Infrastructure Health and Safety Association

Safe Practice Guide

High Voltage Rubber Techniques

up to 36 kV

Foreword

This Guide designates the practices that should be followed by the member firms of the Infrastructure Health and Safety Association (IHSA) when using high voltage rubber techniques on overhead circuits energized up to 36 kV wye. This Guide is not designed as a training manual, but contains information, best practices and general recommendations deemed appropriate to perform a job in a responsible and safe manner.

The contents of this Safe Practice Guide, including all advice, recommendations and procedures, are provided as a service by the Infrastructure Health and Safety Association. No representation of any kind is made to any persons whatsoever with regard to the accuracy, completeness or sufficiency of the information contained herein. Any and all use of or reliance on this Safe Practice Guide and the information contained herein is solely and entirely at the user’s risk. The user also acknowledges that the safe practices described herein may not satisfy all requirements of Ontario law.

The Infrastructure Health and Safety Association wishes to express its appreciation to those who assisted in the preparation of this Guide.
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INTRODUCTION

This Guide has been compiled to familiarize personnel with the specialized techniques, work practices and rubber equipment necessary to safely carry out this work on circuits energized up to 36 kV wye.

PURPOSE

The purpose of the high voltage rubber technique is to:

1. insulate personnel from energized conductors or apparatus
2. insulate personnel from a possible second point of contact (e.g., crossarm, pole, structure, other plant)
3. eliminate inadvertent phase to phase or phase to ground contact of energized conductors or apparatus
SECTION I
GENERAL

100 SAFE EXECUTION OF WORK
101 COMPETENT PERSONNEL
102 JOB PLANNING
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104 TEAMWORK
SECTION I
GENERAL

100 SAFE EXECUTION OF WORK
The safe execution of high voltage rubber techniques must include:
- competent personnel
- job planning
- work methods
- teamwork
- job safety analysis

101 COMPETENT PERSONNEL
1. Only competent personnel, or personnel in training under the direct supervision of a competent person, should implement the high voltage rubber technique.
2. Personnel implementing the rubber glove method should have been previously instructed or be under instruction in the proper use of the techniques involved. All work should be carried out on a “go slow” basis until personnel become proficient in this technique.
3. When implementing the rubber glove technique using an insulated aerial device, only personnel who have been instructed in the proper care and use of the device, should work from it.

102 JOB PLANNING
Communication protocols should be established and
documented prior to the start of any rubber glove technique. Further, these protocols should be re-communicated and documented as needs require (change in tasks) whenever changes occur with work procedures, and whenever new workers are oriented at the job site. Work may not begin until all workers at the job site agree to and have signed the aforementioned documentation. This may be a separate document or it may be a module associated with a document tailboard talk/conference sheet.

103 WORK METHODS
The “Ground to Ground” Rubber Glove Rule as stated in the Electrical Utility Safety Rules (EUSR) shall apply in all high voltage rubber work.

The methods to be used in the high voltage rubber technique should be reviewed thoroughly with the crew performing the work and documented on a tailboard talk sheet. The restricted limits of approach as stated in the EUSR shall apply to work methods.

The methods used for a specific job should be followed as planned. Any variations from these specifics should be communicated to, and thoroughly understood by, everyone involved.

104 TEAMWORK
The best teams are made up of people who will work compatibly with one another. Effective communication is essential while work is being performed.

Only when the preceding requirements are met can the job be carried out safely and efficiently.
SECTION II
RUBBER PROTECTIVE EQUIPMENT

200 OBJECTIVES
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205 TYPE II RUBBER PROTECTIVE EQUIPMENT
206 CARE OF RUBBER PROTECTIVE EQUIPMENT
SECTION II
RUBBER PROTECTIVE EQUIPMENT

200 OBJECTIVES

1. To introduce personnel to rubber protective equipment and develop an awareness of its importance.

2. To illustrate the difference between classifications of high and low voltage rubber protective devices.

3. To teach proper care of rubber protective equipment in storage and use.

The greatest amount of live line work in most electrical utilities is still performed using rubber gloves and rubber protective equipment.

The various types of rubber protective equipment available make it necessary for personnel to have an understanding of their use. There have been some problems created through misapplication and mistreatment of rubber protective equipment. Proper care and maintenance is essential for safety as well as economic reasons.

201 TEST VOLTAGES AND INTERVALS

1. All rubber protective equipment and associated protective equipment must be tested at regularly scheduled intervals. These intervals, test voltage levels and use voltage levels are extremely important and are depicted in Table #1.

2. New rubber protective equipment is electrically tested at a voltage level which will not damage the equipment, but still give a margin of safety. Retesting should be carried out at the same values.
# Live Line Tools and Protective Equipment Electrical

## Retesting Requirements

<table>
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<th>Protective Equipment</th>
<th>Maximum Use Voltage Phase to Phase</th>
<th>Retest Frequency</th>
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<tr>
<td><strong>Rubber Gloves</strong></td>
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<tr>
<td>Class 00</td>
<td>500 V</td>
<td>90 days</td>
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<td>Class 0</td>
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<td>Class 1</td>
<td>7,500 V</td>
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</tr>
<tr>
<td>Class 2</td>
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<td>Class 3</td>
<td>26,500 V</td>
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<td>Class 4</td>
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<td><strong>Rubber Blankets, Line Hose, Couplers and Hoods</strong></td>
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</tr>
<tr>
<td>Class 0</td>
<td>1,000 V</td>
<td>1 year</td>
</tr>
<tr>
<td>Class 1</td>
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<td>1 year</td>
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<td>Class 2</td>
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<td>Class 4</td>
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<td>15 kV</td>
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<td><strong>Fibre/Plastic Cover-up</strong></td>
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</tr>
<tr>
<td>Class 2</td>
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</tr>
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<td>Class 3</td>
<td>26,400 V</td>
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<tr>
<td><strong>Insulated Pole Platform</strong></td>
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<td>15,000 V</td>
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<td>3 years</td>
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<tr>
<td><em><em>FRP</em> Live Line Tools</em>*</td>
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*FRP – Fibre Reinforced Plastic

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**Table #1**

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3. After testing has been completed, a suitable marking is affixed to each piece of rubber protective equipment, indicating the expiry date.

Should the rubber protective device fail the visual or electrical test, it should be clearly stamped “DEFECTIVE” and be removed from service.

Further information on the testing and care of rubber protective equipment is available in the current ANSI/ASTM/CSA standards.

