02 for all steps regarding V&O Inspection

5.0 Major Maintenance

5.1 Insulation testing

5.1.1 Perform Insulation-resistance tests, winding to winding and each winding to ground. Apply Voltage in accordance with manufacturer's published data. Record and Save polarization index readings. Save all test results to test software.

5.1.2 If Core ground strap is available remove and measure

5.1.3 Test Lightning Arrestors for insulation breakdown.

5.2 TTR

5.2.1 Perform TTR test at the designated tap position.

5.2.1.1 On DETC test only the tap position that has been in service. On newer units test all tap positions.

5.2.1.2 On LTC test all tap positions running the equipment through both the raised and lower positions.

5.3 Omicron Testrano 600

5.3.1 Perform power factor test on all windings in accordance with test equipment manufacturer's data.

5.3.2 Perform excitation-current tests in accordance with the test equipment manufacturer's data.

5.3.3 Perform DC winding resistance test last

6.0 Trouble Work

6.1 When there is a fault on a station transformer and there is a known fault through the transformer the following steps should be taken at a minimum

6.2 Insulation testing

This is used to test the overall insulation of the transformer to make sure there has been no breakdowns of the oil or a short somewhere inside the transformer.

6.2.1 Perform Insulation-resistance tests, winding to winding and each winding to ground. Apply Voltage in accordance with manufacturer's published data. Record and Save polarization index readings. Save all test results to test software.

6.2.2 If Core ground strap is available remove and measure.

6.3 Transformer Turns Ratio

This should be performed on every transformer to ensure there is no damage to the windings through fault current which could cause the winding or the core to move and shift.

6.3.1 Perform TTR test at the designated tap position.

6.3.1.1 On DETC test only the tap position that has been in service. On newer units test all tap positions.

6.3.1.2 On LTC test all tap positions running the equipment through both the raised and lower positions.

6.3.2 Oil Sampling

A DGA sample should be pulled when there is a fault involving a transformer. This should be pulled and sent out as an 'urgent' test.

7.0 Reporting

7.1 All testing should be reported and captured on test device software or on Transformer testing report.

7.2 All reports should be given to the Supervisor in a timely manner for review and recordkeeping. All reports should be saved in the proper testing folder on the (W) Drive.

8.0 Acceptance Testing

8.1 All above test should be completed for acceptance testing. This should be done to insure equipment is in good working condition after delivery from manufacturer. Any defects or issues should be brought to the attention of the Supervisor for immediate action.

9.0 Testing Schedule

9.1 To maintain proper working and functional equipment Liberty Utility has decided that major maintenance should be performed on a cyclical basis until such times where that needs to be changed.

Date	Rev #	Description	Lead/Author
7/31/2020	1.0	Creation of document for Liberty Utility Uses	Andrew Furtado

INTRODUCTION

This procedure describes the methods used to handle insulating oil, in compliance with environmental regulations, during the installation, maintenance, and removal, of substation apparatus.

PURPOSE

Substation activities frequently involve the addition, removal and temporary storage of mineral oil dielectric fluid (MODF), or other insulating oils. Oil spills are both damaging to the environment and costly and reflect negatively to the company.

This procedure lists the equipment required, unusual hazards, and methods used, to add, remove and temporarily store insulating oil used in electrical substation apparatus.

Oil handling shall be conducted and/or supervised by personnel, who are familiar with the operation and maintenance of the electrical apparatus, the substation's SPCC Plan, Liberty Utilities Environmental Procedures and Hazard Communication Program.

ACCOUNTABILITY

1. Standards, Policies, and Codes
   A. Update procedure as necessary.
   B. Provide appropriate guidance to field personnel when requested for a specific work related task.
2. Electric Distribution Operations
   A. Ensure that the procedures in this SMP are implemented.
   B. Ensure that all personnel are trained in this procedure.
   C. Provide feedback regarding effectiveness of the procedure and revision input as necessary.
3. Liberty Utilities Employees and Contractors
   A. Demonstrate an understanding of the procedure in this SMP.
   B. Comply with the requirements of the procedures in this SMP.
   C. It is the workers responsibility to read and fully understand and follow the manufacturer's instruction manual and specifications before operating any equipment.
4. Liberty Utilities Environmental
   A. Provide feedback regarding effectiveness of the procedure and revision input as necessary.
   B. Approval of any changes to this procedure.

COORDINATION

Transportation department for moving skid mounted tanks and tanker trailers.

Environmental department for site cleanup and equipment removal disposal procedures.

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures

Federal Motor Carrier Safety Regulations

Environmental Procedure No. 1, Waste Management

Environmental Procedure No. 5, Release Response

Environmental Procedure No. 14, Electrical Equipment Management

Environmental Procedure No. 15, Reporting of Environmental Incidents

Environmental Guidance Documents for the Specific State

SPCC Plan for the Substation

Liberty Utilities Hazard Communication Program

Manufacturer's Installation, Operating, and Maintenance manuals for the specific apparatus

Manufacturer's operating manuals for the specific equipment to be used.

DEFINITIONS

MODF -	Mineral Oil Dielectric fluid, insulating oil.
No-PCB -	Oil with no detectable concentration of PCB's.
Non-PCB -	Oil that has a PCB level below 50 ppm.
PCB contaminated -	Oil that has a PCB level 50 ppm to below 500 ppm.
PCB -	Oil that has a PCB level 500 ppm or greater.
PCB Fluid -	Oil with a PCB level 50 ppm or greater is defined in EP-1 as a PCB Fluid. This term is used to refer to any PCB contaminated oil in this document.
PCB -	Polychlorinated Biphenyl oils (Askeral etc.) and oils containing polychlorinated biphenyl. PCB's are hazardous to human health and the environment.

TRAINING

Workers who have not been trained in or performed oil handling procedures in the preceding year shall not perform the below tasks unless on site training is done.

Initial training for this activity is normally accomplished through:

Attending Training Course on Oil Handling In Substations

Performing equivalent On-The-Job Training.

PROCEDURE CONTENTS

Table of Contents

1. **Test Equipment Required.**
   1.1 Digital Multi-meter, IEC 1010-1 Cat. IV
      1) Spare batteries for multi-meter

2. **Special Tools Required.**
   2.1 Barrel bung wrench

3. **Materials Required.**
   3.1 Clor-N-Oil 50 Test Kit.
   3.2 Plastic trash bags for oily debris.
   3.3 55 gallon drums for used oil filters and/or oily debris.
   3.4 Spill control kit. Verify at substation and complete. (Andax Barrel Pac)
   3.5 Oil absorbent pads. Item no. 8830-5482700.

4. **Special Safety Equipment Required.**
   4.1 If PCB contaminated or PCB oil is being handled.
      1) Nitrile Gloves.
      2) Tyvek Suit
      3) Over boots
      4) Duct Tape.

5. Unusual Hazards

PCB contaminated and PCB oil is considered to be a suspected human carcinogen, and may also cause allergic reactions if in contact with skin.

Oil that has been exposed to arcing may produce vapors that are above the explosive level. If these vapors are exposed to static discharge or other ignition source an explosion may occur.

Flowing insulating oil is capable of generating static charges which may cause sparks and result in fires or explosions. All substation equipment being worked on and all pumps, tanks, drums and other oil handling equipment must be grounded to station ground. If oil is being handled in locations other than substations all equipment should be bonded together and connected to system or earth ground. All oil handling hoses must contain a grounding wire, and any pickup or discharge pipes used must be metal. Splashing oil will also create static charges. The ends of discharge pipes and hoses should below the oil level in tankers and drums.

Caution should be used on and around equipment where oil may have spilled. All oil spills must be reported immediately. Spilled oil or oily surfaces shall be cleaned as soon as possible. When working on top of apparatus, the surface shall be kept clean at all times to reduce the potential for slipping hazard.

Caution should be used to maintain clearance to energized equipment when working on top of oil tankers in substation yards. Portable tanks or tankers should be located in a manner which minimizes exposure to electrical and other hazards.

6. Apparatus to be Removed from Service and Junked

6.1 Prior to removal of oil:

1) Contact the local Environmental Engineer for assistance with disposal procedures, facilities, and site cleanup and inspection.
2) Review Environmental Procedure No. 14, Power Equipment Recycling and MODF Disposal (EP-14).

7. PCB and PCB Contaminated Oil

7.1 Handling of PCB and PCB contaminated oil shall be in accordance with this procedure and the requirements of Environmental Procedure No. 1, Waste Management (EP-1).

7.2 In addition to the normally required personal safety equipment the items listed in section 4, Special Safety Equipment, shall be worn.

8. Oil Spills

8.1 Required notifications

1) Requirements vary by state.
2) All spills to water require regulatory notification.
3) Some states require notification of spills of any size.
4) If you are not absolutely certain of the applicable requirements contact your Supervisor and Environmental Engineer.

8.2 Containment

1) If oil is inadvertently spilled the first priority is to contain the spill to minimize environmental damage.

8.3 Cleanup
1) Once the spill is contained cleanup should be started.
2) Your Supervisor District Environmental Engineer should be immediately notified of all spills to ensure the cleanup meets company and regulatory standards.

9. Oil Sampling

9.1 Care shall be taken to assure that oil is not released into the surrounding environment.
9.2 Appropriate spill control shall be used. This can be accomplished with absorbent pads, plastic drop cloths, drip pans or pails.
9.3 Used oil and oily debris.
1) Used oil shall be placed in closed containers.
2) Oily debris shall be placed in plastic bags or drums.
3) In New Hampshire used oil and oily debris shall be returned to a facility that has an EPA ID number.
a) Exception locations with an EPA ID number.
9.4 Threaded pipe plugs shall be reinstalled using Teflon tape. Steel and galvanized pugs should be replaced with brass plugs.
9.5 Valves and pipe plugs shall be inspected to verify they are sealed and leak free.
9.6 Apparatus that was sampled shall be completely inspected for leaks.
1) If leaks are found they should be repaired, if possible. Leaks that can not be immediately repaired should be contained with absorbent pads or other appropriate measures.
2) Notify your Supervisor of any leaks that were repaired or need repair.
9.7 The apparatus and work area shall be left clean and free of oil stains.

10. Transportation of Oil and Oily Debris

10.1 General
1) Drums used to transport oil shall be DOT and company approved, in good condition, and has permanent closed tops with two top bungs, and no side bung.
a) No rusted (except incidental rust), damaged or leaking drums shall be used.
2) Loads shall be properly secured in accordance with company and DOT requirements.
a) Load securement requirements apply to both enclosed and open bed vehicles.
10.2 All PCB (over 500 ppm) and PCB contaminated (over 50ppm) oil.
1) Refer to Environmental Guidance document EG-103 for shipping paper and placard requirements.
2) Notify the Environmental Engineer before transporting more that 10 gallons of PCB or PCB contaminated oil.
10.3 Small tank trailers (tow behind) shall not be used to transport oil over the road.
10.4 Sight glass isolation valves should be closed on tanker trailers, if present.
10.5 Double walled tanker trailers should be used to transport bulk oil whenever possible.

10.6 New Oil

1) New oil is not considered a hazardous material.

10.7 Oil to be processed and reused

1) Oil to be processed and reused is not considered a hazardous material.

10.8 Waste oil for disposal.

1) Waste oil for disposal is considered a hazardous waste in New Hampshire.
   a) Exception - waste oil that will be burned for energy recovery is not regulated as a hazardous waste in New Hampshire.
   b) Waste oil for disposal is not regulated as a hazardous waste in New York.

10.9 Oily Debris

1) Oily debris is considered hazardous waste in New England, with the exception that spill cleanup debris is not regulated as a hazardous waste in New Hampshire.
2) Oily debris that is not dripping wet may be placed in properly tied plastic bags.
3) Oily debris that is dripping wet shall be placed in open top drums with properly gasketed covers.

11. Temporary Storage of Oil

11.1 General

1) During maintenance and construction activities, non-PCB and no-PCB oil may be transferred and/or stored at a substation.
2) Double walled tanker trailers should be used for large quantities of oil whenever possible.
   a) Double walled tanker delivery should be requested for new oil or oil delivered by vendors of new transformers.
3) Temporary oil storage shall comply with this procedure and the substation's SPCC Plan.
   a) If the storage location does not have a SPCC plan contact the Environmental Department to determine containment requirements and if a SPCC plan will be required.
4) Portable oil containers as used in this section, includes barrels, bladders, tanks, tank trucks, tanker trailers, and small (tow behind) tank trailers etc.
5) Portable oil containers, containing oil, shall only be stored temporarily at a substation.
   a) Storage shall only be for short periods of time during maintenance activities
6) Portable oil containers shall be placed within the substation yard, if possible.
   a) Portable oil containers, containing oil, are not to be left unattended outside of the substation yard.
7) Portable oil containers shall be located on firm level ground.
8) Portable oil containers shall be located in a manner that insures safe working clearances to live parts.
   a) Containers that require the use of ladders or “work on top” require particular care.
9) Portable oil storage tanks shall be inspected to be clean, moisture free, and in good condition prior to use.
10) Portable containers shall be grounded to the substation ground gird while oil is being processed or transferred. Fiberglass tanks shall have their skids or chassis grounded.

a) While containing oil, portable storage containers (barrels, bladders, and portable tanks) and tanker trailers shall have means of secondary spill containment unless they are being used as part of a continuous process.

b) Double walled tanker trailers satisfy the requirement for secondary containment.

c) General containment is the minimum required for portable storage containers being used as part of a continuous process. General containment requirements are usually met by the presence of trap rock at a substation. Sized secondary containment (usually 110%) is required on impervious surfaces.

d) A continuous process is the uninterrupted process of filling or removing oil from electrical apparatus.

   Work must be in process 24 hours a day to be considered a continuous process. Normal, short work breaks, lunch etc., are allowed.

   If the apparatus will be returned to service the process normally starts when hoses are set up for oil removal and ends when oil hoses are removed after oil filling.

   If the apparatus is being drained he process normally starts when hoses are set up for oil removal and ends when oil hoses are removed after oil removal.

   When vacuum filling power transformers the process starts when starting to pull vacuum and ends when the transformer is at its normal oil level.

   If the portable storage container or tanker trailer contains more than residual oil it must be removed the same day the process ends or secondary containment will be required. Residual oil is that oil that remains after normal procedures are used to empty the container or trailer.

   Oil brought to the site before the day an oil filling or removal process starts requires secondary containment.

e) Such containment should be in accordance with SPCC Plan requirements, if applicable.

f) If the Substation's containment structures (berms, trenches, or pits) can not be used, then other temporary means of containment, such as, containment boom, portable berms, or over pack drums must be used.

g) When sized secondary containment is required it must be sufficient to contain the entire capacity of the largest single container. The secondary containment must be impervious and sized sufficiently to account for precipitation (usually 110%). This requirement is usually met with portable, drive-on spill containment specifically designed for tanker trailers. Heavy plastic and hay bales or other suitable berms may also be used.

h) If tankers or containers are empty, or only contain residual oil, they are in a transportation function and not subject to SPCC. Contact the Environmental Department to determine the containment requirements.

11) When not actively transferring oil, portable oil containers shall have all bungs, covers and valves properly gasketed, closed. Valves shall be properly plugged.

12) Storage of oil which is not going to be reused must always be managed as a hazardous waste as follows:
    a) In New Hampshire - Only if the oil will not be recycled by burning for energy recovery.
    b) Management as a hazardous waste may require additional requirements for labeling, inspections and containment. Consult with the Environmental Department.

11.2 Portable (skid mounted) fiberglass or metal tanks.

1) Portable storage tanks are used to transfer medium quantities of oil within substations. Typical sizes are 500 to 1200 gallons.

11.3 Portable bladder and pillow type containers.

1) Portable bladder and pillow type containers are used to transfer oil within substations. Sizes range from 100 to tens of thousands of gallons.
2) Portable bladder and pillow type containers should only be used for short term storage and processing of oil.
3) Inspections - Monthly leak inspections are required for bladder and pillow type containers containing oil when left at a substation. Refer to Appendix C. Tank/Tanker Inspection and Form

11.4 Tank trucks and tanker trailers (tractor trailer).

1) Tank trucks and tanker trailers are used to transfer large quantities of oil within substations and to transport oil over the road. Typical sizes are 5000 to 7500 gallons.
2) Trucks or trailers containing oil shall be parked where they are not likely to be backed into or hit by other vehicles. A light hit may collapse landing gear on loaded tanker trailers.
3) Wheels on trucks or trailers containing oil shall always be chocked when parked.
4) In addition to the tank compartment inspection, all accessories and attached equipment shall be inspected to be in good working order.
5) Tanker trailers landing gear.
    a) Landing gear on tanker trailers may not be rated to support full load. Additional support may be required. The Transportation Department or trailer vendor can verify the ratings of the landing gear and advice on additional support procedures.
    b) Landing gear pads shall be placed on cribbing or steel plates to ensure there is adequate weight distribution.
    c) The rear compartment of a tanker trailers must be loaded first and emptied last. Tanker trailers may “nose dive” if loaded improperly.
6) Inspections - Monthly leak inspections are required for tankers containing oil when left at a substation. Refer to Appendix C. Tank/Tanker Inspection and Form.

11.5 Small tank trailers (tow behind).

1) Small tank trailers are used transfer medium quantities of oil within substations. Typical sizes are 300 to 800 gallons.
2) Wheels on trailers containing oil shall always be chocked when parked.
3) Tongue supports shall be placed on cribbing or steel plates.

11.6 Drums and Barrels

1) Drums used to store oil shall be DOT and company approved, steel construction, in good condition, and have permanent closed tops with two top bungs, and no side bung.
   a) No rusted, damaged or leaking drums shall be used.
2) Drums and barrels are used transfer small quantities of oil within substations. Typical sizes are 30 or 55 gallons.
3) Drums containing oil shall not be stored in the control house of outdoor substations.
4) HazCom requires drums and other containers containing oil to have a label stating the contents, 'transformer oil', and the hazards.

TRANSFORMER OIL	Less than 50 ppm PCB	50 ppm and over PCB
HEALTH	1	1
FLAMMABILITY	0	0
REACTIVITY	0	0
PERSONAL PROTECTION	B	C
B - Glasses and Gloves	C - Glasses, Gloves and Protective Clothing	

5) Oil expands contracts with temperature changes. Three to five inches of air space should be left at the top of the drum to allow for expansion.

12. <u>Permanent Storage of Oil</u>

12.1 Tanks which are installed on concrete pads or saddles are not considered to be associated with temporary storage of oil.

12.2 All such tanks must have impervious, secondary containment, sized to account for precipitation (~ 110 %), whether they contain oil or are empty.

13. <u>Transferring and Filtering Oil</u>

13.1 General

1) Check apparatus for labels to determine the PCB status of its oil before oil is handled. Refer to Appendix B. PCB Classification and Testing.
2) Oil that has been exposed to arcing should be evaluated for the possibility of producing an explosive atmosphere.
   a) Oil DGA results can be evaluated with the spreadsheet tool on the Substation O&M Services web site or contractor.
   b) If explosive levels are found contact O&M Substation Services for instructions.
3) When the tanker or container is engaged in transfer operations, only general containment/diversionary structures are required.
   a) This requirement is usually satisfied by the presence of substation SPCC berms, trap rock ground surface, and/or spill containment and cleanup equipment.
4) The oil quantity contained in the apparatus shall be determined before transferring or filtering is started.

5) The size of any temporary oil storage containers shall be verified to be adequate for the quantity of oil.
6) Proper venting of apparatus and temporary oil storage containers shall be verified, prior to starting oil transfer operations, to prevent equipment damage or oil spills.
7) The substation SPCC spill kit (Andax Barrel Pac) should be located and checked to be complete.
8) An Andax Pac 44 spill kit, or equivalent, equipment shall be at the work site.
9) Filtering equipment and temporary oil storage containers shall be located as close as possible to the apparatus being maintained.
10) The following steps are to be taken prior to commencement of oil transfer:
    a) Check all apparatus, equipment and temporary oil storage container fittings and valves for evidence of leaks. If leaks are found, correct prior to starting transfer operation.

13.2 Hoses and hose connections.

1) Oil hoses shall be tested for electrical continuity between metal end fittings before each use. Hoses failing test shall not be used
2) Threaded connections shall be made using Teflon tape or gaskets and tightened to prevent leaks.
3) Quick connect couplings shall be made with gaskets in place. The locking tabs shall be secured with tie wraps or tape.
4) Appropriate spill control shall be used at each apparatus, equipment or hose connection. This can be done by placing absorbent pads, plastic drop cloths, drip pans or pails under each connection.

13.3 Pumps filter presses and filters.

1) Pumps and filter presses shall be grounded to the substation ground. If oil is being handled in locations other than substations all equipment should be bonded together and connected to system or earth ground.

13.4 Transformer Bushings

1) All transformer bushings should be bonded together and connected to the transformer tank or system ground prior to pumping oil.

13.5 The following should be monitored while oil is being pumped.

a) The ends of discharge pipes and hoses should below the oil level in tankers and drums to prevent splashing of oil which will create static charges.
b) Fluid levels to prevent over-filling of drums, portable storage tank, tanker or electrical apparatus. Storage containers require adequate head space for expansion of oil due to temperature changes.
c) Apparatus, hoses, and equipment connections for oil leaks. If leaks are observed, immediately stop transfer operation until leaks can be corrected.

13.6 Before disconnecting hoses.

1) Each valve shall be checked to determine that it is in the proper position (open or closed).
2) If PCB fluid was processed, flush equipment and hoses with non-PCB oil.

3) During the removal of hoses, care shall be taken to ensure that oil remaining in the hose is contained. Hoses shall be drained of oil before storage.
4) All valves shall be inspected to verify that plugs and connections are sealed and leak free. Threaded pipe plugs shall be reinstalled using Teflon tape. Steel and galvanized plugs should be replaced with brass plugs.

13.7 Apparatus that was worked on shall be inspected for any additional leaks.
1) If leaks are found they should be repaired, if possible. Leaks that can not be immediately repaired should be contained with absorbent pads or other appropriate measures.
2) Notify your Supervisor of any leaks that were repaired or need repair.

13.8 The apparatus and work area shall be left clean and free of oil stains.

14. Substations with Hazardous Waste Generator ID's.

14.1 Hazardous wastes shall not be removed from substations or other locations with Environmental Protection Agency (EPA) Hazardous Waste Generator ID's.

14.2 Hazardous wastes should be properly labeled and stored in that stations hazardous waste accumulation or storage areas.

14.3 New England Substations with EPA ID's on 7/25/2006.
1) Bellows Falls Switchyard
2) Salem NH Operations Center
3) Lebanon NH Operations Center
4) Vernon Switchyard
5) Wilder Switchyard

15. Return of Rental Tank Trailers (MSDS and Bill of Lading)

15.1 The instructions in this section are only applicable to non-PCB oil residue. If the residual oil contains PCBs contact your Environmental Engineer for instructions.

15.2 When returning tankers a Bill of Lading and MSDS sheet may be required to cover the transport of the residual oil to the trailer wash facility.
1) Appendices D and E contain a printable Bill of Lading and instructions.
2) Appendix F contains instructions for obtaining a MSDS sheet.

15.3 The person, or organization, who ordered the tank trailer is responsible for insuring the MSDS and Bill of Lading are available when the trailer is picked up. (Contractor, FCC, Local Substation etc.)

15.4 One copy of the MSDS sheet and one copy of the Bill of Lading should be given to the driver who picks up the tank trailer.

16. Appendix A - Material List

	Stores Code
Broom	8830-5462735
Shovel	8830-5483065
Gloves - Heavy Duty Granflex	8830-8023190
Speedy-Dry Absorbent	8830-5591200
Plastic Drop Cloth - 9 x 12	8830-5466130
Plastic Pail - 10 Qt	8830-5478045
Duct Tape - 2"	8830-5486488
3M Absorbent Pillows	8830-5478400
3M Absorbent Pads	8830-5482700
Tyvek Suit	8830-466860,1,5
ANDAX PAC 44	8830-5475070
ANDAX BARREL PAC	N/A

17. Appendix B - PCB Classification and Testing

17.1 General.

1) This appendix summarizes the information found in the Waste Management and Recycling Procedure (EP-1). EP-1 should be reviewed and its contents understood. The local Environmental Engineer should be contacted for any questions.
2) This appendix applies to PCB classification and testing of oil in substation apparatus. The PCB content of oil shall be determined before the oil is handled. If the PCB content is unknown, then a field test shall be done to determine the PCB concentration.
3) Reasons for concern include: waste handling, waste stream mixing, personnel protection and environmental protection.

17.2 PCB Classification and Labeling.

1) These classifications are a combination of the EPA regulation and EP-1. Classification of new oil in a tanker can be determined by the shipping paper or the MSDS sheet required with the oil delivery.
2) No-PCB - Oil with no detectable concentration of PCB's.
   a) There is usually a manufacturer's label or statement on the nameplate that at the time of manufacturing the equipment was less than 2 ppm or PCB free.
3) Non-PCB - Oil that has a PCB level below 50 ppm.
   a) The label is either a blue and silver label or the notice label sating that the equipment was tested and found to be non-PCB.
4) PCB contaminated - Oil that has a PCB level 50 ppm to below 500 ppm.
   a) The label will be a yellow sticker (New England) stating that the equipment is contaminated with PCBs at or below 500 ppm.
   b) PCB - Oil that has a PCB level 500 ppm or greater.
   c) The label will be a large yellow label stating that the equipment has a PCB concentration greater than 500 ppm.
5) PCB Fluid - EP-1 defines any oil with a PCB level 50 ppm or greater as a PCB Fluid. This term is used to refer to any PCB contaminated oil in this document.

17.3 Field Testing

1) Clor-N-Oil 50 Test Kit - Test results are under 50 ppm.
   a) - Attach a field test label with test kit number and date per the EP-1.
   b) Test results show greater than 50 ppm.
2) Clor-N-Oil 50 Test Kit - Test results are 50 or over ppm.
   a) Re-test with Clor-N-Oil 500 Test Kit.
3) Clor-N-Oil 500 Test Kit - Test results are under 500 ppm.
   a) Attach a PCB Contaminated Label on the apparatus.
   b) Draw a sample for lab testing. See Laboratory Testing.

4) Clor-N-Oil 500 Test Kit – Test results are 500 or over ppm.
   a) Attach a PCB Label on the apparatus.
   b) Draw a sample for lab testing. See Laboratory Testing.
   c) Notify the O&M Supervisor at once.
   d) Notify the Local Environmental Engineer.

17.4 Laboratory Testing

1) Using the method described in the Oil Handling Procedure, Section 9.0; obtain a 4 ounce oil sample from the apparatus. If the apparatus has multiple compartments a sample from each compartment is required (i.e. three tank OCB or LTC compartment).
2) Label each sample with the substation name, apparatus Reference Number, dispatcher's designation, and apparatus serial number. Each compartment requires individual identification (i.e. three tank OCB as A, B and C or transformer with LTC as LTC and main tank).
3) Obtain a "D" Number from Substation O&M Services PCB Coordinator and send the sample to a company approved lab.
4) The lab test results will be sent to Substation O&M Services PCB Coordinator and the appropriate label and memo will then be issued to the field location.

18. Appendix C - Tank/Tanker Inspection and Form

18.1 General.

1) A tank or tanker left at a substation with oil stored in it shall be inspected monthly. This appendix summarizes the inspection and the information that should be recorded.
2) If a tank or tanker is left at a substation with oil in it, the local Environmental Engineer shall be notified.

18.2 Inspection.

1) The tank or tanker and all associated equipment shall be inspected for signs of leaks.
2) Check to ensure all valves are secured.
3) The landing gear and wheels shall be inspected to assure that the tanker is stable.

18.3 EXAMPLE INSPECTION FORM

SUBSTATION ____________________________________ DATE ________________________

Tanker No. ________________________________

Tank Description ___________________________

Reason for Oil Storage ____

Name of Local Environmental Engineer Notified ______________________________________

DATE	NAME	Leaks	Valves	Stability	Remarks

19. Appendix D – Printable Bill of Lading

BILL OF LADING

Shipper No. ____________________

Carrier No. ____________________

Date ____________________

TO:
Consignee ____________________
Street ____________________
Destination ____________________

FROM:
Shipper Liberty
Street ____________________
Origin ____________________

Route ____________________

No. Shipping Units	HM	Kind of Packaging, Description of Articles Special Marks and Exceptions	Weight	Rate	Charges
N/A	N/A	RESIDUE – Mineral Oil Dielectric Fluid	N/A	N/A	N/A
		RA # Non DOT Regulated			
		TANK WASH			

RECEIVED, subject to the classifications and lawfully filed tariffs in affect on the date of issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under contract) agrees to carry to its usual place of delivery at said destination , if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.

Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SHIPPER Liberty Utilities	CARRIER
PER	PER

20. Appendix E –Bill of Lading Instructions

BILL OF LADING

Shipper No. 1 ____________
Carrier No. ____________
Date 2 ____________

TO:
Consignee ____________
Street ____________
Destination ____________
Route ____________

FROM:
Shipper National Grid
Street 3 ____________
Origin 4 ____________

No. Shipping Units	HM	Kind of Packaging, Description of Articles Special Marks and Exceptions	Weight	Rate	Charges
N/A	N/A	RESIDUE – Mineral Oil Dielectric Fluid	N/A	N/A	N/A
		RA # Non DOT Regulated			
		TANK WASH			

RECEIVED, subject to the classifications and lawfully filed tariffs in affect on the date of issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under contract) agrees to carry to its usual place of delivery at said destination , if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.
Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SHIPPER National Grid	CARRIER
PER 5	PER

1 Enter the Shipper No.
Use the first 4 letters of the substation name skipping spaces..
Ex. New Scotland Substation = NEWS
Add the pickup date as ###### (6 digits)
Ex. November 7, 2009 = NEWS110709
If more than 1 tank trailer add an A, B, C etc. to the end. – EX. NEWS110709A

2 Enter the Pickup Date - Ex. 11/07/2009

3 Enter the Street Address - Ex. 152 New Scotland South Road

4 Enter the City, State, ZIP - Ex. New Scotland, NY 12159

5 Sign your Name as Liberty Utilities Representative

The driver picking up the tanker will fill out the remaining required items on the Bill of Lading

21. Appendix F – Instructions for Obtaining MSDS Sheets

21.1 MSDS Sheet can be printed from the INFONET Safety Web Site.

1) Open the INFONET Web Site.
2) Click on [site index] in the top menu.
3) Click on [Safety] in the third column.
4) Click on [Material Safety Data Sheets] in the right side menu.
5) Click on [Liberty Utilities (Dolphin) Site] near the end of the text block.
6) In the search block at the top left enter:
   a) CROSTRANS 206 if the oil residue is Cross 206 and click on the magnifying glass symbol.
   b) HYVOLT II if the oil residue is ERGON HYVOLT II and click on the magnifying glass symbol.
   c) If the oil residue manufacturer is unknown (used oil) either MSDS sheet can be used as a generic MSDS.
7) Click on the magnifying glass symbol next to HYVOLT II or CROSTRANS 106 & 206.
8) Click the printer symbol in the browser (Internet Explorer) top menu or use File-Print to print the MSDS.

22. Record of Revisions

Date	Rev #	Description	Lead/Author
04/01/2015	1.0	Initial Version of Liberty Utilities document. Updated from National Grid document to be NH Specific.	Robert J Johnson

INTRODUCTION

This procedure has been developed to ensure proper work areas are established in substations for maintenance, construction, or high-voltage testing activities.

PURPOSE

Equipment and Equipment Bays in substations can appear similar. Work areas must be properly identified for the equipment to be worked on. Setting up a proper work area is accomplished by marking a boundary between the designated work area and the energized area through the use of a tape barricade, flags, and approved barriers.

The purpose of this procedure is to establish a work practice that shall be followed b y employees, to ensure specific steps are taken, before work is performed in a substation, to identify areas which have been identified for work entry and areas that shall not be entered.

This procedure defines work area identification for work in electrical substations.

Applications of barricades, flags, or signs are to be installed as directed by the person in charge of the work and as indicated on the Job Brief. The preferred method is to obtain the Clearance, if required, install the appropriate work area identification materials at ground level, and test de-energized and ground apparatus to be worked on. Install additional red flags in elevated positions to further delineate energized circuits or apparatus as necessary. Minimum Approach Distances shall be observed at all times.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

COORDINATION

Not Applicable.

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures

LU-EOP G014 - Clearance and Control

LU-ENG-SUB001 Chain Link Fence

LU-ENG-SUB003 Substation Grounding

DEFINITIONS

Not Applicable.

TRAINING

Technical Training Course
On-The-Job-Training

Annual Expert Training

DOCUMENT CONTENTS

Table of Contents

1.0 GENERAL

1.1 This procedure must be utilized when work is to be performed on equipment switched out and tagged in accordance with the Clearance and Control Procedure EOP G014 in an energized substation. It shall also be utilized when construction or maintenance activities need to be delineated from energized equipment or when construction is being performed in close proximity to energized equipment and tagging under the provisions of EOP G014 are not used. Exceptions to this procedure are work activities such as routine operations or inspections, (switching, V&O Inspection, or readings) that are being performed that do not require a formal tagging procedure.

1.2 Only qualified employees shall determine the work area boundary designations and the required location of the barriers and/or barricade to be installed.

1.3 The Qualified person in charge of the work at the job site shall be responsible for the compliance with this procedure.

1.4 Only qualified employees may install work area barricades (cones, tape, and flags) for the designated work and/or test area.

1.5 Before beginning work, there will be a documented Job Brief during which boundaries of the established work areas, test areas, and the associated hazard areas will be reviewed.

1.6 When installing barricades, employees must observe minimum clearances. Refer to the Employee Safety Handbook for the Minimum Approach Distance Tables

1.7 For work on equipment switched out and tagged under the EOP G014 procedure, in an isolated area of an energized substation, modification of this procedure is permitted with the approval of an appropriate management representative and the lead person. Any modification shall be documented on the Job Brief.

1.8 For Mobile Substation installations where the minimum clearance to unguarded live parts to personnel on foot cannot be maintained following established electrical clearance tables, additional barricades such as vinyl fencing or barricade tape, along with signs that indicate overhead energized conductors, is required

1.9 The applicable section of this procedure shall be followed for work activities that require the installation of temporary fencing to ensure protection to the general public.

2.0 WORK AREA BOUNDARY DESIGNATION

2.1 Barriers – A barrier is a physical obstruction that is intended to prevent contact with energized lines or equipment. Electrical Barriers purchased shall be manufactured for this intent.

2.2 Barriers should be used, where necessary, between workers and exposed energized equipment on all electric construction or maintenance work.

2.3 Barriers should be used, where necessary, to protect energized equipment from contact with tools or materials that may cause damage to equipment and where such contact might cause injury to workers working nearby.

2.4 Rubber blankets may be used as barriers, provided that care is taken to keep the blankets from being cut by sharp objects. Rubber blankets should only be used on jobs of short duration, since corona cutting of the rubber may take place when the blankets are placed immediately adjacent to energized equipment. Barriers shall be kept clean, dry, and used appropriately.

2.5 Rubber Gloves shall NEVER be used as a substitute for a barrier or covering to protect against contact with ends of cables, pot-heads, bushings, etc.

2.6 A temporary barrier shall never be held in place by another employee, by hand, while work is in progress. This does not exclude the existing practice for the use of barriers attached to a live line tool.

2.7 See Figure 3 and Figure 4 for more details.

3.0 BARRICADES

Barricading is the use of a visual warning intended to indicate a hazard and to limit access to the area. Employees shall identify the work area through the use of tape and flags. By "OUTLINING" the work area, employees will be able to judge more accurately the proximity of themselves or other personnel to energized equipment.

3.1 Tape Barricade

3.1.1 Approved Barricade tape should be used to outline the work area boundary. The use of Barricade Tape minimizes the possibility of workers misinterpreting the work area boundaries and the location of adjacent energized equipment.

3.1.2 Barricade Tape should be tied in place on the structure, where possible. Illustrations show examples that will fit typical situations of substation construction and/or work activities that must be done at those locations.

3.1.3 When used at ground level or working surface, Tape Barricade should be placed between three (3) and five (5) feet above the ground or any surface on which workers may be located. In the event that there are no structures to attach the tape, traffic cones or other suitable supports may be used as a support for the tape.

3.1.4 Under certain weather conditions, such as high winds, the use of tape barricade may be limited with local substation supervisor approval, when the use of the tape barricade creates a greater hazard at the job site.

3.1.5 Tape Barricades are not to be used as substitutes for barriers.

3.1.6 Yellow flags shall be used to identify the entry/exit point of the designated work area. Multiple entry/exit points are acceptable.

3.1.7 Barricade tape shall not be crossed by personnel.

3.1.8 Barricades shall be located no closer than the minimum approach distance plus the reach of a worker and the length on any conductive tool that might be used in the work area.

3.1.9 In certain applications, (i.e. Mechanism Inspection), the use of a cone or clip on yellow flag at the work area can be used in lieu of full barricade tape installation.

3.2 Barricade Flags

3.2.1 Red Flags shall be used as necessary to further identify any energized equipment located within the work area and/or test area.

3.2.2 Red Flags shall be located no closer than the minimum approach distance plus the reach of a worker and the length on any conductive tool that might be used in the work area.

3.3 Vinyl Fence

3.3.1 Orange vinyl fence fabric may be used as an additional barricade for mobile substation installations to further outline an area that may be energized.

3.3.2 The vinyl fence shall be used within an established metal fabric substation perimeter fence of standard height.

3.3.3 Vinyl fence fabric shall not be solely used outside of an established metal fabric substation perimeter fence to barricade the general public from energized circuits or apparatus. Additional temporary metal fencing shall be installed.

3.3.4 Vinyl fence shall not be stacked to establish additional fence height. A single roll of four (4) foot vinyl fencing material shall be used in this application.

3.3.5 Vinyl fence shall be properly secured to temporary posts or structures for support and to prevent a hazard during high winds.

3.3.6 Temporary posts with pedestal based plates with ballast shall use to support the vinyl fence during the installation. If standard metal fence posts are to be used, UG facilities must be located and marked within the substation yard work area before support posts are driven into the ground.

3.3.7 Temporary vinyl fencing shall not be crossed over by personnel. Temporary vinyl fencing shall be rolled back to allow entry into the delineated area.

3.3.8 If a work area is to be established adjacent to the temporary vinyl fencing, Barricade Tape shall be applied to the vinyl fence to further delineate between the two designated work areas.

3.3.9 If overhead conductors are located within the vinyl fenced in area, a “Caution – Overhead Live Equipment” sign(s) shall be mounted on the temporary vinyl fence as a reminder to workers of energized circuits.

3.3.10 Wooden slat snow fencing with wire strapping shall not be used for temporary fence as outlined in this section.

3.4 Temporary Metal Fence or Portable Panel Fence Installations

3.4.1 Temporary metal fencing for use during construction or for mobile substation installation may be comprised of conventional chain link fence components or an assembly of portable self-supporting fence panels as outlined in SP.03.05.001 Chain Link Fence Specification.

3.4.2 Dig Safe protocol shall be employed prior to exaction for fence posts and driving ground rods.

3.4.3 Portable fence panels shall ensure no object or grade change is close enough to compromise the effectiveness of the fence as a barrier to unauthorized access.

3.4.4 Portable fence panels shall be rigidly linked together and supported with hardware that cannot be removed from outside the fence. Panel pipe base shall be weighted down with sand bags or equivalent weights to prevent moving or tipping. Refer to Appendix A for portable fence panel details.

3.4.5 Gates for temporary fencing or removable panels shall be either hinged or removable panels attached with connecting hardware or hinges at top and bottom aligned such that they cannot be removed from outside the fence or lifted off the hinge pins.

3.4.6 Temporary fence posts shall be embedded a minimum of 2.5 feet into undisturbed earth. End, corner, and pull posts may need deeper embedment based on soil conditions. Posts may be embedded in concrete. Drive anchor assemblies are acceptable. Post spacing shall not exceed ten feet. Fabric shall be pulled tight utilizing tension bars and bands to secure the fabric.

3.5 Grounding

3.5.1 Install a 9/16 inch 19 strand Copperweld wire along the length of the fence on the station side (to deter theft).

3.5.2 Wire shall be bonded to each and every post, every other post for portable panels.

3.5.3 Gates shall be bonded to the Copperweld wire via a braided flexible copper conductor.

3.5.4 At gate crossings, the Copperweld wire shall be buried six inches below the ground surface.

3.5.5 If soil conditions allow, a ground rod shall be driven every 20 feet and bonded to the Copperweld wire.

3.5.6 Where the fence joins an existing substation fence, the copperweld wire shall be bonded to the station ground grid.

3.6 Signs

3.6.1 Temporary fence shall have signs installed per Substation Maintenance Bulletin SMB 499.06.H.001 Substation Signs.

3.6.2 Install "Danger-High Voltage Within-Keep Out" Signs per specified installation guide.

3.6.3 The unhinged side of single gates one (1) foot from gate post on each side of fence at least every 50 feet.

3.6.4 Danger Signs (Item ID 8830-0810029) and No Trespassing Sings (Item ID 8830-5483190) may be obtained through the Liberty Utilities storeroom.

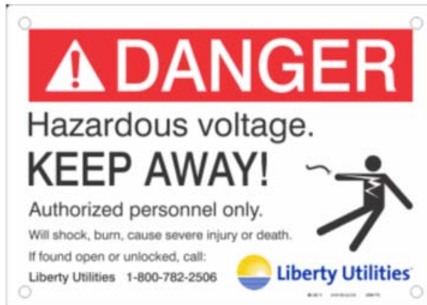


Figure 1 - Danger Sign

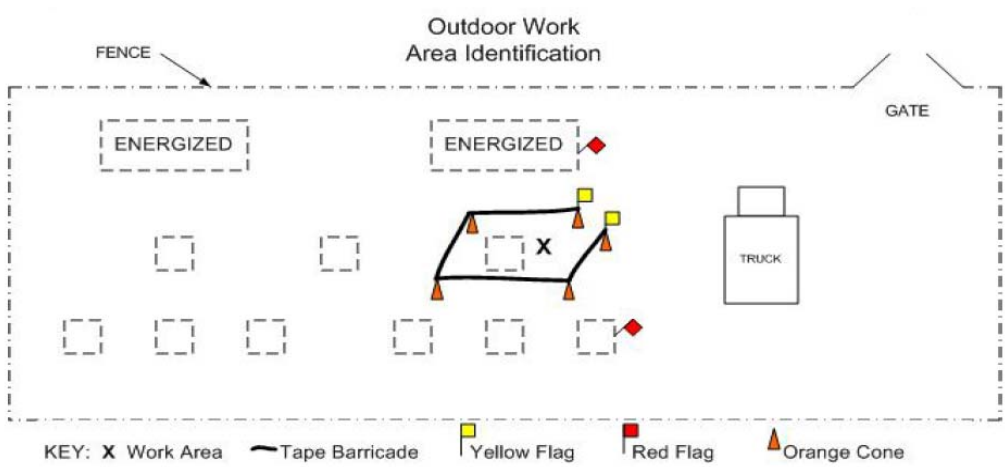
Figure 2 - No Trespassing Sign

Section 1 Work Area Boundary Designations

DIAGRAMS FOR USE OF TAPE BARRICADES AND FLAGS

Solidly drawn lines indicate taped off work zone areas. Yellow Flags are used to Indicate the work area entry/exit path. Red Flags may be placed on structures for Added awareness to further identify energized circuits or apparatus.

TYPICAL OUTDOOR SUBSTATION STRUCTURE APPLICATIONS



TYPICAL INDOOR SUBSTATION APPLICATIONS

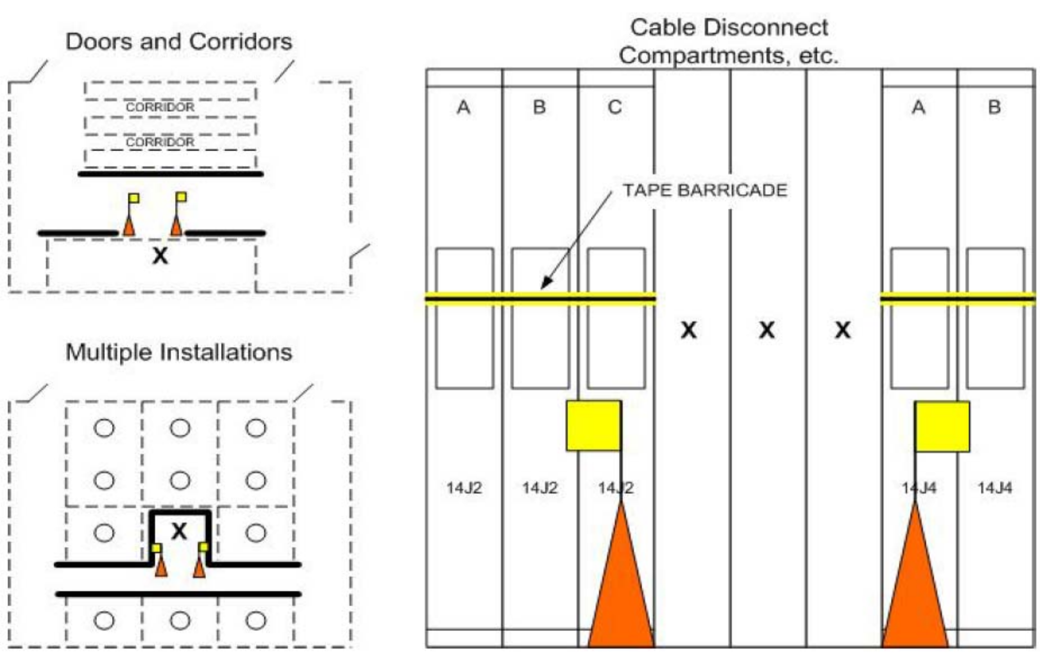


Figure 3 – Section 1 Work Area Boundary Designations Diagrams for use of Tape Barricades and Flags

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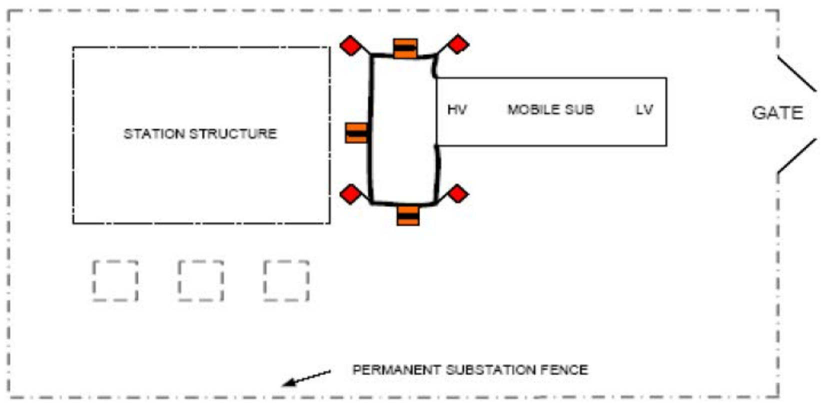
Section 1 Work Area Boundary Designations

DIAGRAMS FOR USE OF ORANGE VINYL FENCE

Solidly drawn lines indicate an area outlined by temporary Vinyl Fencing. Designated area outlined by Vinyl Fencing shall be kept closed when no activity is being conducted in the designated area. Red Flags maybe placed on the temporary support posts or structures for added awareness to further identify energized circuits or apparatus. When circuits are directly above the designated area, the "Caution – Overhead Live Equipment" sign shall be mounted on the temporary Vinyl Fencing.

TYPICAL TEMPORARY ORANGE VINYL FENCE INSTALLATION

Mobile Substation Within Substation Yard



TYPICAL TEMPORARY ORANGE VINYL FENCE INSTALLATION

Mobile Substation Outside Substation Yard

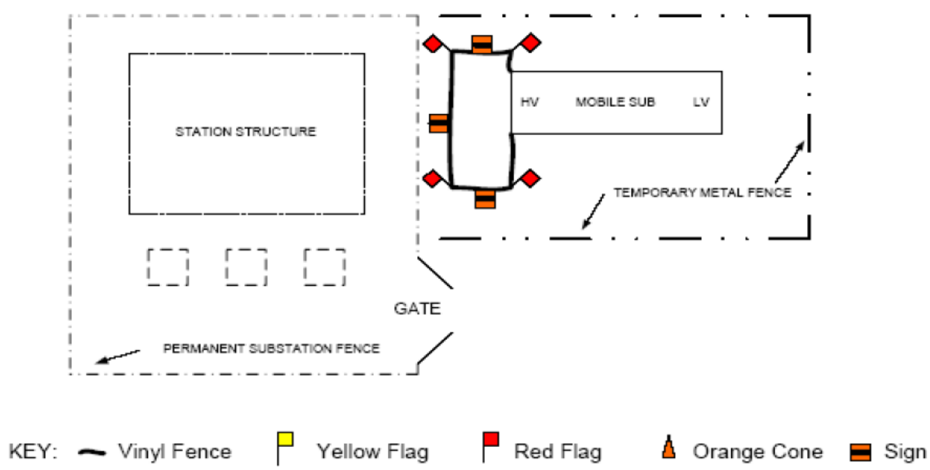


Figure 4 – Section 1 Work Area Boundary Designations Diagrams for use of Orange Vinyl Fence

4.0 IDENTIFYING AND MARKING AERIAL HAZARDS

4.1 In the event that energized equipment is directly above the work area and creates an electrical hazard, additional precautions shall be taken.

4.2 Using extension ladders or step ladders, red flag(s) shall be placed at or below the safe boundary point on the ladder. The red flag shall not be crossed over.

4.3 When the red flag(s) are placed on structures or ladders, do not violate approach distances in establishing a safe work zone from overhead energized circuits or apparatus.

4.4 Red Flags used to identify energized hazards overhead, shall be installed prior to working from lifts, work platforms, aerial equipment, or other means that allow work from an elevated position.

4.5 Additional red flag(s) may be placed on structures for added awareness to further identify circuits or apparatus that are energized above.

4.6 Additionally, signs indicating energized circuits overhead (Figure 5) shall be placed at appropriate locations to remind employees of the energized hazards above.

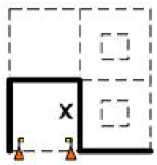
4.7 In places where red flags cannot be installed on structures, signs may be used in place of red flags with the concurrence from supervision.

4.8 See Figure 6 & Figure 7 for more details.

Figure 5 - Substation Overhead Live Equipment Sign

Section 2 Work Identifying Aerial Hazards

DIAGRAMS FOR USE OF TAPE BARRICADES AND FLAGS



Solidly drawn line indicates taped off energized areas within the existing construction. "X" shows location of work area. Cones and Yellow Flags designate safe entry/exit path.

TYPICAL SUBSTATION STRUCTURE APPLICATION

When working in an elevated position, Red Flag(s) shall be installed on the extension ladder along with warning signs on the structure to identify energized circuits above. Additional Red Flags may be placed on structures for added awareness to further identify energized circuits or apparatus.

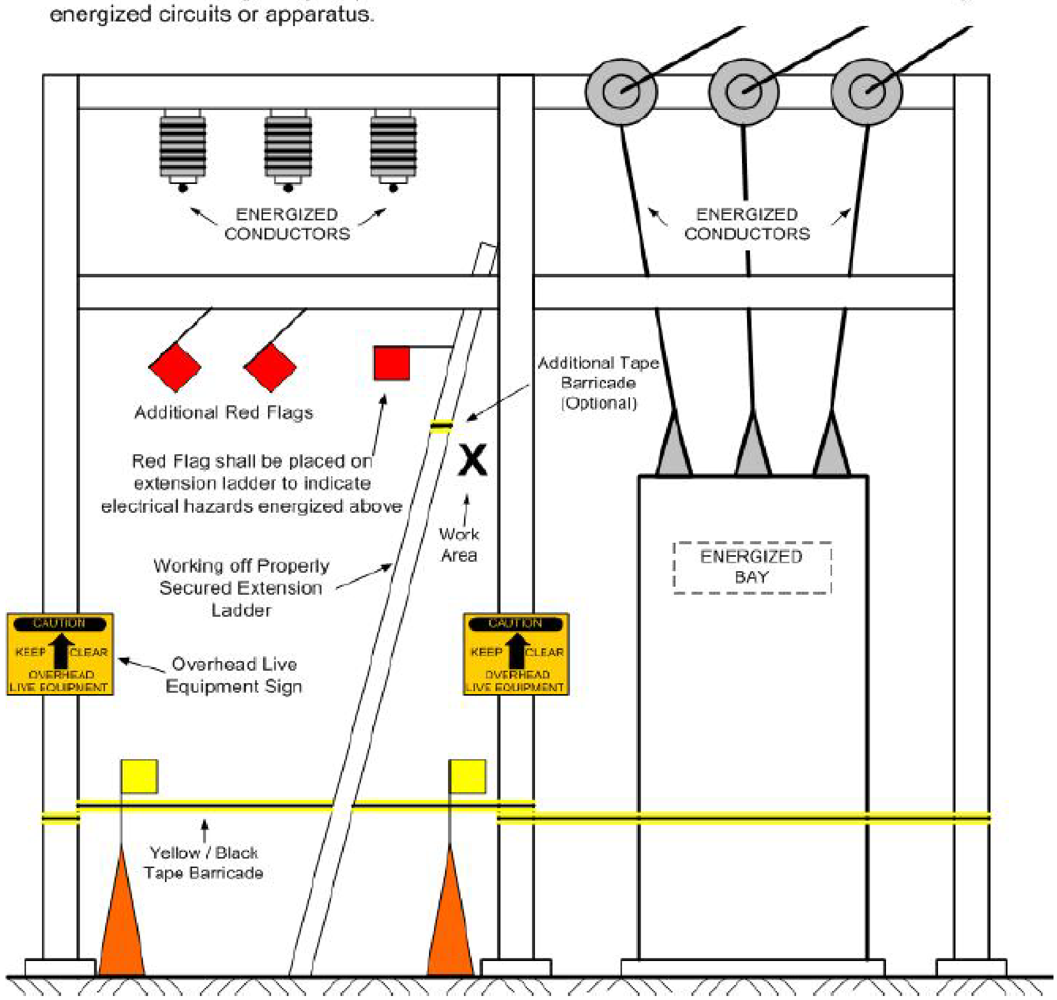


Figure 6 – Section 2 Identifying Aerial Hazards Diagram for use of Tape Barricades and Flags

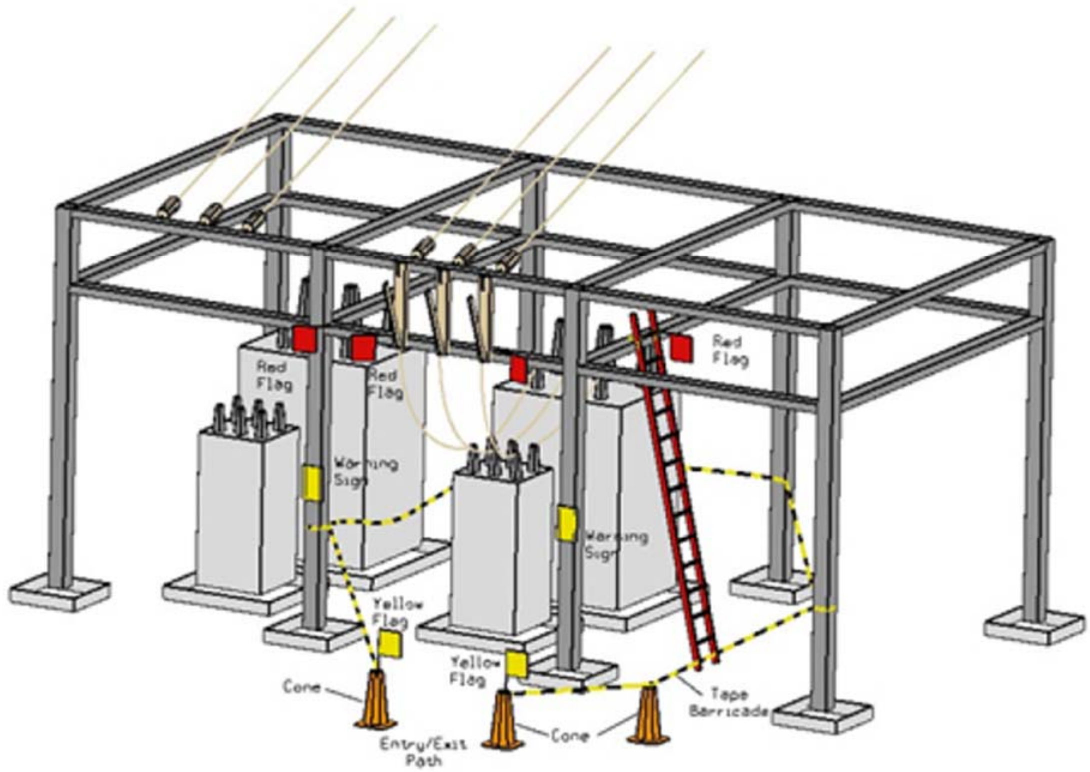


Figure 7 – Identifying Aerial Hazards Diagram

5.0 TEMPORARY TEST AREAS

5.1 This section applies to temporary testing with test equipment that operates at voltages greater than 600 volts. All test sets and cables shall be located within the boundaries of the test area. Any vehicle containing active (energized) test equipment shall also be within the boundaries of the test area and grounded.

5.2 If employees are present within the test area during testing, an observer shall be designated and capable of implementing the immediate deenergization of test equipment, if so designed, for safety purposes.

5.3 Temporary test areas shall be barricaded with yellow/black tape barricade and yellow flags to identify the safe entry/exit point. Placement of barricades shall be based on the applicable minimum approach distances associated with the nominal test voltage(s) applied to the equipment (Allow for increased voltages stepped up from applied voltages).

During an active test, yellow/black barricade tape shall be placed across the safe entry/exit point to prevent inadvertent entry into the active test area.

5.4 As an alternative to the use of a barricade tape, the test area may be guarded by one or more test observers stationed such that the complete active test area (all equipment that will be energized as a part of the test) can be monitored.

5.5 A work area boundary may be used as a test area boundary provided that during an active test, barricade tape is placed across the safe entry/exit point to prevent inadvertent entry into the active test area.

5.6 If the original work area boundary is to be used by the test crew, one of the following options shall be used:

5.6.1 Original work crew may be asked to stop work and exit work area in order for tests to be completed.

5.6.2 Test crew may set up an additional work area boundary within the original work zone established and ensure entry point is closed during active tests.

5.7 Prior to the initial application of test voltage, the person in charge of the test shall conduct routine safety checks and shall verify at the following conditions:

5.7.1 Work area identification is properly installed or as modified and documented on the Job Brief.

5.7.2 System test status signals, if used, are in operable condition (i.e. strobe).

5.7.3 Test power disconnects are clearly marked and readily available in an emergency, (i.e. safety switches).

5.7.4 Ground connections are clearly identified.

5.7.5 Required personal protective equipment is being used.

5.8 See Figure 8 for more details.

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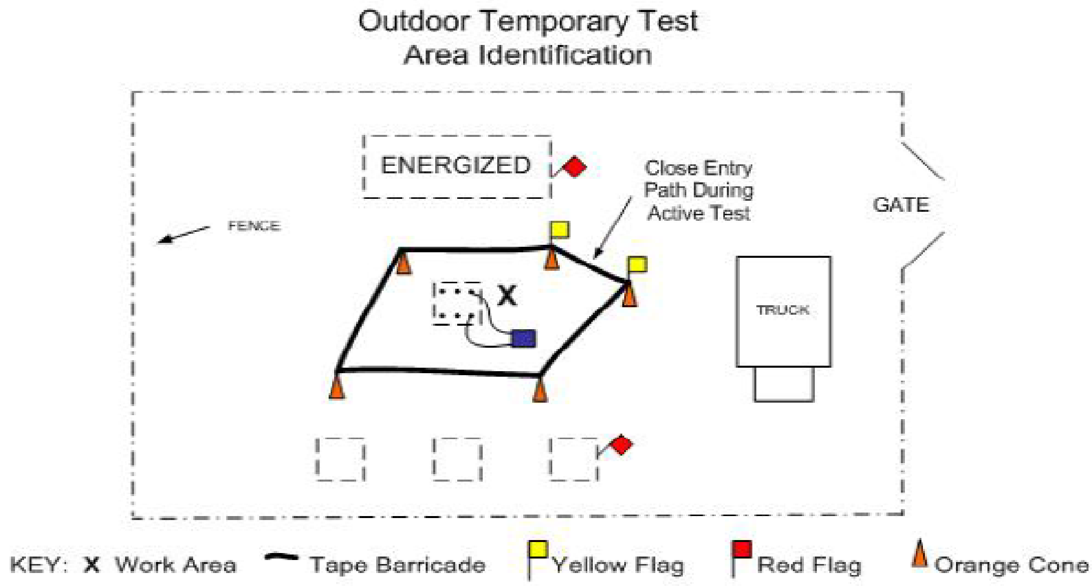
Section 3 Temporary Test Areas

DIAGRAMS FOR USE OF TAPE BARRICADES, CONES, AND FLAGS

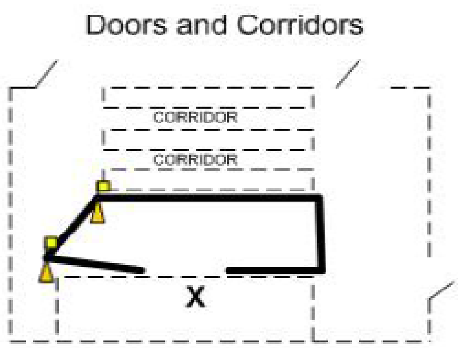
Solidly drawn lines indicate taped off work zone areas. Yellow Flags are used to indicate the work area entry/exit path. Work area entry path must be closed during active tests. Red Flags may be placed on Structures for added awareness to further identify energized circuits or apparatus.

TYPICAL TEMPORARY OUTDOOR TEST AREA



TYPICAL TEMPORARY INDOOR TEST AREA

Close work area entry path during active tests. For constricted locations close off entire work area with tape barricade.



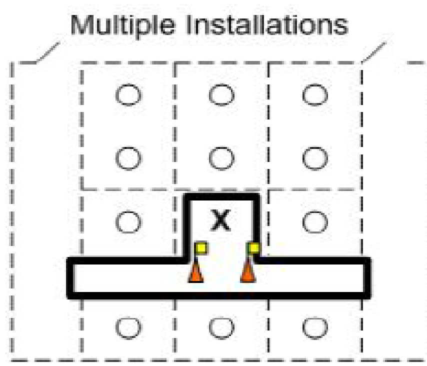


Figure 8 - Section 3 Temporary Test Areas Diagrams for use of Tape Barricades, Cones, and Flags

6.0 DESIGNATED MATERIAL & EQUIPMENT STORAGE AREAS

If a need is identified to establish a designated material or equipment storage area for stored assets within substation yards, the following shall be followed:

6.1 Substation Management shall be contacted to establish designated storage areas and bonding requirements of stored assets within Substation yards

6.2 Per OSHA regulations and internal procedures, no materials or equipment shall be stored under energized bus, energized lines, or near energized equipment, if it is practical to store them elsewhere. When materials or equipment are stored under energized lines or near energized equipment, applicable clearances shall be maintained; and extraordinary caution shall be exercised when moving materials near such energized equipment.

6.3 Stored assets shall be a minimum of ten (10) feet from the perimeter fence.

6.4 Stored assets such as power transformers, circuit breakers, connex containers, roll offs, metal conductor reels, or other metallic objects with a large footprint, shall be bonded to the substation ground grid.

6.5 Other stored small or miscellaneous assets (i.e. conduit) that may be isolated from the substation yard with pallets, cross arms, planks, or timber, need not be bonded to the substation ground grid.

6.6 A minimum of a #2 bonding wire shall be used for bonding of stored assets to the substation ground grid.

6.7 Designated Storage Area signs (Figure 9) shall be placed around the perimeter of the designated storage area. Generally, signs should be no more than fifty (50) feet apart and should face into the designated storage area.

6.8 If the site selected cannot meet electrical hazard clearances, it must be deemed a temporary storage site and a qualified person must be present to observe the loading/unloading process. A temporary storage area is not placarded.

