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Substation Maintenance Instruction

HV switch and switch fuse units

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SUBSTATION MAINTENANCE INSTRUCTION

ASSET STANDARDS AND DESIGN

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SMI 212 HV SWITCH AND SWITCH FUSE UNITS

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1.0 PURPOSE

To outline the broad maintenance requirements for HV switchgear.

2.0 SCOPE

The scope of this instruction includes the maintenance requirements for cast-resin switchgear and sheet metal enclosed switchgear.

This instruction is to be read in conjunction with SMI 101 - Minimum requirements for maintenance of distribution equipment, for distribution substation equipment, and SMI 100 - Minimum requirements for maintenance of transmission and zone substation equipment for transmission and zone substation equipment.

A detailed maintenance manual for Eaton (Holec) switchgear is included in Annexure 1.1.1.1A.A.7.

3.0 REFERENCES

Internal

- Company Policy 9.9.1 - Network Asset Maintenance
- Company Form (Health & Safety) FSY 0118 – Worksite Hazard and Risk Assessment
- Division Procedure GNV 1090.2 - Inspection and Testing of Selected Electrical Equipment Delivered to Stores: High Voltage Fuses
- Branch Form FRG 1538 – Distribution substation installation and maintenance sheet
- Substation Design Instruction SDI 211 - ABB SafeLink 12kV Switchgear
- Substation Mains Instruction 100 - Minimum requirements for maintenance of transmission and zone substation equipment
- Substation Mains Instruction SMI 101 - Minimum requirements for maintenance of distribution equipment
- Substation Mains Instruction SMI 140 – Thermovision of zone and transmission substations
- Endeavour Energy Electrical Safety Rules
- Network Management Plan December 2013 Review
- Safe Work Method Statement SWMS 3.003 – Distribution Switchgear Maintenance

External

- ENA National Electricity Network Safety Code (Doc 01-2008)
- Work Health and Safety Regulation 2011
- Work Health and Safety Act 2011

4.0 DEFINITIONS AND ABBREVIATIONS

HV	High voltage - a voltage exceeding or equal to 1000V AC. Refers to 11kV, 12.7kV and 22kV in this instruction.
PD	Partial discharge
PD(TEV)	Partial discharge test detecting the levels of emitted transient earth voltages
SFU	Static frequency unit

5.0 ACTIONS

5.1. General

The routine maintenance required for HV switchgear comprises of an in-service inspection and a major maintenance. The in-service inspection includes a partial discharge test and a thermovision scan.

Distinct types or brands of equipment may not contain some of the components listed for routine maintenance in which case that particular component is to be disregarded.

The in-service inspection is to include the repair of simple defects and abnormalities that can be easily and safely rectified. These defects must be raised with a separate work order.

5.2. Maintenance records

It is required that maintenance form FRG 1538 - Distribution substation installation and maintenance sheet, is completed during maintenance to record the nameplate details of the switchgear and transformer.

All completed test results must be stored on the network drive at:

G:\EE Maintenance\Distribution\Data

5.3. Nameplate validation

During maintenance works, the nameplate data that has been recorded in Ellipse must be confirmed. If the nameplate data is incorrect or missing in Ellipse, it must be captured and entered into Ellipse.

5.4. Precautions before commencing any work

Prior to commencing any work on site, a Worksite Hazard and Risk Assessment (FSY 0118) is to be completed. The appropriate Safe Work Method Statement referenced in this document is to be used, specifically, SWMS 3.003 – Distribution Switchgear Maintenance.

5.5. Materials approved for use

The following table sets out the approved materials for use on the HV switch and switch fuse units.

Application	Product	Stock code No.	Comments
Cleaning contacts	CRC NF 2017 Contact cleaner	SX10137	
Lubricating contacts	Acid free Vaseline	1010744	Brasso (1030784) may be used only if contact surfaces require heavy duty cleaning.
Cleaning resin of switchgear	MAC-05 cleaning fluid	1550854	
Treating rust	Chelade	1559814	
Cleaning of silver plated contacts (fuses)	Silvo	TBC	
Cleaning of dust covers	CRC glass cleaner	1519366	
Filling cable entry pits	Hilti Foam	SP100000	

5.6. Routine maintenance schedule

Annexure	Title	Applicable Switchgear
Annexure 1	Resin-enclosed HV switch and switch fuse units routine maintenance schedule	Eaton MD4 switchgear
Annexure 2	ABB Safelink routine maintenance schedule	ABB Safelink
Annexure 3	ABB RGB12 routine maintenance schedule	ABB RGB12
Annexure 4	Other sheet metal enclosed HV switch units routine maintenance schedule	- Holec SVS - Fluokit M24 - Merlin Gerin VM6 - Merlin Gerin RM6 - Merlin Gerin SM6 - Siemens 8DJ10/8DJ20 - Areva FBX-C
Annexure 5	HV oil switch and switch fuse units routine maintenance schedule	All oil switch and switch fuse units.

5.7. Partial discharge testing

Partial discharge testing must be conducted as part of the routine in service inspection.

The process in Annexure 6 must be used to identify and prioritise PD defects. Switchgear that is classified as “Category 1 or Category 2” must be defected, have warning tags applied, and not operated live until rectified (PIN defect).

If field employees are unsure of partial discharge results they should consult with the **Asset Standards and Design – Network Maintenance Manager**.

The TEV levels used in the priorities must be the measured result above the background level.

5.7.1. Limits

The prioritisation of the defects must be in accordance with Table 1. The defect must satisfy all the conditions in that category.

Table 1: Limits for partial discharge monitoring

Category	Requirement	Action
Category 1	If any significant carbon tracking is found.	Emergency Repair - 48hr defect
Category 2[^]	If the TEV level is > 20 dB OR Ultrasonic level > 12 dB AND Has at least one (1) critical factors*	Repair within 2 weeks
Category 3	If the TEV level is > 20 dB OR Ultrasonic level > 12 dB AND If any indicators of discharge [#] are found	Repair within 1 month
Category 4	If the TEV level is > 20 dB OR Ultrasonic level > 12 dB	Repair within 3 months
Category 5	If the 10 dB ≤ TEV Level ≤ 20dB OR 6 dB ≤ Ultrasonic level ≤ 12 dB	Re-test in 12-18 months
Category 6	If the TEV level is ≤ 9 dB OR Ultrasonic level ≤ 5 dB	No action

* - Critical Factors include:

- Discharge is audible by ear;
- Discharge emanating between cable terminations

- Indicators of discharge include:

- Presence of white residue
- Verdigris
- Smell of ozone
- Pulse count of measured TEV > 50

[^] - A Category 2 defect must be made a Category 1 defect if the padmount is located in a high pedestrian area. This includes, but not limited to, schools, pre-schools and shopping centres.

Example 1

A test with 15dB TEV, 13dB acoustic level, no audible discharge, would be classified as a Category 4 defect.

Example 2

A test with 21dB TEV, 6dB acoustic level, audible discharge, white powder but no significant carbon tracking, would be classified as a Category 2 defect.

5.8. Thermovision scan

A thermovision scan must be performed as part of the in-service inspection. The thermovision scan is used to identify connections which may be overheating due to a high resistance connection.

5.8.1. HV switchgear procedure

A thermovision scan of switchgear must be performed. The temperature of similar components operating under similar loads must be used as a comparison to determine an overheating component. **The asset under test should be operating in excess of half the normal load.**

The relative temperature rise should be measured between a 'healthy' phase and the overheating connection.

Where a relative temperature rise of more than **5°C** is detected, a defect must be raised and prioritised according to the table in SMI 140 Section 5.7.3.1 – Prioritisation of defects. Cable terminations in epoxy resin switchgear will be assessed to the criteria of 'bushing stems' in the same table.

5.9. Specific switchgear requirements

5.9.1. Eaton (Holec) 12kV switchgear cable terminations

5.9.1.1. Apparent bubbles or voids in R4M cable jointing compound

Bubbles or voids within the compound of the cable box have no effect on the performance of the termination and remedial action is not required.

It should be noted that R4M compound that exhibits the apparent bubbles or voids is also often candied or lumpy in appearance, as discussed in below.

5.9.1.2. Candied appearance of R4M cable jointing compound

R4M compound that is candied or lumpy in appearance still performs in accordance with its specification, and remedial action is not required.

5.9.1.3. Low levels of cable jointing compound in cable end boxes

Cable end boxes with low levels of compound should be defected and prioritised as set out in Table 3.

Table 3: Compound level defect prioritisation

Compound level	Condition	Action	Priority
Within 125mm from top of box	Safe	Record as defect in Ellipse	Rectify at next routine maintenance
Between 125mm and 220mm from top of box	Safe	Record as defect in Ellipse	Rectify within 12 months
More than 220mm from top of box	Not Safe	Record as defect in Ellipse and apply "Hazardous Condition Tag"	Rectify within 48 hours

The compound levels are identified using the markings on the cable termination as shown in Figure 5-1.

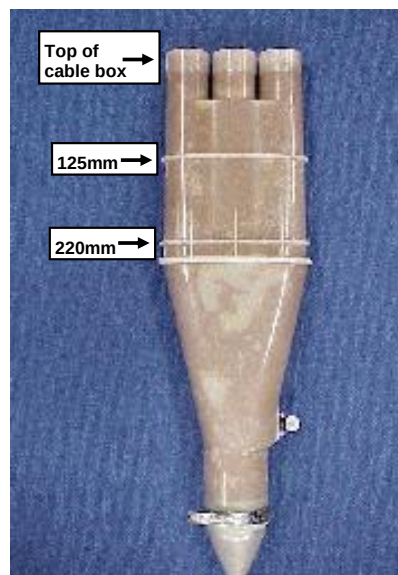


Figure 5-1 - Compound level indication

Defective compound terminations must be replaced with a heat shrink termination, where the replacement will not cause failure due to an unacceptable core cross. If the cable jointer identifies that changing the termination could lead to failure due to an unacceptable core cross, the termination box may be re-pumped. Re-pumping must be performed using *SWMS 3-018 - Holec MD4 cable box re-pump*, the safe work procedure (provided by Eaton Industries) and suitable extraction equipment.