202 TYPE I NATURAL RUBBER PROTECTIVE EQUIPMENT

Rubber, being of an organic origin, is subject to oxidation. The cutting or deterioration resulting from oxidation is greatly accelerated in the presence of ozone. (See Figure #1)

The degree of cutting depends on the concentration of ozone, the voltage stress and duration of exposure. Deterioration first appears at points of mechanical stress or strain. This effect is often referred to as corona cutting, ozone cutting, deterioration, oxidation or cracking.
203  CORONA
Corona is defined as a discharge of electricity due to the ionization of the air surrounding a conductor when the voltage gradient exceeds a certain value. This ionization and discharge produces ozone gas, \( \text{O}_3 \), a very active form of oxygen.

204  CORONA CUTTING
Corona cutting is the action of ozone on natural rubber while under mechanical stress. The cuts are caused by a breakdown of the long chain rubber molecules into shorter chain molecules. Corona cutting is greatly accelerated in high humidity. Since corona cutting completely destroys the usefulness of the rubber, it constitutes a serious hazard that personnel using rubber protective equipment must guard against.

Tests have proven that ozone has little apparent effect on relaxed rubber, but a strain of as little as 2% elongation or compression can cause cracking to start. Maximum ozone cutting takes place when rubber is under a strain of 10% to 20% elongation or compression. Distorted natural rubber insulating equipment, under certain conditions, will cut after several hours at potentials as low as 2,400 volts and, rubber under stress may be cut within three minutes during laboratory tests at the specified test voltage.

205  TYPE II RUBBER PROTECTIVE EQUIPMENT
1. Type II Line Hose, Insulator Hoods & Blankets
Natural rubber substitutes (elastomeric compounds) that are not subject to ozone deterioration or corona cutting, are used in the manufacture of all Type II rubber protective equipment. The material is subject to chemical
deterioration and possible loss of insulating properties after prolonged exposure to heat, sun, oil and grease, or general weathering. Some signs of deterioration are texture changes such as cracking, swelling, softening, hardening, or becoming sticky or inelastic.

To ensure long service, all rubber protective equipment should be kept clean and stored in a cool, dark and dry location, without distortion, bending, or mechanical stress or compression.

All Type II hose, hoods and connectors have a rib grip feature to provide secure interconnection of the rubber equipment. Some Type II hose is designed with an integrated connector. Contoured ends on the hose permit the hose to fit snugly against the skirts of larger pin type insulators.

The noticeable difference between Class 2 Type II and Class 4 Type II hose is that Class 4 is designed with longer lips to provide more flashover protection at voltages above 15 kV. (See Figures #2 and #3)
Class 4 rubber can be used on voltages lower than 15 kV with lower rated rubber, provided the designs are compatible.

**NOTE:** References in Figures #4 and #5 are to Class 4 rubber only.

2. **Class 4 Type II Connector**
   (See Figure #4) This device is used to couple two lengths of Class 4 line hose, and may be used to connect Class 4 line hose to Class 4 hoods. Pinning rings are located on each connector, should it become necessary to secure the connector with blanket clamp pins, as shown in Figure #5.

3. **Class 4 Hoods**
   Pin Type - The Class 4 hood has an inside diameter of 26.7 cm (10.5 in.). It easily covers most old style double skirt insulators, and the single skirt insulator. It can be used on many station type insulators. When the hood and hose are in place, the Class 4 hose is inserted into the openings of the hood to prevent inadvertent separation of hose and hood. Pinning rings are also located on each hood, to secure the hood with blanket clamp pins, if necessary as shown in Figures #6a, b, c and d.
206   CARE OF RUBBER PROTECTIVE EQUIPMENT

1. Rubber or synthetic protective equipment should be consistently inspected in the field and sent in for regular tests as outlined in the Electrical Utility Safety Rules (EUSR) and this Safe Practice Guide.

   In using rubber or synthetic protective equipment, personnel must avoid damage to the protective equipment from tie wires, armour rods, spurs, wood splinters, sharp tools, pole signs, nails, etc.

2. The protective equipment should not be stored when wet or dirty, except on a temporary basis (such as overnight), after which it should be cleaned and dried with a clean cloth.

3. Take care when storing protective equipment to ensure it is not permanently distorted in any manner. It will distort if not in its original shape.
for an extended period of time. Do not store this equipment near electrical apparatus where there is a possibility of corona discharge, or where there is exposure to sunlight, fluorescent lighting, dampness or heat.

4. Chemicals, lubricants and hydraulic oils are natural enemies of rubber. Therefore, rubber protective equipment should be protected from these hazards. Petroleum-based products found on any rubber goods should be wiped off immediately and the rubber washed as soon as possible.

5. Rubber gloves should be washed frequently to remove perspiration, dirt and body salts from the inside of the gloves. A mild soap or detergent can be used with warm or cold water. The gloves should be rinsed thoroughly to avoid possible irritation from cleaning residue, wiped dry and then immediately returned to their natural (right side out) position. Rubber gloves should never be allowed to dry in the sun because of the possibility of ozone damage.

**NOTE:** If wool or cotton liners are used, they should be washed regularly to avoid the possibility of dermatitis occurring. An approved antiseptic powder should be used to lightly dust the inside of the gloves to aid in putting them on and taking them off.

6. Gloves should never be left inside out, as the distortion of the rubber at the finger tips, crotches and side edges will hasten rubber deterioration.

7. Rubber line hose, insulator hoods and blankets may be washed in warm water using a mild soap
or detergent as a cleaning agent. There are also suitable commercial cleansing agents available.

8. Line hose should always be raised and lowered in hose bags, or in the bucket of the aerial device. This eliminates the possibility of a hose falling, which could injure someone or damage the hose.

9. Insulator hoods should be raised and lowered in a material bag, or in the bucket of the aerial device. They should not be slid down a taut line, as this causes rope burns and other damage should the hood fall off.

10. Blankets should be raised and lowered in a blanket bag, or in the bucket of the aerial device. Rubber blankets should not be raised with the hand line hook inserted in one of the corner eyelets, as blankets are susceptible to cuts and gouges from any sharp projections.