Figure 9 - Substation Designated Storage Area Sign

7.0 MATERIALS LIST

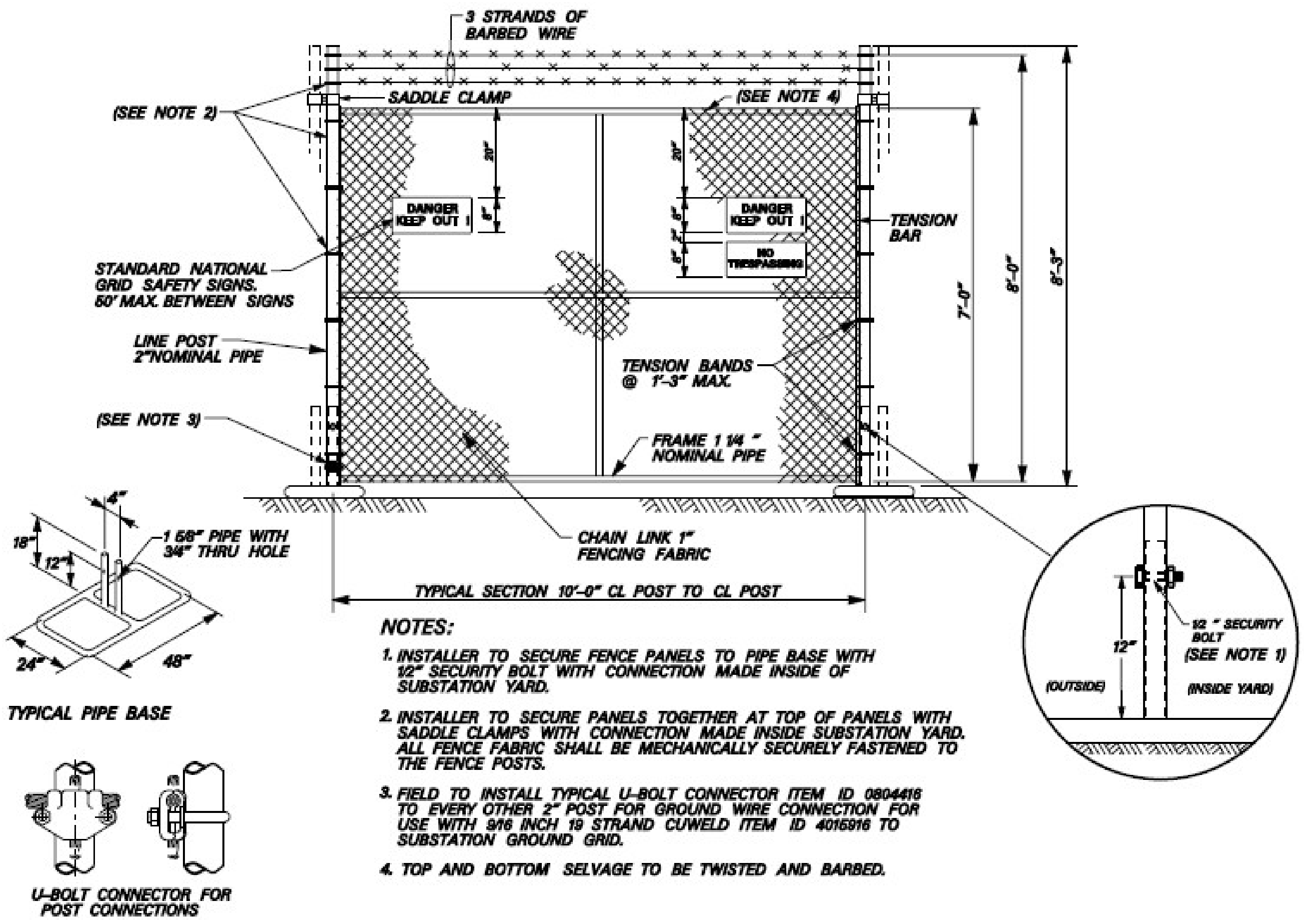
The Standard Barricade materials to be used with Substation work area identification are:

Stores Code	Description
8002231	Cone, Traffic 28 in. high, 14 in. base. Orange
8002050	Flag, Radiant Red, 18 x 18, Vinyl Impreg Nylon, w/staff
8002054	Flag, Radiant Yellow, 18 in. x 18 in., w/Stiffener
8002049	Flag, Nylon, Red, Florescent, 13 x 13, w/Wood Clamp
0809974	Flag, Nylon, Yellow, Fluorescent, 13 x 13, w/Wood Clamp
0811225	Tape, Safety Barrier, Plastic Weave 2” x 200”
0811224	Live Overhead Sign, Yellow/Black
0810400	Designated Storage Area Signs for Substations
5460815	Cone Bar, Plastic Retractable, Yellow/Black

The following optional materials may be purchased separately to facilitate the installation of the standard work area identification materials within this procedure.

Magnetic Holders	Used to facilitate the installation of the Caution Overhead Live Equipment sign and/or tape barricade on substation steel structures. Available through American Safety Utility Corporation, PO Box 1740, Shelby, North Carolina 28151. (1.800.438.6013).
Cone Bars	Used as the tape barricade system or to close the safe entry/exit point to prevent inadvertent entry into an active test area. Cone Bars are available in NE through the storeroom; others contact American Safety Utility Corporation, PO Box 1740, Shelby, North Carolina 28151. (1.800.438.6013).
Cone Adaptors	Used to support straight shaft flags and tape barricade on existing traffic cones with large openings on top. Available through Eastern Metal, 1430 Sullivan Street, Elmira, NY 14901. (1.800.872.7446).

8.0 APPENDIX A - PORTABLE FENCE PANEL DETAILS



9.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	04/01/20	Updated National Grid version to be NH specific

INTRODUCTION

Thermographic Inspection is a quick and cost effective means to detect common electrical problems that result in an abnormal temperature.

It is one of the most important tools used in preventive maintenance.

PURPOSE

The purpose of this standard is to provide temperature guidelines for Thermographic Inspection.

Thermographic Inspection detects abnormal operating temperatures of substation apparatus, while in service, long before discoloration is visible.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.
Substation and other Workers performing thermographic inspection activities.

COORDINATION

Not Applicable

REFERENCES

Liberty Utilities Employee Safety Handbook and Procedures
Flir Camera Operating Manual

DEFINITIONS

Not Applicable

TRAINING

Flir Thermographic Camera Technical Training Course
On-The-Job-Training

Annual Expert Training

DOCUMENT CONTENTS

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1.0 GENERAL

1.1 Typical problems that are detected include:

- 1.1.1 Poor connections
- 1.1.2 Annealed or deteriorated wire
- 1.1.3 Loose or corroded bolted connections
- 1.1.4 Poor jaw to blade contact in disconnecting devices
- 1.1.5 Poor moving or braided connections
- 1.1.6 Undersized wire

1.2 Thermographic Inspections do not require service interruptions or covers to be removed from many types of apparatus.

1.3 Temperatures measured by Thermographic Inspection are approximate temperatures.

1.4 Problem areas are easily prioritized to those requiring immediate attention and those that can wait for corrective action.

2.0 SCHEDULE

2.1 Each substation should have an overall Thermographic Inspection at least once a year. Preferably at peak load periods.

2.2 Any apparatus that shows signs of excessive temperature should be corrected in accordance with the temperature guidelines below.

2.3 Such apparatus requires a Thermographic Inspection Report be filled out for corrective action.

3.0 TEMPERATURE GUIDELINES

3.1 Liberty Utilities has defined the following temperature increases, above reference temperature, as a guideline for scheduling repair.

3.2 Reference temperature is the temperature of similar devices, such as another phase of the apparatus or another jaw of a set of disconnects.

- 3.2.1 For load tap changers it is the comparison between the tap changer compartment tank skin temperature, and the transformer main tank skin temperature.

3.3 During an inspection:

- 3.3.1 A report of all objects exhibiting a temperature of 5°C higher than the reference temperature is to be recorded.
- 3.3.2 In a three phase system, for example, when one phase has 5°C variation, it would be reported; but if all three phases have a 5°C rise, it would not be considered abnormal.

4.0 TABLES

Thermographic Inspection - Temperature Guidelines °C			
Equipment	**Routine** Repair At Next inspection	**Urgent** Repair Within 60 Days	**Emergency** Repair Within 1 Week
PT/CT Devices	----	----	20 or above
Breaker Tank	> 1	2 to 4	5 or above
Transformer Tank	Abnormal		----
Regulator Tank	5 to 9	10 to 19	20 or above
Battery	----	----	5 or above
Capacitor	5 to 9	10 to 19	20 or above
Connector	20 to 49	50 to 74	75 or above
Disconnect 1 Phase	20 to 49	50 to 74	75 or above
Disconnect 3 Phase	20 to 49	50 to 74	75 or above
Insulator	> 1	> 5	10 or above
Load Tap Changer	----	1 to 9	10 or above
Reactor	----	40 to 74	75 or above
Fused Cutout	10 to 39	40 to 59	60 or above
Arrestor	----	----	2 or above
Bushing Connection	5 to 10	10 to 39	40 or above
Bushing	5 to 10	10 to 39	40 or above
Bus Insulator	----	----	2 or above
Terminator/pothead	5 to 9	10 to 19	20 or above
Circuit Breaker Panel	Abnormal	----	----

5.0 REVISION HISTORY

Date	Rev #	Description	Lead/Author
05/01/2014	1.0	Initial Version of document Update from National Grid document to be NH Specific	Robert J Johnson
04/01/2020	1.1	1.3 change “extremely accurate” to “approximate temperatures”	Robert J Johnson

INTRODUCTION

This procedure describes the process used for the release and transportation of mobile substation equipment.

PURPOSE

Movement of mobile substation equipment requires heavy rigging and hauling equipment and expertise, and compliance with state and federal regulations.

Requirements vary by state, and whether emergency response or normally scheduled operations are involved.

Use of this procedure ensures that proper communication, with sufficient detail, occurs to ensure mobile substation equipment is transported in a timely manner. It is particularly important to minimize response time in emergency situations.

ACCOUNTABILITY

Substation Work Methods shall:

> Coordinate the utilization of all mobile substation equipment.
>
> Verify the intended purpose and applicability for the intended location.

Substation Maintenance & Construction and Substation Work Methods Supervision shall:

> Plan and request mobile substation equipment for both normal and emergency work

Equipment Operators/Riggers shall:

> Transport mobile substation equipment to specified sites based on the priority level specified by Substation Maintenance & Construction.
>
> Obtain required permits and insure compliance with DOT and state requirements.
>
> > Annual permits obtained by Fleet Services
> >
> > General/Emergency permits obtained by Supervisors of Equipment Operators/Riggers.

COORDINATION

Not Applicable.

REFERENCES

Not Applicable.

DEFINITIONS

M&C - Maintenance & Construction

TRAINING

Not Applicable.

DOCUMENT CONTENTS

Table of Contents

1.0 MOBILE SUBSTATION EQUIPMENT PRIORITY LEVELS

1.1 Priority levels for the transportation of mobile substation equipment are:

1.1.1 Priority Level 1 - Mobile substation equipment must be moved immediately with minimum transportation time.

1.1.2 Priority Level 2 - Mobile substation equipment is to be transported within 24-48 hours.

1.1.3 Priority Level 3 - Mobile substation equipment is to be transported per scheduled work plan.

2.0 PLANNED MOBILE SUBSTATION EQUIPMENT REQUESTS

2.1 For pre-planned construction or maintenance activities Substation Maintenance & Construction Supervision should use the Cascade mobile substation equipment request.

3.0 EMERGENCY MOBILE SUBSTATION EQUIPMENT REQUESTS

3.1 Substation Maintenance & Construction Supervision shall contact Substation Work Methods for mobile substation equipment availability.

3.2 When Substation Work Methods releases mobile substation equipment for use, Substation Maintenance & Construction Supervision shall contact Equipment Operators/Riggers Supervision or contractor to arrange transportation.

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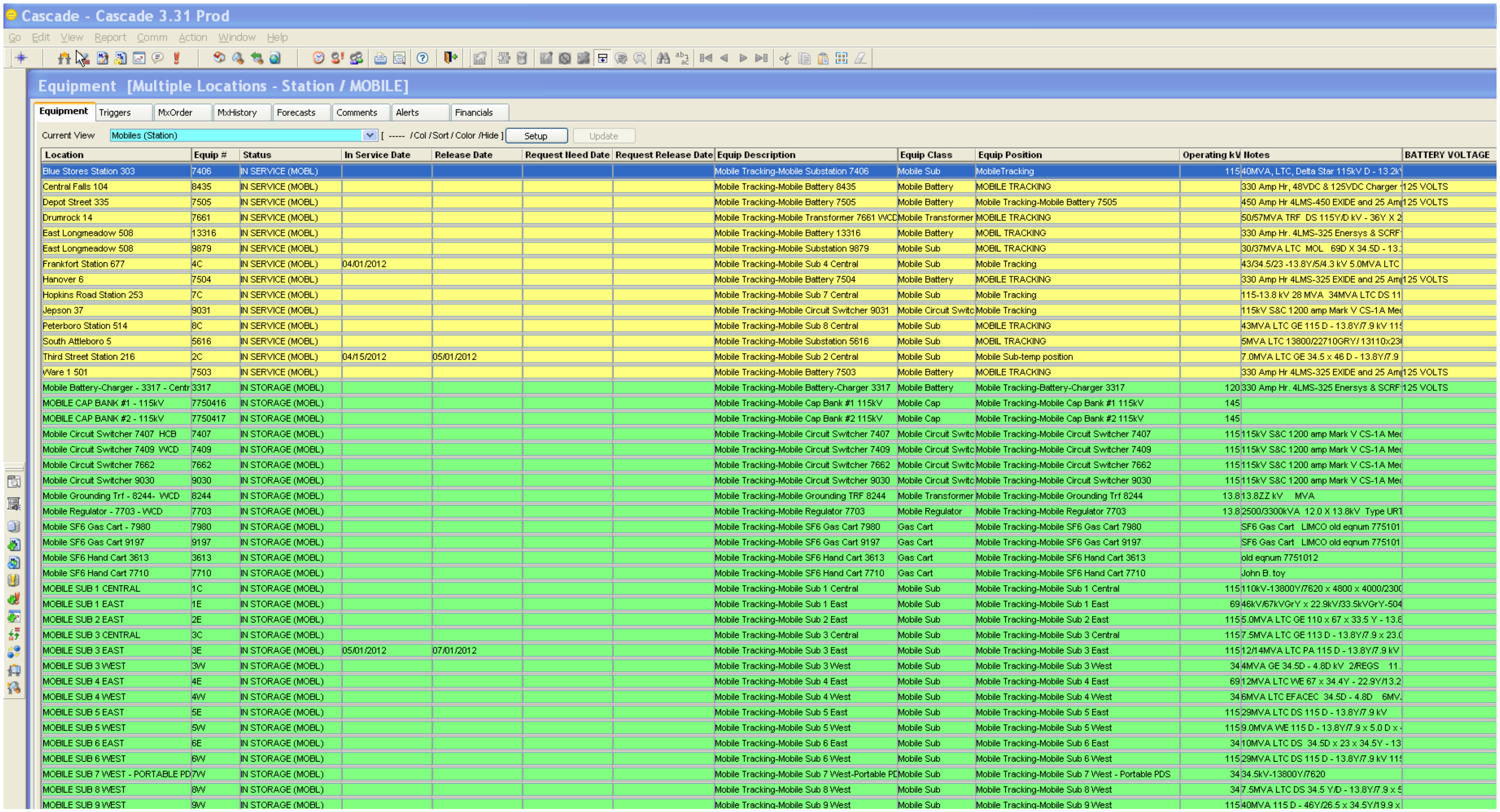
4.0 CASCADE MOBILE EQUIPMENT REQUEST


Cascade - Cascade 3.31 Prod
Go Edit View Report Comm Action Window Help
Equipment [Multiple Locations - Station / MOBILE]
Equipment | Triggers | MxOrder | MxHistory | Forecasts | Comments | Alerts | Financials
Current View: Mobiles (Station) [----- /Col /Sort / Color /Hide] Setup Update

Location	Equip #	Status	In Service Date	Release Date	Request Need Date	Request Release Date	Equip Description	Equip Class	Equip Position	Operating kV	Notes	BATTERY VOLTAGE
Blue Stores Station 303	7406	IN SERVICE (MOBL)					Mobile Tracking-Mobile Substation 7406	Mobile Sub	MobileTracking	115	40MVA, LTC, Delta Star 115kV D - 13.2k	
Central Falls 104	8435	IN SERVICE (MOBL)					Mobile Tracking-Mobile Battery 8435	Mobile Battery	MOBILE TRACKING		330 Amp Hr, 48VDC & 125VDC Charger	125 VOLTS
Depot Street 335	7505	IN SERVICE (MOBL)					Mobile Tracking-Mobile Battery 7505	Mobile Battery	Mobile Tracking-Mobile Battery 7505		450 Amp Hr 4LMS-450 EXIDE and 25 Am	125 VOLTS
Drumrock 14	7661	IN SERVICE (MOBL)					Mobile Tracking-Mobile Transformer 7661 WCD	Mobile Transformer	MOBILE TRACKING		50/57MVA TRF DS 115Y/D kV - 36Y X 2	
East Longmeadow 508	13316	IN SERVICE (MOBL)					Mobile Tracking-Mobile Battery 13316	Mobile Battery	MOBIL TRACKING		330 Amp Hr. 4LMS-325 Enersys & SCRF	
East Longmeadow 508	9879	IN SERVICE (MOBL)					Mobile Tracking-Mobile Substation 9879	Mobile Sub	MOBIL TRACKING		30/37MVA LTC MOL 69D X 34.5D - 13.	
Frankfort Station 677	4C	IN SERVICE (MOBL)	04/01/2012				Mobile Tracking-Mobile Sub 4 Central	Mobile Sub	Mobile Tracking		43/34.5/23 -13.8Y/5/4.3 kV 5.0MVA LTC	
Hanover 6	7504	IN SERVICE (MOBL)					Mobile Tracking-Mobile Battery 7504	Mobile Battery	MOBILE TRACKING		330 Amp Hr 4LMS-325 EXIDE and 25 Am	125 VOLTS
Hopkins Road Station 253	7C	IN SERVICE (MOBL)					Mobile Tracking-Mobile Sub 7 Central	Mobile Sub	Mobile Tracking		115-13.8 kV 28 MVA 34MVA LTC DS 11	
Jepson 37	9031	IN SERVICE (MOBL)					Mobile Tracking-Mobile Circuit Switcher 9031	Mobile Circuit Switc	Mobile Tracking		115kV S&C 1200 amp Mark V CS-1A Me	
Peterboro Station 514	8C	IN SERVICE (MOBL)					Mobile Tracking-Mobile Sub 8 Central	Mobile Sub	MOBILE TRACKING		43MVA LTC GE 115 D - 13.8Y/7.9 kV 11	
South Attleboro 5	5616	IN SERVICE (MOBL)					Mobile Tracking-Mobile Substation 5616	Mobile Sub	MOBIL TRACKING		5MVA LTC 13800/22710GRY/13110x23	
Third Street Station 216	2C	IN SERVICE (MOBL)	04/15/2012	05/01/2012			Mobile Tracking-Mobile Sub 2 Central	Mobile Sub	Mobile Sub-temp position		7.0MVA LTC GE 34.5 x 46 D - 13.8Y/7.9	
Ware 1 501	7503	IN SERVICE (MOBL)					Mobile Tracking-Mobile Battery 7503	Mobile Battery	MOBILE TRACKING		330 Amp Hr 4LMS-325 EXIDE and 25 Am	125 VOLTS
Mobile Battery-Charger - 3317 - Centr	3317	IN STORAGE (MOBL)					Mobile Tracking-Mobile Battery-Charger 3317	Mobile Battery	Mobile Tracking-Battery-Charger 3317	120	330 Amp Hr. 4LMS-325 Enersys & SCRF	125 VOLTS
MOBILE CAP BANK #1 - 115kV	7750416	IN STORAGE (MOBL)					Mobile Tracking-Mobile Cap Bank #1 115kV	Mobile Cap	Mobile Tracking-Mobile Cap Bank #1 115kV	145		
MOBILE CAP BANK #2 - 115kV	7750417	IN STORAGE (MOBL)					Mobile Tracking-Mobile Cap Bank #2 115kV	Mobile Cap	Mobile Tracking-Mobile Cap Bank #2 115kV	145		
Mobile Circuit Switcher 7407 HCB	7407	IN STORAGE (MOBL)					Mobile Tracking-Mobile Circuit Switcher 7407	Mobile Circuit Switc	Mobile Tracking-Mobile Circuit Switcher 7407	115	115kV S&C 1200 amp Mark V CS-1A Me	
Mobile Circuit Switcher 7409 WCD	7409	IN STORAGE (MOBL)					Mobile Tracking-Mobile Circuit Switcher 7409	Mobile Circuit Switc	Mobile Tracking-Mobile Circuit Switcher 7409	115	115kV S&C 1200 amp Mark V CS-1A Me	
Mobile Circuit Switcher 7662	7662	IN STORAGE (MOBL)					Mobile Tracking-Mobile Circuit Switcher 7662	Mobile Circuit Switc	Mobile Tracking-Mobile Circuit Switcher 7662	115	115kV S&C 1200 amp Mark V CS-1A Me	
Mobile Circuit Switcher 9030	9030	IN STORAGE (MOBL)					Mobile Tracking-Mobile Circuit Switcher 9030	Mobile Circuit Switc	Mobile Tracking-Mobile Circuit Switcher 9030	115	115kV S&C 1200 amp Mark V CS-1A Me	
Mobile Grounding Trf - 8244- WCD	8244	IN STORAGE (MOBL)					Mobile Tracking-Mobile Grounding TRF 8244	Mobile Transformer	Mobile Tracking-Mobile Grounding Trf 8244	13.8	13.8ZZ kV MVA	
Mobile Regulator - 7703 - WCD	7703	IN STORAGE (MOBL)					Mobile Tracking-Mobile Regulator 7703	Mobile Regulator	Mobile Tracking-Mobile Regulator 7703	13.8	2500/3300kVA 12.0 X 13.8kV Type UR	
Mobile SF6 Gas Cart - 7980	7980	IN STORAGE (MOBL)					Mobile Tracking-Mobile SF6 Gas Cart 7980	Gas Cart	Mobile Tracking-Mobile SF6 Gas Cart 7980		SF6 Gas Cart LIMCO old eqnum 775101	
Mobile SF6 Gas Cart 9197	9197	IN STORAGE (MOBL)					Mobile Tracking-Mobile SF6 Gas Cart 9197	Gas Cart	Mobile Tracking-Mobile SF6 Gas Cart 9197		SF6 Gas Cart LIMCO old eqnum 775101	
Mobile SF6 Hand Cart 3613	3613	IN STORAGE (MOBL)					Mobile Tracking-Mobile SF6 Hand Cart 3613	Gas Cart	Mobile Tracking-Mobile SF6 Hand Cart 3613		old eqnum 7751012	
Mobile SF6 Hand Cart 7710	7710	IN STORAGE (MOBL)					Mobile Tracking-Mobile SF6 Hand Cart 7710	Gas Cart	Mobile Tracking-Mobile SF6 Hand Cart 7710		John B. toy	
MOBILE SUB 1 CENTRAL	1C	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 1 Central	Mobile Sub	Mobile Tracking-Mobile Sub 1 Central	115	110kV-13800Y/7620 x 4800 x 4000/230	
MOBILE SUB 1 EAST	1E	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 1 East	Mobile Sub	Mobile Tracking-Mobile Sub 1 East	69	46kV/67kVGrY x 22.9kV/33.5kVGrY-504	
MOBILE SUB 2 EAST	2E	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 2 East	Mobile Sub	Mobile Tracking-Mobile Sub 2 East	115	5.0MVA LTC GE 110 x 67 x 33.5 Y - 13.	
MOBILE SUB 3 CENTRAL	3C	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 3 Central	Mobile Sub	Mobile Tracking-Mobile Sub 3 Central	115	7.5MVA LTC GE 113 D - 13.8Y/7.9 x 23.	
MOBILE SUB 3 EAST	3E	IN STORAGE (MOBL)	05/01/2012	07/01/2012			Mobile Tracking-Mobile Sub 3 East	Mobile Sub	Mobile Tracking-Mobile Sub 3 East	115	12/14MVA LTC PA 115 D - 13.8Y/7.9 kV	
MOBILE SUB 3 WEST	3W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 3 West	Mobile Sub	Mobile Tracking-Mobile Sub 3 West	34	4MVA GE 34.5D - 4.8D kV 2/REGS 11.	
MOBILE SUB 4 EAST	4E	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 4 East	Mobile Sub	Mobile Tracking-Mobile Sub 4 East	69	12MVA LTC WE 67 x 34.4Y - 22.9Y/13.2	
MOBILE SUB 4 WEST	4W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 4 West	Mobile Sub	Mobile Tracking-Mobile Sub 4 West	34	6MVA LTC EFACEC 34.5D - 4.8D 6MV.	
MOBILE SUB 5 EAST	5E	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 5 East	Mobile Sub	Mobile Tracking-Mobile Sub 5 East	115	29MVA LTC DS 115 D - 13.8Y/7.9 kV	
MOBILE SUB 5 WEST	5W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 5 West	Mobile Sub	Mobile Tracking-Mobile Sub 5 West	115	9.0MVA WE 115 D - 13.8Y/7.9 x 5.0 D x	
MOBILE SUB 6 EAST	6E	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 6 East	Mobile Sub	Mobile Tracking-Mobile Sub 6 East	34	10MVA LTC DS 34.5D x 23 x 34.5Y - 13	
MOBILE SUB 6 WEST	6W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 6 West	Mobile Sub	Mobile Tracking-Mobile Sub 6 West	115	29MVA LTC DS 115 D - 13.8Y/7.9 kV 11	
MOBILE SUB 7 WEST - PORTABLE PD	7W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 7 West-Portable PD	Mobile Sub	Mobile Tracking-Mobile Sub 7 West - Portable PDS	34	34.5kV-13800Y/7620	
MOBILE SUB 8 WEST	8W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 8 West	Mobile Sub	Mobile Tracking-Mobile Sub 8 West	34	7.5MVA LTC DS 34.5 Y/D - 13.8Y/7.9 x 5	
MOBILE SUB 9 WEST	9W	IN STORAGE (MOBL)					Mobile Tracking-Mobile Sub 9 West	Mobile Sub	Mobile Tracking-Mobile Sub 9 West	115	40MVA 115 D - 46Y/26.5 x 34.5Y/19.9 x	

5.0 EQUIPMENT OPERATORS / RIGGERS – INTERNAL CONTACTS

NEW YORK					
Location	Contact	Title	Telephone		
			Office	Cell	Home
Central	Josh Pierie	Supv Equipment Operators/ Riggers	315 452-7534	315 657-2759	315 692-4781
West	Kevin Urbanski	Supv Equipment Operators/ Riggers	716 831-7496	716 207-9229	716 685-6040
East	Robert Renna	Supv Equipment Operators/ Riggers	518 433-3325	518 312-1841	518 588-2317

NOTE: Alternate Contact for the above is Don Stamer (home 716-667-2460 / cell 716-479-9043)

NEW ENGLAND					
Location	Contact	Title	Telephone		
			Office	Cell	Home
Waltham	Mike Dembkowski	Substation Coordinator	781 907-3117	413 374-1956	508 867-5440
Westboro	Dan Parent	Supv TLS	508 389-2400	508 768-7081	401 639-4969

6.0 HEAVY EQUIPMENT HAULERS – CONTRACTORS

Location	Contact	Title	Company	Telephone	
				Office	Emergency
New England	Internal contacts will coordinate contractors, if required				
West	Dave Clark	VP	Clark Rigging & Rental	716 433-4600	716 695-4860
Central	Rusty Williams	Owner	Rig-All Incorporated	315 732-4138	315 723-7776
	Dave Clark	VP	Clark Rigging & Rental	716 433-4600	716-695-4860
	John Wozniczka David Schwalm	President VP	JPW Riggers	315 374-5911	315 374-5911 315 374-5912
Utica	Rusty Williams	Owner	Rig-All Incorporated	315 732-4138	315 723-7776
Albany	Marty Mullins	Owner	John M. Mullins Rigging & Hauling Inc.	518 273-0771	518 469-9483

7.0 TRANSPORTATION NOTIFICATION

7.1 Equipment Operators/Riggers Supervision shall notify Substation Work Methods of the completed moves of mobile substation equipment.

7.2 E-mail Substation O&M Services (no name is required).

7.2.1 Substation O&M Services is a pick on the To List

7.3 Fax

7.3.1 New England - 508 421-7880

7.3.2 New York - 315 428-3121

7.4 If an outside contractor moves mobile equipment Substation Maintenance & Construction and Substation Work Methods Supervision shall make the notification.

7.5 Sample notification: “Mobile Substation 5W was moved from Gardenville Storage Yard to Inghams Substation on 7/17/06”.

8.0 TRANSPORTATION RESPONSIBILITIES

8.1 Pre and Post trip inspection of the tractor and any associated trailer shall be performed by the driver.

9.0 EMERGENCY PERMITS – NEW YORK

9.1 Fleet Management maintains emergency blanket permits (Type 6) for tractors and trailers that allow the movement of mobile substation equipment in emergencies.

9.1.1 New York Permits

9.1.2 Emergency - State of Emergency declared by the Governor or other official and major power outages).

a. Maximum Gross Weight – 116,000

b. Length – 79' 11", Height – 13' 6", Width – 13" 0'

9.1.3 Radius - Routine Moves – Annual (for use during daytime hours only).

a. Maximum Gross Weight – 108,000

b. Length – 79' 11", Height – 13' 6", Width – 12" 0'

9.1.4 Blanket - Regular Blanket Permit – Annual (for use during daytime hours only)

a. Maximum Gross Weight – 100,000

b. Length – 79' 11", Height – 13' 6", Width – 10" 0

9.1.5 NYS DOT Contacts: Mr. Will Morris or Mr. Tom Golden, North Wolf Road Office, Albany, NY. Business Hours -1 888 783-1685, After Hours – 1 607 937-0590 (Operations Center)

9.1.6 For emergency or scheduled work, NYS DOT requires two (2) hours to respond to route planned.

9.2 If movement of equipment via the New York State Thruway is required, prior approval must be received from the NYS Thruway Authority.

9.2.1 NYS Thruway Contact: Ms. Shannon Van Steenburg or Ms. Sherry Allen, NYS Thruway Authority, Albany, (518) 436-2990.

9.2.2 Blanket letters, for emergency use only, may be issued.

a. A separate letter is required for each tractor-mobile combination is required.

b. The Thruway Authority, (518) 436-2816, must be contacted the first business day following use for billing purposes.

c. All normal permit information (tractor plate, total length/width/height, axle loading and spacing etc. is required.

10.0 EMERGENCY PERMITS – NEW ENGLAND

10.1 There are blanket permits to move oversized over weight loads up to 130,000 lbs. as construction equipment.

10.2 Reducible load permits for tractors with gross weight of 55,000 lbs are used. Reducible loads up to 90,000 lbs may be hauled on the Massachusetts Turnpike or any part thereof.

11.0 APPENDIX A - MOBILE SUBSTATION DATA – NEW ENGLAND

NE MOBILE #	TYPE	WEIGHT (LBS)	HEIGHT	WIDTH	LENGTH	# OF AXELS	REG. #
193	SUB	58930	11'11"	7'11"	27'	2	SM4793
1754	TRANS	68350	10"5"	9'6"	34'1/4"	2	SM2988
1755	TRANS	68350	10"5"	9'6"	34'1/4"	2	SM2990
4230	TRANS	106500	13'6"	10'	34'11"	3	SM12681
5264	SUB	38795	11'10"	7'11"	21'10"		217007
5266	SUB	36000	12'	7'11"	19'6"		217071
5616	SUB					2	NOT
5806	SUB	45000	12'6'			2	REGISTERED
6845	SUB						NOT
6846	SUB						REGISTERED
7661	TRANS	102500	13'6"	8'6"	48'	3	SM61564
7662	CIR SW	14800	13'	8'	20'		SM61565
7703	REG	82000	13'4"	10'6"	39'4"	2	17281
7704	TRANS	97040	12'8"	12'8"	46'5"	3	SM17282
8244	GR TR	40955	11'	7'8"	34'9"	2	SM6918
9030	CIR SW		13'2"	8'6"	20'4"	1	33783
9031	CIR SW		13'2"	8'6"	20'4"	1	33784
9734	SUB	66779		8'	27'	2	97637
9879	SUB	94600	13'6'	8'6"	48'	3	SM27650
9890	SUB	85500	13'6"	8'6"	40'3"	3	SM27813
7131-1	CIR SW						
7131B/1243	TRANS	106000	13'6"	9'11"	42'6"	3	39411

12.0 APPENDIX B - MOBILE SUBSTATION DATA – NEW YORK

Unit No.	NG No.	Location	Weight	Width	Length	Permit	Dolly
1C	5363	HCB	88,200	8’ 0”	48’ 0”	Y	
1E	5260	ALBANY	50,000	8’ 0”	31’ 3”	N	
2C	5347	HCB	53,800	8’ 0”	35’ 4”	N	
2E	5269	ALBANY	66,280	8’ 0”	45’ 0”	N	
3C	5362	POTSDAM	82,800	8’ 0”	48’ 0”	Y	
3E	5263	N. ALBANY	66,720	8’ 0”	44’ 0”	N	
3E	5265	N. ALBANY	13,400	8’ 0”	25’ 0”	N	
3W	5297	BUFFALO	40,500	8’ 0”	24’ 6”	N	
4C	5331	WATERTOWN	53,200	8’ 0”	32’ 0”	N	
4E	5255	AMSTERDAM	85,800	8’ 0”	40’ 6”	Y	
4W	5298	BUFFALO	76,7500	8’ 6”	36’ 1”	N	
5C	91-481	POTSDAM	25,500	8’ 0”	23’ 8”	N	
5W	5299	BUFFALO	56,400	8’ 0”	37’ 1”	N	
6C	91-437	WATERTOWN	25,500	8’ 0”	0’ 17”	N	
6W	5300	BUFFALO	136,800	8’ 6”	60’ 2”	Y	
5E	5291	ALBANY	136,200	8’ 6”	60’ 2”	Y	Y
6E	5555	ALBANY	80,200	8’ 6”	42’ 5”	N	
7C	5589	SYRACUSE	115,500	8’ 6”	62’ 0”	Y	Y
7W	5436	BUFFALO	70,800	8’ 0”	46’ 0”	N	
8C	5435	HCB	125,000	10’ 0”	51’ 0”	Y	
8W	5554	BUFFALO	74,500	8’ 0”	42’ 0”	N	
9W	5577	BUFFALO	134,750	8’ 0”	54’ 0”	Y	Y

13.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	02/23/07	Initial version of document
1.1	05/23/07	Document Added - Documentum Version # to header Added - File name to footer
1.2	11/19/07	Emergency Permits – New York Revised – Section Appendix B - Mobile Substation Data – New York Revised – Mobiles 4W, 6W and 5E
1.3	09/18/08	Appendix B - Mobile Substation Data – New York Revised – New NG Mobile #'s Corrected – Order (by unit number)
2.0	08/31/12	Converted to new format. ACCOUNTIBILITY - Changed “Substation O&M Services shall:” to “Substation Work Methods shall:”; Changed “Power Delivery / O&M Supervision shall:” to “Substation Maintenance & Construction and Substation Work Methods Supervision shall:”; Changed “Heavy Haulers shall:” to “Equipment Operators/Riggers shall:”; Changed “… level specified by Substation O&M Services.” to “… level specified by Substation Maintenance & Construction.”; Added ”Annual permits obtained by Fleet Services”; Added “General/Emergency permits obtained by Supervisors of Equipment Operators/Riggers” Section 2.1 - Changed “… Power Delivery / O&M Supervision should use the Substation O&M Services mobile substation equipment on-line request process.” to “… Substation Maintenance & Construction Supervision should use the Cascade mobile substation equipment request.” Section 3.1 - Changed “Power Delivery / O&M Supervision shall contact O&M Services for mobile …” to “Substation Maintenance & Construction Supervision shall contact Substation Work Methods for mobile …” Section 3.2 - Changed “When O&M Services releases mobile substation equipment for use, Power Delivery / O&M Supervision shall contact Heavy Hauler Supervision …” to “When Substation Work Methods releases mobile substation equipment for use, Substation Maintenance & Construction Supervision shall contact Equipment Operators/Riggers Supervision …” Section 4.0 - Renamed Section 4.0 - Replaced Section 5.0 - Changed “HEAVY EQUIPMENT HAULERS - INTERNAL CONTACTS” to “EQUIPMENT OPERATORS/RIGGERS - INTERNAL CONTACTS” Section 5.0 - Updated Tables; Added Note below New York Table Section 6.0 - Updated Table Section 7.1 - Changed “Heavy Equipment / Heavy Haulers Supervision shall notify Substation O&M Services of the …: to “Equipment Operators/Riggers Supervision shall notify Substation Work Methods of the …” Section 7.4 - Changed “… equipment Power Delivery / O&M Supervision shall …” to “… equipment Substation Maintenance & Construction and Substation Work Methods Supervision shall …” Section 8.0 - Deleted and renumbered accordingly Section 8.2 (old 9.2) - Deleted

INTRODUCTION

This procedure shall be followed for projects that will be administered per the Project Management Playbook to ensure that National Grid substation projects are commissioned into service in a consistent manner and without risk to personnel safety, substation equipment, or system stability.

PURPOSE

The purpose of this procedure is to:

Define the electrical testing and testing documentation requirements for the project.

Define the procedures for approval and energization for new substations or substation additions.

ACCOUNTABILITY

Project Managers, Distribution Operations, Transmission Operations, Substation Work Methods, Substation Maintenance & Construction, Protection, Telecom and Operations (PTO), Work Delivery, and Construction organizations involved in Substation Project Commissioning shall ensure that all appropriate sections within this procedure are complied with.

Project Management will be responsible to notify the appropriate groups/departments that the substation project has been completed and energized, in order for the appropriate maintenance task to be turned on in CMMS.

COORDINATION

Project Managers shall ensure that Commissioning and Energization roles and responsibilities are defined and assigned to specific individuals at the time of the initial project meeting as required based on the scope and complexity of the project. Specific maintenance and relay procedures that shall be followed for the testing and documentation requirements for the project shall be identified at that time.

REFERENCES

National Grid Substation Maintenance Standards – SMS

National Grid Substation Maintenance Procedures – SMP

National Grid System Protection – Relay Procedures PR's

Engineering Document PR.09.03.000 - Project Execution

Investment Recovery Document Substation Decommissioning Procedure SMP 471.03.2

Remote Terminal Unit Commissioning Test Procedure

Meter Commissioning and Site Verification Guideline

DEFINITIONS

OFF-LOAD Testing -	Testing that is performed prior to energization (out of service tests) documented through the use of the ACCEPTANCE CERTIFICATE (Appendix E) by

	each respective team member assigned to perform the specified tests.
ON-LOAD TESTING -	Testing that is performed after initial energization (in service tests) documented through the use of the ACCEPTANCE CERTIFICATE (Appendix F) by each respective team member assigned to perform the specified tests.
OUTAGE PLAN -	A step-by-step switching and testing document used to perform the initial energization of electrical apparatus and protection systems.
TRANSMISSION OUTAGE APPLICATION (TOA) -	A process used to request and schedule system outages and clearances for transmission and distribution substation and circuits.

TRAINING

The Owner will define any required training based on type of apparatus being installed and /or changes in operating procedures.

The Installer shall conduct any necessary training on new equipment for the Owner's personnel. This training is limited to on-site discussions and demonstrations during the initial tests and/or during the commissioning energization process.

DOCUMENT CONTENTS

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1.0 DEFINITION of ROLES and RESPONSIBILITIES

Note: Individuals are selected during the project kick-off / project outage planning meeting to perform the requirements of this procedure and may be management or representative individuals.

1.1 CONSTRUCTOR

National Grid employees or contractor responsible for the project physical installation and connection of structural components, electrical apparatus, and/or associated control, protection, and metering systems

1.2 CONSTRUCTION SUPERVISOR

A National Grid management employee (System Delivery Supervisor, PTO Supervisor, Substation Supervisor, etc.) assigned to coordinate and oversee all construction activities of the CONSTRUCTOR and TESTER. The CONSTRUCTION SUPERVISOR will ensure the project is constructed according to established specifications and be a liaison with the ENERGIZATION COORDINATOR.

1.3 ENERGIZATION COORDINATOR

A National Grid management employee designated by Substation Work Methods responsible to ensure all tests have been performed and results received are complete and acceptable for the operation and energization of the system. In addition, ensures Transmission Outage Application (TOA) is in affect or submitted for the energization of installed electrical apparatus or systems.

The position is supported internally by National Grid Test personnel from Relay, Telecom, Meter, and Substation Maintenance & Construction as required to ensure the collection of required data and reports necessary to certify the substation and apparatus are ready for service.

The ENERGIZATION COORDINATOR may request from the appropriate department management the individuals for the respective area of responsibilities to be assigned.

1.4 OWNER

Is defined as a National Grid or designated representative responsible for the project.

1.5 PROJECT MANAGER

A National Grid or designated representative responsible for all aspects of the project as outlined in the Project Management Playbook.

1.6 TESTER

National Grid Testers from Relay, Telecom, Meter, Substations Maintenance & Construction or TEST CONTRACTOR employees that verify the proper installation of electrical apparatus and components as well as performing all required startup testing and documentation as required by National Grid. Testing includes, but is not limited to, electrical apparatus and equipment acceptance testing, electrical testing, and the testing of associated control, protection, and metering systems.

1.7 APPLICATION COORDINATOR - Transmission

Initial System Control Center contact person with the construction/field for outage requests (TOAs). Initial management for all TOAs submitted. Reviews TOAs for accuracy, correct limits, completeness and for obvious conflicts before submitting to the OUTAGE COORDINATOR for processing. Arranges switch persons, makes notifications to other departments, Muni's and affected major customers. Assists applicants with project TOA requests. Reviews and assists the ENERGIZATION COORDINATOR with energization procedures/TOAs.

1.8 OUTAGE COORDINATOR – Transmission

Reviews & Processes all Transmission TOAs by communicating with the ISO daily & performing formal detailed studies on ALL submitted Transmission TOAs prior to formal submission to the ISO. Assists the project team with input into the outage plan identifying load at risk, constraints, key generation needs, conflicts and performs informal studies on complex outage plans. Works with the ISO, key generators, Distribution Dispatch &

affected Divisions in evaluating emergency restoration times and identifies risks to the system and area customers. Approves TOAs &/or communicates TOA conflicts back through the Application Coordinator. Assists the ENERGIZATION COORDINATOR by identifying high level constraints & available outage windows.

2.0 GENERAL

All substation apparatus and components must be installed, tested, and commissioned in accordance with National Grid Procedures. When these procedures do not specifically address specific tests, the manufacturer's recommendations or standard industry practices shall be followed.

Specific approvals must be obtained for any procedural deviation or alternate tests requested by contacting the appropriate National Grid Procedures Administrators.

Final on site commissioning and energization shall be performed or witnessed by National Grid Personnel.

3.0 OWNER RESPONSIBILITIES

3.1 The Owner shall:

3.1.1 Advise of any project related installation or testing that will not be part of the work scope.

3.1.2 Notify of work site locations and connections to Interconnected Utilities related to the project.

3.1.3 Advise of any approved suppliers, manufacturers, or other vendors for installation and/or testing of electrical apparatus that will be performed as part of the project under the CONSTRUCTOR's/TESTER's direction.

3.1.4 Provide all protective relay settings.

3.1.5 Supply revenue meters for the project.

3.1.6 Arrange for the required telephone circuits.

3.1.7 Provide a Testing and Commissioning Responsibility Matrix prior to the start of work (Reference Appendix V - Sample).

4.0 CONSTRUCTOR RESPONSIBILITIES

4.1 The Constructor shall:

4.1.1 Be responsible to ensure all precautions have been taken to guarantee personnel safety and prevent equipment damage.

4.1.2 Notify the OWNER when any secondary work involving the interconnection to in-service systems is planned. Notification format and documentation forms shall be discussed and agreed to during the initial project team meeting.

a. The CONSTRUCTOR shall be responsible to ensure connection safeguards are installed and removed as necessary.

b. The CONSTRUCTOR shall maintain a report describing the safeguards used, reasons for use, and where applied.

4.1.3 Ensure that all safety aspects of the project are addressed during construction. This shall include but is not limited to:

a. Clearance and Control requirements

b. Work area identification

c. Eyewash stations, portable or permanent

d. Fire fighting equipment

e. Personal Protective Equipment

f. Safe Work Practices

4.1.4 Request any outages required to perform construction, including the date, time, and duration, from the CONSTRUCTION SUPERVISOR. All outage requests need to be included in the project outage plan and meet TOP-08 lead times

4.1.5 Immediately inform the OWNER, and provide written documentation, of any equipment related problems, issues, (i.e. foundation, structural or apparatus damage) or discrepancies.

4.1.6 Document new, removed, or decommissioned electrical apparatus using the appropriate documentation requirements, report formats, and forms as described in this procedure.

4.1.7 Identify other maintenance or testing requirements during the course of the project and inform the ENERGIZATION COORDINATOR for direction.

4.1.8 Verify required telephone circuits will be available for the project from Telecom Engineering

4.1.9 As the construction activities progress, (apparatus placement, cabling, terminations, wiring) the CONSTRUCTOR will inform and coordinate with the TESTER the required acceptance and electrical testing in accordance with the work schedule. Acceptance and testing should not be deferred until the end of the project unless agreed to by the OWNER.

4.1.10 Appropriate outages or coordination shall be conducted in order to schedule and complete testing requirements. All outage requests need to be included in the project outage plan and meet TOP-08 lead times

4.1.11 Participate in the development of and execution of Secondary Circuit Isolation Plans (See Appendix U).

4.1.12 Complete applicable tasks identified on the Testing and Commissioning Matrix provided by the OWNER.

5.0 CONSTRUCTION SUPERVISOR RESPONSIBILITIES

5.1 The Construction Supervisor shall:

5.1.1 Manage all aspects of field construction including the activities of the CONSTRUCTOR and TESTER. Specific activities are included in the text of this procedure and checklists in the appendices section.

5.1.2 Ensure all acceptance, electrical, relay testing is identified and who will perform.

5.1.3 When connections to existing circuits (live or dead) are scheduled, investigate the construction plan and methodology to ensure other equipment within the substation, energized transmission lines, and the power grid have neither their reliability nor integrity compromised.

5.1.4 Ensure that a Secondary Circuit Isolation Plan is developed and executed on all projects at operating substations (See Appendix U).

6.0 TESTER RESPONSIBILITIES

6.1 The Tester shall:

6.1.1 The TESTER has responsibility for the testing and commissioning work including supplying the required trained personnel, test equipment, hardware, vehicles, manlifts, ladders, harnesses, power supplies or other apparatus or materials to complete the equipment tests and comply with the applicable safety regulations.

6.1.2 Perform acceptance, calibration, and performance tests of all new electrical apparatus, systems and circuits required for commissioning and energization.

a. This includes all the electrical tests associated with new installations and the associated tests required to integrate new installations into existing energized facilities following existing testing procedure documents.

b. This includes any tests that may be required or recommended by the equipment manufacturers and shall be stated at the project outage planning meeting Follow equipment manufacturers test requirements if there are no existing test procedures.

c. These tests establish the equipment initial condition and provide a baseline for future maintenance work.

d. Testing shall verify that all components perform satisfactorily both electrically and mechanically at their specified rating. The majority of the testing is normally performed at the substation location under construction. However, testing work may also be required at locations other than the Owner's facilities. Exceptions to on-site testing are to be discussed in advance with the CONSTRUCTION SUPERVISOR.

e. Verify all equipment alarm and status points are connected and function properly. This includes connections to the input points of Remote Terminal Units (RTU) and Event Recorders.

f. As the construction activities progress (apparatus placement, cabling, terminations, wiring) the TESTER shall perform the required acceptance and electrical testing in accordance with the work schedule. Acceptance and testing should not be deferred until the end of the project unless agreed to by the OWNER.

g. Coordination with interconnecting utilities (end-to-end) tests may be required.

6.1.3 The TESTER shall meet with the Owner's project team as required (PTO, Substation Maintenance & Construction, Control Center Coordinators, Substation Supervisor, or System Delivery Supervisor), to review project requirements specific for the work to be performed.

6.1.4 The OWNER will supply an example of a typical Test Plan for the TESTER's use. The Test Plan will include all the standard steps and procedures to test and commission an equivalent facility (i.e. specific macros used for relay or device testing).

6.1.5 It is the TESTER's responsibility to ensure the OWNER's standard procedures and documentation are used, using the OWNER approved version of software for Doble test equipment or other manufacturer's device specific protocols or software.

6.1.6 The TESTER is responsible to ensure testing to be performed has been communicated, and permission to proceed has been received, from the CONSTRUCTION SUPERVISOR.

6.1.7 The TESTER shall test all secondary devices as described in this document.

6.1.8 Protective relays shall be tested by using a programmable current and voltage sources, personal computer and ProTest (Doble Engineering) software and test programs specified by the Owner.

6.1.9 The applicable sections of National Grid Procedures and Standards shall be followed for installation and testing of electrical apparatus and relays being installed.

6.1.10 National Grid will supply the CONSTRUCTOR/TESTER with electronic or paper copies of Procedures and Standards required by the project.

6.1.11 All applicable Substation Maintenance Procedures are listed in SMS 400.00.1 – List of Substation Maintenance Documents and Protection Systems Relay Maintenance Documents.

6.1.12 The TESTER shall submit the following documentation and qualifications:

a. A reference list with contact personnel names, addresses and emails.

b. Resumes for all personnel involved with the work.

c. Employee training and certification such as ANSI Standard ANSI/NETA ETT-2000 (Standard for Certification of Electrical Testing Technicians) or equivalent

d. Summary of the Installer's company experience over the past five years

e. Sample test reports using ProTest Software for relay testing over the past five years.

6.1.13 Participate in the development of and execution of Secondary Circuit Isolation Plans (See Appendix U).

6.1.14 Complete applicable tasks identified on the Testing and Commissioning Matrix provided by the OWNER.

7.0 ENERGIZATION COORDINATION RESPONSIBILITIES

7.1 The Energization Coordinator shall:

7.1.1 Manage the energization of the facility and coordinate activities of the CONSTRUCTION SUPERVISOR and TESTER as outlined but not limited to in this procedure. Specific activities are included in the text of this procedure and checklists in the appendices section.

8.0 WORK PLANS, SCHEDULES, and NOTIFICATIONS

8.1 Work Schedules

8.1.1 Tester shall prepare and submit to the OWNER a schedule for all acceptance tests.

8.1.2 Tester shall designate a principal or on-site contact person who shall be present, as required, during construction and testing.

8.2 Work Sequence Schedule

8.2.1 Tester shall prepare schedule which shows:

a. Date of mobilization on the site

b. A specific outage plan that is incorporated into the project outage plan

c. Approximate date for each piece of equipment to be tested or alternatively how the testing will be coordinated with the construction activities

d. Starting and ending time duration for each test. These times shall incorporate levelized manpower so there will be sufficient people to complete these tests as required by the commissioning schedule. The TESTER shall work with OWNER to ensure all apparatus, components, and hardware are safe, ready for service and properly calibrated and tested.

e. Any discrepancies or irregularities observed by the TESTER shall be identified in writing and communicated immediately to the CONSTRUCTION SUPERVISOR of the specific test conducted. The CONSTRUCTION SUPERVISOR and TESTER shall meet to resolve the issue. Others will be invited to attend as required by the Owner.

8.3 Test Plan Outline

8.3.1 Tester shall prepare and submit to the OWNER a plan outlining:

a. Scope of work

b. List of Reference documents

c. Identify in a table format all hardware, apparatus, components, relays, or other devices to be tested.

d. List of tests to be executed or witnessed and the specific test procedure or specification reference, which describes the test.

8.4 Initial Test Results

8.4.1 Upon completion of a specific test, the TESTER shall provide results to the OWNER per the timeframe agreed to at the project initiation.

8.5 Test Notification

8.5.1 The OWNER shall be notified by the TESTER a minimum of five days in advance of all tests.

8.6 Project Meeting Attendance

8.6.1 The TESTER shall be available to meet with the OWNER on-site or at the project office location specified at a minimum of once every two weeks to review the progress of the work completed. During the outage period the meeting frequency shall be increased as necessary but at the minimum of once every week. Additional meetings may be required periodically with the OWNER, manufacturers, etc. These meetings will be held at a site determined by the OWNER and all participants shall be informed of the meeting details. The TESTER shall attend all scheduled meetings.

8.7 Progress Reports

8.7.1 In a format approved by the OWNER, the TESTER shall submit weekly progress reports, or on a timeframe agreed to, that includes the equipment or systems tested, personnel on-site, schedule compliance, percent completed and percent of tests remaining, discrepancies identified and any other relevant information regarding the facility testing or commissioning.

8.8 Work Documentation

8.8.1 On certain projects it will be necessary to have corrections updated on construction drawings and new drawings reissued for National Grid personnel to complete final commissioning work. The OWNER will determine when this is required.

9.0 GENERAL TESTING REQUIREMENTS

9.1 The OWNER reserves the right to witness all test activities.

9.2 Technical Inquires / Variances / Approvals

9.2.1 As technical questions arise the TESTER shall contact the CONSTRUCTION SUPERVISOR. The CONSTRUCTION SUPERVISOR may delegate this requirement on a case-by-case basis to a member of the project team. The CONSTRUCTION SUPERVISOR shall maintain the list of inquiries and problems along with resolutions as part of the project documentation requirements.

9.3 Relay Settings Modifications

9.3.1 There shall be no changes to any relay settings without the explicit approval of the OWNER's Protection Engineer. Any recommended changes by the TESTER shall be submitted in writing with a detailed explanation for the modification prior to making any modifications to installed components.

10.0 TEST EQUIPMENT REQUIREMENTS

10.1 Calibration Documentation

10.1.1 If equipment or instruments being used on the project require periodic calibration by the manufacturer, the TESTER shall provide to the OWNER Certificates of Instrumentation Calibration, traceable to the National Bureau of Standards, for all test equipment and instruments used for testing and calibration. Such calibration shall have been completed within one year immediately prior to start of any testing.

10.1.2 Refer to National Grid NG-EOP G032 for calibration requirements.

10.2 Required Test Equipment

10.2.1 Tester shall complete all appropriate electrical apparatus tests utilizing the Doble M4000 Insulation Power Factor Test set with DTAF V5.5 software, Doble M4110 Leakage Reactance module, Doble M5x00 Sweep Frequency Response Analyzer with SFRA V5.1 software, Doble TDR-9000 or TDR-900 Circuit Breaker Analyzer with latest version of T-Doble software.

10.2.2 Other test equipment to be used shall be listed in the NG-EOP G032 or as approved by the OWNER.

10.2.3 Tester shall perform protective relay testing using the Doble ProTest software and equipment using the OWNER approved version of software.

10.3 Test Results Forms and Formats

10.3.1 Only the National Grid approved documentation forms or electronic formats will be used.

11.0 CONTROL BUILDING and YARD TEST REQUIREMENTS

11.1 Control Building and Yard resistance and continuity tests shall be discussed and agreed to prior to the start of construction for test requirements and who will perform.

11.2 Ground Grid and Grounding

11.2.1 Ground Grid Resistance test - Perform a ground grid resistance test using a Biddle-Megger Ground Earth Resistance Model DET test set or its equivalent.

11.2.2 Ground Grid continuity to equipment - Verify each piece of equipment in the yard, such as transformers, breakers, regulators, etc. has two grounds connected and measure the resistance to ground using a low resistance ohmmeter.

11.2.3 Ground Grid continuity to structures - Verify that each structure such as columns and stands has one ground lead connected and measure the resistance to ground using a low resistance ohmmeter.

11.2.4 Ground Grid continuity to Control Building - Verify that the grounding system in the control building is connected to the station ground grid and equipment such as control panels, cabinets, raceways, battery racks, etc. inside the building are grounded.

11.2.5 Ground Grid continuity to fence - Verify that the fence is properly grounded per National Grid grounding specification and swinging gates, barbed wire, metal fabric, etc. are properly grounded.

11.3 AC Station Service Checks

11.3.1 Overcurrent Protection - Verify Fusing and circuit breaker settings.

11.3.2 Voltage - Measure voltage and record if it is within plus 2.5% minus 2.5% range. On a 120 volts base, this is plus 2.5% (123 volts) minus 2.5% (117 volts).

11.3.3 Phase Rotation - Verify phase rotation and phase placement on switchboards.

11.3.4 Transfer Switch - Verify settings, proper operation, and phasing of transfer switch for dual service installations, see Emergency Generator section for requirements for emergency generators.

a. CONSTRUCTION SUPERVISOR shall obtain operating requirements and settings from local substation management.

11.4 Emergency Generator

11.4.1 Test per manufacturer's requirements and latest version of SMP and record results on Inspection Card.

a. SMP 405.01.2 Emergency Generator Procedure

b. SMP 405.01.3 Emergency Generator Inspection Card

11.5 DC Station Service

11.5.1 Battery Eyewash - Check that the battery eyewash station is within 25 feet of the battery installation, filled and ready for use. Make sure area immediately beneath eye wash station is clear of obstructions and designated with floor tape markings.

11.5.2 Battery and Charger and alarms - This testing is performed under section 12.2.

11.5.3 DC Panel Board - Check that the panel is labeled with voltage and all circuits are identified. Verify overcurrent protection fuse and breaker sizes.

11.5.4 Ground Test - Test for and clear station battery grounds. Battery grounds must be monitored throughout the construction and commissioning process. The battery shall be tested for grounds at the beginning of each work day and whenever a new DC circuit is energized.

11.5.5 For dual battery installations, verify that there are no cross connections between batteries. The battery shall be tested for cross connects at the beginning to each work day and when a new DC circuit is energized.

11.6 Control Building Power and Lighting

11.6.1 Check that the power panels are all labeled with voltage and circuit information.

11.6.2 Check all receptacles for correct grounding and polarity; check GFI operation.

11.6.3 Check that all building lighting is functioning.

11.6.4 Check that all building emergency lighting is functioning.

11.6.5 Check that any special building power receptacles are properly wired with correct grounding and polarity.

11.7 Yard Power and Lighting

11.7.1 Check that the power panels are all labeled with voltage and circuit information

11.7.2 Check all receptacles for proper grounding and polarity; check GFI operation.

11.7.3 Check that all yard lighting and photo, time clock are functioning and can be operated locally and if EMS, controlled remotely.

11.7.4 Check that yard lighting has proper light distribution at night.

11.7.5 Check that all emergency lighting is functioning

11.7.6 Check that all cabinet heaters are functioning.

11.7.7 Check that any special power receptacles are properly wired with correct grounding and polarity.

11.8 Control Building HVAC

11.8.1 Check that building ventilation fans and controls are functioning, control settings made, and any fire or smoke detector shutdown circuits function.

11.8.2 Check that building heaters and controls are functioning, control settings made, and any fire or smoke detector shutdown circuits function.

11.8.3 Check that air conditioning is commissioned per manufacturer's requirements controls are functioning, control settings made, and any fire or smoke detector shutdown circuits function.

11.9 Control Building Fire Equipment, Fire Alarms, Smoke Alarms

11.9.1 Fire and Smoke alarms - Check that the fire and smoke alarms function and alarm to the RTU if so equipped.

11.9.2 Fire Extinguishers - Check that fire extinguishers are installed and properly labeled.

11.10 Control Building Intrusion Alarms and Security System

11.10.1 Check that the door switches and alarms function and activate the security system

11.10.2 Corporate Security shall coordinate the installation on testing as follows:

a. Check the motion sensors function and activate the security system.

b. Check the station card reader

11.11 Substation Signage

11.11.1 Check that all required signage is installed per ST.03.06.001 Substation Signs

11.12 Wildlife Control Measures

11.12.1 Check that all wildlife control measures have been installed per drawings and specifications.

11.12.2 Check that the wildlife electric fence is functioning per the manufacturer's instructions.

11.13 Locking Provisions

11.13.1 Substation Work Methods shall coordinate and ensure the proper level of locking provisions have been installed for perimeter, control buildings, and electrical apparatus.

12.0 ELECTRICAL APPARATUS TEST REQUIREMENTS

12.1 The Owner shall:

12.1.1 Provide the required National Grid Substation Maintenance Procedures (SMP) for the electrical apparatus or systems that are being installed. Provide the Testing and Commissioning Responsibility Matrix to the CONSTRUCTOR and TESTER. The TESTER shall refer to the Acceptance Test section of the SMP for the required inspections and testing to be performed. The corresponding Inspection Card(s) and Equipment Data Forms shall be filled out by the TESTER and submitted to the ENERGIZATION COORDINATOR.

12.2 Approval by Energization Coordinator

12.2.1 Any deviation from Procedures shall be approved by the ENERGIZATION COORDINATOR in writing prior to performing any acceptance or electrical testing.

12.3 Requirements by Energization Coordinator

12.3.1 Substation Maintenance Procedures and Inspection Cards may also be provided to the TESTER as required by the ENERGIZATION COORDINATOR.

12.4 SMS 400.00.1 List of Substation Maintenance Documents

Refer to SMS 400.00.1 for a complete list of documents. The relevant list of documents is listed below.

12.4.1 Circuit Breakers, Line Reclosers, Vacuum Switches, Sectionalizers and other circuit interrupting devices -

a. The mechanism for all circuit interrupting devices shall be inspected per:

SMP 401.20.2 Circuit Breaker Mechanism Procedure

SMP 401.20.3 Circuit Breaker Mechanism Inspection Card

b. Vacuum Circuit Breakers will be tested per:

SMP 401.03.2 Vacuum Circuit Breaker Procedure

SMP 401.03.3 Vacuum Circuit Breaker Inspection Card

c. Gas Puffer Circuit Breakers will be tested per:

SMP 401.06.2 Gas Puffer Circuit Breaker Procedure

SMP 401.06.3 Gas Puffer Circuit Breaker Inspection Card

d. For other types of circuit interrupting devices, refer to SMS 400.00.1 to find the correct procedure and inspection card.

12.4.2 Power Transformers - Refer to the specific version of SMP 402.xx.x for the type of Transformer being tested.

a. Transformers shall be received per:

SMP 402.11.2 Power Transformer Installation and Acceptance Procedure

SMP 402.13.2 Power Transformer Delivery Inspection Procedure

SMP 402.13.3 Power Transformer Delivery Inspection Card

b. Transformers 15 MVA and above shall be tested per:

SMP 402.01.2 Transformer 15 MVA and Above Procedure

SMP 402.01.3 Transformer 15 MVA and Above Inspection Card

c. Transformers 2.5 to 14.9 MVA and other smaller transformers shall be tested per:

SMP 402.02.2 Transformer 2.5 to 14.9 MVA Procedure

SMP 402.02.3 Transformer 2.5 to 14.9 MVA Inspection Card

12.4.3 Instrument Transformer

SMP 403.01.2 Instrument Transformer Procedure

SMP 403.01.3 Instrument Transformer Inspection Card

12.4.4 Voltage Regulating Equipment - Test per the following SMP. If the substation has a paralleling scheme test, ensure that the scheme maintains a difference of no more than two (2) step positions. The OWNER will supply all settings for the voltage regulating device.

SMP 404.01.2 Step Voltage Regulator Procedure

SMP 404.01.3 Step Voltage Regulator Inspection Card

SMP 412.01.2 Load Tap Changer (LTC) Procedure

SMP 412.01.3 Load Tap Changer (LTC) Inspection Card

12.4.5 Battery and Charger System - Test per the following SMP. Check that all Battery alarms operate to the station annunciator and RTU. Check for and clear battery grounds.

SMP 406.01.2 Lead/Acid Battery Procedure

SMP 406.01.3 Lead/Acid Battery Inspection Card

SMP 406.02.2 Nickel-Cadmium Battery Procedure

SMP 406.02.3 Nickel-Cadmium Battery Inspection Card

SMP 406.03.2 Battery Charger Procedure

SMP 406.03.3 Battery Charger Inspection Card

12.4.6 Bushing Potential Device - Test per below SMP. Adjust output voltage per manufacturer's instructions to obtain correct output voltage.

SMP 407.01.2 Bushing Potential Device Procedure

SMP 407.01.3 Bushing Potential Device Inspection Card

12.4.7 CCVT - Test per below SMP. Adjust output voltage per manufacturer's instructions to obtain correct output voltage.