5.9.2. ABB RGB12 switch units

This equipment is no longer manufactured and spares are rare.

Some spares are currently available for individual trucks and housings that may have problems, but the Network Maintenance Manager, Asset Standards and Design should be consulted before these spares are used.

Generally, the spares are required for fault and emergency work where there is inadequate time to make alternative rectification work.

5.9.3. ABB Safelink switch units

5.9.3.1. Floor plates and transformer rear cable entry

In order to improve the integrity of the cable compartment in Safelink switchgear, the floor and the rear cable penetrations must be fitted with an aluminium plate (referred to as gland plates) to assist in the prevention of vermin entering and damaging the soft rubber termination insulating boots that are used on this switchgear.

When AUPs are working on existing Safelink units, floor and cable penetration plates must be fitted to all cable compartments they are working on and any spare plates must be safely stored adjacent to switchgear for future fitting.

On all new projects where there are spare cable compartments, the plates must be fitted, but the cable penetration punch-out sections must remain intact. Safelink 1 and Safelink 2 require different sized plates and are not interchangeable. Each compartment requires a unique aluminium floor plate and the plates are marked accordingly with an identifier located on the end of each floor plate, and a large **F** is also shown to indicate the front of the switchgear. Refer to SDI 211 - ABB SafeLink 12kV Switchgear, Annexure 1-4 for installation details for Safelink 1 and Safelink 2.

5.9.3.2. Operating handle for Safelink 1 switchgear

The switching operations for all Safelink 1 switchgear must be carried out using one of the operating handles shown in Figure 5-2. The red handle must be used for CLOSE to OPEN (and

vice versa) operations, and the green for OPEN to EARTH (and vice versa) operations. Refer to SDI 211 - ABB SafeLink 12kV Switchgear section 5.4 for further details.



Figure 5-2: Operating handles for ABB Safelink HV switchgear

5.9.4. Substation AFIC switchgear fuse ratings

For AFIC systems using a motor generation set, the fuse ratings are as follows:

- 25kVA isolating transformer: 80A – SIBA full range; stock code 1567247
- 30kVA or 40kVA isolating transformer: 100A – SIBA full range; stock code 1566520

For AFIC systems using SFU, fuses must be replaced with the same rated fuse.

5.10. Replacement of old HV switchgear

Replacement of any existing HV switchgear must be carried out only with new metal enclosed arc vented switchgear.

If, for some reason, switchgear other than Endeavour Energy's current approved switchgear is required to be installed, prior permission will have to be obtained from the Manager, Asset Standards and Design.

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and responsibility for approving this instruction.

Asset Standards and Design Manager has the authority and responsibility for making recommendations to the **General Manager Asset Management** in respect to this instruction.

Network Maintenance Manager is responsible for keeping the content of this instruction up to date.

Regional Transmission Manager/Distribution Manager has the authority and responsibility for:

- confirming Endeavour Energy employees and/or contractors engaged to perform the work have appropriate qualifications;
- confirming that staff are conversant with, and work in accordance with, the Electrical Safety Rules;
- meeting the requirements of this standard;
- prioritising and performing the work in accordance with this standard; and
- checking the appropriate maintenance details are entered into the Ellipse database as part of the maintenance process.

All Endeavour Energy employees and contractors have the authority and responsibility for:

- working in accordance with local and statutory requirements;
- recording maintenance and test data in Endeavour Energy's electronic databases;
- maintaining a high level of public safety; and
- working in accordance with Endeavour Energy's Electrical Safety Rules.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : **Network** Maintenance Manager

Documentation Distribution Coordinator : **Branch** Process Coordinator

A.1. Annexure 1: Cast resin HV switchgear (Holec/Eaton MD4) routine maintenance schedule

Routine maintenance
1.0 Inspection, PD(TEV) and Thermovision
Test resin enclosed switchgear, switchcaps and cable termination stem discharge using UltraTEV Plus+ PD device and prioritise as shown in Table 1 in section 5.7.1
Check compound level in wetbox. Defects must be prioritised as shown in Table 3 in section 5.9.1.3
Examine that labelling is present and legible.
Check switch caps and fuse compartments for overheating using thermovision as shown in section 5.8.1.
For substation AFIC switchgear, contact System Operations to inject AFIC signal 2-3 times prior to conducting thermovision inspection.
2.0 Major maintenance
Examine arcing contacts and arc chamber for signs of burning / discolouration.
Examine resin surface for contamination.
Examine fuse interlock for cracks in plastic material.
Examine fixed permanent magnet for security.
Examine switchgear frame for signs of corrosion.
Examine hold down bolts of steelwork for security and signs of corrosion.
Examine side and top dust cover(s) for damage/distortion.
Examine cable termination stem for signs of tracking and verdigris.
Examine wooden cable cleats for security.
Examine switch cap (newer style) for signs of cracks/damage.
Examine switch cap for signs of cracks/damage.
Examine fuse holder cap for signs of cracks/damage. (Substation AFIC switchgear only) Check fuse rating and replace with same type fuse with rating in accordance with Section 5.9.4.
Check cam and leaf spring integrity by performing three (3) test operations of the switch cap.
3.0 Pre and post operation checks
Install switch dust covers where switch caps are removed.
Examine contacts in switch cap for security.
Clean operating handle.

A.2. Annexure 2: Safelink switch unit routine maintenance schedule

Routine maintenance
1.0 Inspection, PD(TEV) and Thermovision
Test cable termination for discharge using UltraTEV Plus+ and prioritise as shown in Table 1 in section 5.7.1
Examine that labelling is present and legible.
2.0 Major maintenance
Examine the equipment frame and exterior casing for vegetation, build-up of debris, paint degradation, and signs of corrosion.
Examine earthing cables and their connections for security and integrity.
Check switch position indicators for correct display by performing test operations of the mechanism.
Clean outer casing and mimic diagram with dampened cloth.
(Substation AFIC switchgear only) Check fuse rating and replace with same type fuse with rating in accordance with Section 5.9.4.
3.0 Pre and post operation checks
Check striker mechanism slots in fuse cover door are not obstructed when replacing fuses.
Check the SF6 gas density gauge is in the green region prior to any switching operations.

A.3. Annexure 3: ABB RGB12 routine maintenance schedule

Routine maintenance
1.0 Inspection, PD(TEV) and Thermovision
Test cable termination for discharge using UltraTEV Plus+ and prioritise as shown in Table 1 in section 5.7.1
Examine that labelling is present and legible.
2.0 Operational check
Close and open main switch three (3) times manually and where fitted three (3) times electrically
Record truck primary circuit resistance with switch closed. The results should be consistent with manufacturer's recommended values: • 120-150 micro-ohms for switch unit • 250-300 micro-ohms for switch fuse unit, adding 16 milliohms if fuse is inserted.
3.0 Major maintenance
General:
Perform operation check as per section 2.0
Examine the equipment frame and exterior casing for vegetation, build-up of debris, paint degradation, and signs of corrosion.
Examine earthing cables and their connections for security and integrity.
Upper insulation block:
Remove upper insulation block and examine for discharge, cracks, fractures, deformities or other defects.
Inspect switch chambers and main fixed contact tubes for signs of overheating, burning, distortion, burs or other defects.
Lower insulation block:
Remove positioning spring and withdraw the latch. Pull the tulip contact tubes up and secure by fitting a suitable chock and examine contacts for abnormalities.
Truck, housing and fuse contacts:
Examine for contacts for defective plating, broken springs, discolouration, signs of arcing or other defects.
Clean with DELVEX solvent or equivalent
Polish with SILVO silver polish and sparingly lubricate contact surfaces with acid free Vaseline. Note: The main tulip contacts and nozzle must not be lubricated
Nozzles:
Examine for distortion and inspect for fractures or other defects.
O rings:
Inspect O rings on nozzles for deterioration. Replace black O rings with green O rings.

<i>Fibreglass drive rods:</i>
Inspect for tracking or cracks (as the fibreglass drive rods cannot be replaced, if found to be damaged the truck must be replaced).
<i>Interlocks:</i>
Check operation.
<i>Fuse handle:</i>
Inspect tripping lever for deterioration (if cream in colour replace with clear plastic lever).
<i>Operating mechanism:</i>
Examine for defective parts, that is, circlips, split pins, springs, levers or other defects.
Clean the points indicated in the manual with DELVEX solvent or equivalent.
Lubricate the points indicated in the manual with 20W 40 SAE engine oil or Molycote BR2 Plus grease
<i>Insulation:</i>
Clean insulation with lint free cloth.
Clean cast resin with a lint free cloth moistened with Mac-05 cleaning solution.
<i>Auxiliary switches:</i>
Inspect for any abnormalities.
Check operation.
<i>Coils/solenoids:</i>
Measure coil resistance where applicable.
The results should be consistent with the previous results.
<i>Housing:</i>
Clean all dust and dirt from on, in and around the housing.
Lubricate truck interlock guides with acid free Vaseline.
<i>Motor:</i>
Check operation where applicable.
<i>Heaters and thermostats:</i>
Check operation (to be installed if not already fitted).
Check operation (where fitted).
Report signs of carbon around heater area.
Check that base plates are correctly fitted (to be installed if not already fitted).
<i>Insulation resistance:</i>
Record truck insulation resistance at 2.5kV. The results should be consistent with the previous test results.
<i>Operation:</i>
Carry out operational check as set out in section 2.0.
<i>Fuses:</i>
Confirm ratings.
(Substation AFIC switchgear only) Check fuse rating and replace with same type fuse with rating in accordance with Section 5.9.4.

A.4. Annexure 4: Other metal enclosed HV switch units routine maintenance schedule

The following maintenance schedule applies to the following switch units: Holec SVS; Fluokit M24; Merlin Gerin VM6; Merlin Gerin RM6; Merlin Gerin SM6; Siemens 8DJ10/8DJ20; Areva FBX-C.