   It may be necessary to drape a blanket over the edge of a bucket to transfer from one location to another, or when stripping the line. When this is done, use blanket clamp pins to keep the blanket from falling.
SECTION III
BY-PASS JUMPERS

300 GENERAL
SECTION III
BY-PASS JUMPERS

300 GENERAL
There are some key points to remember when using by-pass jumpers:

1. Check that the current carrying capacity and the voltage rating of the by-pass jumper and clamps are sufficient for the job at hand.

2. Clean conductors with a conductor cleaning brush prior to installing by-pass jumper clamps.

3. Support both ends of the by-pass jumper prior to making the first connection on the line.

4. Install by-pass jumpers using live line tools, to remove workers from the flash area.

5. Do not allow by-pass jumpers to rest against personnel or any part of the structure.

6. Inspect by-pass jumpers before each use for damaged insulation, broken conductor strands or loose terminations.

7. Support the weight of rigid tube by-pass jumpers to avoid strain on electrical connections.

   NOTE: Depending on the situation, flexible by-pass jumpers may or may not need to be supported.

8. Electrically test by-pass jumpers a minimum of once every twelve months.
SECTION IV
THE AERIAL DEVICE

400   GENERAL
401   OPERATION OF THE AERIAL DEVICE
SECTION IV
THE AERIAL DEVICE

400 GENERAL

1. The function of the aerial device is to provide sufficient mechanical and dielectric strength to safely support and insulate personnel and material from ground potential. Before going into service, the device should be mechanically and electrically tested to establish its stability and insulating capabilities for its intended use. These tests shall be in accordance with specifications in the appropriate CSA C-225 Standard, Vehicle Mounted Aerial Devices, and repeated at least once a year.

2. To ensure against both mechanical and electrical breakdown, daily inspection and tests should be performed in accordance with:
   - the manufacturer’s operator’s manual
   - the current Commercial Vehicle Operators Registration (CVOR)
   - Occupational Health and Safety Act and Regulations

3. At the job location, the following procedures should be carried out:
   (a) Park the vehicle in a location that offers the most advantageous access to the work.
   (b) If working on a public way, set out work area protection according to the current Ministry of Transportation, Ontario Traffic Control Manual (Book 7) Work Zone Traffic Control, and in accordance with any local bylaws. Fill out a traffic control plan, as required by the MTO
and keep it at the work site.

(c) Stabilize the vehicle:
   (i) If equipped with outriggers, use pads, properly levelled under the outriggers.
   (ii) If equipped with spring lockouts or torsion bars, re-check tire inflation. (A soft or flat tire renders stability less than adequate.)
   (iii) Always use wheel chocks.

(d) Using an approved cleaner and wipes, wipe down the upper boom, buckets, and insulated liners, at least once daily, prior to commencing work. This will remove any dust or contamination that could cause tracking.

(e) Ground the vehicle in an approved manner to the system neutral.
   NOTE: It is optional to ground an aerial device with an insulated lower boom insert for work on voltages below 15 kV.

(f) if the system is over 15 kv phase to phase:
   (i) Attach a current leakage meter to the outlet provided on the boom or turret.
   NOTE: If the lower boom has an insulated insert, ensure the insert has been shorted out for testing procedure.
   (ii) Ground the vehicle in an approved manner to the system neutral.
   (iii) The current leakage meter used for field testing the dielectric integrity of the insulated boom of an aerial device should be verified before the test. These units are equipped with a test button for that purpose.
The cord that is used to attach the meter to the boom circuit and/or the boom circuit itself could be faulty and should also be verified prior to the actual current leakage test of the boom. To accomplish this, use the following procedure:
- Ensure that the meter is set on low range.
- Test the meter using the meter test button. The needle of the meter should deflect to the test area indicated on the dial. If it does not, change the battery and check the internal connections.
- Connect one end of the meter cord (co-axial cable) to the meter. Push the test button. If the cord is not shorted, the needle should deflect to the test area on the dial.
- Take the free end of the meter cord and touch the male connector probe to unpainted metal on the meter housing. Push the test button. If the meter reads “zero,” the meter cord has continuity. If there is a good contact and the needle deflects to the test area on the dial, it indicates an “open” in the meter cord (no continuity). Repair or replace the cord and retest.
- With the meter cord still attached to the meter and verified operational, connect the other end to the outlet on the boom of the aerial device. Push the button. A needle deflection to the test area would indicate that the boom circuit is clear of short circuits or grounds.
- Short out the collector ring located at the base of the insulated boom section to the metal (unpainted) boom section. If the boom circuit has continuity, the needle of the meter should remain at “zero” when the test button is pushed. Needle deflection to the test area would indicate an “open” in the boom circuit. Repair or replace the circuit.
- If all test results are positive, proceed with the current leakage test of the insulated boom.

**NOTE:** Install a probe to the metal components of the boom head and ensure it extends past the jib and buckets to make contact with the intended phase. Use caution to ensure that a cross-phasing flash does not occur. Use a signal person to assist the person on the lower controls.

(iv) Raise the aerial device until contact is made between the metallic components in the vicinity of the upper controls and the energized conductor.

**NOTE:** If the boom is equipped with a conductor handling jib assembly, the assembly should be locked closed or an inadvertent closing onto the conductor could occur.

(v) Record the current leakage reading in a log book.
(vi) If leakage current exceeds the maximum limit, lower the boom and thoroughly reclean it.

**NOTE:** A field calculation for leakage current is one microampere for every 1,000 volts of potential.

(vii) After recleaning, retest.

(viii) If the current readings still exceed the maximum limit, it is possible that the inside of the boom is dirty and should be cleaned in an approved manner.

**NOTE:** The boom should be metered at least once a day, before any work is begun, and the results recorded in an appropriate log book. Where unfavourable conditions, such as road salt, high humidity, industrial contaminants, etc. are encountered, continuous monitoring should be considered.

It is recommended that boom and end covers/shrouds be used when travelling times are extensive, or where the above conditions exist. However, they must be removed before commencing any live line work.

4. Cleaning of the inside of the boom should be performed only by a qualified person, in accordance with the manufacturer’s specifications and procedures.

5. Before workers go aloft in an aerial device, they should use approved fall protection equipment, in accordance with current legislation and standards.
NOTE: Remember to remove the shorting device on the lower boom insert when commencing work.

NOTE: If you are going to continue to monitor the boom, you can leave the lower boom insert in place.