SMP 407.02.2 Coupling Capacitors and CCVT Procedure

SMP 407.02.3 Coupling Capacitors and CCVT Inspection Card

12.4.8 Wave Trap - Test per:

SMP 407.03.2 Wave Trap Procedure

SMP 407.03.3 Wave Trap inspection Card

12.4.9 Capacitor Banks - Test per:

SMP 408.01.2 Station Capacitor Bank Procedure

SMP 408.01.3 Capacitor Inspection Card

12.4.10 Disconnect Switches - Test per:

SMP 409.01.2 Disconnect Switch Procedure

SMP 409.01.3 Disconnect Switch Inspection Card

12.4.11 Circuit Switcher - Test per below SMP

SMP 409.02.2 Circuit Switch Procedure

SMP 409.02.3 Circuit Switch Inspection Card

12.4.12 Metal Clad Bus, Switchgear - Test per below SMP

SMP 417.02.2 Metal Clad Bus, Switchgear and Station Procedure

SMP 417.02.3 Metal Clad Bus, Switchgear and Station Inspection Card

12.4.13 Surge Arrester - Test per below SMP

SMP 419.01.2 Surge Arrester Procedure

SMP 419.01.3 Surge Arrester Inspection Card

12.4.14 High Voltage Bus - Test per below SMP

SMP 417.02.4 Outdoor Open Air Bus Procedure

13.0 CONTROL CABLE and WIRING TESTING

13.1 Control Cable Verification - Insulation and Continuity Checks

13.1.1 After installation of cables, wires, and cable terminations installed by the CONSTRUCTOR are complete and considered finished, the CONSTRUCTOR shall perform the following steps to confirm cable conductor continuity and insulation integrity. Using a person at either end of the cable or wire with communication, lift the wire, verify continuity and perform the following tasks. This needs to be performed one wire at a time on all wires including spares.

a. Follow the appropriate wire and conductor marker requirements.

b. Confirm each electrician has the end of the same wire being checked.

c. Ensure wire sleeves are installed and correctly numbered, if so required.

d. Follow the appropriate wiring color code guideline during installation as required.

e. Inspect the termination, verify the wire insulation is properly stripped, the termination connector/lug is correctly sized and its insulation is correct and proper.

f. Verify the end of the wire is terminated at the correct device terminal. (Check with drawings)

g. Before the wire is re-terminated a 1,000-volt insulation resistance test shall be performed on each conductor, between the conductor and ground by the CONSTRUCTOR. **Note: multiple conductor checks** are not permitted, conductors shall be insulation tested one at a time. The CONSTRUCTOR shall review the insulation resistance tests and report any irregularities to the CONSTRUCTION SUPERVISOR.

    1. Documentation of the above tests shall be on the Point-To-Point Wire Check Form.

h. Re-terminate the wire and physically pull/tug in the wire to confirm that it has seated firmly.

13.1.2 AC and DC Station Service Cables - All interconnecting DC and AC station service cables from the control building to the switchyard shall be checked to be free of shorts or grounds, by 1000volt DC insulation resistance tests

13.1.3 Wiring Drawing Verification - The testing shall be documented on the wiring drawings. **Yellow** pencil or highlighter shall be used to verify circuits that have been checked, **Red** pencil or highlighter shall be used to show conductor changes that need to be added, and **Green** pencil or highlighter shall be used to identify conductor changes that need to be removed

13.1.4 Marked-Up Drawings - Two sets of marked-up drawings shall be made at the jobsite. One set shall be designated a "working copy" and show all modifications made during tests, commissioning etc. The second set shall be the "as-builts" drawings and documentation. The OWNER shall have access to both sets at any time.

13.1.5 Lifted Lead and Jumper Log - Once commissioned any wire that is disconnected or if jumpers are installed for testing purpose, this shall be recorded in the Lifted Lead and Jumper Log. Refer to Documentation and Forms in the Appendix section.

13.1.6 Opened slide links shall be recorded ob the Lifted Lead and Jumper Log during testing.

14.0 TESTER SUPPORT of CONSTRUCTOR PERFORMING WIRING

14.1 The Tester shall:

Support the CONSTRUCTOR for projects that involve connections to existing relay and control facilities by:

14.1.1 Review of construction drawings - The construction drawings shall be reviewed for accuracy and required corrections brought to the attention of the OWNER and CONSTRUCTOR. In particular, the AC current and voltage wiring drawings should be reviewed for continuity and shorts

14.1.2 Hold a pre-construction meeting with CONSTRUCTOR performing wiring to review the sequence of construction and agreed upon testing schedule.

14.1.3 Isolate and identify DC and AC inputs to the schemes.

14.1.4 Provide assistance as required to CONSTRUCTOR performing wiring.

14.1.5 The precautions to be taken shall be agreed to and documented and as determined at the project meeting.

14.1.6 Utilize Appendix U - Tester/Constructor Isolation Guide for secondary circuits.

15.0 PRE-COMMISSIONING RELAY and CONTROL CIRCUIT TESTING

15.1 Relay and Control Circuit Testing

15.1.1 Prior to starting Relay and Control Circuit Testing, the TESTER shall verify the wiring is correct per schematics, power up the control switchboards and test the inputs and outputs function as designed

15.2 Insulation Tests shall:

15.2.1 Only be performed on isolated control cables with no connected devices, cabinets or other components. The CONSTRUCTOR is responsible for continuity and 1,000 volt insulation resistance tests for the control cables and conductors from the control house to the switchyard equipment for all cables the CONSTRUCTOR has pulled and terminated.

15.3 All wiring shall:

15.3.1 Be verified to be connected as per the station's AC elementary for the AC wiring; or the DC elementary for DC controls.

15.4 Two sets of working prints shall:

15.4.1 Be kept to accurately reflect the exact "point to point" and functional areas of verification. Panel wiring and circuits shall be documented by yellow highlighting the drawings. Corrections shall be noted using green for removals, and red for additions.

a. Follow Substation Engineering Procedure PR.02.00.005 Field Change Mark-Up and As-Built Drawings.

15.5 Device Instruction Books shall:

15.5.1 Be consulted as required to ensure that the equipment is being utilized and wired as specified by the manufacturer.

15.6 DC relaying, control and alarm wiring:

15.6.1 In verifying series and parallel contacts, the TESTER shall operate each contact or combination of contacts to verify they perform their intended function.

15.7 AC relaying and metering wiring (AC secondary):

15.7.1 In verifying potential circuits, an AC secondary voltage should be injected to the circuit and that voltage should be measured at all appropriate points as per the elementary drawings. The TESTER shall ensure that it does not back energize the high voltage sources. Measure and record the burden of the potential circuit. Check that each potential circuit has only one ground connection.

15.7.2 In verifying CT circuits, an AC secondary current should be injected to the circuit. Polarity of the current circuit shall be tested and verified for proper connections as indicated on the drawings. Measure and record the burden of the current circuit. Check that each CT circuit has only one ground connection.

16.0 RELAY and CONTROL CIRCUIT TEST REQUIREMENTS

The TESTER shall test relay and control circuits per this section. This section establishes the minimum tests to be performed for testing of protective relays and related equipment for new installations and does not contain step-by-step procedures for performing the tests.

16.1 Current Transformer

16.1.1 Polarity

16.1.2 Ratios

16.1.3 Excitation

16.1.4 Insulation

16.1.5 Confirm CT location for proper over-lapping of protective zones

16.2 Current Circuits

16.2.1 Location of grounds, insulation test

16.2.2 Secondary signal injection

a. A test current should be applied as close to the CT terminals as practical. The test should be made from each set of current transformers and include all phase-to-phase-to-neutral combinations. A check should be made at all devices for the presence or absence and polarity of current for each test condition.

16.2.3 All circuits will be marked as tested on elementary drawings (yellow highlighter)

16.2.4 All changes will be marked on elementary and wiring diagrams (green for remove / red for add)

16.2.5 Volt-Ampere Burden

a. The test should be made at a point as close to the CT terminal as practical. A suggested applied current is 3 amperes. The test should include all phase-to-phase-to-neutral connected burden.

16.3 Voltage Transformer

16.3.1 Polarity

16.3.2 Ratios

16.3.3 Insulation

16.3.4 Confirm VT location for proper voltage sensing of protective zones

16.4 Voltage Circuits

16.4.1 Location of grounds, insulation test

16.4.2 Secondary signal injection

16.4.3 All circuits will be marked as tested on elementary drawings (yellow highlighter)

16.4.4 All changes will be marked on elementary and wiring diagrams (green for remove / red for add)

16.5 Ground Relay Polarizing Circuits

16.5.1 Current polarizing sources, low voltage / high current test

16.5.2 Potential polarizing sources, in-service test

16.5.3 All circuits will be marked as tested on elementary drawings (yellow highlighter)

16.5.4 All changes will be marked on elementary and wiring diagrams (green for remove / red for add)

16.6 Other Transformer Protection

The following must be confirmed by field test:

16.6.1 Fault Pressure

16.6.2 Low Oil

16.6.3 Hot Spot CT properly wired

16.6.4 Over Temperature

16.6.5 Buckholtz Relay

16.6.6 Pressure Relief

16.6.7 Rotation

16.6.8 Water Flow

16.6.9 Other as designed

16.7 Circuit Breakers and Other Interrupting or Insulation Devices

The following are performed in conjunction with the Substations Department

16.7.1 Trip and trip-free, close and anti-pump

16.7.2 Auxiliary switches - Adjusted to proper operating position

16.7.3 Timing

16.8 Dual Trip Coils on Circuit Breakers

16.8.1 Individual test of trip coils

16.8.2 Simultaneous tests of trip coils

16.9 Relays

16.9.1 All testing to be executed in Doble Protest

16.9.2 Sample test plans and data structure will be provided by the local relay office

16.9.3 Electronic test files will be returned to the local relay office

16.10 Relay and Control Circuits (Wiring)

16.10.1 Confirm all wiring circuit checking / ringing / tracing has been completed

16.10.2 Grounds (if any) location and insulation test has been completed

16.11 Relay and Control Circuits (Functional)

16.11.1 Contact logic, functional test of all contact combinations

16.11.2 All DC contact logic chains will be marked (yellow highlighter) as tested on schematic drawings

16.11.3 All changes will be marked on elementary and wiring drawings (green for remove / red for add)

16.11.4 Pilot channels

16.11.5 Transfer Trip

16.11.6 Reclosing

16.11.7 Lockout devices

16.11.8 Breaker failure functional test

16.11.9 Verify all protection (relay or auxiliary device) alarms to EMS

16.11.10 Verify that communication circuit will continue to operate with loss of AC power

16.11.11 Test for proper Alarm and Annunciator Targets

16.12 Power Line Carrier

16.12.1 Line trap - frequency

16.12.2 Line trap - ground behind trap

16.12.3 Line tuning equipment – alignment to specified frequency - VSWR - re-verify when the line is energized and carrying load.

16.12.4 Transceivers - frequency

16.13 Transfer Trip

16.13.1 Transceivers - frequency

16.13.2 Communication circuits - frequency response

16.13.3 Verify that communication circuit will continue to operate with loss of AC power

16.13.4 Supply Control Centers with DTT or POTT channel changes so the EMS System displays can be updated.

16.14 Transient Fault Records

16.14.1 Analog inputs

16.14.2 Digital inputs

16.14.3 Time clock

16.14.4 Remote communications

16.14.5 Distance to Fault Relaying

16.15 End-to-End Tests

16.15.1 The TESTER shall provide the required personnel, equipment, hardware etc. to perform end-to-end tests. In the case of the OWNER's remote substation protection systems, in a similar manner the TESTER shall supply all the personnel, equipment or support required to complete end-to-end tests.

16.15.2 If interconnecting utilities are involved at remote sites, it will be the OWNER's responsibility to schedule the required end-to-end tests. The TESTER shall coordinate with the other utilities personnel to complete the necessary tests.

16.16 Load Check (Energized Circuit)

16.16.1 Currents

16.16.2 Voltage

16.16.3 Phase Angles

16.16.4 Manufacturer recommended in-service tests

16.17 Monitor DC Station Service

16.17.1 Ground Test - Test for and clear station battery grounds. Battery grounds must be monitored throughout the construction and commissioning process. The battery shall be tested for grounds at the beginning of each work day and whenever a new DC circuit is energized.

16.17.2 For dual battery installations, verify that there are no cross connections between batteries. The battery shall be tested for cross connects at the beginning to each work day and when a new DC circuit is energized.

16.18 Documentation

16.18.1 Refer to Section 21 and Section 22 for the required documentation requirements.

16.19 Open Link - Lifted Lead - Jumper Log

16.19.1 After a new panel or cabinet has been determined ready for service by the technicians, a log sheet will be kept at each panel / cabinet so that if any further work needs to be done requiring open links, lifted wires or jumpers to be changed can be tracked. Any changes will be logged on the form with the designation, date, person's name and reason why. When the work is completed, the responsible person will then date and sign when the links, wires or jumpers are returned to the original state.

16.19.2 During any commissioning phase which requires open links, lifted wires or jumpers to be changed from original positions on existing panels or cabinets a log sheet for that location will be implemented immediately. The responsible person will log on the form the designation, date, person's name and reason. When the work is completed, the responsible person will then date and sign when the links, wires or jumpers are returned to the original state. This procedure includes any momentary changes necessary to perform the tasks at hand.

16.19.3 At the end of the project, the log sheets from each panel / cabinet will be gathered and saved in the work folder or filed per the local field offices practice.

17.0 REMOTE TERMINAL UNIT (RTU) COMMISSIONING

17.1 Commissioning Document

17.1.1 Verifies the operation of the Energy Management System (EMS) from the equipment monitored or controlled to the system operator display

17.2 Commissioning of the RTU

17.2.1 Must be scheduled with the EMS center by submitting a request to the outage coordinator for all work on RTU equipment.

17.3 RTU Start-Up and Configuration

Specific information on the tests is in the “Remote Terminal Unit Commissioning Test Procedure”.

17.3.1 The RTU equipment must be verified against the drawings to insure the correct equipment has been received.

17.3.2 The RTU Firmware and Configuration Software versions shall be recorded and checked against the design documents.

17.3.3 The RTU configuration, drawings, and points list shall be checked to see if they agree.

17.3.4 The software, dip switch settings, and board jumpers must be verified. The battery supplying the memory card must be checked on the board.

17.3.5 The field installation shall be checked to see that the RTU is installed according to the drawings and that the status and analog control point wiring is checked from point to point.

17.3.6 Before any testing begins, all station test switches or slide links shall be opened to isolate the RTU from station equipment.

17.3.7 The RTU will be powered up and the AC and DC input supply voltages measured and recorded. The DC power supply output voltages on the RTU must be measured and recorded.

17.3.8 Download the RTU configuration and verify it downloaded without error.

17.3.9 Test each Status, Control and Analog point locally via laptop connection.

17.3.10 The communication circuit between the RTU and the EMS center must be checked against the network print and verified for correct operation. This test must be coordinated with the EMS center technicians, and includes confirmation that the circuit complies with NERC/CIP security requirements and as defined by the OWNER. Verify that communication circuits will continue to operate with loss of AC power.

17.3.11 For telephone circuits, power should be removed from the Positron set to insure that communications continue with loss of power.

17.3.12 Telcom Engineering is responsible to ensure all necessary telephone circuits have been ordered and ensures they are available for the substation commissioning and energization.

17.4 RTU Input/Output Testing

17.4.1 Each input and output from the RTU will be tested. Specific information on the tests is in the "Remote Terminal Unit Commissioning Test Procedure"

17.4.2 The results of the testing will be kept by the EMS group. Points which have tested correctly shall be recorded as in service on the database listing along with any other information that would be helpful for future reference. A point discrepancy form shall be completed for points that have problems and database listing shall be marked to indicate problem.

17.4.3 Follow-up items shall be recorded on a punch list maintained by the EMS group for corrective actions.

17.4.4 All field changes shall be recorded on engineering drawings and documents with a copy to be returned to engineering for correction.

18.0 PANEL METER COMMISSIONING

18.1 Panel Indication Meters

18.1.1 Meters shall be tested by comparing its' displayed and output values in magnitude and direction against a known standard or by calculating the value based on the inputs. If the device supplies the RTU, the value must be compared to the value recorded in the RTU, the EMS database and the value displayed on the operator's screen.

19.0 REVENUE METER COMMISSIONING

19.1 Revenue Metering

Revenue metering will be commissioned per the latest revision of the "*Meter Commissioning and Site Verification Guideline*".

19.1.1 This procedure verifies the operation of the revenue meter from the device to the desired recipient of the metering data to the Energy Management System (EMS), and/or the Meter Data Services MV 90 information system.

19.1.2 The commissioning of the revenue meter must be coordinated with the receiver of the data: EMS center or Meter Data Services for the MV 90 system.

20.0 TRAINING

20.1 The OWNER

Will identify and communicate the training requirements necessary to personnel who shall operate and maintain the equipment based on type of apparatus being installed and changes in operating requirements. The training requirements will be discussed and agreed to at the beginning of the project. The manufacturer's representative(s) shall be fluent in oral and written English to train the OWNER's operating personnel.

20.1.1 The CONSTRUCTION SUPERVISOR and/or PROJECT MANAGER shall provide coordination of manufacturer's representative(s) to train OWNER's operating and Control Center personnel as necessary in the use and application of equipment and apparatus supplied for the project.

20.1.2 The TESTER and/or PROJECT MANAGER shall provide coordination of manufacturer's representative(s) to train the OWNER's operating personnel in the use and application of protective relays, Remote Terminal Units, Digital Fault Recorder, metering equipment or other associated controls and hardware for the project.

20.1.3 The training shall consist of two seminars with both classroom theory (first session) and practical "hands-on" training (second session). The classroom theory training shall be conducted prior to delivery of any apparatus.

20.1.4 Once the project is near completion, the second seminar will be held, and shall include "hands-on" oriented maintenance and equipment tests. A portion of classroom time shall be included in the second session to review project drawings and other site specific documentation.

20.1.5 The outline of the training course and any audio visual equipment requirements shall be submitted in writing to the OWNER. Specific training topics required by the OWNER will be discussed and agreed to at the beginning of the project.

20.1.6 Each two part seminar shall be limited to 8 individuals in multiple training groups. Each session shall be identical in content. The party providing the training shall supply a copy of all drawings, texts, slides or other instructional materials for each individual. The OWNER shall supply the classroom facilities.

20.1.7 Training Documentation - One complete presentation of the training shall be recorded in DVD format for the OWNER's future use.

20.1.8 Twelve (12) copies of the DVD training CDs shall be supplied and the OWNER permitted to make additional copies for internal use only with no additional costs incurred.

21.0 DOCUMENTATION and REPORTING REQUIREMENTS

For all tests including Doble Engineering equipment, paper and electronic test results shall be provided to OWNER. The TESTER shall document all test results for each test requirement outlined in this specification. The test readings shall become benchmarks for all future evaluations.

21.1 Report Formats

21.1.1 The OWNER will specify at the initial meetings the acceptance and electrical tests documentation and reporting requirements for paper and/or electronic test results.

21.1.2 The CONSTRUCTOR shall complete all electrical apparatus and equipment installation forms as outlined and specified by the OWNER.

21.1.3 The TESTER shall complete all electrical apparatus an equipment test results forms for each test requirement outlined and specified by the OWNER.

21.2 Nameplate Data

21.2.1 The CONSTRUCTOR/TESTER shall ensure that the nameplate data is collected and documented using PR.02.00.027 Substation Work Order Summary for equipment being installed or removed from service.

21.2.2 Equipment Data Forms (EDF) may be requested to be completed by the OWNER to collect additional nameplate information for each new primary device, electrical apparatus, secondary devices, or protection relays installed.

21.3 Test Results

21.3.1 Each test result shall include:

a. The date of the test

b. Name and contact information of the individual making the test

c. A description of the test performed

d. The system or device tested

e. Test equipment used with the hardware identification number and certification date

f. The results with any discrepancies or irregularities identified

g. The initial technical test data shall be provided to the OWNER on bond paper for distribution

21.4 Relay Settings

21.4.1 The TESTER shall apply all approved protective relay settings and return to the OWNER the setting sheet or electronic setting data as a certified document/record.

a. The TESTER shall log protective relay setting and logic setting requests upon receipt. Revisions shall be tracked. Upon completion, the TESTER shall sign the cover sheet and return to the OWNER the completed forms and the “as left” relay settings file downloaded from the protective relays.

b. OWNER will specify the format of the “as left” setting file to be saved. The saved file will normally be the same filename as the setting file followed by **_r** which designates that this is a downloaded file. Example Andover 3_87T3 TD/OC_01_01_2009**_r**.mdb

21.5 As-Builts Test Records

21.5.1 At the conclusion of the project, the TESTER shall provide four (4) certified copies of all test records for work performed. This includes conductor insulation tests, ground resistance, circuit continuity, primary or secondary equipment tests etc. The test data records shall be supplied in a bound indexed binder format.

21.5.2 In addition to the required hard copies, all the records and documents including test results shall be in an electronic DVD or CD format. Four (4) copies of the electronic disks (DVD or CD) shall be provided.

21.5.3 A copy of the Protest Database that was used for protective relay testing will be turned over to the owner when requested for periodic review during the project and at the completion of the project.

21.5.4 OWNER has the right to request and the TESTER will provide test results or database during the course of the project.

21.6 As-Builts Drawings

21.6.1 As-Builts are defined as specified changes noted on construction drawings that identify changes per field modifications or observations.

21.6.2 The CONSTRUCTOR/TESTER shall return one copy of every drawing issued, even if no field changes are made on the drawing. Follow Engineering Document PR.02.00.005 Field Change Mark-Up and As-Built Drawings Procedure.

21.6.3 Mark-Up Requirement

a. As-Builts need to be submitted to the Station Engineering & Design Manager

b. As-Builts must be legible

c. As-Builts must be made with red and green colors only. Additions should be noted in red. Deletions should be noted in green.

d. Do not use white out to cover areas of the drawing. This makes it difficult to determine what is changing.

e. Do not use highlighters to color photocopies

f. Original hand as-builts should be submitted

g. Use “stamped” sets for the returned as-builts

h. One copy of every drawing issued shall be returned, even if no field changes are made on the drawing.

i. As-builts from both Relay & Control and Stations should be on the same set of drawings (or at a minimum submitted at the same time).

j. A second complete set of drawings including as-builts information shall be kept in the substation for reference until drawings are issued by Engineering and the substation set replaced.

k. The individual responsible for the work should sign and date as-builts. That way, if questions arise we know whom to contact.

l. As-Builts must be complete and thorough

1. Make sure that changes reflected on one drawing are also shown on associated drawings. (Single Line, AC/DC, Wiring, Panel Fronts, Physicals, etc.)

2. Show conduits with accurate dimensions to reference points such as structures or equipment centerlines.
3. As-Builts should be inclusive of all disciplines.
4. As-Builts should improve the quality of drawings by correcting ANY/ALL incorrect information shown on the prints affected, even if the information does not pertain to that specific project.

m. All affected drawings and diagrams will be marked up as ”Field Checks” and returned to Functional Engineering department within 30 days from acceptance date with notification to the Project Manager.

21.7 Power Equipment Decommissioning Documentation

21.7.1 The CONSTRUCTION SUPERVISOR shall ensure the Power Equipment Decommissioning Worksheets section of this procedure is followed for all electrical apparatus to be removed from service for disposal as defined for the project.

21.8 Manuals and Instruction Books

21.8.1 All manuals, instruction books, or other manufacturer provided documentation used by the TESTER / CONSTRUCTOR shall be provided to the OWNER for distribution to local Substation Management and Substation Work Methods as required.

21.9 The Tester shall

21.9.1 Document all test results for each test requirement outlined in this specification. The test readings shall become benchmarks for all future evaluations.

21.10 Test Results - Each Test shall

21.10.1 Be accompanied by an initial test report including the date, name and contact information of the individual making the test, a description of the test e.g. the system or device and test equipment used with the hardware identification number and certification date, the test results, and any discrepancies or irregularities identified. The initial technical test data shall be provided to the OWNER on bond paper for distribution.

21.11 Relay Settings - The Tester shall

21.11.1 Apply all approved protective relay settings and return to the OWNER a setting sheet or electronic setting data as a certified document/record.

21.12 As-Built Test Records - Project Conclusion

21.12.1 At the conclusion of the project, four (4) certified copies of all test records for work conducted by the TESTER shall be provided. This includes conductor insulation tests, ground resistance, circuit continuity, primary or secondary equipment tests etc. The test data records shall be supplied in a bound indexed binder format.

21.12.2 In addition to the required hard copies, all the records and documents supplied by the TESTER, including test results, may be requested in electronic DVD or CD format. Number of copies shall be determined by OWNER.

22.0 RELAY and WIRING TESTING DOCUMENTATION

For all tests including Doble Engineering equipment, paper and electronic test results shall be provided to OWNER. The TESTER shall document all test results for each test requirement outlined in this specification. The test readings shall become benchmarks for all future evaluations.

APPENDIX G - Current Transformer Excitation Form

APPENDIX H - Single Phase Secondary Current Injection Form

APPENDIX I - Three Phase Secondary Injection Form

APPENDIX J - In-Service Load Checks Form

APPENDIX K - AC Potential Circuit Secondary Injection Form

APPENDIX L - AC Potential Circuit In-Service Form

APPENDIX M - Functional Trip Test Form

APPENDIX N - Scheme Test Form

APPENDIX O - Relay Operating Test Form

APPENDIX P - Relay Test Lead Form

APPENDIX Q - Wave Trap / Line Tuner Form

APPENDIX R - Equipment Data Form

APPENDIX S - Open Link / Lifted Lead Log Form

APPENDIX T - Point-To-Point Wire Check

23.0 SUBSTATION WORK ORDER SUMMARY and EQUIPMENT/RELAY DATA FORMS

23.1 System Changes to National Grid substations

23.1.1 Must be provided to Substation Work Methods (equipment) or Protection Services & Support (relay) for updating the Computerized Maintenance Management System (CMMS) database.

23.1.2 Equipment/Relay Nameplate information shall be collected using the Substation Work Order Summary form by the TESTER/CONSTRUCTOR for each individual piece of apparatus being installed or removed from service.

23.1.3 Equipment/Relay Data Forms - When specified by the OWNER, Equipment Data Forms (EDF) may be requested to be completed to collect additional nameplate information for equipment being installed.

23.1.4 OWNER will supply the Substation Work Order Summary and EDF forms, if required for the project, to collect the necessary information.

23.1.5 The CONSTRUCTOR/TESTER shall complete the required Forms upon the installation of the apparatus in an operating position and submit the data.

23.1.6 All completed Forms shall be submitted to the CONSTRUCTION SUPERVISOR.

23.1.7 CONSTRUCTION SUPERVISOR shall ensure completed forms are submitted for the project folder and a copy provided to Substation Work Methods (equipment forms) or Protection Standards & Support (relay forms) for updating the CMMS database.

24.0 POWER EQUIPMENT DECOMMISSIONING WORKSHEET

24.1 Requirement

24.1.1 Power Equipment Decommissioning worksheets are required for all apparatus to be removed from service and disposed of as defined for the project.

24.2 The Owner shall:

24.2.1 Supply the blank Power Equipment Decommissioning worksheets to the CONSTRUCTION SUPERVISOR.

24.3 Filling Out Form

24.3.1 A Power Equipment Decommissioning form shall be filled out by the CONSTRUCTION SUPERVISOR for each individual piece of apparatus removed for disposal as defined by the construction project.

24.4 The Construction Supervisor shall

24.4.1 Notify Investment Recovery and Substation Work Methods to coordinate arrangements for apparatus disposal.

24.5 Reference

24.5.1 Refer to Investment Recovery & Recycling Services SMP 471.03.2 - Substation Equipment Decommissioning Procedure and SMP 471.03.3 - Substation Equipment Decommissioning Check-List

25.0 ENERGIZATION PROCESS

25.1 Energization Process

25.1.1 The ENERGIZATION COORDINATOR shall be selected and named at the Project Team kick-off Meeting.

25.1.2 The ENERGIZATION COORDINATOR shall obtain the names of those individuals that will be responsible to complete the specific sections of the project Outage Plan.

25.1.3 The ENERGIZATION COORDINATOR shall ensure that the individuals named to complete the specific sections of the Outage Plan are informed if they were not directly involved in the initial meeting and a copy of the list is provided to the individuals listed on the form.

25.1.4 The ENERGIZATION COORDINATOR shall inform the personnel designated to assist in the Outage plan at least one (1) month in advance of the upcoming energization date and tentative rain date.

25.1.5 The ENERGIZATION COORDINATOR shall contact the appropriate Control Center to ensure that the EMS screens are updated to reflect the new installation.

25.2 Outage Plan

25.2.1 The purpose of creating an Outage Plan is to create a step-by-step sequence of what specific outages are required in order to accomplish Project Work. The Outage Plan:

a. Will allow a more accurate cost estimation for the Sanctioning of a project.

b. Will provide Project Management and Operational Planning and Review (OPR) a tool to sequence work on a long term portfolio basis.

c. Will be a valuable tool to communicate plans with others, including other Transmission Operators and Independent System Operators.

d. Is not intended to identify detail switching requirements or the sequence of expanding and collapsing specific Clearance points. It has been a good practice however for the Outage Plan to identify specific Outages required to open and close loops.

e. Is not intended to replace TOA applications for scheduling work, however, the Outage Plan will be a great tool to aid the Construction Supervisor when submitting TOA applications.

25.2.2 The PROJECT MANAGER shall arrange for a team meeting for the development of the project Outage Plan. The project outage plan should be submitted by the Project manager to the Outage Coordinator for approval.

25.2.3 After the Outage Plan is created and approved, TOAs will be submitted in accordance with the TOP-08 lead times.

25.2.4 The OUTAGE COORDINATOR shall:

a. Be a member of the project Outage Plan team

b. Reviews TOA against LAR, TOG, and other conflicts for the Outage Plan.

c. Prepares a workable sequenced outage plan.

d. Notifies the major parties affected to establish the required switch persons.

25.2.5 The APPLICATION COORDINATOR receives TOAs based on the final/firm outage plan with proper 'minimum' lead times (10, 30, 120 days). TOAs are reviewed for completeness and makes notifications as needed. Forwards TOAs to OUTAGE COORDINATOR for processing.

25.2.6 The APPLICATION COORDINATOR assists the ENERGIZATION COORDINATOR with energization plan - step by step details.

a. The Outage Plan shall include such items as but not limited to:

1. Steps for the removal of grounds and releasing of corresponding Clearances
2. A sequence of switching to energize or de-energize apparatus
3. Required phasing and synchronization tests
4. Load and operational tests required to place the apparatus or systems on line without risk to the electrical infrastructure

25.2.7 The APPLICATION COORDINATOR sends approved TOAs on to Control Room.

25.2.8 The associated switching orders for the Outage Plan shall be forwarded by the Control Room to the designated team members identified at the initial meeting for review and implementation.

25.3 Outage Plan Coordination and Responsibilities

25.3.1 At least one (1) month before the anticipated initial energization date, the PROJECT MANAGER, CONSTRUCTOR, TESTER, CONSTRUCTION SUPERVISOR, CONTROL CENTER COORDINATOR, OUTAGE COORDINATOR, APPLICATION COORDINATOR, and ENERGIZATION COORDINATOR will meet to review the approved Outage Plan.

a. Note: additional time should be considered if the project outage plan needs to be updated to meet TOP-08 lead times.

25.3.2 If deemed necessary by the ENERGIZATION COORDINATOR, an on-site meeting will be held prior to the energization date to review details of the initial energization.

25.4 Responsibilities prior to and during the Energization process.

25.4.1 The TESTER/CONSTRUCTOR shall:

a. Follow the TESTER/CONSTRUCTOR (TC) Checklist in Appendix C.

25.4.2 The ENERGIZATION COORDINATOR shall:

a. Follow the Energization Coordinator (EC) Checklist in Appendix A.

25.5 Outage Coordination and Applications

25.5.1 Where new interconnections with adjacent foreign utilities are made, appropriate steps shall be followed to establish the proper inter-company guarantees through the utilization of the Clearance and Control Procedures.

25.5.2 The CONTROL CENTER OUTAGE COORDINATOR shall inform the ISONE or NYISO of the planned and/or successful energization of the facility as required.

25.5.3 Once the facility has been turned over to the CONTROL CENTER, any further testing or maintenance requiring the de-energization of equipment for Clearances must be conducted per the current process and a TOA submitted for approval.

25.6 Approvals for Energization

25.6.1 Prior to the energization of new facilities, the ENERGIZATION COORDINATOR shall ensure that the required testing and certifications have been completed and the results have been reviewed and found acceptable.

25.7 Steps Prior to Initial Energization

25.7.1 The ENERGIZATION COORDINATOR shall ensure that appropriate fixed taps and load tap changing information have been provided to the CONSTRUCTION SUPERVISOR. The tap positions and the LTC voltage level, band width, and compensation settings shall be provided, installed, and verified before the initial energization of the transformer.

25.7.2 Prior to energization, all deluge or fire protection systems, where installed, shall be fully operational.

25.8 Phasing and Synchronization Steps

25.8.1 Phasing and synchronization tests shall be made by the TESTER on all circuits that can be energized from two or more sources.

a. The phasing and synchronization is to be identified in the Outage plan.

b. A visual walk down inspection, where possible, shall be made prior to energization to check for proper phase installations.

c. When interconnecting with adjacent utilities using other than the phase 1, 2, 3 notation, proper correlation of phasing shall be made during the design stage.

d. Following energization, phase identification and rotation shall be verified before interconnection with the system or picking up load.

e. Phasing tests should verify transformer nameplate phase relationships.

25.8.2 Test operation of synchroscopes on control boards by comparing two potentials energized from the same source.

a. Check and record all phase angles on all phases for permanent record.

25.8.3 After synchroscopes have been tested, test synchronizing connections and synchronism check relays for individual lines

a. By operation of respective synchronizing switches, or removal of individual potential sources to the synchroscope or relay

25.9 Load and Operation Tests

25.9.1 For each step of the bus or equipment Outage Plan, the TESTER shall measure and record:

a. Voltage checks on all applicable relays, meters, etc

b. Phase angle checks on all applicable relays, meters, etc

25.9.2 Once load is applied, the TESTER shall complete a final set of load tests and checks to include, but not be limited to, the following:

a. Current checks on all applicable relays, meters, etc

b. Voltage checks on all applicable relays, meters, etc

c. Phase angle checks on all applicable relays, meters, etc

d. The measurements may also be made by obtaining the protective relay records.

e. Should breakers need to be opened to facilitate a load test, a TOA may be required by the appropriate ISO when system load flow changes dictate.

25.9.3 The TESTER shall also record all circuit breaker operation counter readings, and circuit breaker gas pressure readings, where applicable.

25.9.4 The TESTER shall perform a test on the new revenue meters to verify the meter wiring and final accuracy, when there is sufficient load.

25.10 Operating Requirements

25.10.1 The ENERGIZATION COORDINATOR shall:

a. Coordinate with the CONTROL CENTER the development of the required substation operating procedures for new or modified National Grid substations as necessary.

b. Ensure that changes to the substation Operating Diagrams are submitted to Substation Engineering and Design for updating and distribution.

25.11 Trouble / Emergency Switching

25.11.1 If either the SYSTEM OPERATOR or the Switch Person determines that there is a safety or operational concern they must stop all switching and communicate these concerns to the SYSTEM OPERATOR and the ENERGIZATION COORDINATOR.

a. The OUTAGE COORDINATOR and ENERGIZATION COORDINATOR will review the concern and modify the Outage Plan if necessary before proceeding.

25.11.2 Under emergency conditions that endanger life or property, a qualified person working for National Grid can perform switching to open apparatus without first contacting the SYSTEM OPERATOR per EOP G014 Clearance and Control.

a. The person performing the emergency switching assumes full responsibility for the switching and must inform the SYSTEM OPERATOR and ENERGIZATION COORDINATOR as soon as possible.

b. If a device is opened for any reason, it shall not be closed without receiving permission from the SYSTEM OPERATOR.

26.0 APPENDIX A - ENERGIZATION COORDINATOR (EC) CHECKLIST

ENERGIZATION COORDINATOR Checklist

Project Title: ________________________________ Project Funding No: ________________________

Name:______________________________________ Dept:_________________ Date:______________

The following checklist is not intended to be in sequential order

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

The **ENERGIZATION COORDINATOR** shall ensure that all of the following steps have been completed for the energization phase of the project.

- ☐ EC1- Ensure the Commissioning and Energization Team Member list is completed.
- ☐ EC2- Collaborate with the OUTAGE COORDINATOR to develop the Outage Plan.
- ☐ EC3- Coordinate with the CONSTRUCTION SUPERVISOR, TESTERS, and OUTAGE COORDINATOR the necessary construction, testing, and operating requirements for initial energization.
- ☐ EC4- Determine and inform all concerned parties the method of voice communication to be used during the commissioning / energization process.
- ☐ EC5- Ensure appropriate personnel are scheduled to perform the removal of personal protective grounds, releasing of corresponding EOP G014 Clearances, and to perform the required switching to energize or de-energize apparatus.
- ☐ EC6- Confirm all personal grounds are removed and grounding switches, if applicable, have been opened checked opened, and locked in the open position.
- ☐ EC7- Verify all circuit breaker air, SF6, or hydraulic pressures are normal.
- ☐ EC8- Verify operations counters on all apparatus used for energization have been recorded.
- ☐ EC9- Confirm automatic reclosing has been disabled from circuit breakers used for energizing apparatus or circuits
- ☐ EC10- Be present and witness the initial energization or operation of equipment.
- ☐ EC11- Ensure initial energization of equipment is performed in accordance with the energization sequence per the Outage Plan.
- ☐ EC12- Ensure all primary and secondary connections have been made and Clearance released in order to initiate the Outage Plan.
- ☐ EC13- Ensure load and power flows after initial energization are performed.
- ☐ EC14- Verify voltage regulation and parallel schemes are operational.
- ☐ EC15- Verify DGA sample is taken before energizing.
- ☐ EC16- All transformers shall be allowed to remain energized after initial energization before applying load to the transformer. Deviations from these times must be discussed with Substation O&M Services prior to energization and development of the energization sequence.
- ☐ EC17- Ensure additional DGA samples are taken within 1 week of initial energization and monthly thereafter for the first three months

ENERGIZATION COORDINATOR Checklist

Project Title: ______________________________ Project Funding No: ______________________

Name:____________________________________ Dept:________________ Date:_____________

<u>The following checklist is not intended to be in sequential order</u>

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

- ☐ EC18- Have full responsibility to hold the release of the new facility to the Control Center until any and all issues associated with the initial energization have been satisfied
- ☐ EC19- Coordinate the amendment of the initial Outage Plan if required, with the consent of OUTAGE COORDINATOR.
- ☐ EC20- Ensure all training required is completed for new apparatus
- ☐ EC21- Ensure all reports are submitted by TESTER in paper and electronic format
- ☐ EC22- Ensure a setting sheet or electronic setting data is submitted by TESTER
- ☐ EC23- Ensure As-Built Test Records are completed and submitted
- ☐ EC24- Ensure As-Built Drawings are completed and submitted
- ☐ EC25- Ensure Change and Addition or Equipment Data Forms are completed and submitted
- ☐ EC26- Ensure Power Equipment Decommissioning Worksheets are completed and submitted.
- ☐ EC27- Ensure Acceptance Certificate – Part 1 OFF-LOAD Inspection and Acceptance Testing Form is completed and submitted.
- ☐ EC28- Ensure Acceptance Certificate – Part 2 – ON-LOAD Inspection and Acceptance Testing is completed and submitted.
- ☐ EC30- If applicable ensures station operating diagram has been completed or updated as necessary.
- ☐ EC31- Turnover facilities to Local Operations which includes all completed acceptance and inspection/maintenance forms.
- ☐ EC32- Ensure all necessary Relay, DETC, LTC settings are available for installation.

Special Precautions:

Note: The Control Center and Customer Operations designees shall de-energize the facilities immediately if problems are encountered, or other unusual conditions are detected following initial energization.

The OWNER, or his Representative, may stop energization from proceeding if such work, in their estimation, will or may cause OWNER'S system to operate unsatisfactorily or jeopardize service to its electric customers or if ISONE or NYISO so requires.

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27.0 APPENDIX B - CONSTRUCTION SUPERVISOR (CS) CHECKLIST

CONSTRUCTION SUPERVISOR (CS) Checklist

Project Title: ________________________________ Project Funding No: ________________________

Name:_______________________________________ Dept:__________________ Date:______________

The following checklist is not intended to be in sequential order

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

The **CONSTRUCTION SUPERVISOR** shall ensure that all of the following steps have been completed for the commissioning phase of the project.

- ☐ CS1- Coordinate and oversee the physical installation and acceptance testing as required for the commissioning phase of the project.
- ☐ CS2- Ensure all aspects for job safety are followed for the project, (i.e. Work Area Identification, PPE, personal protective grounding, Eye Wash Station, Fire Extinguishers, etc.).
- ☐ CS3- Attend project meetings as required.
- ☐ CS4 - Assist in the development of the project Outage Plan and complete all steps assigned.
- ☐ CS5- Ensure the TOA process is followed and coordinates with the CONTROL CENTER and ENERGIZATION COORDINATOR the appropriate zone of protection required to obtain the necessary Clearances for testing and commissioning.
- ☐ CS6- Complete work required for initial energization. Note: No work is to proceed on primary voltage existing facilities until authorization for Clearances have been given or obtained.
- ☐ CS7- Obtain, hold, or ensure Clearance is in place on existing facilities to allow final permanent connections to be made as required for construction or testing.
- ☐ CS8- Verify required telephone circuits will be available for the project from Telcom engineering.
- ☐ CS9- Participate in the Outage Plan and ensure TOA's follow TOP-08 lead times.
- ☐ CS10- Ensure all acceptance, electrical, relay testing is identified and who will perform.
- ☐ CS11- Ensure technical inquiries, variances, and approvals are documented and submitted by the TESTER. Notify appropriate departments or issues and resolutions.
- ☐ CS12- Ensure Change and Addition process is followed and information is submitted online.
- ☐ CS13- Ensure Equipment Data Forms are completed and submitted, if so required.
- ☐ CS14- Ensure all Electrical Apparatus Inspection Cards are completed and submitted.
- ☐ CS15- Ensure all training required is completed for new apparatus.
- ☐ CS16- Ensure Power Equipment Decommissioning Worksheets are completed and submitted.
- ☐ CS17- Ensure As-Built Drawings are completed and submitted.
- ☐ CS18- In conjunction with the TESTER and ENERGIZATION COORDINATOR, perform necessary corrective work required during initial energization if so required.
- ☐ CS19- Verify settings and proper operation of AC Transfer Switch. Obtain transfer switch operating requirements and settings from local substation management.
- ☐ CS20- Ensure Standby Generator installed and tested per SMP.

CONSTRUCTION SUPERVISOR (CS) Checklist

Project Title: ____________________________________ Project Funding No: __________________________

Name:____ Dept:___________________ Date:_______________

The following checklist is not intended to be in sequential order

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

- ☐ CS21- Ensure physical security of yard, doors, and alarms are functioning properly.
- ☐ CS22- Ensure all required tests are completed prior to initial energization.
- ☐ CS23- Coordinate with manufacturer's field representative when such representative's presence is required for initial energization.
- ☐ CS24- Provide personnel during initial energization as required.
- ☐ CS25- Verify all secondary fuses are installed in their respective AC and DC circuits for initial energization.
- ☐ CS26- Coordinate an onsite walk through with the principle team members as required (PM, TESTER, ENERGIZATION COORDINATOR) Assist the PM in the preparation of a Punch List. The Punch List will identify items that require corrective measures or follow-up prior to energization.
- ☐ CS27- Coordinate the completion of the Punch List items and informs the ENERGIZATION COORDINATOR when the facilities installed are ready for initial energization.
- ☐ CS28- Ensure Punch List (including site walk through) is completed and submitted with corrective action items completed.
- ☐ CS29- Complete appropriate sections of the Acceptance Certificate – Part 1 OFF-LOAD Inspection and Acceptance Testing Form is completed and submitted.
- ☐ CS30- Complete appropriate sections of the Acceptance Certificate – Part 2 – ON-LOAD Inspection and Acceptance Testing is completed and submitted.
- ☐ CS31- Turnover to Local Operations, and others as requested, all completed acceptance and inspection/maintenance forms.
- ☐ CS32- Ensure CONSTRUCTOR / TESTER site demobilization is completed.
- ☐ CS33- Ensure all electrical equipment, perimeter gates, and control buildings have padlocks installed as required.

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28.0 APPENDIX C - TESTER/CONSTRUCTOR (TC) CHECKLIST

TESTER/CONSTRUCTOR (TC) Checklist

Project Title: ______________________________________ Project Funding No: ____________________

Name:_______________________________________ Dept:__________________ Date:_______________

The following checklist is not intended to be in sequential order

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

The **TESTER/CONSTUCTOR** shall ensure that all of the following steps have been completed during the construction phase of the project.

- ☐ TC1 - Participate in the initial Project Team Meeting, accepts, and/or assigns responsibilities as required per the Project Management Playbook.
- ☐ TC2 - Attend project meetings as required to review issues and work completed
- ☐ TC3 - Review Engineering drawings prior to formal review (Page Turn)
- ☐ TC4 - Review formal Engineering drawing issue.
- ☐ TC5 - Create a set of working drawings to keep track of testing and as-built information.
- ☐ TC6 - Participate in a Project Pre-Construction meeting.
- ☐ TC7 - Develop and execute a secondary circuit isolation plane (See Appendix U).
- ☐ TC8 - Coordinate the isolation and testing with the physical installation of the equipment and construction schedule as required.
- ☐ TC9 - Ensure all aspects for job safety are followed for the work being performed.
- ☐ TC10 - Ensure TESTERS/CONSTRUCTORS are working under appropriate Clearances that provide adequate work zone protection for the work being performed.

  Note: No work is to proceed on primary voltage existing facilities until authorization for Clearances have been given or obtained.
- ☐ TC11 - Coordinate with the CONSTRUCTION SUPERVISOR to obtain the required clearances.
- ☐ TC12 - Ensure technical inquiries, variances, and approvals are documented and submitted to the CONSTRUCTION SUPERVISOR. Notify appropriate departments of issues and resolutions.
- ☐ TC13 - Ensure Change and Addition process or Equipment Data Forms are completed and submitted.
- ☐ TC14 - Ensure Relay Data Forms are completed and submitted
- ☐ TC15 - Ensure all training required is completed for new systems and equipment.
- ☐ TC16 - Ensure As-Built Drawings are completed and submitted.
- ☐ TC17 - In conjunction with the CONSTRUCTION SUPERVISOR, perform necessary corrective work required during installation or initial energization. Ensure punch list items are completed and corrective actions items submitted.
- ☐ TC18 - Make final preparations (e.g. remove/add test leads or jumpers, close slide links) required for initial energization.
- ☐ TC19 - Complete all construction and testing required for initial energization.

TESTER/CONSTRUCTOR (TC) Checklist

Project Title: ______________________________________ Project Funding No: _____________________

Name:_______________________________________ Dept:_________________ Date:_______________

The following checklist is not intended to be in sequential order

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

- ☐ TC20 - Verify all necessary test blocks are in place.
- ☐ TC21 - Verify all secondary fuses sizes and that they are installed in their respective AC and DC circuits.
- ☐ TC22 - Verify all required AC and DC supplies are in service and have satisfactory voltage.
- ☐ TC23 - Test for battery grounds before and during construction and prior to energization.
- ☐ TC24 - Verify all necessary trouble alarms are working and in service.
- ☐ TC25 - Verify all necessary communications for relaying are in service.
- ☐ TC26 - Verify all required oscillographs and other recorders have been installed and are ready to operate if so required.
- ☐ TC27 - Verify grounding switches on coupling-capacitor type voltage transformers (CCVT) are open.
- ☐ TC28 - Verify all required metering is in service.
- ☐ TC29 - Verify that turning on all pumps simultaneously on the transformer, if so equipped will not operate the fault pressure relaying.
- ☐ TC30 - Obtain and install all necessary Relay, DETC, LTC settings.
- ☐ TC31 - Coordinate with manufacturer’s field representative for initial energization when such representative’s presence is required.
- ☐ TC32 - Provide personnel during initial energization as required or on an as agreed to basis.
- ☐ TC33 - Ensure all tests are performed and documented on the appropriate forms and electronic files are completed and submitted to the OWNER. The electronic format will be agreed to at the project meeting.
- ☐ TC34 - Ensure the as-left protection setting sheets or electronic settings file are submitted to the PROTECTION ENGINEER if so required.
- ☐ TC35 - Complete all steps of the Outage Plan as assigned.
- ☐ TC36 - Inform ENERGIZATION COORDINATOR that all protective relays, temporary protective relays, back-up relaying, or other devices designated in the Outage Plan are in service or ready for service.
- ☐ TC37 - Complete appropriate sections of the Acceptance Certificate - Part 1 OFF-LOAD Inspection and Acceptance Testing Form is completed and submitted.
- ☐ TC38 - Ensure that the Substation Operating Diagram has been updated.
- ☐ TC39 - Perform current, voltage and phase angle measurements on all protection and metering CT circuits.
- ☐ TC40 - Complete appropriate sections of the Acceptance Certificate - Part 2 ON-LOAD Inspection and Acceptance Testing is completed and submitted.
- ☐ TC41 - Turn over all manuals and test documents to the appropriate personnel.
- ☐ TC42 - Update all necessary local and shared relay setting databases.

TESTER/CONSTRUCTOR (TC) Checklist

Project Title: ______________________________________ Project Funding No: _____________________

Name:_______________________________________ Dept:__________________ Date:_______________

The following checklist is not intended to be in sequential order

✓ a checked box indicates item Completed --- a strikethrough box indicates item Not Applicable

- ☐ TC43 - Update substation and office drawings with As-Built information.
- ☐ TC44 - Initiate, monitors, and ensures site demobilization.
- ☐ TC45 - Participate in a Post Construction Project Review Meeting.

Notes:

____

____

29.0 APPENDIX D - COMMISSIONING & ENERGIZZATION TEAM MEMBER LIST

Project Initiation Project Team List Procedure PR.09.01.000 shall be followed to select team members. PROJECT MANAGER and ENERGIZATION COORDINATOR are to ensure the Commissioning and Energization Team Members are selected at time of Project Team Meeting.

Project No. CCCCCC Work Order No 9999999999
Description
Sponsor(s)
Project Team List

Issue Date:

Function	Name	Office Phone	Cell Phone	Email (if not standard)	Location
Project Manager					
Electrical Engineer					
Civil Engineer					
Relay Engineer					
Control & Instrumentation Eng					
Meter Engineer					
Telecom Engineer					
Transmission Line Engineer					
Planning Engineer					
Asset Sponsor					
Design – Civil					
Design - Structural					
Design - Electrical					

Function	Name	Office Phone	Cell Phone	Email (if not standard)	Location
Design – Primary					
Design – Secondary					
Design – Admin					
Design – Transmission Design					
Regional Environmental Eng.					
Permitting – Environmental					
Legal					
Substation Work Methods					
Business Services					
Station Construction Services					
Transmission Line Services					
Meter, Relay &/or Testing Field Supervisor					
Power Delivery or O&M Field Supervisor					
Real Estate					
Outage Planner					
Dispatch/Control Switching					
Dispatch/Control EMS					
Dispatch/Control RTU					
Safety					

Function	Name	Office Phone	Cell Phone	Email (if not standard)	Location
Security					
Supply Chain Management					

For Contractors acting as team members the Location field shall contain the name of the contracting organization and a full mailing address.

30.0 APPENDIX E - ACCEPTANCE CERTIFICATE - PART 1

ACCEPTANCE CERTIFICATE – PART 1 COMPLETION: OFF-LOAD INSPECTION and ACCEPTANCE TESTING	
Project Title:	Project Funding No:
The Apparatus and/or Relays identified below have been satisfactorily OFF-LOAD tested per the required sections of Substation Maintenance Procedure SMP 400.80.2 Commissioning and Energization Procedure and conditions specified in the contract. The Apparatus and/or Relays may now be energized and tested in accordance with PART 2 of the Commissioning Plan. All appropriate forms, Inspection Cards, and Tests Results have been provided to the ENERGIZATION COORDINATOR.	
DESCRIPTION OF APPARATUS and/or RELAYS TESTED	**DESCRIBE WORK PERFORMED**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
EXCEPTIONS: OUTSTANDING WORK (List items that remain outstanding, remediation plan and responsible party).	
ISSUED BY:	Date:
ACKNOWLEDGED BY:	Date:

31.0 APPENDIX F - ACCEPTANCE CERTIFICATE - PART 2

ACCEPTANCE CERTIFICATE – PART 2 COMPLETION: ON-LOAD INSPECTION and ACCEPTANCE TESTING	
Project Title:	Project Funding No:
The Apparatus and/or Relays identified in PART 1 of the ACCEPTANCE CERTIFICATE, and as listed below, have been satisfactorily ON-LOAD tested per the required sections of Substation Maintenance Procedure SMP 400.80.2 Commissioning and Energization Procedure and conditions specified in the contract and are available for operational service with any Exceptions or Limitations noted below. The drawings and requirements for operational service of the Apparatus and/or Relays have been provided to the ENERGIZATION COORDINATOR.	
DESCRIPTION OF APPARATUS and/or RELAYS TESTED	**DESCRIBE WORK PERFORMED**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
EXCEPTIONS: OUTSTANDING WORK (List items that remain outstanding, remediation plan and responsible party).	
ISSUED BY:	Date:
ACKNOWLEDGED BY:	Date:

32.0 APPENDIX G - CURRENT TRANSFORMER EXCITATION FORM

CT EXCITATION SHEET

STATION	DATE
CIRCUIT	TEST BY
TRANS / BKR / DEVICE SERIAL NO.	MAKE

POLARITY [ ] MEGGAR [ ]

PHASE										
BUSHING										
CT BLOCK										
TAPS										
AMPS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS	VOLTS
							SKETCH			

TYPE						
CODE						
TURNS	X1 X2 X3 X4 X5	X1 X2 X3 X4 X5	X1 X2	X1 X2		
Excited Taps						
IN SERVICE TAPS						
IN SERVICE RATIO						

	REVISIONS		DATE	BY
1				
2				
3				

33.0 APPENDIX H - SINGLE PHASE SECONDARY CURRENT INJECTION FORM

34.0 APPENDIX I - THREE PHASE SECONDARY INJECTION FORM

STA. ______________________ PRI CIR ________________________ DATE __________
CT LOC & ID __________________________ AØ __________ BØ ___________ CØ _____
CT RATIO & TAPS ______________________________ GRD (S) LOC ________________
CIR MEGGER _______________ CABLE # ____________

Bumping Quantities	TEST SET							
IA = 1 amp @ 0'	1 @ 0'	PHASE						
IB = 2 amp @ 120'	2 @ -120'	BUSHING						
IC = 3 amp @ 240'	3 @ +120	BLOCK						
IG = 1.73 amp @ 210'		BUMP FROM TAPS						

Device	Stud No.	D - DG		E - EG		F - FG	
BURDEN @ 3 AMPS = __________							
BURDEN @ 3 AMPS = __________							
BURDEN @ 3 AMPS = __________							

35.0 APPENDIX J - IN SERVICE LOAD CHECKS FORM

IN SERVICE / LOAD CHECKS

STATION: ______________________ DATE: __________

CIRCUIT: ______________________ REF: ____________________
____
____

PAGE ___ OF ___ TECH'S: _________

CIRCUIT	PH	STUD	CT RATIO			

NOTE:____
____
____
____
____

36.0 APPENDIX K - AC POTENTIAL CIRCUIT SECONDARY INJECTION FORM

AC POTENTIAL CIRCUIT SECONDARY INJECTION

STATION:	DATE:	
CIRCUIT:	CABLE#	PANEL#
BUMPING FROM:		
VA =	VB =	VC =

CIRCUIT	PHASE	STUD	PHASE TO PG	PHASE	STUD	PHASE TO PHASE

37.0 APPENDIX L - AC POTENTIAL CIRCUIT IN-SERVICE FORM

AC POTENTIAL CIRCUIT IN-SERVICE MEASUREMENT

STATION:	DATE:
CIRCUIT:	
NOTE:	REF:

CIRCUIT	PHASE	STUD	PHASE TO PG	PHASE	STUD	PHASE TO PHASE

38.0 APPENDIX M - FUNCTIONAL TRIP TEST FORM - Sheet 1, 2, & 3

	Fill in information in blocks below:
Office:	National Grid
CWU:	22212
Station Name:	Somewhere
Voltage kV:	345
File name:	Somewhere 345 Trip Test.xls

Make sure this file name matches what is actually saved

Relay Operations Group			October 13, 2009
National Grid	22212		
Type 1 Test Trip Report		kV:	345
Station:	Somewhere		
Test Date:	_____/_____/_____	File:	Somewhere 345 Trip Test.xls

	Fill in information in blocks below:
Office:	National Grid
CWU:	22212
Station Name:	Somewhere
Voltage kV:	345
File name:	Somewhere 345 Trip Test.xls

Make sure this file name matches what is actually saved

Relay Operations Group — October 13, 2009

National Grid — 22212

Type 1 Test Trip Report — kV: 345

Station: Somewhere

Test Date: ____/____/____ — File: Somewhere 345 Trip Test.xls

Circuit	System	O-T	Date	Remarks

	Fill in information in blocks below:
Office:	National Grid
CWU:	22212
Station Name:	Somewhere
Voltage kV:	345
File name:	Somewhere 345 Trip Test.xls

Make sure this file name matches what is actually saved

Relay Operations Group — October 13, 2009

National Grid 22212

BFI Functional Test kV: 345 Techs: ________________

Station: Somewhere

Test Date: ____/____/____ File: Somewhere 345 Trip Test.xls

Circuit	BFI Source	Yes	No	Trip Relay	Links & Location	Links Open A	Links Open B	Links Clsd A	Links Clsd B	Remarks

39.0 APPENDIX N - SCHEME TEST FORM

SCHEME TEST

WORK ORDER:
Scheme test on Leeds Cap#1

"CKT SWR #2166 FAILURE & POLE DISAGREEMENT "

	DEVICE	CONTACTS	TEST DEVICE	SWITCH	TARGETS
	☐ 89/CS/SWR #2166	2,2T			
	☐ 201T/SWR #2166	7,8			
	☐ 94/SWR #2166	111,112	TS#-3/CAP #1	4,5	
	☐ 94/CAP #1	111,112	TS#-1/CAP #1	8,9	
Not In Service	☐ 86B/CAP #1	315,316	TS#-1/86B/CAP #1	6,7	
	☐ 86A/CAP #1	2,2C	TD-1/86A/CAP #1		

DEVICE :
RELAYS ABOVE } Thru { a2/SWR# 2166 & 9/SWR#2199 } Operates { 62BF/SWR#2166 ☐ → Operates { 94BF-1/SWR#2166 ☐, 94BF-2/SWR #2166 ☐ → Ann Drop #27 ☐, 74-4 /SWR#2166 ☐ → Draws target ☐ }; & 62/SI/SWR#2166 ☐ → Seals in trip from relays ☐ }

↓ 2199 closed & 2166 open
Jumper from TS#3/2166BF (9) to ☐
TS#2/PD (13) to simulate close switches

DEVICE : ☐
50 PD/SWR#2166 → Operates → 62PD/SWR#2166 ☐ → Operates { 94BF-1/SWR#2166 ☐, 94BF-2/SWR #2166 ☐, 74--3/SWR#2166 ☐ → Draws target ☐ }
(TS-2/PD 2,17)

TESTER: F Agostino, W Kellogg
DATE: 09/26/08

40.0 APPENDIX O - RELAY OPERATING TEST FORM

RELAY OPERATING TEST

STATION: ____________ BREAKER: ______ DATE: ________ TESTERS: ________

TIMING/ FIRST SHOT

Profiler #: ______

Trip 1 Test #: ______ *MCon:* ______
Close Test #: ______ *MCon:* ______
Trip 2 Test #: ______ *MCon:* ______
DC on Close *Inl.:* ______ *Min.:* ______
No timing, breaker open before test ☐

COUNTER:

Start: ______
# of Trips: ______
End: ______

TRIPS:

TRIP COIL #1

Device:	*Contacts:*	*Test Device*	*/ Studs:*	
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐

TRIP COIL #2

Device:	*Contacts:*	*Test Device*	*/ Studs:*	
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐
				☐

TIMER /RECLOSE:

	Conditions:	*Operated:*
1st Reclose:		☐
2nd Reclose:		☐
3rd Reclose:		☐
RS Contact		☐
Lockout:		☐
Reset:		☐
Manual Close:		☐

EMS /RE01:

Open ☐ *Close* ☐ *Status* ☐

ALARMS

Local ☐

ANTI-PUMP

OK ☐

BLOCKS:

Device:	*Contacts:*	*1st*	*2ND:*	*3RD:*	*Auto:*	*Man:.*
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐

43 Switch

	Auto	Man
In manual blocks →	☐	☐
In auto (auto/man) blocks →	☐	☐
In off blocks →	☐	☐
In test blocks →	☐	☐
In HS blocks →	☐	☐

REMARKS:

____

____

41.0 APPENDIX P - RELAY TEST LEAD FORM

RELAY TEST LIST

ATTACHMENT 7

Date:____________

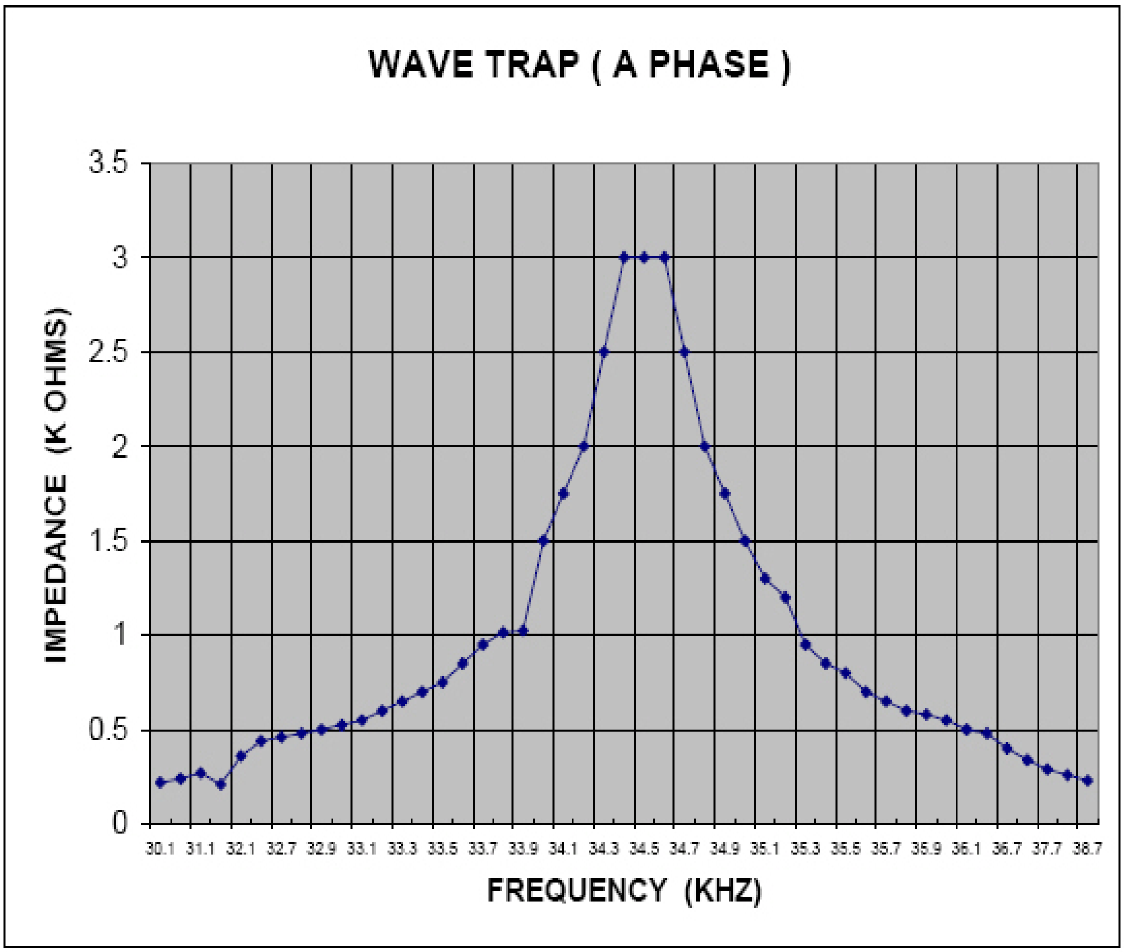
STATION No.	DESCRIPTION: Panel Identification Protected Element: Transmission Line, Bus, Transformer _______________			
ITEM	RELAY/type	NMPC DESIGNATED FUNCTION	RELAYS (CKT/FDR/TB)	TOTAL
Example: 1	SEL587	87	TB1	1
RELAY TOTALS				

Performed by: _______________ Company: ____________ Date: ________
Print Name/Signature
Approved by: _______________ Company: ______________ Date:_____
Print Name/Signature
Reviewed by: ________________ Company: _________________ Date:_____
Print Name/Signature

42.0 APPENDIX Q - WAVE TRAP / LINE TUNER FORM

Freq (KHZ)	K OHMS
30.1	0.22
30.6	0.24
31.1	0.27
31.6	0.21
32.1	0.36
32.6	0.44
32.7	0.46
32.8	0.48
32.9	0.5
33.0	0.525
33.1	0.55
33.2	0.6
33.3	0.65
33.4	0.7
33.5	0.75
33.6	0.85
33.7	0.95
33.8	1.015
33.9	1.025
34.0	1.5
34.1	1.75
34.2	2
34.3	2.5
34.4	3
34.5	3
34.6	3
34.7	2.5
34.8	2
34.9	1.75
35.0	1.5
35.1	1.3
35.2	1.2
35.3	0.95
35.4	0.85
35.5	0.8
35.6	0.7
35.7	0.65
35.8	0.6
35.9	0.58
36.0	0.55
36.1	0.5
36.2	0.48
36.7	0.4
37.2	0.34
37.7	0.29
38.2	0.26
38.7	0.23

NATIONAL GRID USA		DATE :		CARRIER FREQUENCY :	34.5	KHZ
SUBSTATION :	STATION NAME	LINE :		DTT FREQUENCY :	N/A	KHZ



Wave Trap Make:	TRENCH	LINE AMPS :	2000
TYPE	Single Freq. (Adjustable)	FREQ. RANGE:	30 - 90 KHZ
MODEL #	L2000XZ0265-632PA1	CLASS:	H
S/N #	0050385-1		
L-TAP	0		
C-TAP	1,2,3 & 4		

SUBSTATION: ______________________ DATE: __________

LINE: __________________________ SYSTEM: ______________

LINE TUNER TEST PERFORMANCE

CARRIER

CARRIER TRAP UNIT (PARALLEL L & C)
Trap to block DTT frequencies,
CARRIER side of tuner cabinet.

