

HV Circuit Breakers

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For any enquiries relating to the content of this document please contact the Standards Coordinator on 13 10 81.

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1 Purpose

This standard provides high level details and requirements for tasks required to be undertaken during the specified CB maintenance activities to support safe, reliable and effective operation across Endeavour Energy's network

2 Scope

This standard sets out in detail the broad requirements and minimum expectation for routine maintenance and post-fault maintenance for HV circuit breakers to ensure their safe, reliable and effective operation with the network.

It applies to all HV circuit breakers installed across zone and transmission substations as well as switching stations across the network. This includes but not limited to following types:

- Vacuum circuit breakers
- SF6 gas circuit breakers
- Oil circuit breakers (bulk and minimum oil)

Refer to Annexure 2 for the specific requirements for routine maintenance of HV circuit breakers that have been analysed using the RCM process.

This instruction does not cover HV circuit breakers associated with:

- 33kV to 132kV indoor air and gas insulated switchgear (refer to SMI 210).

This instruction is to be read in conjunction with SMI 1000 - Maintenance requirements for transmission, substation and distribution equipment.

3 References

External Regulations
Electricity Supply Act 1995 (NSW)
Electricity Supply (Safety and Network Management) Regulation 2014
Work Health and Safety Act 2011(NSW)
Work Health and Safety Regulation 2017 (NSW)
National Electricity (NSW) Law 1997
National Electricity Rules

External Standards		
Standard No.	Year	Title
DOC 01	2008	ENA National Electricity Network Safety Code
	2013	Asbestos Product Guide
IEC 60050.441	2000	International Electrotechnical Vocabulary
AS 2467	2025	Maintenance of Switchgear – Code of Practice
AS 62271.100	2019	High-Voltage Switchgear and Controlgear

Company Policies and Procedures
Board Policy 3.0 – Work Health and Safety
Board Policy 4.0 – Environment
Company Policy 9.9.1 – Network Asset Maintenance
Division Procedure GNV 1094.12 – Testing of Network Equipment- Insulation resistance testing
Division Procedure GNV 1094.14 – Dielectric dissipation factor (DDF) testing
Endeavour Energy Electrical Safety Rules

Company Standards	
Substation Design Instruction SDI 545	Acceptable purity limits for SF6 gas
Substation Maintenance Instruction SMI 1000	Minimum requirements for maintenance of transmission and zone substation equipment
Substation Maintenance Instruction SMI 122	Substation Maintenance Instruction SMI 122
Substation Maintenance Instruction SMI 156	Breathers

4 Definitions and Abbreviations

Term	Definition
DDF	Dielectric dissipation factor test (also known as DLA - dielectric loss angle test). The dielectric loss angle is the angle by which the insulation current fails to lead the test voltage by 90°. The DDF is the tangent of this angle.
Dead tank breaker	A circuit breaker with interrupters in an earthed metal tank. The current interrupting chamber is contained within a metal tank and the metal tank is earthed. All bulk oil, most vacuum and some SF ₆ breakers fall into this category.
DRM	dynamic resistance measurement
GIS	gas insulated switchgear
Live tank breaker	A circuit-breaker with interrupters in a tank insulated from earth. The current interrupting chamber is contained within an insulated housing and is at line voltage level. Most minimum oil and SF ₆ breakers fall into this category.
Operation check	Operational check is list of the tasks that are performed during minor and major overhaul of the circuit breakers.
Post-fault maintenance	Maintenance necessary on a circuit breaker after a specified number of fault clearance operations. Post fault maintenance must be carried out as a major maintenance.
RCM	Reliability Centred Maintenance
SAP	Endeavour Energy's asset management database
SF6	sulphur hexafluoride

5 Circuit Breaker Maintenance Strategy

To achieve appropriate balance between the risk, lifecycle cost and performance, minor overhauls shall be planned and executed using a risk-based approach.

FMECA/RCM developed for circuit breakers are used as the foundational data inputs for the risk-based maintenance prioritisation of circuit breakers. Where risk is employed in determining the maintenance needs of an asset, assets of higher criticality are maintained at intervals that control failure risks to acceptable levels, while lower-criticality assets may tolerate greater failure risk within defined thresholds. Maintenance activities are optimised to ensure ALARP principles are upheld.

The following enterprise portfolio risk categories are considered as the minimum requirement in maintenance planning:

- Reliability (SAIDI, SAIFI, CAIDI)
- Bushfire (network-initiated fire risk)
- Safety (public and employee)
- Sustainability and Environmental
- Financial

Risk shall be determined through the evaluation of both the Probability of Failure (PoF) and the Consequence of Failure (CoF) for each circuit breaker. The combined assessment of PoF and CoF shall be used to calculate the risk cost associated with each asset and to prioritise maintenance interventions accordingly.

Major overhauls shall follow a trigger-based approach, initiated when defined thresholds are exceeded including condition degradation, performance degradation and operation metrics (e.g., duty cycles, fault operations).

6 General Maintenance Requirements

6.1 General

All safety precautions must be taken when maintaining circuit breakers. Potential hazards include charged springs in circuit breaker mechanisms; asbestos, possible X-ray emission from vacuum interrupters when subjected to the test voltages in excess of rated voltage, and contaminated products in arcing chambers.

All defects found during routine maintenance must have a separate defect work order raised in SAP.

6.2 Nameplate Validation

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

6.3 Gas-based Insulation Medium

Filling or degassing of any insulative gas products must only be performed with the equipment de-energised and in alignment with OEM requirements.

Refer to SMI 122 - Use and handling of sulphur hexafluoride (SF₆), on guidelines for the use and handling of SF₆ gas.

6.3.1 SF₆ Gas Leakages

Where practicable, SF₆ gas leakages on circuit breakers shall be repaired using the Belzona range of products.

All repair activities shall be performed in accordance with the applicable “SF₆ Leakage Repair Instruction Using Belzona Products”, including surface preparation, product selection, application methodology, curing requirements, and post-application inspection criteria.

Repaired units shall undergo post-repair inspection and testing to verify the effectiveness and integrity of the repair. As a minimum, this shall include:

- Confirmation through monitoring that SF₆ leakage has been successfully eliminated.
- Visual inspection of repaired area for defects, degradation or incomplete bonding.

In addition, high voltage testing shall be conducted to confirm dielectric strength and insulation integrity post-repairs. High voltage testing shall be:

- Shall be appropriate to the equipment voltage class and insulation system.
- Performed in accordance with applicable standards, manufacturers requirements and internal procedures
- Demonstrated to confirm that the repair has not adversely affected electrical clearance, insulation performance and/or operational safety.

6.4 Test Results

It is important to perform following tests to assess the condition of circuit breakers before and after maintenance:

- Timing test;
- contact resistance test; and
- insulation resistance test.

All test results must be entered using HV circuit breaker minor/major maintenance form and sent to the relevant Regional Technical Support Officer Asset Data to be stored on the network location ‘G:\EE Maintenance\Transmission\Region Maintenance Data\Substation\CB’s – Txs’ etc within two weeks of testing.

6.5 Spare HV Contacts

High voltage contacts in circuit breakers are the most difficult components to fabricate locally due to difficulties in duplicating the original alloy composition. As a result, locally fabricated contacts may not comprise the same alloy as the original and may therefore not have adequate fault withstand capability.

Accordingly, locally fabricated main contacts must not be used unless they have been type-tested or otherwise proven to be fit for purpose by way of a trial and approved by the Manager Asset Engineering. In all other cases, replacement main contacts must be manufactured by the original equipment manufacturer or under their licence.

6.6 Lubrication Strategy

The table below sets out the approved lubricants to be used on all circuit breakers in Endeavour Energy's network.

General purpose or in-house mixed lubricants must not be used. When found, they must be cleaned off before the appropriate lubricant set out in the table below is applied.

Where a part of the mechanism can be easily dismantled and reassembled, Mobilgrease 28 is the preferred grease. For parts that cannot be dismantled and reassembled, Isoflex Topas NB 52 which comes in aerosol cans shall be used.

Interflon Eco degreaser and CRCNF-contact cleaner shall be the approved degreasing options.

Product	Application	Comments
Interflon Eco Degreaser	Contactors and degreasing mechanisms	- Removes oils, greases, tar, ink and adhesives. - Ready to use without the need for dilution. - Low toxicity, non-flammable and compatible with various types of oil. - Compatible with wide variety of surfaces. - Packaged in aerosols
CRCNF Contact Cleaner	Contactors and degreasing mechanisms	- Removes oils, greases, waxes and sealant residue. - Test on plastics before use and non-corrosive on metals. - Low toxicity, odourless and non-allergenic. - Fast drying. - Pressure pack can dispenser.
Isoflex Topas NB 52	Linkages, pins, hinges, latch pivots, cams and bushes Bearings that cannot be removed and re-lubricated	- Fully synthetic-based - PAO base oil with barium soap thickener - Protection against corrosion and oxidation - Ageing stability. - Wide service temperature range. - Can come in aerosol can. Mobilgrease 28 would have been the preferred option but due to accessibility issues, a synthetic lubricant that comes in aerosol is adopted for ease of use for parts that cannot be dismantled for Mobilgrease 28 application.
Mobilgrease 28	Gears, bearings, solenoid slugs/plungers	- Synthetic based. - High oxidation stability - Excellent protection against wear and corrosion. - Superb bearing protection - Wide range of operating temperature.

Product	Application	Comments
	and worm threads.	Use this grease for all parts of the mechanism that are accessible.
	Bearings that can be removed and re-lubricated.	

Spare roller bearings shall be procured and be readily available to be used to replace removed bearings during overhaul activities. The spare bearings shall be cleaned and lubricated before installation. Where compatible, the use of sealed roller bearings as spare bearings is preferred.

6.7 345GCN Circuit Breaker Bushings

In the past there have been instances of 33kV 345GCN bushing failures as a result of pitch/compound leaks. As Endeavour Energy no longer refurbishes bushings, this situation will be managed according to the process set out in Annexure 2.

6.8 Post-fault Maintenance

Post-fault maintenance must be carried out as a major maintenance. Post fault maintenance will reset the nominated maintenance cycle, and a major maintenance will reset the post fault maintenance operation count.

6.8.1 Bulk and Small Oil

For bulk oil and small oil circuit breakers, post-fault maintenance must be performed once the circuit breaker reaches the permissible number of fault operations (set out in SMI 1000 - Minimum requirements for maintenance of transmission and zone substation equipment). However, it should be noted that when the fault cycle limit is reached, the fault history (for example, through SCADA) must be examined to identify and exclude any falsely registered faults (such as protection maintenance trips) or fault currents below normal rated load (such as sensitive earth fault).

6.8.2 SF6 and Vacuum

The fault operation limit for a circuit breaker, as detailed in SMI 1000, is based on individual characteristic of the circuit breaker type and the fault current that is interrupted. The fault cycle for each of these circuit breakers has been determined by using the maximum fault level at the substation where the type of circuit breaker is located. The fault cycle for a circuit breaker may be reviewed if the fault level for a substation significantly changes (for example, due to changes in network configuration).

For SF6 and vacuum circuit breakers, post-fault maintenance must be performed once the permissible number of fault operations is reached. However, it should be noted that when the fault cycle limit is reached, the fault history (for example, through SCADA) must be examined to identify and exclude:

- Faults incorrectly registered (such as protection maintenance trips), or
- Fault currents below normal rated load (such as sensitive earth faults).

Furthermore, it should be noted that the fault cycle limit applies to each pole/phase individually. Where the fault history data provides details of the phases involved in the fault, this can be taken into account to determine a fault count per phase. Where this data is not available, the fault is assumed to affect all phases. Maintenance is only required, where at least one phase has reached the fault cycle limit.

For SF6 circuit breakers, dynamic resistance measurements (DRM) can be taken where required to further assess the condition of the contacts.

All the above checks must be made before intrusive maintenance is carried out.

7 Routine Maintenance Schedule

Where applicable, the requirement set for maintenance of circuit breakers in the maintenance schedule below must be met.

Refer to Annexure 2 for the specific requirements for routine maintenance of HV circuit breakers that have been analysed using the RCM process.

Note: Some types or brands of HV circuit breakers may not contain some of the components listed for routine maintenance, in which case that particular component is to be disregarded.

7.1 Bulk Oil

A- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Check oil level.
1.5	Record oil colour.
1.6	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.7	Carry out infra-red survey on outdoor circuit breaker terminations.
1.8	Inspect panel lamps (annunciators) and replace if not working.
1.9	Report Cyclo reading annually.
1.10	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.11	Inspect tank for oil leaks, spillage or other defects.

IN-SERVICE INSPECTION

1.12	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.13	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.14	Before leaving visually inspect the equipment in general, check and note any defects that are not included above.

B- EXERCISE

EXERCISE

- 1.1 Exercise the circuit breaker by performing opening and closing operation(s).

C- OPERATIONAL CHECK

OPERATIONAL CHECK

1.1	Connect the <i>profile</i> tester to the CB and trip.
1.2	Close and open electrically applying normal voltage.
1.3	Close and open manually.
1.4	Record injected current and resistance when carrying out primary circuit resistance measurements. Care must be taken when injecting current to avoid initiating busbar protection. The test results will be consistent with the manufacturer's recommendation.
1.5	Record circuit breaker close and trip time.

D- MINOR OVERHAUL

MINOR OVERHAUL

1.1	Carry out preliminary visual check as defined in section 6.1 A – IN-SERVICE INSPECTION.
1.2	Carry out preliminary operational check as defined in section 6.1 C - OPERATIONAL CHECK.
1.3	Measure and record ambient temperature (deg. C) and relative humidity prior to the commencement of tests.
1.4	Carry out as found and final tests of DDF (33kV and higher voltage bushings). Refer to HVT001 Section 23 for test setup for bushings without DDF taps.
1.5	Carry out as found and final tests of insulation resistance. Record breaker insulation resistance at 2.5 kV for 1 minute.

Pass Criteria:
IR > 1GΩ and
not be less than

MINOR OVERHAUL

- 1) Test each bushing with the CB in open position and earth all other bushings (six [6] tests on each CB). 10% of previous results.
- 2) Test each phase with CB in closed position and earth all other phases (three [3] tests on each CB).

The results should be consistent with manufacturer's recommendations.

Note: *Insulation resistance between each bushing to rest of CB and earth at 2.5kV DC must not be less than 10% of previous results and must be greater than 1GΩ. If the above values are not achievable, the Substation Assets Manager must be contacted for further actions.*

1.6	Carry out as found and final tests of primary contact resistance. Record injected current and resistance when carrying out primary circuit resistance measurements. Appropriate protection isolation must be carried out prior to the current injection test to avoid triggering the protection schemes (busbar protection, CB failure protection, and the like) which trips the adjacent in-service equipment. The test results must be consistent with the manufacturer's recommendation. Notes: 1) <i>The injected current during the measurement must have a minimum of any convenient value between 50A and the rated normal current of the circuit breaker.</i> 2) <i>The contact resistance must be measured under conditions similar to those under which the corresponding test was made by the manufacturer, with regard to ambient air temperature and points of measurement.</i>
1.7	Carry out as found and final tests of timing. Record trip and close times for all circuit breakers, including 11kV.
1.8	Inspect busbars condition (where possible).
1.9	Inspect primary isolating/secondary isolating/auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.10	Inspect primary isolating bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.11	Inspect tank for oil/gas leaks.
1.12	Inspect housing condition of spout orifice safety shutters and operating linkages.
1.13	Examine mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins, spring release plunger, trip plungers or other defects.
1.14	Check springs of mechanism for correct tension.
1.15	Clean mechanism with recommended solvent.
1.16	Lubricate moving parts of mechanism with the recommend lubricant <i>detailed in section 5.6.</i>
1.17	Examine spring release block for defective parts.

MINOR OVERHAUL	
1.18	Check operation of spring release block.
1.19	Examine isolating/racking components for defective parts.
1.20	Clean isolating/racking components with recommended solvent.
1.21	Grease moving parts of isolating/racking components with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.22	Clean plunger of trip/close/solenoid coil with recommended solvent.
1.23	Polish plunger of trip/close/solenoid coil with recommended polish.
1.24	Lubricate plunger of trip/close/solenoid coil with the recommend lubricant <i>detailed in section 5.6</i> .
1.25	Adjust plunger of trip/close/solenoid coil and check that it has adequate free travel to and after the trip operation.
1.26	Measure coil resistance of trip/close/solenoid coil. Results should be consistent with manufacturer's recommendations.
1.27	Check operation of control switches.
1.28	Clean and replace contacts of auxiliary/solenoid cut off/ pressure switch if necessary.
1.29	Check operation of auxiliary/solenoid cut off/ pressure switch.
1.30	Check operation of latch.
1.31	Adjust and or replace latch if necessary.
1.32	Clean and or replace contacts of relays/contactors if necessary.
1.33	Check operation of anti-pumping relay.
1.34	Clean and or replace contacts of anti-pumping relay if necessary
1.35	Check operation of follower relay.
1.36	Clean and or replace contacts of follower relay if necessary
1.37	Check solenoid cut off operation.
1.38	Confirm proper operation of interlocks.
1.39	Check correct operation of trip lever.
1.40	Clean primary isolating/secondary isolating contacts with recommended solvent.
1.41	Polish primary isolating/secondary isolating contacts with good quality silver polish and sparingly lubricate contact surfaces with conductive paste.