401 OPERATION OF THE AERIAL DEVICE

1. All personnel working with this type of equipment should be trained, or be in training, in the operation of all controls on the vehicle.
SECTION V
STANDARD SAFE PRACTICES

500 PERSONAL PROTECTION

501 WORK ON SYSTEMS 750 V TO 5 kV PHASE TO PHASE

502 WORK ON WYE CONNECTED SYSTEMS 5 kV to 15 kV PHASE TO PHASE

503 WORK ON WYE CONNECTED SYSTEMS BETWEEN 15 kV AND 26.5 kV PHASE TO PHASE

504 WORK ON WYE CONNECTED SYSTEMS BETWEEN 26.5 kV AND 36 kV PHASE TO PHASE

505 PREPARATION FOR WORK
SECTION V
STANDARD SAFE PRACTICES

500 PERSONAL PROTECTION

1. Effective communication between personnel aloft and ground supervision is essential for safety and efficiency.

2. Personnel should ensure that all rubber protective equipment is properly stored and maintained, and is in good condition for the job at hand.

3. When performing high voltage rubber work, personnel should wear rubber gloves of the appropriate voltage rating with protective covers.

   The distance from the protective cover cuff to glove bead should be as follows: (See Figure #7)

<table>
<thead>
<tr>
<th>Glove Class</th>
<th>Distance “D”</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, 00</td>
<td>13 mm (0.5 in.)</td>
</tr>
<tr>
<td>1</td>
<td>25 mm (1 in.)</td>
</tr>
<tr>
<td>2</td>
<td>51 mm (2 in.)</td>
</tr>
<tr>
<td>3</td>
<td>76 mm (3 in.)</td>
</tr>
<tr>
<td>4</td>
<td>102 mm (4 in.)</td>
</tr>
</tbody>
</table>

Distance between Gauntlet and Cuff

Figure #7
4. When performing high voltage rubber work, wear personal protective equipment and clothing, as specified in the Electrical Utility Safety Rules (EUSR).

5. Conduct a tailboard talk with all personnel involved in the work, so that everyone becomes fully aware of the hazards, and the barriers and procedures required to control them.

6. This technique should be performed under the protection of a hold-off, as outlined in the Utility Work Protection Code.

7. If by-pass jumpers are to be used, use an approved meter for the appropriate voltage to be worked on, and take an amperage reading to determine the load on the circuit prior to starting work. Once the by-pass jumpers are installed, take another amperage reading, to verify the jumper is carrying approximately one third of the total line current at the time of the initial test.

8. In this type of work, all energized conductors and equipment, and all attachments or equipment that could create an electrical hazard, should be either covered with rubber, fibre or composite protective equipment of the appropriate rating, or removed from the work area.

9. Confine work to one potential. Do not make simultaneous contact with the potential being worked on and apparatus or equipment at a different potential. Install rubber protective barriers on all other potentials different from that being worked in the immediate work zone. (This will control the second point of contact should a first point of contact be made.)
10. Use approved procedures and equipment when connecting or disconnecting apparatus (including sections of line).

11. If there is a possibility that an inadvertent operation of any fused or solid blade disconnect switch could place personnel in a potential flash area, either by-pass the switch installation and remove the fuse holder, or provide other suitable protection.

12. Where conductors are unclamped, maintain positive control of the conductor at all times.

501 WORK ON SYSTEMS 750 V TO 5 kV PHASE TO PHASE

1. This work should only be performed using rubber gloves and protective equipment with a minimum Class 1 voltage rating (10,000 volts).

2. This work can be carried out from an aerial device, a pole platform or from a pole.

3. Use only approved capstan type web hoists to support strain. When the hoist is connected to apparatus at different potentials, use the hoist in conjunction with an insulated link stick.

4. Dielectrically test all protective equipment at the intervals specified in the EUSR and this Guide.

502 WORK ON WYE CONNECTED SYSTEMS 5 kV TO 15 kV PHASE TO PHASE

1. This work should only be performed using rubber gloves and high voltage rubber protective equipment with a minimum Class 2 voltage rating
(20,000 volts).

2. This work should only be performed while personnel are standing in an insulated aerial device or on an approved insulated platform, if the phase to phase voltage exceeds 5 kV. While standing on an approved insulated platform, personnel must secure themselves to the staging of the platform in an approved manner.

If it is necessary to install rubber protective equipment before installing the platform, the rubber should be installed using approved live line tools and cover-up.

3. Use only approved capstan type web hoists to support strain. When the hoist is connected to apparatus at different potentials, use the hoist in conjunction with an insulated link stick.

4. Dielectrically test all protective equipment at the intervals specified in the EUSR and this Guide.

503 WORK ON WYE CONNECTED SYSTEMS BETWEEN 15 kV AND 26.5 kV PHASE TO PHASE

1. This work should only be performed using rubber gloves and protective equipment with a minimum Class 3 voltage rating (30,000 volts).

2. This work should only be performed while personnel are standing in an approved insulated aerial device and after current leakage testing has been performed.

3. Use only approved capstan type web hoists to support strain. When the hoist is connected to apparatus at different potentials, use the hoist in
conjunction with an insulated link stick.

4. Dielectrically test all protective equipment at the intervals specified in the EUSR and this Guide.

504 WORK ON WYE CONNECTED SYSTEMS BETWEEN 26.5 kV AND 36 kV PHASE TO PHASE

1. This work should only be performed using rubber gloves and protective equipment with a minimum Class 4 voltage rating (40,000 volts).

2. This work should only be performed while personnel are standing in an approved insulated aerial device and after current leakage testing has been performed.

3. Use only approved capstan type web hoists to support strain. When the hoist is connected to apparatus at different potentials, use the hoist in conjunction with an insulated link stick.

4. Dielectrically test all protective equipment at the intervals specified in the EUSR and this Guide.

505 PREPARATION FOR WORK

1. The immediate supervisor and personnel who are to perform the job should be familiar with the previous sections of this Guide.

2. Arrange for hold-off protection on the circuit. (Determine load on the line or any additional loading that may be introduced on the line from the controlling authority.)

3. Position the vehicle in the most advantageous location – consider stability, road clearance and
bucket positioning required for the task.

4. Assure work area protection and traffic control is in accordance with current legislation.

5. Hold a thorough tailboard talk to familiarize all personnel with the hazards, barriers and procedures to be followed and document the details.

6. Thoroughly inspect all tools, rubber protective equipment and personal protective equipment. Ensure nothing is placed in a contaminated area.