Routine maintenance
1.0 Inspection, PD(TEV) and Thermovision
Test cable termination for discharge using UltraTEV Plus+ and prioritise as shown in Table 1 in section 5.7.1
Examine that labelling is present and legible.
Examine metal casing for rust or poor paintwork.
Check operation of neon potential indicators.
Check operation of fault indicators.
2.0 Operational check
Operate earthing switch, where fitted, three (3) times.
Operate main switch three (3) times manually and where fitted three (3) times electrically
3.0 Major maintenance
General:
Perform inspection tasks as set out in section 1.0
Perform operation check as set out in section 2.0
Examine the equipment frame and exterior casing for vegetation, build-up of debris, paint degradation, and signs of corrosion.
Examine earthing cables and their connections for security and integrity.
Examine cable terminations for damage/distortion.
Fuse chamber: (MERLIN GERIN RM6 ONLY)
Clean conical surface with Rhodorsil 47V50 silicon oil then cover the clean surface with natural talc Westmin 8.
Earthing contact covers: (MERLIN GERIN RM6 ONLY)
Clean with water.
Interlocks:
Check operation.
Operating mechanism: (HOLEC SVS ONLY)
Clean the points indicated in the manual with DELVEX solvent or equivalent.
Lubricate the points indicated in the manual with Molycote BR2 Plus grease
Operating mechanism: (MERLIN GERIN VM6 ONLY)
Clean the points indicated in the manual with DELVEX solvent or equivalent.
Lubricate the points indicated in manual moving parts with 20W 40 SAE engine oil.
Insulation:
Clean insulation with lint free cloth.

Auxiliary switches:
Inspect for any abnormalities.
Check operation.
Coils/solenoids:
Measure coil resistance where applicable. The results should be consistent with the previous results.
Housing:
Clean all dust and dirt from on, in and around the housing.
Lubricate truck interlock guides with acid free Vaseline.
Motor:
Check operation where applicable.
Heaters and thermostats:
Check operation (where fitted).
Operation:
Carry out operational check as set out in section 2.0.
Fuses:
Confirm ratings.
(Substation AFIC switchgear only) Check fuse rating and replace with same type fuse with rating in accordance with Section 5.9.4.

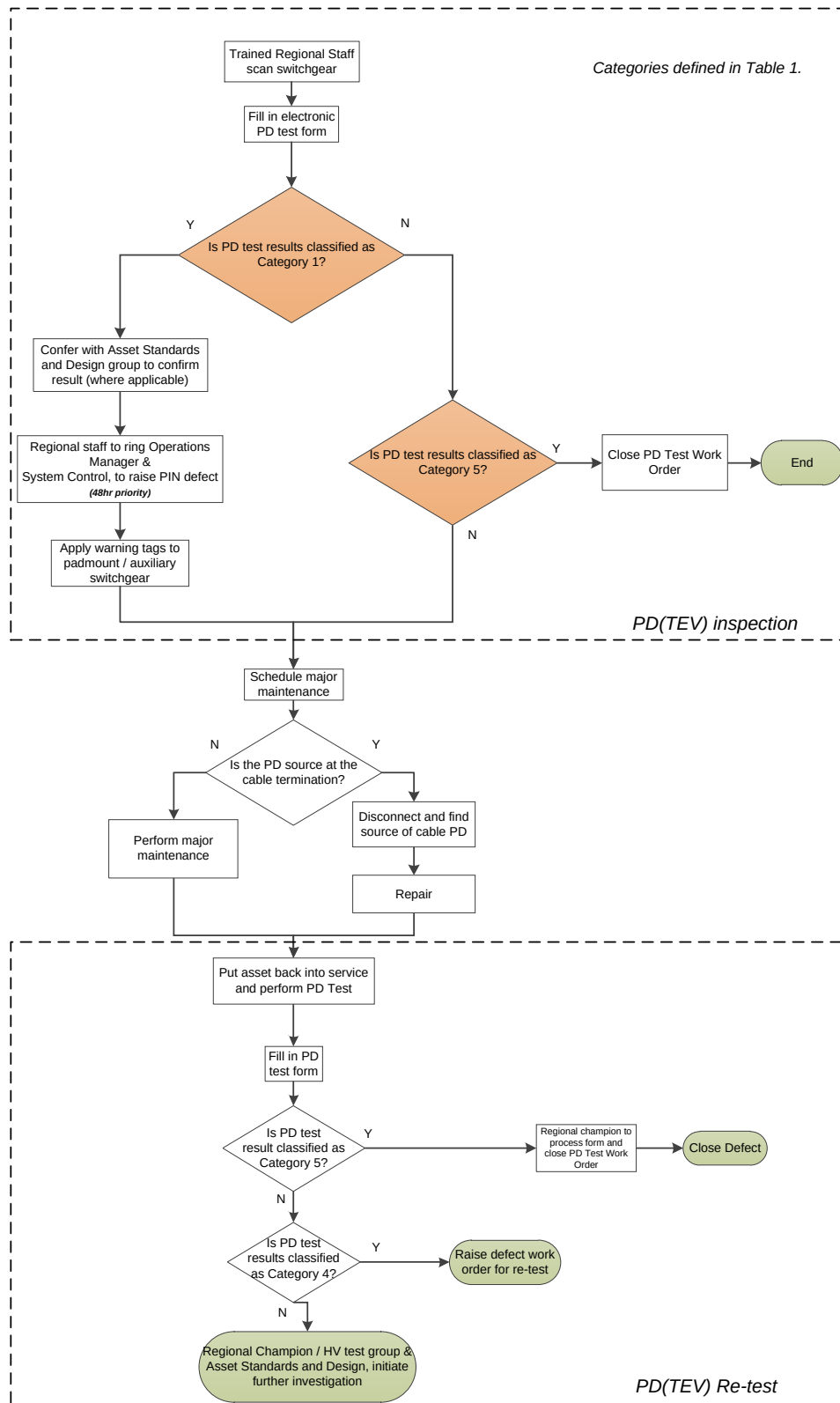
A.5. Annexure 5: HV oil switch and switch fuse units routine maintenance schedule

Routine maintenance
1.0 Inspection, PD(TEV) and Thermovision
General:
Inspect the equipment and note any defects.
Inspect for moisture or sweating.
Inspect for discharge for example, visual indication, unusual noise or aroma, and the like.
Tank:
Inspect for oil leaks or spills.
Steelwork:
Inspect unit for faulty welds and distortion.
Inspect for rust, corrosion, poor paintwork condition or other defects.
Inspect unit for faulty welds and distortion.
Cable box:
Inspect for compound leaks.
Labels:
Check labels/signs are legible and correctly fitted.
Neon indicators:
Check operation of neon potential indicator panel.
PD(TEV) test:
Test cable termination for discharge using UltraTEV Plus+ and prioritise as shown in Table 1 in section 5.7.1
Thermovision:
Examine main body and fuse compartment for overheating using thermovision as shown in section 5.8.1.
For substation AFIC switchgear, contact System Operations to turn on AFIC system for 3 minutes, prior to conducting thermovision inspection.
2.0 OPERATIONAL CHECK
Close and open earthing switch three (3) times quickly and a further three (3) times slowly.
Close and open main switch three (3) times quickly and a further three (3) times slowly. (It is not advisable to operate the switch fuse frequently without fuse links).
Record primary circuit resistance with switch closed. The results should be consistent with the manufacturer's recommendations.
3.0 MAJOR OVERHAUL
3.1 Preliminary operational checks
Carry out operational check as set out in section 2.0.

Routine maintenance
3.2 As found checks
Operating handle:
Check condition.
Tank:
Inspect for leaks.
3.3 Overhaul
General:
Dust unit externally.
Contacts:
Fixed, moving and earthing
Examine for abnormalities, that is, burning, loose or bent components or other defects - dress or replace if necessary.
Clean with recommended solvent and or very fine grade emery paper.
Adjust and align as required.
Moving (extra checks)
Clean the silver contact surfaces on each main moving contact hinge with recommended solvent.
Measure resistance from moving contact hinge to fixed contact. The results should be consistent with the manufacturer's recommendations.
Tank:
Flush out and clean with clean oil.
Refill with clean oil.
Clean electrical and mechanical components contained within the switch tank with clean oil.
After unit is re-assembled and all hardware has been checked for correctness and tightness wash down all the components that are normally contained in oil with clean oil.
Gaskets:
Inspect condition. Replace if necessary.
Inspect weather seals (outdoor units only). Replace if necessary.
Insulation:
Clean tank lining/inter phase barriers with clean oil (remove first if possible).
Inspect for treeing or tracking.
Inspect bushings for abnormalities, that is, cracks, chips, damaged flanges or other defects.
Mechanism:
Examine for defective springs, linkages, circlips, split pins or other defects.
Replace flange gasket.
Check alignment of drive crank with operating shaft.
Clean with recommended solvent.

Routine maintenance
Lubricate moving parts with recommended lubricant.
Interlocks:
Check condition.
Trip lever:
Inspect condition.
Check operation.
Seals:
Inspect oil seals and glands.
Pressure relief:
Inspect condition, that is, free from obstructions.
Damping device:
Inspect condition.
Check operation (it is not advisable to operate the unit frequently without oil in the switch tank).
Neon indicators:
Inspect condition of test switch, lamp holders and wiring.
Check condition of neon potential indicator panel (this is to be carried out while switchgear is in service).
Fuse carriage: (where applicable)
Check electrical connections, that is, flexible braids and the like.
Inspect condition of throw off spring.
Busbar chamber:
Inspect band joints and gaskets.
Inspect compound for correctness (outdoor units only).
Replace band joint gaskets (outdoor units only).
Secondary terminal box:
Inspect condition.
Earth connections:
Inspect condition.
3.4 Final checks
Insulation resistance:
Record insulation resistance at 2.5kV. The results should be consistent with the manufacturer's recommendations.
Operation:
Check interlocks.
Carry out operational check as set out in section 2.0.
Fuses: (where applicable)
Confirm ratings.
(Substation AFIC switchgear only) Check fuse rating and replace with same type fuse

Routine maintenance
with rating in accordance with Section 5.9.4.
Measure resistances in accordance with Division Procedure GNV 1090.2 and compare with initial values.

A.6. Annexure 6: Flowchart for PD measurements

A.7. Annexure 7: Detailed maintenance instruction for Holec MD4 Switchgear

The following annexure sets out a detailed maintenance procedure for Eaton Magnefix MD4 HV switchgear. This must be read in conjunction with the major overhaul routine maintenance schedule detailed in Section 2.0 of Annexure 1.