MINOR OVERHAUL	
1.42	Check operation of racking/air compressor/close spring charging motors.
1.43	Check heater and thermostat operation.
1.44	Inspect condition and confirm tightness of earth connections
1.45	Carry out final checks/tests as defined in clause 1.3 ~1.7 or, if major overhaul is being carried out, continue as set out in 6.1E - MAJOR OVERHAUL.
1.46	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.47	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

E- MAJOR OVERHAUL

MAJOR OVERHAUL	
1.1	Carry out minor maintenance as set out in section 6.1 D - MINOR OVERHAUL.
1.2	Inspect truck wheels.
1.3	Check that truck enters housing freely.
1.4	Examine for abnormalities of fixed/moving/arcng contacts, for example burning, loose or bent components, contact wear or other defects (dress or replace if necessary).
1.5	Examine for abnormalities of transfer finger/bushing finger, for example burning, loose, or bent components or other defects (dress or replace if necessary).
1.6	Check that the penetration, spring tensions, alignment, opening dimensions (contact break), arcing lead or other items of moving contacts comply with the manufacturer's recommendations.
1.7	Adjust stop bolts of moving contacts.
1.8	Check that the torque of primary isolating complies with manufacturers recommendations.
1.9	Flush out and clean tank with clean oil.
1.10	Refill tank with clean oil.
1.11	After unit is re-assembled wash down all the components in tank that are normally contained in oil with clean oil.
1.12	Inspect condition of gaskets and replace where needed.
1.13	Inspect weather seals and replace where needed.
1.14	Clean interphase barriers with clean oil (remove first if possible).

MAJOR OVERHAUL

1.15	Inspect for treeing or tracking of insulation components.
1.16	Measure insulation resistance of racking/air compressor/close spring charging motors at 500V. Results should be consistent with manufacturer's recommendations.
1.17	Check control switch operation of racking/air compressor/close spring charging motors.
1.18	Inspect condition of interrupter tube.
1.19	Inspect condition of arc control device (remove first if possible).
1.20	Clean arc control device with clean oil.
1.21	Clear out arc chutes.
1.22	Inspect condition of shock absorbers.
1.23	Inspect condition of vents.
1.24	Inspect condition of vermin proofing.
1.25	Inspect condition of damping device (remove first if possible).
1.26	Clean damping device with clean oil.
1.27	Clean housing/control panel by dusting.
1.28	Lubricate moving parts of housing/control panel, for example spout orifice safety shutter and operating linkages and the like with the recommend lubricant <i>set out in section 5.6</i> .
1.29	Inspect condition indoor parts of current transformers for example, mounting clamps, secondary wiring and the like.
1.30	Inspect condition outdoor parts of current transformers, for example, mounting clamps, secondary wiring, bushings, primary connections, secondary wiring, secondary wiring terminal box weather sealing and the like.
1.31	Inspect condition of control wiring.
1.32	Inspect condition of electrical connections.
1.33	Check tightness of electrical connections.
1.34	Inspect condition of control wire coupling.
1.35	Check that correct fuse link is installed in carrier.
1.36	Check operation of indicating lamps.
1.37	Check if plug box fits.

MAJOR OVERHAUL	
1.38	Check that mechanism stop bolt gap is within limits and adjust if necessary.
1.39	Check that operating mechanism trip gap is within limits and adjust if necessary.
1.40	Check operation of interlocks.
1.41	Check trip free operation.
1.42	Test alarms.
1.43	Test SCADA.
1.44	Test breaker anti-pump relay.
1.45	Test CB lockout.
1.46	Carry out operational check of CB as set out in section 6.1 C - OPERATIONAL CHECK.
1.47	Report counter reading at the completion of maintenance.
1.48	Carry out final tests as detailed in clause 1.3~1.7 in 6.1 D - MINOR OVERHAUL and report results.
1.49	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.50	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

7.2 Minimum Oil

A- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Inspect air receivers for rust.
1.5	Check oil level.
1.6	Record oil colour.
1.7	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.8	Carry out infra-red survey on outdoor circuit breaker terminations.
1.9	Inspect panel lamps (annunciators) and replace if not working.
1.10	Report Cyclo reading annually.
1.11	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.12	Inspect tank for oil leaks, spillage or other defects.
1.13	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.15	Before leaving visually inspect the equipment in general, check and note any defects that are not included above.

B- EXERCISE

EXERCISE	
1.1	Exercise the circuit breaker by performing opening and closing operation(s).

C- OPERATIONAL CHECK

OPERATIONAL CHECK	
1.1	Connect the <i>profile</i> tester to the CB and trip.
1.2	Close and open electrically applying normal voltage.

OPERATIONAL CHECK

1.3 Close and open manually.

1.4 Record injected current and resistance when carrying out primary circuit resistance measurements. Care must be taken when injecting current to avoid initiating busbar protection. The test results will be consistent with the manufacturer's recommendation.

1.5 Record circuit breaker close and trip time.

D- MINOR OVERHAUL

MINOR OVERHAUL

1.1 Carry out preliminary visual check as defined in section 6.2 A - IN-SERVICE INSPECTION.

1.2 Carry out preliminary operational check as defined in section 6.2 C - OPERATIONAL CHECK.

1.3 Measure and record ambient temperature (deg. C) and relative humidity prior to the commencement of tests.

1.4 Carry out as found and final tests of DDF (33kV and higher voltage bushings). Refer to HVT001 Section 23 for test setup for bushings without DDF taps.

Carry out as found and final tests of insulation resistance. Record breaker insulation resistance at 2.5 kV for 1 minute.

Pass Criteria:

IR > 1GΩ and not be less than 10% of previous results.

- 1) Test each bushing with the CB in open position and earth all other bushings (six [6] tests on each CB).
- 2) Test each phase with CB in closed position and earth all other phases (three [3] tests on each CB).

1.5 The results should be consistent with manufacturer's recommendations.

Note: Insulation resistance between each bushing to rest of CB and earth at 2.5kV DC must not be less than 10% of previous results and must be greater than 1GΩ. If the above values are not achievable, the Substation Assets Manager must be contacted for further actions.

1.6 Carry out as found and final tests of primary contact resistance. Record injected current and resistance when carrying out primary circuit resistance measurements. Appropriate protection isolation must be carried out prior to the current injection test to avoid triggering the protection schemes (busbar protection, CB failure protection, and the like) which trips the adjacent in-service equipment. The test results must be consistent with the manufacturer's recommendation.

Notes:

1) The injected current during the measurement must have a minimum of any convenient value between 50A and the rated normal current of the circuit breaker.

MINOR OVERHAUL	
	<i>2) The contact resistance must be measured under conditions similar to those under which the corresponding test was made by the manufacturer, with regard to ambient air temperature and points of measurement.</i>
1.7	Carry out as found and final tests of timing. Record trip and close times for all circuit breakers, including 11kV.
1.8	Inspect busbars condition (where possible).
1.9	Inspect primary isolating/secondary isolating/auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.10	Inspect primary isolating bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.11	Inspect tank for oil/gas leaks.
1.12	
1.13	Inspect housing condition of spout orifice safety shutters and operating linkages.
1.14	Examine mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins, spring release plunger, trip plungers or other defects.
1.15	Check springs of mechanism for correct tension.
1.16	Clean mechanism with recommended solvent.
1.17	Lubricate moving parts of mechanism with the recommend lubricant <i>detailed in section 5.6</i> .
1.18	Examine spring release block for defective parts.
1.19	Check operation of spring release block.
1.20	Examine isolating/racking components for defective parts.
1.21	Clean isolating/racking components with recommended solvent.
1.22	Grease moving parts of isolating/racking components with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.23	Clean plunger of trip/close/solenoid coil with recommended solvent.
1.24	Polish plunger of trip/close/solenoid coil with recommended polish.
1.25	Lubricate plunger of trip/close/solenoid coil with the recommend lubricant <i>detailed in section 5.6</i> .
1.26	Adjust plunger of trip/close/solenoid coil and check that it has adequate free travel to and after the trip operation.

MINOR OVERHAUL

1.27	Measure coil resistance of trip/close/solenoid coil. Results should be consistent with manufacturer's recommendations.
1.28	Check operation of control switches.
1.29	Clean and replace contacts of auxiliary/solenoid cut off/ pressure switch if necessary.
1.30	Check operation of auxiliary/solenoid cut off/ pressure switch.
1.31	Check operation of latch.
1.32	Adjust and or replace latch if necessary.
1.33	Clean and or replace contacts of relays/contactors if necessary.
1.34	Check operation of anti-pumping relay.
1.35	Clean and or replace contacts of anti-pumping relay if necessary
1.36	Check operation of follower relay.
1.37	Clean and or replace contacts of follower relay if necessary
1.38	Check solenoid cut off operation.
1.39	Confirm proper operation of interlocks.
1.40	Check correct operation of trip lever.
1.41	Clean primary isolating/secondary isolating contacts with recommended solvent.
1.42	Polish primary isolating/secondary isolating contacts with good quality silver polish and sparingly lubricate contact surfaces with conductive paste.
1.43	Check operation of racking/air compressor/close spring charging motors.
1.44	Check heater and thermostat operation.
1.45	Inspect condition and confirm tightness of earth connections
1.46	Carry out final checks/tests as defined in clause 1.3~1.7 or, if major overhaul is being carried out, continue as set out in E - MAJOR OVERHAUL.
1.47	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.48	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

E- MAJOR OVERHAUL

MAJOR OVERHAUL	
1.1	Carry out minor maintenance as set out in section D - MINOR OVERHAUL.
1.2	Inspect condition of vents.
1.3	Inspect condition of vermin proofing.
1.4	Inspect truck wheels.
1.5	Check that truck enters housing freely.
1.6	Examine for abnormalities of fixed/moving/arc contacts, for example burning, loose or bent components, contact wear or other defects (dress or replace if necessary).
1.7	Examine for abnormalities of transfer finger/bushing finger, for example burning, loose, or bent components or other defects (dress or replace if necessary).
1.8	Check that the penetration, spring tensions, alignment, opening dimensions (contact break), arcing lead or other items of moving contacts comply with the manufacturer's recommendations.
1.9	Adjust stop bolts of moving contacts.
1.10	Check that the torque of primary isolating complies with manufacturers recommendations.
1.11	Flush out and clean tank with clean oil.
1.12	Refill tank with clean oil.
1.13	After unit is re-assembled wash down all the components in tank that are normally contained in oil with clean oil.
1.14	Inspect condition of gaskets and replace where needed.
1.15	Inspect weather seals and replace where needed.
1.16	Inspect for treeing or tracking of insulation component.
1.17	Measure insulation resistance of racking/air compressor/close spring charging motors at 500V. Results should be consistent with manufacturer's recommendations.
1.18	Check control switch operation of racking/air compressor/close spring charging motors.
1.19	Inspect condition of arc control device (remove first if possible).
1.20	Clean arc control device with clean oil.
1.21	Clean housing/control panel by dusting.

MAJOR OVERHAUL	
1.22	Lubricate moving parts of housing/control panel, for example spout orifice safety shutter and operating linkages and the like with the recommend lubricant <i>set out in section 5.6</i> .
1.23	Inspect condition indoor parts of current transformers for example, mounting clamps, secondary wiring and the like.
1.24	Inspect condition outdoor parts of current transformers, for example, mounting clamps, secondary wiring, bushings, primary connections, secondary wiring, secondary wiring terminal box weather sealing and the like.
1.25	Inspect condition of control wiring.
1.26	Inspect condition of electrical connections.
1.27	Check tightness of electrical connections.
1.28	Inspect condition of control wire coupling.
1.29	Check that correct fuse link is installed in carrier.
1.30	Check operation of indicating lamps.
1.31	Check if plug box fits.
1.32	Check that mechanism stop bolt gap is within limits and adjust if necessary.
1.33	Check that operating mechanism trip gap is within limits and adjust if necessary.
1.34	Check oil level is correct.
1.35	Check operation of interlocks.
1.36	Check trip free operation.
1.37	Test alarms.
1.38	Test SCADA.
1.39	Test breaker anti- pump relay.
1.40	Test CB lockout.
1.41	Carry out operational check of CB as set out in section C - OPERATIONAL CHECK.
1.42	
1.43	Carry out final tests as detailed in clause 1.3~1.7 in D - MINOR OVERHAUL and report results.
1.44	Report counter reading at the completion of maintenance.

MAJOR OVERHAUL

- 1.45 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
- 1.46 Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

7.3 SF6 Circuit Breaker

A- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect air receivers for rust.
1.4	Check gas pressure gauge (where installed) is within acceptable range of gauge limits. Note: <i>Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Substation Assets Manager notified.</i>
1.5	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.6	Carry out infra-red survey on outdoor circuit breaker terminations.
1.7	Inspect panel lamps (annunciators) and replace if not working.
1.8	Report Cyclo reading annually.
1.9	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect for cracks/degradation of current transformer covers of dead tank CB.
1.11	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.13	Before leaving visually inspect the equipment in general, check and note any defects that are not included above.

B- EXERCISE

EXERCISE	
1.1	Exercise the circuit breaker by performing opening and closing operation(s).

C- OPERATIONAL CHECK

OPERATIONAL CHECK	
1.1	Connect the <i>profile</i> tester to the CB and trip.

OPERATIONAL CHECK	
1.2	Close and open electrically applying normal voltage.
1.3	Close and open manually.
1.4	Record injected current and resistance when carrying out primary circuit resistance measurements. Care must be taken when injecting current to avoid initiating busbar protection. The test results will be consistent with the manufacturer's recommendation.
1.5	Record circuit breaker close and trip time.

D- MINOR OVERHAUL

MINOR OVERHAUL	
1.1	Carry out preliminary visual check as defined in section 6.3 A - IN-SERVICE INSPECTION.
1.2	Carry out preliminary operational check as defined in section 6.3 C - OPERATIONAL CHECK.
1.3	Measure and record ambient temperature (deg. C) and relative humidity prior to the commencement of tests.
1.4	Carry out as found and final tests of insulation resistance. Record breaker insulation resistance at 2.5 kV for 1 minute. 1) Test each bushing with the CB in open position and earth all other bushings (six [6] tests on each CB). 2) Test each phase with CB in closed position and earth all other phases (three [3] tests on each CB). The results should be consistent with manufacturer's recommendations. Note: <i>Insulation resistance between each bushing to rest of CB and earth at 2.5kV DC must not be less than 10% of previous results and must be greater than 1 GΩ. If the above values are not achievable, the Substation Assets Manager must be contacted for further actions.</i>
1.5	Carry out as found and final tests of primary contact resistance. Record injected current and resistance when carrying out primary circuit resistance measurements. Appropriate protection isolation must be carried out prior to the current injection test to avoid triggering the protection schemes (busbar protection, CB failure protection, and the like) which trips the adjacent in-service equipment. The test results must be consistent with the manufacturer's recommendation. Notes: 1) <i>The injected current during the measurement must have a minimum of any convenient value between 50A and the rated normal current of the circuit breaker.</i> 2) <i>The contact resistance must be measured under conditions similar to those under which the corresponding test was made by the manufacturer, with regard to ambient air temperature and points of measurement.</i>

MINOR OVERHAUL	
1.6	Carry out as found and final tests of timing. Record trip and close times for all circuit breakers, including 11kV.
1.7	Inspect busbars condition (where possible).
1.8	Inspect primary isolating/secondary isolating/auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.9	Inspect primary isolating bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect tank for gas leaks.
1.11	Record gas pressure and ambient temperature and humidity.
1.12	Inspect housing condition of spout orifice safety shutters and operating linkages.
1.13	Examine mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins, spring release plunger, trip plungers or other defects.
1.14	Check springs of mechanism for correct tension.
1.15	Clean mechanism with recommended solvent.
1.16	Lubricate moving parts of mechanism with the recommend lubricant <i>detailed in section 5.6</i> .
1.17	Examine spring release block for defective parts.
1.18	Check operation of spring release block.
1.19	Examine isolating/racking components for defective parts.
1.20	Clean isolating/racking components with recommended solvent.
1.21	Grease moving parts of isolating/racking components with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.22	Clean plunger of trip/close/solenoid coil with recommended solvent.
1.23	Polish plunger of trip/close/solenoid coil with recommended polish.
1.24	Lubricate plunger of trip/close/solenoid coil with the recommend lubricant <i>detailed in section 5.6</i> .
1.25	Adjust plunger of trip/close/solenoid coil and check that it has adequate free travel to and after the trip operation.
1.26	Measure coil resistance of trip/close/solenoid coil. Results should be consistent with manufacturer's recommendations.

MINOR OVERHAUL

1.27	Measure coil resistance of intake magnet valve. Results should be consistent with manufacturer's recommendations.
1.28	Check operation of control switches.
1.29	Clean and replace contacts of auxiliary/solenoid cut off/ pressure switch if necessary.
1.30	Check operation of auxiliary/solenoid cut off/ pressure switch.
1.31	Check operation of latch.
1.32	Adjust and or replace latch if necessary.
1.33	Clean and or replace contacts of relays/contactors if necessary.
1.34	Check operation of anti-pumping relay.
1.35	Clean and or replace contacts of anti-pumping relay if necessary
1.36	Check operation of follower relay.
1.37	Clean and or replace contacts of follower relay if necessary
1.38	Confirm proper operation of interlocks.
1.39	Check correct operation of trip lever.
1.40	Clean primary isolating/secondary isolating contacts with recommended solvent.
1.41	Polish primary isolating/secondary isolating contacts with good quality silver polish and sparingly lubricate contact surfaces with conductive paste.
1.42	Check operation of racking/air compressor/close spring charging motors.
1.43	Check heater and thermostat operation.
1.44	Inspect condition and confirm tightness of earth connections
1.45	Carry out final checks/tests as defined in clause 1.3-1.7 or, if major overhaul is being carried out, continue as set out in E - MAJOR OVERHAUL.
1.46	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.47	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

MAJOR OVERHAUL	
1.1	Carry out minor maintenance as set out in section D - MINOR OVERHAUL.
1.2	Inspect truck wheels.
1.3	Check that truck enters housing freely.
1.4	* Examine for abnormalities of fixed/moving/arcing contacts, for example burning, loose or bent components, contact wear or other defects (dress or replace if necessary). Notes: 1) For SF₆ circuit breaker, assess the interrupter contact wear prior to overhaul by estimating the remaining permissible number of interruptions. If this number is less than the estimated required number of interruptions before the next major overhaul, use the circuit breaker analyser TM1800™ or equivalent to carry out the DRM test for further assessment of contact wear. ¹ Replace the interrupter if necessary.
1.5	*Examine for abnormalities of transfer finger/bushing finger, for example burning, loose, or bent components or other defects (dress or replace if necessary).
1.6	*Check that the penetration, spring tensions, alignment, opening dimensions (contact break), arcing lead or other items of moving contacts comply with the manufacturer's recommendations.
1.7	*Adjust stop bolts of moving contacts.
1.8	Check that the torque of primary isolating complies with manufacturers recommendations.
1.9	*De-gas all poles.
1.10	*Vacuum dust produced by decomposed gases from all surfaces. Refer to SMI 122 - Use and handling of sulphur hexafluoride (SF ₆), for guidelines for the use and handling of SF ₆ .
1.11	Inspect condition of gaskets and replace where needed.
1.12	Inspect weather seals and replace where needed.
1.13	Inspect for treeing or tracking of insulation component.
1.14	Measure insulation resistance of racking/air compressor/close spring charging motors at 500V. Results should be consistent with manufacturer's recommendations.