7. Personnel should thoroughly inspect rubber gloves and protective equipment.
   (a) Perform visual and air tests.
   (b) Remove all rings, watches and jewellery that poses a hazard to the integrity of the rubber protective equipment before putting on the gloves.
   (c) The use of liners, worn inside the gloves, is recommended.
   (d) Thoroughly inspect glove covers. Check for cuts, holes, broken stitches and particles of dirt, wood chips, grease, oil or small bits of wire inside and/or embedded in the leather that could cause damage.

8. Ground the aerial device in an approved manner to the system neutral. Use a ground probe if there is no system neutral and ensure that both employees and members of the public stay clear of the aerial device while work is being done aloft. (This is done to avoid the possibility of dangerous step and touch potentials.)
NOTE: This is an optional requirement for aerial devices with insulated lower boom inserts.

9. (a) Remove surface contaminants on external insulating surfaces of the aerial device immediately prior to performing high voltage rubber work.

   (b) Use approved cleaners and waxes, as per manufacturer’s specifications, to remove initial contaminants.

10. Verify the integrity of the aerial device’s holding valves, using the lower controls.

11. When the circuit to be worked on is operating from 15 kV to 36 kV phase to phase, the leakage current of the boom should be checked and recorded. (See Section IV.)
SECTION VI
JOB PROCEDURES

600 GENERAL
601 INSTALLATION OF IN-LINE SWITCHES
602 REMOVAL OF IN-LINE SWITCHES
603 AIR BREAK SWITCH (ABS)
MAINTENANCE
SECTION VI
JOB PROCEDURES

600 GENERAL
Procedures outlined in this section of the Guide are for work on 15 kV to 36 kV phase to phase wye connected circuits.

601 INSTALLATION OF IN-LINE SWITCHES
The following procedure can be used to install a set of in-line switches on an energized 27.6/16 kV three-phase circuit, using an approved high voltage rubber glove technique.

1. Material and Equipment
   (a) insulated aerial device
   (b) work area protection
   (c) protective cover-up
       - Class 4 line hose [minimum of 12, 1.8 m (6 ft.) pieces]
       - Class 4 blankets (split and solid)
       - blanket pins
       - Class 4 insulator hoods
   (d) auxiliary arm (complete with insulator) or link stick and sling
   (e) live line jumper of appropriate current rating and length (See Figure 8)
   (f) conductor cleaning brush
   (g) two grip-all sticks
   (h) ratchet cutters
   (i) approved ammeter
   (j) six dead-end strain clamps (swing away)
   (k) three solid blade switches

Figure #8
(l) six Ampact connectors and shells  
(appropriate size)  
(m) Ampact gun  
(n) live line web hoist  
(o) conductor grips (appropriate size)  
(p) rubber gloves of the appropriate rating with protective covers  
(q) personal protective equipment including arc/flash clothing approved for the system being worked on

2. Safe Limits of Approach
The applicable safe limits of approach when implementing the rubber glove technique on 15 kV to 36 kV circuits are found in the current EUSR.

NOTE: A minimum length of 0.6 m (2 ft.) of insulated jib must be used when supporting an energized conductor. Adhere to the manufacturer’s dimension if different from the above.

3. Pre-Job Review
(a) Prior to commencement of any rubber glove procedure, conduct a thorough tailboard talk.

(b) All rubber protective equipment used on 27.6/16 kV circuits and underbuild should have a minimum rating of Class 4 (40,000 volts).

(c) During all rubber glove procedures, application of protective equipment will be governed by a system of multiple barriers to provide a safe work environment. That is, more than one physical barrier (protective line hose, hoods, blankets, rubber gloves and
covers and insulating portions of the aerial device) should be in place at all times to serve as back-up protection.

The key, in any rubber glove technique, is that all conductors or attachments that could create an electrical hazard should be removed from the work area or covered with the appropriate protective equipment.

Strict adherence to all restricted limits of approach is required to maximize work zone safety and effectively minimize the risk to personnel and the general public.

**NOTE:** Eliminate the second point of contact. The first point of contact is that part of the body where current enters when inadvertent contact is made with exposed energized equipment. The second point of contact is the point where current exits the body when inadvertent contact is made with equipment at another potential.

4. **Procedure for Installation of In-Line Switches**

This procedure will outline, step-by-step, a safe work method for installing in-line switches on a three-phase overhead system. Regardless of the type of framing (crossarm, improved, vertical, armless construction), the switches should be installed in a following sequence: furthest phase, centre phase, nearest phase. (See Figure #9)

**NOTE:** If the switch is the positive locking type, you may remove the jumper. If it is not, the jumper must remain on until all switches are installed. If you need to cover the switch, the jumper must be left on.
This procedure eliminates the need to work with your back between a jumpered out in-line switch assembly, bound ineffectively with blankets, and the energized conductor you are working on.

(a) Establish required work area protection.
(b) Hold a tailboard talk and review job procedures.

(c) Set the aerial device perpendicular to the work area. The centre line of the aerial device should be centred on the area where the in-line switches will be installed, to make easier access for both line workers. Consideration should be given to elevator equipped aerial devices. (See Figure #10)

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<table>
<thead>
<tr>
<th>Far</th>
<th>Centre</th>
<th>Near</th>
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<tr>
<td>Preferred</td>
<td></td>
<td>Optional</td>
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*Figure #10*

(d) Obtain a hold-off on the circuit to be worked on and any adjacent circuits on the same structure.
(e) Ground the vehicle to the system neutral.
(f) A current leakage check should be done prior to commencement of work (refer to Section 400).
(g) Cover up and/or relocate any underbuild on the way up.
(h) On the circuit to be worked, cover the near phase with the appropriate cover-up [minimum of 4, 1.8 m (6 ft.) hoses] and relocate the phase if necessary (suspend in an auxiliary arm or link stick. (See Figure #11)
(i) Cover the centre phase. (See Figure #11)
(j) Clean the far phase conductor with the conductor cleaning brush and install a temporary by-pass jumper using live line grip-all sticks. (See Figure #12)

Figure #11
(k) Verify the integrity of the temporary by-pass jumper by taking a current reading with an approved ammeter, first on the conductor, then on the jumper.

NOTE: The jumper must be inspected for broken strands and loose connections prior to use.

The jumper must be one of large enough capacity to carry the amperage on the line. The jumper should carry at least one-third (33%) of the total line current.

(l) Install and tighten a dead-ending strain clamp on the conductor nearest the structure.