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A.8. Annexure 8: Switchgear components

The following sections detail the various components of the switchgear.

A.8.1. Fixed assembly

Figure 7-1 shows a typical set up for the fixed assembly of the MD4 switchgear. The construction can vary depending on the number of HV feeders.

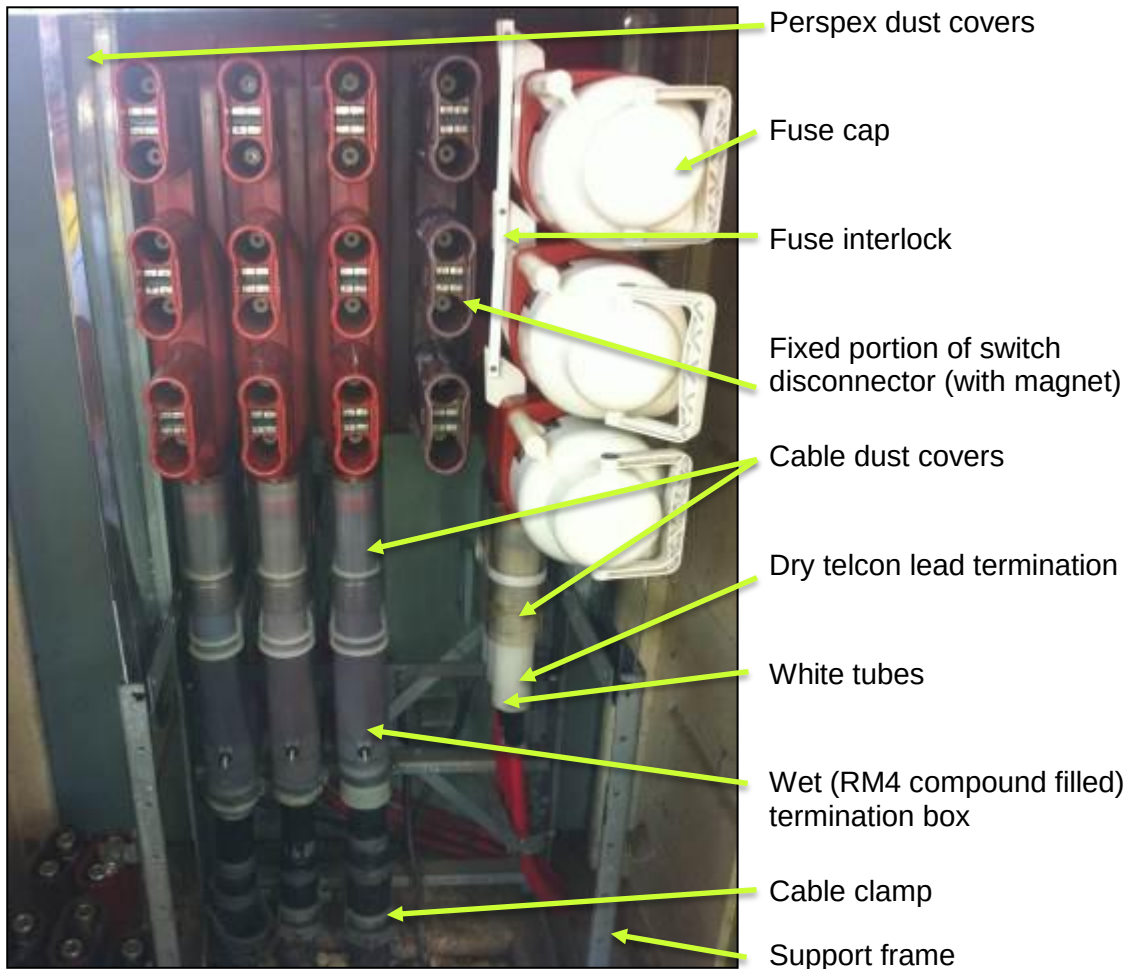


Figure 7-1: Fixed switchgear components

A.8.2. Switch cap assembly



Figure 7-2: Components of switch cap



Figure 7-3: Three phase and single phase switch cap

A.8.3. Leaf spring

The leaf spring (behind the nylon cam) for a three phase unit is larger than that of a single phase unit. This can be identified by the blue stripe (shown below).



Figure 7-4: Three phase (blue) and single phase leaf springs

A.8.4. Short circuit indicators

There are two (2) different short circuit indicators used in Endeavour Energy - the older electromechanical short circuit indicators and the newer, electronic indicators (eSCI).



Figure 7-5: a) eSCI unit b) switch cap with eSCI c) electromechanical

When current passes through the switch cap that exceeds the rating of the indicator, a red flag will appear on the switch cap.

The electromechanical indicator needs to be reset with a magnet slid through the slot in the front of the switch cap. An electronic indicator will self-reset after being exposed to system voltage after a five (5) minute period.

As shown in Figure 7-6, the white insulating cap with an electronic short circuit indicator is slightly larger and this could potentially cause clearance issues.



Figure 7-6: Switch cap with (top) and without indicator

Short circuit indicators are only required in strategic locations and should not be actively installed into HV switchgear.

A.8.5. Operating handles

Figure 7-7 shows the different handles used to open and close the switch caps.



Figure 7-7: a) Single phase and b) Three phase operating handles

A.8.6. Fuse cap assembly

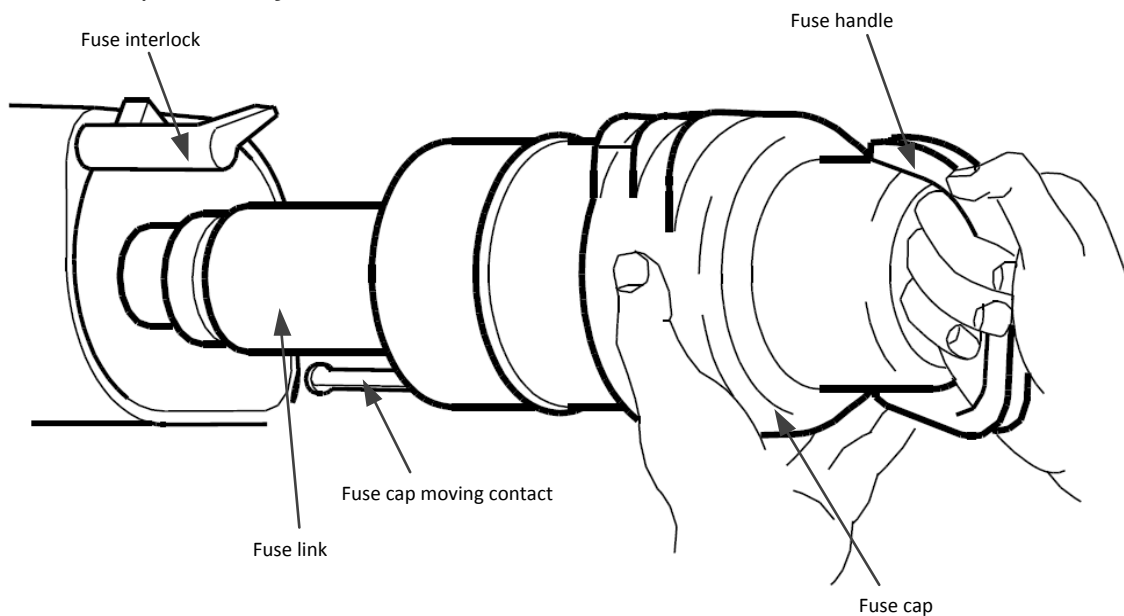


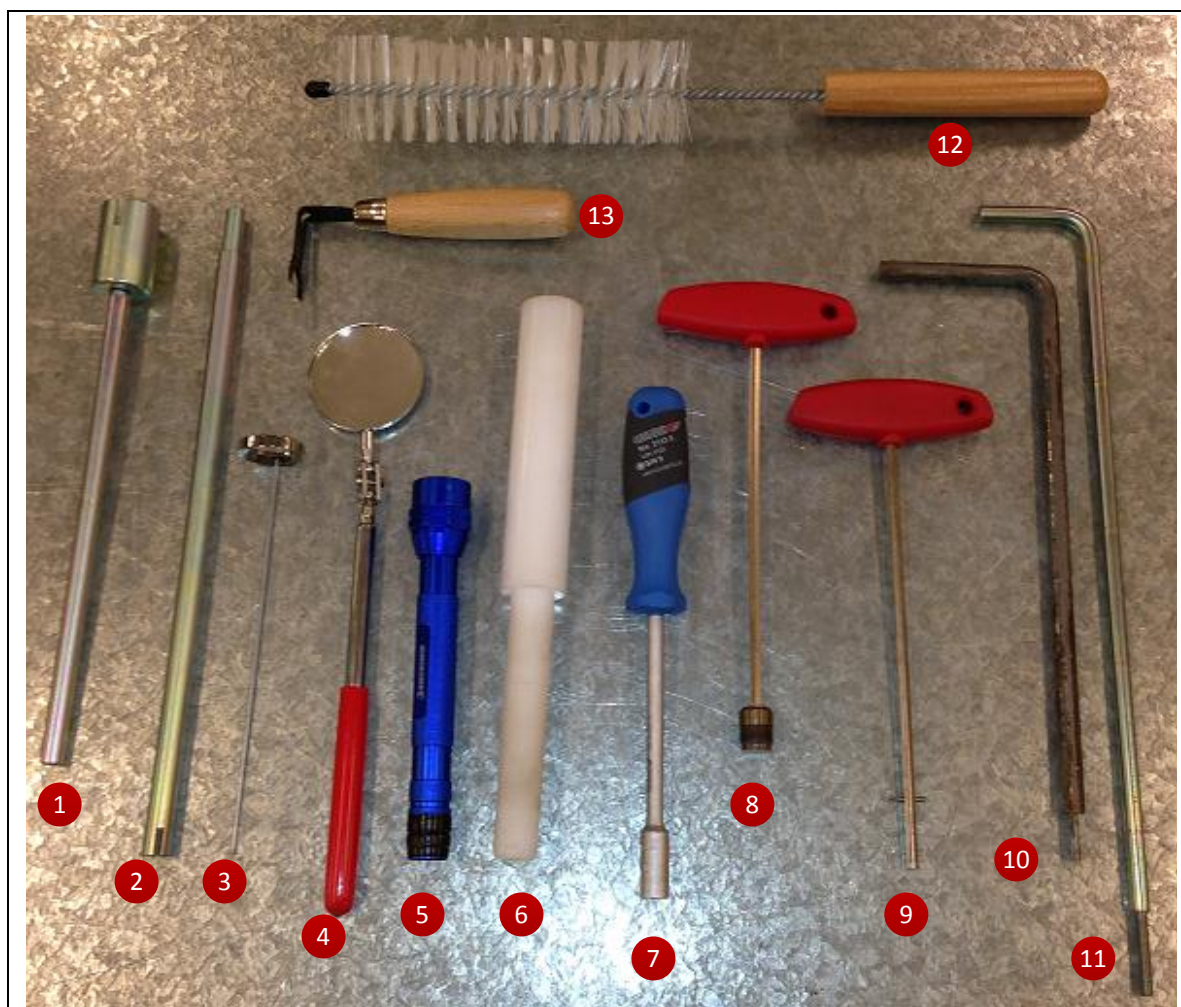
Figure 7-8: Fuse cap and associated fuse



Figure 7-9: Fuse link

A.9. Annexure 9: Required tool kit

The following section details the required tools to perform the major maintenance for the switchgear.