¹ Refer to Annexure 1 for the details of estimating the remaining permissible number of interruptions of the SF₆ and vacuum circuit breaker.

MAJOR OVERHAUL

1.15	Check control switch operation of racking/air compressor/close spring charging motors.
1.16	*Inspect condition of interrupter tube.
1.17	*Inspect condition of arc control device (remove first if possible).
1.18	*Inspect condition of connecting rod.
1.19	*Replace molecular sieve if fitted. This is only to be done if the molecular sieve can be easily removed.
1.20	Inspect condition of gas nozzle (orifice).
1.21	*Inspect condition seals of piston.
1.22	*Inspect condition of moving guide.
1.23	Inspect condition of vents.
1.24	Inspect condition of vermin proofing.
1.25	Clean housing/control panel by dusting.
1.26	Lubricate moving parts of housing/control panel, for example spout orifice safety shutter and operating linkages and the like with the recommend lubricant <i>set out in section 5.6</i> .
1.27	Inspect condition indoor parts of current transformers for example, mounting clamps, secondary wiring and the like.
1.28	Inspect condition outdoor parts of current transformers, for example, mounting clamps, secondary wiring, bushings, primary connections, secondary wiring, secondary wiring terminal box weather sealing and the like.
1.29	Inspect condition of control wiring.
1.30	Inspect condition of electrical connections.
1.31	Check tightness of electrical connections.
1.32	Inspect condition of control wire coupling.
1.33	Check that correct fuse link is installed in carrier.
1.34	Check operation of indicating lamps.
1.35	Check if plug box fits.
1.36	Check that mechanism stop bolt gap is within limits and adjust if necessary.
1.37	Check that operating mechanism trip gap is within limits and adjust if necessary.
1.38	*Check that vacuum is achieved prior to re-gassing.

MAJOR OVERHAUL

1.39	Check gas level is correct.
1.40	Check operation of interlocks.
1.41	Check trip free operation.
1.42	Test alarms.
1.43	Test alarm while simulating low gas.
1.44	Test SCADA.
1.45	Test breaker anti- pump relay.
1.46	Test CB lockout.
1.47	Carry out operational check of CB as set out in section C - OPERATIONAL CHECK.
1.48	Report counter reading at the completion of maintenance.
1.49	Carry out final tests as detailed in clause 1.3-1.7 in 6.3 D - MINOR OVERHAUL and report results.
1.50	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.51	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

* Dismantling, other than to service mechanism, is to be carried out only as condition-based maintenance.

7.4 Vacuum Circuit Breaker

A- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.4	Carry out infra-red survey on outdoor circuit breaker terminations.
1.5	Inspect panel lamps (annunciators) and replace if not working.
1.6	Report Cyclo reading annually.
1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect for cracks/degradation of current transformer covers of dead tank CB.
1.9	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.11	Before leaving visually inspect the equipment in general, check and note any defects that are not included above.

B- EXERCISE

EXERCISE	
1.1	Exercise the circuit breaker by performing opening and closing operation(s).

C- OPERATIONAL CHECK

OPERATIONAL CHECK	
1.1	Connect the <i>profile</i> tester to the CB and trip.
1.2	Close and open electrically applying normal voltage.
1.3	Close and open manually.
1.4	Record injected current and resistance when carrying out primary circuit resistance measurements. Care must be taken when injecting current to avoid initiating

OPERATIONAL CHECK

- | | |
|-----|--|
| | busbar protection. The test results will be consistent with the manufacturer's recommendation. |
| 1.5 | Record circuit breaker close and trip time. |

D- MINOR OVERHAUL

MINOR OVERHAUL

- | | |
|-----|--|
| 1.1 | Carry out preliminary visual check as defined in section 6.4 A - IN-SERVICE INSPECTION. |
| 1.2 | Carry out preliminary operational check as defined in section 6.4 C- OPERATIONAL CHECK. |
| 1.3 | Measure and record ambient temperature (deg. C) and relative humidity prior to the commencement of tests. |
| 1.4 | <p>Carry out as found and final tests of insulation resistance. Record breaker insulation resistance at 2.5 kV for 1 minute.</p> <ol style="list-style-type: none"> 1) Test each bushing with the CB in open position and earth all other bushings (six [6] tests on each CB). 2) Test each phase with CB in closed position and earth all other phases (three [3] tests on each CB). <p>The results should be consistent with manufacturer's recommendations.</p> <p>Note: <i>Insulation resistance between each bushing to rest of CB and earth at 2.5kV DC must not be less than 10% of previous results and must be greater than 1GΩ. If the above values are not achievable, the Substation Assets Manager must be contacted for further actions.</i></p> |
| 1.5 | <p>Carry out as found and final tests of primary contact resistance. Record injected current and resistance when carrying out primary circuit resistance measurements. Appropriate protection isolation must be carried out prior to the current injection test to avoid triggering the protection schemes (busbar protection, CB failure protection, and the like) which trips the adjacent in-service equipment. The test results must be consistent with the manufacturer's recommendation.</p> <p>Notes:</p> <ol style="list-style-type: none"> 1) <i>The injected current during the measurement must have a minimum of any convenient value between 50A and the rated normal current of the circuit breaker.</i> 2) <i>The contact resistance must be measured under conditions similar to those under which the corresponding test was made by the manufacturer, with regard to ambient air temperature and points of measurement.</i> |
| 1.6 | Carry out as found and final tests of timing. Record trip and close times for all circuit breakers, including 11kV. |
| 1.7 | Inspect busbars condition (where possible). |

Pass Criteria:

IR > 1GΩ and not be less than 10% of previous results.

MINOR OVERHAUL	
1.8	Inspect primary isolating/secondary isolating/auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.9	Inspect primary isolating bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect housing condition of spout orifice safety shutters and operating linkages.
1.11	Examine mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins, spring release plunger, trip plungers or other defects.
1.12	Check springs of mechanism for correct tension.
1.13	Clean mechanism with recommended solvent.
1.14	Lubricate moving parts of mechanism with the recommend lubricant <i>detailed in section 5.6</i> .
1.15	Examine spring release block for defective parts.
1.16	Check operation of spring release block.
1.17	Examine isolating/racking components for defective parts.
1.18	Clean isolating/racking components with recommended solvent.
1.19	Grease moving parts of isolating/racking components with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.20	Clean plunger of trip/close/solenoid coil with recommended solvent.
1.21	Polish plunger of trip/close/solenoid coil with recommended polish.
1.22	Lubricate plunger of trip/close/solenoid coil with the recommend lubricant <i>detailed in section 5.6</i> .
1.23	Adjust plunger of trip/close/solenoid coil and check that it has adequate free travel to and after the trip operation.
1.24	Measure coil resistance of trip/close/solenoid coil. Results should be consistent with manufacturer's recommendations.
1.25	Check operation of control switches.
1.26	Clean and replace contacts of auxiliary/solenoid cut off/ pressure switch if necessary.
1.27	Check operation of auxiliary/solenoid cut off/ pressure switch.
1.28	Check operation of latch.
1.29	Adjust and or replace latch if necessary.

MINOR OVERHAUL									
1.30	Clean and or replace contacts of relays/contactors if necessary.								
1.31	Check operation of anti-pumping relay.								
1.32	Clean and or replace contacts of anti-pumping relay if necessary								
1.33	Check operation of follower relay.								
1.34	Clean and or replace contacts of follower relay if necessary								
1.35	Confirm proper operation of interlocks.								
1.36	Check gas / vacuum level is correct. Note: Use the vacuum tester VIDAR™ or equivalent to verify vacuum level of the vacuum interrupter by applying the manufacturer's recommended test voltage across its open contacts². Failed vacuum interrupters must be replaced. If the manufacturer's recommended test voltage is not available, 80% of the relevant rated short-duration power frequency withstand voltage (peak value) shall be used as per the table below. <table> <tr> <th>Voltage (kV) - AC</th><th>Vidar Test Voltage (kV) - DC</th></tr> <tr> <td>11</td><td>30</td></tr> <tr> <td>22</td><td>56</td></tr> <tr> <td>33</td><td>78**</td></tr> </table>	Voltage (kV) - AC	Vidar Test Voltage (kV) - DC	11	30	22	56	33	78**
Voltage (kV) - AC	Vidar Test Voltage (kV) - DC								
11	30								
22	56								
33	78**								
1.37	Check correct operation of trip lever.								
1.38	Clean primary isolating/secondary isolating contacts with recommended solvent.								
1.39	Polish primary isolating/secondary isolating contacts with good quality silver polish and sparingly lubricate contact surfaces with conductive paste.								
1.40	Check operation of racking/air compressor/close spring charging motors.								
1.41	Check heater and thermostat operation.								
1.42	Inspect condition and confirm tightness of earth connections								
1.43	Carry out final checks/tests as defined in clause 1.3~1.7 or, if major overhaul is being carried out, continue as set out in E - MAJOR OVERHAUL.								

² Refer to the manufacturer's information in the CB manual or AS/NZS IEC 62271.1, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.

MINOR OVERHAUL

1.44	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.45	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

***Maximum test voltage for the vidar test instrument is 60kV DC. For test voltages that exceed 60kV DC, use 60kV DC as test voltage.*

E- MAJOR OVERHAUL**MAJOR OVERHAUL**

1.1	Carry out minor maintenance as set out in section D - MINOR OVERHAUL.
1.2	Inspect truck wheels.
1.3	Check that truck enters housing freely.
1.4	*Examine for abnormalities of fixed/moving/arcing contacts, for example burning, loose or bent components, contact wear or other defects (dress or replace if necessary). Notes: <i>For vacuum circuit breaker, follow the instructions in the manual to check vacuum contact wear by measuring the wipe/snatch gap or by estimating the remaining permissible number of interruptions. ³ Replace the vacuum interrupter if necessary.</i>
1.5	*Examine for abnormalities of transfer finger/bushing finger, for example burning, loose, or bent components or other defects (dress or replace if necessary).
1.6	*Check that the penetration, spring tensions, alignment, opening dimensions (contact break), arcing lead or other items of moving contacts comply with the manufacturer's recommendations.
1.7	*Adjust stop bolts of moving contacts.
1.8	Check that the torque of primary isolating complies with manufacturers recommendations.
1.9	Inspect condition of gaskets and replace where needed.
1.10	Inspect weather seals and replace where needed.
1.11	Inspect for treeing or tracking of insulation component.
1.12	Measure insulation resistance of racking/air compressor/close spring charging motors at 500V. Results should be consistent with manufacturer's recommendations.
1.13	Check control switch operation of racking/air compressor/close spring charging motors.
1.14	*Inspect condition of arc control device (remove first if possible).

MAJOR OVERHAUL

1.15	Inspect condition of vents.								
1.16	Inspect condition of vermin proofing.								
1.17	Clean housing/control panel by dusting.								
1.18	Lubricate moving parts of housing/control panel, for example spout orifice safety shutter and operating linkages and the like with the recommend lubricant <i>set out in section 5.6</i> .								
1.19	Inspect condition indoor parts of current transformers for example, mounting clamps, secondary wiring and the like.								
1.20	Inspect condition outdoor parts of current transformers, for example, mounting clamps, secondary wiring, bushings, primary connections, secondary wiring, secondary wiring terminal box weather sealing and the like.								
1.21	Inspect condition of control wiring.								
1.22	Inspect condition of electrical connections.								
1.23	Check tightness of electrical connections.								
1.24	Inspect condition of control wire coupling.								
1.25	Check that correct fuse link is installed in carrier.								
1.26	Check operation of indicating lamps.								
1.27	Check if plug box fits.								
1.28	Check that mechanism stop bolt gap is within limits and adjust if necessary.								
1.29	Check that operating mechanism trip gap is within limits and adjust if necessary.								
1.30									
	Check gas / vacuum level is correct. <i>Note: Use the vacuum tester VIDAR™ or equivalent to verify vacuum level of the vacuum interrupter by applying the manufacturer's recommended test voltage across its open contacts³. Failed vacuum interrupters must be replaced. If the manufacturer's recommended test voltage is not available, 80% of the relevant rated short-duration power frequency withstand voltage (peak value) shall be used as per the table below.</i>								
1.31	<table> <tr> <th>Voltage (kV) - AC</th><th>Vidar Test Voltage (kV) - DC</th></tr> <tr> <td>11</td><td>30</td></tr> <tr> <td>22</td><td>56</td></tr> <tr> <td>33</td><td>78**</td></tr> </table>	Voltage (kV) - AC	Vidar Test Voltage (kV) - DC	11	30	22	56	33	78**
Voltage (kV) - AC	Vidar Test Voltage (kV) - DC								
11	30								
22	56								
33	78**								

³ Refer to the manufacturer's information in the CB manual or AS/NZS IEC 62271.1, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.

MAJOR OVERHAUL	
1.32	Check operation of interlocks.
1.33	Check trip free operation.
1.34	Test alarms.
1.35	Test alarm while simulating low gas.
1.36	Test SCADA.
1.37	Test breaker anti- pump relay.
1.38	Test CB lockout.
1.39	Carry out operational check of CB as set out in section C - OPERATIONAL CHECK.
1.40	Report counter reading at the completion of maintenance.
1.41	Carry out final tests as detailed in clause 1.3~1.7 in D - MINOR OVERHAUL and report results.
1.42	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.43	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

* Dismantling, other than to service mechanism, is to be carried out only as condition-based maintenance.

** Maximum test voltage for the vidar test instrument is 60kV DC. For test voltages that exceed 60kV DC, use 60kV DC as test voltage.

7.5 Earthing Truck

A- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- | | |
|-----|---|
| 1.1 | Inspect panel lamps (annunciators) and replace if not working. |
| 1.2 | Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects. |
| 1.3 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.4 | Before leaving visually inspect the equipment in general, check and note any defects that are not included above. |

B- OPERATIONAL CHECK

OPERATIONAL CHECK

- | | |
|-----|---|
| 1.1 | Connect the <i>profile</i> tester to the CB and trip. |
| 1.2 | Close and open manually. |

C- MINOR OVERHAUL

MINOR OVERHAUL

- | | |
|-----|---|
| 1.1 | Carry out preliminary visual check as defined in section 6.5 A - IN-SERVICE INSPECTION. |
| 1.2 | Carry out preliminary operational check as defined in section 6.5 C - OPERATIONAL CHECK. |
| 1.3 | Inspect primary isolating/secondary isolating/auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects. |
| 1.4 | Inspect primary isolating bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects. |
| 1.5 | Examine mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins, spring release plunger, trip plungers or other defects. |
| 1.6 | Check springs of mechanism for correct tension. |
| 1.7 | Clean mechanism with recommended solvent. |
| 1.8 | Lubricate moving parts of mechanism with the recommend lubricant <i>detailed in section 5.6</i> . |

MINOR OVERHAUL

- | | |
|------|---|
| 1.9 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.10 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR OVERHAUL

MAJOR OVERHAUL

- | | |
|-----|---|
| 1.1 | Inspect truck wheels. |
| 1.2 | Check that truck enters housing freely. |
| 1.3 | <p>Examine for abnormalities of fixed/moving/arcng contacts, for example burning, loose or bent components, contact wear or other defects (dress or replace if necessary).</p> <p>Notes:</p> <p>1) For SF₆ circuit breaker, assess the interrupter contact wear prior to overhaul by estimating the remaining permissible number of interruptions. If this number is less than the estimated required number of interruptions before the next major overhaul, use the circuit breaker analyser TM1800™ or equivalent to carry out the DRM test for further assessment of contact wear. ⁴ Replace the interrupter if necessary.</p> <p>2) For vacuum circuit breaker, follow the instructions in the manual to check vacuum contact wear by measuring the wipe/snatch gap or by estimating the remaining permissible number of interruptions. ³ Replace the vacuum interrupter if necessary.</p> |
| 1.4 | Report counter reading at the completion of maintenance. |
| 1.5 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.6 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

⁴ Refer to Annexure 1 for the details of estimating the remaining permissible number of interruptions of the SF₆ and vacuum circuit breaker.

8 Authorities and Responsibilities

General Manager Future Grid & Asset Management has the authority and responsibility for:

- Making all decisions concerning compliance in respect of this Standard.
- Delegating any of these authorities and responsibilities to the Head of Asset Management & Digital.
- Head of Asset Management & Digital has the authority and responsibility for:
- Approving this Standard, including any variations
- Reviewing this Standard and making recommendations to the General Manager Future Grid & Asset Management.
- Making recommendations concerning compliance in respect of this Standard.