(m) Connect the switch assembly and the second dead-end strain clamp to the first clamp.

(n) Attach a conductor grip to the conductor outside the furthest bucket, a live line hoist to
the conductor grip, and then the web strap to the dead-end strain clamp on the switch assembly.

**NOTE:** Consider the web strap conductive. Maintain safe limits of approach to the strap and unprotected parts of the body.

(o) Take up enough tension with the live line hoist to allow the attachment of the second dead-end strain clamp to the conductor and tighten. Take up enough strain to allow slack conductor to pass over the switch assembly.

(p) Remove the web hoist and conductor grip. Operate the switch to check the integrity of its mechanical operation and then check that the switch is closed.

(q) Using ratchet cutters, cut the conductor at the midway point of the switch assembly. Tape conductor at point of cutting.

(r) Shape the tails back and connect the switch leads to the conductor with Ampacts.

(s) Check the switch connection with an approved ammeter to verify the switch is carrying load (at least one third of the total line current).

(t) Move away a safe distance from the switch assembly and remove the temporary by-pass jumper using live line grip-all sticks.

(u) Remove cover-up from the centre phase and install the switch assembly in the same manner. (See Figure #13)

(v) Relocate near phase if necessary and clamp in. Remove cover-up and install switch assembly in the same manner. (See Figure #14)

(w) Remove cover-up from the underbuild and surrender the hold-off when equipment and
personnel are clear.

Figure #13

Figure #14

5. Alternative Method
This is an approved alternative method that may be used if preferred.
(a) Follow previous steps (a) to (k).

(b) Measure the length of the switch assembly, pin to pin. (See Figure #15)

(c) Install and tighten two dead-end strain clamps to the measurement taken.

(d) Install two conductor grips and attach a live line hoist to both grips. Take up tension on the hoist until weight is transferred from the conductor to the hoist. (See Figure #16)

(e) Control the conductor by taping it to the web strap in two places. Cut the conductor (tape the conductor at the point where the cut is to be made) midway between the clamps.

(f) Bend the tails of the conductor back over the dead-end strain clamps.

(g) Install the in-line switch assembly, then release tension from the web hoist.

(h) Remove the hoist and conductor grips.

(i) Attach the leads of the switch assembly to the conductor, using Ampact connections.
(j) Operate the switch to check the integrity of its mechanical operation. Check that the door is closed. Check the switch connection with an ammeter to verify the switch is carrying load (minimum one-third of the total line current).

(k) Move away a safe distance from the switch assembly and remove the temporary by-pass jumper using live line grip-all sticks.

(l) Remove cover up from the centre phase and install the switch assembly in the same manner. (Refer back to Figure #13)

(m) Relocate and clamp in the near phase, then remove the cover-up. Install near phase switch assembly in the same manner. (Refer back to Figure #14)

(n) Remove cover-up from the underbuild and surrender the hold-off when equipment and personnel are clear.

602 REMOVAL OF IN-LINE SWITCHES
The following procedure can be used to remove a set of in-line switches on an energized 27.6/16 kV three phase circuit using an approved high voltage rubber glove technique.

1. Material and Equipment
   - insulated aerial device
   - work area protection
   - protective cover up: Class 4 line hose [minimum of 12, 1.8 m (6 ft.) pieces], Class 4 blankets (split and solid), blanket pins, Class 4 insulator hoods
   - auxiliary arm (complete with insulator),
   - live line jumpers of appropriate current rating and length (See Figure #17)
   - conductor cleaning brush
- 2 grip-all sticks
- ratchet cutters
- approved ammeter
- 6 dead-end strain clamps (swing away)
- 3 solid blade switches
- 6 Amp connectors and shells (appropriate size)
- Ampact gun
- live line web hoist
- conductor grips (appropriate size)
- rubber gloves of the appropriate rating, with covers
- personal protective equipment including arc/flash clothing appropriate for the system being worked on

2. Safe Limits of Approach
The applicable safe limits of approach when implementing the rubber glove technique on 15 kV to 36 kV circuits are found in the current EUSR.

**NOTE:** A minimum length of 0.6 m (2 ft.) of insulated jib must be used when supporting an energized conductor. Adhere to the manufacturer’s dimension if different from above.

3. Pre-Job Review
(a) Prior to commencement of any rubber glove procedure, conduct a thorough tailboard talk.

(b) All rubber protective equipment used on 27.6/16 kV circuits and underbuild should have a minimum of Class 4 rating.
(c) During all rubber glove procedures, application of protective equipment is governed by a system of multiple barriers to provide a safe work environment. That is, more than one physical barrier (protective line hose, hoods, blankets, rubber gloves and covers, and insulating portions of the aerial device) should be in place at all times to serve as backup protection.

The key, in any rubber glove technique, is that all conductors or attachments that could create an electrical hazard shall be removed from the work area or covered with the appropriate protective equipment.

Strict adherence to all safe limits of approach is required to maximize work zone safety and effectively minimize the risk to personnel and the general public.

**NOTE:** Eliminate the second point of contact. The first point of contact is that part of the body where current enters when contact is made with exposed energized equipment. The second point of contact is the point where current exits the body after contact is made with equipment at another potential.

4. **Procedure for Removal of In-Line Switches**

This procedure will outline, step by step, a safe work method for the removal of in-line switches on a three-phase overhead system. Regardless of the type of framing (crossarm, improved or vertical construction), the switches should be removed in the following sequence: nearest, centre, farthest. (See Figure #18)
This procedure eliminates the need to work with your back between a jumpered out in-line switch assembly bound ineffectively with blankets, and the energized conductor on which you are working.

(a) Establish required work area protection.

(b) Hold a tailboard talk and review job procedures.

(c) Set up the aerial device perpendicular to the work area. The centre line of the aerial device should be centred on the area where the in-line switches will be removed, to make easier access for both line workers. Consideration should be given to elevator equipped aerial devices. (See Figure #19)

(d) Obtain a hold-off on the circuit to be worked and any adjacent circuits on the same structure.

(e) Ground the vehicle to the system neutral.

(f) A current leakage check should be done prior
(g) Cover-up and/or relocate any underbuild on the way up.

(h) Clean the near phase conductor with a conductor brush and live line tool and install a temporary by-pass jumper, using a grip-all stick, to remove personnel from the flash area if the door of the switch drops open [minimum of 0.4 m (1.5 ft.) from the structure].