Tool description	Manufacturer Part Number
1. Scouring pad holder	052.132
2. Slotted pin	3052.135
3. Mirror (main contacts)	052.131
4. Mirror	N/A
5. Torch Light	EE Stock Code - TT10396
6. Hollow drift	052.138
7. Socket key (9mm)	2052.044
8. Main contact extractor	685.420
9. Arcing chamber key	685.416
10. 'Haze' key (long handled allen key)	TK10227
11. Threaded key	3052.144
12. 50mm Brush (alternative to feather duster)	052.139
13. Benzing ring spanner	052.005
14. Feather duster (not shown)	N/A

Additional recommended items:

- Fold away table
- Dust pan and broom / vacuum cleaner.

A.10. Annexure 10: List of standard consumable goods

The following table details approved products to be used during maintenance.

No.	Product Description	Stock Code No.
1.	CRC NF 2017 Contact Cleaner ¹	SX10137
2.	Brasso ²	1030784
3.	Lubricant (Acid-free Vaseline)	1010744
4.	Pressurised air (can)	3843268
5.	Chelade	1559814
6.	PF cleaning solvent wipes	1556497
7.	Bag of lint free cloth	1031030
8.	Chux Wipes (Roll)	SC21009
9.	Paper Towel (Roll)	1030991
10.	Garbage Bags	SL20312
11.	Mac-05 cleaning fluid (500mL)	1550854
12.	CRC Glass Cleaner	1519366
13.	Edge Sealer	SE10529
14.	Hilti Foam	SP100000

Notes:

1. Contact cleaner must not be used on the white protective caps on both the switch and fuse caps.
2. Brasso must be used **only** if contact surfaces require heavy duty cleaning. Brasso can be damaging to silver plated surfaces, and as such must only be used sparingly.

A.11. Annexure 11: Recommended list of spares

The following table details a list of recommended spares that should be readily available at the time of maintenance.

No.	Product Description	Recommended Quantity	Stock Code No.	Part No.
1.	Fixed main contacts	12	1547215	2682.486
2.	Nylon arcing chamber (straight)	12	TBC	
3.	Nylon arcing chamber (tapered)	12	TBC	3681.702
4.	Arcing contacts	12	TBC	2681.155
5.	Switch cap (complete)	12	SC14266	2683-497
6.	Metal spring plate (single phase)	12	1547173	3048.031
7.	Metal spring plate (three phase)	3	1547181	3048.548
8.	Plastic clip spring holder for switch cap (cam)	12	1547199	3681.520
9.	Fuse cap	3	SC15572	2683-274
10.	Perspex dust cover (Top – ABCA)	1	SD11490	432-2006
11.	Perspex dust cover (Top - AABCA)	1	SD11504	
11.	Perspex dust cover (Side)	2	SD11512	432-0001
12.	White tubes	1 box	TBC	
13.	Cable dust covers	4	1022659	
14.	Fuse Interlocks	1 set	TBC	432.0103
15.	Switch insulating cap (white)	12	1547207	2685.157
16.	Electronic fault indicators	12	TBC	
17.	70mm ² earth conductor (to extend earthing bar)	1 metre	TBC	
18.	Single phase operating handle	1 (as required)	SH10336	3681-074
19.	Three phase operating bazooka	1 (as required)	TBC	
20.	Set of 450A electronic short circuit indicator (3 units)	4	TBC	MD4_ELEC_SCI000
21.	Set of 1000A electronic short circuit indicator (3 units)	4	TBC	MD4_ELEC_SCI450
22.	White switch insulating cap (to suit short circuit indicators)	12	TBC	2685.155
23.	Three phase conversion kit	1	1551720	

A.12. Annexure 12: Routine maintenance procedure

The following section details the required steps for maintenance of MD4/Holec switchgear.

Note: It is advised that maintenance staff (where practical and available) be present prior to, and during, high voltage switching operations of the equipment to assist fault identification and location of defects (for example: partial discharge).

A.12.1. Precautions before commencing any work

Prior to commencing any work on site, a Worksite Hazard and Risk Assessment (FSY 0118) is to be completed. The appropriate Safe Work Method Statement referenced in this document is to be used, specifically, **SWMS 3.003 – Distribution Switchgear Maintenance**.

All tools and equipment must be kept in a reasonable working condition so that they are safe to use at all times. Any tools and equipment that require inspection must be current in their period of inspection and tagged/logged accordingly.

Set up a clean work station including the fold out table, required cleaning products and a bag for waste products as shown in Figure 7-10 .



Figure 7-10: Typical work station

A.12.2. Pre de-energisation

Where reasonably practicable, an initial partial discharge test must be performed on the HV switchgear before the asset is de-energised. This helps to identify any defects which may be present. If PD is found within the HV switchgear, this should be noted and attempted to be corrected during maintenance.

A.12.3. Fixed assembly

Step 1: Initial Checks

As the district operator removes the switch caps, place each cap with the open end downwards on the fold out table in a sequenced order. This will help identify the positions of where each switch cap and fuse cap were removed.

Examine the main moving contacts of each switch cap. Burnt or discoloured contacts as shown in Figure 7-11, will identify the associated fixed main contacts that will need to be closely examined when maintaining the fixed assembly.



Figure 7-11: Discolouration of moving main contact

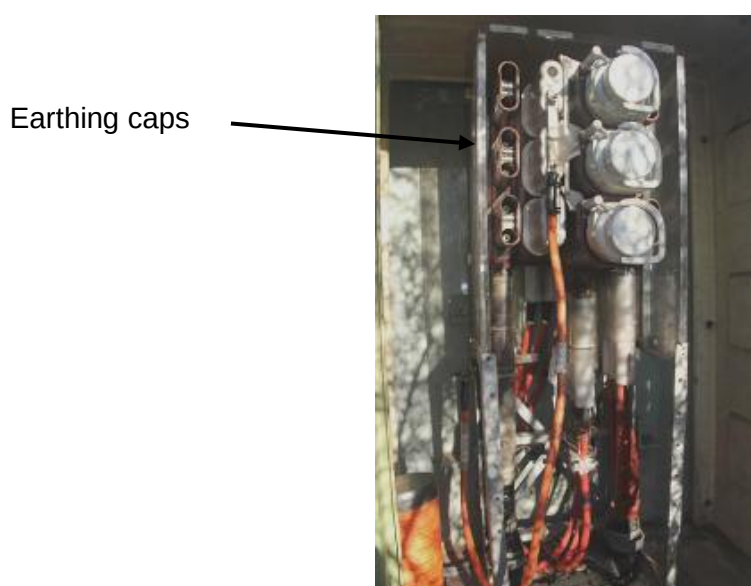


Figure 7-12: Earthed switchgear after de-energisation and earthing

After the district operator has issued the Access Authority (AA), turn the fuse interlock cam counter-clockwise then withdraw each fuse cap together and place on the fold out table.

Remove the earthing caps and portable operational earths using the earthing installation rod shown in Figure 7-13.



Figure 7-13: Earthing installation rod

Step 2: Initial Cleaning

Remove perspex top and side dust covers from HV cubicle compartment area. Check for signs of damage and replace where necessary.

Clean HV switchgear cubicle area with a dustpan and broom (or vacuum if available) and remove any dust, dirt or vermin.



Figure 7-14: Vacuuming of HV switchgear enclosure

Wipe down the epoxy casing of the HV switchgear and steelwork using a dry cloth.

Examine all components of the fuse interlock assembly for cracks, fractures, deformities, missing or defective circlips. If the fuse interlock needs replacement, refer to [A.13](#) for the procedure.

Step 3: Disassembly

Remove nylon arcing chambers from switch housings using the arcing chamber key.



Figure 7-15: Removal of arcing chamber

Examine each arcing chamber thoroughly. Abnormal discolouration of an arcing chamber will require replacement and the associated fixed arcing contact will need to be checked.

Note: Care should be taken not to mix older style straight arcing chambers with newer style (tapered) arcing chambers.



Figure 7-16: New (left) and old (right) arcing chambers

Remove each fixed arcing contact using the socket key (4mm).