Asset Engineering Manager has the responsibility for:

- Clarifying all the technical aspects of this Standard with stakeholders.
- Updating the relevant actions required and outlined in this Standard.
- Ensuring that the content of this instruction is kept up to date.

Head of Systems Operations has the authority and responsibility for:

- Providing information on the CB fault levels where required.
- Carrying out the requirements of this instruction.

Head of Field Operations has the authority and responsibility for:

- Confirming that the Endeavour Energy employees performing the work have appropriate qualifications.
- Meeting the requirements of this instruction.
- Working in accordance with local and statutory requirements.
- Maintaining a high level of public safety.
- Confirming that employees are conversant with, and work in accordance with, the Electrical Safety Rules.
- Analysing test results to identify potential problems and take appropriate action.

All Endeavour Energy employees and/or contractors are responsible 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.
- Working in accordance with Endeavour Energy's Electrical Safety Rules.

Annexure 1: Estimation of the remaining permissible number of interruptions of SF6 and vacuum circuit breaker

The remaining permissible number of interruptions at a certain breaking current I_x can be estimated using the following guide from the manufacturer's CB manual and formula A2.1:

Figure 1: SF6 circuit breaker permissible number of interruptions as a function of the breaking current

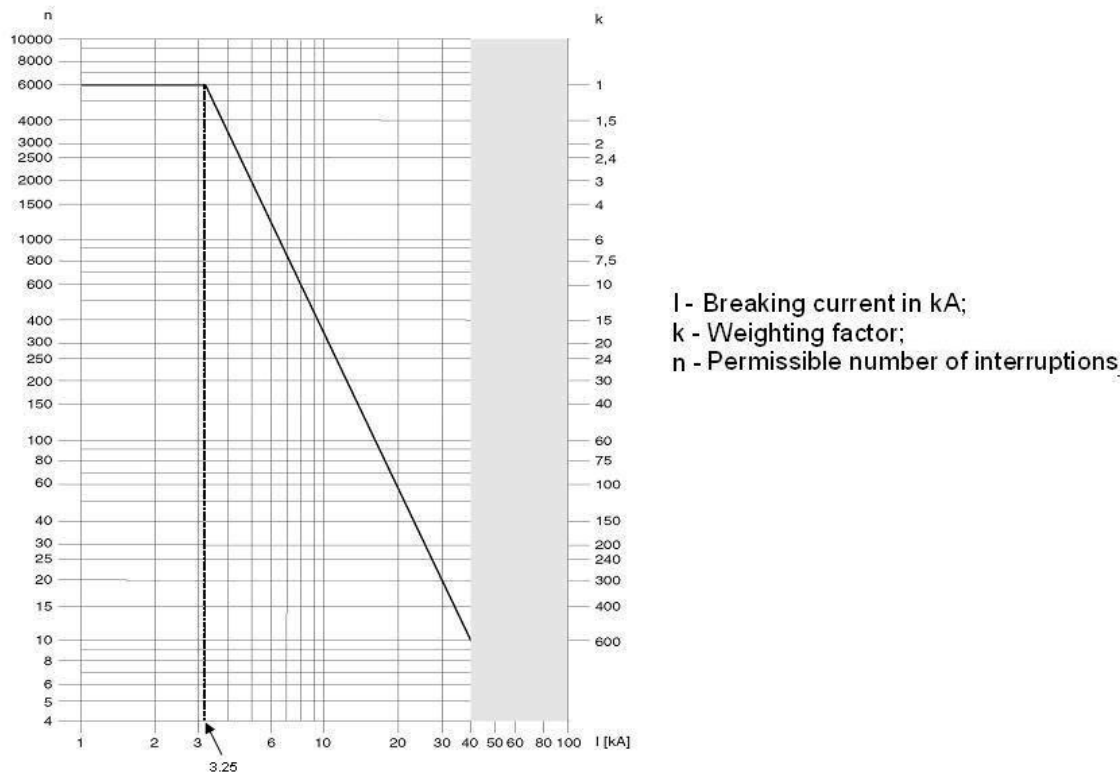
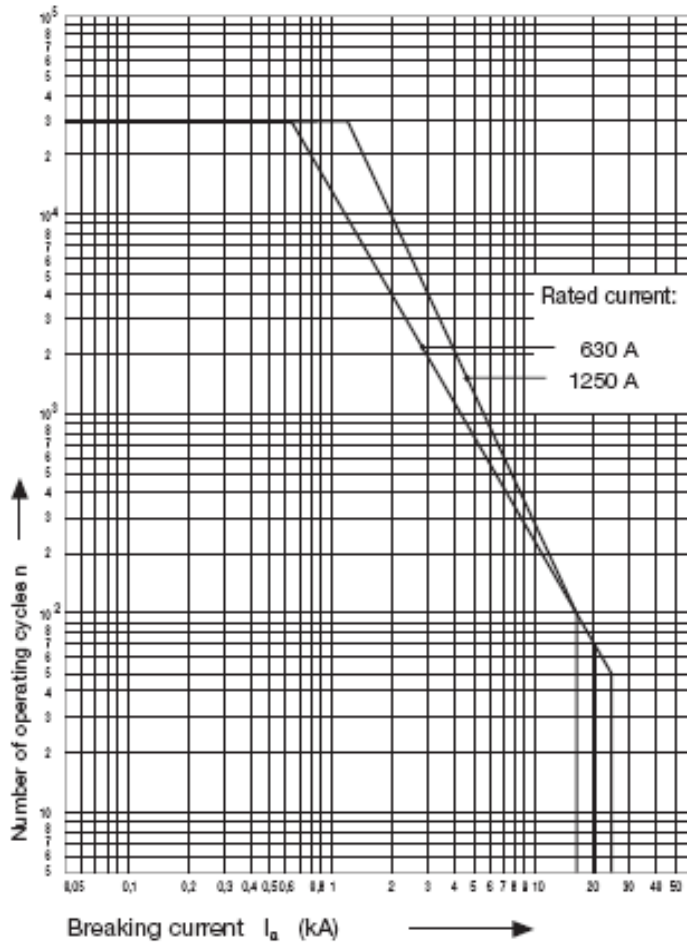


Figure 2: Vacuum circuit breaker permissible number of interruptions as a function of the breaking current



I – Breaking current in kA

n – Permissible number of interruptions

$$n_x = \frac{n_r - \sum_1^m (n_i \cdot k_i)}{k_x} \quad (\text{A2.1})$$

n_r Number of interruptions the circuit breaker can carry out at the breaking current whose weighting factor is 1 (shown in Figure 1) or number of interruptions the circuit breaker can carry out at rated current (shown in Figure 2).

n_i Number of carried out interruptions at breaking current I_i .

k_i Weighting factor for breaking current I_i (can be identified in Figure 1 at I_i).

n_x Number of remaining permissible interruptions at breaking current I_x .

m Number of breaking current types.

k_x Weighting factor for breaking current I_x (can be identified in Figure 1 at I_x).

Note: If the weighting factor “k” is not available on the manufacturer’s CB manual. It can be calculated using the following formula:

$$k_i = \frac{n_r}{n_i}$$

If the breaking currents the CB performed cannot be identified from the protection system, the calculated value of the fault levels from Protection Section, Secondary Systems⁵ can also be used as the breaking currents for more conservative estimation.

For example, a SF6 circuit-breaker with a rated short-circuit breaking current of 40kA has performed the following interruptions in the last 18 years as shown in the two (2) scenarios:

- 25 interruptions at $\leq 3.25\text{kA}$ and four (4) interruptions at 30kA during each nine (9) year period. The circuit breaker is set at non-auto reclose.
- 25 interruptions at $\leq 3.25\text{kA}$ and four (4) interruptions at 40kA during each nine (9) year period. The circuit breaker is set to auto-reclose.

The remaining permissible number of interruptions prior to post-fault maintenance can be estimated as follows:

Scenario 1:

$$n_{3.25 \text{ remaining}} = \frac{6000 - (25 \cdot 1 + 4 \cdot 300)}{1} = 3550$$

The predicted required number of interruptions can be estimated as follows, using 25 non fault operations at 3.25kA and 1 fault operation at 30kA.

$$n_{3.25 \text{ required}} = (25 \cdot 1 + 1 \cdot 300) = 325$$

As $n_{3.25 \text{ remaining}} > n_{3.25 \text{ required}}$, the interrupter is still suitable for service. However, if additional fault operation(s) occur resulting in $n_{3.25 \text{ remaining}} < n_{3.25 \text{ required}}$, post-fault maintenance is required.

If a major overhaul is performed on the circuit breaker, the interrupter does not need replacement.

Scenario 2:

$$n_{3.25 \text{ remaining}} = \frac{6000 - (25 \cdot 1 + 4 \cdot 600)}{1} = 1150$$

The predicted required number of interruptions can be estimated as follows, using 25 non fault operations at 3.25kA and 2 fault operations at 40kA (auto-reclosing operation).

$$n_{3.25 \text{ required}} = (25 \cdot 1 + 2 \cdot 600) = 1225$$

As $n_{3.25 \text{ remaining}} < n_{3.25 \text{ required}}$, the interrupter is not suitable for service up to next auto-reclosing operation. Therefore post-fault maintenance is required.

⁵ If the calculated value of the fault levels from Protection Section, Secondary Systems is not available, the calculated value of the fault levels in Endeavour Energy's *NETWORK PARAMETERS* can also be used as the breaking currents for further conservative estimation.

During post-fault maintenance, the DRM test⁶ is required for further assessment of contact wear out.

If the DRM test shows that the contact wear is 2mm after 4 auto-reclosing operations (totally 8 fault operations) in the last 18 years, which is equivalent to 0.5mm for each auto-reclosing operation and the manufacturer's recommended maximum contact wear is 3mm; the interrupter is therefore still suitable for service up to next auto-reclosing operation, as the contact wear will be approximately 2.5mm prior to the post-fault maintenance.

If the DRM test shows that the contact wear is 2.5mm in the last 18 years, which is equivalent to 0.625mm for each auto-reclosing operation, the interrupter is therefore not suitable for service up to the next auto-reclosing operation, as the contact wear will be approximately 3.125mm. The interrupter must be replaced during post-fault maintenance.

In this scenario where the contact wear out is 2.5mm in the last 18 years, if a major overhaul were being performed on the circuit breaker, the contacts require replacement.

⁶ DRM test is only applicable to SF6 circuit breaker. For vacuum circuit breaker if $n_{3,25 \text{ remaining}} < n_{3,25 \text{ required}}$ the post-fault maintenance is needed for replacement of vacuum interrupter.

Annexure 2- Routine maintenance of HV circuit breakers analysed using RCM

1. Bulk oil, outdoor, Westinghouse 33kV 345GCN CB

Asbestos Product Guide Nov 2013: Medium density asbestos cement sheet has been identified in the arc chute close contactor covers of the 33kV 345GCN CB. Asbestos PPE must be worn when working in close proximity. Any occurrences must be reported to Asbestos Management to be scheduled for removal.

8.1 Strategy for managing 345GCN bushings

The DDF of all in-service 345GCN bushings must be tested during routine maintenance and out of cycle to maintenance.

If a bushing's DDF exceeds 20mR or its IR is less than 10 G Ohms using 2.5kV megger, the CB must not be returned to service under normal circumstances. A replacement bushing must be sourced from essential spares and the failed bushing replaced. The Manager System Control, Network Operations in consultation with the Regional Transmission Manager and Asset Standards & Design may override this and return these CBs to service in emergency situations but must treat them as hazardous to employees and equipment. Adequate precautions must be put in place, so the risks identified are controlled.

At least 18 GCN bushings must be maintained as system spares. This will be managed centrally by Substation Assets, Asset Standards & Design.

Bushings with DDF values of less than 15mR and an IR greater than 100 GΩ using 2.5kV megger must be retained as essential spares. Bushings taken from essential spares for replacement must be retested to check they are fit for service.

On testing all bushings, the appropriate guarding must be applied to obtain correct DDF measurements.

Bushings that are found leaking must be replaced.

8.2 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Carry out breather inspection in accordance with SMI 156.
- 1.4 Check oil level.

IN-SERVICE INSPECTION

1.5	Record oil colour.
1.6	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.7	Carry out infra-red survey on outdoor circuit breaker terminations.
1.8	Inspect panel lamps (annunciators) and replace if not working.
1.9	Report Cyclo reading annually.
1.10	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.11	Inspect tank for oil leaks, spillage or other defects.
1.12	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.13	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- BUSHING TEST

BUSHING TEST

1.1	Test and record bushing DDF is < 20 mRad (check there is no step change in capacitance) using DDF tester and bushing IR is $> 10G$ Ohms using 2.5kV megger. Tests to be performed with tank down for major maintenance and tank up for minor maintenance and 3 yearly bushing tests. If DDF and IR test fails with the tank up, a retest is required with the tank down.	Pass Criteria: DDF < 20 mRad IR $> 10G\Omega$
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D- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1	Carry out preliminary visual check as defined in 1.2B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" total resistance of each phase is < 200 micro Ohms at 100A using CB micro-ohm meter. An "as left" test is only required at a major maintenance after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase $< 200\mu\Omega$

MINOR MAINTENANCE

1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 100ms and closing time to be < 450ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 100ms Closing time < 450ms Variance between phases < 2ms
1.4	Examine bushings for cleanliness.	
1.5	Examine bushings for mechanical damage.	
1.6	Test and record bushing DDF is < 20 mRad (check there is no step change in capacitance) using DDF tester and bushing IR is > 10G Ohms using 2.5kV megger. Tests to be performed with tank down for major maintenance and tank up for minor maintenance and 3 yearly bushing tests. If DDF and IR tests fail with the tank up, a retest is required with the tank down.	Pass Criteria: DDF < 20 mRad IR > 10GΩ
1.7	Examine exterior control cabinet for surface protection coverage.	
1.8	Examine exterior steelwork for surface protection coverage.	
1.9	Check operation of control cabinet latch.	
1.10	Examine control cabinet door seals for degradation.	
1.11	Examine auxiliary contact linkage integrity and contact operation.	
1.12	Check fuse size is correct for the closing solenoid resistance. (Use for 0.75 ohm solenoid, 60 AEE for 0.55 ohm solenoid).	Fuse size: 50 AEE for 0.75Ω solenoid 60 AEE for 0.55Ω solenoid
1.13	Check the security of trip coil mounting bolts.	
1.14	Check that compression spring is not misaligned in closing solenoid plunger.	
1.15	Lubricate closing solenoid plunger using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.16	Check cut off switch set to between 6.4 and 9.6mm.	
1.17	Examine latch check switch spring for adequate spring tension.	
1.18	Check latch check switch (trigger) is set between 1.6mm - 3.2mm from its final rest position.	

MINOR MAINTENANCE

1.19	Lubricate all linkages and pivots using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.20	Lubricate trip bar using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.21	Lubricate closing mechanism latch pivot using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.22	Clean closing coil contactor using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.23	Examine closing latch is fully seated when mechanism is closed.
1.24	Examine shock absorber seal for signs of oil leakage.
1.25	Check shock absorber needle valve is adjusted so that breaker mechanism is stopped without heavy shock.
1.26	Examine the footing for signs of movement.
1.27	Examine the footing anchor bolts for corrosion.
1.28	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.29	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

E- MAJOR MAINTENANCE

MAJOR MAINTENANCE

1.1	Carry out preliminary visual check as defined in 1.2B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" total resistance of each phase is < 200micro Ohms at 100A using CB micro-ohm meter. An "as left" test is only required at a major maintenance after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 200μΩ
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB is > 5G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR between phases (CB closed and earth all other phases) of CB > 5GΩ

MAJOR MAINTENANCE		
1.4	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 100ms and closing time to be < 450ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 100ms Closing time < 450ms Variance between phases < 2ms
1.5	Examine bushings for cleanliness.	
1.6	Examine bushings for mechanical damage.	
1.7	Examine bushing mounting studs and nuts for signs of corrosion.	
1.8	Test and record bushing DDF is < 20 mRad (check there is no step change in capacitance) using DDF tester and bushing IR is > 10G Ohms using 2.5kV megger. Tests to be performed with tank down for major maintenance and tank up for minor maintenance and three (3) yearly bushing tests. If DDF and IR tests fail with the tank up, a retest is required with the tank down.	Pass Criteria: DDF < 20 mRad IR > 10GΩ
1.9	Remove, examine and clean turbulator.	
1.10	Examine top plate of turbulator for elongation of moving contact penetration hole.	
1.11	Examine main and arcing contacts for arcing damage and wear.	
1.12	Check that the top of each moving contact is between 38 - 41mm above the bottom of the fixed contact bracket when the CB is fully closed.	
1.13	Examine the tap for leaks.	
1.14	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare the "as found" with "as left" test results.	
1.15	Examine exterior control cabinet for surface protection coverage.	
1.16	Examine exterior steelwork for surface protection coverage.	
1.17	Check operation of control cabinet latch.	
1.18	Examine control cabinet door seals for degradation.	
1.19	Check heater for heat output. If thermostat or timer fitted check operation.	
1.20	Examine auxiliary contact linkage integrity and contact operation.	