(See Figure #20)
NOTE: Temporary by-pass jumpers are FIRST ON and LAST OFF.

(i) Verify the integrity of the temporary by-pass jumper by taking a current reading with an approved ammeter. The jumper should carry at least one-third (33%) of the total line current.

NOTE: The jumper should have been inspected for broken strands and loose connections prior to use. The jumper must be of a large enough capacity to carry the amperage on the line.

(j) Install a conductor grip at least 1.2 m (4 ft.) from the dead-end strain clamp that is farthest from the structure. Install a live line hoist to
the conductor grip and attach the web strap to the dead-end strain clamp.

**NOTE:** The web strap is considered conductive. You should maintain safe limits of approach to the strap and unprotected parts of the body.

(k) Take up enough tension with the live line hoist to put slack in the conductor between the conductor grip and the dead-end strain clamp. Tape the conductor to the web strap, loosen off the bolts to the dead-end strain clamp and remove the conductor from it. Straighten the tails of the conductor, install the sleeve, and take up on the hoist, to allow the press to fit between the switch assembly and the sleeve.

(l) Make three compressions on each side of the centre mark of the sleeve. Let the tension off the web hoist, to put strain back on the conductor and slack into the web hoist. **NOTE:** Do not remove the hoist. Finish compressions on each side of the sleeve.

(m) Remove the web hoist and conductor grip.

(n) Remove the switch assembly and dead-end strain clamp.

(o) Move away a safe distance and remove the temporary by-pass jumper using live line grip-all sticks.

(p) Cover the near phase with appropriate cover up [minimum of 4, 1.8 m (6 ft.) hoses] and relocate the conductor if necessary (suspend in auxiliary arm or link stick). (See Figure #21)
(q) Repeat procedure for the centre phase. (See Figure #22) When the switch assembly and the by-pass jumper are removed and the conductor sleeved through, cover with appropriate cover-up.

(r) Repeat procedure for the far phase. (See Figure #23)

(s) When the switch removal is complete, remove the cover-up from the centre phase on the way out.

(t) Relocate and clamp in the near phase. Remove the cover-up.

(u) Remove the cover-up from the underbuild on the way down and surrender the hold-off when equipment and personnel are clear.
5. **Alternative Method**

This is an approved alternative method that may be used if preferred.

(a) Follow previous steps (a) to (k).

(b) Clean the conductor with a conductor brush and live line stick and install a temporary by-pass jumper using grip-all sticks to remove personnel from flash area if the door to the switch drops open [minimum 0.4 m (1.5 ft.) from structure].

**NOTE:** Temporary by-pass jumpers are **FIRST ON and LAST OFF**.

(c) Verify the integrity of the temporary by-pass jumper by taking a current reading with an ammeter.

**NOTE:** The jumper’s capacity should be large enough to carry the amperage on the line. The jumper should carry at least one third (33%) of the total line current.

(d) Remove Ampact from switch leads using Ampact tool.

(e) Install a conductor grip on each side of the switch assembly and attach a live line hoist to both grips. Take up tension to transfer the weight to the hoist and put slack into the switch assembly. Loosen the bolts of the dead-end strain clamps and remove the switch assembly.

(f) Straighten the tails and install the sleeve. Take up the hoist to allow enough slack to install the press between the web strap and sleeve. Make three compressions on each side of the centre mark on the sleeve.
(g) Let the tension off the web hoist to put strain on the sleeve and slack into the web hoist. **NOTE: Do not remove the hoist.**

(h) Finish compressions on each side of the sleeve.

(i) Remove the web hoist and conductor grips.

(j) Move away a safe distance and remove the temporary by-pass jumper, using live line grip-all sticks.

(k) Cover conductor with appropriate cover-up [minimum 4, 1.8 m (6 ft.) hoses].

(l) Relocate conductor to auxiliary arm or link stick, if necessary.

(m) Repeat procedure for the centre phase. When the switch assembly and the by-pass jumper are removed, cover with appropriate cover-up.

(n) Repeat procedure for the far phase.

(o) Remove the cover-up on the centre phase on the way out.

(p) Relocate the near phase, clamp in and remove the cover-up.

(q) Relocate and remove the cover-up on the underbuild on the way down.

(r) Surrender the hold-off when equipment and personnel are clear.

603 AIR BREAK SWITCH (ABS) MAINTENANCE

1. Introduction

As a line worker, you will be involved in the regular maintenance of various air break switches (ABS). There are basically two different types of these three-phase, gang operated switches:

- The first, an older style switch, is operated to
isolate an overhead line and has copper arcing horns, usually made of 2/0 solid copper. This switch is not used to break load.

- The second type of switch is a load break switch (LBS), that can interrupt load. These units contain snuffers to extinguish the loading arc. They can also be fitted with a motor, which allows opening and closing by remote control.

A maintenance schedule should be set up for these switches, since lightning, cracked insulators, constant vibration, heated connections, and pole shrinking can cause mechanical realignment.

Regular maintenance allows defects to be spotted and corrected before a major interruption occurs.

When air break switches are connected using live line taps, the disconnection, using approved live line tools, is relatively straightforward.

Utilizing the approved rubber glove technique, the disconnection of compression-fitted plant can be performed safely and efficiently while maintaining continuity of supply.

2. **By-Pass Jumpers**

There are two types of by-pass equipment used. One is built inside a fibreglass reinforced plastic tube with a current rating of 350 amperes. The second is a device using an underground cable, with a current rating of 600 amperes, inside a polypropylene tube.

These jumpers are suspended under the crossarm using approved dead-end insulator straps and spiral link sticks. You must check the line
amperage to determine jumper size, and ensure connections are clean and wire-brushed.

**NOTE:** Teamwork can usually be best attained by using compatible personnel. Effective communication is essential while the work is being performed. Only when the preceding requirements are met can the job be done safely and efficiently.

3. **Safe Limits of Approach (Competent Person)**
   Refer to the current EUSR for the safe limits of approach.

4. **Live Line Tools/Equipment Required**
   - an insulated aerial device with traffic control equipment
   - appropriate cover up material (for any underbuild) and centre jumper
   - 3 by-pass jumpers (appropriate rating),
   - 6 insulated spiral link sticks [0.60 m (2 ft.)]
   - 2 grip-all clamp sticks [1.8 m (6 ft.)]
   - approved wrench stick with 14 mm and 16 mm (9/16 in. and 5/8 in.) deep sockets
   - conductor cleaning brush
   - tools, oil can, emery cloth, steel wool, etc.
   - Class 4 (40 kV) rubber gloves with leather protective covers
   - approved ammeter with a live line tool
   - wire holding stick
   - approved cleaner
   - earth/crank megger
   - all appropriate personal protective equipment including arc/flash clothing appropriate for the system being worked on
NOTE: The material and equipment is inspected prior to commencement of the maintenance.