FREQUENCY KHZ	DTT FREQ. @ CARR SIDE DB'S	DTT FREQ. @ DTT SIDE DB'S	ISOLATION DB'S

CARRIER TUNING UNIT (SERIES L&C)

IMPEDANCE MATCHING TRANSFORMER (IMT)

FREQUENCY KHZ	REFLECTED POWER

DTT

DTT TRAP UNIT (PARALLEL L & C)
Trap to block CARRIER frequencies,
DTT side of tuner cabinet.

FREQUENCY KHZ	CARR FREQ. @ CARR SIDE DB'S	CARR FREQ. @ DTT SIDE DB'S	ISOLATION DB'S

DTT TUNING UNIT (SERIES L&C)

IMPEDANCE MATCHING TRANSFORMER (IMT)

FREQUENCY KHZ	REFLECTED POWER

43.0 APPENDIX R - EQUIPMENT DATA FORM

Equipment Data Form – Relays

Equip No. 33

Substation:

OP Position:

Package: (A, B)

Nominal kV:

Equipment:

Manufacturer:

Item:

Vendor:

Serial No:

Relay Design Type: (EM, SS, uP)

Firmware Version:

Basic Relay Range:

Warranty Date:

Installation Date:

Remarks:

2/28/06 Name: Date Completed:

44.0 APPENDIX S - OPEN LINK / LIFTED LEAD LOG FORM

OPEN LINK_LIFTED LEAD_JUMPER REMOVED LOG SHEET LOCATION __________

Designation	Date Link Opened, Wire lifted, Jumper removed	Responsible Person	Reason	Date Link Closed, Wire landed, Jumper replaced	Responsible Person

45.0 APPENDIX T - POINT-TO-POINT WIRE CHECK

Point – To – Point Wire Check

Job Aid:

- All Protection wires should be "checked after all wiring "has been terminated and considered finished.
- Using an electrician at either end of the wire, lift the wire and pass current. (Light, phone, or other equivalent instrument). This needs to be performed one wire at a time, No multiple wire checks.
- With radio or phone communication confirm the following.
  - Each electrician has the end of the same wire being checked.
  - That the wire tag is in place and is the same at each end.
  - That the wire number is correct.
  - Cable # is correct.
  - Wire color code is correct and is the same at each end.
  - That the end of the wire is terminated in the right place. (Check with drawings)
  - 1000v megger to ground test is performed.
- Record the above information in a preprinted form, to document the check.
- Re-terminate the wire.
- Physically pull/tug on the wire to confirm that it has seated firmly. (Record the re-termination.)
- Go to the next wire and perform the steps in the same manor.

Job Name & Location:	Date:
	Electricians Names:
Company Name & Location:	

Cable #	Wire #	Wire Color	Equipment From	Equipment To	Wire Check	Tag Check	Megger to Ground 1000 v	Terminal Point Check	Re – Terminal Point Check

46.0 APPENDIX U - TESTER/CONSTRUCTOR ISOLATION GUIDE for SECONDARY CIRCUITS

nationalgrid

PREFACE

Prior to the retirement of old and installation of new wiring and circuits in an operating station, it is essential that in addition to the primary high voltage protection points established by the clearance, additional protection must be established for secondary power and relay and control schemes. The circuits and schemes include:

1.1 AC station service circuits

1.2 DC station service circuits

1.3 Voltage Transformer Circuits

1.4 Current Transformer Circuits

1.5 Trip and Close Circuits from primary relay packages, secondary relay packages, breaker failure schemes, EMS/SCADA and special protection schemes.

1.6 Communication Circuits for teleprotection and other communication channels that may interface directly with the digital relays.

A Secondary Circuit Isolation Plan shall be developed by the Constructor and Tester. The following procedures and documents should be consulted to develop the plan:

1.1 NG-USA EOP G014: Clearance and Control - This procedure provides the steps and documentation necessary to establish proper tagging of secondary circuits of 600 volts or less.

1.2 PR.05.02.001: Protection System Security: Removing Protection to Facilitate Construction - This procedure provides the steps necessary and approval required to remove protective relays and schemes from service.

1.3 PR.10.03.005: Protections Systems: Mitigating Mis-operations during Construction - This procedure provides the steps necessary to prevent inadvertent operations during panel and cabinet cutting/removal.

1.4 NG-EOP G001: Current Transformers - This procedure provides the steps necessary to safely work on current transformer (CT) circuits in the de-energized or energized state.

1.5 Power Control order - PCO 7-3: This document outlines the TCC outage procedures that must be followed by the Constructor and Tester during all primary and secondary construction and maintenance work.

In addition, a simple seven step approach to decommissioning was developed to aid the Constructor and Tester. The first three steps involve circuit isolation and the last four steps involve wire cutting and removal. The seven steps of decommissioning will ensure a safer worksite as well as mitigate the potential for unplanned incidents during construction.

Similar to the six steps of switching, the Seven Steps of Decommissioning is meant to guide the Constructor and Tester through a formal process that ensures a safe and secure environment while engaged in any type of substation construction project where there is collaboration between multiple disciplines.

DOCUMENT CONTENTS

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47.0 APPENDIX V - TEST and COMMISSIONING RESPONSIBILITY MATRIX SAMPLE

nationalgrid

Item #	Testing Activity		Contractor	NGrid O&M	NGrid PTO Relay	NGrid PTO Telecomm	Start Date	Finish Date	Remarks
1	Control Building and Yard Test								
2	EDP-RYF 9.2	Ground Grid Resistance and Ground Grid Continuity							
3	SMP 402.02.2	AC Station Service Checks							
4	SMP 405.01.2	Emergency Generator							
5	Charger: SMP 406.03.2 Lead Acid: SMP 406.01.2 Nickle-Cadmium: SMP 406.02.2	DC Station Service							
6	To be Determined	Control Building Power and Lighting							
7	To be Determined	Control Building HVAC							
8	To be Determined	Control Building Fire Equipment							
9	To be Determined	Control Building Security System							
10	To be Determined	Station Signage							
11	To be Determined	Wild life Control Measures							
12	To be Determined	Locking Provisions							
13	Electrical Apparatus Test								
14	Vacuum: SMP 401.03.2 Gas Puffer: 401.06.2 Profile Testing: SMP 401.20.2	Circuit Breakers							
15		Power Transformers							
16	SMP 403.01.2	Instrument Transformers							
17		Voltage Regulating Equipment							
18	Charger: SMP 406.03.2 Lead Acid: SMP 406.01.2 Nickle-Cadmium: SMP 406.02.2	Battery and Charger System							
19		Bushing Potential Devices							
20	SMP 407.02.2	CCVTs							
21	SMP 407.03.2	Wave Traps/Line Tuners							
22	SMP 408.01.2	Capacitor Banks							
23	SMP 409.01.2	Disconnect Switches							
24	SMP 409.02.2	Circuit Switchers							
25	To be Determined	Metal Clad Switchgear							
26	SMP 419.01.2	Surge Arrester							
27	To be Determined	High Voltage Bus							
29	Control Cable and Wiring Testing								
30		Continuity and Insulation Test (1000V) from CH to Yard							
31		AC/DC Station Service Cable Checks, Insulation Test (1000V)							

SMP 400.102.3 | Versioin 1.0 Appendix V of SMP 400.80.2 Substation Commissioning and Energization | 04/20/12 1 of 4

48.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	07/30/09	Initial version of document.
1.1	10/13/09	Section 22 Revised Appendix Titles. Replaced Appendix G through S with updated forms provided by PTO.
2.0	04/01/10	Revised Definitions Update Appendix A – EC Checklist Updated Appendix B – CS Checklist Updated Appendix C – T/C Checklist Inserted Project Initiation Project Team List Procedure PR.09.01.000 form to be used for selection of Commissioning and Energization team members. Section 23 – Updated C&A process. Updated throughout.
3.0	04/20/12	ACCOUNTABILITY - Changed REFERENCES - Changed “Investment Recovery Document Substation Decommissioning Procedure SMP IRP 313.2” to “Investment Recovery Document Substation Decommissioning Procedure SMP 471.03.2” Originating Department - Changed “Substation O&M Services” to “Substation Work Methods” Sponsor - Changed - “Donald T. Angell” to “Susan Fleck” Section 3.1.7 - Added Section 4.1.11 - Added Section 4.1.12 - Added Section 5.1.4 - Added Section 6.1.13 - Added Section 6.1.14 - Added Section 10.0 - Changed “… REQUIREMETNS” to “… REQUIREMENTS” Section 11.0 - Changed “… REQUIREMETNS” to “… REQUIREMENTS” Section 12.0 - Changed “… REQUIREMETNS” to “… REQUIREMENTS” Section 12.1.1 - Changed “… are being installed. The TESTER shall refer …” to “… are being installed. Provide the Testing and Commissioning Responsibility Matrix to the Constructor and Tester. The TESTER shall refer …” Section 13.1.1.g.1 - Changed ‘… shall be discussed and agreed to with the CONSTRUCTION SUPERVISOR.’ to ‘… shall be on the Point-To-Point Wire Check Form.’ Section 14.0 - Changed “… CONSTRUTOR …” to “… CONSTRUCTOR …” Section 4.1.6 - Added Section 21.0 - Changed “… REQUIREMETNS” to “… REQUIREMENTS” Section 21.2 - Changed 21.2.1 & Added 21.2.2. Section 21.12.2 - Added. Section 22.0 - Added ‘APPENDIX T - Point-To-Point Wire Check’ Section 23.0 - Changed Heading ‘CHANGE & ADDITION PROCESS and …‘ to ‘SUBSTATION WORK ORDER SUMMARY and …’ Section 23.1 - Updated Section 24.5.1 - “… Services IRP 313.2.1 - Substation Equipment Decommissioning Procedure and IRP 313.3.2 - Substation Equipment Decommissioning Check-List” to “… Services SMP 471.03.2 - Substation Equipment Decommissioning Procedure and SMP 471.03.3 - Substation Equipment Decommissioning Check-List” Section 25.2.1 - Updated Section 25.2.2 - Changed to 25.2.3 Section 25.2.3 - Changed to 25.2.2 Appendix C - Replaced (many items were updated) Appendix T - Added

		Appendix U - Added Appendix V - Added
3.1	08/31/12	Accountability - Changed “… Transmission Operations, Substation O&M Services, Substation O&M, Protection, Telecom and Operations (PTO), Work Delivery, and Construction & Services organizations involved in Substation …” to “… Transmission Operations, Substation Work Methods, Substation Maintenance & Construction, Protection, Telecom and Operations (PTO), Work Delivery, and Construction organizations involved in Substation …” Section 1.3 - Changed “… designated by Substation O&M Services responsible to …” to “… designated by Substation Work Methods responsible to …” Section 1.3 - Changed “… Meter, and Station O&M as required …” to “… Meter, and Substation Maintenance & Construction as required …” Section 1.6 - Changed “… Meter, Stations O&M or TEST …” to “… Meter, Substations Maintenance & Construction or TEST …” Section 6.1.3 - Changed “… as required (PTO, O&M Services, Control Center …” to “… as required (PTO, Substation Maintenance & Construction, Control Center …” Section 10.1.2 - Changed “Refer to National Grid SMS 400.90.1 Approved Test Equipment for calibration requirements.” to “Refer to National Grid NG-EOP G032 for calibration requirements.” Section 10.2.2 - Changed “… listed in the SMS 400.90.1 Approved Test Equipment or as approved …” to “… listed in the NG-EOP G032 or as approved …” Section 11.11.1 - Changed “Check that all required signage is installed per SMS 400.84.1 Substation Signs and Placards.” To “Check that all required signage is installed per ST.03.06.001 Substation Signs” Section 11.13.1 - Changed “Substation O&M Services shall coordinate …” to “Substation Work Methods shall coordinate …” Section 12.4.7 - Changed “SMP 403.02.3 Coupling …” to “SMP 407.02.3 Coupling …” Section 12.4.14 - Changed “SMP 417.03.2 Open Air Substation Bus Procedure” to “SMP 417.02.4 Outdoor Open Air Bus Procedure” Section 21.2.1 - Changed “… using the Substation Work Order Summary - Plant Additions/Removals form, PR.09.02.A0K, for equipment …” to “… using PR.02.00.027 Substation Work Order Summary for equipment …” Section 21.8.1 - Changed “…Management and Substation O&M Services as required.” to “… Management and Substation Work Methods as required.” Section 23.1.1 - Changed “… provided to Substation O&M Services (equipment) or …” to “… provided to Substation Work Methods (equipment) or …” Section 23.1.7 - Changed “… provided to Substation O&M Services (equipment forms) or …” to “… provided to Substation Work Methods (equipment forms) or …” Section 24.1.1 - Changed “… and Substation O&M Services to coordinate arrangements …” to “… and Substation Work Methods to coordinate arrangements …”

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INTRODUCTION

This procedure describes the processes associated with an electric fence. It includes the installation, inspection and maintenance, and disassembly of an electric fence.

This fence uses an impulse electric fence energizer. The fence is not part of the electric distribution, electric transmission or electric generation system therefore rules involving working on or near primary voltages such as clearance and control, minimum approach distances, testing de-energized and grounding do not apply.

PURPOSE

The purpose of this procedure is to define the procedure for installing, inspecting and maintaining, and disassembling a TransGard Electric Fence.

ACCOUNTABILITY

This procedure applies to all National Grid personnel who work on National Grid Transmission and Distribution Substations.

COORDINATION

Not Applicable

REFERENCES

National Grid Safety Handbook

TransGard Fence Systems Installation/Operating Manual

ST.04.18.002 - Animal Deterrents in Electric Substations

SMS 400.85.1 - Substation Wildlife Mitigation Program

User Manual - Fault Finder Handset

DEFINITIONS

Not Applicable

TRAINING

Not Applicable

DOCUMENT CONTENTS

Table of Contents

1.0 GENERAL

1.1 Animal intrusions into electric power substations are one of the most common causes of electric power outages throughout the country and have been one of the most prevalent and most costly nuisances to the electric utility industry since the earliest days of power transmission and distribution. The costs associated with these outages are escalating and will continue to do so.

1.2 An electric fence is a type of animal deterrent in substations. Refer to ST.04.18.002 – Animal Deterrents in Substations for a listing of animal deterrents. TransGard is the approved vendor for electric fences.

1.3 This document covers the following processes with an electric fence:

1.3.1 Installation

1.3.2 Inspection and Maintenance of Electric Fence

1.3.3 Disassembly

2.0 SAFETY

2.1 When entering a substation with an electric fence, the following steps shall be done:

2.1.1 Check with Dispatch regarding the EMS automatic alarm.

2.1.2 Turn the electric fence's power off.

2.1.3 Check to see if the light and meter measuring current for the electric fence are off. These items are located near the knob that turns the electric fence off.

2.1.4 Use care when working inside the fence control panel as there are some components that may be hot, and others that are energized with 120VAC station power supply even when the switch on the outside of the panel is in the off position.

2.2 If the fence impedes on the work zone or in the way of the construction & maintenance activity or blocks easy exit from the work area, disassemble the animal fence by following the process below.

3.0 INSTALLATION OF ELECTRIC FENCE

3.1 Refer to TransGard Installation/Operation Manual for the proper steps to install an electric fence.

3.2 Leave enough room around structure / components inside the enclosure to allow workers to easily move about without having to disassemble the fence.

3.3 Be certain that the non-electrified gateway is earth grounded with 3/0 or 4/0 conductor and that it is tied to the grounding of the substation.

4.0 INSPECTION AND MAINTENANCE OF ELECTRIC FENCE

4.1 If a worker is going to come into contact with the fence for the purpose of disassembly, trouble shooting, or during a maintenance / repair activity, then the use of Stations Control Tagging is required

4.2 The electric fence shall require inspection and maintenance during bi-monthly substation V&O inspection routine.

4.3 The following items shall be inspected and maintained:

4.3.1 The meter lights are able to be turned on.

4.3.2 The proper amount of stone is placed on the fence posts, stands, and Gateway Unit.

4.3.3 The fence is properly aligned and level.

4.3.4 The jumper wires are connected and not damaged.

4.3.5 The fence and its stands are not damaged.

4.3.6 Stone is properly placed under fence to deter animals from intruding.

4.3.7 Insulating post is properly placed on stand.

4.3.8 Proper operation of the fence Energizer utilizing the **Speedrite**™ device.

4.3.9 Replace the energizer every three years

5.0 TROUBLESHOOTING

5.1 If a worker is going to come into contact with the fence for the purpose of disassembly or trouble shooting or during a maintenance/repair activity, then the use of Stations Control Tagging is required.

5.2 A testing device shall be used to determine if there is enough voltage at the output. Readings shall be taken around the fence. Straps and jumpers shall also be checked. **Speedrite**™ – Fault Finder Handset shall be used.

5.2.1 Voltage does not register

a. If there is no voltage reading at all:

i. Check the voltage at the Gateway first. If that's bad, then the fault is in the controller.

ii. Check that all insulators are present.

iii. Check all panel connections.

5.2.2 Voltage is too low

a. Check the first ten sections to the left of the gateway at the end of the tenth section.

i. If the reading is low, backtrack until you find the individual section that is bad.

ii. If the reading is good, proceed to the next section of ten and so on, until you find the faulty section.

5.3 The door at the Gateway may hit the fence. This should no longer be an issue with fences purchased after September 2009. If this problem is found, contact Transgard to request gate stop.

5.4 Control panel LED is not lit

5.4.1 If no voltage across the switch, replace.

5.5 Fence Energizer

5.5.1 Energizer LED is not lit.

a. If power to energizer checks out OK, replace energizer

5.5.2 Energizer LED is in a continuous red condition

a. Replace energizer

5.5.3 Energizer LED is cycling from red to green and not reaching a continuous green condition

a. If no shorts found on fence panels, replace energizer

5.6 Control Center Voltmeter on Gateway

5.6.1 No movement on control center voltmeter at 0 or 10,000 volts

a. If 8,000 to 10,000 volts detected at fence, replace control center voltmeter

5.7 Fence panels

5.7.1 Control center voltmeter not cycling to 10,000 volts

a. Repair fence as needed

5.8 Procedure for detecting faults in fence

5.8.1 Turn off power to fence

5.8.2 Verify that all fence stand insulators are installed correctly. With a screwdriver carefully pry off the black caps on each end post. By looking inside the end post, ensure that there is an insulator installed on each fence stand, replace caps with a rubber mallet.

5.8.3 Verify all panel-to-panel 12 ga. non-insulated jumper wires are installed correctly and tightened.

5.8.4 Turn on the power to fence

5.8.5 Walk the perimeter of the fence enclosure and look for, and listen for faults. You may see an arc or you may hear the snapping sound of the fault.

5.8.6 Using a Fault Finder Digital Fence Meter (**Speedrite**™) check the voltage on the first 10 fence panels to the left of the entryway at the end of the tenth section. If the reading is low at that point, backtrack toward the entryway until you find the faulty section of fence. If the readings are good on the first 10 sections then repeat this procedure for the next 10 fence panels. Continue this until the faulty section is isolated.

5.9 Alternate Procedure for Detecting Faults

5.9.1 Start close to where the energizer lead-out wire connects to the fence.

5.9.2 Press the ‘I’ button

5.9.3 Align and insert the fence into the fault finder slot, ensuring fence wire touches the fault finder contact. Note the current reading (in amps) in large numbers.

5.9.4 Traveling in the direction of the current flow, work your way along the fence line taking readings at regular intervals and at all junction points. At a junction, follow the branch that indicates an abnormal current reading. Each time you take a reading, compare it with the previous reading (this displays briefly in the top, right hand corner of the screen each time the handset is turned on).

5.9.5 A significant reduction in current between one point and the next indicates the presence of a fault between these two points.

5.9.6 Move back in the direction of the previous reading until fault is located.

6.0 DISASSEMBLY OF ELECTRIC FENCE FOR MAINTENANCE OR CONSTRUCTION PURPOSES

6.1 If a worker is going to come into contact with the fence for the purpose of disassembly or trouble shooting or during a maintenance/repair activity, then the use of Stations Control Tagging is required

6.2 The following steps shall be completed to disassemble an electric fence:

6.2.1 Turn the fence off.

6.2.2 Disconnect the fence from the AC source according to the proper work procedures.

6.2.3 Place notice at Gateway Unit that panels have been removed and fence is not in service.

6.2.4 Unground the Gateway Unit's base from the substation's ground grid.

6.2.5 Carefully unscrew the jumper wires. Two workers may be needed with one worker unscrewing the jumper wires inside the fence and the other worker unscrewing the jumper wires outside the fence.

6.2.6 Rake stone away from the stand bases, fence base, and Gateway Unit's base.

6.2.7 Two workers shall be required to disassemble the fence. Disassembling the fence shall be accomplished by completing the following steps:

a. Remove the insulators from the tall stand rods by one worker lifting the panel over the end of the tall stand rods.

b. The other worker shall lift the panel over the short peg.

c. Remove the metal strap loop over the adjoined upright.

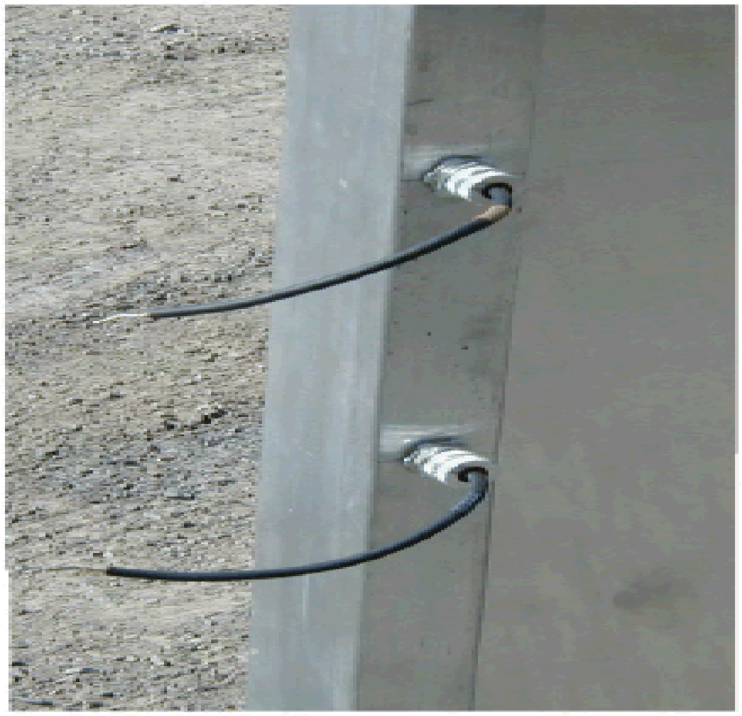
d. Continue with steps 6.2.7.a to 6.2.7.c until all necessary fence panels have been disassembled.

6.2.8 Remove the fence panels and stands from the work area.

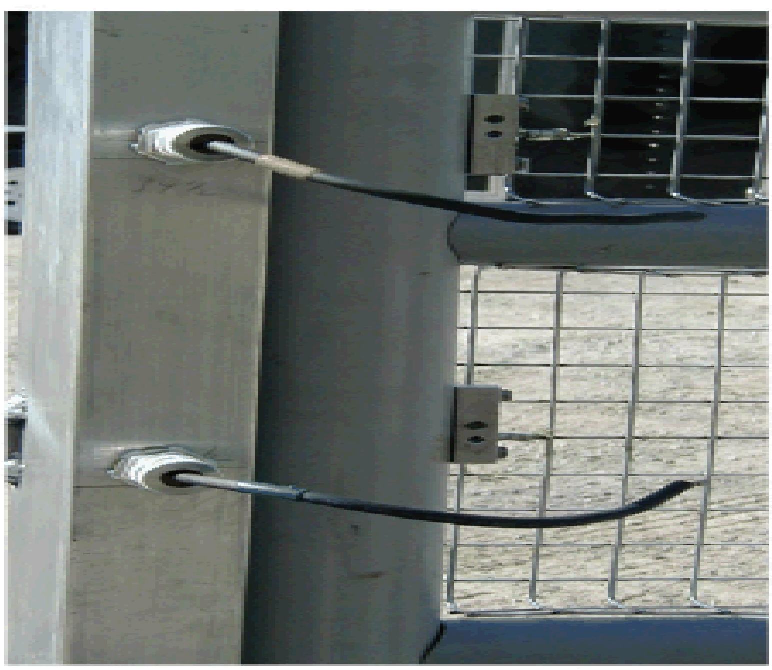
6.2.9 If the Gateway Unit requires removal, the following steps shall be completed:

a. Proceed to the left side of the entryway and detach the cable with the green tape (negative) from the lower aluminum connection block.

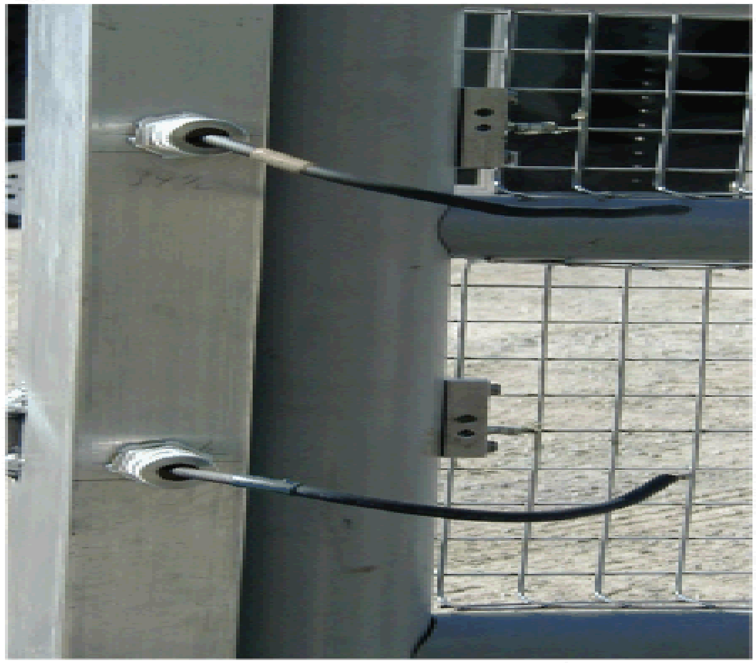
b. Detach the cable with the red tape (positive) from the upper aluminum connection block.



c. Proceed to the right side of the entryway and detach the cable with the green tape (negative) from the lower aluminum connection block.



d. Detach the cable with the red tape (positive) from the upper aluminum connection block.



7.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	12/20/10	Initial version of document.
2.0	08/31/12	Originating Department - Changed “Substation O&M Services” to “Substation Work Methods” Sponsor - Changed “Donald T. Angell” to “Susan Fleck” ACCOUNTIBILITY - Changed “… on National Grid USA Transmission and Distribution Substations.” to “… on National Grid Transmission and Distribution Substations.” REFERENCES - Added “SMS 400.85.1 - Substation Wildlife Mitigation Program” Section 5.4.1 - Changed “…across the switch, replace (what switch? Replace switch or control panel)” to “…across the switch, replace.”

INTRODUCTION

This procedure describes the process to be followed in the event of a storm or disaster. It includes how to assess a substation's condition prior to re-energization.

PURPOSE

The purpose of this procedure is to define the procedure for re-energizing station equipment after an emergency.

ACCOUNTABILITY

This procedure will apply to all National Grid personnel that are required to perform substation inspections and restoration activities in the event of a storm or disaster impacting substation facilities.

All appropriate PPE shall be worn when performing inspections as required by the National Grid Employee Safety Handbook. All work shall be performed in accordance with the National Grid Employee Safety Handbook and applicable Work Procedures, utilizing all appropriate safe work methods.

COORDINATION

Coordination shall occur between Emergency Planning and Substation Work Methods.

REFERENCES

EOP G023 – Inspection of Electric Facilities Following an Earthquake

National Grid Employee Safety Handbook

New England Emergency/Storm Restoration Manual

NY Electric Emergency Procedures Manual EEP.03

DEFINITIONS

N/A

TRAINING

As required and through SEAL Program assignments

DOCUMENT CONTENTS

Table of Contents

1.0 GENERAL

1.1 Emergency situations may occur from time to time causing a substation to de-energize. A substation’s condition must be assessed prior to re-energizing station equipment.

1.2 An emergency situation may be considered any of the following events:

1.2.1 Earthquake

1.2.2 Lightning Storm

1.2.3 Ice Storm

1.2.4 Flood Damage

1.2.5 Other Major Event

2.0 EARTHQUAKES

2.1 The following are guidelines in determining when an inspection must be performed after an earthquake.

2.1.1 When the magnitude of the earthquake is reported to have been 4.0 or higher as measured on the Richter scale and facilities are within a 75 mile radius of the reported epicenter.

2.1.2 When the earthquake, as determined by divisional authority, might have caused damage or abnormal conditions within your division

2.1.3 When so ordered by higher authority

2.2 Inspections to be performed after an earthquake shall include:

2.2.1 All Electric Substations: equipment, structures, foundations, buses and insulators shall be visually inspected.

2.2.2 All 230kV and above substations shall be given priority.

2.2.3 All affected substations shall have an infrared inspection conducted as soon as practicable.

3.0 LIGHTNING STORMS

3.1 The following are guidelines for determining when an inspection must be made after a lightning storm.

3.1.1 An inspection shall be conducted immediately if a substation has experience a total outage.

3.1.2 An inspection must be conducted during the next business day or as requested by local supervision when a substation has experience a bus trip and reclose operation.

3.2 Inspections to be performed after a major lightning storm shall include:

3.2.1 All Electric Substations: equipment, buses and insulators shall be visually inspected.

3.2.2 All 230kV and above substations shall be given priority.

3.2.3 All affected substations shall have an infrared inspection conducted as soon as practicable.

4.0 ICE STORMS

4.1 The following are guidelines for determining when an inspection must be made after a major ice storm.

4.1.1 An inspection shall be conducted immediately is a substation has experienced a total outage.

4.1.2 An inspection must be conducted during the next business day or as requested by local supervision when a substation has experience a bus trip and reclose operation.

4.2 Inspections to be performed after a major ice storm shall include:

4.2.1 All equipment, buses and insulators shall be visually inspected.

4.2.2 All 230kV and above substations shall be given priority.

4.2.3 All affected substations shall have an infrared inspection conducted as soon as practicable.

4.3 Removal of accumulated ice is not normally required from substation live parts or current carrying conductors. If required, removal of some ice build up shall be performed with switch sticks only on de-energized substation apparatus with authorization from local substation supervision only. Care must be taken during removal of ice build up with a switch stick to ensure equipment does not get damaged. Other methods for ice removal require authorization from Substation Work Methods. Minimum approach distances shall be maintained.

5.0 FLOOD DAMAGE

5.1 Ensure substation or affected equipment is de-energized and appropriate Clearances are established.

5.2 Determine height of initial flood stage.

5.3 Determine equipment affected and prepare assessment with documentation (checklist) of equipment required.

5.3.1 Primary Components

a. Control Building Enclosure

b. Circuit Breakers

c. Transformers

d. Motor Operators

e. Circuit Switchers

f. Reclosers

g. Station Service Safety Switches

h. DC Cabinets

i. Underground Cable Trench

j. Metal-Clad Switchgear

k. Padmount Transformers

5.3.2 Secondary Components

a. Transformer Gauges/Fault Pressure

b. Protection Schemes

c. Auxiliary VT/CT

d. Charger Battery

e. Ancillary Devices

f. Control Switchboards

g. Secondary/Outdoor Junction Box

h. Communication Schemes

i. RTU's

j. AC/DC Cabinets

k. Station/Revenue Metering

l. HVAC

5.3.3 Civil/Structural Components

a. Oil Containment/Environmental

b. Fence Perimeter

c. Soil/Foundations

d. Crushed Stone

e. Erosion around poles/foundations/conduits/ductbanks

f. Buildings/Structures

5.3.4 Debris/Waste Management

5.4 Process of Cleanup

5.4.1 Evaluate level of cleanup required

5.4.2 Drying out facilities and Components

a. Hand held heaters

b. Portable Generators

c. De-Humidifiers

d. Pumps

e. Fans

5.4.3 Clean and sanitize

a. Using approved chemicals by environmental engineering

5.5 An Action Plan, including energization outage plan, will be developed and the resource required based on various department assessments.

5.5.1 Review assessments with the following departments as required

a. Customer Operations

b. Substation Work Methods

c. Protection and Control

d. Protection and Telecommunications group

e. Substation Engineering and Design

f. Protection Engineering

g. Transmission/Regional Control Center

h. Transmission and Distribution Planning

i. Materials Management

j. Environmental

k. Corporate Communications

l. Corporate Security

m. Corporate Safety

5.5.2 Re-establish Station Services to main feed only with all secondary branch circuits open

5.5.3 Re-establish battery charger and establish DC Station Service to main feed only with all secondary branch circuits open

5.5.4 At this point, primary and secondary repairs will be made concurrently based on condition assessment results and follow the energization outage plan.

a. This includes but is not limited to Replace/Repair designated equipment or components

5.5.5 Testing

a. Concurrently Primary and Secondary testing

1. Secondary Testing

i. Set and test protective relays

ii. Establish switchboard DC

iii. Verify panel equipment

iv. Megger all current voltage and control circuits cables

v. Functional Testing of all schemes

vi. Perform in-service checks on equipment as placed in service

vii. RTU's/Metering verification or testing

viii. DFR's/Event Recorders/Fault Recorders

ix. Communication Equipment

x. PLC

xi. Alarms and remote controls

2. Primary Testing per the components listed in Section 5.3.1

5.5.6 Station Re-energization

a. Based on the severity of the damage assessment, the local energization coordinator shall be identified. The person identified shall have the same duties and responsibilities per SMP 400.80.2 Substation Commissioning and Energization.

5.6 Process Safety

5.6.1 Evaluate and make recommendations for near and long term solutions

6.0 OTHER MAJOR EVENTS

6.1 Following are guidelines for establishing restoration efforts for other major substation events such as apparatus failures resulting in major system disturbances impacting load served, high media events, long restoration lead times, and equipment replacements requiring multiple organizations and resources to complete the restoration.

6.1.1 Substation Work Methods Manager shall assemble the required level of personnel required for developing a restoration plan for other substation major events.

6.1.2 Major events are categorized as Level A Major Events involving Critical Facilities and Level B Events Not Involving Critical Facilities. Refer to Appendix A.

6.1.3 The Substation Work Methods Manager shall designate the appropriate Level for the disturbance.

7.0 ASSIGNMENTS

7.1 Company substations are included in the emergency planning process. Any substation equipment affected by an emergency situation will have its restoration performed by the Substation Operations & Maintenance workers assigned to that Substation's District and/or other resources as required. Technical Support is provided by the System Substation Coordinator when required by District personnel during emergencies. If no area substation is damaged by the emergency, Substation Maintenance & Construction workers are typically assigned to check the status of the substations and switchyard equipment, and to perform switching and tagging operations, to enable repair work to be done on transmission and distribution lines.

7.1.1 Action Required:

a. The District Emergency Operations Coordinator assigns Substation Maintenance & Construction Workers to be positioned at critical substations and switchyards within the District, in advance of foreseen emergency events, when such assignments will help reduce duration of interruptions.

b. The District Substation Coordinator will assign Substation Maintenance & Construction Workers to investigate substation and switchyard equipment status, based upon system conditions and specific substation status. The System Substation Coordinator will provide technical support to field restoration forces as required.

1. System Substation Coordinator Pre-Emergency Responsibilities:
    - i. Check on availability of all mobile/spare equipment (update Mobile Substation List).
    - ii. Determine if District Maintenance & Construction Departments have adequate manpower available.
    - iii. Assign staff personnel as needed to assist District operations.
2. System Substation Coordinator Responsibilities during an Emergency
    - i. Monitor and coordinate National Grid substation and switchyard restoration.
    - ii. Investigate major substation incidents.
    - iii. Provide support to field restoration forces as needed.
    - iv. Advise System Emergency Director of major problems and plan for restoration of service.

c. Substation Maintenance & Construction Workers will be assigned to perform switching and tagging operations as needed to facilitate restoration.

8.0 SUBSTATION INSPECTION & RESTORATION EFFORTS

8.1 Substation Maintenance & Construction, PTO, and other Field Operations personnel shall perform and coordinate the following tasks prior to re-energization.

8.1.1 The following tasks shall be assigned as required for substation inspection and restoration efforts:

a. PTO body for electronic relay data downloads

b. Battery/Charger inspections and replacements

c. Standby generator inspections and repairs

d. Coordinate Standby Generator Fuel Delivery every 24 hours

e. Assess by performing V&O inspection after storm or event

f. Execute switching orders as necessary to restore system configuration

g. Coordinate System spare inventory utilization

h. Perform any emergency repairs/maintenance before restoration of equipment and circuits

i. Initiate EEP.03, http://us1infonet/sites/emergency_planning/Documents/NY%20EEPs%2009/EEP.03.pdf, Restoration Organization as necessary

j. Ensure availability of Mobile Equipment Fleet

9.0 REPORTING

9.1 Any abnormal conditions, emergency situation or indication of change which might result in an abnormal condition potential damage or outage shall be reported to Customer Operations Divisional Supervision, Substation Work Methods, Director PTO, and Director of Distribution Services, System Operations as applicable.

9.2 The following items shall be included in the report.

9.2.1 Inspection start time and date

9.2.2 Facilities inspected

9.2.3 Geographic description of the area inspected

9.2.4 All abnormal conditions, equipment/structures, change or emergency condition

a. **NOTE:** Should an emergency condition be discovered, appropriate action to safeguard life, property and the integrity of the electrical system shall be taken

9.2.5 All conditions or indications which may require engineering, or other evaluation

9.2.6 Completion time and date of the inspection

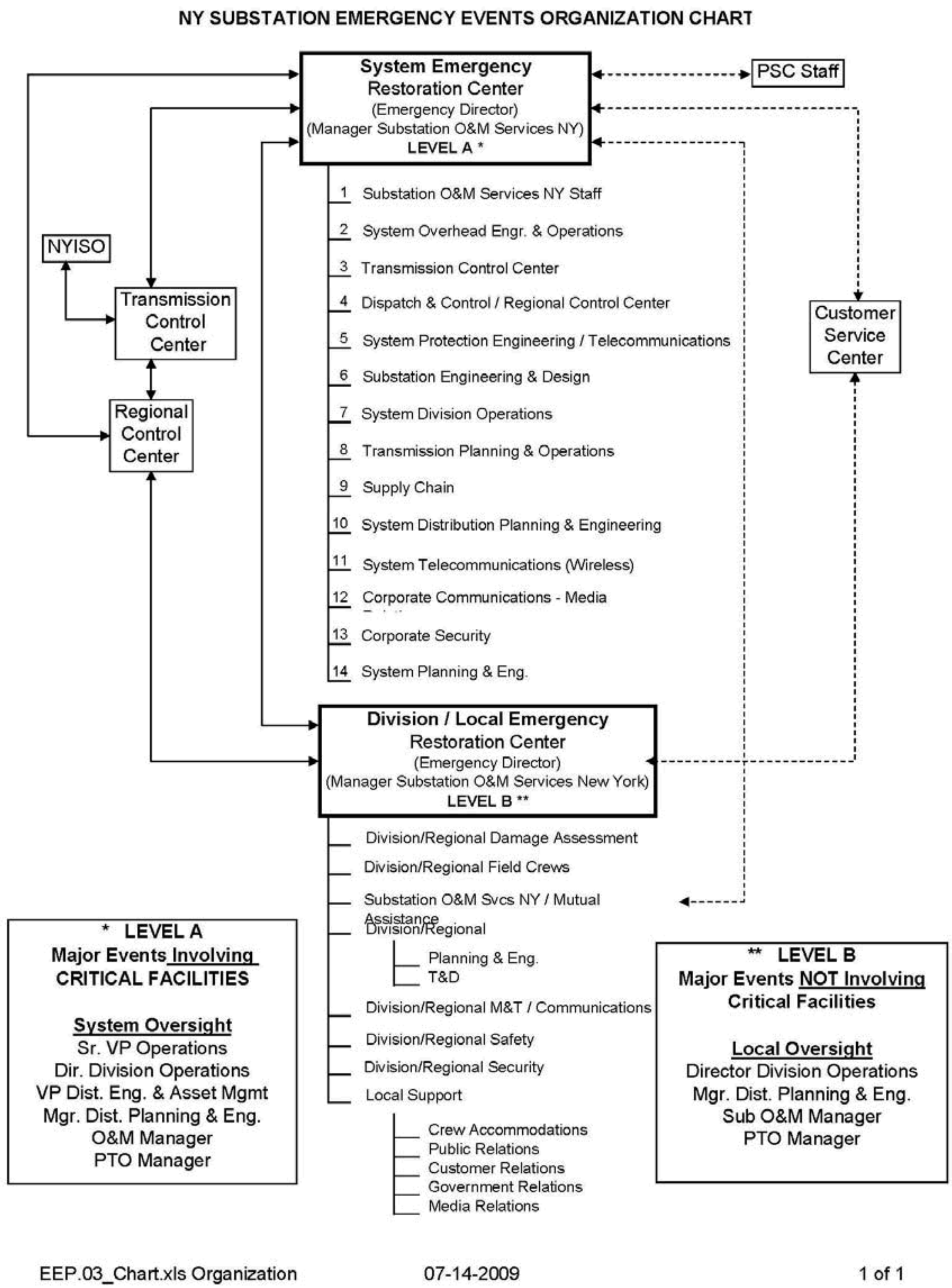
9.3 Protection Systems

9.3.1 Refer to PR.10.00.004 Procedure for Gathering Post Event Fault Data.

9.3.2 Refer to PR.10.00.003 Procedure for Reporting & Tracking Special Protection System Failures.

9.3.3 Refer to PR.10.00.001 Disturbance Analysis Procedure.

10.0 APPENDIX A - NY SUBSTATION EMERGENCY ORGANIZATION CHART



11.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	03/31/10	Initial version of document. Replaces SMS400.87.1 Earthquake Response.
2.0	08/31/12	Originating Department - Changed “Substation O&M Services” to “Substation Work Methods” Sponsor - Changed “Donald T. Angell” to “Susan Fleck” Document - Changed “Substation O&M Services” to “Substation Work Methods” throughout the document Section 2.1.1 - Changed “… within a 130 mile radius …” to “… within a 75 mile radius …” Sections 7.1, 7.1.1.a, 7.1.1.b, 7.1.1.b.ii, 7.1.1.c, and 8.1 - Changed “… Substation O&M …” to “… Substation Maintenance & Construction …” Section 10.0 - Changed (expanded)

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INTRODUCTION

This procedure describe the methods use to perform Visual and Operational, Diagnostic, and Acceptance inspections on lead acid batteries used in electrical substations.

PURPOSE

Scheduled equipment inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used, to inspect lead acid batteries.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

COORDINATION

Battery Chargers are inspected at the same time as the battery banks they are connected to. See SMP 406.03.2.

REFERENCES

National Grid USA Safety Handbook

NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Battery -	Group of cells in a common container. Using three cells to create a 6 volt battery is common in electrical substations.
Battery Bank -	Group of cells, or batteries connected in series to create higher voltages. Battery banks of 24, 48, 120, and 240 volts are common in electrical substations.
Battery Charger -	Device that converts station service AC voltage to a precise, stable DC voltage. Used to maintain the charge on station batteries and supply normal DC station loads.
Case -	Container enclosing a group of battery cells.
Cell -	Basic component of a battery or battery bank. In a lead acid battery each cell generates approximately 2.2 volts.

Equalizing Charge - Charging batteries at slightly higher than the normal float voltage for a period of time. Use to correct unbalances in charge between cells and remove electrolyte stratification.

Freshening Charge – Charge applied to a pre-charged battery after installation to bring battery to a fully charged state.

TRAINING

(Optional Section) List any training requirement(s) (One-Time Training, Annual Training, etc.).

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1.1 V&O Inspection

1.1.1 Digital Multi-meter, 0.25% DC accuracy, IEC 1010-1 Cat. IV

1.1.2 Spare batteries for multi-meter.

1.1.3 Resistors and leads to measure battery to ground voltages. (See Substation Batteries and Chargers training manual).

1.2 Diagnostic Inspection

1.2.1 All of above plus.

1.2.2 MBite battery impedance test set, AVO-Biddle, Catalog # 246005B or (preferred) or catalog # 246005. Check for test leads and AC power cable.

1.2.3 Spare roll of paper for MBite Test set.

1.3 Acceptance Inspection

1.3.1 All of above.

2.0 SPECIAL TOOLS REQUIRED

2.1 V&O Inspection

2.1.1 Insulated or non-conductive battery wrenches.

2.1.2 Insulated torque wrench 0 to 150 in-lb.

2.2 Diagnostic Inspection

2.2.1 All of the above plus:

2.2.2 Insulated torque wrench 0 to 150 in-lb.

2.3 Acceptance Inspection

2.3.1 All of the above.

3.0 MATERIALS REQUIRED

3.1 V&O Inspection

3.1.1 PDA with National Grid V&O software installed.

3.1.2 Inspection card/record from last V&O inspection.

3.1.3 Replacement bottles of eyewash solution.

3.1.4 Bulk eyewash solution for larger eyewash stations.

3.1.5 Danger sign “EXPLOSIVE GAS”.

3.1.6 Baking soda.

3.1.7 Stiff bristled, synthetic (nylon etc.) brush for use on battery terminals.

3.1.8 Wire brush for use on battery rack and floor.

3.1.9 Scotchbrite green industrial abrasive pads.

3.1.10 Distilled water.

3.1.11 No-Ox-Id battery terminal grease.

3.1.12 Small hot plate to heat No-Ox-Id.

3.1.13 Small paint brush to apply No-Ox-Id.

3.1.14 Battery jump-out box (See Batteries and Chargers training manual).

3.1.15 Spare battery inter-cell straps (type varies by battery and manufacturer).

3.1.16 Spare battery inter-cell bolts, nuts and washers (types vary by battery and manufacturer).

3.1.17 Spare flame arrestors and caps (type varies by battery and manufacturer).

3.1.18 Spare battery thermometer. (Do not use thermometers containing mercury or that have been used in NiCad batteries).

3.1.19 Metal primer and paint for battery racks.

3.1.20 Acid proof paint for floor.

3.2 Diagnostic Inspection

3.2.1 All of the above plus:

3.2.2 Inspection card/record from last Diagnostic inspection.

3.2.3 Calculator.

3.3 Acceptance Inspection.

4.0 SPECIAL SAFETY EQUIPMENT REQUIRED

4.1 Acid proof gloves.

4.2 Acid proof apron.

4.3 Full face shield.

5.0 UNUSUAL HAZARDS

The fluid in lead acid batteries (electrolyte) is a mixture of sulfuric acid and distilled water. Contact with electrolyte can cause blindness, burn skin, and burn holes in clothing. Electrolyte on skin or clothing should be rinsed off with generous amounts of water. Electrolyte in eyes should be flushed generously with bottled eyewash solution, or at an eyewash station, and immediate medical attention sought. Acid proof gloves and aprons and a full face shield shall be worn when inspecting or working on batteries.

Lead acid batteries emit hydrogen gas, which is explosive. No smoking, open flames or sparks are allowed in their vicinity. Only insulated tools should be used when working on batteries. Substation batteries are capably of very high short-circuit currents. Accidentally shorting cells or batteries can result in severe burns and possibly battery explosions. The use of 1000 volt disposable cover-up (SC 92008882) should be considered.
Although rare, batteries can explode violently and spew electrolyte and plastic shards from battery jars in all directions. Battery explosions can be caused by internal or external short circuits, or the ignition of hydrogen gases.

6.0 NPCC - BULK POWER STATIONS - CHARGER AND BATTERY INSPECTION

6.1 This section meets the applicable requirements of NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

6.2 Check charger AC and DC circuit breakers are on.

6.3 Check that there is output voltage on charger DC voltmeter.

6.4 Check that there is output current on the charger DC ammeter.

6.5 Visually check all battery cells for general condition and proper electrolyte level.

7.0 VISUAL AND OPERATIONAL INSPECTION

7.1 Perform battery charger inspection before performing battery inspection.

7.2 Check eyewash stations.

7.2.1 Plumbed Eyewash Stations shall be activated to flush the line and to verify proper operation.

7.2.2 Portable or self-contained units shall be visually inspected.

a. The inspection shall ensure that the protective caps are in place and that the seal has not been broken.

b. Expiration dates shall be checked on sealed fluid cartridges and cartridges replaced when necessary.

c. Portable or self contained units that have been discharged shall have fluid cartridges replaced immediately.

7.2.3 All inspections and operational checks shall be recorded on the Eyewash Station Inspection Tag, NG0139.

7.3 Record battery voltage with charger off.

7.3.1 Turn the digital multi-meter on and select DC voltage and a range higher that the overall battery voltage to be measured (Range selection is not necessary if the multi-meter is auto-ranging).

7.3.2 Turn the battery charger’s AC Circuit breaker off

7.3.3 Measure and record the overall voltage between the positive and negative ends of the battery (points where the battery charger and DC supply leads are connected).

a. Read the voltage immediately after turning off the charger, the battery voltage will continue to drop.

7.3.4 Turn the battery charger's AC Circuit breaker on.

7.4 Refer to Appendix B at the end of this document to determine battery type. Voltage should not be below:

Battery Size	Lead Antimony	Lead Calcium	Lead Selenium
24 volt - 12 cell	25 volts	26 volts	26 volts
48 volt - 23 cell	48 volts	50 volts	49 volts
48 volt - 24 cell	50 volts	52 volts	52 volts
120 volt - 58 cell	120 volts	125 volts	123 volts
120 volt - 60 cell	124 volts	129 volts	128 volts
240 volt - 116 cell	240 volts	240 volts	240 volts
240 volt - 117 cell	242 volts	242 volts	242 volts
240 volt - 120 cell	248 volts	248 volts	248 volts

7.5 Check for battery grounds.

7.5.1 If the battery charger has ground detector lamps record if a positive or negative lamp is lit.

7.5.2 If the charger has a ground detection voltmeter record the voltages with the meter switch in both the positive and negative ground positions. If the voltmeter reads voltage when the switch is in the positive position the battery has a positive ground. If the voltmeter reads voltage when the switch is in the negative position the battery has a negative ground.

7.5.3 If the charger has no ground detection system use a multi-meter and the procedure in Appendix A at the end of this document to record the battery positive and negative voltages to ground. Note: Resistors and additional test leads required.

7.6 Record Pilot cell.

7.6.1 Record Pilot cell Voltage

a. The pilot cell is the cell with the lowest cell voltage and contains the thermometer.

b. Turn on the digital multi-meter on and select DC voltage and a select the lowest range higher then 2 volts. (Range selection is not necessary if the multi-meter is auto-ranging).

c. Measure and record the cell voltage between the exposed conductors either side of the thermometer. These points may be bolted connections or metal inter-cell connections on top of the battery case. The voltage should be approximately 2.2 volts.

7.6.2 Record pilot cell temperature.

a. Withdraw the thermometer from the cell only enough to read the temperature. To avoid electrolyte (acid) drips outside the cell do not completely remove it.

b. Read and record the temperature.

7.7 Visually inspect all battery cells. Refer to the Substation Batteries and Chargers training manual for details. Record problems and cell numbers on inspection card/record.

7.7.1 Electrolyte level. Add distilled water to bring electrolyte level to between the low and high level lines on the jar or case. Record cell numbers and amount added on inspection card.

7.7.2 If water is added equalize charge the battery bank.

a. If the charger has an equalizing (overcharging) timer set the timer to:

1. - 72 hours for lead calcium and lead antimony batteries.

2. - As specified in the manufacturer's instruction manual for lead selenium batteries. Normally 4 hours maximum, periodic monitoring may be required.

b. If the charger has an equalizing (overcharging) switch; turn the switch on. Refer to the chargers instruction manual to insure the charger will automatically stop the equalizing charge after a set period of time.

c. If the charger does not stop equalizing charging automatically return before the maximum equalize time to shut the equalizing charge off.

d. The charger’s DC ammeter reading should increase when the charger is put on equalizing charge.

7.7.3 Plate buckling. Wavy plates and separators.

7.7.4 Sulfating. Sparkling crystals on plates and separators.

7.7.5 Hydration. Dull grey material embedded on separators.

7.7.6 Accumulation of sediment in bottom of jar. Sediment touching battery plates requires immediate attention.

7.7.7 Leaking or damaged jars or cases. Leaking jars or cases require immediate attention.

7.7.8 Check each jar/case to be clean and dry.

a. Clean the tops of jars and case with a solution off 1 gallon of water mixed with 1 pound baking soda. Do not allow the baking soda solution to enter the battery cells. It will neutralize the electrolyte and destroy the cell.

7.7.9 Check Flame arrestors and dust caps.

a. Clean and dry flame arrestors and caps as necessary. Do not use baking soda solution on flame arrestors. Use distilled water.

7.7.10 Replace any missing or damaged flame arrestors and dust caps.

7.7.11 Check each terminal for corrosion.

a. Clean corrosion off inter-cell conductors with the stiff bristled synthetic brush or green Scotchbrite and baking soda solution. Caution the corrosion byproducts are corrosive. Do not use a metal bristled, wire brush.

b. Rinse or wipe the baking soda solution residue off with clean water and rags.

c. Apply a thin coat of heated No-Ox-Id battery terminal grease to any inter-cell conductors that have been cleaned, with the paint brush. The No-Ox-Id must be heated to a cream like consistency to avoid applying excessive amounts that will collect dirt and dust.

d. Connections with sever corrosion should be bypassed with the battery jump-out box, disassembled, cleaned and painted with No-Ox-Id. (See the Substation Batteries and Chargers training manual for details on using the battery jump-out box.)

e. Any connections that have been loosened should be retorqued with a torque wrench. See Appendix B at the end of this document for common battery torque values.

7.7.12 Record “as left” overall visual condition of battery bank on inspection card.

7.8 Check rack and floor for paint and cleanliness and grounding.

7.8.1 Wire brush, prime, and paint any chipped or corroded areas on the battery rack.

7.8.2 Wire brush and paint any chipped or corroded areas on the floor under the battery with acid proof paint. Paint floor areas that are unpainted.

7.8.3 Battery jars and cases should be insulated from the rack with rubber or plastic strips.

7.8.4 Battery jars and cases should not touch each outer.

7.8.5 Battery rack should be grounded to station ground with 4/0 ground wire.

7.9 Replace damaged of missing “Danger Explosive Gas” signs.

8.0 DIAGNOSTIC INSPECTION

8.1 Perform battery charger diagnostic inspection before performing battery diagnostic inspection.

8.1.1 The short amount of time the battery is on equalize during the charger inspection will not affect battery test results.

8.2 Perform all of the steps listed in Visual and Operations Inspections above.

8.3 Record the battery charger's output current.

8.4 Record the charger's DC ammeter reading on the inspection card.

8.5 Perform an MBite test on the battery.

8.5.1 Battery banks over 130 volts must be tested in sections. Do not make MBite connections until the procedure has been reviewed in the MBite manufacturer's instruction manual or the Substation Batteries and Chargers training manual.

8.5.2 Refer to the Substation Batteries and Chargers Training Manual or manufacturer's instruction manual for operation of the MBite test set and details on MBite testing.

8.5.3 Do voltage, impedance and resistance (strap) tests on each cell before moving to the next cell. If the battery has inter-cell connections that are insulated, with the only bare spot in the middle, put both probes on this spot when doing the strap test.

8.5.4 If test probes are not 'dug in" firmly oxide on conductors and/or battery grease can result in bad readings.

8.5.5 Be sure to wait for the MBite display reading to settle before pushing the test button. Wait for the "beep" before releasing the test button and moving to the next test. If the button is released early the test results won't be captured.

8.5.6 Print out the test results.

8.5.7 Evaluate the MBite test results.

8.5.8 Find the cell with the lowest cell voltage and circle it.

8.5.9 Find the cell with the highest cell voltage. If the difference between the lowest and highest cell is more than 0.1 volts or the lowest cell voltage is below 2.14 volts the battery requires an equalizing charge.

8.5.10 Refer to the graph printout of cell impedance. If and cell deviates more than 30%, plus or minus, the battery requires an equalizing charge.

8.5.11 Strap resistance is shown in the "Rs mΏ" column of the printout. Strap resistances for inter-cell connections on the top of multi-cell batteries will be different than connections between batteries.

8.5.12 Strap resistances higher than twice the value of other straps of the same type should be bypassed with the battery jump-out box, disassembled, cleaned and re-torqued.

8.5.13 Refer to the Substation Batteries and Chargers training manual for more detail on evaluating MBite results and the battery jump-out box.

8.5.14 Retest any suspect cells and reprint results. Attach final printout to inspection card/record.

8.6 Designate a new pilot cell.

8.6.1 Refer to the MBite printout to find the previously circled lowest cell voltage. This cell will become the new pilot cell.

8.6.2 Move the thermometer to the new pilot cell.

8.6.3 When removing the thermometer from the old pilot cell wait for the electrolyte to drip off before completely removing it.

8.7 Record battery voltage after 30 minute discharge.

8.7.1 Turn the digital multi-meter on and select DC voltage and a range higher that the overall battery voltage to be measured (Range selection is not necessary if the multi-meter is auto-ranging).

8.7.2 Turn the battery charger's AC circuit breaker off.

8.7.3 Measure and record the overall voltage between the positive and negative ends of the battery (points where the battery charger and DC supply leads are connected). Leave the multi-meter leads connected.

8.7.4 Monitor the battery voltage for 30 minutes:

8.7.5 If voltage drops below column 1 continue test.

a. Retest voltage/impedance with MBite when test is complete.

b. Leave charger off.

c. Mark printout "After 30 minute discharge test".

d. It is not necessary to retest strap/connection resistance.

8.7.6 If voltage drops below column 2 discontinue test.

a. Turn charger on.

b. Retest voltage/impedance with MBite.

c. Mark printout "After 30 minute discharge test aborted at (##) minutes".

d. It is not necessary to retest strap/connection resistance.

Battery Size	**Column 1**	**Column 2**
24 volt - 12 cell	22 volts	21 volts
48 volt - 23 cell	43 volts	42 volts
48 volt - 24 cell	46 volts	44 volts
120 volt - 58 cell	112 volts	106 volts
120 volt - 60 cell	118 volts	109 volts
240 volt - 116 cell	228 volts	210 volts
240 volt - 117 cell	230 volts	212 volts
240 volt - 120 cell	236 volts	214 volts

8.8 Record final voltage on inspection card.

8.9 Turn the battery charger's AC circuit breaker on.

8.10 If indicated by the MBite test results equalize charge the battery bank.

8.10.1 If the charger has an equalizing (overcharging) timer set the timer to:

a. 72 hours for lead calcium and lead antimony batteries.

b. As specified in the manufacturer's instruction manual for lead selenium batteries. Normally 36 hours maximum, periodic monitoring probably will be required.

8.10.2 If the charger has an equalizing (overcharging) switch; turn the switch on. Refer to the chargers instruction manual to insure the charger will automatically stop the equalizing charge after a set period of time.

8.10.3 If the charger does not stop equalizing charging automatically return before the maximum equalize time to shut the equalizing charge off.

8.10.4 The charger’s DC ammeter reading should increase when the charger is put on equalizing charge.

9.0 ACCEPTANCE INSPECTION

9.1 Perform battery charger inspection before performing battery inspection.

9.2 Insure that a freshening charge has been applied to the batteries after installation.

9.2.1 Refer to the manufacturer’s operating and installation manuals.

9.2.2 Typically this will be similar to an equalizing charge of 110 hours for lead antimony and 72 hours for lead calcium and lead selenium batteries.

9.3 Perform all of the steps listed in Visual and Operational, and Diagnostic Inspections above.

10.0 APPENDIX A - TESTING FOR BATTERY GROUNDS WITH A MULTI-METER

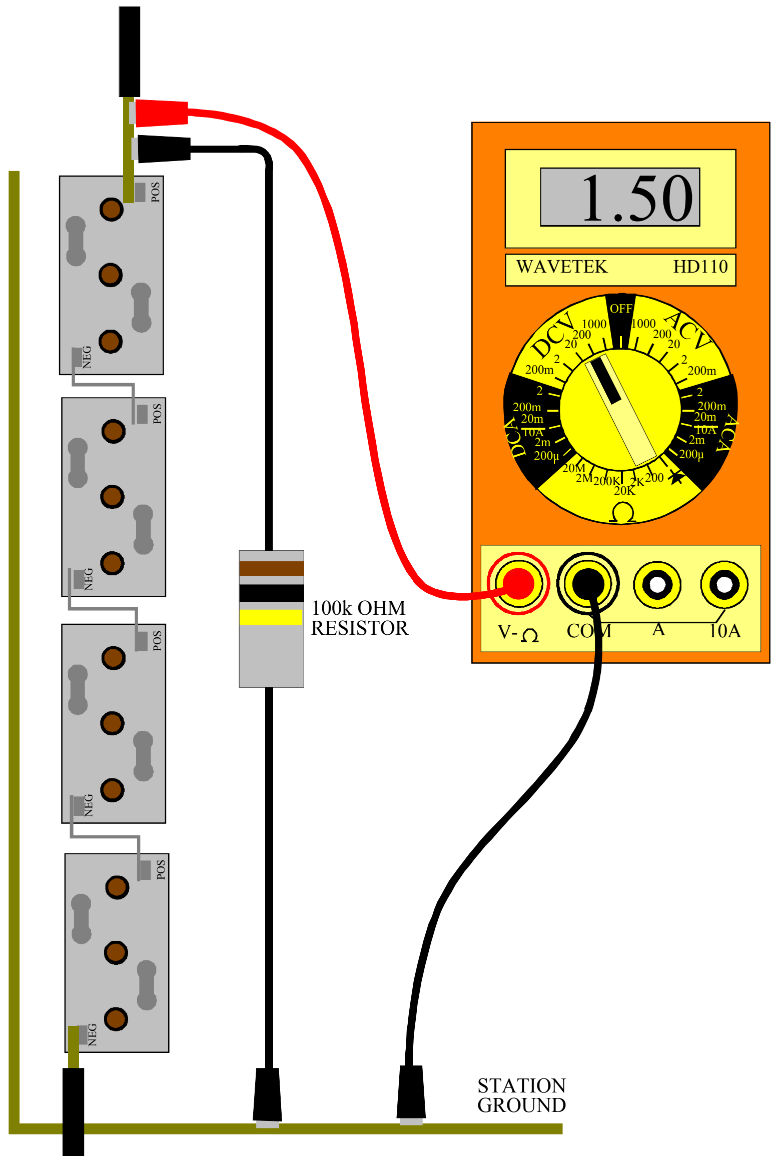
Digital multi-meters can be used to test for battery grounds if no ground detection is provided in the charger.