MAJOR MAINTENANCE

1.21	Check fuse size is correct for the closing solenoid resistance. (Use 50 AEE for 0.75 ohm solenoid, 60 AEE for 0.55 ohm solenoid).	Fuse size: 50 AEE for 0.75Ω solenoid 60 AEE for 0.55Ω solenoid
1.22	Check the security of trip coil mounting bolts.	
1.23	Check that compression spring is not misaligned in closing solenoid plunger.	
1.24	Lubricate closing solenoid plunger using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.25	Check cut off switch set to between 6.4 and 9.6mm.	
1.26	Examine latch check switch spring for adequate spring tension.	
1.27	Check latch check switch (trigger) is set between 1.6mm - 3.2mm from its final rest position.	
1.28	Lubricate all linkages and pivots using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.29	Lubricate trip bar using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.30	Clean closing coil contactor using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.31	Examine closing latch is fully seated when mechanism is closed.	
1.32	Examine shock absorber seal for signs of oil leakage.	
1.33	Check shock absorber needle valve is adjusted so that breaker mechanism is stopped without heavy shock.	
1.34	Check trip mechanism rollers on roller lever spin freely.	
1.35	Check that the clearance between the trip roller and the cam is between 0.8 - 1.6mm.	
1.36	Examine the screw securing the closing coil cut-off switch bar for security.	
1.37	Check CB operation using trip check.	
1.38	Check correct operation of anti-hunting circuit.	
1.39	Examine the footing for signs of movement.	
1.40	Examine the footing anchor bolts for corrosion.	

MAJOR MAINTENANCE

- 1.41** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
- 1.42** Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

2. Bulk oil, outdoor, AEI 33kV LGIC44 CB

8.3 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1** Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1** Inspect the equipment in general and record any defects.
- 1.2** Inspect for moisture or sweating.
- 1.3** Carry out breather inspection in accordance with SMI 156.
- 1.4** Check oil level.
- 1.5** Record oil colour.
- 1.6** Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.7** Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.8** Inspect panel lamps (annunciators) and replace if not working.
- 1.9** Report cyclo reading annually.
- 1.10** Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.11** Inspect tank for oil leaks, spillage or other defects.
- 1.12** Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.

- 1.13** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1** Carry out preliminary visual check as defined in 2.1B
- IN-SERVICE INSPECTION.

1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 100ms and closing time to be < 450ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 100ms Closing time < 450ms Variance between phases < 2ms
1.3	Test and record the "as found" and "as left" total resistance of each phase is < 200micro Ohms at 100A using CB micro-ohm meter. An "as left" test is only required at a major maintenance after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 200μΩ
1.4	Examine bushings for surface contamination.	
1.5	Examine bushing mounting studs and nuts for signs of corrosion.	
1.6	Examine bushings for mechanical damage.	
1.7	Test and record bushing DDF is < 20 mRad (check there is no step change in capacitance) using DDF tester and bushing IR is > 10G Ohms using 2.5kV megger. Tests to be performed with tank down for major maintenance and tank up for minor maintenance. If DDF and IR tests fail with the tank up, a retest is required with the tank down.	Pass Criteria: DDF < 20 mRad IR > 10GΩ
1.8	Check operation of control cabinet latch.	
1.9	Examine control cabinet door seals for degradation.	
1.10	Check heater for heat output. If thermostat or timer fitted, check operation.	
1.11	Check that the clearance between trip roller and trip latch does not exceed 0.127mm (while in tripped position).	Pass Criteria: Clearance ≤ 0.127mm

MINOR MAINTENANCE		
1.12	Check closing solenoid fuse size is correct for the solenoid resistance (Use 50 AEE for 0.75 ohm solenoid, 60 AEE for 0.55 ohm solenoid).	Fuse size: 50 AEE for 0.75Ω solenoid 60 AEE for 0.55Ω solenoid
1.13	Check solenoid housing for cracks.	
1.14	Check solenoid for loose mounting bolts.	
1.15	Check solenoid for loose connections.	
1.16	Check that compression spring in closing solenoid plunger is not misaligned.	
1.17	Lubricate closing solenoid plunger using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.18	Lubricate trip bar using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.19	Lubricate all linkages and pivots using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.20	Examine the footing anchor bolts for corrosion.	
1.21	Examine footing for signs of movement.	
1.22	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.23	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE		
1.1	Carry out preliminary visual check as defined in 2.1B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 100ms and closing time to be < 450ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 100ms Closing time < 450ms Variance between phases < 2ms

MAJOR MAINTENANCE

1.3	Test and record the "as found" and "as left" total resistance of each phase is < 200micro Ohms at 100A using CB micro-ohm meter. An "as left" test is only required at a major maintenance after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 200μΩ
1.4	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB is > 10G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 10GΩ
1.5	Examine bushings for surface contamination.	
1.6	Examine bushing mounting studs and nuts for signs of corrosion.	
1.7	Examine bushings for mechanical damage.	
1.8	Test and record bushing DDF is < 20 mRad (check there is no step change in capacitance) using DDF tester and bushing IR is > 10G Ohms using 2.5kV megger. Tests to be performed with tank down for major maintenance and tank up for minor maintenance. If DDF and IR tests fail with the tank up, a retest is required with the tank down.	Pass Criteria: DDF < 20 mRad IR > 10GΩ
1.9	Remove, examine and clean turbulator.	
1.10	Examine main and arcing contacts for arcing damage and wear.	
1.11	Check that moving contact travel is 13mm after initial contact is made with the fixed contacts and the fixed contacts is not hard up against their stops when in fully closed position.	
1.12	Examine CT for loose connections.	
1.13	Check dashpot for damage or wear.	
1.14	Examine the oil drain tap for leaks.	
1.15	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 200μΩ IR > 10GΩ
1.16	Examine control cabinet exterior for surface protection coverage.	

MAJOR MAINTENANCE

1.17	Check operation of control cabinet latch.	
1.18	Examine control cabinet door seals for degradation.	
1.19	Check heater for heat output. If thermostat or timer fitted, check operation.	
1.20	Check that the clearance between trip roller and trip latch does not exceed 0.127mm (while in tripped position).	Pass Criteria: Clearance $\leq$ 0.127mm
1.21	Check security of closing mechanism circlips.	
1.22	Examine closing coil contactor for damage.	
1.23	Examine closing coil latch for contamination.	
1.24	Check closing solenoid fuse size is correct for the solenoid resistance (Use 50 AEE for 0.75 ohm solenoid, 60 AEE for 0.55 ohm solenoid).	Fuse size: 50 AEE for 0.75Ω solenoid 60 AEE for 0.55Ω solenoid
1.25	Check solenoid housing for cracks.	
1.26	Check solenoid for loose mounting bolts.	
1.27	Check solenoid for loose connections.	
1.28	Check that compression spring in closing solenoid plunger is not misaligned.	
1.29	Lubricate closing solenoid plunger using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.30	Lubricate trip bar using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.31	Lubricate all linkages and pivots using CB lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.32	Check correct operation of anti-hunting circuit.	
1.33	Examine the footing anchor bolts for corrosion.	
1.34	Examine footing for signs of movement.	
1.35	Examine exterior steelwork for surface protection coverage.	
1.36	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	

3. Bulk oil, indoor, Reyrolle 33kV L800 CB

8.4 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Carry out breather inspection in accordance with SMI 156.
- 1.4 Check oil level.
- 1.5 Record oil colour.
- 1.6 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.7 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.8 Inspect panel lamps (annunciators) and replace if not working.
- 1.9 Report cyclo reading annually.
- 1.10 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.11 Inspect tank for oil leaks, spillage or other defects.
- 1.12 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.13 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

MINOR MAINTENANCE		
1.1	Carry out preliminary visual check as defined in 3.1B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB is > 5G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 5GΩ
1.3	Test and record the "as found" and "as left" total resistance through each pole is < 100micro Ohms at 100A using CB micro-ohm meter. An "as left" test is to be performed after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 100μΩ at 100A
1.4	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 50ms and closing time to be < 300ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 50ms Closing time < 300ms Variance between phases < 2ms
1.5	Remove, disassemble, examine and clean turbulator.	
1.6	Examine contacts for arcing damage and wear.	
1.7	Examine truck bushings for signs of damage.	
1.8	Examine truck bushings for cleanliness.	
1.9	Test and record the bushing IR is > 10G Ohms using 2.5kV megger.	Pass Criteria: IR > 10GΩ
1.10	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 100μΩ IR > 5GΩ
1.11	Examine primary isolating contact for loss of silver coating and signs of overheating.	
1.12	Examine plug board female contacts and brass rivets for security and damage.	
1.13	Lubricate closing coil solenoid plunger using lubricant as set out in Section 5.6 (do not lubricate excessively).	

MINOR MAINTENANCE	
1.14	Lubricate all latch pivots in operating mechanisms using lubricant as set out in Section 5.6 (do not lubricate latch face).
1.15	Check for correct operation of anti-hunting circuit.
1.16	Clean truck track and lubricate wheel bearings with grease.
1.17	Lubricate rack drive and gears with grease.
1.18	Check the operation of the truck interlock assembly. Examine for integrity and security of interlocking components.
1.19	Examine the end boxes/busbar chambers for signs of recent leakage of compound.
1.20	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.21	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

4. Minimum oil, outdoor, ABB 132kV HLR CB

8.5 Maintenance schedule

A- EXERCISE

EXERCISE	
1.1	Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Inspect air receivers for rust.
1.5	Check oil level.
1.6	Record oil colour.
1.7	Inspect HV terminations for corrosion, burning, overheating or other defects.

IN-SERVICE INSPECTION	
1.8	Carry out infra-red survey on outdoor circuit breaker terminations.
1.9	Inspect panel lamps (annunciators) and replace if not working.
1.10	Report cyclo reading annually.
1.11	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.12	Inspect tank for oil leaks, spillage or other defects.
1.13	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Carry out preliminary visual check as defined in 4.1B - IN-SERVICE INSPECTION.
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 35ms and closing time to be < 130ms. Variance between phases to be < 3ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 35ms Closing time < 130ms Variance between phases < 3ms
1.3	Test and record the "as found" and "as left" total resistance of each phase is < 50micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare as left reading with as found. Pass Criteria: Total resistance of each phase < 50μΩ
1.4	Check operation of spring charge does not exceed 15 seconds (HLR 145 2501E) or nine (9) seconds for all other types. Pass Criteria: HLR 145 2501E: Time spring charge≤15s Other types:Time spring charge≤9s
1.5	Examine auxiliary contacts for signs of burning.
1.6	Examine the dashpot oil level.

MINOR MAINTENANCE

1.7	Lubricate closing latch pivot using CB lubricant as set out in Section 5.6 (do not lubricate latch face).
1.8	Lubricate closing mechanism using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.9	Lubricate primary drive rod pivots using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.10	Examine insulators for cleanliness/damage.
1.11	Examine the oil sight glasses for leaks.
1.12	Examine pole externally for oil leaks.
1.13	Examine control cabinet eyebolt O ring for degradation.
1.14	Check heater and thermostat (if fitted) for correct operation.
1.15	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.16	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

1.1	Carry out preliminary visual check as defined in 4.1B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 35ms and closing time to be < 130ms. Variance between phases to be < 3ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 35ms Closing time < 130ms Variance between phases < 3ms
1.3	Test and record the "as found" and "as left" total resistance of each phase is < 50micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare the "as left" with "as found" test results.	Pass Criteria: Total resistance of each phase < 50μΩ
1.4	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger (CB closed and earth all other phases). An "as left" test is to be performed after	Pass Criteria: IR > 50GΩ

MAJOR MAINTENANCE				
	the oil has been replaced. Compare the "as found" with "as left" test results.			
1.5	Clean the turbulator and flush with clean oil.			
1.6	Check if the width of the slot on the underside of the top washer has reached the maximum dimensions below.			Maximum dimensions:
	HLR145	2501E	-	30.5mm
	HLR145	2502B	-	27.0mm
	HLR145 3152C - 32.0mm			
1.7	Examine main and arcing contacts for damage and wear. If moving contact is eroded > 6mm, replace moving contact.			Pass Criteria:
	Dimension	new	moving	contact tip:
	HLR145	2501E	-	236mm
	HLR145	2502	-	173mm
	HLR145 3152C - 179mm			
1.8	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare the "as found" with "as left" test results.			Pass Criteria:
				Total resistance of each phase < 50μΩ IR > 50GΩ
1.9	Check after refill with new oil, each pole is charged with nitrogen to a pressure of 0.5MPa - 0.6MPa.			Pass Criteria: Pressure is 0.5MPa - 0.6MPa.
1.10	Check correct operation of control cabinet door latch.			
1.11	Examine control cabinet lock and hinges for corrosion.			
1.12	Examine control cabinet seals for degradation.			
1.13	Check clutch slips by 10 to 50mm after the spring bridge reaches the stops.			
1.14	Check and record trip spring thread length exposed (after removing trip spring cover) has not changed since last maintenance.			
1.15	Check operation of spring charge does not exceed 15 seconds (HLR 145 2501E) or nine (9) seconds for all other types.			Pass Criteria:
				HLR 145 2501E: Time spring charge<=15s Other types: Time spring charge<=9s

MAJOR MAINTENANCE	
1.16	Examine auxiliary contacts for signs of burning.
1.17	Examine the dashpot oil level.
1.18	Lubricate closing latch pivot using CB lubricant as set out in Section 5.6 (do not lubricate latch face).
1.19	Lubricate closing mechanism using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.20	Lubricate primary drive rod pivots using CB lubricant as set out in Section 5.6 (do not lubricate excessively).
1.21	Examine insulators for cleanliness/damage.
1.22	Examine the oil sight glasses for leaks.
1.23	Examine pole externally for oil leaks.
1.24	Examine control cabinet eyebolt O ring for degradation.
1.25	Check heater and thermostat (if fitted) for correct operation.
1.26	Examine exterior steelwork for surface protection coverage.
1.27	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.28	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

5. Minimum oil, outdoor, ABB 66kV HLC CB

8.6 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.

IN-SERVICE INSPECTION	
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Inspect air receivers for rust.
1.5	Check oil level.
1.6	Record oil colour.
1.7	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.8	Carry out infra-red survey on outdoor circuit breaker terminations.
1.9	Inspect panel lamps (annunciators) and replace if not working.
1.10	Report cyclo reading annually.
1.11	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.12	Inspect tank for oil leaks, spillage or other defects.
1.13	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MAJOR MAINTENANCE

MAJOR MAINTENANCE			
1.1	Carry out preliminary visual check as defined in 5.1B - IN-SERVICE INSPECTION.		
1.2	<table border="1"> <tr> <td>Test and record "as found" and "as left" IR is > 20G Ohms using 2.5kV megger (CB closed and earth all other phases). Compare "as found" with "as left" test results. If IR is < 5G Ohms, CB is to be removed from service and replaced.</td><td>Pass Criteria: IR > 20GΩ</td></tr> </table>	Test and record "as found" and "as left" IR is > 20G Ohms using 2.5kV megger (CB closed and earth all other phases). Compare "as found" with "as left" test results. If IR is < 5G Ohms, CB is to be removed from service and replaced.	Pass Criteria: IR > 20GΩ
Test and record "as found" and "as left" IR is > 20G Ohms using 2.5kV megger (CB closed and earth all other phases). Compare "as found" with "as left" test results. If IR is < 5G Ohms, CB is to be removed from service and replaced.	Pass Criteria: IR > 20GΩ		
1.3	<table border="1"> <tr> <td>Test and record the "as found" and "as left" open and close CB timing using CB timing tester. Opening time to be < 55ms and closing time to be < 130ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.</td><td>Pass Criteria: Opening time < 55ms Closing time < 130ms Variance between phases < 2ms</td></tr> </table>	Test and record the "as found" and "as left" open and close CB timing using CB timing tester. Opening time to be < 55ms and closing time to be < 130ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 55ms Closing time < 130ms Variance between phases < 2ms
Test and record the "as found" and "as left" open and close CB timing using CB timing tester. Opening time to be < 55ms and closing time to be < 130ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 55ms Closing time < 130ms Variance between phases < 2ms		

MAJOR MAINTENANCE		
1.4	Test and record the "as found" and "as left" resistance of each phase is < 55micro Ohms at 100A using CB micro-ohm meter. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 55μΩ
1.5	Examine poles externally for oil leaks.	
1.6	Examine the insulators for cleanliness/damage.	
1.7	Examine main/ moving contacts and arcing rings for damage and wear.	
1.8	Examine turbulator arc controlling segments for cracking and wear.	
1.9	Clean the turbulator and flush with clean oil.	
1.10	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 55μΩ IR > 20GΩ
1.11	Check operation of control cabinet door latch.	
1.12	Examine control cabinet seals for degradation.	
1.13	Check heater and thermostat (if fitted) for correct operation.	
1.14	Examine auxiliary contacts for burning or contamination.	
1.15	Examine closing mechanism drive pins circlips for security.	
1.16	Check clutch slips by 10mm - 50mm after the spring bridge reaches the stops.	
1.17	Examine lower dash pot for excessive play and oil leaks.	
1.18	Examine tripping dash pot for excessive play and oil leaks.	
1.19	Lubricate chain sprockets, drive gears, operating linkages, sliding surfaces and gearbox ratchet pawl using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.20	Lubricate closing mechanism latch pivot using lubricant as set out in Section 5.6 (do not lubricate latch face).	
1.21	Lubricate primary drive rod pivots using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.22	Examine exterior steelwork for surface protection coverage.	

MAJOR MAINTENANCE

- 1.23** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
- 1.24** Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

6. Minimum oil, outdoor, Sprecher and Schuh 66kV HPF CB

8.7 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1** Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1** Inspect the equipment in general and record any defects.
- 1.2** Inspect for moisture or sweating.
- 1.3** Carry out breather inspection in accordance with SMI 156.
- 1.4** Inspect air receivers for rust.
- 1.5** Check oil level.
- 1.6** Record oil colour.
- 1.7** Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.8** Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.9** Inspect panel lamps (annunciators) and replace if not working.
- 1.10** Report cyclo reading annually.
- 1.11** Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.12** Inspect tank for oil leaks, spillage or other defects.

IN-SERVICE INSPECTION

- 1.13** Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.14** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1** Carry out preliminary visual check as defined in 6.1B
- IN-SERVICE INSPECTION.