5. Procedure for the Maintenance of a Normally Closed Air Break Switch

HOW DO THEY WORK?
Air break switches are usually operated by two methods:

**Direct Drive**
A main control pipe is attached directly to one of the switch blade insulators, which drives the other two.

**Indirect Drive**
A rod connecting all the blade insulators is operated by an offset arm driving the rod.

If the blade and jaws are aligned, the operation will be correct in the direct drive ABS. For the indirect drive, when the blades and jaws are fully closed, the offset drive arm must be adjusted and checked to ensure it has travelled past centre. This now acts as a locking feature so, in the event the blades should try to open independently of the pipe drive, any movement of the blade toward the open position forces the drive arm against its stop block, preventing any other movement.

(a) Establish required work area protection.
(b) Conduct a tailboard talk and review work procedures. Feedback is important and is used as a check for any misunderstandings. (Refer to Sections 503 and 504 of this guide)
(c) Obtain a hold-off.
(d) If switching is to be done, follow the Order
to Operate and complete.

(e) Set up the insulated aerial device in the most advantageous position to access the by-pass jumpers, remembering the following:
   (i) The by-pass jumpers must be insulated first.
   (ii) Boom operation should be maintained perpendicular to the line.
   (iii) Boom configuration should optimize reaching and lifting capacity.

(f) Ground the vehicle.

(g) Perform an inspection:
   (i) Verify proper location and number of switch to be worked on.
   (ii) Check the air break structure and adjacent structures for possible hazards.
   (iii) Check the condition of the air break switch blades and all jumper connections.

(h) A current leakage test of the aerial device must be done. (Refer to Section 400 of this guide)

(i) Apply cover-up material of the appropriate voltage rating, as required, to any underbuild and the structure.

(j) With an approved ammeter, check the current in each phase to determine loading is not in excess of the current carrying capacity of the by-pass jumpers.

(k) Clean each conductor properly for installation of the by-pass jumper clamps.

(l) Suspend the by-pass jumpers below the air break switch base. A sling arrangement of synthetic rope with an insulated link stick can be used to isolate the jumpers from the grounded structure.
(m) The configuration and underbuild will influence the procedure to be adopted while installing the by-pass jumpers. When a safe procedure has been decided upon, install the by-pass jumpers.

(i) Hold one end clear while the other is installed on the conductor at the point previously cleaned.

(ii) Install the second clamp of the by-pass jumper.

(iii) Relocate and duplicate the procedure for the remaining phases.

(n) Upon receiving permission from the controlling authority (if required), open the air break switch, check open, lock open and tag.

**NOTE:** When opening or closing air break switches, the operator must wear rubber gloves and stand on a ground gradient control mat that is bonded to the air break switch’s grounding grid.

(o) Starting at the near phase, on one side of the air break switch structure:

(i) Engage the clamp stick adapter on the pigtail connector with a grip-all clamp stick.

(ii) Loosen the nuts with an approved wrench stick.

(iii) Transfer the pigtail connector to its parking stud on the structure. (A wire holding stick may be necessary to assist in the removal of the jumper to its parking stud.)

(iv) Secure the pigtail connector in position with a wrench stick.

(v) Remove the grip-all clamp stick.
(vi) Complete the remaining phases on one side and then the opposite side of the structure, repeating steps (i) to (vi) to isolate the air break switch.

(p) The grounding connections should be inspected, cleaned and tested using the proper procedures.

**Testing the ground network** - Grounding connections on the pole and at the base of the pole should be inspected. The ground rod or rod network is meggered using an earth megger. A reading of 25 ohms or less is desirable. If necessary, additional ground rods should be driven at 3 m (10 ft.) intervals until an acceptable reading is obtained.

(q) Using the necessary tools, perform maintenance on the air break switch. Check for alignment, cracked or broken insulators, burned or defective contacts, adjustment of arcing horns, loose hardware, etc. Lubricate where necessary and clean insulating components.

(r) Discoloured and pitted insulators should be thoroughly checked and, if needed, replaced.

(s) All electrical connections should be cleaned, tightened, lubricated and torqued to the manufacturer’s specifications.

(t) On some switches, the copper flex jumper of the blade and swivel section must be tightened and checked for conductivity. Always inspect for heated connections.

(u) Pigtail connectors should be checked, tightened and oiled after inspecting them for corrosion.
(v) Check the switch jaw mechanism and assembly for proper alignment and closing. Check to see that all components are hitting their rubber stops. Oil and lubricate after cleaning all moving parts. (Be sure to check for loose nuts and bolts on the structure and pole, as well as the bottom handle assembly.) Check for any missing parts, cotter keys, nuts, cracked nuts, stripped threads, etc.

(w) The arcing horns which make or break the arc on older style switches can become pitted. Clean with an emery cloth or brush to remove the roughness and apply a light coating of non-oxide paste. These horns, because of their importance, are the last to be adjusted.

6. Procedure for Restoring the ABS
(a) If you have surrendered your hold-off, reacquire it.
(b) Check the air break switch is open, check open, locked and tagged.
(c) Replace the pigtail connections to the male jumper studs on the dead-end clamps.
(d) Check the air break switch, close, check closed, lock and tag.
(e) Remove the by-pass jumpers.
(f) Remove the by-pass jumpers from the structure.
(g) Surrender the hold-off protection when equipment and personnel are clear.
ABS BEFORE ISOLATION

POLYPROPYLENE BY-PASS TUBE

ISOLATED ABS
Available Safe Practice Guides

- Bare Hand Live Line Techniques
- Conductor Stringing
- Entry and Work in a Confined Space
- Excavating with Hydrovacs in the Vicinity of Underground Electrical Plant
- High Voltage Rubber Techniques up to 36 kV
- Hydraulics
- Ladder Safety
- Line Clearing Operations
- Live Line Tool Techniques
- Low Voltage Applications
- Pole Handling
- Ropes, Rigging and Slinging Hardware
- Temporary Grounding and Bonding Techniques
- Underground Electrical Systems