However, due to their very high input impedance, a parallel resistor jumper lead must be fabricated and used. If the resistor lead is not used the multi-meter will indicate grounds when none are present.

The resistor jumper lead is fabricated using a 100k ohm resistor. 100k ohm resistors are available at Radio Shack and other electronic component suppliers.

With the leads connected to the positive battery terminal as shown you are testing for negative grounds. Move the resistor and meter leads from the positive to the negative battery terminal. This will test for positive grounds.

With this setup voltages less than 10% of the battery voltage (12 volts for 120-volt battery) indicate no significant grounds. Full battery voltages indicate hard (metal to metal) grounds. Voltages in-between indicate resistive grounds.



11.0 APPENDIX B - TORQUE VALUES FOR COMMON BATTERIES AND CELLS

MFR	TYPE	Battery Type	Cell/ Battery	Installation Torque	Inspection Re-Torque
ALCAD	SD-5, SD-7, SD-9, SD-11, SD-13, SD-15, SD-21	Lead-Selenium	Cell	70 in.-lb.	70 in.-lb.
ALCAD	SGL-7, SGL-13	Lead-Selenium	Battery	50 in.-lb.	50 in.-lb.
Chloride	YCP-9, YCP-11, YCP-13, YCP-17, YCP-25	Lead-Calcium	Cell	??	??
C&D	DCU-9, DCU-13, DCU-15, DCU-17	Lead-Calcium	Cell	110 in.-lb.	100 in.-lb.
C&D	KCR-7, KCR-9, KCR-11, KCR-13	Lead-Calcium	Cell	110 in.-lb.	100 in.-lb.
C&D	KCR-15, KCR-17, KCR-19, KCR-21	Lead-Calcium	Cell	160 in.-lb.	125 in.-lb.
C&D	KCU-7, KCU-9, KCU-11, KCU-17	?	Cell	110 in.-lb.	100 in.-lb.
C&D	JC-100, JC-150	Lead-Calcium	Cell	110 in.-lb	100 in.-lb.
C&D	Liberty 2000	Lead-Calcium	Battery	160 in.-lbs.	125 in.-lbs.
C&D	LS 6-125	Lead-Calcium	Battery	80 in.-lb	75 in.-lb
C&D	LS 12-25, LS 6-50, LS 12-55	Lead-Calcium	Battery	45 in.-lb.	40 in.-lb.
C&D	LS 12-80, LS 12-100	Lead-Calcium	Battery	110 in.-lb.	100 in.-lb.
C&D	LS 6-200, LS 4-300	Lead-Calcium	Battery	110 in.-lb	100 in.-lb
C&D	LST	Lead-Calcium	Battery	130 in.-lbs.	110 in.-lbs.
C&D	KC-7, KC-13	?	Cell	110 in.-lb	100 in.-lb
C&D	KCT-300, KCT-360	Lead-Calcium	Cell	110 in.-lb	100 in.-lb
C&D	XT4-JC9	Lead-Calcium	Cell	110 in.-lb	100 in.-lb
C&D	2JC-300	Lead-Calcium	Battery	110 in.-lb	100 in.-lb
C&D	3DCU-3, 3DCU-5, 3DCU-7, 3DCU-9, 3DCU-11, 3DCU-15	Lead-Calcium	Battery	70 in.-lb.	60 in.-lb.

(Continued)

MFR	TYPE	Battery Type	Cell/ Battery	Installation Torque	Inspection Re-Torque
C&D	3DU-3, 3DU-5, 3DU-7, 3DU-9, 3DU-11	Lead-Antimony	Battery	70 in.-lb.	60 in.-lb.
C&D	3JC-100	Lead-Calcium		110 in.-lb	100 in.-lb
C&D	3KCR-5	?	Battery	160 in.-lb	125 in.-lb
C&D	4JC50, 4JC100, 4JC150	Lead-Calcium	Battery	110 in.-lb.	100 in.-lb.
C&D	XLB	?	?	160 in.-lbs.	125 in.-lbs.
Excide	All with 1/4 -20 bolts	--------------	All	70 in.-lbs.	60in.-lbs.
Excide	All with 5/16 -18 bolts	--------------	All	120 in.-lbs.	110 in.-lbs.
Excide	All with “CA” in Type	Lead-Antimony	All	----------------	---------------
Excide	All with “CC” in Type	Lead-Calcium	All	----------------	---------------
Continued on next pageMFR	TYPE	Battery Type	Cell/ Battery	Installation Torque	Inspection Re-Torque
Electric Storage Battery	All with 1/4 -20 bolts	--------------	All	70 in.-lbs	60in.-lbs
Electric Storage Battery	All with 5/16 -18 bolts	--------------	All	120 in.-lbs.	110 in.-lbs.
Electric Storage Battery	All with “CA” in Type	Lead-Antimony	All	----------------	---------------
Electric Storage Battery	All with “CC” in Type	Lead-Calcium	All	----------------	---------------
FIAMM	SD-5, SD-7, SD-9, SD-11, SD-13, SD-15, SD-21	Lead-Selenium	Cell	70 in.-lb.	70 in.-lb.
Storage Battery Systems	SR	Lead-Selenium	?	132 in.-lb.	132 in.-lb.
Yuasa	All with 1/4 -20 bolts	--------------	All	70 in.-lbs.	60in.-lbs.
Yuasa	All with 5/16 -18 bolts	--------------	All	120 in.-lbs.	110 in.-lbs.
Yuasa	All with “CA” in Type	Lead-Antimony	All	----------------	---------------
Yuasa	All with “CC” in Type	Lead-Calcium	All	----------------	---------------

12.0 APPENDIX C - UTILIZING NATIONAL GRID BATTERY BYPASS BOX FOR BATTERY SYSTEM MAINTENANCE

It is a mandatory practice that battery maintenance be performed in a manner that insures all substation DC equipment remains energized during the work. Any exceptions to this practice must be approved by Protection. This approval will include documented mitigation steps necessary (including none) for maintenance allowed that will subject the station to a momentary DC outage.

It is a mandatory that construction and repair of the Battery Bypass Box will only be performed by the National Grid Lab. The Lab contact information:

National Grid USA

Engineering Laboratory

7437 Henry Clay Blvd., Bldg. #1

Liverpool, NY 13088-3504

315-460-2491

Within the various substation maintenance departments at National Grid there exist many fixtures/switches/cables constructed in the past to support battery maintenance. This equipment consists of some or all of the components that exist in the Training Center/Engineering Laboratory developed Battery Bypass Box. The Battery Bypass Box and steps outlined below in this SMP is the only permitted manner to remove specific cells/straps in a battery bank from service for maintenance/replacement. It is recognized that there are maintenance areas where different colors/symbols are used to signify positive (red, white, +) and negative (black, -) polarity. The labeling of the leads on Battery Bypass Box can be ordered or changed to match what has been adopted in the area.

The following are steps on how to utilize the Battery Bypass Box in order to perform necessary maintenance tasks. This procedure assumes that Battery Bypass Box will have leads that are labeled white for positive polarity and black for negative polarity.

12.1 Take a multimeter and place in continuity test mode. Place the Battery Bypass Box switch in the **OFF** position and confirm open with the meter.

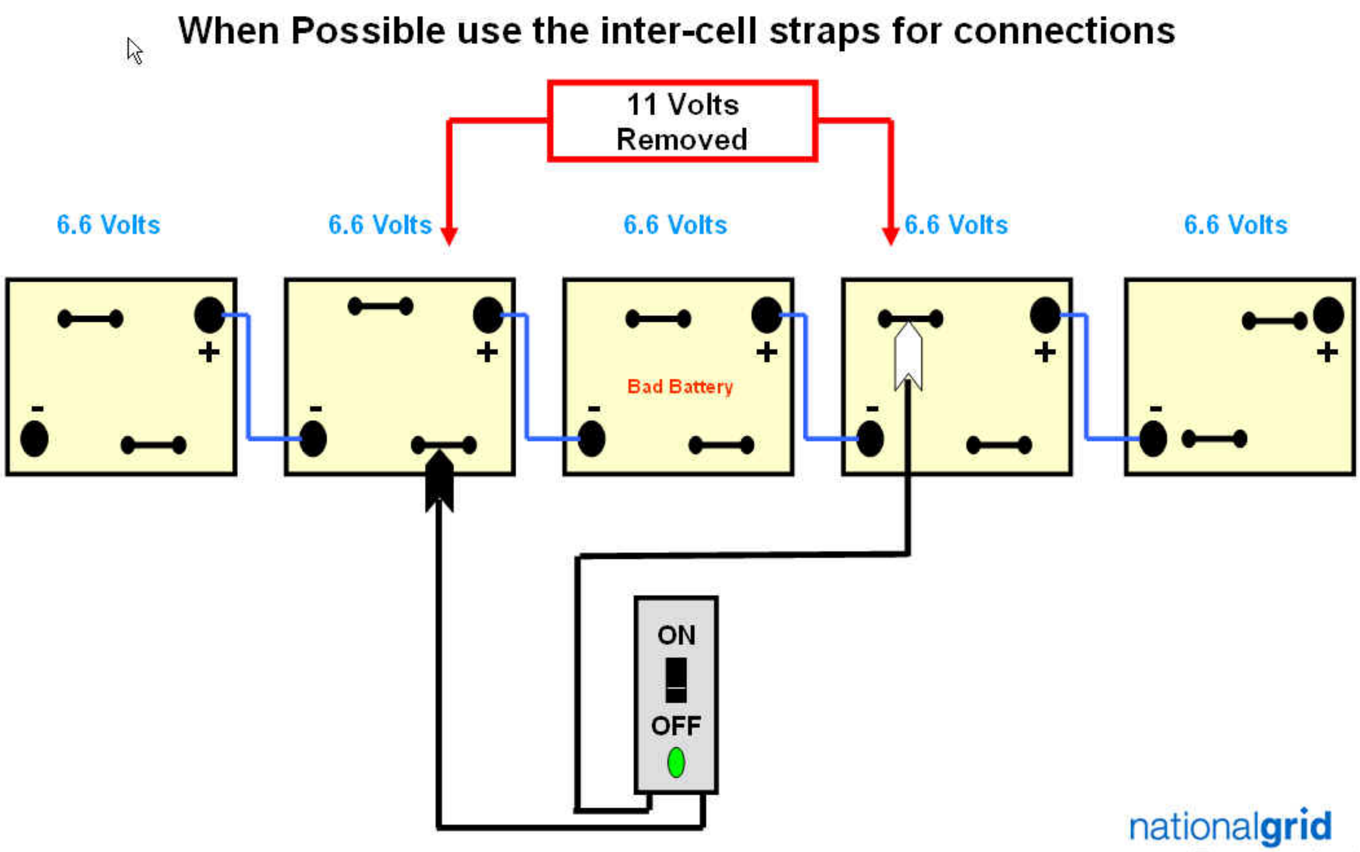
12.2 The black lead connection must be closest to the negative post at the end of the battery string. This most negative point has the connection that goes directly to the DC panel or disconnect switch. Connect black lead of the Battery Bypass Box as close as possible to the battery equipment being bypassed.

12.3 The white lead connection must be closest to the positive post at the end of the battery string. This most positive point has the connection that goes directly to the DC panel or disconnect switch. Connect white lead of the Battery Bypass Box as close as possible to the battery equipment being bypassed. (See Figures 1-4)

12.4 Confirm that the Battery Charger output current is less than 35 amps. If the charger output current is greater than 35 amps then review the application with O&M Services before proceeding.

12.5 **Turn off the battery charger.**

12.6 Take a multimeter measurement to confirm that battery cell voltage being bypassed does not exceed 22 volts for a 60 cell (120VDC) bank, 8 volts for a 24 cell (48VDC) bank or 4 volts for a 12 cell (24VDC) bank. These limits are set in order to not expose the operating equipment to voltage levels any lower than the limits set when sizing batteries at the location.



12.7 Check that the Battery Bypass Box green light has come on. The green light will only light when the Battery Bypass Box has been connected properly.

12.8 Place the Battery Bypass Box switch in the on position.

12.9 Remove the first intercell connection within the Battery Bypass Box connections. The green light will now go out.

12.10 After the first strap has been removed, check the string voltage >105 volts on a 120VDC bank, >40 volts on a 48VDC cell bank, or > 20 volts on 24VDC bank. If the measured value does not meet these minimums then reinstall the strap and investigate the cause.

12.11 Perform necessary maintenance work. At the end of the work when the final strap is reinstalled the green light will again light. Investigate if the light does not come on prior to taking any of the next steps.

12.12 If the maintenance is going to involve removing cells on a temporary basis from the bank then remember to readjust the float voltage on the charger.

12.13 If the maintenance consists of permanent replacement of a cell confirm that the new cell has same Amp Hour rating and has undergone a freshening charge.

12.14 Place the Battery Bypass Box switch in off position. Mbite or micro-ohm (10 amp rated unit) test the cells and connections that were bypassed to confirm good readings.

12.15 Remove the Battery Bypass Box white and black lead connections.

12.16 Turn the Battery Charger on. Check battery string voltage good.

Examples – Battery Bypass Switch Connections

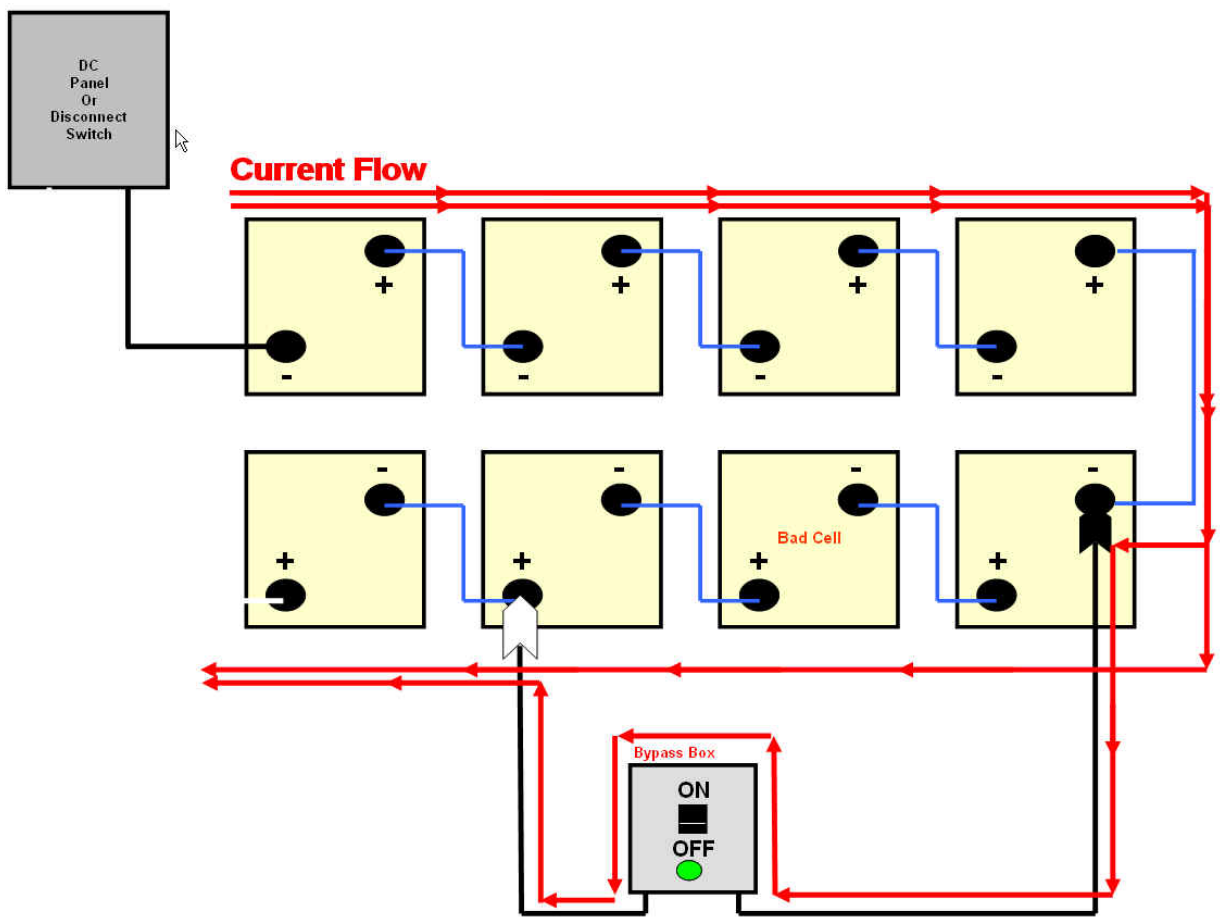


Figure 1 - Bad Cell or Battery in Upper Bank

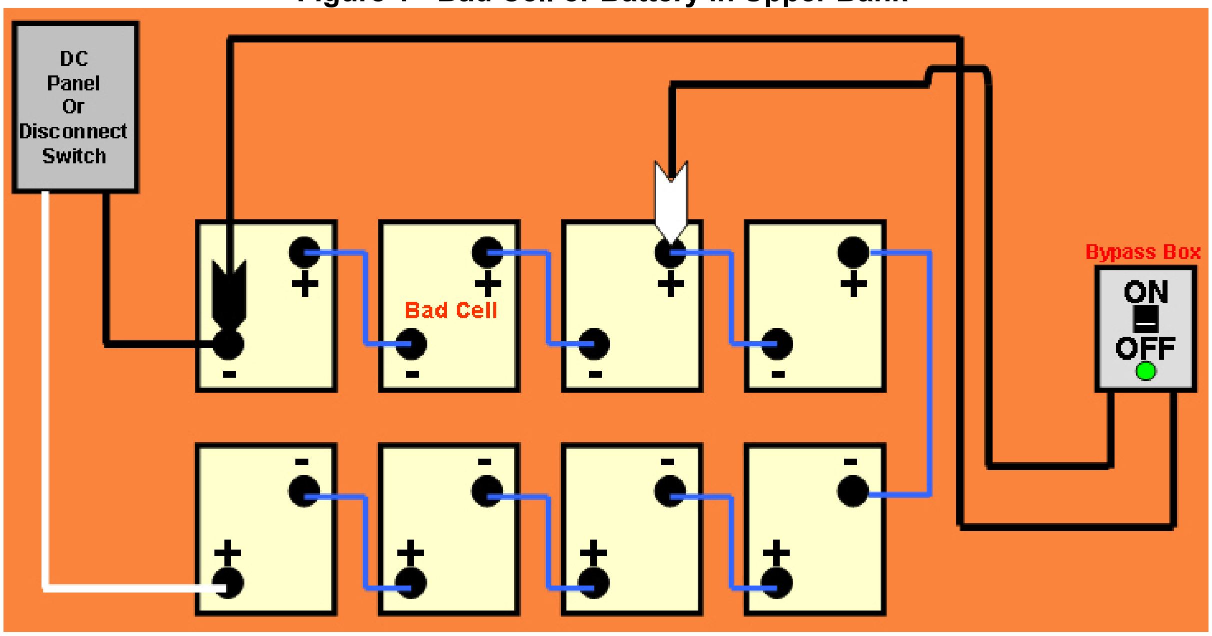


Figure 2 - Bad Cell or Battery in Lower Bank

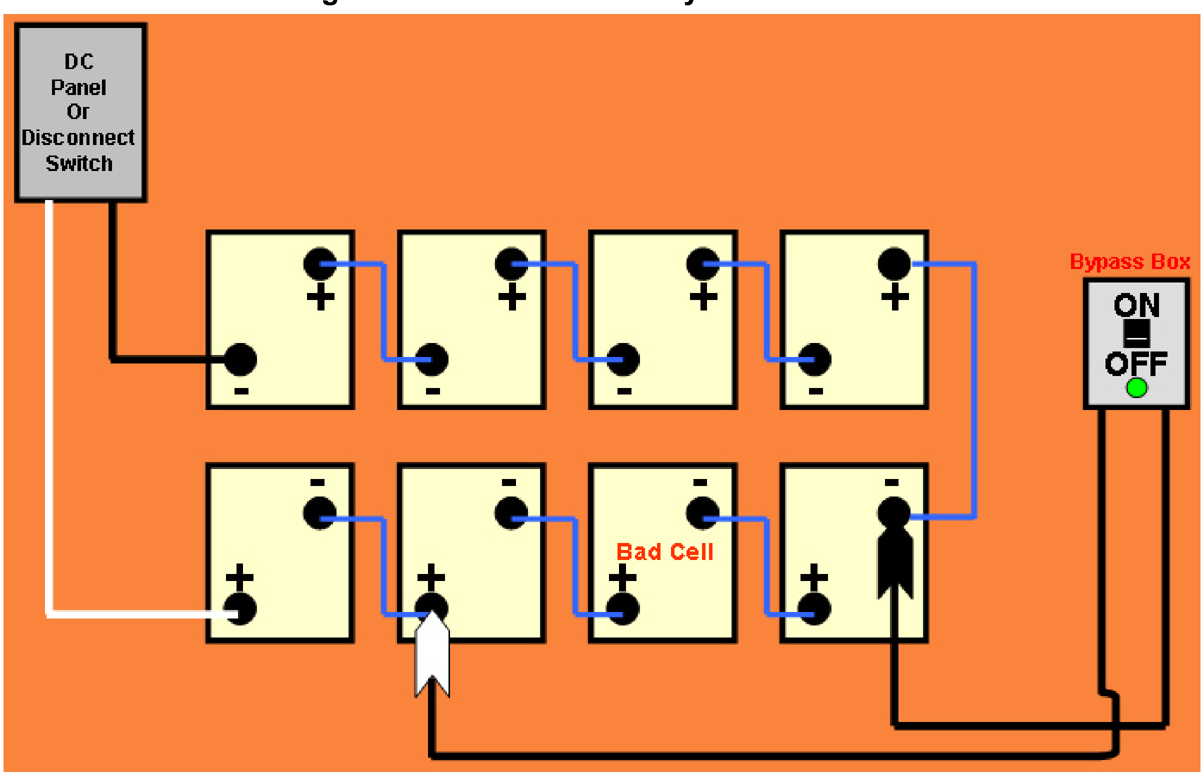


Figure 3 - Bad Cell or Battery in Upper Bank

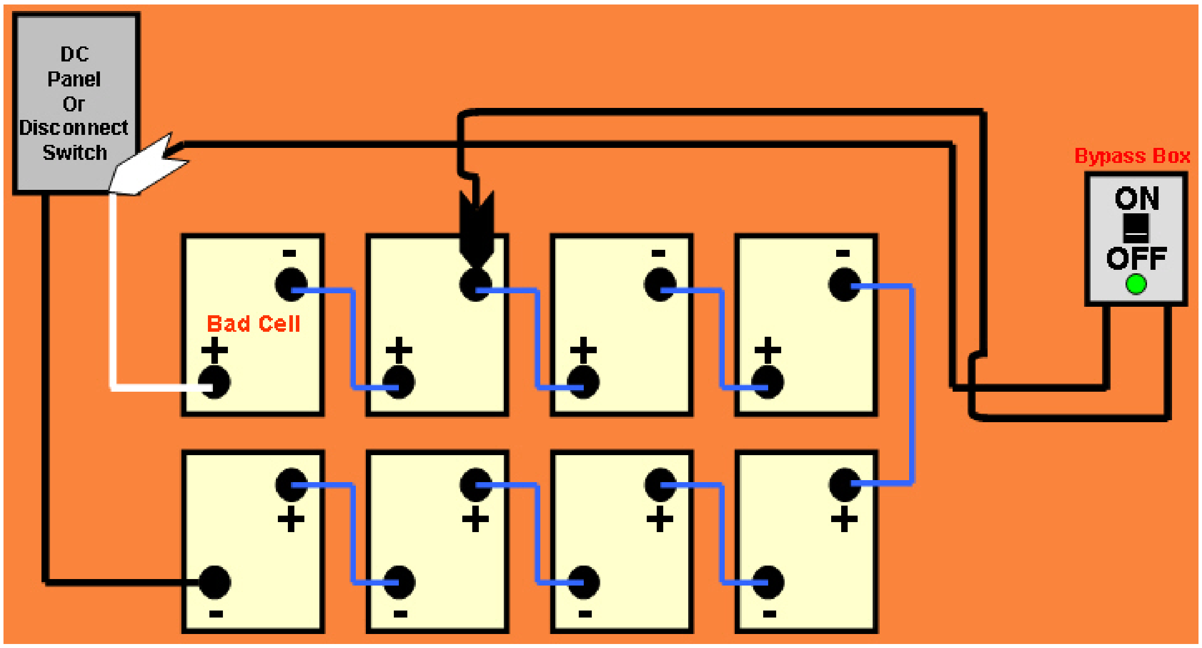


Figure 4 - Bad 4-Cell Battery in Bank
When Possible use the Inter-Cell Straps for Connections

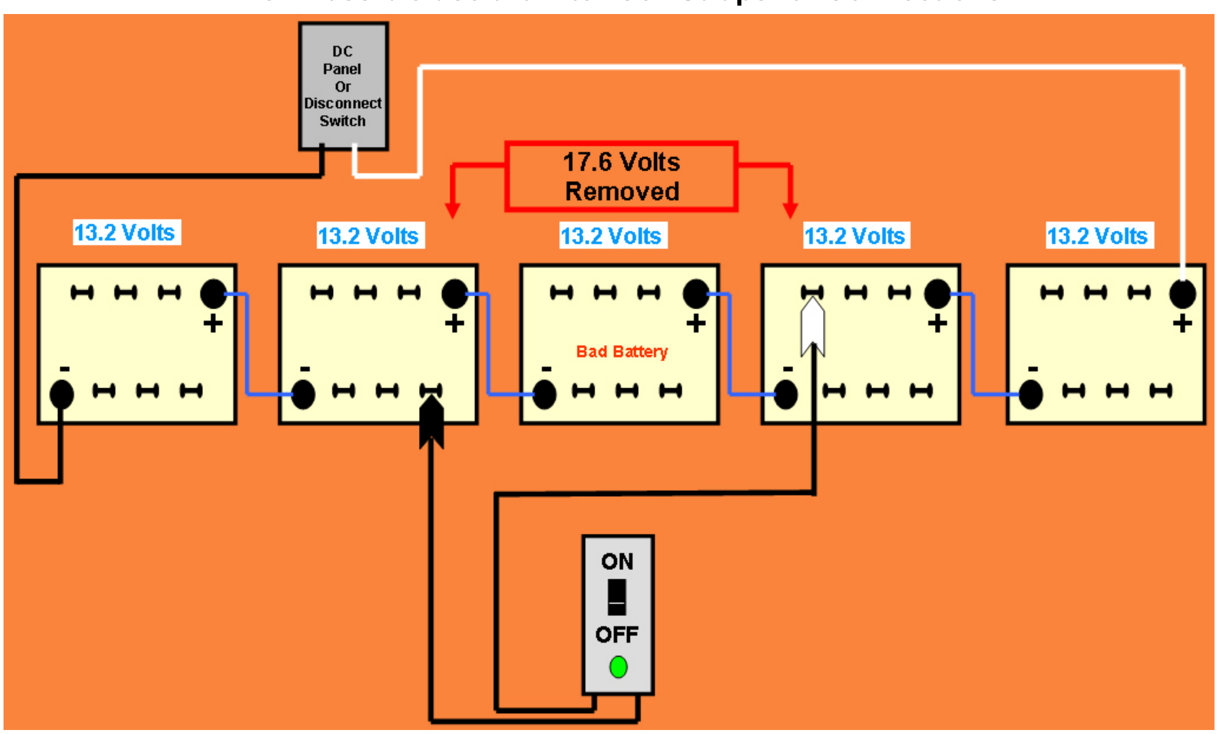
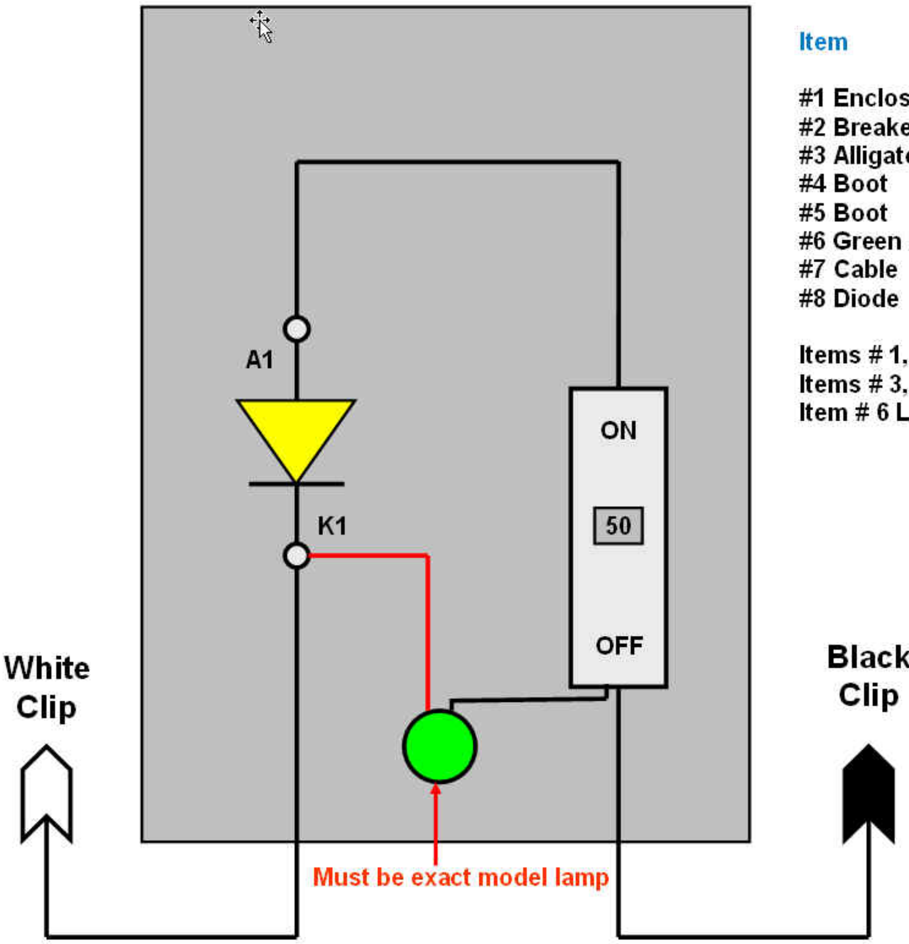


Figure 5 - Battery Bypass Box



Parts List

Item	Manufacturer	Part #
#1 Enclosure	Square D	FA100S
#2 Breaker	Square D	FAL14050
#3 Alligator Clips	Mueller	BU-21CPS
#4 Boot	Mueller	White BU-23-9
#5 Boot	Mueller	Black BU-23-0
#6 Green LED	Ledtronics	PFS50CG5-28V-W6
#7 Cable	Any	12/3 SJO
#8 Diode	Powerex	CS240650-PRX

Items # 1, 2 & 7 Graybar
Items # 3, 4, 5 & 8 Newark Electronics
Item # 6 Ledtronics

13.0 APPENDIX D - UTILIZING BATTERY TRAILER FOR BATTERY SYSTEM MAINTENANCE/REPLACEMENT

The National Grid mobile equipment fleet includes battery trailers for that can be utilized in order to remove the entire station battery (60 cell 120Volt) (24 cell 48 volt) from service for the maintenance or replacement of battery.

13.1 This Appendix applies to utilizing these battery trailers.

13.2 It is standard practice that the cutover be performed in a manner where all substation DC equipment remains energized.

13.3 Protection must be contacted and determine the mitigation steps necessary in order to approve a cutover that will subject the station to a momentary DC outage.

13.4 **Cutting Over Substation DC system from Station Battery to Battery Trailer**

13.4.1 Verify Battery Trailer is prepared to go into service.

a. O&M Services approval of install if battery trailer is being installed in a station where existing battery bank has a rating > 350 AH.

b. AC connection to Battery Trailer has been done. Battery Trailer blower (if equipped with one) is running.

c. Loss AC and Low DC Charger alarm contacts on Battery Trailer have been connected into station battery alarm circuit if possible.

d. Station service AC breaker being utilized is at least 40 amps. If 40 amps or greater breaker can not be utilized and trailer has no alarm connection then charger current limiting circuit must be adjusted to insure station AC breaker will not trip due to charger load.

e. Charger switch is on correct tap setting (240VAC or 208VAC) for station AC. Charger AC and DC breakers are closed and output voltage within 1 volt of 135 for 60 cell bank or refer to SMP 406.3.2 for other values. If battery charger is not on then close DC breaker first then close the charger AC breaker. Monitor trailer voltage until its value reaches those listed above before proceeding.

f. All Battery Trailer DC disconnects are in the open position. With a multi meter verify there is continuity across the DC disconnect fuses.

13.4.2 Install battery trailer cables from existing DC system to open battery trailer disconnect switch.

a. Choose the 50 amp Disconnect \ Twist Lock cable connection only for mobile equipment or stations that have a existing DC fused safety switch or single DC panel main breaker of 50 amps or less.

b. When choosing location for connecting battery trailer cables to station DC system consider how will accomplish the transfer of substation DC back to the battery bank utilizing an open disconnect (even if temporary) after work is complete. Typical battery bank replacement/major maintenance work should consist of the installation of a safety switch with dual lugs on the DC system side to facilitate future battery trailer installations.

13.4.3 Match the DC system voltage and Battery trailer DC voltage at the open Battery Trailer switch that will be making tie.

a. Verify match in battery polarity across open disconnect switch of trailer with multi-meter. Put meter probes across blades on DC System Voltage side of open switch and note the polarity (+,-). Move the probes directly across the open switch to the Battery Trailer DC voltage side and confirm the meter is reading the same polarity.

b. Match the DC voltage values on each side of the open switch to be within .1 (1/10th) of a volt with a multi-meter. This can be accomplished by adjusting the float voltage on the battery trailer charger.

13.4.4 Tie the two DC systems together by closing the Battery Trailer switch.

13.4.5 Turn the substation battery charger off. (AC breaker then DC breaker)

13.4.6 Disconnect the station battery from the DC system by opening the existing Station Battery Safety Switch or by lifting and taping the positive and negative leads from the battery output posts.

13.4.7 Check Station DC voltage good, Battery Trailer Charger has no alarms, and Battery Trailer Charger DC output is less than charger rating.

13.5 Cutting Over Substation DC from Battery Trailer to Station Battery

13.5.1 Verify that Station Battery is prepared to go into service.

a. Charger AC and DC breakers are closed and output voltage within 1 volt of 135 for 60 cell bank or refer to SMP 406.3.2 for other values.

b. If the Station Battery is a new installation that it and the charger passed required acceptance testing including alarms.

c. With a multi meter verify there is continuity across the battery Safety Switch fuses that are going to be used.

13.5.2 Verify that there is an open safety switch (even if installed temporary) that the Station Battery DC is tied into on one side and the station DC system is tied into the other side.

13.5.3 Match the DC system and Station Battery DC at the open safety switch that will be making the tie.

a. Verify match in battery polarity across open safety switch with multi-meter. Put meter probes across blades on DC System Voltage side of open switch and note the polarity (+,-). Move the probes directly across the open switch to the Station Battery DC voltage side and confirm the meter is reading the same polarity.

b. Match the DC voltage values on each side of the switch to be within .1 (1/10th) of a volt with a multi-meter. This can be accomplished by adjusting the float voltage on the Station Battery charger.

13.5.4 Tie the two DC systems together by closing the Station Battery Safety Switch.

13.5.5 Disconnect the Battery Trailer from the DC system by opening the battery trailer DC disconnect.

13.5.6 Check Station DC voltage good, Station Battery Charger has no alarms, and Station Battery Charger DC output is less than charger rating.

13.5.7 Additional Battery Trailer considerations

a. Disconnect the Battery Trailer charger alarms

b. Disconnect AC feed to the battery trailer (If within 3 days of trailer being transported).

c. Insure all cables are repacked into battery trailer cabinet.

d. Check battery electrolyte level (face shield PPE, flashlight required) 1/8” below bottom of filling tube and add if lower.

Figure 1 - Typical Battery Trailer Arrangement in Connection Cabinet

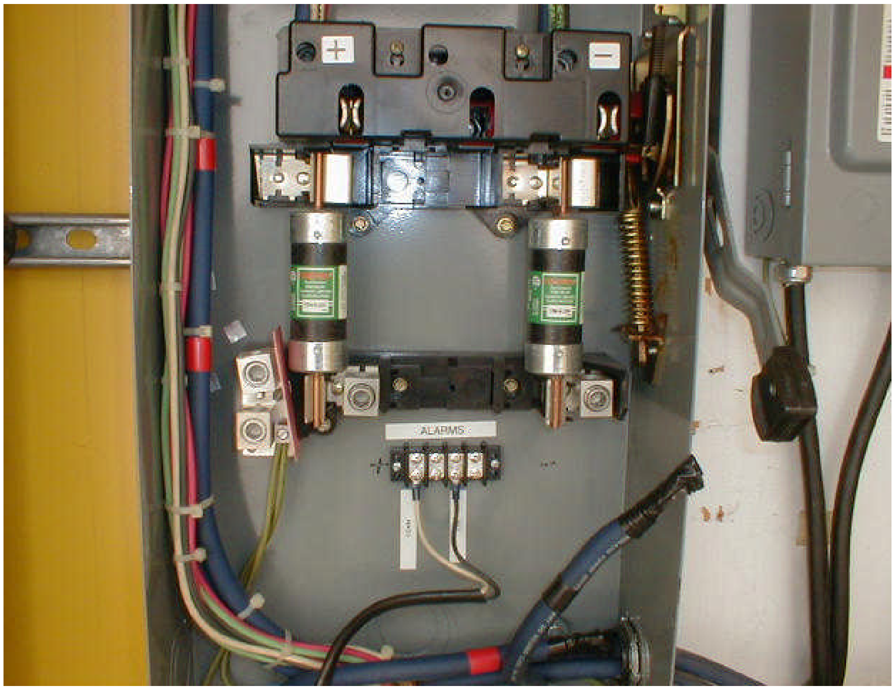


Figure 2 – Battery Trailer Disconnect with external charger alarm terminal

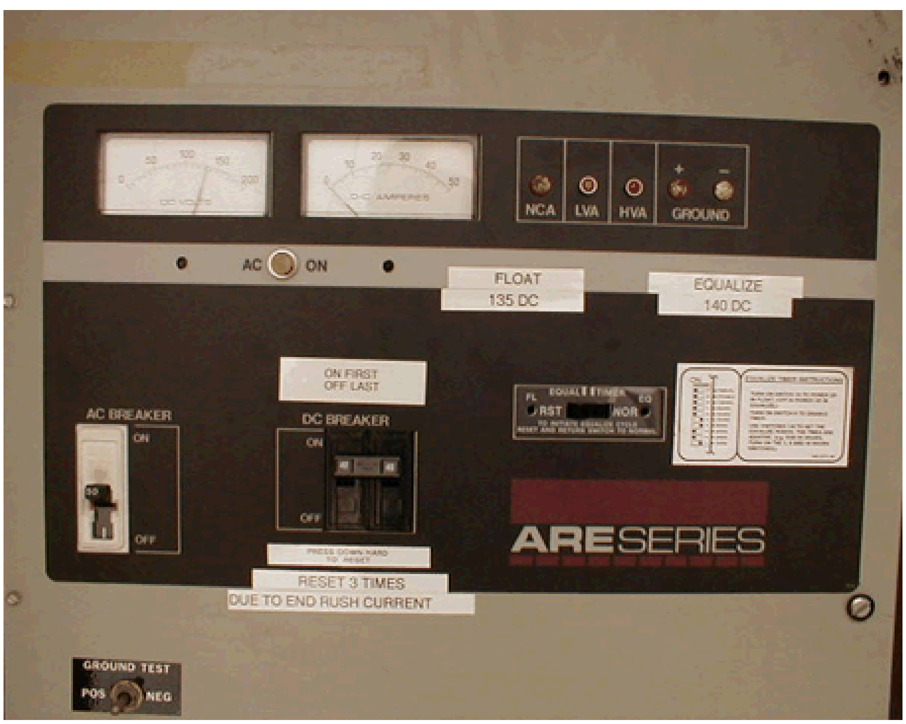


Figure 3 – Typical Charger in Battery Trailer

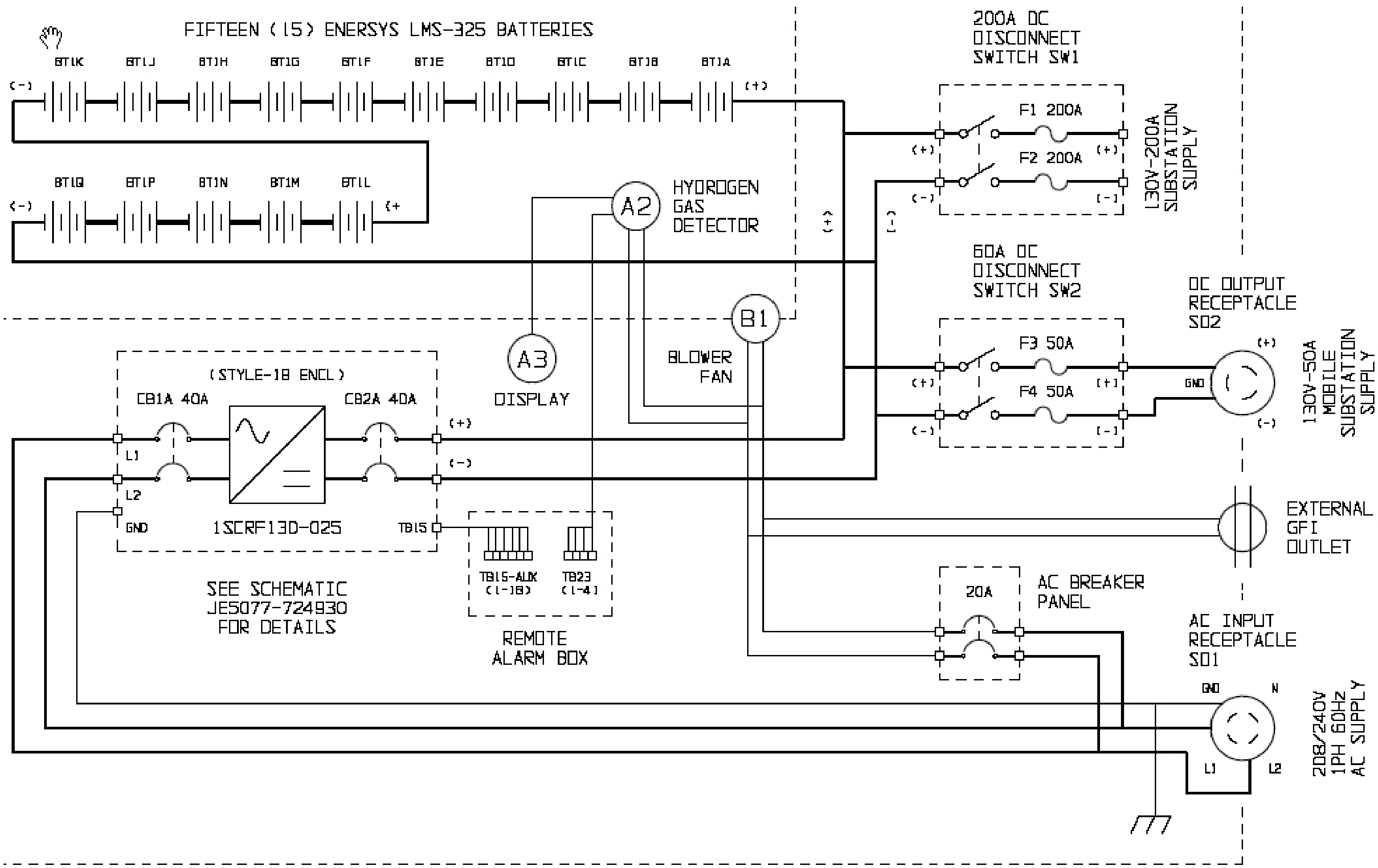


Figure 4 – Typical Battery Trailer Schematic

14.0 REVISION HISTORY

Version	Date	Description of Revision
0.0	xx/xx/xx	Initial version of document
0.1	09/30/06	Visual and Operational Inspection Changed - Turn the battery charger's DC Circuit breaker off to Turn the battery charger's AC Circuit breaker off. Changed - Turn the battery charger's DC Circuit breaker on to Turn the battery charger's AC Circuit breaker on.
1.0	12/26/06	Corrected - Formatting Changed - Header title, Document number prefix Removed - Subtitle Changed - First page footer to reference Documentum
1.1	01/29/07	Diagnostic Inspection Revised – 30 min. discharge test failure actions.
1.2	02/12/07	Diagnostic Inspection Added – Equalize during charger inspection will not affect battery inspection results.
1.3	02/15/07	V&O Inspection Changed – Eyewash station inspection
1.4	04/10/07	V&O Inspection Changed – Equalize charge time Diagnostic Inspection Changed – Equalize charge time
1.5	05/03/07	NPCC A-4 - Bulk Power Stations - Charger and Battery Inspection Added Section Replaced – EOP with SMP 1 place
1.6	05/23/07	Document Added - Documentum Version # to headers Added - File name to footer
1.7	05/22/08	Diagnostic Inspection Changed - perform battery charger inspection to perform battery charger diagnostic inspection Changed - performing battery inspection before performing battery diagnostic inspection
1.8	09/30/08	Record of Revisions – Diagnostic Inspection Changed - Perform battery charger inspection before performing battery charger diagnostic inspection Record of Revisions – Acceptance Inspection Corrected – Perform battery charger inspection before performing battery inspection
1.9	02/27/09	Procedure Changed – NPCC A-4 - Bulk Power Stations….. to NPCC - Bulk Power Stations…… Reference Added – NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

		NPCC - Bulk Power Stations - Charger and Battery Inspection Added –This section meets the applicable requirements of NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection
2.0	03/01/10	Converted to new format. Added - Appendix C Added - Appendix D

NICKEL-CADMIUM BATTERY

INTRODUCTION

This procedure describe the methods use to perform Visual and Operational, Diagnostic, and Acceptance inspections on nickel-cadmium batteries used in electrical substations.

PURPOSE

Scheduled equipment inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used, to inspect nickel-cadmium.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

REFERENCE

National Grid USA Safety Handbook

NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Battery -	Group of cells in a common container. Using three cells to create a 6 volt battery is common in electrical substations.
Battery Bank -	Group of cells, or batteries connected in series to create higher voltages. Battery banks of 24, 48, 120, and 240 volts are common in electrical substations.
Battery Charger -	Device that converts station service AC voltage to a precise, stable DC voltage. Used to maintain the charge on station batteries and supply normal DC station loads.
Case -	Container enclosing a group of battery cells.
Cell -	Basic component of a battery or battery bank. In a lead acid battery each cell generates approximately 1.42 volts.
Equalizing Charge -	Charging batteries at slightly higher than the normal float voltage for a period of time. Use to correct unbalances in charge between cells and remove electrolyte stratification.
Freshening Charge –	Charge applied to a pre-charged battery after installation to bring battery to a fully charged state.

ASSOCIATED EQUIPMENT

Battery Chargers are inspected at the same time as the battery banks they are connected to. See SMP 406.03.2

PROCEDURE CONTENTS

Table of Contents

1. Test Equipment Required.

1.1 V&O Inspection

1) Digital Multi-meter, 0.25% DC accuracy, IEC 1010-1 Cat. IV
2) Spare batteries for multi-meter.
3) Resistors and leads to measure battery to ground voltages. (See Substation Batteries and Chargers training manual).

1.2 Diagnostic Inspection

1) All of above.
2) MBite battery impedance test set, AVO-Biddle, Catalog # 246005B or (preferred) or catalog # 246005. Check for test leads and AC power cable.
3) Spare roll of paper for MBite Test set.

1.3 Acceptance Inspection

1) All of above.

2. Special Tools required.

2.1 V&O Inspection

1) Insulated or non-conductive battery wrenches.
2) Insulated torque wrench 0 to 150 in-lb.

2.2 Diagnostic Inspection

1) All of the above.

2.3 Acceptance Inspection

1) All of the above.

3. Materials Required.

3.1 V&O Inspection

1) PDA with National Grid V&O software installed.
2) Inspection card/record from last V&O inspection.
3) Replacement bottles of eyewash solution.
4) Bulk eyewash solution for larger eyewash stations.
5) Danger sign "EXPLOSIVE GAS".
6) Cleaning solution -three parts water and one part boric acid.
7) Wire brush for use on battery rack and floor.
8) Scotchbrite green industrial abrasive pads.
9) Distilled water.
10) No-Ox-Id battery terminal grease.
11) Small hot plate to heat No-Ox-Id.
12) Small paint brush to apply No-Ox-Id.
13) Battery jump-out box (See Batteries and Chargers training manual).
14) Spare battery inter-cell straps (type varies by battery and manufacturer).
15) Spare battery inter-cell bolts, nuts and washers (types vary by battery and manufacturer).
16) Spare vent caps (type varies by battery and manufacturer).
17) Spare battery thermometer. (Do not use thermometers containing mercury or that have been used in Lead Acid batteries).
18) Metal primer and paint for battery racks.
19) Acid proof paint for floor.

3.2 Diagnostic Inspection

a) All of the above plus:
b) Inspection card/record from last Diagnostic inspection.

3.3 Acceptance Inspection.

a) All of the above.

4. Special Safety Equipment Required.

4.1 Chemical proof gloves.
4.2 Acid proof apron.
4.3 Full face shield.

5. Unusual Hazards

The fluid in nickel-cadmium batteries (electrolyte) is a mixture of potassium hydroxide and distilled water. Contact with electrolyte can cause blindness, burn skin, and burn holes in clothing. Electrolyte on skin or clothing should be rinsed off with generous amounts of water. Electrolyte in eyes should be flushed generously with bottled eyewash solution, or at an eyewash station, and immediate medical attention sought. Chemical proof gloves and aprons and a full face shield shall be worn when inspecting or working on nickel-cadmium batteries.

Substation batteries are capably of very high short-circuit currents. Accidentally shorting cells or batteries can result in severe burns and possibly battery explosions. Only insulated tools should be used when working on batteries. The use of 1000 volt disposable cover-up (SC 92008882) should be considered.

Nickel-cadmium batteries may emit small amounts of hydrogen gas during charging.

Although rare, batteries can explode violently and spew electrolyte and plastic shards from battery jars in all directions. Battery explosions can be caused by internal or external short circuits.

6. NPCC - Bulk Power Stations - Charger and Battery Inspection

6.1 This section meets the applicable requirements of NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

6.2 Check charger AC and DC circuit breakers are on.

6.3 Check that there is output voltage on charger DC voltmeter.

6.4 Check that there is output current on the charger DC ammeter.

6.5 Visually check all battery cells for general condition and proper electrolyte level.

7. Visual and Operational Inspection.

7.1 Perform battery charger inspection before performing battery inspection.

7.2 Check eyewash stations.

1) Plumbed Eyewash Stations shall be activated to flush the line and to verify proper operation.
2) Portable or self-contained units shall be visually inspected.
    a) The inspection shall ensure that the protective caps are in place and that the seal has not been broken.
    b) Expiration dates shall be checked on sealed fluid cartridges and cartridges replaced when necessary.
    c) Portable or self contained units that have been discharged shall have fluid cartridges replaced immediately.
3) All inspections and operational checks shall be recorded on the Eyewash Station Inspection Tag, NG0139.

7.3 Record battery voltage with charger off.

1) Turn the digital multi-meter on and select DC voltage and a range higher that the overall battery voltage to be measured (Range selection is not necessary if the multi-meter is auto-ranging).

2) Turn the battery charger's AC Circuit breaker off
3) Measure and record the overall voltage between the positive and negative ends of the battery (points where the battery charger and DC supply leads are connected).
   a) Read the voltage immediately after turning off the charger, the battery voltage will continue to drop.
4) Turn the battery charger's AC Circuit breaker on.

7.4 Refer to the manufacturer's instruction manual for the proper float voltage.
1) Voltage will be approximately 1.42 volts per cell but will vary slightly by manufacturer and type.
2) If the battery charger has ground detector lamps record if a positive or negative lamp is lit.
3) If the charger has a ground detection voltmeter record the voltages with the meter switch in both the positive and negative ground positions. If the voltmeter reads voltage when the switch is in the positive position the battery has a positive ground. If the voltmeter reads voltage when the switch is in the negative position the battery has a negative ground.
4) If the charger has no ground detection system use a multi-meter and the procedure in Appendix A at the end of this document to record the battery positive and negative voltages to ground. Note: Resistors and additional test leads required.

7.5 Visually inspect all battery cells. Refer to the Substation Batteries and Chargers training manual for details. Record problems and cell numbers on inspection card/record.
1) Electrolyte level. Add distilled water to bring electrolyte level to between the low and high level lines on the jar or case. Record cell numbers and amount added on inspection card.
2) Accumulation of sediment in bottom of jar. Sediment touching battery plates requires immediate attention.
3) Leaking or damaged jars or cases. Leaking jars or cases require immediate attention.
4) Check each jar/case to be clean and dry.
   a) Clean the tops of jars or cases with a solution of three parts water and one part boric acid if necessary. Do not allow the solution to enter the battery cells. It will neutralize the electrolyte and destroy the cell.
5) Check vent caps.
   a) Clean and dry vent caps as necessary. Use distilled water.
6) Replace any missing or damaged vent caps.
7) Check each terminal for corrosion.
   a) Clean corrosion off inter-cell conductors with the stiff bristled synthetic brush or green Scotchbrite and part boric acid/water solution. Do not use a metal bristled, wire brush.
   b) Rinse or wipe the boric acid/water solution residue off with clean water and rags.

c) Apply a thin coat of heated No-Ox-Id battery terminal grease to any inter-cell conductors that have been cleaned, with the paint brush. The No-Ox-Id must be heated to a cream like consistency to avoid applying excessive amounts that will collect dirt and dust.

d) Connections with sever corrosion should be bypassed with the battery jump-out box, disassembled, cleaned and painted with No-Ox-Id. (See the Substation Batteries and Chargers training manual for details on using the battery jump-out box.)

e) Any connections that have been loosened should be retorqued with a torque wrench. See manufacturer's instruction manual for battery torque values.

8) Record “as left” overall visual condition of battery bank on inspection card.

7.6 Check rack and floor for paint and cleanliness and grounding.

1) Wire brush, prime, and paint any chipped or corroded areas on the battery rack.

2) Wire brush and paint any chipped or corroded areas on the floor under the battery with acid proof paint. Paint floor areas that are unpainted.

3) Battery jars and cases should be insulated from the rack with rubber or plastic strips.

4) Battery jars and cases should not touch each outer.

5) Battery rack should be grounded to station ground with 4/0 ground wire.

7.7 Replace damaged of missing “Danger Explosive Gas” signs.

8. <u>Diagnostic Inspection.</u>

8.1 Perform battery charger diagnostic inspection before performing battery diagnostic inspection.

1) The short amount of time the battery is on equalize during the charger inspection will not affect battery test results.

8.2 Perform an MBite test on the battery.

1) The primary purpose of the MBite test is to find strap and connection problems.

2) Battery banks over 130 volts must be tested in sections. Do not make MBite connections until the procedure has been reviewed in the MBite manufacturer’s instruction manual or the Substation Batteries and Chargers training manual.

3) Refer to the Substation Batteries and Chargers Training Manual or manufacturer’s instruction manual for operation of the MBite test set and details on MBite testing.

4) Do voltage and resistance (strap) tests on each cell before moving to the next cell. If the battery has inter-cell connections that are insulated, with the only bare spot in the middle, put both probes on this spot when doing the strap test.

a) It is not necessary to test cell impedances.

5) If test probes are not ‘dug in” firmly oxide on conductors and/or battery grease can result in bad readings.

6) Be sure to wait for the MBite display reading to settle before pushing the test button. Wait for the “beep” before releasing the test button and moving to the next test. If the button is released early the test results won’t be captured.

7) Print out the test results.
8) Evaluate the MBite test results.
9) Find the cell with the lowest cell voltage and circle it.
10) Refer to the manufacturer's instruction manual to evaluate cells voltages.
    a) If not information is available look for abnormal cells.
11) Strap resistance is shown in the “Rs mΩ” column of the printout. Strap resistances for inter-cell connections on the top of multi-cell batteries will be different than connections between batteries.
12) Strap resistances higher than twice the value of other straps of the same type should be bypassed with the battery jump-out box, disassembled, cleaned and re-torqued.
13) Refer to the Substation Batteries and Chargers training manual for more detail on evaluating MBite results and the battery jump-out box.
14) Retest any suspect cells and reprint results. Attach final printout to inspection card/record.

8.3 Perform all of the steps listed in Visual and Operations Inspections above.
8.4 Record the charger’s DC ammeter reading on the inspection card.

9. <u>Acceptance Inspection</u>

9.1 If batteries are supplied without electrolyte follow manufacturer's instructions for adding electrolyte.
    1) If electrolyte is added cell oil may need to be added after the commissioning charge is performed.

9.2 Perform battery charger inspection before performing battery inspection.
9.3 Refer to the manufacturer’s operating and installation manuals to see if a commissioning charge is required.
9.4 Perform all of the steps listed in Visual and Operational, and Diagnostic Inspections above.

10. Appendix A - Testing For Battery Grounds With A Multi-meter

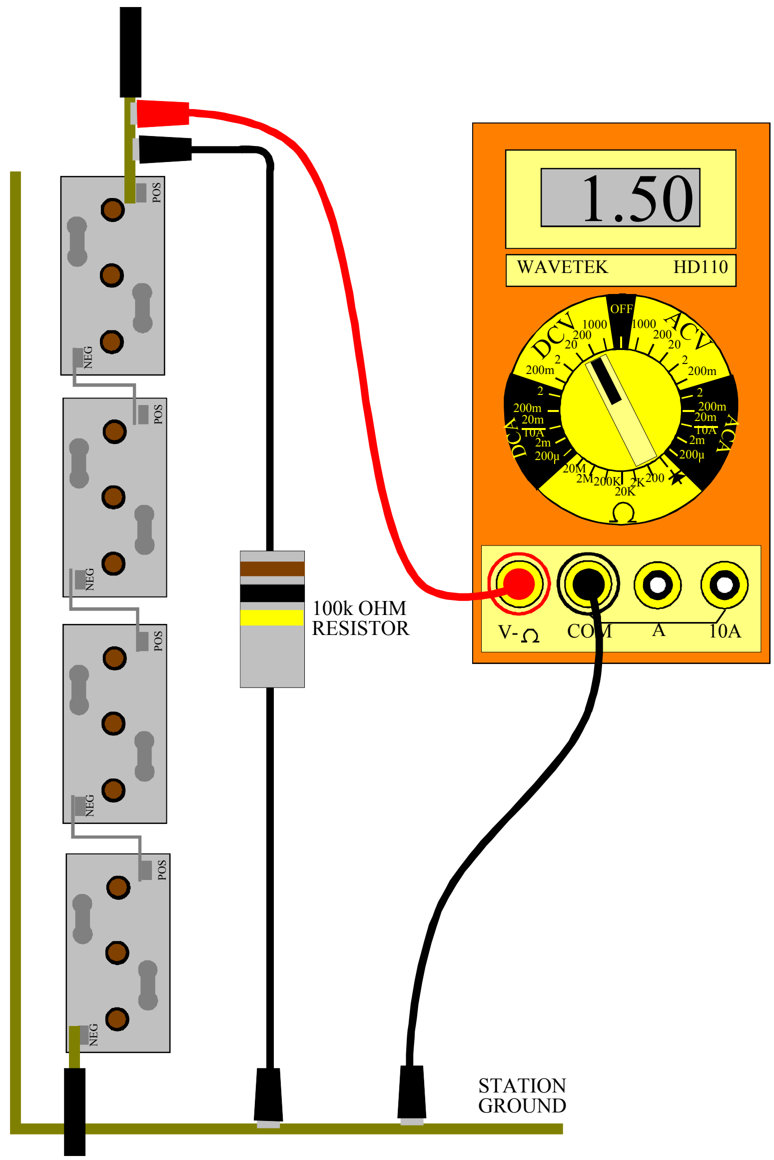
Digital multi-meters can be used to test for battery grounds if no ground detection is provided in the charger.

However, due to their very high input impedance, a parallel resistor jumper lead must be fabricated and used. If the resistor lead is not used the multi-meter will indicate grounds when none are present.

The resistor jumper lead is fabricated using a 100k ohm resistor. 100k ohm resistors are available at Radio Shack and other electronic component suppliers.

With the leads connected to the positive battery terminal as shown you are testing for negative grounds. Move the resistor and meter leads from the positive to the negative battery terminal. This will test for positive grounds.

With this setup voltages less than 10% of the battery voltage (12 volts for 120-volt battery) indicate no significant grounds. Full battery voltages indicate hard (metal to metal) grounds. Voltages in-between indicate resistive grounds.



11. Record of Revisions

Revision	Changes
09/30/2008	Record of Revisions - Acceptance Inspection Corrected - Perform battery charger inspection before performing battery inspection
02/270/2009	Procedure Changed – NPCC A-4 - Bulk Power Stations….. to NPCC - Bulk Power Stations…… Reference Added – NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection NPCC - Bulk Power Stations - Charger and Battery Inspection Added –This section meets the applicable requirements of NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

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nationalgrid	SUBSTATION MAINTENANCE PROCEDURE	**SMP 406.03.2** **Version 1.8** **Date 02/27/2009** **Page 1 of 12**

BATTERY CHARGER

INTRODUCTION

This procedure describes the methods use to perform Visual and Operational, diagnostic, internal, and acceptance inspections on battery chargers used in electrical substations.

PURPOSE

Scheduled equipment inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used, to inspect battery chargers.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

REFERENCES

National Grid USA Safety Handbook

NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Battery -	Group of cells in a common container. Using three cells to create a 6 volt battery is common in electrical substations.
Battery Bank -	Group of cells, or batteries connected in series to create higher voltages. Battery banks of 24, 48, 120, and 240 volts are common in electrical substations.
Battery Charger -	Device that converts station service AC voltage to a precise, stable DC voltage. Used to maintain the charge on station batteries and supply normal DC station loads.
Equalizing Charge -	Charging batteries at slightly higher than the normal float voltage for a period of time. Use to correct unbalances in charge between cells and remove electrolyte stratification.
Float Voltage -	Voltage required to maintain the battery at full charge. Battery chargers are set to this voltage. Float voltages need to be set accurately to avoid under or overcharging batteries.
Lead Antimony -	One of the three commonly used types of lead acid batteries used in substation applications. The others are lead calcium and lead selenium.

Lead Calcium -	One of the three commonly used types of lead acid batteries used in substation applications. The others are lead antimony and lead selenium.
Lead Selenium -	One of the three commonly used types of lead acid batteries used in substation applications. The others are lead antimony and lead calcium.
PDA -	Personal Digital Assistant. Pocket size computer.

ASSOCIATED EQUIPMENT

Batteries are inspected at the same time as battery chargers they are connected to. See SMP 406.01.2.

PROCEDURE CONTENTS

TABLE OF CONTENTS

1. Test Equipment Required.

1.1 V&O Inspection

1) Digital Multi-meter, 0.25% DC accuracy, IEC 1010-1 Cat. IV
2) Spare batteries for multi-meter.

1.2 Diagnostic Inspection

1) All of the above plus.
2) Resistor and leads to measure battery to ground voltages. See Substation Batteries and Chargers training manual.
3) Resistor (cabinet heater elements) and leads to set alarm and lockout voltages. (See Substation Batteries and Chargers training manual.)
4) Test lead with 1 amp inline fuse in series with a 10k ohm, 10 watt resistor for testing battery charger ground detection circuit.
5) DC clamp-on ammeter accessory for digital multi-meter.
6) Manufacturer's Instruction sheet for the clamp-on ammeter accessory.
7) Spare batteries for clamp-on accessory.

1.3 Acceptance Inspection
   1) All of the above plus:
   2) Resistor (cabinet heater elements) and leads to set alarm and lockout voltages. (See Substation Batteries and Chargers training manual.)

2. Materials Required.

2.1 V&O Inspection
   1) PDA with National Grid V&O software installed.
   2) Inspection card from last V&O Inspection.

2.2 Diagnostic Inspection
   1) All of the above plus:
   2) Inspection card from last diagnostic inspection.
   3) Two 375 watt cabinet strip heaters and leads to load charger during alarm and ripple tests.