1.2	Test and record the "as found" and "as left" IR between phases of CB is > 50G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ
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1.3	Test and record the "as found" and "as left" total resistance through each pole is < 100micro Ohms at 100A using CB micro-ohm meter. An "as left" test is to be performed after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 100μΩ
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1.4	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 25ms and closing time to be < 160ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 25ms Closing time < 160ms Variance between phases < 2ms
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- 1.5** Examine oil dash pot for damage or wear.

- 1.6** Check gearbox oil level.

- 1.7** Examine auxiliary contacts for signs of burning.

- 1.8** Check that trip latch spring exerts positive pressure.

- 1.9** Lubricate all moving parts in operating mechanisms using lubricant as set out in Section 5.6 (do not lubricate excessively).

- 1.10** Clean interior of control cabinet of dust.

- 1.11** Check operation of control cabinet door latch.

- 1.12** Examine control cabinet seals for degradation.

MINOR MAINTENANCE

1.13 Examine exterior steelwork for surface protection coverage.

1.14 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

1.15 Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

1.1 Carry out preliminary visual check as defined in 6.1B
- IN-SERVICE INSPECTION.

1.2	Test and record the "as found" and "as left" IR between phases of CB is > 50G Ohms using 2.5kV megger (CB closed and earth all other phases). An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ
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1.3	Test and record the "as found" and "as left" total resistance through each pole is < 100micro Ohms at 100A using CB micro-ohm meter. An "as left" test is to be performed after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 100μΩ
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1.4	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 25ms and closing time to be < 160ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 25ms Closing time < 160ms Variance between phases < 2ms
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1.5 Remove, examine and clean turbulator. Flush with clean oil.

1.6 Examine turbulator top washer for wear.

1.7 Examine main and arcing contacts for arcing damage and wear.

1.8	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 100micro Ohms IR > 50G Ohms
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MAJOR MAINTENANCE

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|------|---|
| 1.9 | Examine oil dash pot for damage or wear. |
| 1.10 | Check gearbox oil level. |
| 1.11 | Examine auxiliary contacts for signs of burning. |
| 1.12 | Check that trip latch spring exerts positive pressure. |
| 1.13 | Examine drive chain for lack of lubrication, signs of corrosion and uneven tension. |
| 1.14 | Lubricate all moving parts in operating mechanisms using lubricant as set out in Section 5.6 (do not lubricate excessively). |
| 1.15 | Clean interior of control cabinet of dust. |
| 1.16 | Check operation of control cabinet door latch. |
| 1.17 | Examine control cabinet seals for degradation. |
| 1.18 | Examine exterior steelwork for surface protection coverage. |
| 1.19 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.20 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

7. Minimum oil, outdoor, Magrini Galileo 33kV MGE CB

8.8 Maintenance schedule

A- EXERCISE

EXERCISE

- | | |
|-----|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|-----|---------------------------------|

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- | | |
|-----|---|
| 1.1 | Inspect the equipment in general and record any defects. |
| 1.2 | Inspect for moisture or sweating. |
| 1.3 | Carry out breather inspection in accordance with SMI 156. |

IN-SERVICE INSPECTION	
1.4	Inspect air receivers for rust.
1.5	Check oil level.
1.6	Record oil colour.
1.7	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.8	Carry out infra-red survey on outdoor circuit breaker terminations.
1.9	Inspect panel lamps (annunciators) and replace if not working.
1.10	Report cyclo reading annually.
1.11	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.12	Inspect tank for oil leaks, spillage or other defects.
1.13	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE		
1.1	Carry out preliminary visual check as defined in 7.1B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 70ms and closing time to be < 110ms. Variance between phases to be < 3ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 70ms Closing time < 110ms Variance between phases < 3ms
1.3	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ
1.4	Test and record the "as found" and "as left" total resistance of each phase is < 50micro Ohms at 100A using CB micro-ohm meter. An "as left" test should	Pass Criteria: Total resistance of each phase < 50μΩ

MINOR MAINTENANCE		
	only be performed during a major maintenance. Compare the "as left" with "as found" test results.	
1.5	Examine striker on close coil plunger for damage.	
1.6	Lubricate all moving parts in trip mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.7	Lubricate all moving parts of closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.8	Lubricate latch pivot on closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.9	Check heater and thermostat (if fitted) for correct operation.	
1.10	Examine the oil sight glass for leaks and clarity.	
1.11	Examine pole externally for oil leaks.	
1.12	Examine insulators for cleanliness/damage.	
1.13	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.14	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE		
1.1	Carry out preliminary visual check as defined in 7.1B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 70ms and closing time to be < 110ms. Variance between phases to be < 3ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 70ms Closing time < 110ms Variance between phases < 3ms
1.3	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger (CB closed and earth all other phases). An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ

MAJOR MAINTENANCE		
1.4	Test and record the "as found" and "as left" total resistance of each phase is < 50micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare the "as left" with "as found" test results.	Pass Criteria: Total resistance of each phase < 50μΩ
1.5	Examine arc controlling segments of turbulator for carbon, wear or cracking.	
1.6	Examine the main and arcing contacts for damage and wear.	
1.7	Replace oil.	
1.8	Examine the dash pot for oil leaks or damage.	
1.9	Check trip latch spring exerts positive pressure.	
1.10	Check distance between trip coil plunger and trip lever is 4mm +/- 0.5 mm.	Pass Criteria: Distance between trip coil plunger and trip lever: 4mm +/- 0.5
1.11	Examine striker on close coil plunger for damage.	
1.12	Lubricate all moving parts in trip mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.13	Lubricate all moving parts of closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.14	Lubricate latch pivot on closing mechanism using lubricant as set out in Section 5.6 (do not lubricate latch face).	
1.15	Check heater and thermostat (if fitted) for correct operation.	
1.16	Examine the oil sight glass for leaks and clarity.	
1.17	Examine pole externally for oil leaks.	
1.18	Examine insulators for cleanliness/damage.	
1.19	Examine exterior steelwork for surface protection coverage.	
1.20	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.21	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

8. Minimum oil, indoor, Magrini Galileo 33kV MG CB

8.9 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Carry out breather inspection in accordance with SMI 156
- 1.4 Inspect air receivers for rust.
- 1.5 Check oil level.
- 1.6 Record oil colour.
- 1.7 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.8 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.9 Inspect panel lamps (annunciators) and replace if not working.
- 1.10 Report cyclo reading annually.
- 1.11 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.12 Inspect tank for oil leaks, spillage or other defects.
- 1.13 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.14 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

MINOR MAINTENANCE

- 1.1 Carry out preliminary visual check as defined in 8.1B
- IN-SERVICE INSPECTION.

1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 70ms and closing time to be < 110ms. Variance between phases to be < 3ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 70ms Closing time < 110ms Variance between phases < 3ms
1.3	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ
1.4	Test and record the "as found" and "as left" total resistance of each phase is < 50micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare the "as left" with "as found" test results.	Pass Criteria: Total resistance of each phase < 50μΩ
1.5	Lubricate all moving parts in trip mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.6	Lubricate all moving parts of closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	
1.7	Lubricate latch pivot on closing mechanism using lubricant as set out in Section 5.6 (do not lubricate latch face).	
1.8	Examine the oil sight glass for leaks and clarity.	
1.9	Examine pole externally for oil leaks.	
1.10	Examine insulators for cleanliness/damage.	
1.11	Examine plug board female contacts and brass rivets for security and damage.	
1.12	Examine pole palm connections for signs of burning.	
1.13	Lubricate truck wheel bearing (Do not lubricate excessively).	
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.15	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

- 1.1** Carry out preliminary visual check as defined in 8.1B
- IN-SERVICE INSPECTION.

1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 70ms and closing time to be < 110ms. Variance between phases to be < 3ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 70ms Closing time < 110ms Variance between phases < 3ms
1.3	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger (CB closed and earth all other phases). An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ
1.4	Test and record the "as found" and "as left" total resistance of each phase is < 50micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare the "as left" with "as found" test results.	Pass Criteria: Total resistance of each phase < 50μΩ
1.5	Examine arc controlling segments of turbulator for carbon, wear or cracking.	
1.6	Examine the main and arcing contacts for damage and wear.	
1.7	Replace oil.	
1.8	Examine the dash pot for oil leaks or damage.	
1.9	Check trip latch spring exerts positive pressure.	
1.10	Check distance between trip coil plunger and trip lever is 4mm +/- 0.5 mm.	Pass Criteria: Distance between trip coil plunger and trip lever: 4mm +/- 0.5
1.11	Lubricate all moving parts in trip mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).	

MAJOR MAINTENANCE	
1.12	Lubricate all moving parts of closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).
1.13	Lubricate latch pivot on closing mechanism using lubricant as set out in Section 5.6 (do not lubricate latch face).
1.14	Examine the oil sight glass for leaks and clarity.
1.15	Examine pole externally for oil leaks.
1.16	Examine insulators for cleanliness/damage.
1.17	Examine plug board female contacts and brass rivets for security and damage.
1.18	Examine pole palm connections for signs of burning.
1.19	Lubricate truck wheel bearing (Do not lubricate excessively).
1.20	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.21	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

9 Minimum oil, outdoor, Delle 66kV HPGE CB

9.1 Maintenance schedule

A- EXERCISE

EXERCISE	
1.1	Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Inspect air receivers for rust.
1.5	Check oil level.

IN-SERVICE INSPECTION	
1.6	Record oil colour.
1.7	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.8	Carry out infra-red survey on outdoor circuit breaker terminations.
1.9	Inspect panel lamps (annunciators) and replace if not working.
1.10	Report cyclo reading annually.
1.11	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.12	Inspect tank for oil leaks, spillage or other defects.
1.13	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Carry out preliminary visual check as defined in 9.1B - IN-SERVICE INSPECTION.
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be less than 100ms. For circuit breakers with reclosing, check that the circuit breaker recloses automatically. Pass Criteria: Opening time < 100ms
1.3	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results. Pass Criteria: IR > 50GΩ
1.4	Test and record the "as found" and "as left" total resistance of each phase is < 160micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare the "as left" with "as found" test results. Pass Criteria: Total resistance of each phase < 160μΩ
1.5	Examine striker on close coil plunger for damage.

MINOR MAINTENANCE	
1.6	Lubricate all moving parts in trip mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).
1.7	Lubricate all moving parts of closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).
1.8	Lubricate latch pivot on closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).
1.9	Examine the exhaust grate for blockages.
1.10	Check heater and thermostat (if fitted) for correct operation.
1.11	Examine the oil sight glass for leaks and clarity.
1.12	Examine pole externally for oil leaks.
1.13	Examine insulators for cleanliness/damage.
1.14	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.15	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE		
1.1	Carry out preliminary visual check as defined in 9.1B - IN-SERVICE INSPECTION.	
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be less than 100ms. For circuit breakers with reclosing, check that the circuit breaker recloses automatically.	Pass Criteria: Opening time < 100ms
1.3	Test and record "as found" and "as left" IR is > 50G Ohms using 2.5kV megger (CB closed and earth all other phases). An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR > 50GΩ
1.4	Test and record the "as found" and "as left" total resistance of each phase is < 160micro Ohms at 100A using CB micro-ohm meter. An "as left" test should only be performed during a major maintenance. Compare the "as left" with "as found" test results.	Pass Criteria: Total resistance of each phase < 160μΩ

MAJOR MAINTENANCE

1.5	Examine arc controlling segments of centering tube, explosion pot and arcing ring.
1.6	Examine the main and arcing contacts for damage and wear.
1.7	Replace oil.
1.8	Examine the dash pot for oil leaks or damage.
1.9	Check trip latch spring exerts positive pressure.
1.10	Check distance between trip coil plunger and trip lever.
1.11	Examine striker on close coil plunger for damage.
1.12	Lubricate all moving parts in trip mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).
1.13	Lubricate all moving parts of closing mechanism using lubricant as set out in Section 5.6 (do not lubricate excessively).
1.14	Lubricate latch pivot on closing mechanism using lubricant as set out in Section 5.6 (do not lubricate latch face).
1.15	Examine the exhaust grate for blockages.
1.16	Check heater and thermostat (if fitted) for correct operation.
1.17	Examine the oil sight glass for leaks and clarity.
1.18	Examine pole externally for oil leaks.
1.19	Examine insulators for cleanliness/damage.
1.20	Examine exterior steelwork for surface protection coverage.
1.21	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.22	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

10 SF6, outdoor, Siemens 66/132kV 3A1PDT

10.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect air receivers for rust.
- 1.4 Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: *Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.*
- 1.5 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.6 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.7 Inspect Panel lamps (annunciators) and replace if not working.
- 1.8 Report cyclo reading annually.
- 1.9 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.10 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.11 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.12 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1 Carry out preliminary visual check as defined in 10.1B
- IN-SERVICE INSPECTION.
- 1.2 Test SF6 gas quality (in accordance with **SDI 545** – Acceptable purity limits for SF6 gas)
Pass Criteria:
Air (O₂ and N₂): <= 3% volume in total

MINOR MAINTENANCE		
		CF4: $\leq 3\%$ volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (-28°C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by-products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000 ppmv SF ₄ and WF ₆ : ≤ 100 ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be $31\text{ms} \pm 3\text{ms}$ and closing time to be $55\text{ms} \pm 5\text{ms}$. Variance between phases to be $< 2\text{ms}$. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time = $31\text{ms} \pm 3\text{ms}$ Closing time = $55\text{ms} \pm 5\text{ms}$ Variance between phases $< 2\text{ms}$
1.4	Test and record the total resistance of each phase at 100A using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available).	
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR $> 1\text{G}\Omega$.
1.6	Check function of the SF ₆ density monitor (by undoing the sealing cap on test connection W2 and checking whether the density monitor contacts respond).	
1.7	Examine bushings for cleanliness and mechanical damage.	
1.8	Examine cubicle and gas piping for rust and damage.	
1.9	Check security and tightness of fastenings.	
1.10	Examine auxiliary contacts for signs of damage.	
1.11	Examine the auxiliary switch coupling gear for damage.	
1.12	Examine low voltage wiring and terminals for signs of damage.	
1.13	Examine shock absorber for signs of damage.	
1.14	Check that anti-pumping is functioning correctly.	

MINOR MAINTENANCE

- | | | |
|-------------|---|--|
| 1.15 | Check operation of motor and limit switches (charge time < 15 sec). | Pass Criteria:
Motor charge time < 15s |
| 1.16 | Check heater and thermostat (if fitted) for correct operation. | |
| 1.17 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. | |
| 1.18 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. | |

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

- | | |
|------------|---|
| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter). |
| 1.2 | The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance. |
| 1.3 | <ul style="list-style-type: none"> • De-gas the circuit breaker. • Check the condition of the contact system and replace as required. • Replace moisture filter. • Refill with new gas. |
| 1.4 | Carry out tasks in the Minor Maintenance . |

11 SF6, outdoor, Areva 66kV DT1/DT09

11.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- | | |
|------------|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|------------|---------------------------------|

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect air receivers for rust.
1.4	Check gas pressure gauge (where installed) is within acceptable range of gauge limits. Note: <i>Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.</i>
1.5	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.6	Carry out infra-red survey on outdoor circuit breaker terminations.
1.7	Inspect Panel lamps (annunciators) and replace if not working.
1.8	Report cyclo reading annually.
1.9	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.11	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE			
1.1	Carry out preliminary visual check as defined in 11.1B - IN-SERVICE INSPECTION.		
1.2	<table border="1"> <tr> <td>Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)</td><td> Pass Criteria: Air (O₂ and N₂): ≤ 3% volume in total CF4: ≤ 3% volume in total </td></tr> </table>	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF4: ≤ 3% volume in total
Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF4: ≤ 3% volume in total		

MINOR MAINTENANCE		
		H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 30ms and closing time to be < 90ms. Variance between phases to be < 3ms closing and <1.5ms opening. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 30ms Closing time < 90ms Variance between phases < 3ms for closing Variance between phases < 1.5ms for opening
1.4	Test and record the total resistance of each phase is < 156micro Ohms at 100A using CB micro-ohm meter.	Pass Criteria: Total resistance of each phase < 156μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1 GΩ.
1.6	Examine bushings for cleanliness and mechanical damage.	
1.7	Examine cubicle and gas piping for rust and damage.	
1.8	Check security and tightness of fastenings.	
1.9	Examine auxiliary contacts for signs of damage.	
1.10	Examine low voltage wiring and terminals for signs of damage.	
1.11	Examine shock absorber for signs of damage.	
1.12	Check that anti-pumping is functioning correctly.	
1.13	Check operation of motor and limit switches (charge time < 10 sec).	Pass Criteria: Motor charge time < 10s

MINOR MAINTENANCE

- | | |
|------|---|
| 1.14 | Check heater and thermostat (if fitted) for correct operation. |
| 1.15 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.16 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

- | | |
|-----|---|
| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter). |
| 1.2 | The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance. |
| 1.3 | <ul style="list-style-type: none"> • De-gas the circuit breaker. • Check the condition of the contact system and replace as required. • Replace moisture filter. • Refill with new gas. |
| 1.4 | Carry out tasks in the Minor Maintenance . |

12 SF6, outdoor, ABB 33/66kV EDF

12.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- | | |
|-----|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|-----|---------------------------------|

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- | | |
|-----|--|
| 1.1 | Inspect the equipment in general and record any defects. |
|-----|--|

IN-SERVICE INSPECTION	
1.2	Inspect for moisture or sweating.
1.3	Inspect air receivers for rust.
1.4	Check gas pressure gauge (where installed) is within acceptable range of gauge limits. Note: <i>Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.</i>
1.5	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.6	Carry out infra-red survey on outdoor circuit breaker terminations.
1.7	Inspect Panel lamps (annunciators) and replace if not working.
1.8	Report cyclo reading annually.
1.9	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.11	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Carry out preliminary visual check as defined in 12.1B - IN-SERVICE INSPECTION.
1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas) Pass Criteria: Air (O₂ and N₂): <= 3% volume in total CF4:<= 3% volume in total H₂O ppmv (dew point): <= 470 ppmv (- 28 °C) Mineral oil:<= 10 ppmw Total reactive gaseous decomposition by- products (HF,

MINOR MAINTENANCE		
		SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 35ms and closing time to be < 60ms. Variance between phases to be < 3ms closing and <1.5ms opening. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 35ms Closing time < 60ms Variance between phases < 3ms for closing Variance between phases < 1.5ms for opening
1.4	Test and record the total resistance of each phase at 100A using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: Total resistance of each ≤ 50μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ.
1.6	Examine bushings for cleanliness and mechanical damage.	
1.7	Examine cubicle and gas piping for rust and damage.	
1.8	Check security and tightness of fastenings.	
1.9	Examine auxiliary contacts for signs of damage.	
1.10	Examine low voltage wiring and terminals for signs of damage.	
1.11	Examine shock absorber for signs of damage.	
1.12	Check that anti-pumping is functioning correctly.	
1.13	Check operation of motor and limit switches (charge time < 15 sec).	
1.14	Check heater and thermostat (if fitted) for correct operation.	
1.15	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.16	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

- 1.1** This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter).