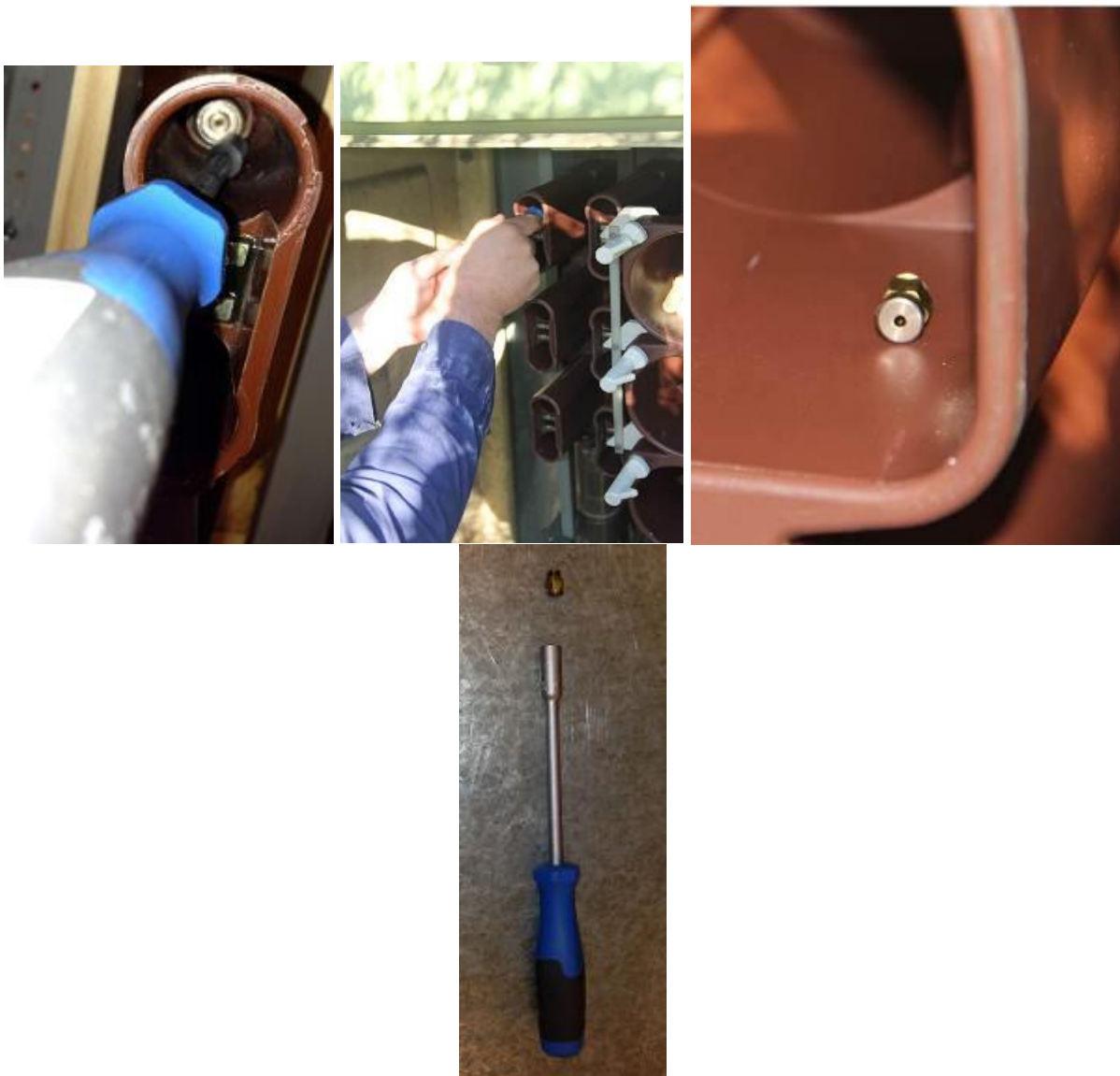


Figure 7-17: Removal of the arcing contact

Examine the condition of the fixed arcing contact. Badly burnt or defective arcing contacts must be removed and replaced.

Using the mirror and the torch, inspect the fixed main contacts.



Figure 7-18: Inspection of main contact with mirror

Remove any fixed main contacts that have any signs of discolouration, pitting, burn marks, or have been identified previously (damage to moving main contact, burnt arcing chamber), using the main contact key. Refer to A.12 for a detailed procedure.

Note: Removing the main contacts will sometimes require significant force. Moving the main contact up and down will help release the contact.



Figure 7-19: Removal of main contact



Figure 7-20: Damaged fixed main contacts

Light corrosion on contacts may be removed using CRC NF 2017 contact cleaner and a lint free cloth. Only in extreme cases of corrosion must a small amount of brasso be used, wiped off and then immediately followed by contact cleaner.

Note: Touching of the main contacts with hands should be avoided.



Figure 7-21: Cleaning of the main contact

To clean the main contacts which have not been removed from the fixed assembly, wrap a cloth moistened with CRC NF 2017 contact cleaner around the scouring pad holder. Insert the scouring pad holder with the cloth into the fixed assembly to clean the main contacts.

Inspect the permanent magnet for signs of discolouration, verdigris or looseness. Figure 7-22(b) shows an example of a failed permanent magnet. If discolouration or verdigris is present, clean with a contact cleaner. If the magnet is loose, the switchgear will need to be replaced.



Figure 7-22: (a) Clean permanent magnet (b) missing permanent magnet

Check the support frame, bolts, nuts, and other hardware for security and any signs of rust. If any rust is present, apply a coating of Chelade.

Step 4: Cleaning

Wipe all accessible parts of the cast resin using a lint free cloth moistened with Mac-05 cleaning solution as shown in Figure 7-23.



Figure 7-23: Cleaning of the fixed assembly

Wrap a cloth soaked in Mac-05 cleaning solution around a feather duster. Clean inside and between the fixed assembly (including the switch disconnectors and fuse bays) as shown in Figure 7-24.



Figure 7-24: Cleaning the fixed assembly using the feather duster

Finish rubbing the cast resin with a new dry lint free cloth in a polishing action.



Figure 7-25: Switchgear after the cast resin has been treated

Step 4: Reassembly

To reassemble the main contacts, arcing contacts and arcing chambers, refer to Annexure A.14.2.

A.12.4. Fuse caps

Inspect the cast resin of each fuse cap for cracks, fractures or other deformities. A fuse cap with defective cast resin must be replaced

Check the fuse rating. These must be consistent with Table 1 below (extracted from MCI 0006 Section 7.2.1).

Table 2: 11kV and 22kV Padmount and Indoor Substation fuse selection chart

Transformer Size (kVA)	MV HRC Fuse Rating	
	11kV	22kV
300	50A	25A
500	63A	32A
750-1000	100A	50A

Wipe the fuse contact with a dry lint free cloth.

Wipe all accessible parts of the cast resin using a lint free cloth moistened with Mac-05 cleaning solution.

Note: Do not apply CRC NF 2017 contact cleaner on or near the fuse cap handle as this damages the springs/bolts and will cause the handle to break.



Figure 7-26: How CRC NF 2017 contact cleaner damages fuse cap handle

Inspect the contacts of each removable fuse for signs of burning, overheating or defective plating. If any fuse is found with defective plating, all fuses must be replaced.



Figure 7-27: Fuse before cleaning

If significant corrosion is present, apply a small amount of Brasso, otherwise apply Silvo to the contacts of each removable fuse, and wipe each contact.



Figure 7-28: The use of Brasso to clean fuse contacts

Clean off excess brasso using a new dry lint cloth.

Finish cleaning each contact with CRC contact cleaner and a lint free cloth.



Figure 7-29: Applying contact cleaner and showing the final cleaned fuse

Lubricate the removable contact of each fuse link by applying a thin film of vaseline.

Replace each fuse link with the fuse striker facing away from fuse cap handle.

Replace fuse caps in fixed assembly.

Apply the interlock.

A.12.5. Switch caps

Inspect the cast resin of each switch cap for cracks, fractures or other deformities. A switch cap with defective cast resin must be replaced.

Inspect the white cap of each switch cap for cracks, fractures, discolouration or other deformities.



Figure 7-30: a) Cracked protective cap

A defective white protective cap must be cut away and replaced as shown in Figure 7-31.



Figure 7-31: Procedure to replace a protective cap

Examine each switch cap's main moving contact for burning or discoloured contacts.



Figure 7-32: Discoloured main contact

Check the security of the switch cap mechanism by inspecting mounting screws (indicated in Figure 7-33). Also check the condition and positioning of the internal spring mechanism. If the spring mechanism is loose, replace the switch cap.



Figure 7-33: Location of the mounting screws

Inspect the internal condition of the switch cap, by inspecting the mechanical stop, the condition (as far as possible) of the connecting block for the moving main contacts, the ferromagnetic plate, and the circlips around the moving contacts.

Inspect spring loaded nylon cam and leaf spring for cracks, fractures, deformities or other defects. The procedure to replace the nylon cam or leaf spring is detailed in Annexure 10.

Clean fuse cap and white protective cap with a lint free cloth moistened with the Mac-05 cleaning solution, lightly wiping all accessible parts, both inside and outside the switch cap.



Figure 7-34: Applying cleaning agent to the outside of the switch cap

Clean the moving main contacts with a lint free cloth moistened with CRC contact cleaner.



Figure 7-35: Cleaning the main contacts

Lubricate the moving main contacts of each switch by applying a thin film of vaseline.

If performing a three phase to single phase switch cap conversion, check the switch cap is fitted with the correct leaf spring (three phase leaf springs will have a blue stripe).

Operate each switch cap, by closing and opening, three (3) times using the operating handle, as demonstrated in Figure 7-36. Check that the nylon cam is facing in the correct orientation and place the non-operating hand underneath the switch cap as it is withdrawn from the fixed assembly.

While operating, inspect the switchgear for signs of excessive movement that would prevent safe operation or possibly cause damage to the equipment.

During the closing operation:

- Check that the nylon cam holds the switch cap open until the operating handle spring is fully charged and then overcome with force, giving a fast close.

During the opening operation:

- Check that the permanent magnet holds the ferromagnetic plate on the switch cap until the arcing contact has been fully charged, giving a fast open.

After the close/open operation:

- Inspect the condition of the permanent magnet for cracks or movement and has not become loose;
- Check the protective cap has not become loose or cracked; and
- Check the spring loaded nylon cam for signs of damage. If the nylon cam or leaf spring needs to be replaced, refer to [Annexure A.15](#).

If any repairs are made, repeat the operations for the relevant switch cap.

After all operations are successfully completed, recheck the fixed assembly for any signs of looseness or misalignment.



Figure 7-36: Performing three (3) test operations

Leave the switch caps in the HV switchgear cubicle with the contacts sitting upwards.



Figure 7-37: How to leave switch caps

If the switch caps are to be left for an extended period of time, the caps should be sealed as to not allow debris/moisture to enter.