2.3 Acceptance Inspection
   1) All of the above.

3. Unusual Hazards

Filter capacitors in battery chargers may be charged up to full battery voltage even with the chargers AC and DC switches off. Filter capacitors are typically large, round, two-terminal cylinders.

Battery chargers will have full battery voltage on side of the DC switch/circuit breaker if connected to the battery. If the DC switch is closed internal sections of the charger will have full battery voltage even if the AC switch is off.

Lead acid batteries emit hydrogen gas, which is explosive. No smoking, open flames or sparks are allowed in their vicinity. Only insulated tools should be used when working on them.

Substation batteries are capable of very high short-circuit currents. Accidentally shorting cells or batteries can result in severe burns and possibly battery explosions.

4. NPCC - Bulk Power Stations - Charger Inspection

4.1 This section meets the applicable requirements of NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

4.2 Check charger AC and DC circuit breakers are on.

4.3 Check that there is output voltage on charger DC voltmeter.

4.4 Check that there is output current on the charger DC ammeter.

4.5 Visually check all battery cells for general condition and proper electrolyte level.

5. Visual and Operational Inspection.

5.1 Perform battery charger inspection before performing battery inspection.

5.2 Check for abnormal noise.
   1) Abnormally loud humming from relays or transformer laminations should be investigated.

5.3 Record battery charger DC float voltage with charger on.

1) Turn the digital multi-meter on and select DC voltage and a range higher than the overall battery voltage to be measured (Range selection is not necessary if the multi-meter is auto-ranging).
2) Measure and record the overall float voltage between the positive and negative ends of the battery (points where the battery charger and DC supply leads are connected).
3) Voltage should agree with the chargers DC voltmeter.
4) Lead Acid Batteries - Refer to Appendix A at the end of this document to determine battery type. Voltage read with multi-meter should be within 1 volt of:

Battery Size	Lead Antimony	Lead Calcium	Lead Selenium
24 volt – 12 cell	26 volts	27 volts	27 volts
48 volt – 23 cell	50 volts	52 volts	51 volts
48 volt – 24 cell	52 volts	54 volts	54 volts
120 volt – 58 cell	126 volts	131 volts	129 volts
120 volt – 60 cell	130 volts	135 volts	134 volts
240 volt – 116 cell	252 volts	252 volts	252 volts
240 volt – 117 cell	254 volts	254 volts	254 volts
240 volt – 120 cell	260 volts	260 volts	260 volts

5.4 Nickel-Cadmium (NICAD) Batteries – Refer to the manufacturers Instruction Manual.

1) Voltage will be approximately 1.42 volts per cell but will vary slightly with manufacturer and type.

5.5 High voltages can be caused by:

1) Battery charger float voltage set to high. Adjust float voltage. (See Substation Batteries and Chargers training manual).
2) Battery charger is set to equalize (overcharge) mode. Check with supervisor before turning battery charger equalize timer/switch off.

5.6 Low voltages can be caused by:

1) Battery charger float voltage set to low. Adjust float voltage. (See Substation Batteries and Chargers training manual).
2) Battery recovering from a recent discharge. Retest before leaving station, and if still low notify supervisor. Battery charger DC current higher than noted on last inspection card is an indication of the battery recovering from a discharge.
3) Adjust the float voltage if necessary. Normally their will be a small, screwdriver adjustment accessible on the front panel. Be careful not to turn the equalizing voltage adjustment by mistake. Refer to the Substation Batteries and Chargers training manual and/or the manufacturer's instruction book for further information.
4) Record the final float voltage on the inspection card.

5.7 Record battery charger DC load current.

1) Record the battery charger's DC current from the charger's panel ammeter on the inspection card.

5.8 Check for ground indication.
1) If the battery charger has ground detector lamps record if a positive or negative lamp is lit.
2) If the charger has a ground detection voltmeter record the voltages with the meter switch in both the positive and negative ground positions.
3) If there is no ground detection system use the procedure in the Substation Batteries and Chargers training manual to record the battery positive and negative voltages to ground. Note: Resistor and additional test leads required. See Substation Batteries and Chargers Training manual.

5.9 Test loss of AC alarm.
1) Notify dispatch center you will be sending an alarm
2) Turn off the charger's AC circuit breaker.
3) Verify the dispatch center received the alarm.
4) Turn the charger's AC circuit breaker.
5) Record the test result on the inspection card.

5.10 Check charger for cleanliness and grounding.
1) Wire brush, prime, and paint any chipped or corroded areas on charger's cabinet.
2) Battery charger should be grounded to station ground.
3) With the charger AC and DC switches off inspect the inside of the cabinet for dust, leaking capacitors, and overheated or damaged components.

6. <u>Diagnostic Inspection.</u>

6.1 Perform battery charger diagnostic inspection before performing battery diagnostic inspection.
6.2 Perform all of the steps listed in Visual and Operations Inspections above.
6.3 Test equalizing timer switch and record equalizing voltage.
1) Turn the chargers equalize switch or timer on. Current indicated on the charger's ammeter should increase.
   a) The current should not be higher than 90% of the DC circuit breaker rating. Example: DC circuit breaker is 20A. 90 times 20 =1800. Throwaway the last two digits. Current should not be more than 18 amps. If the current is over the limit refer to the manufacturer's instruction manual and adjust the current limiting setting.
   b) If the chargers ammeter reads over 3/4 full scale the charger may be in the current limiting mode. Wait 15 minutes, if the ammeter doesn't drop below 3/4 full scale do not adjust the equalizing voltage. Note on the inspection card/record that the charger may be current limiting on equalize.
2) Turn the digital multi-meter on and select DC voltage and a range higher that the overall battery voltage to be measured (Range selection is not necessary if the multi-meter is auto-ranging).
3) Measure and record the overall voltage between the positive and negative ends of the battery (points where the battery charger and DC supply leads are connected).

4) Lead Acid Batteries - Refer to Appendix A at the end of this document to determine battery type. Voltage should be within 1 volt of:

Battery Size	Lead Antimony	Lead Calcium	Lead Selenium
24 volt – 12 cell	29 volts	28 volts	28
48 volt – 23 cell	55 volts	54 volts	54
48 volt – 24 cell	57 volts	56 volts	56
120 volt – 58 cell	138 volts	135 volts	136
120 volt – 60 cell	143 volts	140 volts	140
240 volt – 116 cell	277 volts	271 volts	271
240 volt – 117 cell	279 volts	273 volts	274
240 volt – 120 cell	286 volts	280 volts	281

5) Nickel-Cadmium (NICAD) Batteries – Refer to the manufacturers Instruction Manual.
6) Adjust the equalizing voltage if necessary. Normally there will be a small, screwdriver adjustment accessible on the front panel. Be careful not to turn the float voltage adjustment by mistake. Refer to the Substation Batteries and Chargers training manual and/or the manufacturer’s instruction book for further information.
7) Record the final equalizing voltage on the inspection form/record.
8) Turn the battery charger’s equalizing timer or switch off.

6.4 Test Ground detection circuit – non microprocessor based chargers.

1) Connect a10k (10,000) ohm, 10 watt or greater resistor from the positive terminal of the battery to station ground.
2) If the battery charger has ground detector lamps the positive lamp should light.
3) If the charger has a ground detection voltmeter the meter will show voltage when the switch is in the positive position.
4) Connect a10k (10,000) ohm, 10 watt or greater resistor from the positive terminal of the battery to station ground.
5) If the battery charger has ground detector lamps the negative lamp should light.
6) If the charger has a ground detection voltmeter the meter will show voltage when the switch is in the negative position.
   a) Resistors may be available a Radio Shack and are available from electronic distributors such as Newark Electronics.

6.5 Test Ground detection circuit – microprocessor based chargers.

1) Access the battery ground setting through the chargers menu system.
2) Verify the alarm is set to 20k ohms (20,000 ohms).
   a) Use 10k (10,000) ohm, 10 watt or greater resistor to test the ground detection circuit.
   b) Test the positive ground detection by connecting the resistor from positive to ground.
   c) Test the negative ground detection by connecting the resistor from negative to ground.
   d) Resistors may be available a Radio Shack and are available from electronic distributors such as Newark Electronics.

6.6 Verify Operation of DC voltmeter.

1) Turn the digital multi-meter on and select DC voltage and a range higher that the overall battery voltage to be measured (Range selection is not necessary if the multi-meter is auto-ranging).
2) Measure and record the overall float voltage between the positive and negative ends of the battery (points where the battery charger and DC supply leads are connected).
3) Compare reading to the reading on the battery charger’s DC panel voltmeter.
4) Adjust the charger’s panel voltmeter to agree with the multi-meter reading with the panel meter’s Zero Adjust screw located on the meter face. It is OK if the meter no longer reads zero, with the charger off. If the charger has a digital voltmeter note both readings on the inspection card.

6.7 Verify Operation of DC ammeter.

1) Refer the manufacturer’s instruction sheet for the DC clamp-on ammeter accessory. You might have to set the multi-meter on a voltage range even though you are measuring current. Normal clamp-on ammeters, with out special provisions for measuring DC, will not read DC battery currents.
2) Clamp the ammeter accessory around the small positive (white) wire from the charger to the battery.
3) Measure and record the current. Ignore any minus signs.
4) Adjust the charger’s panel ammeter to agree with the multi-meter reading with the panel meter’s Zero Adjust screw located on the meter face. It is OK if the meter no longer reads zero, with the charger off. If the charger has a digital ammeter note both readings on the inspection card.
5) Record the charger’s ammeter reading on the inspection card/form.

7. <u>Acceptance Inspection.</u>

7.1 Perform battery charger inspection before performing battery inspection.

7.2 Set the battery ground detection setting to 20k ohms (20,000 ohms).

a) This step is normally only required on microprocessor based chargers.
b) A separate menu step may be needed to activate the ground detection alarm after it is entered.

7.3 Perform all of the steps listed in Visual and Operations, and Diagnostic Inspections above.

7.4 Set and test low and high DC voltage alarms, battery ground alarm, and high voltage shut down.

1) Refer to the manufacturer’s literature and the Substation Batteries and Chargers training manual for more detail.
2) Microprocessor based charger alarms and settings are made through the chargers menu system and display.
   a) A separate menu step may be needed to activate alarms and settings after they are entered.
3) Not all chargers have all of the features listed below. Refer to the manufacturer’s literature.
4) If the features are installed in the charger, and not connected, note this on the inspection card.

5) Test the low voltage alarm.
   a) Disconnect and tape the charger to battery leads from the charger one at a time. Be careful not to short or ground them.
   b) The charger output voltage should still indicate the proper float voltage.
   c) Mark the position of the float voltage adjustment.
   d) Slowly lower the float voltage until the low voltage alarms.
   e) Measure the charger output voltage and record the value on the inspection card.
   f) Turn the float adjustment back to its initial position.
6) Test the high voltage alarm
   a) Turn the chargers equalize switch or timer on.
   b) Mark the position of the equalize adjustment.
   c) Slowly increase the equalize voltage until the high voltage alarms.
   d) Measure the charger output voltage and record the value on the inspection card.
   e) Test the high voltage shutdown, if equipped. (C&D ARE, ARR-M – Others check Instruction Manual).
   f) Monitor and continue to increase the equalize voltage until the charger shuts down.
   g) Record the value on the inspection card.
   h) Turn the equalize adjustment back to its initial position.
7) Return the charger to service
   a) Turn off the chargers DC circuit breaker.
   b) Turn off the chargers AC circuit breaker.
   c) Reconnect the battery to the charger.
   d) Turn on the charger’s DC circuit breaker.
   e) Turn on the chargers AC circuit breaker.
8) Check and adjust the equalize voltage if necessary.
9) Turn off the equalize switch or timer.

10) Check and adjust the float voltage if necessary
11) Lead Acid Batteries - Alarm and shutdown Voltages should be with in 1 volt of:

Battery Size	Low Voltage Alarm	High Voltage Alarm	High Voltage Shutdown
24 volt – 12 cell	24 volts	30 volts	32 volts
48 volt – 23 cell	47 volts	56 volts	58 volts
48 volt – 24 cell	49 volts	58 volts	60 volts
120 volt – 58 cell	119 volts	138 volts	140 volts
120 volt – 60 cell	123 volts	143 volts	145 volts
240 volt – 116 cell	238 volts	276 volts	280 volts
240 volt – 117 cell	240 volts	279 volts	283 volts
240 volt – 120 cell	246 volts	286 volts	290 volts

7.5 Nickel- Cadmium (NICAD) Batteries.
1) Low Voltage Alarm - 90% of manufacturer's recommended float voltage.
2) High Voltage Alarm - 108% of manufacturer's recommended float voltage.
3) High Voltage Shutdown – 2 volts higher than high voltage alarm setting.

8. Appendix A

MFR	TYPE	Battery Type
ALCAD	SD-5, SD-7, SD-9, SD-11, SD-13, SD-15, SD-21	Lead-Selenium
ALCAD	SGL-7, SGL-13	Lead-Selenium
Chloride	YCP-9, YCP-11, YCP-13, YCP-17, YCP-25	Lead-Calcium
C&D	DCU-9, DCU-13, DCU-15, DCU-17	Lead-Calcium
C&D	KCR-7, KCR-9, KCR-11, KCR-13	Lead-Calcium
C&D	KCR-15, KCR-17, KCR-19, KCR-21	Lead-Calcium
C&D	KCU-7, KCU-9, KCU-11, KCU-17	?
C&D	JC-100, JC-150	Lead-Calcium
C&D	Liberty 2000	Lead-Calcium
C&D	LS 4-300, LS 6-50, LS 6-125, LS 6-200	Lead-Calcium
C&D	LS 12-25, LS 12-55, LS 12-80, LS 12-100	Lead-Calcium
C&D	LST	Lead-Calcium
C&D	KC-7, KC-13	?
C&D	KCT-300, KCT-360	Lead-Calcium
C&D	XT4-JC9	Lead-Calcium
C&D	2JC-300	Lead-Calcium
C&D	3DCU-3, 3DCU-5, 3DCU-7, 3DCU-9, 3DCU-11, 3DCU-15	Lead-Calcium
C&D	3DU-3, 3DU-5, 3DU-7, 3DU-9, 3DU-11	Lead-Antimony
C&D	3JC-100	Lead-Calcium
C&D	3KCR-5	?
C&D	4JC50, 4JC100, 4JC150	Lead-Calcium
C&D	XLB	?
Excide	All with “CA” in Type	Lead-Antimony
Excide	All with “CC” in Type	Lead-Calcium
Electric Storage Battery	All with “CA” in Type	Lead-Antimony
Electric Storage Battery	All with “CC” in Type	Lead-Calcium
FIAMM	SD-5, SD-7, SD-9, SD-11, SD-13, SD-15, SD-21	Lead-Selenium
Storage Battery Systems	SR	Lead-Selenium
Yuasa	All with “CA” in Type	Lead-Antimony
Yuasa	All with “CC” in Type	Lead-Calcium

9. Record of Revisions

Revision	Changes
02/12/2009	Materials Required - Diagnostic Inspection Added –Resistor (cabinet heater elements)….. Materials Required – Acceptance Inspection Removed – Resistor (cabinet heater elements)….. Acceptance Inspection – Test Low Voltage Alarm Removed – If it doesn't connect the strip heaters to the charger…….
02/72/2009	Procedure Changed – NPCC A4 – Charger Check to NPCC - Bulk Power Stations…… Reference Added – NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection NPCC - Bulk Power Stations - Charger Inspection Added –This section meets the applicable requirements of NPCC Regional Reliability Reference Directory 3 Maintenance Criteria for Bulk Power System Protection

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INTRODUCTION

This procedure describes the methods used to locate substation battery grounds.

PURPOSE

This procedure lists special tools and equipment required, unusual hazards, and methods used, to locate substation battery grounds.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

COORDINATION

Not Applicable

REFERENCES

National Grid USA Safety Handbook

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Battery -	Group of cells in a common container. Using three cells to create a 6 volt battery is common in electrical substations.
Battery Bank -	Group of cells, or batteries connected in series to create higher voltages. Battery banks of 24, 48, 120, and 240 volts are common in electrical substations.
Battery Charger -	Device that converts station service AC voltage to a precise, stable DC voltage. Used to maintain the charge on station batteries and supply normal DC station loads.
Battery Ground -	The positive, negative or both sides of the stations battery, or its associated circuits, have a connection to station ground with an impedance of less than 1 megOhm.
Case -	Container enclosing a group of battery cells.
Cell -	Basic component of a battery or battery bank. In a lead acid battery each cell generates approximately 2.2 volts.

TRAINING

Not Applicable

DOCUMENT CONTENTS

Table of Contents

1.0 TEST EQUIPMENT REQUIRED

1.1 Digital Multi-meter (always required)

1.1.1 Clip leads with a 1 amp inline fuse and a 100k Ohm, 5 Watt resistor in series

1.2 Ground Detection Test Set

1.2.1 Biddle Groundbuster – Catalog # 246100 (Currently sold as Megger BGFT) or;

1.2.2 Megger Battery Ground Fault Locator – Catalog #835140 or;

1.2.3 ELECTROM - GDL-201

1.3 Megohmmeter with 500V and 1kV voltage ranges

2.0 UNUSUAL HAZARDS

2.1 The fluid in lead acid batteries (electrolyte) is a mixture of sulfuric acid and distilled water.

2.1.1 Contact with electrolyte can cause blindness, burn skin, and burn holes in clothing.

2.1.2 Electrolyte on skin or clothing should be rinsed off with generous amounts of water.

2.1.3 Electrolyte in eyes should be flushed generously at an eyewash station and immediate medical attention sought.

2.1.4 Acid proof gloves and aprons and a full face shield shall be worn when inspecting or working on batteries.

2.2 Lead acid batteries emit hydrogen gas, which is explosive.

2.2.1 No smoking, open flames or sparks are allowed in their vicinity. Only insulated tools should be used when working on batteries.

2.3 Substation batteries are capably of very high short-circuit currents.

2.3.1 Accidentally shorting cells or batteries can result in severe burns and possibly battery explosions.

2.3.2 The use of 1000 volt disposable cover-up (SC 92008882) should be considered.

2.4 Although rare, batteries can explode violently and spew electrolyte and plastic shards from battery jars in all directions.

2.4.1 Battery explosions can be caused by internal or external short circuits, or the ignition of hydrogen gases.

3.0 METHODS USED TO LOCATE DC GROUNDS

Normally a combination of the following methods will be used to located DC grounds depending on the individual circumstances and criticality of the DC circuits involved.

3.1 Interruption

3.1.1 Interruption is the monitoring of the circuits ground status while opening sections of the circuit. Monitoring shall be done using the test setup shown in Appendix D of this document.

3.1.2 Interruption is a fast method for determining the subsection, or area, of the circuit containing the ground. The disadvantages are possible interruption of tripping and unanticipated operations of control schemes or protective relays.

3.2 Signal Tracing

3.2.1 Signal Tracing consists of injecting an AC signal into the ground path and tracing it with a special AC current clamp and/or headphones. The signal will only appear on wires that are in the ground path. The injected signal is very low level and should not affect control circuits or protective relays.

3.2.2 Signal tracing can be done with the circuit energized and is relatively fast. The disadvantage is as the impedance of the ground goes up is more difficult to find. Hard (metal to metal) grounds are easy to trace. Locating grounds of 10,000 ohms or more is difficult, 100,000 ohms or more may not be possible. Multiple high resistance grounds will be difficult, or impossible, to find with this method.

3.3 Insulation Impedance testing.

3.3.1 Insulation impedance testing (megger) is done with the wires to be tested de-energized and isolated. Although it can be used on any wire its primary use is to test cable runs and bundles.

3.3.2 High impedance grounds can be easily identified. However the difference between hard (metal to metal) and grounds of 10s of thousands of ohms can not be distinguished. Impedance testing with a multi-meter after megger testing can be used to determine the values. Insulation impedance testing is also effective in identifying intermittent grounds caused by moisture and deteriorated insulation. The megger will often show relatively low values after the alarm has cleared in these cases.

3.3.3 Disadvantages are the circuits must be de-energized and isolated for relatively long periods of time and if isolation is not done properly damage to electronic control circuits and protective relays or unanticipated operations may occur.

3.4 Mechanical Testing

3.4.1 Mechanical testing may be done once the ground has been located to a relatively small area. Movement of swing panels, doors or wire bundles may help identify grounds caused by insulation chafing. This may be the only way to identify some intermittent grounds.

3.5 Visual Inspection

3.5.1 Visual Inspection may be done once the ground has been located to a relatively small area. It is not usually an effective way to identify grounds.

4.0 DC GROUND VERIFICATION PROCEDURE

4.1 Notify the System Operator that you will be investigating a battery ground following Substation Maintenance Procedure SMP 406.10.2 and that it will impact station alarms only.

4.2 Verify Battery Ground by one or more of the following:

4.2.1 Battery grounds may be intermittent; previously reported battery grounds may not be present at time of testing.

a. Intermittent battery grounds may be due to moisture.

4.2.2 If the battery charger has ground detector lamps record if the positive or negative lamp is lit.

4.2.3 If the charger has a ground detection voltmeter record the voltages with the meter switch in both the positive and negative ground positions.

a. If the voltmeter reads voltage when the switch is in the positive position the battery has a positive ground.

b. If the voltmeter reads voltage when the switch is in the negative position the battery has a negative ground.

4.2.4 Whether, or not, the charger has indicates a ground use the multi-meter and the test setup shown in Appendix D, at the end of this document, to record the battery positive and negative voltages to ground.

a. Measured voltage from positive post to ground indicates a negative ground on system and measured voltage from negative post to ground indicates a positive ground on system.

b. Resistor with test leads is required to get meaningful results.

c. Turn off the charger’s AC circuit breaker.

d. Turn off the charger’s DC circuit breaker.

e. Wait 10 minutes and then use a multi-meter to record the battery positive and negative voltages to ground measured across the connected resistor jumper.

f. Turn on the charger’s DC circuit breaker.

g. Turn on the charger’s AC circuit breaker.

h. Categorize the measured positive and negative voltage results based on table below.

Battery Size	No Ground	> 10K ohm Ground	< 10K ohm (Hard) Ground
24 volt	< 3 volts	< 22 volts	> 22 volts
48 volt	< 5 volts	< 41 volts	> 41 volts
120 volt	< 12 volts	< 105 volts	> 105 volts
240 volt	< 24 volts	< 210 volts	> 210 volts

> = greater than, < = smaller than

4.3 Follow up based on results obtained from the table above.

4.3.1 When the battery ground has been detected as a Likely < 10k ohm Ground:

a. It should be located within 10 work days.

b. Enter a follow up work order, priority 4, into AIMMS to address the necessary action if the ground is not located the same day as verified.

4.3.2 When the battery ground has been detected as a Likely >10k ohm Ground:

a. It should be located within 30 work days.

b. Enter a follow up work order, priority 4, into AIMMS to address the necessary action if the ground is not located the same day as verified.

4.3.3 No Ground - Investigate charger.

a. Repeat procedure with charger in service to confirm if it is the cause of battery ground.

b. If confirmed investigate charger with assistance of manufacturer or replace charger.

c. If ground still does not exist then note weather/soil conditions and file all information collected in a trouble report.

5.0 LOCATING BATTERY GROUNDS - INTERRUPTION METHOD

5.1 While shutting off of DC circuits at the DC circuit breaker/fuse panel is an efficient method of narrowing the search area it can only be utilized after the risk is confirmed to be reasonable.

5.2 Before interruption DC circuits must be confirmed by both DC circuit breaker/fuse position labeling and the current station DC one-line print.

5.3 If these two sources of information conflict, then use the DC schematic and field checking to resolve the conflict.

5.4 Circuits should only be shut off for the time necessary to verify the ground status utilizing procedure in Appendix D (less than a minute).

5.5 At a substation with single pole breakers or individual fuses in the DC circuits always turn off the Positive side first then the Negative side. To return the circuit to service put the Negative on first then the Positive.

5.6 Under No Circumstances shall the DC supply to the following be interrupted

5.6.1 DC supply to the DC Panel (battery safety switch)

5.6.2 DC panel main breaker (if applicable)

5.6.3 DC Switch Board Power

5.6.4 DC supply to Relay Cabinets

5.6.5 DC supply to Relays

5.6.6 DC supply to RTU or PLC

5.6.7 DC supply to Fault Recorders

5.6.8 DC supply to telephone panel (Positron)

5.6.9 DC supply to Local Control Cabinets

5.7 Only the types of circuits listed below are permitted to be shut off to determine the source of a DC ground.

5.7.1 DC Emergency Lighting supply

5.7.2 Circuit Switcher DC supply

5.7.3 Motorized Air break DC supply

5.7.4 DC supply to annunciators

5.7.5 DC supply to a single transmission/distribution circuit breaker/recloser

5.7.6 DC supply to panel meters

5.7.7 DC supply to alarm circuits

Note: If the above circuits have further isolation points (08 switches, fuses) beyond the DC panel these may be opened once their location is confirmed using station schematic and/or wiring prints. Do not open slide links or lift wires.

Note: If a circuit, as identified on the panel and/or DC One Line, does not specifically match the permitted list do not shut the circuit off.

5.8 If a circuit interruption changes the voltage measurement in a manner that the battery ground category has gone from < 10k Ohm to > 10k Ohm or from any category to No Ground, as defined in the table in section 4.2 – 4), stop using the interrupting method.

5.8.1 Perform one of the following on the DC circuit identified as having the battery ground.

5.8.2 Use the Signal Tracing method to attempt to further pinpoint location.

5.8.3 Remove the associated equipment from service so that circuit can undergo further isolation/insulation impedance testing and close visual inspection.

a. Requires normal equipment outage application process.

6.0 LOCATING BATTERY GROUNDS - SIGNAL TRACING METHOD

6.1 The following signal tracing test equipment is available within National Grid USA and is known to have reasonable success rate locating battery grounds.

6.1.1 Biddle Groundbuster – Catalog # 246100

6.1.2 Megger Battery Ground Fault Locator – Catalog #835140

6.1.3 ELECTROM - GDL-201

6.2 Use this equipment, and its associated instruction manual, to attempt to find ground.

6.3 This may not be successful since effectiveness diminishes when ground impedance values are above 10k ohm.

6.4 If there are multiple high impedance grounds success will also be unlikely.

6.5 Use of one of these test sets It is required to determine if Signal Tracing will be able to pinpoint a battery ground to a specific circuit or area.

6.6 Appendices A, B, and C provide information about each signal tracing equipment and how to determine if success is likely.

7.0 GROUND CAN NOT BE LOCATED BY ABOVE TESTS

7.1 Contact O&M Services with Data collected up to this point.

7.1.1 Other options will be explored with agreement of all groups. These may include:

a. Attempt to locate with alternative equipment (oscilloscope + signal generator or megohmmeter).

b. Perform review to determine if additional mitigating steps can be taken to interrupt DC circuits originally skipped with an acceptable risk level.

c. Explore the use of standby switching personnel, locally or remotely, to minimize risk during testing.

d. Explore removing portions of station, or station from service, to locate the ground.

e. Accept existence of the DC ground based on measured impedance level and a documented plan to monitor ground and trigger further action.

8.0 REPAIRING BATTERY GROUNDS

8.1 Repair of grounds that require DC interruption of protective or control schemes, require the removal of the associated equipment from service.

8.1.1 Normal equipment outage application process is required.

8.2 Battery grounds should be repaired immediately, when ever possible.

8.3 When the battery ground is less than 10k Ohms repairs shall be completed within thirty days.

8.3.1 Unless multiple grounds, each above 10 k Ohms, can be conclusively identified the 30 day time frame applies.

8.3.2 If there is no existing follow up work order.

a. Enter a follow up work order, priority 4, into AIMMS to document the problem and repair.

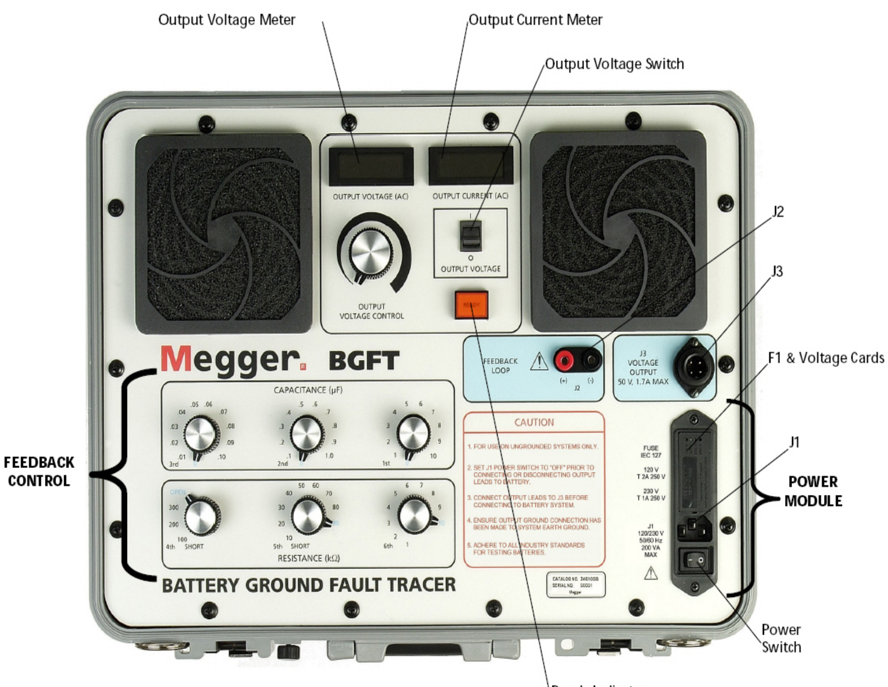
8.4 When the battery ground is more than 10k Ohms repairs shall be completed within six months.

8.4.1 If there is no existing follow up work order.

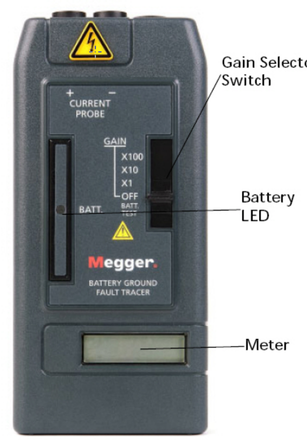
a. Enter a follow up work order, priority 3, into AIMMS to document the problem and repair.

9.0 APPENDIX A - SIGNAL TRACING EQUIPMENT - BIDDLE GROUNDBUSTER

Catalog # 246100 (Currently sold as Megger BGFT)



TRANSMITTER



RECEIVER

9.1 The Megger BGFT Transmitter outputs an adjustable (0-50V, 1.7 Amp max, 20HZ) AC signal. Its CT clamp Receiver detects the presence of this signal in wires on the DC system.

9.2 Steps to utilize the BGFT and evaluate the results:

9.2.1 Set voltage control fully counterclockwise to minimum.

9.2.2 Set output voltage switch and power supply switch to off (0 or Disconnect).

9.2.3 Turn all capacitance selector switches fully counter-clockwise.

9.2.4 Turn the left-most resistance selector switch to open and the other two resistance selector switches fully clockwise.

9.2.5 Insert transmitter output cable (2 wires with leads on one end, and round connector on other) into the J3 Voltage Output plug.

9.2.6 Connect the other end of the transmitter output cable (source leads) at the battery location.

a. Black boot to bare metal ground, red boot to DC battery cable connection, positive, or negative, that has a ground.

9.3 Connect the transmitter power cord and turn the Power Switch on.

9.3.1 When Ready Indicator comes on, about 30 seconds, turn the Output Voltage switch on.

9.3.2 Slowly turn the Output Voltage Control clockwise until 20 Volts is shown on the Output Voltage meter.

9.4 Assemble the receiver (CT clamp banana jacks plugged into top).

9.4.1 Put the Receiver Gain switch to battery test. Green BATT LED indicates a good battery.

9.4.2 Set the Receiver to X10 Gain and place the current probe clamp around the battery cable, positive or negative, that has the ground. The current probe red marking should be facing toward the battery.

9.4.3 If the Receiver Meter shows a 1 or greater the BGFT may be able to locate the ground.

9.4.4 If the first measured value is less than 1 then ensure the ground connection is making good contact on a bare grounded surface. If the measured value remains less than 1 stop the test and document on the Inspection Card (SMP 406.10.3)

9.5 At the DC Panel, with the receiver red marking facing toward the battery, determine which DC circuit has the largest signal.

9.5.1 Record all measurements taken on the Inspection Card (SMP 406.10.3).

9.5.2 The signal current may split into multiple circuits or wires indicating more than one ground.

9.5.3 Trace each circuit or wire with a ground signal, moving away from the Battery/DC Panel and attempt to locate the ground(s).

9.5.4 If tracing becomes difficult attempting options, such as turning up Receiver Gain, (sensitivity) or moving Transmitter connection closer to the Receiver could help.

10.0 APPENDIX B - SIGNAL TRACING EQUIPMENT - MEGGER BATTERY GROUND FAULT LOCATOR

Catalog # 835140 (Currently sold as Megger BGFT)

10.1 The Meggar BGL has a Transmitter which outputs an (3.5 volt, 110 mA max, 25HZ) AC signal and an integrated Receiver with CT clamp for detecting this signal at locations on the DC system.

10.2 Steps to utilize equipment and evaluate results it may give:

10.2.1 Set the Power Toggle switch to Off, Function Toggle Switch to Resistance, and Memory Toggle switch to Normal.

10.2.2 Insert transmitter Output Cable, 3 wires with leads on one end, and round connector on other, into the Output connector.

10.2.3 Connect the other end of the Output Cable (source leads) at battery location.

a. Green and Black boot to bare metal ground, Red boot to DC battery cable connection polarity, positive, or negative, that has a ground.

10.2.4 Connect the power cord and turn the Power switch ON. (Unit can also operate using battery, if tested charged).

10.2.5 Connect CT clamp cable to the CT and to the Input Sensor connector on the Transmitter.

10.2.6 Clamp on current probe around the polarity battery cable, positive, or negative, that has the ground

a. The current probe red marking should face toward the battery

10.2.7 If the Meter shows 10k ohms or less the test set may be able to locate the ground.

a. If the meter shows greater than 10k ohms ensure the ground connection is making good contact on a bare grounded surface.

b. If he measured value remains greater 10k ohms stop the test and document on Inspection Card (SMP 406.10.3).

10.3 At the DC Panel, with the receiver red marking facing toward the battery, determine which DC circuit has the largest signal.

10.3.1 Record all measurements taken on the Inspection Card (SMP 406.10.3).

10.3.2 The signal current may split into multiple circuits or wires indicating more than one ground.

10.3.3 Trace each circuit or wire with a ground signal, moving away from the Battery/DC Panel and attempt to locate the ground(s).

11.0 APPENDIX E - SIGNAL TRACING EQUIPMENT - ELECTROM - GDL-201

11.1 The Electrom-GDL-201 Transmitter generates a low current, audio frequency (AF) signal when a connection exists between the two leads.

11.1.1 A separate Receiver is used to track this signal.

11.2 Steps to utilize equipment and evaluate results it may give:

11.2.1 Make sure battery is not in transmitter.

11.2.2 Set the Frequency adjustment knob on lowest setting (counterclockwise).

11.2.3 Insert transmitter output cable (2 wires with leads on one end, a round connector on other) into transmitter Output connector and connect two leads together.

11.2.4 Assemble two silver probes and insert them into the receiver.

11.2.5 Insert headphone plug into the Receiver and turn The Receiver On.

11.2.6 Put the battery into transmitter and place the Receiver rubber probe tip against the Transmitter output leads.

a. Increase Sensitivity level until a strong signal is heard.

11.3 Connect the transmitter output (source) leads at battery location.

11.3.1 Connect black boot to bare metal ground.

11.3.2 Connect Red boot to DC battery cable connection polarity, positive, or negative, that has a ground.

11.4 Compare the sound intensity heard with this connection to the initial test of the Transmitter output leads.

11.4.1 The best situation is a large difference between the intensity of the two signals.

11.4.2 If this is the case the test set may be able to locate the ground.

11.4.3 If there is no change in intensity then capacitors in electronic equipment are likely causing false readings.

11.4.4 If no audible signal is heard then check ground connection to make sure it is making good contact with a bare surface.

11.4.5 If the situations in 11.4.3 and in 11.4.4 remain then stop the test and document on Inspection Card (SMP 406.10.3). Retest using one of the other signal tracing test sets.

11.5 At the DC Panel determine which DC circuit has the largest signal.

11.5.1 Record all measurements taken on the Inspection Card (SMP 406.10.3).

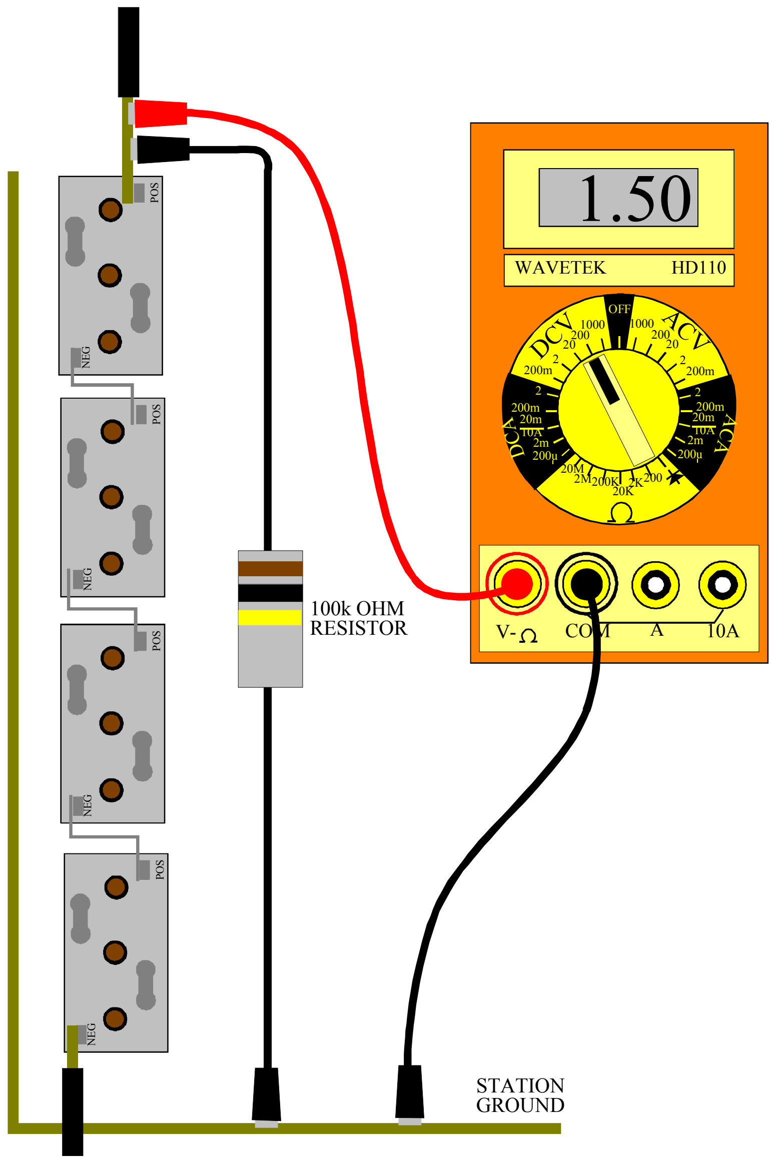
11.5.2 The signal current may split into multiple circuits or wires indicating more than one ground.

11.5.3 Trace each circuit or wire with a ground signal, moving away from the Battery/DC Panel and attempt to locate the ground(s).

11.6 If tracing becomes difficult attempting options, such as turning up Receiver sensitivity, or moving Transmitter connection closer to the Receiver could help.

11.7 Caution! When testing is complete make sure to remove the battery from transmitter prior to unplugging the output cables. Otherwise damage to the test set may result.

12.0 APPENDIX F - TESTING FOR BATTERY GROUNDS WITH A MULTI-METER



12.1 Digital multi-meters can be used to test for battery grounds if no ground detection is provided in the charger.

12.2 However, due to their very high input impedance, a parallel resistor jumper lead must be fabricated and used. If the resistor lead is not used the multi-meter will indicate grounds when none are present.

12.3 The resistor jumper lead is fabricated using a 100k ohm 5 Watt resistor. 100k ohm resistors are available at Radio Shack and other electronic component suppliers.

12.4 With the leads connected to the positive battery terminal as shown you are testing for negative grounds.

12.5 Move the resistor and meter leads from the positive to the negative battery terminal. This will test for positive grounds.

12.6 With this setup, voltages less than 10% of the battery voltage (12 volts for 120-volt battery) indicate no significant grounds. Full battery voltages indicate hard (metal to metal) grounds. Voltages in-between indicate resistive grounds.

13.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	02/27/09	Initial version of document.
2.0	04/01/10	Converted to the new EDO format. Section 2.1.3 - Changed "… generously with bottled eyewash solution, or at an eyewash station, and immediate …" to "… generously at an eyewash station and immediate …" Section 4.2.4 - Modified table. Header of last column changed from "Low Impedance (Hard) Ground" to "< 10K ohm (Hard) Ground" Section 4.3.1 - Changed "… detected as a Low Impedance Ground:" to "… detected as a Likely < 10k ohm Ground:" Section 5.8 - Changed "… category has gone from Low Impedance to > 10k Ohm …" to "… category has gone from < 10k Ohm to > 10k Ohm …" Section 11.4.5 - Changed "If situations c) and d) remain then …" to "If the situations in 11.4.3 and in 11.4.4 remain then …"

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CAPACITOR BANK

INTRODUCTION

This procedure describes the methods used to perform Visual and Operational, Thermographic, Mechanism, and Diagnostic on capacitor banks used in electrical substations.

PURPOSE

Scheduled equipment inspections are necessary to protect both the public and electric utility workers, prevent unnecessary customer outages, and maximize equipment operating life. This procedure lists special tools and equipment required, unusual hazards, and methods used, to inspect capacitor banks.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

COORDINATION

New England - Worcester Lab – Thermographic Inspection.

Relay Department needed to check Bank Guard Relaying - Diagnostic Inspection (If applicable).

REFERENCES

National Grid USA Safety Handbook

SMP 408.01.4 Working On Substation Capacitor Banks

Manufacturer’s Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer’s operating manuals for the specific test equipment to be used.

DEFINITIONS

PDA -	Personal Digital Assistant. Pocket size computer.
Bleed down Resistor -	High-value (megohms) internal resistor connected across a capacitor. Provides a current path to discharge the capacitor when power is removed.
Bank Guard Relay -	Relay that monitors the neutral current ,or voltage ,on some Y connected capacitor banks. Excessive neutral current, or voltage, indicates failed capacitor units or other phase related problems.
Impedance Relay -	Relay that measures phase voltages and currents and computes phase impedance. Most sensitive method of detecting failed capacitor units or other phase related problems.
Halo -	Manufacturer’s trade name for hot-stick ammeter.

KVA - Kilo volt ampere. Current times voltage divided by 1000.
Microfarad - Measure of capacitance.

ASSOCIATED EQUIPMENT

Capacitor switch

PROCEDURE CONTENTS

Table of Contents

1. Test Equipment Required.

1.1 V&O Inspection

1) Digital Multi-meter, IEC 1010-1 Cat. IV
2) Spare batteries for multi-meter.
3) Fuseless (internally fused) capacitor banks.
   a) Hot-stick Ammeter and universal hot-stick. HD Electric model 8280 (Halo) or equivalent.
   b) Spare batteries for hot-stick ammeter.

1.2 Thermographic Inspection

1) Infrared test set. Lab supplies in NE

1.3 Pre-Peak Inspection

1) Hot-stick Ammeter and universal hot-stick. HD Electric model 8280 (Halo) or equivalent.
2) Spare batteries for hot-stick ammeter.

2. Materials Required.

2.1 V&O Inspection

1) PDA with National Grid V&O software installed.
2) Inspection data from last V&O inspection.
3) Binoculars.

3. Unusual Hazards

Capacitor units used in modern substation capacitor banks contain bleeder resistors to discharge them when de-energized. Even with bleeder resistors capacitors may be remain charged up to 5 minutes. Failed units or even pieces of internal plate material from blown-up units may remain charged for several days. Before working on, or near, capacitor units they should be discharged, between terminals (2 bushing) or terminal to case ground (single bushing). Use a ground lead and insulated hot-stick to discharge capacitors. When grounding units hold ground on for a slow count of 5.

4. Visual and Operational Inspection.

4.1 Check for abnormal noise.

1) Arcing and other unusual noises. If capacitor banks are making unusual noise leave the area immediately and contact the dispatch center and your supervisor.

4.2 Check Individual capacitor units for:

1) Record any blown fuses.
2) Bulged cases.
3) Leaking oil. Dripping or flowing oil requires immediate attention.
4) Deteriorating paint and/or rusting.

4.3 Check bushings for:

1) Surface contamination, dirt, rust, salt, etc.
2) Evidence of tracking.
3) Chipped or cracked porcelain.
4) Discoloration of, or heat rising from, bushing connections (overheating).

4.4 Check rack for:

1) Ground connections.
2) Check rack insulators, if equipped, for:
   a) Surface contamination, dirt, rust, salt, etc.
   b) Evidence of tracking.
   c) Chipped or cracked porcelain.
3) Deteriorating paint and/or rusting.

4.5 Check Control Cabinet for:

1) Door gasket deterioration.
2) Evidence of moisture or water.
3) Deteriorating paint and/or rusting.
4) Missing insect screens
5) Unsealed conduits.
6) Cabinet light working, if equipped.
7) Heaters on below 40 degrees F.

4.6 Check capacitor control, if equipped.
   1) Check control auto.
   2) Record operations counter reading.
      a) Check for excessive operations.
   3) Check date, time-of-day and day-of-week, if equipped.
      a) Reset if necessary.

4.7 Alarm indications, if equipped.
   1) Record and rest any alarm indications.
   2) Verify all alarms in service (ON), Check with your supervisor before restoring alarms that are off.

4.8 Read and record the capacitor currents on banks rated above 35 KV.
   1) Record phase and neutral currents from station ammeters, if equipped.
   2) If the capacitor bank is off line read and record the capacitor and neutral currents in step 4.10 below.

4.9 Check fuseless (internally fused) capacitor unit currents on banks rated 35 KV and below.
   1) If the capacitor bank is on line (energized).
      a) Check each unit for current with the hot-stick ammeter. Measure current just above the bushing connector.
   2) Currents should be very similar.
      a) Refer to Appendix A at the end of this document for more information on evaluating readings.
      b) Refer to Appendix B at the end of this document for more information on calculating expected readings.

4.10 Operate capacitor from automatic control if possible.
   1) If the capacitor bank is remotely controlled from the dispatch center.
      a) Visually check the position of the capacitor switch.
      b) Request the dispatcher to operate the control.
      c) Visually verify the operation of the capacitor switch.
      d) Three phase ammeter readings can be used to verify operation if available.
   2) If the capacitor bank is automatically controlled.
      a) Obtain an order from the dispatch center to switch the capacitor bank.
      b) Visually check the position of the capacitor switch.
      c) Make the capacitor control manual and operate the capacitor switch manually from the control.
      d) Visually verify the operation of the capacitor switch.
      e) Three phase ammeter readings can be used to verify operation if available.
      f) Make the capacitor control auto.
   3) If the capacitor is automatically controlled with dispatcher override perform both of the above.
   4) Check counter for proper operation.

5. Pre-Peak Inspection

5.1 Perform V&O Inspection Items

5.2 Read and record the capacitor currents on banks rated 35 KV and below.

1) If the capacitor bank is on line (energized).
   a) Read and record the capacitor current in each phase with the hot-stick ammeter.
   b) If the bank is wye connected and has a single, grounded neutral (insulated structure) read and record the neutral current with the hot-stick ammeter.
   c) If capacitor bank is fuseless (internally fused) check each unit for current with the hot-stick ammeter. Measure current just above the bushing connector.
2) If the capacitor bank is off line read and record the capacitor and neutral currents in step 4.10.
3) Currents should be very similar.
   a) Use the hot-stick ammeter readings, not the station ammeters to compare phase's currents.
   b) Refer to Appendix A at the end of this document for more information on evaluating readings.
   c) Refer to Appendix B at the end of this document for more information on calculating expected readings.

6. Thermographic Inspection

6.1 Inspect all high voltage connections.

6.2 Inspect all capacitor units.

6.3 Record connections or capacitor units significantly hotter or colder than adjacent units.

7. Appendix A – Evaluating Current and Capacitance Readings

7.1 Phase currents readings.

1) Comparison to previous absolute measurements can only be used to detect gross errors such as open capacitor units, or an open phase in capacitor switch.
2) Differences of less than 4% are inconclusive between phases measured at the same time.
3) Partially shorted units cannot be detected reliably without measuring and comparing individual capacitor units.

7.2 Phase capacitance readings.

1) Although slightly more accurate than phase current reads same comments apply.

7.3 Capacitor bank protective relaying.

1) Modern capacitor bank relaying schemes can eliminate or reduce some of the errors described below and in general are more accurate that the measurements described in this procedure.

7.4 Capacitor failure modes.

1) Partially shorted. One or more of the series elements in a capacitor unit have shorted. This will result in increased capacitance and increased current. Fuse may or may not blow depending on the number of shorted elements.
2) Many layers shorted or completely shorted. Fuse will blow on fused units.
3) Fuse blown but not properly expelled. Capacitor unit is clear but fuse looks OK visually.

7.5 The following affect the phase current measured in a capacitor bank.

1) Partially shorted capacitors. Shorted layers within a capacitor will not cause an increase in capacitance and higher current. The effect will be small and may masked by measurement and other errors. In a typical 4 layer-per-unit, 7 unit-per-phase 13 KV bank one shorted layer in a unit would increase phase current 5%.
2) Open capacitors. Open capacitors will result in a significant decrease in capacitance and current in that phase. In a typical 7 unit-per-phase 13 KV bank one open unit would reduce current 14%.
3) Bus voltage. Bus voltage directly effects capacitor current. A 2% change in bus voltage will cause a 2% change in current. Even a well regulated station bus voltage differences may be several percent.
4) Ammeter accuracy. The Halo hot-stick ammeter has an accuracy specification of 3% +/- 1 digit. Repeatability is not specified but probably is in the order of 1-2% +/- 1 digit. Other hot-stick ammeters have similar accuracies.
5) Capacitor manufacturing tolerances. The ANSI specification for power capacitors is minus 0% to plus15%. Most manufacturer's target for plus 4% +/- 2%. New banks typically are +/- 2% between phases, Banks that have had capacitor units replaced can be expected to have larger differences between phases.

7.6 Phase capacitance measured in a capacitor bank. Since current is directly proportional to capacitance all of the errors, with the exception of bus voltage unbalance, apply to phase capacitance measurements.

1) Capacitance meter accuracy. Capacitance meters are slightly more accurate than the hot-stick ammeters , with typical accuracy specifications of 1 to 2% +/- 1 digit. Repeatability is not specified but probably is in the order of 1% +/- 1 digit.

8. Appendix B – Calculating Phase Currents

8.1 Determine the total KVAR or MVAR of all three phases the bank.

1) KVAR (thousands of volt-amperes reactive) is usually listed on the One-Line print. This may also be listed in MVAR (millions of volt-amperes reactive).
2) Total KVAR can also be determined by multiplying the KVAR of each capacitor unit by the total number of capacitor units on the rack. This only works on racks where all capacitors are in parallel. It will not work with banks that have series parallel configurations. Example 27 units X 200 KVAR each = 5400 KVAR total.
3) If the bank is listed in MVAR. Multiply the MVAR rating by 1000 to get KVAR. Example 5.4 MVAR X 1000 = 5400 KVAR.
4) Divide the KVAR rating by the phase-to-phase voltage. Example 5400 KVAR / 13.8 KV = 391.
5) Divide this by 1.73. Example 391 / 1.73 = 226.
6) The expected phase current is 226 amperes.
7) If the bus voltage is higher or lower than nominal this will affect the phase expected phase current. Example bus voltage 3% high (14.2KV). Expected current will be 233 amperes.
8) If the capacitors have a higher voltage rating then required this will also affect the expected current. Example a 5400 KVAR capacitor bank rated for a 14.4 KV phase-to-phase application is used in a 13.8 KV station. Expected current will be 217 amps.

9. Appendix C – Calculating Capacitances from KVAR Rating.

1) Record the KVAR and voltage rating from one capacitor unit's data plate. Example 200 KVAR, 7960 volts.
2) Divide the voltage rating by 10. 7960 / 10 = 796
3) Multiply the result by itself. 796 X 796 = 633,616
4) Divide the result by the KVAR rating. 633,616 / 200 = 3168
5) Divide the result by 377. 3168 / 377 = 8.4
6) Capacitance of each unit is 8.4 microfarads.
7) Multiply by the number of units in each phase to get phase capacitance. Example 9 units per phase (27 units in bank). 9 X 8.4 = 75.6 microfarads.
8) The numbers calculated above represent the minimum acceptable values. To get a more realistic expected value multiply them by 1.04. Example 8.4 X 1.04 = 8.7 microfarads, 75.6 X 1.04 = 79 microfarads.
9) The following table shows minimum and maximum acceptable values for common sizes of capacitor units. Voltages are nameplate i.e. 7960 for a wye connected bank in a 13.8 KV station.

10. Appendix D – Test Values for Power Capacitors

Nameplate Voltage	100 KVAR		150 KVAR		200 KVAR		300 KVAR	
	Min	Max	Min	Max	Min	Max	Min	Max
2400	46.1	53.0	69.1	79.4				
4160	15.3	17.6	23.0	26.4	30.7	35.3		
4800	11.5	13.2			23.0	26.5		
6640	6.0	6.9	9.0	10.4	12.0	13.8	18.1	20.8
7200	5.1	5.9	7.7	8.8	10.2	11.8	15.4	17.7
7620	4.6	5.3	6.9	7.9	9.1	10.5	13.7	15.8
7960	4.2	4.8	6.3	7.2	8.4	9.6	12.6	14.4
13200	1.5	1.7	2.3	2.6	3.0	3.5	4.5	5.2
13800	1.4	1.6	2.1	2.4	2.8	3.2	4.2	4.8
14400	1.3	1.5	1.9	2.2	2.6	2.9	3.8	4.4
19920	0.67	0.77	1.00	1.15	1.34	1.54	2.01	2.31

11. Record of Revisions

Revision	Changes
05/23/2007	Document Added - Documentum Version # to headers Added - File name to footer
09/18/2008	Introduction Removed – Internal Inspection from list of inspections. Coordination Added – "If Applicable" to Relay Department

INTRODUCTION

This procedure describes the methods used to isolate, test de-energized and ground electrical apparatus for inspection, maintenance and repair.

PURPOSE

Grounding of electrical apparatus provides protection from accidental energization of apparatus and lines, and from static and induced voltages. Grounds also provide visual confirmation that apparatus and lines are de-energized.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

COORDINATION

Not Applicable.

REFERENCES

National Grid Safety Handbook

EOP G014 Clearance and Control Procedure

SMP 408.01.4 – Working On Substation Capacitor Banks

SMS 499.09.1 – PPE for Switching Indoor Substations Standard

SMP 499.10.1 – Substation Work Area Identification

SMP 499.10.2 – Substation Work Area Identification Procedure

Manufacturer's Installation, Operating, and Maintenance manuals for the specific equipment to be inspected.

Manufacturer's operating manuals for the specific test equipment to be used.

DEFINITIONS

Apparatus -	Devices or equipment, other than cables, lines and their associated hardware, used to transmit or distribute electrical energy.
Authorized Person -	A person designated by a Departmental Manager, or their designee, who has successfully been tested and has demonstrated proficiency and understanding of Clearance and Control (EOP G014). A person who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of an Authorized Person is

	considered to be an authorized person in the performance of those duties
Daisy Chaining	Term used for attaching personal protective grounds from system ground to a tested de-energized phase conductor and then applying a jumper form the grounded phase conductor to the next two phase conductors in succession. Daisy Chain Grounding with personal protective grounds by substation workers in substations is not allowed.
Disconnecting Switch -	Automatically or manually operated disconnecting device where the break in the primary path can be visually seen
Circuit Breaker -	Automatically operated disconnecting device where the break in the primary path cannot be visually seen.
Clearance (for work) -	Permission for an Authorized Person to perform specified work.
Clearance Person -	The person holding the Clearance.
Conventional Ground -	Wire conductor ground with phase and ground clamps, with or without permanently attached Live Line Tool. Commonly referred to as bag, heavy duty, stick or stickless grounds.
De-energized -	The absence of normal operating voltages associated with the operation of the system or control circuits.
Equi-potential Zone -	Physical area where all uninsulated conductors are at the same potential. This potential may not be earth ground or system neutral, particularly under fault conditions.
GDIT-	Ground Device Identification Ticket. Tag placed on grounds or grounding devices to insure grounds are removed before re-energization.
Ground, Mechanical -	Grounds permanently installed in substations that are not used for personal protection except in Gas Insulated Substations (GIS) or network applications.
Ground, Personal	Portable grounds directed by the Clearance Person and applied for the protection of workers.
Grounding Device -	Device used to establish an equi-potential zone or ground conductors.
Grounding Switch -	Permanently installed switch used to apply a ground, usually to a transmission line, after the conductor has been de-energized.
Grounding Truck -	Device installed in a circuit breaker cubicle to apply a protective ground after the bus or line has been de-energized and the circuit breaker has been removed. Also referred to as the Ground & Test (G&T) Cart.

High Speed Grounding Switch -	Automatically closing switch used to, deliberately apply a fault, usually to a transmission line, and force remote tripping, to protect apparatus.
Insulation -	Covering applied to energized conductors or live parts that are designed to withstand at least the full voltage that is applied in normal operation.
Protective Ground -	Device used to establish an equi-potential zone or ground conductors for the protection of workers.
Grounds At Remote Locations -	Grounds installed at locations other than the work site.
Higher Authority -	An Authorized Person at the same or higher level of Management above the Clearance Person who is holding the Clearance and is knowledgeable in the work to be performed.
Qualified Person -	A person knowledgeable in the construction and operation of electric power generation, transmission, substation, and/or distribution apparatus involved along with the associated hazards in specific duties pertaining to electric operations.
Source of Inadvertent Energization -	Source of primary voltage that could energize the work area if a disconnecting device were to be closed
System Operator -	Person authorized by the company to write and issue Switching Orders.
Three Phase Ground -	Ground with three phase ends connected to a common ground end.
Weather Cover -	Covering applied to energized conductors or live parts that are designed to protect the conductor or live part from the effects of weather. It may have some insulating value but is not designed to withstand the full voltage that is applied in normal operation.

TRAINING

Workers who have not been trained in or performed grounding operations on high voltage apparatus in the preceding year shall not perform the below tasks unless on site training is done.

Initial training for this activity is normally accomplished through:

Attending Training Course NS9081 – SMP 499.01.2 Protective Grounding Maintenance Procedure

Performing Approved On-The-Job Training

DOCUMENT CONTENTS

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1.0 HAZARDS

1.1 Great care and attention are required during testing and grounding operations to avoid inadvertently attempting to ground a live conductor.

1.2 The immediate area should be carefully examined for energized conductors and evaluated to ensure grounding can be accomplished safely.

1.3 Testing and grounding procedures should be strictly followed.

2.0 SPECIAL SAFETY EQUIPMENT REQUIRED

2.1 Class 2 Rubber Gloves and fire retardant clothing are required for all testing and grounding operations.

2.2 In addition, Arc Flash Ensembles are required in indoor substations for specific work activities that include testing and grounding. Refer to SMP 499.30.2 - Substation Personal Protective Equipment.

3.0 EXCEPTIONS TO THIS PROCEDURE

3.1 Lines and apparatus may be worked ungrounded and treated as dead only if National Grid Management can demonstrate:

3.1.1 That the installation of grounds is impracticable.

3.1.2 Conditions resulting from the installation of grounds would present greater hazards than working without grounds.

3.1.3 And the following conditions are met:

a. The apparatus or lines have been isolated and tested de-energized under the provisions of this document and other referenced procedures.

b. There is no possibility of contact with any other energized source.

c. The hazard of induced voltage is not present.

3.2 Exceptions from, or deviations to, normal grounding procedures require agreement and approval, by concurrence, of the:

3.2.1 Manager of Substation Maintenance & Construction,

3.2.2 Manager Substation Work Methods,

3.2.3 Or their designees.

4.0 APPROVED GROUNDING DEVICES

4.1 Conventional grounds

4.1.1 Refer to the National Grid Approved Tools and Equipment Catalog for approved grounds.

4.2 Grounding Trucks

4.2.1 Grounding trucks supplied and/or approved by the apparatus manufacturer.

a. Exceptions must be approved by Manager Substation Maintenance & Construction involved and the Manager Substation Work Methods.

4.3 Permanently installed grounding switches.

4.3.1 Permanently installed grounding switches that are part of Gas Insulated Substation (GIS) installations may be used for personal protective grounding

4.3.2 Permanently installed air gap type grounding switches, designed for transmission line grounding, may not be used for personal protective grounding.

a. Exception - Permanently installed grounding switches may be used for personal protective grounding in HVDC stations.

4.4 Live Line Tools used for attaching grounds.

4.4.1 Refer to the National Grid Approved Tools and Equipment Catalog for approved Live Line Tools.

5.0 GROUNDING DEVICES THAT HAVE BEEN FAULTED

5.1 Portable wire conductor type grounds that have been faulted shall be cut up and discarded.

5.2 Grounding Trucks or Ground and Test (G&T) Carts that have been faulted shall be completely disassembled, inspected, and repaired. They shall be inspected by a substation supervisor before reassembly and use.

5.3 Permanently installed grounding switches

5.3.1 Refer to Substation Maintenance Bulleting 409.09.N.001 Substation Ground Disconnects > 69kV for guidance for grounding switches used in substation for overhead circuit applications that have been subjected to fault conditions.

5.3.2 Grounding switches for Underground Cable Systems and Gas Insulated Substations (GIS) that have been faulted shall be visually inspected and tested for contact resistance.

a. Test results shall be approved by a substation supervisor before the grounding disconnects are returned to service.

6.0 APPROVED TESTING DEVICES (TESTING DE-ENERGIZED)

6.1 Only devices listed in the National Grid Approved Tools and Equipment Catalog shall be used to test de-energized before grounding.

7.0 WIRE SIZE OF GROUNDS

7.1 Minimum conductor size of conventional grounds is 4/0 copper in New England.

7.2 Minimum conductor size of conventional grounds is 2/0 copper in New York.

7.3 Refer to Appendix A and Appendix B of this document for locations where, multiple grounds per phase, or wire sizes larger than the minimum size are required.

8.0 REQUIRED INSPECTIONS

8.1 Grounds and grounding devices shall be visually inspected before each use for:

8.1.1 Fraying of wire at terminations.

8.1.2 Damaged or deteriorated connections.

8.1.3 Damaged of deteriorated heat shrink, if used.

8.1.4 Tightness of bolted connections, if used.

8.1.5 Any other physical damage

8.2 Live Line Tools used for testing or grounding shall be visually inspected before each use for:

8.2.1 Physical damage. Live Line Tools with any sign of damage should be sent to the manufacturer, Worcester Lab or New York Lab for evaluation and possible repair.

8.2.2 Unauthorized modifications. (Cut short etc.).

8.2.3 Cleanliness. Clean with approved Live Line Tool wipes if necessary.

8.2.4 Within required electrical test (HiPot) date period (Inspection Date Sticker).

9.0 JOINT USE OF GROUNDS

9.1 Joint use of grounds shall be permitted only with the knowledge and consent of each Clearance Person for whom the apparatus is tagged.

9.2 Jointly used grounds must be within the Tagged Areas of all Clearance Persons using them.

9.3 Each Clearance Person shall attach a Ground Device Identification Ticket (GDIT) to the jointly used grounds.

9.4 Each Clearance Person shall include the jointly used grounds on their list of ground locations and GDIT numbers documented on the Field Clearance and Control Form.

9.5 The first Clearance Person to clear off shall remove their Ground Device Identification Ticket (GDIT) and leave the ground attached.

9.6 The last Clearance Person to clear off is responsible for the removal of the ground.

9.7 Grounds shall never be removed if they are tagged with another person's Ground Device Identification Ticket (GDIT).

10.0 LOCATIONS OF GROUNDS

10.1 General.

10.1.1 The Clearance Person shall determine the required number and locations of grounds.

10.1.2 All three phases shall be grounded.

10.1.3 Grounds shall be placed as close to the work area as reasonably possible.

10.1.4 Grounds shall be placed between the work area and all possible sources of inadvertent energization, wherever possible.

a. If multiple sources of inadvertent energization feed the work area, for example a substation bus, it is not necessary to ground each source.