- 1.2** The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance.

- De-gas the circuit breaker.
- Check the condition of the contact system and replace as required.
- Replace moisture filter.
- Refill with new gas.

- 1.4** Carry out tasks in the **Minor Maintenance**.

13 SF6, outdoor, Merlin Gerin 33kV 36GI-E25

13.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- 1.1** Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1** Inspect the equipment in general and record any defects.

- 1.2** Inspect for moisture or sweating.

- 1.3** Inspect air receivers for rust.

- 1.4** Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.

IN-SERVICE INSPECTION

1.5	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.6	Carry out infra-red survey on outdoor circuit breaker terminations.
1.7	Inspect Panel lamps (annunciators) and replace if not working.
1.8	Report cyclo reading annually.
1.9	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.11	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1	Carry out preliminary visual check as defined in 13.1B - IN-SERVICE INSPECTION.	
1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF ₄ : ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 63ms and closing time to be < 72ms. Variance between phases to be < 1ms. An "as left" test is to be	Pass Criteria: Opening time < 63ms Closing time < 72ms

MINOR MAINTENANCE

performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Variance between phases < 1ms

1.4	Test and record the total resistance of each phase using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: Total resistance of each $\leq 30\mu\Omega$
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ.
1.6	Examine bushings for cleanliness and mechanical damage.	
1.7	Examine cubicle and gas piping for rust and damage.	
1.8	Check security and tightness of fastenings.	
1.9	Examine auxiliary contacts for signs of damage.	
1.10	Examine springs for loss of tension (via disabling spring charge motor).	
1.11	Examine low voltage wiring and terminals for signs of damage.	
1.12	Examine shock absorber for signs of damage.	
1.13	Check that anti-pumping is functioning correctly.	
1.14	Check operation of motor and limit switches.	
1.15	Check heater and thermostat (if fitted) for correct operation.	
1.16	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.17	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

- 1.1 This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter)

1.2	The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance.
1.3	• De-gas the circuit breaker. • Removal of all powder deposits from inside the interrupting element • Replacement of worn parts (if any) • Refill with new gas.
1.4	Carry out tasks in the Minor Maintenance .

14 SF6, outdoor, Specher & Schuh 132kV HGF

14.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.

- 1.2 Inspect for moisture or sweating.

- 1.3 Inspect air receivers for rust.

- 1.4 Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.

- 1.5 Inspect HV terminations for corrosion, burning, overheating or other defects.

- 1.6 Carry out infra-red survey on outdoor circuit breaker terminations.

- 1.7 Inspect Panel lamps (annunciators) and replace if not working.

- 1.8 Report cyclo reading annually.

- 1.9 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.

IN-SERVICE INSPECTION

1.10	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.11	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1	Carry out preliminary visual check as defined in 14.1B - IN-SERVICE INSPECTION.	
1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF ₄ : ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 30ms and closing time to be < 154ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 30ms Closing time < 154ms Variance between phases < 2ms
1.4	Test and record the total resistance of each phase using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: Total resistance of each phase ≤ 45μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB.	Pass Criteria: IR > 1GΩ.

MINOR MAINTENANCE

Compare with commissioning test results (or previous maintenance test results if not available).

1.6	Examine bushings for cleanliness and mechanical damage.	
1.7	Examine cubicle and gas piping for rust and damage.	
1.8	Check security and tightness of fastenings.	
1.9	Examine auxiliary contacts for signs of damage.	
1.10	Examine low voltage wiring and terminals for signs of damage.	
1.11	Examine shock absorber for signs of damage.	
1.12	Check that anti-pumping is functioning correctly.	
1.13	Check densimeter functionality at the switching point.	
1.14	Check operation of motor and limit switches (charge time 10-14 sec).	Pass Criteria: Motor charge time is 10 -14s
1.15	Check heater and thermostat (if fitted) for correct operation.	
1.16	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.17	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter).	
1.2	The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance.	
	De-gas the circuit breaker.	
1.3	- Check the condition of the contact system and replace as required. - Replace moisture filter.	

MAJOR MAINTENANCE

- Refill with new gas.

1.4 Carry out tasks in the **Minor Maintenance**.

15 SF6, outdoor, ABB 132kV HPL

15.1 Maintenance Schedule

A- EXERCISE

EXERCISE

1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

1.1 Inspect the equipment in general and record any defects.

1.2 Inspect for moisture or sweating.

1.3 Inspect air receivers for rust.

1.4 Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.

1.5 Inspect HV terminations for corrosion, burning, overheating or other defects.

1.6 Carry out infra-red survey on outdoor circuit breaker terminations.

1.7 Inspect Panel lamps (annunciators) and replace if not working.

1.8 Report cyclo reading annually.

1.9 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.

1.10 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.

1.11 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.

IN-SERVICE INSPECTION

- 1.12** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1** Carry out preliminary visual check as defined in 15.1B
- IN-SERVICE INSPECTION.

1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF ₄ : ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be 24±2ms and closing time to be < 65ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time = 24±2ms Closing time < 65ms Variance between phases < 2ms
1.4	Test and record the total resistance of each phase using CB micro-ohm meter. Contact resistance must be ≤ 50 micro ohms. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: Total resistance of each phase ≤ 50μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ.
1.6	Examine bushings for cleanliness and mechanical damage.	

MINOR MAINTENANCE

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|------|---|
| 1.7 | Examine cubicle and gas piping for rust and damage. |
| 1.8 | Check security and tightness of fastenings. |
| 1.9 | Examine auxiliary contacts for signs of damage. |
| 1.10 | Examine low voltage wiring and terminals for signs of damage. |
| 1.11 | Examine shock absorber for signs of damage and oil level. |
| 1.12 | Check that anti-pumping is functioning correctly. |
| 1.13 | Check operation of motor and limit switches (charge time 10-14 sec). |
| 1.14 | Check heater and thermostat (if fitted) for correct operation. |
| 1.15 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.16 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

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|-----|---|
| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter). |
| 1.2 | The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance. |
| 1.3 | <ul style="list-style-type: none"> De-gas the circuit breaker. Check the condition of the contact system and replace as required. Replace moisture filter. Refill with new gas. |
| 1.4 | Carry out tasks in the Minor Maintenance . |

16 SF6, outdoor, Siemens 66/132kV SPS2

16.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect air receivers for rust.
- 1.4 Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.
- 1.5 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.6 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.7 Inspect Panel lamps (annunciators) and replace if not working.
- 1.8 Report cyclo reading annually.
- 1.9 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.10 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.11 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.12 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1** Carry out preliminary visual check as defined in 16.1B
- IN-SERVICE INSPECTION.

1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF ₄ : ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be 20 - 26ms and closing time to be ≤ 63ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time is between 20 - 26ms Closing time ≤ 63ms Variance between phases < 2ms
1.4	Test and record the total resistance of each phase at 100A using CB micro-ohm meter. Contact resistance must be < 130 micro ohms. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: Total resistance of each phase ≤ 130μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ.
1.6	Check function of the SF6 density monitor (by undoing the sealing cap on test connection W2 and checking whether the density monitor contacts respond).	
1.7	Examine bushings for cleanliness and mechanical damage.	
1.8	Examine cubicle and gas piping for rust and damage.	
1.9	Check security and tightness of fastenings.	
1.10	Examine auxiliary contacts for signs of damage.	
1.11	Examine the auxiliary switch coupling gear for damage.	

MINOR MAINTENANCE	
1.12	Examine low voltage wiring and terminals for signs of damage.
1.13	Examine shock absorber for signs of damage.
1.14	Check that anti-pumping is functioning correctly.
1.15	Check operation of motor and limit switches (charge time < 15 sec).
1.16	Check heater and thermostat (if fitted) for correct operation.
1.17	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.18	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

Pass Criteria:

Motor charge time < 15s

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.	
1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter).
1.2	The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance.
1.3	• De-gas the circuit breaker. • Check the condition of the contact system and replace as required. • Replace moisture filter. • Refill with new gas.
1.4	Carry out tasks in the Minor Maintenance .

17 Vacuum/SF6, outdoor, Areva 33kV OX36

17.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect air receivers for rust.
- 1.4 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.5 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.6 Inspect Panel lamps (annunciators) and replace if not working.
- 1.7 Report Cyclo reading annually.
- 1.8 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.9 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.10 Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.11 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1 Carry out preliminary visual check as defined in 17.1B
- IN-SERVICE INSPECTION.

MINOR MAINTENANCE		
1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF ₄ : ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 40ms and closing time to be < 60ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 40ms Closing time < 60ms Variance between phases < 2ms
1.4	Test and record the total resistance of each phase at 100A using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available).	
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ.
1.6	Check vacuum integrity using VIDAR test. Refer to Section 6.4, E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.7	Check the contact wear indicator. Note: Major maintenance may have to be carried out if indicator shows that contacts have reached the limit of wear.	
1.8	Check function of the SF6 pressure switch.	
1.9	Examine bushings for cleanliness and mechanical damage.	

MINOR MAINTENANCE	
1.10	Examine cubicle and gas piping for rust and damage.
1.11	Check security and tightness of fastenings.
1.12	Examine auxiliary contacts for signs of damage.
1.13	Examine low voltage wiring and terminals for signs of damage.
1.14	Examine shock absorber for signs of damage.
1.15	Check that anti-pumping is functioning correctly.
1.16	Examine status indicator for correct operation.
1.17	Check operation of motor and limit switches (charge time < 15 sec).
1.18	Check heater and thermostat (if fitted) for correct operation.
1.19	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.20	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

Pass Criteria:

Motor charge time < 15s

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.	
1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter).
1.2	The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance.
1.3	- De-gas the circuit breaker. - Replace the interrupters. - Refill with new gas.
1.4	Carry out tasks in the Minor Maintenance .

18 Vacuum/SF6, outdoor, Hawker Siddeley 33kV Horizon

18.1 Maintenance Schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect air receivers for rust.
- 1.4 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.5 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.6 Inspect Panel lamps (annunciators) and replace if not working.
- 1.7 Report Cyclo reading annually.
- 1.8 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.9 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.10 Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.11 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1 Carry out preliminary visual check as defined in 18.1B
- IN-SERVICE INSPECTION.

MINOR MAINTENANCE

1.2	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF ₄ : ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.3	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be 30-50ms and closing time to be 150-250ms. Variance between phases to be < 1ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time is between 30 - 50ms Closing time is between 150 - 250ms Variance between phases < 1ms
1.4	Test and record the total resistance of each phase at 100A using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: 1250A CB Total resistance of each phase ≤ 75μΩ 2000A CB Total resistance of each phase ≤ 55μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ.
1.6	Check vacuum integrity using VIDAR test. Refer to Section 6.4, E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.7	Examine bushings for cleanliness and mechanical damage.	

MINOR MAINTENANCE

1.8	Examine cubicle and gas piping for rust and damage.
1.9	Examine CT wiring/conduit for damage.
1.10	Check security and tightness of fastenings.
1.11	Examine auxiliary contacts for signs of damage.
1.12	Examine low voltage wiring and terminals for signs of damage.
1.13	Check that anti-pumping is functioning correctly.
1.14	Check heater and thermostat (if fitted) for correct operation.
1.15	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.16	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.8.2 before major maintenance is carried out.

1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter).
1.2	The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance.
1.3	- De-gas the circuit breaker. - Replace the interrupters. - Refill with new gas.
1.4	Carry out tasks in the Minor Maintenance .

19 Bulk oil, indoor, English Electric or GEC 11kV OLX

19.1 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Carry out breather inspection in accordance with SMI 156.
- 1.4 Check oil level.
- 1.5 Record oil colour.
- 1.6 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.7 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.8 Inspect panel lamps (annunciators) and replace if not working.
- 1.9 Report cyclo reading annually.
- 1.10 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.11 Inspect tank for oil leaks, spillage or other defects.
- 1.12 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.13 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 100ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 100ms
1.2	Test total resistance through each pole using a 100A micro ohm meter (up to 800A, limit - 200 micro ohms / above 800A, limit - 100 micro ohms). Record the resistance.	Pass Criteria: Total resistance of each phase < 200μΩ for CB current rating up to 800A Total resistance of each phase < 100μΩ for CB current rating above 800A
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.4	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.5	Examine bushings for surface contamination and signs of damage.	
1.6	Inspect condition of spout orifice safety shutters and operating linkages. Lubricate where necessary.	
1.7	Inspect truck wheels.	
1.8	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.9	Check interlocks.	
1.10	Measure coil resistances.	
1.11	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.12	Check closing solenoid and plunger for security and alignment.	

MINOR MAINTENANCE

1.13	Lubricate moving parts of the operating mechanism using CB lubricant as set out in Section 5.5.4 (do not lubricate excessively).
1.14	Check correct operation of anti-hunting circuit.
1.15	Check heater for heat output. If thermostat or timer fitted, check operation.
1.16	Inspect current transformer, for example, mounting clamps, secondary wiring and the like.
1.17	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.18	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

1.1	Carry out the tasks set out in the Minor Maintenance.
1.2	Remove, examine and clean turbulator.
1.3	Examine main and arcing contacts for arcing damage and wear.
1.4	Check that the internal mechanism operates freely and that the moving contact cross head moves smoothly on the guide rods.
1.5	Check condition of dashpot.
1.6	Examine the oil drain tap for leaks.
1.7	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results. Pass Criteria: Total resistance of each phase < 200$\mu\Omega$ for CB current rating up to 800A Total resistance of each phase < 200$\mu\Omega$ for CB current rating above 800A IR > 1GΩ

- | | |
|------------|--|
| 1.8 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |
|------------|--|

20 Bulk oil, indoor, Hawker Siddeley 11kV (Q and R series)

20.1 Maintenance schedule

A- EXERCISE

EXERCISE

- | | |
|------------|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|------------|---------------------------------|

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- | | |
|-------------|---|
| 1.1 | Inspect the equipment in general and record any defects. |
| 1.2 | Inspect for moisture or sweating. |
| 1.3 | Carry out breather inspection in accordance with SMI 156. |
| 1.4 | Check oil level. |
| 1.5 | Record oil colour. |
| 1.6 | Inspect HV terminations for corrosion, burning, overheating or other defects. |
| 1.7 | Carry out infra-red survey on outdoor circuit breaker terminations. |
| 1.8 | Inspect panel lamps (annunciators) and replace if not working. |
| 1.9 | Report cyclo reading annually. |
| 1.10 | Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects. |
| 1.11 | Inspect tank for oil leaks, spillage or other defects. |
| 1.12 | Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects. |
| 1.13 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |

C- THERMOVISION**THERMOVISION**

		Temperature rise >10 degrees: Repair within 48 hours
1.1	Carry out thermovision to identify possible overheating contacts and connections.	Temperature rise is 5 – 10 degrees: Report to Substation Assets Manager Temperature rise < 5 degrees: No action

D- MINOR MAINTENANCE**MINOR MAINTENANCE**

1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 100ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 100ms
1.2	Test total resistance through each pole using a 100A micro ohm meter (up to 800A, limit - 200 micro ohms / above 800A, limit - 100 micro ohms). Record the resistance.	Pass Criteria: Total resistance of each phase < 200μΩ for CB current rating up to 800A Total resistance of each phase < 100μΩ for CB current rating above 800A
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ, and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.4	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.5	Examine bushings for surface contamination and signs of damage.	
1.6	Inspect condition of spout orifice safety shutters and operating linkages.	
1.7	Inspect truck wheels.	

MINOR MAINTENANCE	
1.8	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.9	Check interlocks.
1.10	Measure coil resistances.
1.11	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.
1.12	Check closing solenoid and plunger for security and alignment.
1.13	Lubricate moving parts of the operating mechanism using CB lubricant as set out in Section 5.5.4 (do not lubricate excessively).
1.14	Check correct operation of anti-hunting circuit.
1.15	Check heater for heat output. If thermostat or timer fitted, check operation.
1.16	Inspect current transformer, for example, mounting clamps, secondary wiring and the like.
1.17	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.18	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

E- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
1.1	Carry out the tasks set out in the Minor Maintenance.
1.2	Remove, examine and clean turbulator.
1.3	Examine main and arcing contacts for arcing damage and wear.
1.4	Check that the internal mechanism operates freely and that the moving contact cross head moves smoothly on the guide rods.
1.5	Check condition of dashpot.
1.6	Examine the oil drain tap for leaks.
1.7	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results.