A.12.6. Fault indicators

If a defective indicator is found, replace all fault indicators.



Figure 7-38: Switch caps indicating a fault

Reset any electromechanical indicators with a permanent magnet slid through the switch cap. The electronic short circuit indicators are self-resetting.

A.12.7. Cable termination

For information relating to the rectification of PD issues in the cable terminations, refer to Annexure A.16.



Figure 7-39: Wet termination (left) and dry termination (right)

Check that power cables are correctly aligned and cable clamps are securely tightened.

- For XLPE cables: Check the flexible earth braids from the screening of the power cables to the earth bar are in a serviceable condition.

- *For paper cables (PILC):* Check that the lugged 70mm earth connection is in a serviceable condition. The earth connection should be bolted to a “bangle” which has been plumbed to the lead sheath.



Figure 7-40: Acceptable earth connections

A.12.7.1 Dry termination

Inspect the condition of the heat shrink terminations.

Check that there is a minimum clearance of 20mm between phases at the area in which the semi-conductive layer has been removed. Do not apply excessive mechanical stress to the cable or the switchgear when trying to achieve the minimum clearance.

Insufficient cable clearance between phases can lead to partial discharge activity and lead to a breakdown of the heat shrink termination. This breakdown can appear as a white powdery substance (Alumina trihydrate) on the surface of the cable.

If any white residue is present on the cables, attempt to gain the minimum 20mm clearance between the cable cores. This will require disconnecting the cable termination.



Figure 7-41: Sufficient and Insufficient cable separation

Remove all phase indication tape that may be present on the cables.

Remove cable dust covers and clean with CRC glass cleaner.



Figure 7-42: Dry termination with dust covers removed

Pull down the white tubes to expose the cable termination. Discolouration of the white tubes can give an indication as to whether there may be a cable termination problem and will need to be replaced.

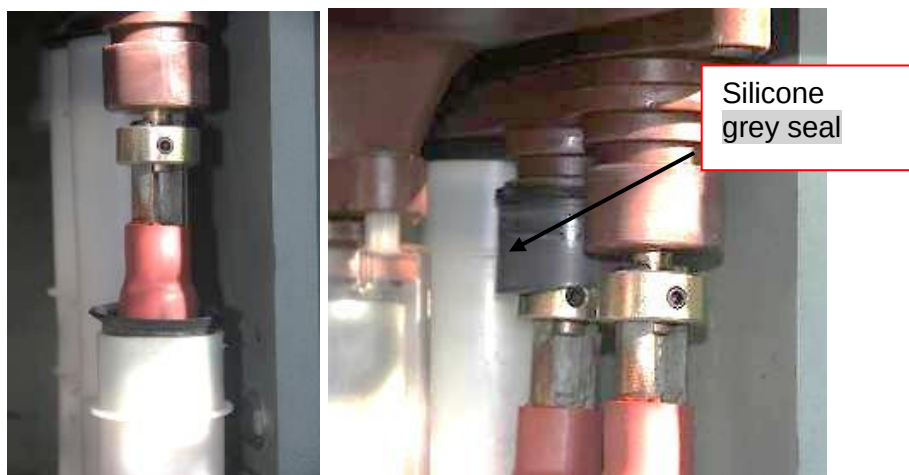


Figure 7-43: Inspection of cable terminations

Check the condition of the grey seals and it has sufficient silicone grease, as to appear “wet”. Check for signs of arcing/tracking. Replace the grey seal if it is damaged or dry.

Check condition of the cable core connection terminations. Check the tightness of the lugged connections with the Haze Key as shown in **Figure 7-44**. If there is evidence of discolouration, looseness or verdigris:

- Undo the termination;
- Check the condition internally and clean with CRC contact cleaner as required;
- If the connection was loose and the lug can be easily removed without damaging the core strands, the lug must be replaced.
- Redo the termination;



Figure 7-44: Checking the tightness of the cable connection

Clean HV cables with PE solvent wipes.



Figure 7-45: Cleaning the cables with solvent wipe

Refit the white tubes, with the flat edge of the “ridges” are inline as indicated in Figure 7-46.

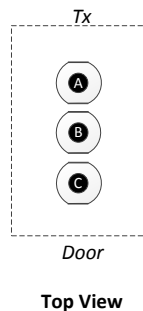


Figure 7-46: Alignment of white tubes

A.12.7.2 Wet termination

Check that the sealing plugs and hose clamp (at the base of the termination box) are secure and in a good condition.

Check the level of insulating compound (R4M) within the cable end box. “Air bubbles” in the compound is normal where the compound has not adhered to the inside wall of the cable box. This has no effect on the performance of the termination. However, if there are signs the compound is leaking, the priority must be dependent on the level of compound as specified in Table 3 in section 5.9.1.3 of this instruction.

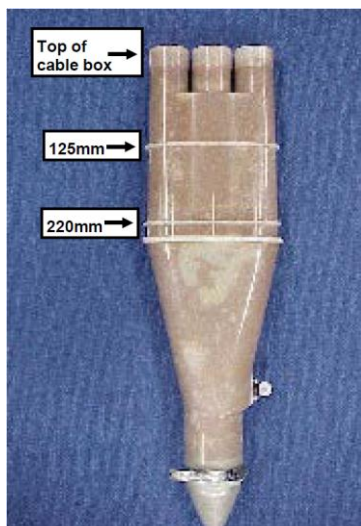


Figure 7-47: Compound level indication

If a compound termination is defective (broken cable box or unacceptable low compound) the cable termination must be replaced with a heat shrink termination, provided the replacement will not cause an unacceptable cross in the cable cores.

A.12.8. Earthing

Fit an extension to the earth bar if the earth is not readily accessible at the side of the switchgear. This can be achieved either by using a spare/salvaged earth bar or using a 70mm² copper earth conductor affixed to a lug on the side of the switchgear.

Check all earthing is in serviceable condition and correctly bolted in position.

A.12.9. Final checks

Clean the perspex dust cover assembly with CRC glass cleaner.

Refix the perspex dust cover to the HV switchgear support frame. Screws must be used for the front fixtures but cable ties can be used for the rear and lower attachments.



Figure 7-48: Perspex dust covered affixed using cable ties

Fit a cover cap over any empty switch or fuse cap compartment.

Check that the feeders are correctly labelled, as per SOPS diagram.

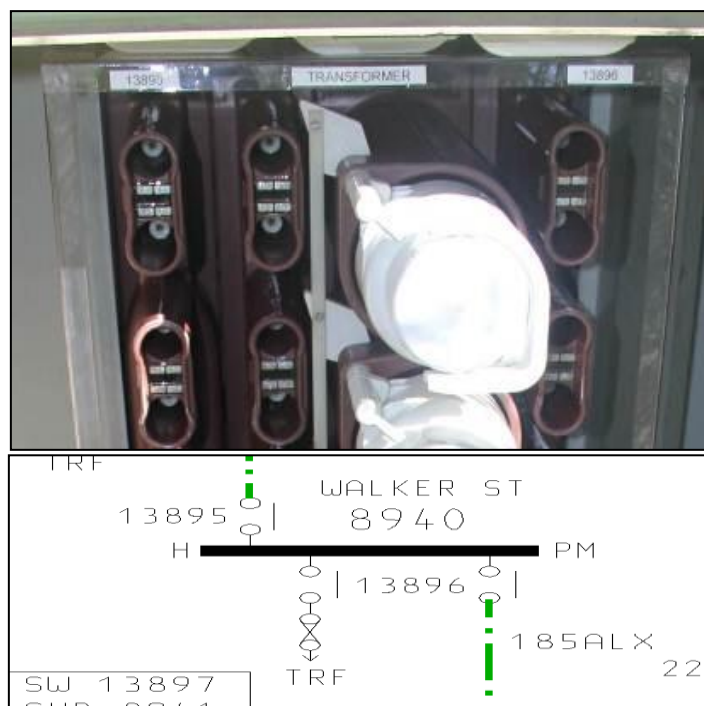


Figure 7-49: Labelling as per SOPS

If any labels and numbers need to be re-attached, seal these with Edge Sealer.

Note any sign of water entering enclosure and the cable entry is suitably sealed with foam to stop any flow of air from the cable tunnel.

Complete form FAE 3146 noting any defects identified or any future maintenance that must be performed.

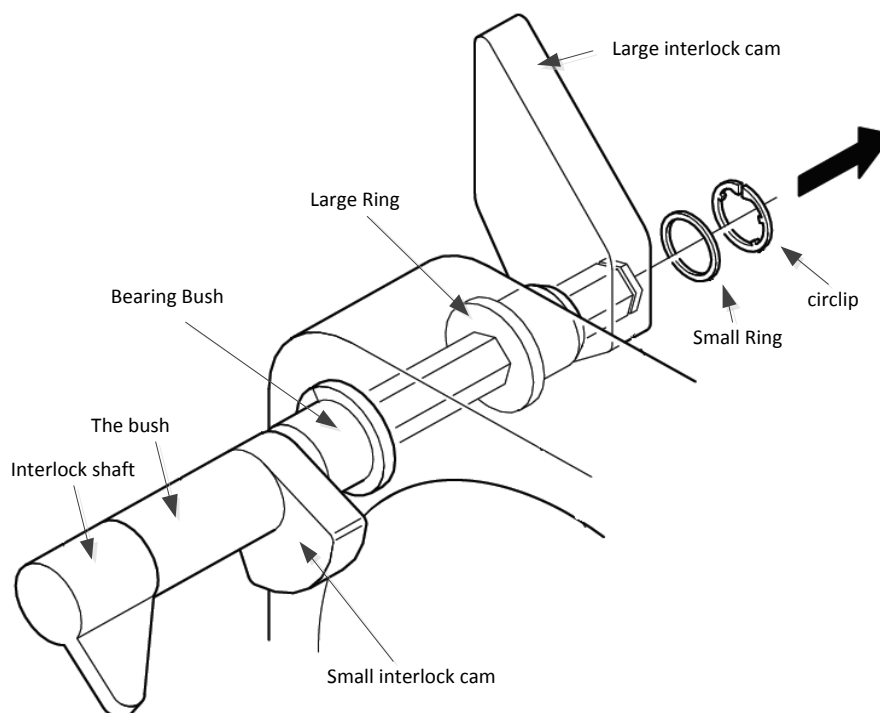
Complete form FRG 1538 with the nameplate details of both the HV switchgear and the padmount.