10.1.5 The preferred work practice is to work between grounds.

a. This provides the best protection and further defines the limits of the work area.

10.1.6 Work between a ground and a possible source of inadvertent energization (past the ground and toward the potential source) shall only be done within 10 conductor feet of the phase end of the ground.

10.2 Grounding through protective shutters in cubicles or other enclosures.

10.2.1 Only grounding trucks or other devices approved and/or supplied by the apparatus manufacturer shall be used to ground through protective shutters.

a. Exceptions must be approved by the Manager Substation Maintenance & Construction and the Manager Substation Work Methods.

10.3 Capacitors and Capacitor Racks and Structures – Additional Requirements.

10.3.1 Review SMP 408.01.4 – Working On Substation Capacitor Banks before grounding or working on substation capacitor banks.

10.3.2 Use additional substation grounds to ground any ungrounded structure that will be within minimum approach distance during the work.

a. This includes ungrounded structure that could be fallen into.

b. Sections may be grounded in series by grounding each section to the section below until a connection to the ground grid is reached.

10.3.3 Use additional substation grounds to ground any ungrounded bus sections that will be within minimum approach distance during the work.

a. This includes bus sections that could be fallen into.

10.3.4 Use an additional substation ground to ground across any neutral sensing devices in wye connected banks.

10.3.5 Use an additional substation ground to ground neutral in ungrounded wye connected banks.

11.0 GROUNDING THROUGH CIRCUIT BREAKERS AND DISCONNECTS

Grounding through disconnects or circuit breakers is the least preferred method and should only be considered when all other options have been evaluated.

11.1 Grounding through a disconnect or circuit breaker shall be thoroughly discussed and documented during the Job Brief.

11.1.1 Refer to local agreements for additional work procedures that may be required for grounding through circuit breakers and disconnects.

11.2 Grounding through circuit breakers.

11.2.1 The breaker shall be verified closed by means of the mechanical indicator (trip/close flag).

11.2.2 Tripping shall be disabled.

11.2.3 The circuit breaker shall be tagged with a locally applied hold tag.

11.3 Grounding through disconnects.

11.3.1 Disconnects shall be visually verified to be closed.

11.3.2 The disconnect shall be inspected for overheating, mechanical wear, and to otherwise be in good condition.

11.3.3 The mechanism shall be de-coupled and locked closed on motor operated disconnects.

a. Shunt tripping shall also be disabled on circuit switchers, if applicable.

11.3.4 Gang operated disconnects shall be locked closed.

11.3.5 Single blade disconnects shall be verified fully closed and properly latched.

11.3.6 The disconnect(s) shall be tagged with a locally applied hold tag

12.0 GROUNDS AT REMOTE LOCATIONS

12.1 The Clearance Person shall order the point of grounding tested and grounded by two Authorized Persons. At least one of the persons must be on the Authorized Person List.

12.2 One of the persons performing the grounding shall notify the Clearance Person that the grounds have been installed and give him the numbers of the Grounding Device Identification Tickets (GDIT) used.

12.3 The Clearance Person shall identify the grounds by GDIT number and location and order the grounds removed by Two Authorized Persons. At least one of the persons must be on the Authorized Person List.

12.4 One of the persons removing the grounds shall notify the Clearance Person that the grounds have been removed and give him the numbers of the associated Ground Device Identification Tickets.

12.5 If necessary, the System Operator may be used to relay these communications.

13.0 TESTING BEFORE GROUNDING

13.1 Wait 5 minutes after de-energizing a capacitor bank before testing de-energized and grounding.

13.2 Two Authorized Persons are required to test and ground. At least one of the persons must be on the Authorized Person List.

13.3 The Clearance Person may act as one of the two required persons

13.4 Testing shall be in the presence of, and the responsibility of the Clearance Person.

13.4.1 Exception Grounds At Remote Locations.

13.5 Only devices listed in the National Grid USA Approved Tools and Equipment Catalog shall be used to test de-energized before grounding.

13.6 No more than 9 grounding points (a group) shall be tested de-energized at one time and then only if they are with in 10 feet of each other, or are on bushings or taps of the same apparatus.

13.7 The tester shall be tested both before and after testing each group of grounding points to verify that it is working correctly.

13.7.1 Tests shall be made on the same voltage range as the normal energized voltage of the points to be tested and this range shall be used to test de-energized.

13.7.2 The tester shall be tested by: (listed in order of preference).

a. Testing on known live source of the same voltage as the points to be tested de-energized.

b. Tested with a test source designed to test high voltage testers that is listed in the Approved Tools and Equipment Catalog.

c. Tested with the self-test button or feature incorporated in the tester.

d. Testers that appear to be acting abnormally should not be used. They should be sent to the manufacturer, Worcester Lab or New York Lab for evaluation and possible repair.

13.8 The exact points where the grounds will be applied shall be tested de-energized.

13.9 If either of the two persons required to test de-energized and ground leave the immediate area of testing and grounding, or the testing and grounding process is otherwise interrupted:

13.9.1 Any ungrounded points shall be retested before additional grounds are applied.

13.10 Ground and Test (G&T) Cart or Grounding Trucks.

13.10.1 Ensure SMP 499.01.3 Ground and Test (G&T) Cart Checklist is reviewed and completed for proper set up and inspection instructions prior to the installation of G&T or Grounding Trucks.

13.10.2 Manually opening shutters is prohibited.

13.10.3 Verify if substation is posted as having been identified as having incident energy above 8 cal/cm2 and ensure proper level of PPE is worn before testing, installing, or removing G&T Cart.

13.10.4 Class II rubber gloves shall be worn used when installing (jacking in) or removing (jacking out) grounding trucks.

13.10.5 Class II rubber gloves and a Live Line Tool shall be used when attaching or removing leads from installed grounding trucks.

13.10.6 Preferred method.

a. Remove ground leads from the truck.

b. Install bushings ((source/load), if equipped.

c. Install insulating caps on ground connection points on the truck that will not be used, if equipped.

d. Install (jack in) the grounding truck into the cubicle.

e. Test de-energized on the points on the truck that will be grounded.

f. Attach the ground leads to system ground.

g. Attach the ground leads to the truck with an approved Live Line Tool.

13.10.7 If the connections from the ground leads to the ground truck are bolted.

a. Remove ground leads from the truck.

b. Install (jack in) the grounding truck into the cubicle.

c. Test de-energized on the points on the truck that will be grounded.

d. Withdraw the grounding truck sufficiently to de-energize the truck and close shutters.

e. Maintain minimum approached distance and safely connect the ground leads.

f. Attach the ground leads to system ground.

g. Attach the ground leads to the truck.

h. Install (jack in) the grounding truck into the cubicle.

13.11 Permanently installed grounding switches in Gas Insulated Substations (GIS).

13.11.1 Grounding switches shall only be operated and tagged under a System Operator's order.

13.11.2 If it is not possible to test de-energized do to the GIS construction:

a. The Clearance Persons and one other Authorized Person shall review the One-Line diagram and visually verify that the correct isolating disconnects are open before closing the grounding switch.

14.0 GROUND DEVICE IDENTIFICATION TICKETS (GDIT)

14.1 Grounding Device Identification Tickets shall be used for all grounding devices.

14.2 A separate GDIT shall be used for each ground connection.

14.3 Grounding Device Identification Tickets may be attached for the System Operator or the Clearance Person

15.0 LIST OF GROUNDS INSTALLED

15.1 The Clearance Person shall maintain a list of all grounds attached, including those at remote locations on the Field Clearance and Control Form.

15.1.1 This list shall include the specific locations and Ground Device Identification Ticket (GDIT) numbers.

16.0 ATTACHING AND REMOVING CONVENTIONAL GROUNDS

16.1 All of the ground clamp ends of a group of grounds shall be attached first.

16.1.1 Class II rubber gloves shall be used.

16.1.2 The point of attachment shall be visually verified to be connected to the ground grid.

16.1.3 The connection points in order of preference are:

a. Jug handle specifically installed for grounding.

b. Structure directly connected to the ground grid.

c. Structure connected to the ground grid through bolted structure connections.

16.1.4 Connection to galvanized or painted structure.

a. Ensure the grounding location is properly grounded.

b. Remove paint, oxidation, or galvanization to ensure a good ground source.

c. Set screws used for mechanically holding the ground end clamp to the ground source connection shall be screwed in after the clamp end is tightened, if equipped. Caution must be exercised not to over tighten the set screws.

16.2 All of the phase ends of a group of grounds shall be attached second.

16.2.1 Live Line Tool and Class II rubber gloves shall be used.

16.2.2 Phase ends shall be a suitable size, and design, for the bus, pad or wire.

16.3 All of the phase ends of a group of grounds shall be removed first.

16.3.1 Live Line Tool and Class II rubber gloves shall be used.

16.4 All of the ground clamp ends of a group of grounds shall be removed second.

16.4.1 Class II rubber gloves shall be used.

16.5 A live line tool of sufficient length shall be used to maintain the distances listed in the Minimum Approach Distance Table.

16.5.1 For specific grounding applications in NE, if a grounding Live Line Tool of sufficient length to maintain the distances listed in the Minimum Approach Distance Table is not available, a shorter Live Line Tool may be used providing:

a. The distances listed in the Minimum Approach Distance Table are maintained until the conductor has been tested de-energized.

b. The insulated portion of the Live Line Tool is at least 4 feet 6 inches long.

c. The worker maintains at least 2 feet of clearance from the conductor to be grounded.

17.0 INSTALLING AND REMOVING GROUNDING TRUCKS

17.1 Installing grounding trucks - See Section 13.10

17.2 Removing grounding trucks.

17.2.1 Withdraw the grounding truck from the cubicle.

17.2.2 Remove ground leads from system ground.

18.0 GROUNDING IN METAL-CLAD SWITCH GEAR

This section shows a limited number of examples of grounding procedures for metal clad substations. For work not included here refer to the general testing and grounding requirements in the other sections of this SMP

18.1 For Work from circuit breaker to cable terminations – stations without load side disconnects.

18.1.1 Test and ground at the riser terminals.

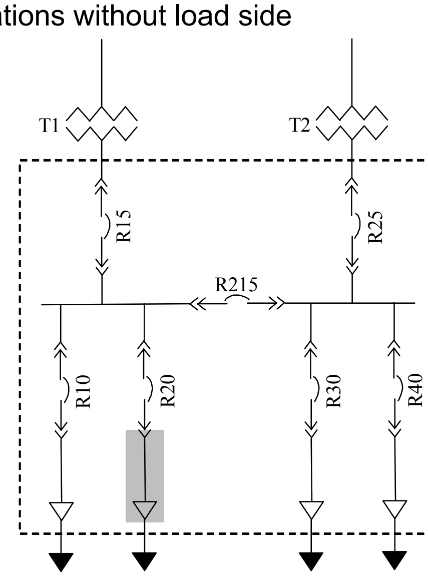
a. Sections 13 and 16.

18.1.2 If a grounding truck is available use it to test and ground the line side circuit breaker terminals.

a. See Section 13.10.

18.1.3 Test at the cable terminations, at the rear of the cubicle, using a tester approved for testing through unshielded insulation.

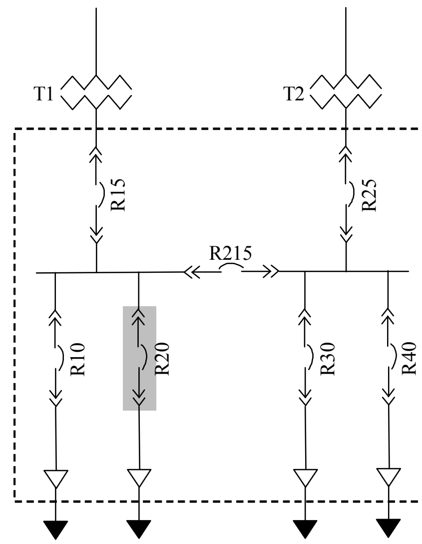
a. See Section 13



18.2 For work at the circuit breaker cubicle terminals – stations without load side disconnects.

18.2.1 Rack out all breakers on the bus section.

18.2.2 Exception – breaker that will be used for grounding the bus, if necessary.



18.2.3 Test and ground the feeder.

a. See Sections 13 and 16.

b. If grounding studs are available test and ground the feeder at the grounding studs.

c. If there are no grounding studs test and ground the feeder as close to the work as possible.

18.2.4 Test and ground the bus section.

a. See Sections 13 and 16.

18.2.5 If a grounding truck is available use it to test and ground the bus side circuit breaker terminals.

18.2.6 The grounding truck may be installed in an adjacent breaker position or the bus tie position.

a. See Section 13.10.

18.2.7 If a grounding truck is not available test the bus dead.

a. See Section 13

b. Test and ground an adjacent feeder.

c. Close the feeder breaker to ground the bus.

d. Remove tripping from the breaker for the duration of the work.

e. Tag the breaker with a locally applied hold tag

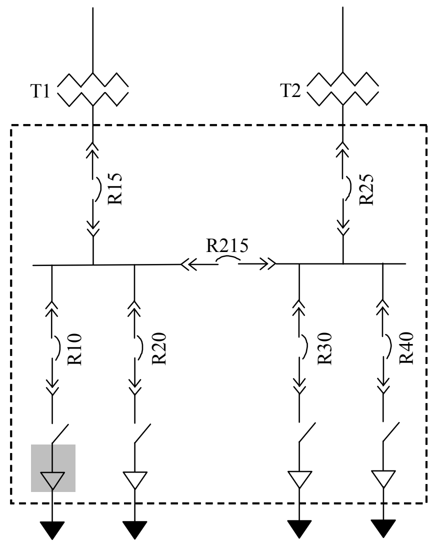
18.3 For work between the load side disconnects and the cable – stations with load side disconnects and grounding studs.

18.3.1 Test and ground the feeder.

a. See Sections 13 and 16.

b. If grounding studs are available test and ground the feeder at the grounding studs.

c. If there are no grounding studs test and ground the feeder as close to the work as possible.



18.3.2 Test at cubicle before removing covers from grounding studs. See Section 13.

18.3.3 Remove the covers from the grounding studs using an approved insulated tool adequate for thee voltage level.

18.3.4 Retest at grounding studs. See Section 13.

18.3.5 Apply grounds to grounding studs.

18.3.6 See Section 16.

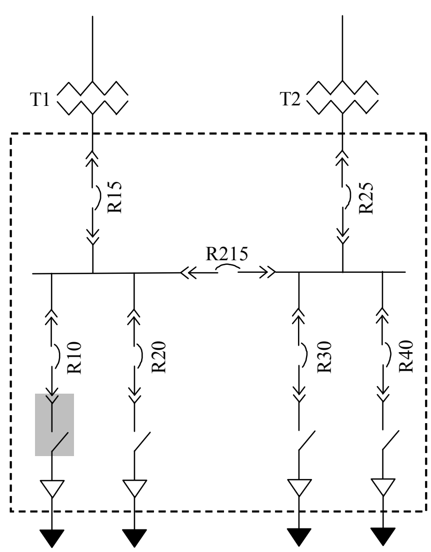
18.4 For work on the load side disconnects or between the circuit breaker and load side disconnects – stations with load side disconnects and grounding studs.

18.4.1 Test and ground the feeder.

a. See Sections 13 and 16.

b. If grounding studs are available test and ground the feeder at the grounding studs.

c. If there are no grounding studs test and ground the feeder as close to the work as possible.



18.4.2 If a grounding truck is available use it to test and ground the load side circuit breaker terminals.

a. See Section 13.10.

18.4.3 If a grounding truck is not available.

a. Test at cubicle before removing covers from grounding studs. See Section 13.

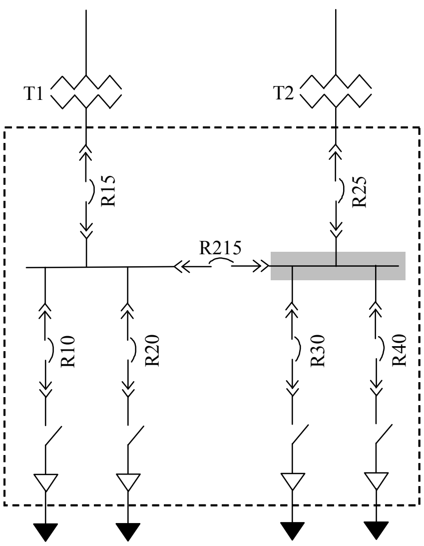
b. Remove the covers from the grounding studs using an approved insulated tool adequate for thee voltage level.

c. Retest at grounding studs. See Section 13.

d. Apply grounds to grounding studs. See Section 16.

18.5 For work on a bus section – stations with load side disconnects.

18.5.1 Include the transformer bank feeding the bus section if possible.



18.5.2 Open and truck out the bus tie circuit breaker.

18.5.3 Test and ground on the low side (preferable) or high side of the transformer.

a. See Sections 13 and 16.

18.5.4 Close the associated transformer breaker.

a. Remove tripping from the breaker for the duration of the work.

b. Tag the breaker with a locally applied hold tag.

18.5.5 Optional - If a grounding truck is available use it to test and ground the bus-side transformer circuit breaker terminals. See Section 13.10.

18.5.6 If a grounding truck is not available:

a. Test the bus dead. See Section 13.

b. Test and ground a feeder on the bus.

c. See Sections 13 and 16.

d. Close the feeder breaker to ground the bus.

e. Remove tripping from the breaker for the duration of the work.

19.0 OPERATING PERMANENTLY INSTALLED GROUNDING SWITCHES

19.1 Permanently installed grounding switches shall only be operated and tagged under a System Operator's order.

19.2 The System Operator will order the Ground Device Identification Ticket (GDIT) applied and removed and maintain a list of the locations and GDIT numbers used.

20.0 REMOVAL OF GROUNDED TAPS FROM APPARATUS

20.1 After clearance to go to work is received grounded taps may be removed from apparatus bushings and pulled away.

20.2 The grounds must remain on the taps until they are reconnected to the bushings and work is complete.

20.3 It is not necessary to apply grounds to the bushing connectors

21.0 REMOVAL OF GROUNDS FOR ELECTRICAL TESTING

21.1 Grounds may be temporarily removed from apparatus when required for electrical testing.

21.2 If grounded taps are to be removed from the apparatus bushings and pulled back isolating the equipment from the system to facilitate testing, it is not necessary to place additional grounds on the bushings before attaching, moving, or removing test set leads.

21.3 If grounded taps are NOT to be removed from the apparatus bushings, the test leads shall be attached before the grounds are removed.

21.3.1 The apparatus shall be considered as energized until the grounds are re-installed.

21.3.2 Grounds shall be re-installed before test leads are moved or removed.

21.4 Class II rubber gloves and a Live Line Tool shall be used to install and remove conventional grounds.

21.5 Class II rubber gloves shall be used to remove and reinstall links on Gas Insulated Substation (GIS) ground switches.

22.0 FABRICATION AND REPAIR OF GROUNDING DEVICES

22.1 Substation workers may repair conventional grounds.

22.1.1 Replacement components used shall be the same design and construction used by the original manufacturer.

22.2 Substation workers may fabricate conventional grounds.

22.2.1 Connections to wire shall be compression type.

a. Verify the correct die is used.

22.2.2 Use clear heat-shrink tubing.

a. Leave 1/2 inch of bare conductor showing under the heat shrink between the connector and wire insulation.

22.2.3 Ground and phase ends shall be the same as used in a ground listed in the Approved Tools and Equipment Catalog.

22.2.4 The maximum length shall be 30 feet.

22.3 Substation workers may repair grounding trucks.

22.3.1 Replacement components used shall be the same design and construction used by the original manufacturer.

22.4 Substation workers may repair permanently installed grounding switches.

22.4.1 Replacement components used shall be obtained from the switches manufacturer.

22.5 All future ground set cable purchased shall be low temperature clear jacket.

23.0 REPAIR OF TESTING DEVICES (TESTING DE-ENERGIZED)

23.1 Testing Devices may be repaired by the following:

23.1.1 Manufacturer.

23.1.2 New York Laboratory.

23.1.3 Worcester Laboratory.

23.1.4 A vendor approved by the New York Laboratory or the Worcester Laboratory

24.0 APPENDIX A - NEW YORK LOCATIONS REQUIRING MORE THAN SINGLE 2/0 GROUNDS

EASTERN DIVISION - CAPITOL REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
ADIR-WTRFRD HYDR	4.16	2-4/0		GE Co	115	4/0
AIRPROD	115	4/0		GE PLASTICS	115	4/0
ALBANY STM GEN1	115	4/0		GE PLASTICS	13.2	4/0
ALBANY STM GEN1	13.2	4/0		GENESEE 34.5kV 24/0	34.5	2-4/0
ALBANY STM GEN2	115	4/0		GREEN ISLAND	13.2	4/0
ALBANY STM GEN2	13.2	4/0		GREENBUSH	115	4/0
ALBANY STM GEN3	115	4/0		IRON&BRS	34.5	4/0
ALBANY STM GEN3	13.2	4/0		JMCII GT201	13.8	4/0
ALBANY STM GEN4	115	4/0		JMCII GT301	13.8	4/0
ALBANY STM GEN4	13.2	4/0		JMCII ST202	13.8	2-4/0
ALBANY WASTE	115	4/0		JMCSLKRK G1	13.8	2-4/0
ALBANYRES	2.4	2-4/0		JMCSLKRK G2	13.8	2-4/0
AVE. A	34.5	4/0		KRUMKILL	4.16	4/0
BENNINGTON P	0.48	2-4/0		LEEDS-SV	18	2-4/0
BETHLEHEM	115	4/0		LG&E RENSSEL	13.8	2-4/0
BETHLEHEM	34.5	4/0		LIBERTY ST	34.5	4/0
BETHLEHEM	4.8	2-4/0		MAPLEWOOD	34.5	4/0
CENTRAL AVE	34.5	4/0		MENANDS	115	4/0
CETI FORT ORANGE G	13.8	2-4/0		MENANDS	34.5	4/0
COMMERCE AVE	34.5	4/0		MENANDS	4.16	4/0
CROSS PUMP	34.5	4/0		MENANDS	5	2-4/0
CURRY RD TB 1	13.2	4/0		MHWKPAPR	34.5	4/0
CURRY RD TB 2	13.2	4/0		NEWARKST	34.5	4/0
ELLIS HOSP	0.48	2-4/0		NORLITE	34.5	4/0
EVERETT RD	115	4/0		N TROY	34.5	4/0
FED BLDG	34.5	4/0		N TROY	5	2-4/0
FEDBLDG8	34.5	4/0		NORTON-NASH	34.5	4/0
FUERA BUSH33	115	4/0		NORTON-NASH	13.8	4/0
FUERA BUSH77	115	4/0		NSCOT33	115	4/0

EASTERN DIVISION - CAPITOL REGION

Station/Bus	kV	Ground		Station/Bus	kV	Ground
FUERA BUSH99	115	4/0		NSCOT77	115	4/0
NSCOT99	115	4/0		SCHOOL ST G2	13.2	4/0
OWENS CORNING GL	115	4/0		SCHOOL ST G3	13.2	4/0
PACKING	34.5	4/0		SCHOOL ST G4	13.2	4/0
PARTRIDGE ST	34.5	4/0		SILICONE	5	4/0
PARTRIDGE ST	4.16	4/0		STUYVESNT	2.4	4/0
PATROON	115	4/0		SWAGGERTOWN	34.5	4/0
PATROON	34.5	4/0		TEKHUGHS	34.5	4/0
QUALITY INN	34.5	4/0		TEN EYKE	34.5	4/0
RENSS WASTE	115	4/0		THE BANK	34.5	4/0
REYNOLDS RD	115	4/0		THE BANK 8	34.5	4/0
RIVERSIDE	115	4/0		TRIN RISER	115	4/0
RIVERSIDE	13.2	4/0		TRIN RISER	115	4/0
RIVERSIDE	34.5	4/0		TRINITY STA	115	4/0
ROTT33G	115	4/0		TRINITY STA	13.2	4/0
ROTT44G	115	4/0		TRINITY STA	4.16	4/0
ROTT77G	115	4/0		UNIONVILLE	115	2-4/0
ROTT99G	115	4/0		VISCHERS FERRY	2.4	2-4/0
SAMARITAN	0.48	2-4/0		WATT ST	4.16	4/0
SCHAGHTICOKE	4.8	4/0		WOODLAWN	34.5	4/0
SCHOOL ST	34.5	4/0		WYNANTSKILL	115	4/0
SCHOOL ST G1	13.2	4/0				

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground

EASTERN DIVISION - NORTHEAST REGION

Station/Bus	kV	Ground		Station/Bus	kV	Ground
AHDC HUDSON	13.8	4/0		INDECK CORINTH ST	13.8	2-4/0
BEARDSLEE HYDRO	6.9	4/0		INGHAMS MILLS HYDR	2.4	2-4/0
CLARK MILL 1	0.48	2-4/0		IPCURTIS	4.16	2-4/0
CLARK MILL 2	0.48	2-4/0		IPPALME	13.8	4/0
CLARK MILL 3	0.48	2-4/0		S GLEN FALLS ADR HY	13.8	2-4/0

EASTERN DIVISION - NORTHEAST REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
CLARK MILL 4	0.48	2-4/0		S GLEN FALLS ADR HY	2.4	2-4/0
E J WEST	6.9	2-4/0		SPIER FALLS HYDRO	13.8	2-4/0
EPHRATAH HYDRO	2.4	4/0		SPIER FALLS HYDRO	4.8	2-4/0
FORT MILLE	4.16	4/0		SPIER FALLS HYDRO	6.9	2-4/0
GLENS FALLS	4.16	4/0		WELLS HYDRO	0.48	2-4/0
GLOVERSVILLE	4.16	4/0				
INDECK CORINTH GT	13.8	2-4/0				

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground

CENTRAL DIVISION - CENTRAL REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
GM TERNS	115	4/0		OSWEGO G3	13.2	2-4/0
HEADSON	34.5	4/0		OSWEGO G4	13.2	2-4/0
HIGH DAM 1	4.16	2-4/0		OSWEGO G5	21.2	2-4/0
HIGH DAM 2	4.16	2-4/0		PAUL TRINITY	0.48	2-4/0
HIGH DAM 3	4.16	2-4/0		PEAT ST	115	4/0
HIGH DAM 4	4.16	2-4/0		PEBBLE HILL	115	4/0
INDECK HAMG 1	13.8	2-4/0		ROME	4.8	2-4/0
INDECK HAMG2	13.8	2-4/0		SALTCITY COGEN	115	4/0
INDEPENDENCE	345	4/0		SALTCITY COGEN	13.8	2-4/0
KAMINE SYR COGEN	115	4/0		SCRIBA	345	4/0
KAMINESYR COGEN GT	13.8	2-4/0		SITHE-IND G1	18	2-4/0
KAMINESYR COGEN ST	13.8	4/0		SITHE-IND G2	18	2-4/0
KILLIAN	34.5	4/0		SITHE-IND G3	18	2-4/0
LHH	12	4/0		SITHE-IND G4	18	2-4/0
MESSINA	34.5	4/0		SITHE-IND G5	18	2-4/0
MESSINA	4.16	4/0		SITHE-IND G6	18	2-4/0
NMP#1	24	2-4/0		SITHE-INDE	345	4/0
NMP#1	345	4/0		SOLVAY VILLAGE	115	4/0
NMP#2	23.7	4/0		SOLVAY STA	115	4/0
NMP#2	345	4/0		S OSWEGO	115	4/0

CENTRAL DIVISION - CENTRAL REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
NMP2-1SG	13.8	4/0		SYRACUSE POWER G1	4.16	4/0
NMP2-3SG	13.8	4/0		SYRACUSE POWER G2	4.16	4/0
OCRRA	13.8	4/0		SYRACUSE POWER G3	4.16	4/0
OSWEGERF G1	4.16	4/0		TEMPLE	115	4/0
OSWEGERF G2	4.16	4/0		USG E SYR GEN 1	13.8	2-4/0
OSWEGO G1	13.8	2-4/0		USG E SYR GEN 2	13.8	2-4/0
OSWEGO G2	13.2	2-4/0		USG E SYR GEN 3	13.8	2-4/0
OSWEGO G6	21.2	2-4/0		W OSWEGO	2.4	2-4/0
OSWEGO M1&2	115	4/0		VARICK	2.4	2-4/0
OSWEGO M3&4	115	4/0		VOLNEY	345	4/0
SYRINDCP	34.5	4/0				
SYRRENDC	34.5	4/0				
TEALL AVE	34.5	4/0				

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground.

CENTRAL DIVISION – MOHAWK REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
PORTER	115	4/0				
TERMINAL	13.2	4/0				
TRENTON	13.2	4/0				

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground.

CENTRAL DIVISION - NORTHERN REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
None						

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground

WESTERN DIVISION - FRONTIER REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
DUPONT #133	4.16	4/0		HUNTLEY G68	13.2	2-4/0
GARDENVILLE	115	4/0		MOUNTAIN	115	4/0
GARDENVL T2	13.2	2-4/0		PACKARD	230	4/0
GIBSON	12	4/0		SENECA	23	4/0
HARPER	12	4/0		STATION #26	4.16	4/0
HUNTLEY	12	4/0		STATION #33	4.16	4/0
HUNTLEY	23	4/0		STATION #39	4.16	4/0
HUNTLEY G63	13.2	2-4/0		STATION #44	4.16	4/0
HUNTLEY G64	13.2	2-4/0		STATION #78	23	4/0
HUNTLEY G65	13.2	2-4/0		STATION #129	4.16	4/0
HUNTLEY G66	13.2	2-4/0				
HUNTLEY G67	13.2	2-4/0				

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground.

WESTERN DIVISION - GENESSEE REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
DOLOMITE #09	0.48	2-4/0				4/0

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground.

WESTERN DIVISION - SOUTHWEST REGION						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
DUNKIRK	2.4	4/0		DUNKIRK G3	13.2	2-4/0
DUNKIRK G1	13.2	2-4/0		DUNKIRK G4	13.2	2-4/0
DUNKIRK G2	13.2	2-4/0				

Note: two parallel 2/0 grounds may be used in place of one 4/0 ground

25.0 APPENDIX B - NEW ENGLAND LOCATIONS REQUIRING MORE THAN SINGLE 4/0 GROUNDS

ALL						
Station/Bus	**kV**	**Ground**		**Station/Bus**	**kV**	**Ground**
AUBURN ST	115	2-4/0		RAILYARD	115	2-4/0
BRAYTON PT G1	115	2-4/0		SALEM HARBOR	115	2-4/0
BRIDGEWATER	115	2-4/0		SANDY POND	115	2-4/0
EVERETT	115	2-4/0		SOUTH ST	115	2-4/0
FRANKLIN SQ	115	2-4/0		TEWKSBURY	115	2-4/0
GOLDEN HILLS	115	2-4/0		WEST FARNUM	115	2-4/0
HARTFORD AVE	115	2-4/0		WOONSOCKET	115	2-4/0
MELROSE	115	2-4/0				
PERRY ST	115	2-4/0				

26.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	xx/xx/xx	Initial version of document
1.0	12/26/06	Corrected - Formatting Changed - Header title, Document number prefix Removed - Subtitle Changed - First page footer to reference Documentum Changed – References to EOP to SMP
1.1	02/05/07	Removed – Duplicate table Eastern Division – Northeast Region
1.2	02/12/07	Minor spelling and grammar corrections Stations Requiring 4/0 Grounds Tables Removed – IPP/Customer stations from 4/0 required table in Central-Northern Region NY Added – Note: two parallel 2/0 grounds may be used in place of one 4/0 ground. Exceptions to this procedure Added – OSHA wording Grounding in metal clad switchgear Changed – References to section 11 and 14 to section 12 and 15

1.3	05/23/07	Grounds At Remote Locations Changed – grounded by two persons on the Authorized Person List. to grounded by Two Authorized Persons. At least one of the persons must be on the Authorized Person List. Changed – removed by two persons on the Authorized Person List. to removed by Two Authorized Persons. At least one of the persons must be on the Authorized Person List. Testing Before Grounding Changed – Two persons on the Authorized Person List are required to test and ground. to Two Authorized Persons are required to test and ground. At least one of the persons must be on the Authorized Person List. Changed – The Clearance Person and one other person on the Authorized Person list to The Clearance Person and one other Authorized Person Document Added - Documentum Version # to headers Added - File name to footer Changed – Hot Stick to Live Line Tool References Changed – GOP 014 to EOP G014 Exceptions To This Procedure Deleted – Control Center Manager, Manager of Safety and Health Grounding Devices That Have Been Faulted Permanently Installed Grounding Switches Revised – Section Approved Testing Devices (Testing De-energized) Revised – Section Locations of Grounds General – Section Revised Capacitors and Capacitor Racks and Structures – Additional Requirements Changed - includes structure to includes ungrounded structure Grounding Through Circuit Breakers and Disconnects Revised – Section introduction Removal Of Grounds for Electrical Testing Changed – Minor grammar Wire Size of Grounds Changed –Reworded for clarity Approved Grounding Devices Grounding Trucks Added – Approval for exceptions to manufacturer supplied/approved Locations OF Grounds Grounding through protective shutters in cubicles or other enclosures. Added – Approval for exceptions to manufacturer supplied/approved Testing Before Grounding Changed - 13.6 No more than 6 grounding points to No more than 9 grounding points
1.4	06/29/07	Locations of Grounds Remove - Duplicate paragraph
1.5	07/12/07	Attaching And Removing Conventional Grounds - All of the ground clamp ends ………… Added - Class II rubber gloves shall be used. Grounding Trucks. Added - Class II rubber gloves shall be worn used when installing (jacking in) or removing (jacking out) grounding trucks. Added - Class II rubber gloves and a Live Line Tool shall be used when attaching or removing leads from installed grounding trucks. Grounding In Metal-Clad Switch Gear Corrected – References to other Sections. Installing and Removing Grounding Trucks

		Corrected – Reference Section 12.9 to Section 13.10 List Of Grounds Installed Added – List of grounds maintained on Field Clearance and Control Form.
1.6	10/29/07	Appendix A Added – Buffalo Station #33 Changed - Buffalo Station #33 voltage from ? to 4.16
1.7	06/23/08	Section 16 – 16.1, 4) Connection for galvanized or painted structures. 16.5, 1) Specific grounding applications in NE. Section 22 – Replacement Ground Set cables to be low temp clear jacketed. Consolidated Ground Lead Tables.
1.8	09/18/08	APPENDIX A – New York Locations Requiring More Than Single 2/0 Grounds. Corrected – Alphabetical Order.
2.0	12/14/12	Converted to new format. References - Changed “National Grid USA Safety Handbook” to “National Grid Safety Handbook” Definitions - Added “Daisy Chaining”; Changed “Grounding Truck - … has been removed.” to “Grounding Truck - … has been removed. Also referred to as the Ground & Test (G&T) Cart.” Section 2.2 - Changed “In addition switching coats and hoods are required in indoor substations; see SMS 499.09.1 PPE for Switching Indoor Substations Standard.” to “In addition, Arc Flash Ensembles are required in indoor substations for specific work activities that include testing and grounding. Refer to SMP 499.30.2 - Substation Personal Protective Equipment.” Section 3.2.1 - Changed “Manager of the Operating Department involved,” to “Manager of Substation Maintenance & Construction, “ Section 3.2.2 - Changed “Manager Substation O&M Services” to “Manager Substation Work Methods,” Section 4.2.1.a - Changed “Exceptions must be approved by Manager of the Operating Department involved and Manager Substation O&M Services.” to “Exceptions must be approved by Manager Substation Maintenance & Construction involved and the Manager Substation Work Methods.” Section 4.4.1 - Changed “Refer to National Grid USA Approved Tools …” to “Refer to National Grid Approved Tools …” Section 5.1 - Changed “Portable wire conductor type grounds” to “Portable wire conductor type grounds that have been faulted shall be cut up and discarded” Section 5.1.1 - Deleted Section 5.1.2 - Deleted Section 5.2 - Changed “Grounding Trucks” to “Grounding Trucks or Ground and Test (G&T) Carts that have been faulted shall be completely disassembled, inspected, and repaired. They shall be inspected by a substation supervisor before reassembly and use.” Section 5.2.1 - Deleted Section 5.3.1 - Changed “Grounding switches used in overhead circuit applications that have been subjected to fault conditions shall be mechanically disconnected from the system and shall no longer be used.” to “Refer to Substation Maintenance Bulleting 409.09.N.001 Substation Ground Disconnects > 69kV for guidance for grounding switches used in substation for overhead circuit applications that have been subjected to fault conditions.” Section 6.1 - Changed “Only devices listed in the National Grid USA Approved Tools …” to “Only devices listed in the National Grid Approved Tools …” Section 9.4 - Changed “Each Clearance Person shall include the jointly used grounds on his list of ground locations and GDIT numbers.” to “Each Clearance Person shall include the jointly used grounds on their list of ground locations and GDIT numbers documented on the Field Clearance and Control Form.” Section 9.5 - Changed “The first Clearance Person to clear off shall remove his Ground Device Identification Ticket (GDIT) and leave the ground attached.” to “The first Clearance Person to clear off shall remove their Ground Device Identification Ticket (GDIT) and leave the ground attached.” Section 10.2.1.a - Changed “Exceptions must be approved by Manager of the Operating Department involved and Manager Substation O&M Services.” to “Exceptions must be approved by the Manager Substation Maintenance & Construction and the Manager Substation Work Methods.”

Section 13.9 - Changed "… otherwise interrupted." to "… otherwise interrupted:"
Section 13.10 - Changed "Grounding Trucks." to "Ground and Test (G&T) Cart or Grounding Trucks."
Section 13.10.1 - Added and re-numbered accordingly
Section 13.10.3 - Added and re-numbered accordingly
Section 21.2 - Changed "If grounded taps have been removed from the apparatus and pulled back it is not necessary to attach grounds before attaching or removing test leads." to "If grounded taps are to be removed from the apparatus bushings and pulled back isolating the equipment from the system to facilitate testing, it is not necessary to place additional grounds on the bushings before attaching, moving, or removing test set leads."
Section 21.3 - Changed "Class II rubber gloves and a Live Line Tool shall be used to remove and reinstall conventional grounds." to "If grounded taps are NOT to be removed from the apparatus bushings, the test leads shall be attached before the grounds are removed."
Section 21.3.1 - Added
Section 21.3.2 - Added
Section 21.4 - Changed "Class II rubber gloves shall be used to remove and reinstall links on Gas Insulated Substation (GIS) ground switches." to "Class II rubber gloves and a Live Line Tool shall be used to install and remove conventional grounds."
Section 21.5 - Changed "Test leads shall be attached before the grounds are removed." to "Class II rubber gloves shall be used to remove and reinstall links on Gas Insulated Substation (GIS) ground switches."
Section 21.5.1 - Deleted
Section 21.6 - Deleted
Section 22.5 - Changed "Upon approval by NG USA, all future ground set cable shall be low temperature clear jacket." to "All future ground set cable purchased shall be low temperature clear jacket."

nationalgrid	SUBSTATION MAINTENANCE PROCEDURE	**SMP 499.02.2** **Version 1.2** **Date 06/23/2008** **Page 1 of 8**

MOBILE SUBSTATION GROUNDING

INTRODUCTION

This procedure describes the methods used to properly ground mobile substations before placing them in service.

PURPOSE

Mobile substations must be properly grounded when installed to protect both the public and electric utility workers and to ensure proper operation of protective devices.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

REFERENCES

National Grid USA Safety Manual

EOP 499.10.2 - Substation Work Area Identification Procedure

PROCEDURE CONTENTS

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1. General

1.1 The qualified person in charge of the work at the job site shall be responsible for the compliance with this procedure and shall ensure the mobile substation is properly grounded before energizing the unit.

1.2 For Mobile Substation installations where the minimum clearance from unguarded live parts, as specified in the National Grid USA Safety Handbook, to personnel on foot can not be maintained

1) Barricades (vinyl fencing, barricade tape, signs that indicate overhead energized conductors etc.), are required.

   a) See SMP 499.10.2 - Substation Work Area Identification Procedure.

2) Barricades and signs shall be installed by qualified employees in accordance with SMP 499.10.2 - Substation Work Area Identification Procedure.

1.3 This procedure is to be used in conjunction with the Mobile Substation Installation Checklists and setup procedures.

2. Grounding When Inside Substation

2.1 Mobile Substations and Transformers

1) At least two points on the trailer shall be bonded to the station ground grid.
   a) Bond to the trailer frame or mobile grounding system using 4/0 wire and connectors approved by their manufacturer for 4/0 wire and the connection type.
2) All operating handles and other metal on, or part of, the trailer, except high voltage parts, shall be verified to be welded or bonded to the trailer frame and have a high-current path to the station ground grid.
   a) The transformer tank should have at least two ground connections to the trailer if it is not welded to the trailer frame.
3) Portable, protective ground mats shall be installed under all operating handles and control cabinets.
   a) Bond to the trailer frame or mobile grounding system using at least #2 wire and connectors approved by their manufacturer for the wire size and the connection type.
   b) Do not connect portable, protective ground mats directly to the station ground grid.

2.2 Separate Trailer Mounted Associate equipment.

1) Trailer mounted circuit switchers and other equipment shall be grounded in the same manner as mobile substations and transformers.

2.3 Temporary Equipment mounted on cribbing etc.

1) Other temporary equipment shall be connected to the station ground grid at two opposite corners.
   a) Use 4/0 wire and connectors approved by their manufacturer for 4/0 wire and the connection type.

2.4 Appendix A at the end of this document shows a typical installation.

3. Grounding When Outside Substation

3.1 Grounding With Ground Rods.

1) Before digging or driving ground rods:
   a) Notify Dig-Safe. (MA, ME, NH, RI, VT)
   b) Notify Dig Safety (NY except Long Island and NYC)
   c) Notify New York City One-Call (Long Island and NYC)
2) Install six ground rods to a depth of 6 feet and connect to trailer.
   a) Install at the four corners of the trailer and the centers of the long sides.
   b) Connect ground rods to the trailer frame or mobile grounding system using 4/0 wire and connectors approved by their manufacturer for 4/0 wire and the connection type.
3) All operating handles and other metal on, or part of, the trailer, except high voltage parts, shall be verified to be welded or bonded to the trailer frame and have a high-current path to the ground rod system.

4) Portable, protective ground mats shall be installed under all operating handles and control cabinets.
   a) Bond to the trailer frame or mobile grounding system using at least #2 wire and connectors approved by their manufacturer for the wire size and the connection type
   b) Do not connect portable, protective ground mats directly to the ground rods.

3.2 Grounding To The Station Ground Grid.

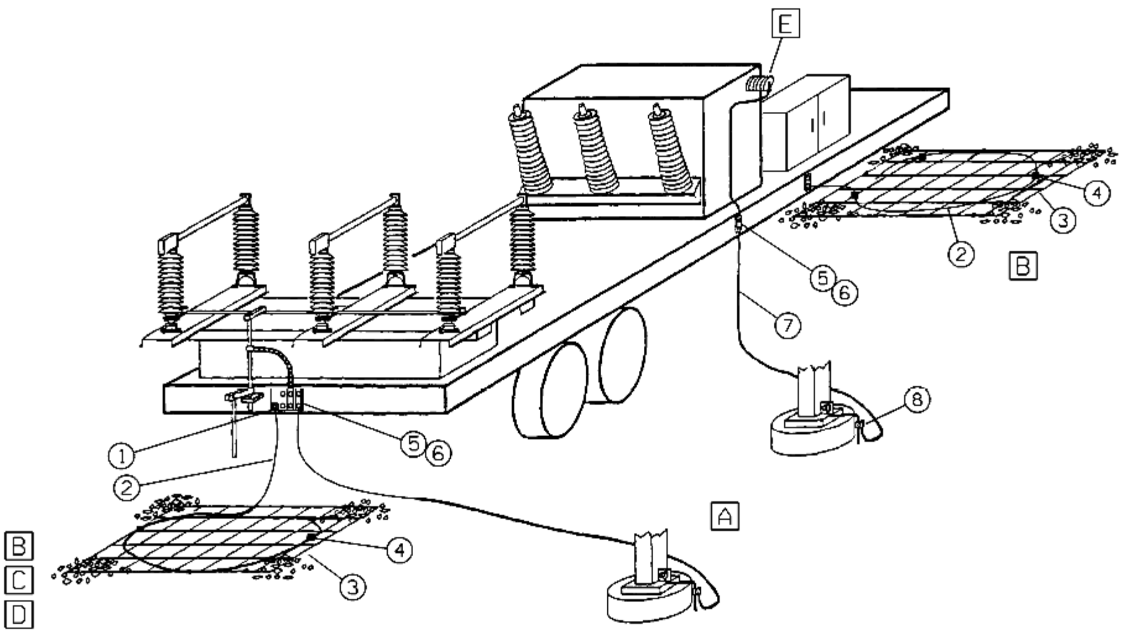
1) The mobile must be located within 50 feet of the station ground grid connections.
2) Substation ground grid.
3) At least two points on the trailer shall be bonded to the station ground grid.
   a) Route two ground wires back into the substation yard for connection to the station ground grid.
   b) Bond to the trailer frame or mobile grounding system using 4/0 wire and connectors approved by their manufacturer for 4/0 wire and the connection type.
4) All metal on, or part of, the trailer, except high voltage parts, shall be verified to be welded or bonded to the trailer frame and have a conductive, high-current path to the station ground grid.
5) Portable, protective ground mats shall be installed under all operating handles and control cabinets.
   a) Bond to the trailer frame or mobile grounding system using at least 2/0 wire and connectors approved by their manufacturer for the wire size and the connection type.
   b) Do not connect portable, protective ground mats directly to the station ground grid.
6) The trailer should also be tied to transmission counterpoise or distribution feeder ground using 4/0 wire and connectors approved by their manufacturer for 4/0 wire and the connection type, if possible.

3.3 Appendix A at the end of this document shows a typical installation.

3.4 Temporary Fence

1) Temporary chain-link fencing at least 7 feet high is required if energized mobile equipment is located outside the normal substation fence.
   a) Bond all posts and gates together with 4/0 wire.
   b) Drive ground rods every 20 feet around perimeter and connect to post/gate bond loop.
   c) At least one ground rod should be at the entrance gate.
2) Install "Danger-High Voltage Within-Keep Out" Signs at eye level on:
   a) The center of all gates.
   b) The unhinged side of single gates 1 foot from gate post.
   c) On each side of fence at least every 50 feet.

4. **Typical Grounding When Inside Substation**
   4.1 Connect trailer frame to nearest structure using 4/0 cable and connector. Detail A.
   4.2 Lay protective ground mat on surface and restrain with gravel or use Hastings grounding mat (no gravel required). Detail B.
   4.3 Connect mat to trailer frame a close as possible to braid to establish equal potential zone. Detail C.
   4.4 Connections between switch handle, column, equalizing/ground mat, and station main grounding grid are to be made in such a manner that no fault current will be carried through the equalizing/grounding mat. Detail D.
   4.5 Connect neutral when required. Detail E.



   4.6 Materials Required
      1) Connector compression for #2 copper.
      2) #2 stranded copper wire.
      3) Potential equalizing grid 8" wire mesh 6' by 10' or portable protective ground mat 58'" by 120" Hastings Cat. #6615).
      4) Connector compression.
      5) Connector bolted to flat surface.
      6) Connector compression to pad.
      7) Wire 4/0 copper
      8) Connector bolted cables to cable.

5. **Typical Grounding When Outside Substation**

5.1 Install six ground rods to a depth of 6' and connect to trailer. If the mobile is located just outside the substation fence two ground cables may be routed back into the substation yard and connected to the substation ground at structures as depicted by the dashed lines. The trailer should also be tied to transmission counterpoise or distribution feeder ground if available. Detail A.

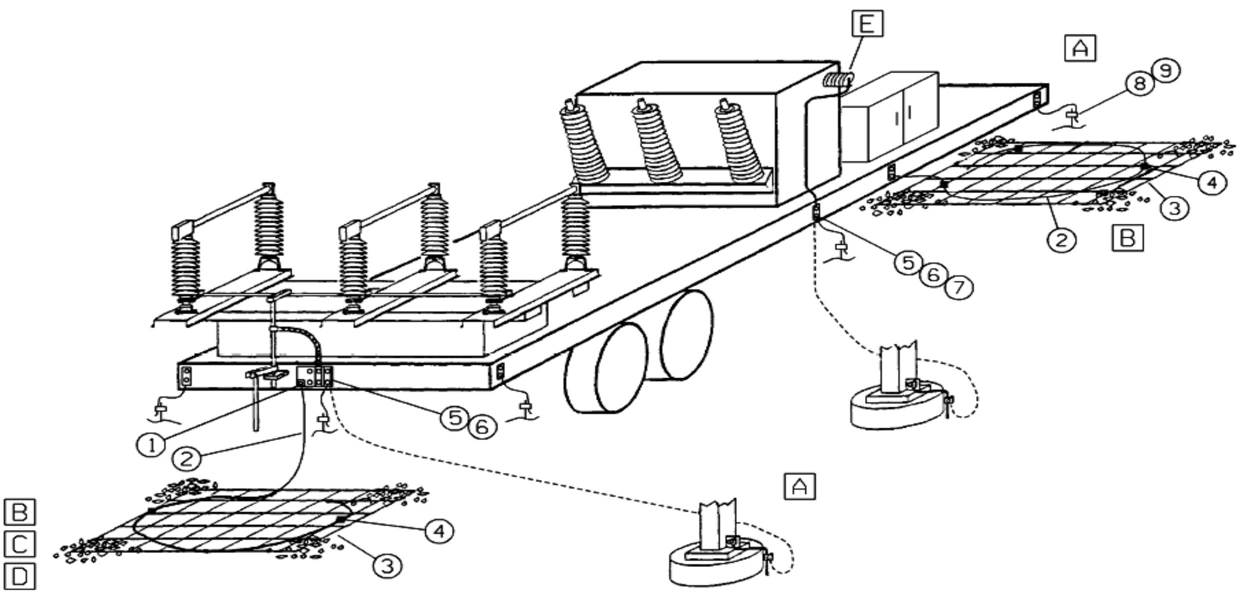
5.2 Lay copper equalizing mat on surface and restrain with gravel or use Hastings grounding mat (no gravel required). Detail B.

5.3 Connect equalizing mat to frame a close as possible to braid to establish equal potential zone. Detail C.

5.4 Connections between switch handle, column, equalizing/ground mat, and station main grounding grid are to be made in such a manner that no fault current will be carried through the equalizing/grounding mat. Detail D.

5.5 Connect neutral when required. Detail E.

5.6 Temporary metal fence must be installed and grounded.



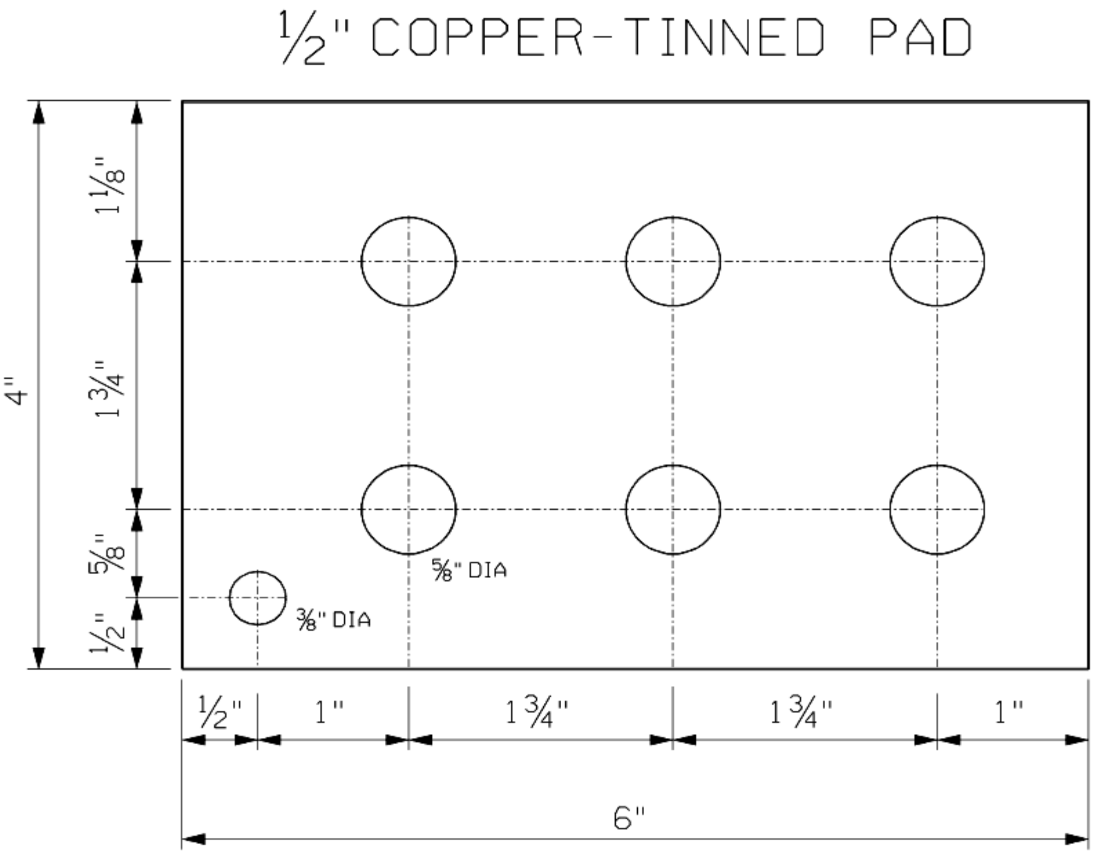
5.7 Materials Required

1) Connector compression for #2 copper – 2 ea.
2) #2 stranded copper wire.
3) Potential equalizing grid 8" wire mesh 6' by 10' or portable protective ground mat 58"' by 120" - Hastings Cat. #6615) – 1 ea.
4) Connector Compression.
5) Connector bolted cable to cable.
6) Connector compression to pad.
7) Wire 4/0 copper.
8) Ground rod.
9) Connector 20-07-823 bolted cable to ground rod.

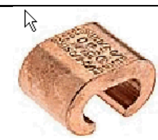
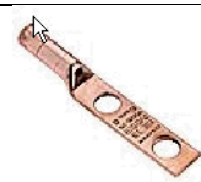
6. **Ground Pad Detail**

   Ground pad detail for local fabrication, if required.

   Ground Pad bolts to 2-hole welded pad on trailer frame to allow more ground connections.



7. Typical Materials

Inside	Outside	Stores Item #		
1	1	2007728	Anderson VHCS Burndy YA2C	
2	2	4015032		#2 stranded copper wire
3	3	3503039		Ground Mat
4	4	3507128	Burndy YC2C4TN Homac CC24TN	
7	5	5962562	Anderson LC4025 Burndy UC4W28	
5	6	3506453	Burndy YCA28-2N Homac HDC4-ON	
6	7	4035019		4/0 bare copper cable
	8	3503013	Ground Rod 5/8 CU	
	9	3503390	Burndy GAR6429 Blackburn GUV5825 (2 per ground rod)	
		483450	Danger High Voltage Within Sign	

8. Record of Revisions

Revision	Changes
05/23/2007	New Procedure
01/31/2008	Grounding When Inside Substation Changed – Ground mat to trailer wire size from 2/0 to #2
06/23/2008	Grounding when Outside Substation Changed – ground mat to trailer wire size from 2/0 to #2

INTRODUCTION

This procedure covers the requirements for the identification of underground (UG) power circuits at National Grid USA owned and operated substations.

PURPOSE

The purpose of this procedure is to define the process for contacting district personnel to assist in the effort to identify or verify UG power circuits in Substations and may be applicable for other UG facilities such as control circuits, telephone circuits, or gas lines. The assistance may be providing access to local documents, drawings, or sketches used to record installed facilities, to provide escort services to contracted agencies as required, or to assist in the marking or staking of UG facilities for project or emergency requirements in order to prevent inadvertent operation or damage to substation equipment from work activities in proximity of underground power circuits, control circuits, telephone circuits, or gas lines.

ACCOUNTABILITY

This procedure will apply to all National Grid personnel and National Grid contracted personnel that are required to evaluate, located, and mark substation underground power circuits, control circuits, telephone circuits, or gas lines.

COORDINATION

Coordination may be required between one or more of the following departments: Substation Engineering, Telcom Engineering, Gas Engineering, Substation Performance Supervisor, and Damage Prevention personnel.

REFERENCES

National Grid Employee Safety Handbook

DEFINITIONS

Not Applicable

TRAINING

Not Applicable

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1.0 UG LOCATING FOR SUBSTATION PROJECTS

1.1 If the substation drawings do not show the routing of underground power circuits operating at voltages greater than 600V (herein referred to as underground power circuits and the work foreseen under the project is expected to be in the vicinity of the underground power circuits, an investigation shall be made to document the existence and location of the underground power circuits during the preliminary engineering phase of the project. This investigation shall focus on the project work area and where feasible cover the area within the substation fence and extend to five feet beyond the substation fence perimeter.

1.2 To facilitate the investigation, the Substation Engineer assigned to the project will send two sets of full size substation conduit plan drawings to the designated District personnel with project work areas identified.

1.2.1 At least four weeks turnaround time shall be given for review by the District personnel.

1.2.2 The review to be undertaken by District personnel shall include comparison of District records to the plans.

1.2.3 District personnel shall place special emphasis on locating the underground power circuits in the project work area and **ALL** underground distribution feeder getaways within the substation fence.

1.2.4 Any missing or incorrect information on the conduit plans shall be marked up to scale and returned to the project substation engineer.

a. Red shall be used for additions and green for deletions.

b. All field notes shall be in a color other than red or green.

1.2.5 District Personnel shall note the drawing number and title of their record drawing used to mark the underground power cable location on the conduit plan for future reference.

1.2.6 If the conduit plans are accurate, the District Personnel shall confirm the same to the Project Substation Engineer via email for documentation.

1.3 If the District has no underground power cable records for the substation or the investigating personnel feel the information is not complete or may be inaccurate, a field investigation shall be performed by the District personnel.

1.3.1 This investigation shall include the use of electronic equipment designed to verify the existence of underground facilities.

1.3.2 All findings are to be recorded on both sets of plans supplied to the District.

a. One set shall be returned to the Substation Engineer.

b. The second set of plans shall be maintained in District files.

1.3.3 If the conduit plans are accurate, the District personnel shall confirm the same to the Project Substation Engineer via email for documentation.

1.3.4 District may have their drawing references noted on the substation conduit plan drawings.

a. To do this the drawing number & title shall be marked up on the returned conduit plan drawings.

1.3.5 If local conduit plans are deemed accurate but electronic methods fail to locate underground power circuits, test holes may be required to locate the exact location. Follow the Employee Safety Handbook, Electrical Safety-Related Work Practices, section 1.15.10.

2.0 DRAWING UPDATES – PRE CONSTRUCTION

Once the District personnel complete the review and return of the plan drawings to the Substation Engineer actions shall be taken as follows:

2.1 It shall be the responsibility of Substation Engineering to update all documents reviewed and returned by District with comments.

2.1.1 This shall be done electronically with the information obtained by the investigation.

a. This will insure Substation Engineering maintains the most up to date drawings available.

2.1.2 These updated drawings will be issued as part of the primary drawing package for the project. If civil foundation drawings are issued in advance, these updated drawings shall be included as part of the sub-surface electrical drawings accompanying the civil drawing package.

3.0 FIELD RESPONSIBILITIES DURING CONSTRUCTION

3.1 It is the responsibility of National Grid construction personnel and/or Contractors to have all sites inspected by Dig Safe and perform a risk assessment for underground hazards.

3.1.1 This is to ensure actions are in accordance with other corporate standards and local regulations.

3.2 Upon completion of construction at any location or when making changes actions shall be taken as follows:

3.2.1 It is the responsibility of the parties involved, whether it is construction or District personnel, to furnish accurate field changes promptly to Substation Engineering.

a. This will facilitate updates of drawing records to reflect actual ‘As Built’ conditions.

4.0 EMERGENCY INVESTIGATIONS

4.1 For substation emergencies that require immediate identification of underground power circuits or control circuits:

4.1.1 Contact District personnel for coordination of the locating and marking requirements based on local agreements.

4.1.2 Local District records shall be reviewed and used by local District personnel or provided to Dig Safe or Damage Prevention personnel for use in underground facilities investigations and marking requirements.

4.1.3 If local conduit plans are deemed accurate but electronic methods fail to locate underground power circuits, test holes may be required to locate the exact location. Follow the Employee Safety Handbook, Electrical Safety-Related Work Practices, section 1.15.10.

4.1.4 Changes to local District records or drawings shall be marked and forwarded to Substation Engineering by the person making the changes.

a. Any missing or incorrect information on the conduit plans shall be marked up to scale.

b. Red shall be used for additions and green for deletions. All field notes shall be in a color other than red or green.

4.2 Substation Engineering to update all documents returned by District. This will insure Substation Engineering maintains the most up to date drawings available.

5.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	02/28/11	Initial version of document.

INTRODUCTION

This procedure details the requirements for fall protection that shall be used when employees are working four feet or more above a lower level in electrical substations.

PURPOSE

Fall protection is required by National Grid USA Safety Rules to protect employees from possible injury, or death, and by state and federal regulations.

This procedure is designed to ensure employees are trained and knowledgeable in fall protection in accordance with National Grid USA Safety Rules and OSHA regulations and to recognize fall hazards associated with substation work activities.

ACCOUNTABILITY

Substation and other Supervisors supervising inspection and maintenance activities.

Substation and other Workers performing inspection and maintenance activities.

COORDINATION

Not Applicable

REFERENCES

National Grid USA Safety Handbook

Code of Federal Regulations 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution; Electric Protective Equipment.

Code of Federal Regulations 29 CFR 1926.500 Subpart M – Fall Protection

29 CFR 1926.104

Manufacturer's Operating and Maintenance manuals for the specific fall protection equipment to be used.

DEFINITIONS

Attachment Point -	A secure point to fasten lifelines, lanyards, or deceleration devices on a harness or climbing belt
Anchorage Point -	A secure point of attachment for lifelines, lanyards, or deceleration devices
Climbing Belt (Safety Strap) -	A belt with two D Rings designed to secure the employee about the waist. Climbing belts are not acceptable or to be used as part of a personal fall arrest system. Single D Ring climbing belts are not allowed.
Body Harness -	Straps which may be secured about the employee in a manner that will distribute the fall arrest forces over at least the thighs,

	pelvis, waist, chest, and shoulders with means for attaching it to other components of a personal fall arrest system.
Body Harness H Type -	Full body harness with adjustable nylon web chest strap.
Body Harness - X Type -	Full body harness with crossing nylon web straps.
Buckle -	Any device for holding the climbing belt or body harness closed around the employee's body.
Cable Grab -	A deceleration device which travels on a 3/8" cable with the user while ascending or descending that will lock onto the cable preventing the user from falling more than one foot.
Climbing Belt -	A positioning device equipped with two D-rings designed to secure the employee about the waist in an elevated working position.
Controlled access zone (CAZ) -	An area in which certain work (e.g., overhand bricklaying) may take place without the use of guardrail systems, personal fall arrest systems, or safety net systems and access to the zone is controlled.
Deceleration device -	Any mechanism, such as a rope grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines/lanyards, etc., which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.
Deceleration distance -	The additional vertical distance a falling employee travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which the deceleration device begins to operate. It is measured as the distance between the location of an employee's body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the deceleration device during a fall, and the location of that attachment point after the employee comes to a full stop.
Designated Area -	A space which has a perimeter barrier erected to warn employees when they approach an unprotected side or edge, and serves also to designate an area where work may be performed without additional fall protection.
Drop Line -	A vertical line used for rope grab fall arrest applications.
Fall Arrest System -	A personal fall arrest system is a system used to arrest an employee in a fall from an elevated position. It consists of an anchorage points, connectors, or full body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these. As of January 1, 1998, the use of a climbing belt for fall arrest is prohibited.
Fall Hazard -	The act or circumstances that could result in the possibility of slipping or tripping on, or falling off a surface.