A.12.10. Re-energisation PD scan

Where partial discharge activity was initially found, a final PD “re-test” must be performed on the HV switchgear after re-energisation.

If the initial PD test was categorised as a “Category 1” defect, the re-test must be performed within (2) days of the switchgear maintenance. For the other categories, the “re-test” must be performed when reasonably practical.

Any previous partial discharge activity that was identified should have been corrected during maintenance. If this is not the case, contact the relevant Operations Manager for further advice or alternatively notify System Operations.

A.13. Annexure 13: Procedure for replacing an interlock on the fuse panel

Remove the circlip and the small ring behind the large interlock cam

Remove the large interlock cam

Remove the interlock shaft with the small interlock cam, the bush, the bearing bush and the large ring.

Discard all the disassembled parts

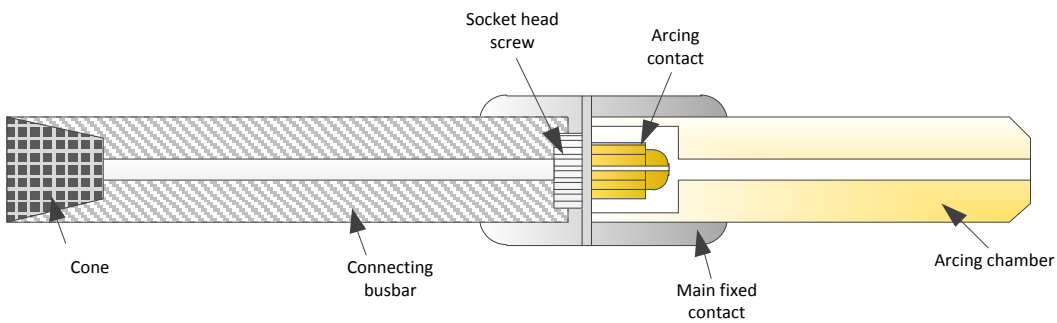
Fit the bearing bush and security it using the large ring.

Slide the bush and the small interlock cam onto the interlock shaft

Fit the new interlock shaft

Fit the large interlock cam again.

Fit the small ring and the circlip again using the Benzing ring spanner.

A.14. Annexure 14: Removing and installing a connecting busbar*A.14.1. Disassembling main contact and busbar*

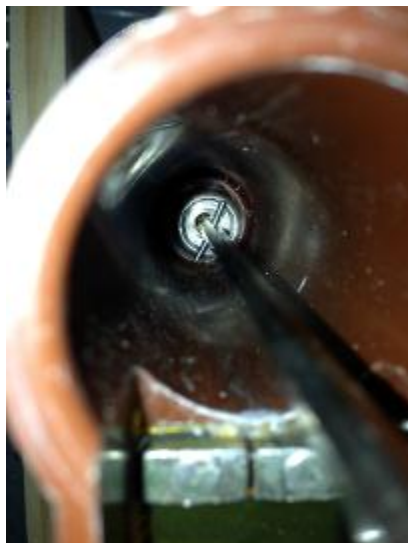
Unscrew and remove the arcing chamber using the arcing chamber key.



Unscrew and remove the arcing contact using the socket key.



Slightly loosen the hexagon socket head screw using the arcing chamber key.



Tap on the hexagon socket head screw, so that the back cone comes off.

Screw the main contact key into the main contact



Remove the main contact

Note: the busbar should not be removed as part of routine maintenance and the following steps should only be followed if the busbar is suspected to be faulty.

Undo the hexagon socket head screw and the front cone.

Screw the key with threaded end for disassembly of the busbar into the back cone.

Remove the connecting busbar and the cone.



Note: Once the hexagon socket head screw and the connecting busbar have been loosened, they **may be reused, provided they are in a good condition.**

A.14.2. Installing main contact and busbar

Fit the main contact onto the complete connecting busbar.

Apply a thin film of Vaseline to the exterior of the main contact.

Fit the connected main contact and busbar into the cast resin insulating switchgear assembly.

Set the main contact to the correct depth with the aid of the hollow drift.

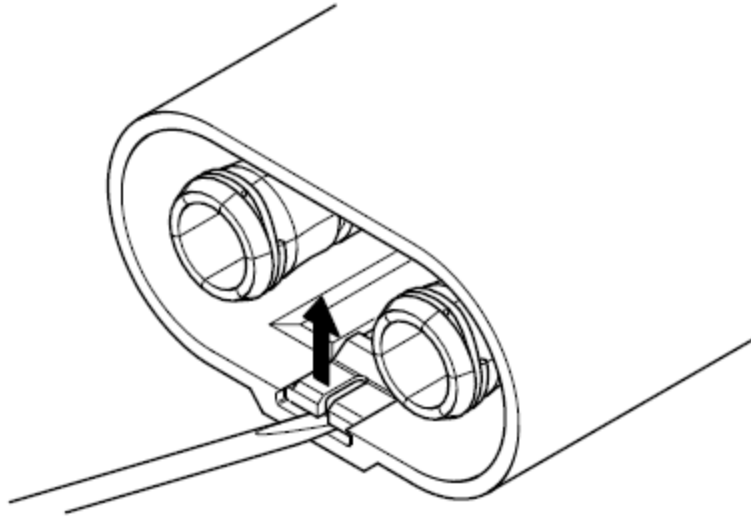
Tighten the hexagon socket head screw using a 7.5Nm torque wrench.

Assemble the arcing contact using the socket key.

Assemble the new arcing chamber using the arcing chamber key.

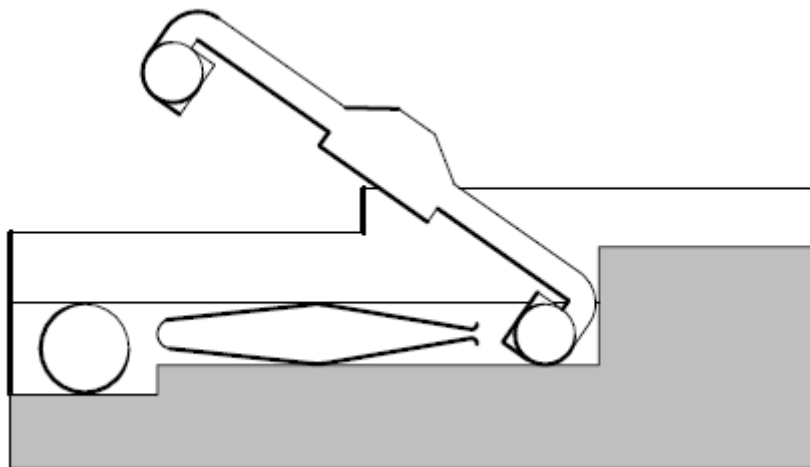
A.15. Annexure 15: Replacement of spring loaded nylon cam and leaf spring

Loosen the spring holder using a 9mm screwdriver.



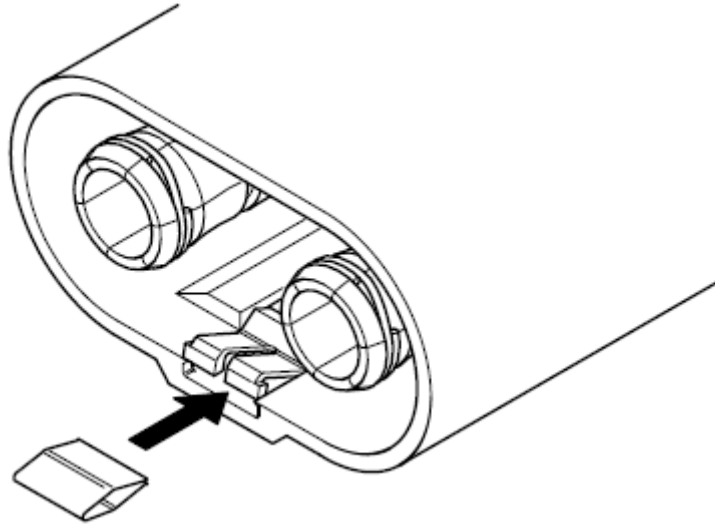
Remove the spring holder and the leaf spring.

Push the back side of the new spring holder in the appropriate slots of the switch cap



Slide a leaf spring underneath the spring holder, with its closed side pointing outwards.

Check that the right leaf spring is being installed in the fuse cap. (The more heavy duty three phase leaf spring has a blue line)



Push the cams into position on the top side of the spring holder and into the appropriate openings in the switch cap (open edge of spring plate downwards as shown in the picture above)

Firmly press the cam so it sits flat in the switch cap.

A.16. Annexure 16: Repair of cables with partial discharge

If there is PD activity emanating from the Telcon leads, these must be replaced.

PD detected on the cable will be located either at the connection to the switchgear or more likely in the “critical area”. This is the point on each core where the screen papers (PILC) or the semi-con (XLPE) has been removed (generally around 150mm - 200mm from the cable crutch).

At the “critical area” – because the cores are set ABC from the TX towards the door (as indicated in) the tracking is more likely to be between AØ/BØ or BØ/CØ.

For a PILC cable with metallic screen papers, assuming BØ and CØ are crossed and touching (with a clear gap between AØ and BØ), the recommended method of repair is to:

- Disconnect the core from the switchgear (marking the phasing on the lug).
- Remove the core insulation and stress control tube from BØ.
- Apply yellow stress relief mastic at the paper cut.
- Install a conductive CNTM heat shrink over this area overlapping the screen papers so that the top of the CNTM sits 40mm – 50mm above the cut. This effectively extends the screening by 40mm – 50mm therefore increasing the gap between the critical areas on BØ and CØ.
- Apply yellow stress relief mastic at the top end of the CNTM and install a replacement stress control heat shrink.
- Install a replacement core insulation heat shrink.
- Replace the white dust cover tubes and reconnect the core to the switchgear.

This same repair will also fix a problem between AØ and BØ.

If all cores are close (or crossed) in the critical area, it may be required to install CNTM tubes on all cores but stagger the BØ higher than AØ and CØ therefore creating gaps.