Fall Protection -	Fall arrest equipment, work positioning, or travel restricting equipment used by employees working at elevated locations more than four (4) feet above the ground or above a lower level.
Fall Restraint -	Travel restricting equipment designed and used to prevent the worker from reaching an area where a free fall could occur.
Fixed Ladder -	A ladder, including individual rung ladders, that are permanently attached to a structure, building, or equipment. It does not include manhole steps.
Free fall distance -	The distance from the beginning of the fall to when some type of device begins to arrest the fall. Free fall must not exceed six (6) feet.
Guardrail system -	A vertical barrier, normally consisting of, but not limited to, an assembly of top rails, mid rails, and posts, erected to prevent employees from falling to lower levels
Handrail -	A rail used to provide employees a handhold for support.
Hole -	An opening more than two inches (5.1 cm) in its least dimension in a floor, roof, or other walking/working surface.
Ladder -	A device typically used to gain access to a different elevation consisting of two or more structural members crossed by rungs, steps, or cleats.
Ladder cage -	A barrier surrounding or nearly surrounding the climbing area of a ladder. It fastens to the ladder's side rails, to one side rail, or to other structures.
Lanyard -	A flexible line of rope, wire rope, or strap which generally has a connector at each end for connecting a synthetic strap or full body harness to a deceleration device, lifeline, or anchorage.
Leading edge -	The edge of a floor, roof, or formwork for a floor or other walking/working surface (such as the deck) which changes location as additional floor, roof, decking, or formwork sections are placed, formed, or constructed. A leading edge is considered to be an "unprotected side and edge" during periods when it is not actively and continuously under construction.
Lifeline -	A component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.
Lower level -	Those areas to which an employee could fall. Such areas include ground levels, floors, roofs, ramps, runways, excavations, pits, tanks, materials, water, equipment, and similar surfaces.

Manhole -	An access through which an employee gains entry to a work area or to equipment below a surface or behind a vertical partition such as a vessel wall.
Manhole steps -	A series of steps individually attached or set into the walls of a manhole structure. They are not considered to be an individual rung ladder.
Man way -	An opening through which employee can access vessels and equipment.
Mid rail -	The rail located approximately midway between the top rail and the toe board or work surface of a guardrail system.
Mobile elevating work platform -	A portable platform that can be elevated and moved about on wheels or casters
Mobile scaffold -	A portable caster or wheel-mounted supported scaffold. It may also be referred to as a mobile work platform
Overall Fall Distance -	Free Fall Distance and Deceleration Distance must be combined to determine overall fall distance.
Platform -	A work surface elevated above the surrounding work area
Platform Unit -	The individual wood planks, fabricated planks, fabricated decks, and fabricated platforms such as ladder- type and light metal-type, which comprise the platforms and walkways of a scaffold.
Portable ladder -	A ladder that can readily be moved or carried, usually consisting of side rails joined at intervals by steps, rungs, cleats, or rear braces.
Positioning Device -	A climbing belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning.
Qualified person -	A person designated by the employer who is knowledgeable about and familiar with all relevant manufacturers' specifications and recommendations; is capable of identifying existing or potential hazards in specific surroundings or working conditions which may be hazardous or dangerous to employees; and has been trained for the specific task assigned. When work is to be supervised by a qualified person, the qualified person shall have the necessary authority to carry out the assigned work responsibilities.
Qualified climber -	An employee who, by virtue of physical capabilities, training, work experience and job assignment, is authorized by the employer to routinely climb fixed ladders, step bolts or similar climbing devices attached to structures.
Refresher Training -	Annual Fall Protection refresher training is required if a specific fall protection system has not been used within the last 12 months by the employee. Refresher training on the specific equipment shall

be conducted prior to the use of the fall protection system. Refresher training can be accomplished through a video program, AET, or On-The-Job Training.

Rope Grab - A deceleration device which travels on a drop line (vertical lifeline) and automatically, by friction, engages the lifeline and locks so as to arrest the fall of an employee. A rope grab usually employs the principle of inertial locking, cam/level locking, or both.

Safety Strap - A strap used in conjunction with the climbing belt with a minimum width of 1 5/8 inch.

Safety Monitor - A competent person responsible for recognizing and warning employees of fall hazards.

Safety net - A non-rigid barrier supported in such a manner as to catch employees who have fallen off a work surface and bring them to a stop before contacting surfaces or structures below the net which might otherwise injure them.

Scaffold - Any temporary elevated or suspended platform, and its supporting structure, used for supporting employees or materials or both, except this term does not include crane or derrick suspended personnel platforms.

Self-retracting lifeline/lanyard - A deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under slight tension during normal employee movement, and which, after onset of a fall, automatically locks the drum and arrests the fall.

Shock Absorbing Packs (Lanyard) - The outer portion of the shock-absorbing pack should be examined for burn holes and tears. Stitching on areas where the pack is sewn to the D-ring, belt or lanyard should be examined for loose strands, rips and deterioration.

Snap hook - A connector comprised of a hook-shaped member with a normally closed keeper, or similar arrangement, which may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object.

Snap hooks are generally one of two types:

The locking type with a self-closing, self-locking keeper which remains closed and locked until unlocked and pressed open for connection or disconnection; or

The non-locking type with a self-closing keeper which remains closed until pressed open for connection or disconnection. As of January 1, 1998, the use of a non-locking snap hook as part of personal fall arrest systems and positioning device systems is prohibited.

Step bolt -	A bolt or rung attached at intervals along a structural member and used for foot placement during climbing or standing. Step bolts may also be called "pole steps."
Step ladder -	A self-supporting portable ladder, non- adjustable in length, with flat steps and a hinged back.
Substation Structure -	An assembly of steel/wood poles or fabricated steel designed and constructed to support substation electrical components, conductors, and hardware.
Toe board -	A low protective barrier placed to prevent the fall of materials to a lower level, or when used without a guardrail, to prevent an employee's feet from slipping over the edge of a surface.
Unprotected sides and edges -	Any side or edge of a surface, except at entrances to points of access, where there is no wall or guardrail system.
Wall Opening -	An opening at least 30 inches high and 18 inches wide, in any wall or partition, through which persons may fall.
Walking and working surface -	Any surface, within the scope of this standard, on which employees perform or gain access to their job duties or upon which employees are required or allowed to walk or work while performing assigned tasks.
Work Positioning -	A work method used with equipment designed to position the user at an elevated work site in order that he/she may have free use of both hands not intended to arrest a fall unless also equipped for fall arrest.

TRAINING

Initial training is required for all employees that may perform work in substations that requires fall protection (more than four feet above a lower level).

If in the performance of the annual work, an employee has not used Fall Protection equipment, they must have refresher training before the application and use of fall protection systems.

Refresher training is required if a specific fall protection system has not been used within the last 12 months by the employee. Refresher training on the specific equipment shall be conducted prior to the use.

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1.0 GENERAL INFORMATION

1.1 Fall Protection must be used when fall hazards have been identified in performing substation related work unless deemed infeasible.

1.1.1 Infeasible means that it is impossible to perform the construction work using a conventional fall protection system (i.e., guardrail system, safety net system, or personal fall arrest system) or that it is technologically impossible to use any one of these systems to provide fall protection.

1.1.2 The appropriate management representative and the lead person shall be involved in this determination. The determination shall be documented on the Job Brief form.

1.1.3 The determination shall be documented by the appropriate management representative using the Hazardous Condition reporting process and shall be communicated to all Substation Managers, Substation Construction & Services, and Substation O&M Services.

2.0 SAFETY

2.1 The following items shall be adhered to:

2.1.1 Conduct Job Brief and identify fall hazards

2.1.2 Follow all applicable Safety Handbook sections and rules

2.1.3 Wear all required Personnel Protective Equipment

2.1.4 Electrical apparatus and circuits shall be electrically isolated, tagged, and grounded when required.

2.1.5 Personal harnesses and fall protection systems shall be inspected prior to each use for wear damage and other deterioration.

a. Defective components must be removed from service.

b. Fall Arrest systems shall not be modified in any way.

c. Only approved Fall Arrest systems shall be used.

2.1.6 Fall arrest systems or their components shall not violate minimum approach distances during installation, removal, or utilization.

2.1.7 The use of bushings, insulators, arresters, or any other porcelain or polymer products for work positioning or fall arrest anchor points is not allowed.

3.0 FALL HAZARDS IN A SUBSTATION

3.1 Fall protection or fall arrest systems shall be utilized by employees working in substations:

3.1.1 When working in an elevated position more than four feet above the ground or a lower level.

3.1.2 While working on a walking/working surface with an unprotected edge which is four feet or more above a lower level.

3.2 Fall protection may by accomplished by the use of a guardrail system, a fall restraint system, or fall arrest system.

4.0 FALL PROTECTION MATERIALS AND EQUIPMENT

4.1 Only approved materials, equipment, and systems, including anchorage connectors, shall be used in fall protection applications.

4.1.1 These can be found in the Distribution Engineering Services Web Page for Approved Tool and Equipment Catalog.

a. Infonetus - Engineering an Asset Management - Distribution Engineering Services -Tools Catalog

4.1.2 Only approved fall protection equipment shall be used and shall not be modified.

5.0 EXCEPTION APPROVALS

5.1 Any exceptions to or deviations from this procedure will require the approval of the Manager of the Substation Department involved or their designees.

6.0 SELECTING FALL PROTECTION EQUIPMENT

6.1 A full body harness provides the greatest protection during a fall.

6.2 Climbing belts are not acceptable or to be used as part of a personal fall arrest system.

6.3 Acceptable systems to arrest an employee in a fall form a working level include a full body harness with suitable combinations of:

a) Anchorage points	b) Drop Line
c) Connector	d) Deceleration Device
e) Lanyard	f) Rope Grab
g) Life Line	h) Retractable Life Line

7.0 STORING FALL PROTECTION EQUIPMENT

7.1 Store harness and other fall protection equipment in a clean dry area away from direct sunlight and allow to air dry if exposed to water.

8.0 INSPECTIING FALL PROTECTION EQUIPMENT

8.1 All fall protection equipment shall be inspected prior to each use.

8.1.1 A fall protection harness must be properly selected, fitted and adjusted for the specific user.

a. The preferred attachment point when using fall arrest systems with a harness shall be the rear centered attachment point.

8.1.2 Webbing and Straps, including Shock Absorbing Lanyards, shall be inspected for:

a) Cuts	b) Chemicals
c) Kinks	d) Distortion
e) Abrasions	f) Excessive Wear
g) Burns	h) Loose, cut, missing stitching

8.2 Buckles, D-Rings, Snap Hooks and Other Hardware Shock Absorbing Lanyards

8.2.1 Cracks

8.2.2 Corroded or nicked areas

8.2.3 Distortion

8.3 Snap Hooks

8.3.1 Snap Hooks shall be the locking type with a self-closing, self-locking keeper which remains closed and locked until unlocked and pressed open for connection or disconnection.

8.3.2 Never attach a lanyard back to itself unless specifically allowed by the manufacturer.

8.3.3 Snap Hooks may not be attached to each other.

8.3.4 Never attach multiple lanyards together.

8.4 Self Retracting Lanyards shall be inspected for:

8.4.1 Proper operation of the locking mechanism.

8.4.2 Physical damage.

8.4.3 Condition of lanyard and attaching devices

8.5 Anchorage Points

8.5.1 When used as part of a fall arrest system, the anchorage point must be capable to withstand a force of 5000 pounds per attached employee and must be independent of any anchorage used to support or suspend platforms.

a. See recommended attachment / anchorage points in Appendix C.

8.5.2 Climbing on bushings or insulators or their use as an anchor point for a fall arrest system is not permitted.

8.5.3 The use of bushings on transformers for work positioning is not allowed.

9.0 EQUIPMENT DAMAGED OR HAS EXPERIENCED AN ARREST

9.1 Any fall protection equipment that has arrested a fall or sustained damage shall be removed from service and tagged “Defective - Do Not Use” and nature of defect indicated on the DNU Tag.

9.2 Fall protection equipment shall only be repaired by the original manufacturer or a vendor approved by the National Grid USA.

9.3 Fall protection equipment may be returned to service after recertification by the original manufacturer or facility approved by original manufacturer.

10.0 FALL PROTECTION METHODS

10.1 Fall Restraint

10.1.1 Designed to prevent the employee from moving into the fall hazard area

10.1.2 Typical methods used for fall restraint is the lifting eye of a bushing or the grounded portion of the bushing flange or bushing well or the installation of an approved eye bolt to a manhole cover.

10.2 Work Positioning (Climbing Belt)

10.2.1 Designed to prevent the employee form falling no more than two (2) feet

10.2.2 Typical methods used for work positioning is the use of a climbing belt with safety strap.

10.2.3 Work positioning may be used on a properly secured extension ladder, substation structure, or poles.

10.3 Guard Rail Systems

10.3.1 Electrical apparatus with prefabricated rail systems may be used in lieu of other fall arrest systems.

a. Employees shall use fall restraint or fall arrest until the guard rail system is installed.

10.3.2 Guard rail requirements:

a. Top rails shall be 42 inches above the walking/working surface.

b. Mid rails shall be 21 inches above the walking/working surface.

c. Top and mid rails shall be at least ¼ inch nominal diameter.

d. Wire ropes for top rails must be flagged at no more than 6 foot intervals with high visibility material.

e. Steel or plastic banding shall not be used.

f. Chain and rope with 200 pound normal deflection are acceptable.

10.4 Scaffolding

10.4.1 Follow appropriate section in the Safety Handbook when using scaffolding to perform work in substations.

10.4.2 Guardrails shall be installed at all working levels or fall arrest systems shall be implemented, if a fall hazard exists.

10.5 Safety Lines (Vertical or Horizontal)

10.5.1 Safety lines shall be approved for this specific use.

10.5.2 Follow all recommended manufacturer's installation instructions.

10.5.3 Safety lines shall be secured above the point of operation to an anchorage or structural member per manufacturer's instructions. Refer to Appendix C of this procedure for typical anchorage points.

10.5.4 Only one person shall be attached to the safety line.

10.6 Controlled Access Zones

10.6.1 The following shall be followed:

a. Access Control – When used to control access to areas where leading edge and other operations are taking place, the controlled access zone shall be defined by the control line or by an other means that restricts access.

b. Control Lines – When control lines are used, they shall be erected not less than six (6) feet nor more than twenty five (25) feet from the unprotected or leading edge, except when erecting precast concrete members.

c. Area Accessibility – Only employees engaged in leading edge, overhand bricklaying, precast concrete erection or related work shall be permitted in the controlled access zone.

10.7 Personal Fall Arrest Systems

10.7.1 When personal fall arrest systems are utilized, systems shall be rigged such that an employee can not free fall more than six (6) feet nor contact any lower level.

10.7.2 Portable Fall Arrest Poles

a. Manufactured devices used to secure employees when working in an elevated position above four feet, (i.e. of transformers, switches, circuit breakers).

10.7.3 Hook Device (Buck Hook)

a. A device to be secured to a steel or aluminum structure above a transformer or circuit breaker. Used in conjunction with a self-retracting lanyard (preferred) or with a shock absorbing lanyard.

b. The hook can be installed using a Live Line Tool. The hook and other fall arrest components shall not violate minimum approach distances of any live conductors.

10.7.4 Self Retracting System

a. The preferred method for attachment of the Self Retracting System is to anchor the device at shoulder level or above.

b. When used for fall protection Eye Bolts or lifting eyes on the cover of a transformer or lifting eyes of bushings may serve as an anchorage point for a fall protection system until the fall arrest system is installed. The retracting assembly of the self-retracting lanyard is attached to the eyebolt or lifting eyes while the other end is attached to the harness. All self-retracting systems must meet ANSI standard Z359.1.

10.8 Eye Bolt / Lifting Eyes

10.8.1 All of these may serve as an anchorage point for fall restraint or until fall arrest systems are installed.

10.8.2 Only approved eye bolts or manufactured devices specifically designed for fall protection shall be used for an anchorage point.

10.9 Manufactured Devices

10.9.1 Only approved manufactured devices specifically designed for fall protection shall be installed for use as part of a fall protection system.

a. Approved devices such as eye bolts, flange, or step bolts shall be installed to provide a suitable anchorage point.

10.10 Portable Mounting Base

10.10.1 Designed to be mounted on a manhole cover for the installation of the portable fall arrest pole assembly.

a. This system is composed of slotted leg extensions mounted to the standard mounting plate for use with the portable fall arrest pole. The movable leg extensions are secured on transformer manhole covers by the use of four (4) manhole cover bolts.

b. This system is normally used with older transformers that do not have permanently installed mounting plates or guard rail systems.

10.11 Safety Nets

10.11.1 Safety nets are not used at National Grid substation applications.

11.0 TRANSFORMERS

The following work methods are approved for working on transformers.

11.1 Properly secured ladders.

11.1.1 See following section on ladders.

11.2 Aerial Lifts, Bucket Trucks

11.2.1 See following section on aerial lifts.

11.3 Uni-Hoist

11.3.1 Consists of a mast assembly, an extension mast for the winch assembly, and an extension mast for extending the anchor point.

11.3.2 May be mounted on a portable mounting base or the welded-on base plate.

11.4 Carbon Mast Tower

11.4.1 Designed for use on transformers and other electrical equipment or structures.

11.4.2 May be mounted on permanently installed base plate assemblies or portable mounting base assemblies.

11.4.3 Features independent swivel anchor points for up to three employees with self retractable lanyards

11.5 New power transformers purchased by National Grid are specified to have a mounting plate welded to the top of the transformer.

11.5.1 A mounting plate may also be welded on transformers that were not originally equipped with the standard mounting plates.

a. If the transformer is not equipped with mounting plate a portable mounting base may be utilized.

11.6 The use of bushings, insulators, arresters, or any other porcelain or polymer products for work positioning or fall arrest anchor points is not allowed.

11.6.1 Exception: The lifting eye of a bushing or the grounded portion of the bushing flange or bushing well or the installation of an eye bolt to a manhole cover.

12.0 CIRCUIT BREAKERS

The following work methods are approved for working on circuit breakers.

12.1 Properly secured ladders

12.1.1 See following section on ladders.

12.2 Aerial Lifts, Bucket Trucks

12.2.1 See following section on aerial lifts.

12.3 Adjustable Circuit Breaker Fall Protection Tower

12.3.1 Preferred fall protection system when working on top of typical transmission oil circuit breakers.

12.3.2 Mounts on a portable base plate that is installed on the circuit breaker main support beam or a mounting plate permanently anchored to the circuit breaker foundation.

12.3.3 Uses a retractable lanyard to the tower anchor ring

12.3.4 A second portable fall arrest tower may need to be installed when working on top of multiple phase tanks.

12.3.5 Employees must be attached to a fall arrest system at all times when working on, or traversing the top of the circuit breaker from one work position to another.

12.4 Horizontal life line with structure to structure attachment points

12.5 The use of bushings on circuit breakers for work positioning or fall arrest is not allowed.

13.0 SUBSTATION STRUCTURES

13.1 Free climbing a substation structure is not allowed. The following work methods are approved for climbing substation structures.

13.2 Vertical life line

13.3 Dual Climbing Lanyards

13.4 Buck Hook or Sheppard's Hook

13.5 Substation structures may be used as an anchorage point for a personal fall arrest system.

13.5.1 Several hook devices are available that can be secured to substation structure above a transformer, circuit breaker or other substation apparatus.

a. Hook devices may be installed using a Live Line Tool. The hook and other fall arrest component shall not violate minimum approach distances of any energized conductors.

b. The hook device must be used in conjunction with a self-retracting lanyard.

13.5.2 Refer to appendix C for anchorage points on substation structures.

14.0 LADDERS

14.1 Work may be performed from ladders.

14.2 Only non-conductive company approved ladders shall be used.

14.3 Use the appropriate length ladder to reach your work when standing no higher than the third rung from the top of the ladder or the second step from the top of a step ladder.

14.4 Extension or straight ladders will extend a minimum of three (3) feet above the landing surface unless doing so will violate minimum approach distances.

14.5 A ladder is considered secured for the purposes of belting off when the following conditions are satisfied, but not limited to:

14.5.1 Ladders is tied off at the top or bottom, or help by another;

or

14.5.2 Proper 4:1 pitch used and the ladder's base is level, with non-skid feet/shoes appropriately placed on solid ground/surface;

or

14.5.3 Ladder spur feet are dug into mud, snow or ice;

or

14.5.4 The ladder base is supported by a fixed barrier (i.e. curb or structure).

14.6 Working from ladders does not require the use of a fall arrest system.

14.7 When using a properly secured extension ladder, an employee that is belted in with a safety strap may step off the extension ladder to attach a fall restraint or fall arrest system.

14.7.1 The safety strap shall encompass a ladder rung and one side rail at a minimum. If additional stability is desirable, the safety strap may be placed around both side rails if it is also placed around a rung to prevent falling.

14.7.2 This method of work positioning shall prevent the worker from a fall to no more than two (2) feet.

14.8 Portable ladders used to access to an upper landing surface must extend a minimum of three (3) feet above the landing surface, or where not practical, be provided with grab rails and be secured against movement while in use.

14.9 When performing work from a straight or extension ladder, the worker shall assume a position no higher than the fourth rung from the top.

14.10 After an extension ladder has been raised:

14.10.1 Check to make certain that hooks are fully engaged.

14.10.2 Tie the lift rope securely to one or more rungs of lower section.

14.11 When additional stability is desirable, the safety strap may be placed around both side rails if it is also placed around a rung to prevent falling. If work from an extension ladder required the use of two hands to be free, employees shall use a work positioning belt and safety strap properly attached to the secured ladder.

14.12 Step ladders shall be fully open with braces locked before anyone uses them.

14.12.1 Climb on the side of the step ladder designed for climbing.

14.12.2 The worker shall face the ladder when climbing.

14.12.3 Follow the manufacturer’s safety guidelines.

14.12.4 Straddling or sitting on the top of the step ladder is prohibited.

15.0 AERIAL LIFTS

15.1 Follow appropriate sections of the Safety Handbook when using aerial lifts in substations.

15.2 Fall protection (harness/lanyard) is required when using aerial lifts.

15.2.1 Not required when entering or exiting a bucket in the cradled position.

15.3 Employees may exit elevated work platforms to access the work area provided that fall protection such as guardrails or a fall arrest system are used while the worker moves between the lift and the working surface.

15.3.1 Before any such transfer is made, the employee shall be properly tied off to an adequate support, the pole or structure prior to and in the direction of the transfer.

15.4 Aerial lifts must be properly grounded.

15.5 Scissors lifts without an approved permanently affixed attachment point are exempt from wearing harnesses and attachments.

16.0 OTHER WORK AREAS

16.1 Roofs

16.1.1 Work on roofs may be conducted with a safety monitor or the installation of warning lines or a rail systems meeting specific requirements.

a. Top Rail:

Rope, wire, chain, or wood planks shall be installed at a minimum of forty two (42) inches above the working surface (+ 3” allowance) and supported so that the lowest point (sag) is no more than thirty nine (39) inches from the walking/working surface. The support stanchions must be capable of resisting force without tipping over.

Rope, wire, or chain warning lines shall be flagged no more than six (6) foot intervals with high visibility material.

b. Mid Rail:

Required if there is no wall or parapet wall at least twenty one (21) inches high.

16.1.2 When mechanical equipment is not being used, warning lines shall be erected around all sides of the work area not less than six (6) feet from the work edge.

16.1.3 When mechanical equipment is being used, warning lines shall be erected not less than six (6) feet from the roof edge which is parallel to the direction of the mechanical equipment in operation.

17.0 COMMUNICATION TOWERS

17.1 Climbing or working on communication structures or towers shall require the use of fall protection similar to those used on substation structures.

18.0 VAULTS/NETWORKS

18.1 Entering vaults is normally performed by the use of permanently mounted steel ladders and fall protection is not required.

18.2 Follow established confined space / enclosed space entry procedures.

19.0 VEHICLES/TANKERS/MOBILE SUBSTATION EQUIPMENT

19.1 Fall protection is not required when working on top of tanker vehicles.

19.2 Fall protection is not required when working on the bed of a tractor trailer rig to install or remove rigging used in transportation activities.

19.2.1 When it is necessary to perform work activities on top of the load, Fall Protection methods must be used.

19.3 Fall protection shall be used for work activities on top of Mobile Substations.

20.0 PROGRAM ADMINISTRATOR

20.1 Questions and/or clarification regarding this document and proposed changes under the Exception Approval section of this document shall be forwarded to the Manager of Substation Engineering & Maintenance Standards.

21.0 RESPONSIBILITIES

21.1 Substation Engineering & Maintenance Standards

21.1.1 Update this procedure as necessary.

21.2 Management and Supervision

21.2.1 Ensure the components of this procedure are implemented.

21.2.2 Ensure personnel are trained in this procedure.

21.2.3 Ensure approved materials are available.

21.2.4 Provide revision input as necessary.

21.2.5 Ensure that individuals changing jobs are qualified to perform the functions of this procedure.

21.3 Worker

21.3.1 Demonstrate the knowledge and understanding of this procedure and successfully complete initial training requirements.

21.3.2 Comply with the requirements of this procedure.

21.3.3 Unqualified employees, including trainees, are required to use an independent fall arrest system composed of a full body harness at any time they are more than four (4) feet above the ground.

21.4 Technical Training

21.4.1 Develop training lesson plans and training aids.

21.4.2 Support initial or refresher training

22.0 MOUNTING THE SB-SM1 PORTABLE MOUNTING BASE

22.1 Note: in mounting the SB-SM1, no more than two (2) legs shall point in a single direction.

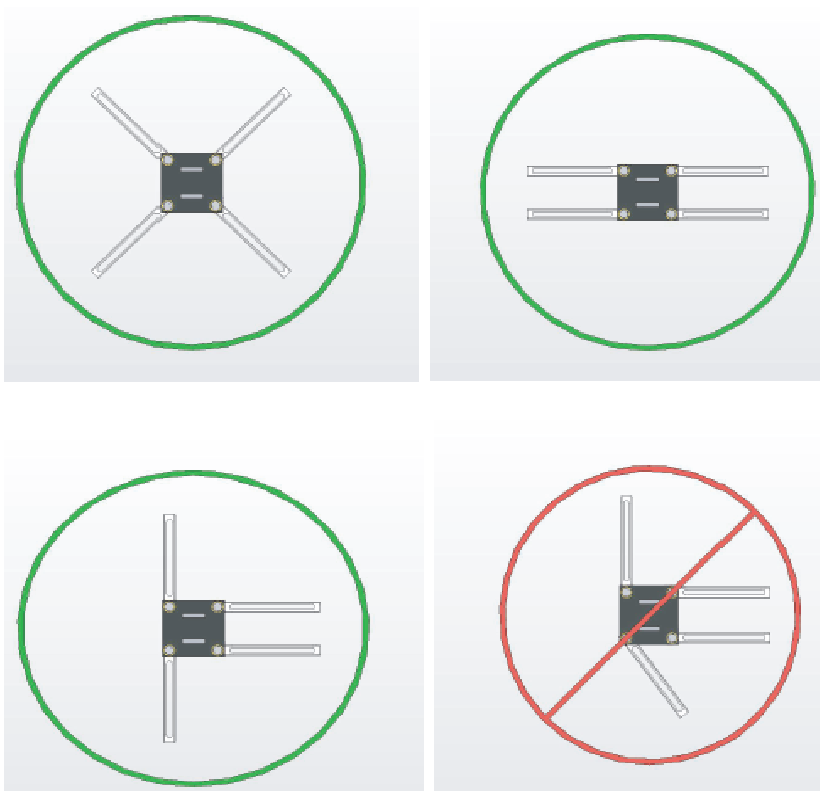
22.2 Lock onto the man way without disturbing the integrity of the seal.

22.3 Should be used on closed Man ways.

22.4 May be used on round or square man ways.

22.5 May be used on man way sizes from sixteen (16) inches to thirty six (36) inches.

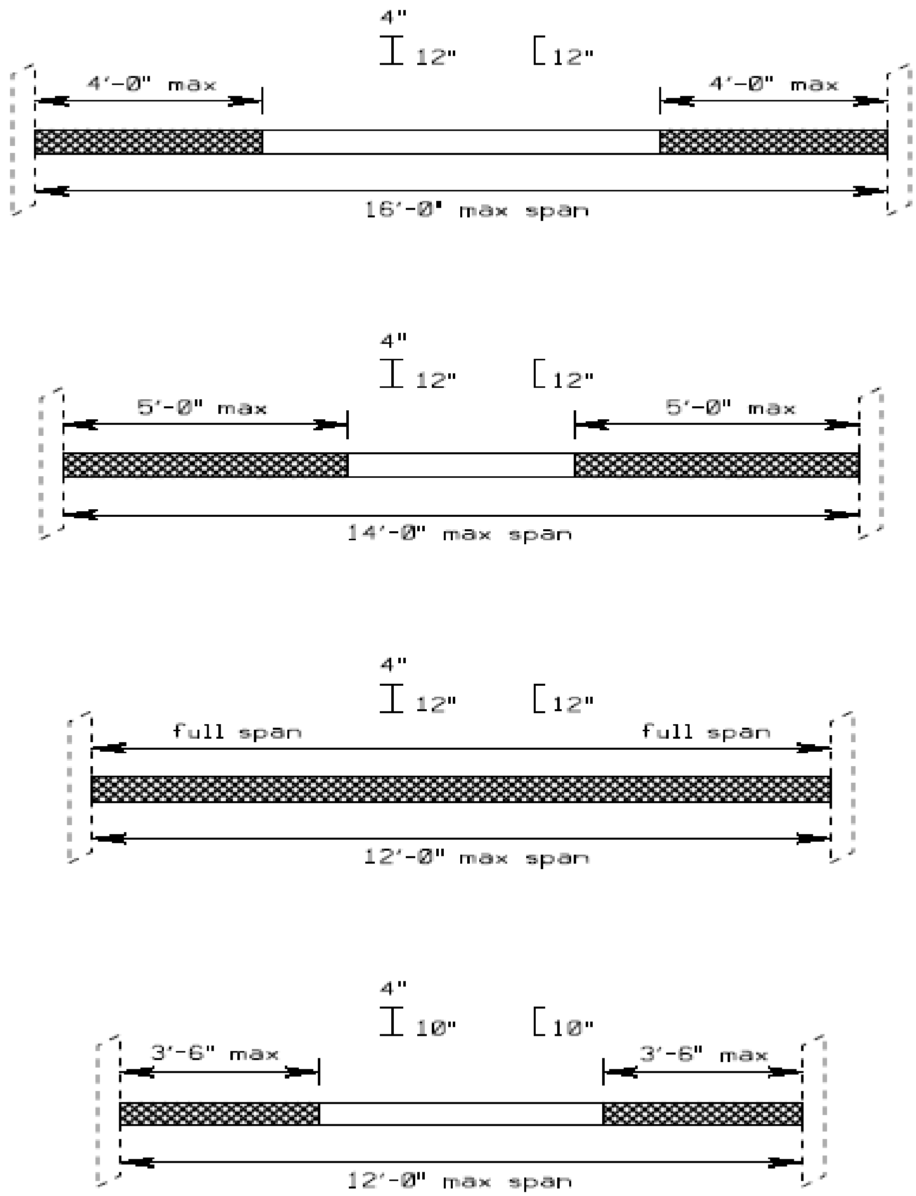
22.6 May be used on a variety of bolt patterns and sizes.



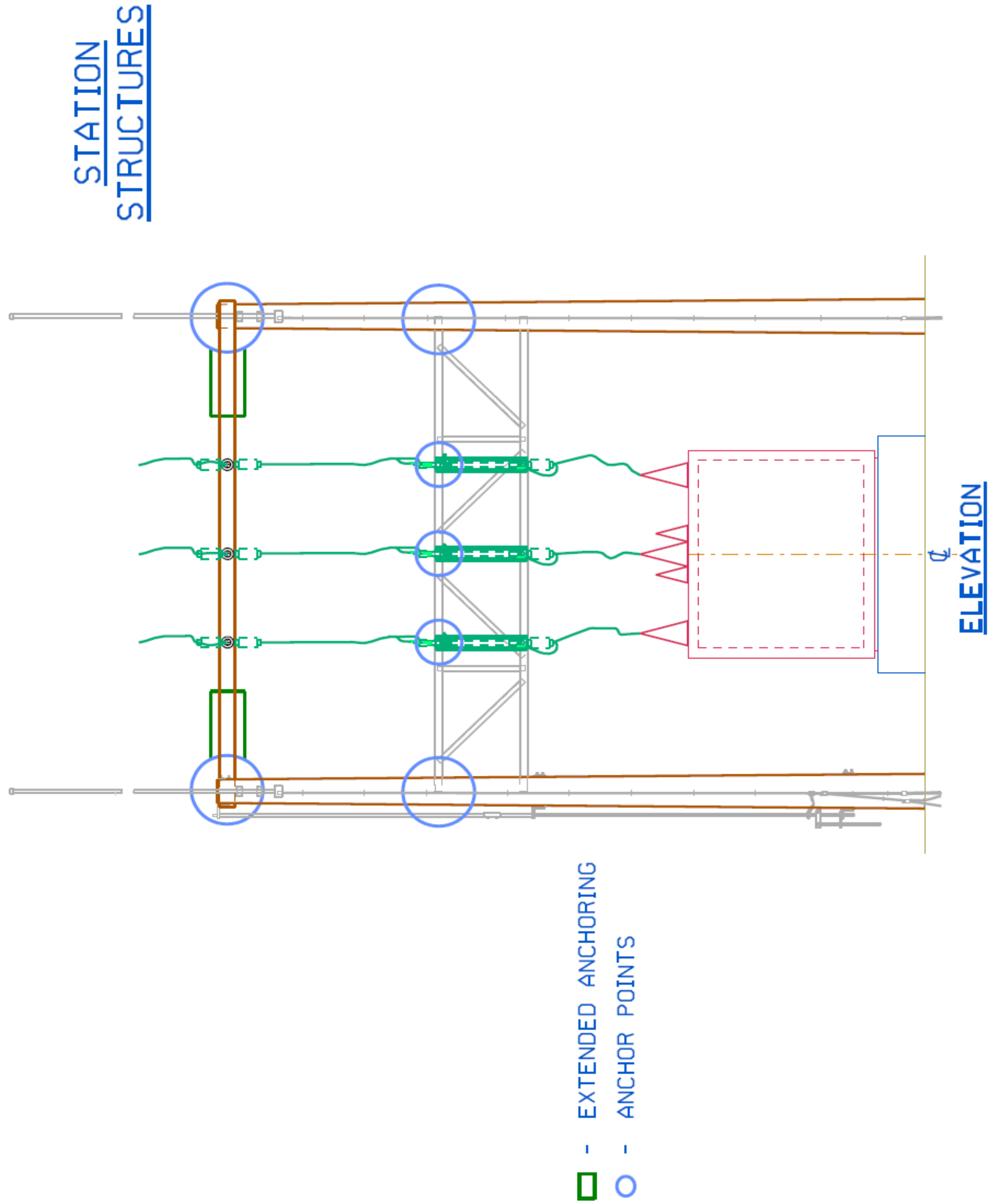
23.0 APPENDIX C - ANCHORAGE POINTS

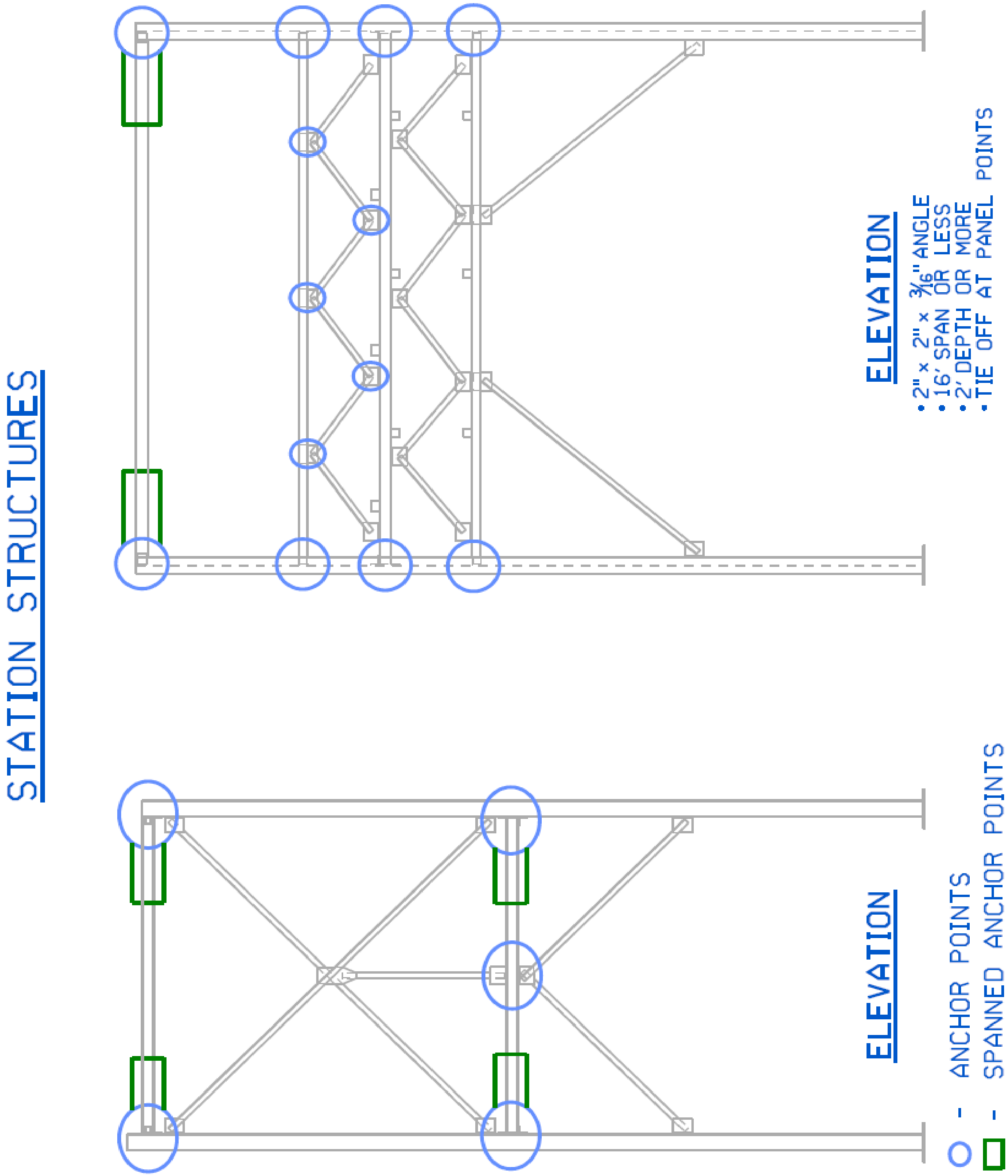
23.1 This section depicts the different anchorage points.

Note: Additional isolation may be required and minimum approach distances must be maintained during installation of Fall Arrest Svstems.



LOCATING ANCHOR POINTS


STATION STRUCTURES
ELEVATION
℄
- EXTENDED ANCHORING
- ANCHOR POINTS


STATION STRUCTURES
ELEVATION
• 2" x 2" x 3/16" ANGLE
• 16' SPAN OR LESS
• 2' DEPTH OR MORE
• TIE OFF AT PANEL POINTS
ELEVATION
- ANCHOR POINTS
- SPANNED ANCHOR POINTS

24.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	06/24/08	Initial version of document.
1.1	09/20/08	Minor revisions throughout based on Core Team comments,
2.0	11/11/09	Converted to new EDO format Minor revisions throughout based on review of L&D training lesson plans

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INTRODUCTION

The following document contains rules pertaining to personal protective equipment (PPE) for substation entry and work requirements. These rules were developed to ensure employee safety and regulatory compliance and to provide some clarification and consistency for the variety of workers and visitors who enter indoor or outdoor substations.

PURPOSE

The purpose of this document will identify the minimum PPE required when entering substations or when performing work activities that expose employees to hazards of electric arcs or flames.

ACCOUNTABILITY

All personnel entering substations or working on or near exposed energized circuits or equipment.

All personnel responsible for implementing the requirements specified in this document.

COORDINATION

Not Applicable

REFERENCES

National Grid Arc Flash Analysis and Mitigation Safety Procedure

National Electrical Safety Code (NESC)

National Fire Protection Association (NFPA) 70E Standard

National Grid Employee Safety Handbook

Occupational Safety and Health Administration (OSHA) 1910.269

SMP 400.14.2 - Substation Security

ASTM F2413 - Foot Protection

ANSI Z87.1 - Safety Glasses

DEFINITIONS

Arc flash hazard -	A dangerous condition associated with the release of thermal energy caused by an electric arc.
Arc rating -	Incident energy on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury, cal/cm^2. Arc ratings are defined as Arc Thermal Performance Values (ATPVs) or Energy Before Breakthrough (EBT) and are expressed in cal/cm^2.

Boundary Distance - The calculated distance in inches that must be observed when working on or near energized lines or equipment to not exceed the 8 cal/cm^2 PPE arc rating. Boundary distance calculated to be less then the minimum approach distance (below MAD), the proper working distance must be observed for the appropriate voltage being worked on.

Designated Work Area - A boundary established through the use of tape barricade, flags, and other approved barriers within a substation to provide physical obstruction and to prevent contact with energized lines or equipment.

Flame Resistant (FR) - The property of a material whereby flaming combustion is prevented, terminated, or inhibited following application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source.

Hazard Risk Category (HRC) - Classification for specifying personal protective equipment. HRC level is determined by the minimum amount of calories per square centimeter (ATPV or cal/cm^2) a treated garment must pass through with a 50% probability of a 2nd or 3rd degree burn occurring, thus the protective level of the treated clothing. The higher the ATPV, the higher the HRC level attained, the greater the protection.

Incident energy - The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is measured in calories per centimeter squared (cal/cm^2).

Personal Protective Equipment - PPE includes hard hat, sturdy work shoe or boot, safety glasses, and other specialized equipment required for tasks where unique hazards have been identified per section 1.31 of the National Grid Employee Safety Handbook.

Qualified Person - A person knowledgeable in the construction and operation of electric power generation, transmission, substation, and/or distribution apparatus involved along with the associated hazards in specific duties pertaining to electric operations.

Switching Ensemble - Includes arc flash coat, bib overall, arc flash hood, Class 2 Rubber Gloves, EH rated safety foot protection.

Visitor - Persons who do not work in substations normally as part of their job.

TRAINING

Initial - New employee orientation and when new FR clothing requirements are introduced.

DOCUMENT CONTENTS

Table of Contents

1.0 GENERAL INFORMATION

1.1 Company approved Flame Resistant (FR) clothing shall be worn when employees control, operate, or work on energized equipment or circuits and when distance and position will expose the employee to electric arc or flame hazards.

1.2 For legacy National Grid (Upstate NY, New England) substations worker, the standard FR clothing shall meet a minimum arc rating of 8 cal/cm² (HRC 2). Additional FR clothing protection (above HRC 2) is required when performing identified tasks at legacy National Grid substations.

1.3 Garments worn as outer layers over FR clothing, such as jackets or rainwear, shall also be made from FR material. Note: These FR garments may be rated less than 8 cal/cm² as long as an 8 cal/cm² garment is worn underneath.

1.4 The standard arc flash rated switching ensemble shall consist of an arc-rated FR coat, bib overall, and hood specifically rated for the work to be performed. Refer to Appendix A and B for Upstate NY and NE substation lists.

1.5 Contractors who may be involved with tasks requiring the implementation of this program shall be informed by National Grid. Contractors will be required to follow all aspects of OSHA and The National Electrical Safety Code (NESC), Rule 410 A3 as it applies to the tasks they perform.

1.6 All persons shall wear the required level of FR clothing when entering a designated work area where work is being performed on or near energized circuits or equipment.

1.7 Supervisors may require the use of additional flash protection if they determine that the task being performed warrants it.

1.8 If the clothing creates additional and greater hazards than the possible exposure to the heat energy of the electric arc, then clothing with an arc rating less than that required can be worn. [NESC 410 (A) (3) Exception 1]

1.8.1 For identified cases at National Grid, agreement and approval is required by concurrence of the manager of the operating department involved, and the Director of Safety (or their designees). If concurrence cannot be achieved among these parties, they will seek concurrence at the next higher level of management. The determination shall be documented on the Job Brief form.

2.0 SUBSTATION VISITORS

2.1 General requirements for Substation Entry

2.1.1 General substation entry by visitors may not require the use of FR clothing.

2.1.2 The following items must be performed prior to entering the substation:

a. Follow SMP 400.14.2 – Substation Security and Section 5.1 Employee Safety Handbook for access to or entering substations.

b. Follow SMP 499.30.2 Substation Personal Protective Equipment.

c. Identify the hazards for entering the substation with the visitor.

d. Perform a hazard assessment identifying if and what level of FR clothing is appropriate for the work being performed during the visit.

e. Record the hazards identified and the requirements discussed and being followed on the job brief.

2.2 Unqualified escorted individuals who require entry to a Substation.

2.2.1 Follow the General Requirements for Substation Entry.

2.2.2 Must be escorted at all times by a qualified person.

2.2.3 Must have on the following minimum PPE to enter a substation yard:

a. Hard Hat.

b. Safety Glasses with side shields.

c. Sturdy work boot or shoe.

2.2.4 Based on the Hazard Assessment, the following additional PPE may be required:

a. Natural Fiber clothing.

b. Appropriate rated FR clothing per SMP 499.30.2.

c. Work shoe that meets ASTM F2413 standard for impact and compression

2.3 National Grid Employees who require entry to a Substation

2.3.1 Follow the General Requirements for Substation Entry.

2.3.2 Hard Hat (section 1.31 Employee Safety hand book).

2.3.3 Safety Glasses with side shields (section 1.31 Employee Safety hand book).

2.3.4 Work shoe that meets ASTM F2413 standard for impact and compression and EH rated (section 1.31 Employee Safety hand book).

2.3.5 Natural Fiber Clothing (Section 2.18.12 Employee Safety Handbook).

2.3.6 Based on the Hazard Assessment, the following additional PPE may be required:

a. FR rated clothing per SMP 499.30.2

3.0 WORKERS WITHIN SUBSTATIONS

3.1 Qualified workers performing substation work activities as part of their routine tasks.

3.2 Employees performing physical work in substation yards are expected to wear the following:

3.2.1 Protective footwear - Work shoe that meets ASTM F2413 standard for impact and compression and EH rated (section 1.31 Employee Safety hand book).

3.2.2 Hard Hat (section 1.31 Employee Safety hand book).

3.2.3 Safety Glasses with side shields (section 1.31 Employee Safety hand book).

3.3 Where exposure exists to the hazards of electric arc flash, Flame Resistant clothing shall be worn.

3.3.1 This clothing shall be in accordance with arc flash analysis.

3.4 Employees shall not wear clothing which will contribute to burn injuries. Only clothing made from natural fibers shall be worn.

3.4.1 Prohibited clothing in substations includes Acetate, Nylon, Rayon, and Polyester.

3.4.2 These fibers such as acetate, nylon, polyester, polypropylene, and spandex are not permitted to be worn. These materials melt as a result of arc flash exposure, form contact with the skin and aggravate the burn injury.

3.4.3 Non-melting, flammable materials (i.e. untreated cotton, wool, or silk, or blends of these materials) are not arc rated. These garments are permitted to be worn but do not contribute to the arc rating of the required FR clothing system.

3.5 All protective footwear shall comply with ASTM F2413 - Foot Protection by having the following:

3.5.1 An impact rating of 75

3.5.2 A compression rating of 75

3.5.3 An electrical hazard (EH) rating

3.6 Appropriate rubber gloves shall be used where required in accordance with section 2 of the National Grid Employee Safety Handbook.

3.7 Fall protection is required where a fall of four feet or more, to or onto a lower level is possible.

3.7.1 Fall protection will be in accordance with SMP 499.20.2 - Fall Protection

3.7.2 Only approved FR rated fall protection harnesses shall be used.

3.8 Substations workers must determine if the substation has been posted with the appropriate signage to ascertain if additional flash protection is required. Substations that have been identified to have incident energy above 8 cal/cm^2 through the arc flash analysis are to be posted with the proper signage. Employees are to ensure proper arc flash rated FR clothing is used at those posted substation locations.

3.9 Personal protective equipment appropriate to the fault energy shall be worn when working, switching, testing energized or de-energized, grounding, or performing other work activities as described in this procedure.

3.10 Flame Resistant clothing is the minimum requirement for flash protection when operating, or working on or near, exposed energized primary circuits or equipment.

3.11 All persons shall wear the required level of FR clothing when entering a designated work area where work is being performed on or near energized circuits or equipment.

4.0 FR CLOTHING CLASSIFICATION

4.1 Classification of FR personal protective clothing is comprised of the following articles to ensure proper protection is provided for the specific activity to be performed.

4.1.1 Standard FR issue - 8 cal FR Shirt and FR pants or 8 cal coverall.

4.1.2 Arc Flash Rated Switching Ensembles - includes arc flash coat, bib overall, arc flash hood, Class 2 Rubber Gloves, EH rated safety foot protection.

a. Note: the appropriate arc rated switching ensemble shall be selected to cover the arc rating for the location and work to be performed.

Hazard/Risk Category (HRC)	Substation Protective Clothing Systems	Required Minimum Arc Rating of PPE (cal/cm^2)
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd2.	Not for Substation Application
1	FR Clothing (4 cal) 4 cal Arc-rated FR shirt and 4 cal FR pants or 4 cal FR coverall	Not for Substation Application

Hazard/Risk Category (HRC)	Substation Protective Clothing Systems	Required Minimum Arc Rating of PPE (cal/cm^2)
2	STANDARD ISSUE (8 cal) 8 cal Arc-rated FR shirt and 8 cal FR pants or 8 cal FR coverall	8
3	ELECTRICAL FLASH ENSEMBLE (20/31* cal) 8 cal Arc-rated FR shirt and 8 cal FR pants and 20/31* cal ensemble (Hood, Switching Coat, Bib Overall) or 8 cal FR coverall and 20/31* cal ensemble (Hood, Switching Jacket, Bib Overall)	25
4	ELECTRICAL FLASH ENSEMBLE (40/55* cal) 8 cal Arc-rated FR shirt and 8 cal FR pants and 40/55* cal ensemble (Hood, Switching Coat, Bib Overall) or 8 cal FR coverall and 40/55* cal ensemble (Hood, Switching Coat, Bib Overall)	40

*The 20 cal/cm² arc-rated ensembles are available for Upstate NY stations and the 31 cal/cm² and 55 cal/cm² arc-rated ensembles are available for New England stations. The 20 cal/cm² arc-rated ensembles are acceptable for HRC 3 in Upstate NY based on the calculated incident energy data. The 31 cal/cm² arc-rated ensembles are acceptable for HRC 4 in New England based on the calculated incident energy data. Where the incident energy is listed in New England above 31cal/cm², the 55 cal/cm² arc-rated ensembles must be used.

5.0 WORK ACTIVITIES REQUIRING FR CLOTHING

5.1 For any work activity that currently requires rubber gloves or rubber gloves and sleeves, FR clothing shall be worn.

5.2 Employees shall wear the standard 8 cal/cm^2 FR clothing when working on or near substation energized circuits or equipment.

5.2.1 NESC includes an exception for secondary systems. For systems below 1000 V, in lieu of performing an arc hazard analysis, clothing or a clothing system with a minimum effective arc rating of 4 cal/cm² shall be required to limit the likelihood of ignition. Minimum standard for substation worker for Upstate NY and NE is 8 cal/cm².

5.3 The appropriate rated arc flash switching ensembles and standard 8 cal/cm^2 FR clothing shall be worn when performing specific work activities in substations identified of having an incident energy exposure of higher than 8 cal/cm^2.

5.3.1 Specific substations are listed in Appendix A for New York North and Appendix B for New England.

5.4 When performing the following work activities within the arc boundary distance as depicted in the enclosed tables, the appropriate rated switching ensembles shall be worn for:

5.4.1 Breaker Operations (Metalclad doors open/closed).

5.4.2 Breaker racking operations (in or out).

5.4.3 Operating unguarded (electrically exposed) primary disconnects (Gang, Single Blade, or fused).

5.4.4 Operating unguarded (electrically exposed) grounding switches.

5.4.5 Operation of Primary Fuses – Metalclad (remove/install).

5.4.6 Removal of Bolted or Hinged Covers of primary compartments to Expose Live Parts.

5.4.7 Testing live parts de-energized or energized with contact type high voltage testers.

5.4.8 Application and Removal of Personal Protective Grounds using insulated live line tools.

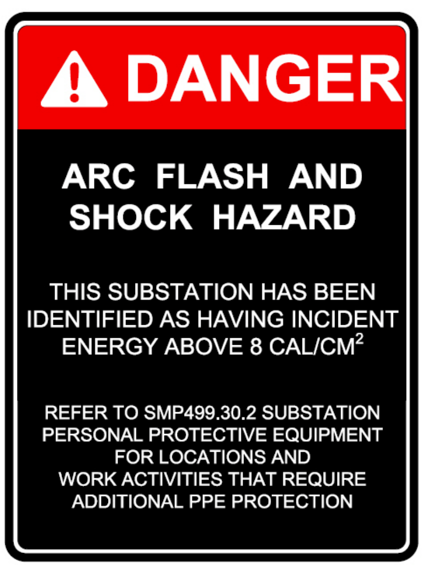
6.0 SUBSTATION SIGNAGE

6.1 Substations shall be posted with permanent danger signs.

6.2 Danger Signs shall be posted in control rooms and entrances to rooms that have been determined to have incident energy above 8 calorie/cm^2 requiring additional arc flash protection.

6.3 The sign will serve to remind employees to wear higher levels of arc flash protection during specific work activities as listed in this procedure.

6.4 Additional required flash protection shall be worn over Flame Resistant clothing.



7.0 SAFETY BY DESIGN

7.1 As substations modifications are engineered, the validation of incident energy for the substation shall be conducted. Substation Engineering & Maintenance Standards shall:

7.1.1 Request a formal analysis by Protection Engineering to validate the incident energy calculations for the proposed substation changes.

7.1.2 Update the substation lists in Appendix A or B accordingly to add, remove, or modify the incident energy calculations, boundary, and hazard risk category (HRC).

7.1.3 Update SMP499.30.2, develop training materials, and roll out changes to applicable departments.

7.1.4 Ensure substation signs are installed or removed based on the incident energy analysis.

7.1.5 Notify Corporate Safety of analysis results for required changes to the Arc Flash Analysis and Mitigation Safety Procedure.

8.0 APPENDIX A - UPSTATE NEW YORK SUBSTATION HRC LIST

Substations - UNY	Voltage (kV)	Incident Energy (cal/cm^2)	8 cal/cm^2 Boundary (in)	Hazard Risk Category (HRC)	Mitigation Comments
Ash Street Station 223	12	12.6	42	3	
Avenue A Station 291	4.16	8.6	28	3	
Batavia Station 01	13.2	12.0	40	3	
Beech Ave 81	4.16	16.5	54	3	
Brighton Ave 8	4.16	8.6	28	3	
Brockport Station 74	13.2	9.8	32	3	
Chrisler Avenue Station 257	4.16	8.2	27	3	
Curry Road Station 365	13.2	12.8	42	3	
Delaware Avenue Station 330	4.16	8.4	27	3	
Duguid Station 265	13.2	8.8	29	3	
East Batavia Station 28	13.2	9.8	32	3	
Eighth St Station 80	4.16	10.5	34	3	
Eleventh St Station 82	4.16	14.1	46	3	
Elsmere Station 407	4.8	8.4	27	3	
Fayette Street Station 28	4.16	16.2	54	3	
Front Street Station 360	13.2	9.9	33	3	
Gloversville 72	4.16	10.8	35	3	

Substations - UNY	Voltage (kV)	Incident Energy (cal/cm^2)	8 cal/cm^2 Boundary (in)	Hazard Risk Category (HRC)	Mitigation Comments
Hanson Aggregate - Middleville	4.16	8.4	26	3	
Hill Street Station 311	4.16	11.6	30	3	
Johnson Road Station 352	13.2	10.1	33	3	
Liberty Street 94	4.16	14.6	48	3	
Menands Station 101	4.16	11.6	38	3	
Mill Street Station 748	4.8	13.7	45	3	
New Krumkill Station 421	4.16	8.7	28	3	
Oakwood Ave 232	13.2	11.0	36	3	
Renaissance Drive 229	13.2	14.7	49	3	
Riverside Station 288	13.2	16.8	56	3	
Station 140	13.2	13.1	43	3	
Station 21	4.16	8.7	29	3	
Station 212	13.2	8.7	28	3	
Station 214	4.16	10.8	35	3	
Station 22	4.16	8.9	29	3	
Station 25	4.16	18.2	59	3	
Station 27	4.16	14.1	47	3	
Station 30	4.16	16.4	55	3	
Station 31	4.16	14.6	48	3	
Station 32	4.16	18.3	59	3	
Station 33	4.16	9.2	27	3	
Station 34	4.16	9.6	31	3	
Station 35	4.16	18.5	60	3	
Station 37	4.16	17.1	55	3	
Station 38	4.16	17.8	58	3	
Station 39	4.16	16.5	55	3	
Station 40	4.16	14.0	46	3	
Station 41	4.16	10.7	35	3	
Station 42	4.16	8.3	27	3	
Station 44	4.16	9.5	31	3	
Station 45	4.16	9.4	31	3	
Station 48	4.16	14.7	49	3	
Station 49	4.16	9.9	32	3	
Station 50	4.16	16.9	55	3	
Station 51	4.16	21.6	71	3	16 cal/cm^2 - Open R101; R201, R301 or R401 before performing switching in Substation.

Substations - UNY	Voltage (kV)	Incident Energy (cal/cm^2)	8 cal/cm^2 Boundary (in)	Hazard Risk Category (HRC)	Mitigation Comments
Station 53	4.16	17.7	59	3	
Station 54	4.16	15.5	51	3	
Station 60	13.2	11.0	36	3	
Station 61	4.16	16.2	54	3	
Station 64	13.2	10.4	34	3	
Stephenson Station 85	4.8	11.1	37	3	
Temple Station 243	13.2	14.6	48	3	
Terminal Station 651	13.2	18.3	61	3	
Valley Station 594	4.16	11.1	36	3	
Welch Station 83	4.16	13.9	45	3	
Whitesboro Station 632	4.16	8.2	27	3	

9.0 APPENDIX B - NEW ENGLAND SUBSTATION HRC LIST

Substations - NE	Voltage (kV)	Incident Energy (cal/cm^2)	8 cal/cm^2 Boundary (in)	Hazard Risk Category (HRC)	Mitigation Comments
Dyer Street 2	4.16	50.5	173	4	27 cal/cm^2 - One (1) transformer in operation during switching
Faraday Street 11	4.16	43.1	147	4	34 cal/cm^2 - Two (2) transformers in parallel during switching
Franklin Square 11	11.5	35.9	122	4	
Glendale 6	4.16	33.8	114	4	17 cal/cm^2 - One (1) transformer in service during switching
Grafton Street 9	4.16	34.3	115	4	28 cal/cm^2 - Two (2) transformers in parallel operation
Harris Ave 12	4.16	26.6	89	4	
Harris Ave 12	11.5	29.3	72	4	
Lawrence 1	4.16	37.1	124	4	23 cal/cm^2 - One (1) transformer in service during switching
Lynn 21	4.16	40.5	138	4	20 cal/cm^2 - One (1) transformer in service during switching
Malden 5	4.16	46.6	145	4	22 cal/cm^2 - One (1) transformer in service during switching
Maplewood 16	4.16	36.6	73	4	23 cal/cm^2 - All Tie Breakers are open during switching
Melrose 4	4.16	45.9	157	4	25 cal/cm^2 - One (1) transformer in service during switching
Olneyville 6	4.16	30.6	103	4	17 cal/cm^2 - One (1) transformer in service during switching

Substations - NE	Voltage (kV)	Incident Energy (cal/cm^2)	8 cal/cm^2 Boundary (in)	Hazard Risk Category (HRC)	Mitigation Comments
Pawtucket 1 107 B71	13.8	26.1	88	4	
Revere Beach 35	4.16	45.6	116	4	35 cal/cm^2 - All Tie Breakers are open during switching
Sprague Street 36	4.16	32.3	107	4	24 cal/cm^2 - All Tie Breakers are open during switching
Thorndike 10	4.16	60.1	203	4	34 cal/cm^2 - Open CB140 or CB240 during switching
Walnut Street 32	4.16	26.1	88	4	
Water Street 31	4.16	25.5	82	4	
Admiral Street 9	4.16	23.2	78	3	16 cal/cm^2 - Bus fed by TR5, TR2 on standby
Admiral Street 9	11.5	15.7	36	3	
Beverly 12	4.16	14.2	34	3	
Blossom 5	4.16	20.9	70	3	11 cal/cm^2 - One (1) transformer in operation during switching
Bridge 6	4.16	10.8	36	3	
Dupont 91	13.8	12.8	42	3	
East Bridgewater 797	13.8	12.4	41	3	
Elmwood 7	23	9.9	32	3	
Field Street 1	4.16	23.5	79	3	13 cal/cm^2 - One (1) Transformer in service during switching
Kent Corner 47	4.16	16.5	36	3	
Kent County 22	34.5	8.8	54	3	
Lawrence 1 B1	13.8	13.1	42	3	
Lawrence 1 B2	13.8	12.3	41	3	
Lawrence 2	13.8	14.1	44	3	
Lawrence Street 53	13.8	9.6	31	3	
Lynn 21	13.8	23.5	79	3	
Manchester 23	2.4	15.0	50	3	
Medford 9	4.16	14.1	47	3	
Norman Street 8	23	17.5	58	3	
North Quincy 11	13.8	13.5	45	3	
Olneyville 6	11.5	10.2	33	3	
Pawtucket 1 107 B74	13.8	20.9	71	3	
Pawtucket 2 148	4.16	17.3	58	3	
Pawtucket 2 148	13.8	17.3	64	3	
Perry Street 3	13.2	12.7	42	3	
Pine Banks 67	4.16	15.6	52	3	
Riverside 8	13.8	11.4	38	3	
Rochambeau 37	4.16	16.7	55	3	
Salem 1 Peabody Street	4.16	12.7	40	3	

Substations - NE	Voltage (kV)	Incident Energy (cal/cm^2)	8 cal/cm^2 Boundary (in)	Hazard Risk Category (HRC)	Mitigation Comments
Swansea 11	13.8	10.6	35	3	
Union Street 348	13.8	8.6	28	3	
Walnut 11	4.16	10.3	34	3	
Webster 6	4.16	19.7	66	3	
West Howard 154	4.16	12.3	40	3	
Wilbraham 507	13.8	10.9	36	3	
Winthrop 22	4.16	10.6	29	3	

10.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	04/01/10	Initial version of document Converted to new format Combined SMS499.40.1 Substation Personal Protective Equipment with SMS499.30.1 Indoor Substation Personal Protective Equipment and changed document to SMP499.30.2 Substation Personal Protective Equipment. Inserted Definitions section. Inserted Arc Flash Analysis tables for Upstate NY and NE. Updated 2.4 and 3.10 for others entering designated work area. Added Section 4, FR Clothing Classification and Clothing Systems Table. Added Section 5, Work Activities Requiring FR Clothing. Added Section 6, posting substations identified to have incident energy above 8 cal/cm^2 Added Section 7, Safety By Design requiring updates to this procedure based on modifications to substations affecting incident energy.
1.1	04/02/10	Section 4.0 - Updated Note under Table. Section 5.0 - Added Section 5.2.1. Section 5.0 - Changed 5.4.5 and 5.4.6 Update table format.
2.0	12/06/11	Changed Originating Department “Substation O&M Services” to “Substation Work Methods” Changed Sponsor “Donald T. Angell” to “Susan Fleck” Section 2.0 - Completely re-written to coincide with current practices Section 3.2.1 - Changed “Protective footwear” to “Protective footwear - Work shoe that meets ASTM F2413 standard for impact and compression and EH rated (section 1.31 Employee Safety hand book).” Section 3.2.2 - Changed “Hard Hat” to “Hard Hat (section 1.31 Employee Safety hand book).” Section 3.2.3 - Changed “Safety Glasses” to “Safety Glasses with side shields (section 1.31 Employee Safety hand book).” Section 8.0 - Changed Title “APPENDIX A - UPSTATE NEW YORK SUBSTATION LIST” to ““APPENDIX A - UPSTATE NEW YORK SUBSTATION HRC LIST” Section 8.0 - Replaced Table Section 9.0 - Changed Title “APPENDIX B - NEW ENGLAND SUBSTATION LIST” to ““APPENDIX B - NEW ENGLAND SUBSTATION HRC LIST” Section 9.0 - Replaced Table