Pass Criteria:

Total resistance of each phase < 200μΩ

for CB current rating
up to 800A

Total resistance of
each phase < 100μΩ
for CB current rating
above 800A

IR > 1GΩ

- | | |
|------------|--|
| 1.8 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |
|------------|--|

21 Bulk oil, indoor, Reyrolle 11kV LMT/LMI

21.1 Maintenance schedule

A- EXERCISE

EXERCISE

- | | |
|------------|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|------------|---------------------------------|

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- | | |
|-------------|---|
| 1.1 | Inspect the equipment in general and record any defects. |
| 1.2 | Inspect for moisture or sweating. |
| 1.3 | Carry out breather inspection in accordance with SMI 156. |
| 1.4 | Check oil level. |
| 1.5 | Record oil colour. |
| 1.6 | Inspect HV terminations for corrosion, burning, overheating or other defects. |
| 1.7 | Carry out infra-red survey on outdoor circuit breaker terminations. |
| 1.8 | Inspect panel lamps (annunciators) and replace if not working. |
| 1.9 | Report cyclo reading annually. |
| 1.10 | Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects. |
| 1.11 | Inspect tank for oil leaks, spillage or other defects. |
| 1.12 | Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects. |

- 1.13** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- | | | |
|-------------|--|---|
| 1.1 | Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 80ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. | Pass Criteria:
Opening time < 80ms |
| 1.2 | Test total resistance through each pole using a 100A micro ohm meter (up to 800A, limit - 200 micro ohms / above 800A, limit - 100 micro ohms). Record the resistance. | Pass Criteria:
Total resistance of each phase < 200μΩ for CB current rating up to 800A
Total resistance of each phase < 100μΩ for CB current rating above 800A |
| 1.3 | Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ, and compare with commissioning test results (or previous maintenance test results if not available). | Pass Criteria:
IR > 1GΩ |
| 1.4 | Check the CB status in local and remote conditions. | |
| 1.5 | Check the local and remote indications 'as left'. | |
| 1.6 | Examine truck bushings for damage / contamination. | |
| 1.7 | Examine the main tank's gaskets for signs of deterioration and leaks. | |
| 1.8 | Examine the plug box for security, where applicable. | |
| 1.9 | Examine availability switch. | |
| 1.10 | Examine cyclometer for loose connection during maintenance and tighten the connection. | |
| 1.11 | Examine trip coil mounting bolts for tightness. | |
| 1.12 | Examine vermin guard for condition and integrity. | |
| 1.13 | Examine outdoor enclosure and door seals for signs of leakage and corrosion. | |

MINOR MAINTENANCE	
1.14	Examine the oil drain tap for leaks.
1.15	Examine the circuit breaker housing for ingress of leaves / vermin. (outdoor enclosures)
1.16	Examine the end boxes / busbar chambers for signs of recent leakage of compound / insulant.
1.17	Examine the panel and truck for cleanliness, clean with a dry cloth as required.
1.18	Examine racking mechanism and perform functional checks.
1.19	Perform functional check of anti-pumping relay.
1.20	Examine auxiliary contact in earth position for contamination and misalignment.
1.21	Examine the secondary isolating contacts for surface contamination. Clean as required with a dry cloth.
1.22	Clean the closing solenoid plunger using a soft cloth.
1.23	Test insulation resistance of the truck bushings using 2.5kV megger.
1.24	Check the operation of the truck interlock assembly. Examine for integrity and security of interlocking components.
1.25	Check the trip coil solenoid plunger for free movement. Lubricate with approved lubricants as set out in Section 5.5.4. (Do not use excessive amount of lubricant).
1.26	Measure the resistance of trip coil.
1.27	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.28	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
1.1	Carry out the tasks set out in the Minor Maintenance.
1.2	Examine tank lining / phase barriers for damage, pay attention to the security of the securing bolts.
1.3	Replace oil, record as found and as left condition.

MAJOR MAINTENANCE	
1.4	Examine the busbar spout bushing for surface contamination and mechanical damage.
1.5	Examine main and arcing contacts for pitting, any sign of damage., replace where necessary
1.6	Examine pallet switches for loose /incorrect wiring.
1.7	Examine closing solenoid for damage.
1.8	Remove, examine and clean turbulator.
1.9	Examine turbulator vent blocks for any sign of damage, examine the turbulator bottom plate for integrity, replace where necessary.
1.10	Examine operating mechanism and clean off old lubricants.
1.11	Lubricate moving parts of the operating mechanism using CB lubricant as set out in Section 5.5.4 (do not lubricate excessively).
1.12	Check heater for heat output. If thermostat or timer fitted, check operation.
1.13	Check security of closing mechanism circlips.
1.14	Examine closing coil contactor for damage.
1.15	Examine closing coil latch for contamination.
1.16	Check solenoid housing for cracks.
1.17	Check solenoid for loose mounting bolts and any loose connections.
1.18	Examine exterior steelwork for surface protection coverage.
1.19	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

22 Bulk oil, indoor, South Wales Electric 11kV D series

22.1 Maintenance schedule

A- EXERCISE

EXERCISE	
1.1	Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Check oil level.
1.5	Record oil colour.
1.6	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.7	Carry out infra-red survey on outdoor circuit breaker terminations.
1.8	Inspect panel lamps (annunciators) and replace if not working.
1.9	Report cyclo reading annually.
1.10	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.11	Inspect tank for oil leaks, spillage or other defects.
1.12	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.13	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 100ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 100ms
1.2	Test total resistance through each pole using a 100A micro ohm meter (up to 800A, limit - 200 micro ohms / above 800A, limit - 100 micro ohms). Record the resistance. Pass Criteria: Total resistance of each phase < 200μΩ for CB current rating up to 800A Total resistance of each phase < 100μΩ for CB

MINOR MAINTENANCE		
		current rating above 800A
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be $> 1\text{G}\Omega$, and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: $\text{IR} > 1\text{G}\Omega$
1.4	Clean track & lubricate the truck wheel axles with approved lubricant.	
1.5	Examine truck bushings for damage / contamination.	
1.6	Test insulation resistance of the truck bushings at 2.5kV using appropriate test set.	
1.7	Check the operation of the truck interlock assembly. Examine for integrity and security of interlocking components.	
1.8	Examine the main tank gaskets for signs of deterioration and leaks.	
1.9	Examine trip coil mounting bolts for tightness.	
1.10	Measure trip coil resistance.	
1.11	Check the trip coil solenoid plunger for free movement. Lubricate lightly with approved lubricants, if required. Do not use excessive amount of lubricant.	
1.12	Examine tank lining / phase barriers for damage, pay attention to the security of the securing bolts.	
1.13	Examine vermin guard for condition and integrity.	
1.14	Examine enclosure and door seals for signs of leakage and corrosion.	
1.15	Examine the circuit breaker housing for ingress of dust / vermin.	
1.16	Examine the cable entry cubicles / busbar chambers for signs of dust or moisture ingress.	
1.17	Examine the panel and truck for cleanliness, clean with a dry cloth as required.	
1.18	Record Trip and close timing. Opening time to be less than 100ms. For circuit breakers with reclosing, check that the circuit breaker recloses automatically.	Pass Criteria: Opening time $< 100\text{ms}$
1.19	Examine the secondary isolating contacts for surface contamination. Clean as required with a dry cloth.	

MINOR MAINTENANCE	
1.20	Clean the closing solenoid plunger using a soft cloth.
1.21	Examine the plug box for fit and cleanliness.
1.22	Examine availability switch.
1.23	Examine cyclometer for loose connection during maintenance and tighten the connection if necessary.
1.24	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.25	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
1.1	Carry tasks as per minor maintenance.
1.2	Examine the oil drain tap for leaks.
1.3	Examine the oil vapour vent tap for leaks or damage.
1.4	Replace oil, record as found and as left condition.
1.5	Examine the busbar spout bushing for surface contamination and mechanical damage.
1.6	Examine main and arcing contacts for pitting, mechanical or arc damage, replace where necessary.
1.7	Examine pallet switches for loose /incorrect wiring.
1.8	Examine closing solenoid for damage
1.9	Remove, examine and clean turbulator.
1.10	Examine turbulator vent blocks for any sign of damage, examine the turbulator bottom plate for integrity, replace where necessary.
1.11	Examine operating mechanism and clean off old lubricants. If required dismantle the mechanism to remove old lubricants.
1.12	Lubricate moving parts of the operating mechanism using CB lubricant as set out in Section 5.5.4 (do not lubricate excessively).
1.13	Examine racking mechanism and clean or adjust if necessary.

MAJOR MAINTENANCE		
1.14	Functional check of anti-pumping relay.	
1.15	Test and record the "as found" and "as left" total resistance of each phase is < 200micro Ohms at 100A using CB micro-ohm meter. An "as left" test is only required at a major maintenance after the oil is replaced. Compare the "as found" with "as left" test results.	Pass Criteria: Total resistance of each phase < 200μΩ for CB current rating up to 800A Total resistance of each phase < 100μΩ for CB current rating above 800A
1.16	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB is > 5G Ohms using 2.5kV Megger test set or similar unit. An "as left" test is to be performed after the oil has been replaced. Compare the "as found" with "as left" test results.	Pass Criteria: IR ≥ 5GΩ
1.17	Check operation of control cabinet latch.	
1.18	Check functionality of heaters. If thermostat or timer fitted, check operation.	
1.19	Check security of closing mechanism circlips.	
1.20	Examine closing coil contactor for damage.	
1.21	Examine closing coil latch for contamination.	
1.22	Check solenoid housing for cracks.	
1.23	Check solenoid for loose mounting bolts.	
1.24	Check solenoid for loose connections.	
1.25	Examine exterior steelwork for surface protection coverage.	
1.26	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

23 Bulk oil, Westinghouse 11kV B18

23.1 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156.
1.4	Check oil level.
1.5	Record oil colour.
1.6	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.7	Carry out infra-red survey on outdoor circuit breaker terminations.
1.8	Inspect panel lamps (annunciators) and replace if not working.
1.9	Report cyclo reading annually.
1.10	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.11	Inspect tank for oil leaks, spillage or other defects.
1.12	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.13	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 100ms. Phase variance to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 100ms Variance between phases < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter (up to 800A, limit - 200 micro ohms / above 800A, limit - 100 micro ohms). Record the resistance. Pass Criteria: Total resistance of each phase < 200μΩ for CB current rating up to 800A Total resistance of each phase < 100μΩ for CB

MINOR MAINTENANCE		
		current rating above 800A
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.4	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.5	Examine bushings for surface contamination and signs of damage.	
1.6	Inspect condition of spout orifice safety shutters and operating linkages.	
1.7	Inspect truck wheels.	
1.8	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.9	Check interlocks.	
1.10	Measure coil resistances.	
1.11	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.12	Check closing solenoid and plunger for security and alignment.	
1.13	Lubricate moving parts of the operating mechanism using CB lubricant as set out in Section 5.5.4 (do not lubricate excessively).	
1.14	Check correct operation of anti-hunting circuit.	
1.15	Check heater for heat output. If thermostat or timer fitted, check operation.	
1.16	Inspect current transformer, for example, mounting clamps, secondary wiring and the like.	
1.17	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.18	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
1.1	Carry out the tasks set out in the Minor Maintenance.
1.2	Remove, examine and clean turbulator.
1.3	Examine main and arcing contacts for arcing damage and wear.
1.4	Check that the internal mechanism operates freely and that the moving contact cross head moves smoothly on the guide rods.
1.5	Check condition of dashpot.
1.6	Examine the oil drain tap for leaks.
1.7	Replace oil. Perform "as left" total resistance of each phase and IR between phases. Compare "as found" with "as left" test results.
1.8	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

Pass Criteria:
IR > 1GΩ

24 Bulk oil, Westinghouse 11kV J series**24.1 Maintenance schedule****A- EXERCISE**

EXERCISE	
1.1	Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Carry out breather inspection in accordance with SMI 156
1.4	Check oil level.
1.5	Record oil colour.
1.6	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.7	Carry out infra-red survey on outdoor circuit breaker terminations.
1.8	Inspect panel lamps (annunciators) and replace if not working.

IN-SERVICE INSPECTION

1.9 Report cyclo reading annually.

1.10 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.

1.11 Inspect tank for oil leaks, spillage or other defects.

1.12 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.

1.13 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1 Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be less than 100ms. For circuit breakers with reclosing, check that the circuit breaker recloses automatically.

Pass Criteria:
Opening time < 100ms

1.2	Test total resistance through each pole using a 100A micro ohm meter. Record the resistance.		Pass Criteria: Westinghouse J18: Total resistance of each phase < 200 $\mu\Omega$ Westinghouse J22: Total resistance of each phase < 100 $\mu\Omega$
	Circuit breaker type	Contact resistance ($\mu\Omega$)	
	Westinghouse J18	200	
	Westinghouse J22	100	

1.3 Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1G Ω , and compare with commissioning test results (or previous maintenance test results if not available).

Pass Criteria:
IR > 1G Ω

1.4 Clean track & lubricate the truck wheel axles with approved lubricant.

1.5 Examine truck bushings for damage / contamination.

1.6 Test insulation resistance of the truck bushings at 2.5kV using appropriate test set.

MINOR MAINTENANCE

1.7	Check the operation of the truck interlock assembly. Examine for integrity and security of interlocking components.
1.8	Examine the main tank gaskets for signs of deterioration and leaks.
1.9	Examine trip coil mounting bolts for tightness.
1.10	Measure trip coil resistance.
1.11	Check the trip coil solenoid plunger for free movement. Lubricate lightly with approved lubricants, if required. Do not use excessive amount of lubricant.
1.12	Examine tank lining / phase barriers for damage, pay attention to the security of the securing bolts.
1.13	Examine vermin guard for condition and integrity.
1.14	Examine enclosure and door seals for signs of leakage and corrosion.
1.15	Examine the circuit breaker housing for ingress of dust / vermin.
1.16	Examine the cable entry cubicles / busbar chambers for signs of dust or moisture ingress.
1.17	Examine the panel and truck for cleanliness, clean with a dry cloth as required.
1.18	Examine the secondary isolating contacts for surface contamination. Clean as required with a dry cloth.
1.19	Clean the closing solenoid plunger using a soft cloth.
1.20	Examine the plug box for fit and cleanliness.
1.21	Examine availability switch.
1.22	Examine cyclometer for loose connection during maintenance and tighten the connection if necessary.
1.23	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.24	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

- 1.1** Carry out the tasks set out in the Minor Maintenance.

	MAJOR MAINTENANCE
1.2	Examine the oil drain tap for leaks.
1.3	Examine the oil vapour vent tap for leaks or damage.
1.4	Replace oil, record as found and as left condition.
1.5	Examine the busbar spout bushing for surface contamination and mechanical damage.
1.6	Examine main and arcing contacts for pitting, mechanical or arc damage, replace where necessary.
1.7	Examine pallet switches for loose /incorrect wiring.
1.8	Examine closing solenoid for damage.
1.9	Remove, examine and clean turbulator.
1.10	Examine turbulator vent blocks for any sign of damage, examine the turbulator bottom plate for integrity, replace where necessary.
1.11	Examine operating mechanism and clean off old or excessive lubricants if found.
1.12	Lubricate moving parts of the operating mechanism using CB lubricant as set out in Section 5.5.4 (do not lubricate excessively).
1.13	Examine racking mechanism and clean or adjust if necessary.
1.14	Functional check of anti-pumping relay.
1.15	Check operation of control cabinet latch.
1.16	Check functionality of heaters. If thermostat or timer fitted, check operation.
1.17	Check security of closing mechanism circlips.
1.18	Examine closing coil contactor for damage.
1.19	Examine closing coil latch for contamination.
1.20	Check solenoid housing for cracks.
1.21	Check solenoid for loose mounting bolts.
1.22	Check solenoid for loose connections.
1.23	Examine exterior steelwork for surface protection coverage.
1.24	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

25 SF6, indoor, ABB 11kV GK1M

25.1 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.

- 1.2 Inspect for moisture or sweating.

- 1.3 Inspect air receivers for rust.

- 1.4 Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.

- 1.5 Inspect HV terminations for corrosion, burning, overheating or other defects.

- 1.6 Carry out infra-red survey on outdoor circuit breaker terminations.

- 1.7 Inspect Panel lamps (annunciators) and replace if not working.

- 1.8 Report cyclo reading annually.

- 1.9 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.

- 1.10 Inspect current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.

- 1.11 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.

- 1.12 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1 Test SF6 gas quality (in accordance with **SDI 545** – Acceptable purity limits for SF6 gas) **Pass Criteria:**

MINOR MAINTENANCE

Air (O₂ and N₂): ≤ 3% volume in total

CF₄: ≤ 3% volume in total

H₂O ppmv (dew point): ≤ 470 ppmv (- 28 °C)

Mineral oil: ≤ 10 ppmw

Total reactive gaseous decomposition by-products (HF, SO₂, SO₂F₂, SF₄, WF₆): ≤ 2000ppmv

SF₄ and WF₆: ≤ 100ppmV

1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Total break time to be <80ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 80ms
1.3	Examine main and arcing contacts.	
1.4	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase < 200μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.6	Measure coil resistances.	
1.7	Examine the operating mechanism and lubricate if required. Every effort must be made to remove old lubrication, where possible.	
1.8	Check that auto-reclose function works.	
1.9	Check that anti-pumping is functioning correctly.	
1.10	Check operation of motor and limit switches, record charging time (charging time limit as per O& M manual).	Pass Criteria: Motor charging time: 15-24s
1.11	Examine the racking mechanism, check operation of racking mechanism and look for defects with shutters.	
1.12	Lube the shutter and racking mechanism, where required.	

MINOR MAINTENANCE

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| 1.13 | Examine bushings for cleanliness and mechanical damage. |
| 1.14 | Examine cubicle and gas piping for rust and damage. |
| 1.15 | Check security and tightness of fasteners. |
| 1.16 | Examine the plug box and trailing lead for damage / security. |
| 1.17 | Examine auxiliary contacts for signs of damage. |
| 1.18 | Examine low voltage wiring and terminals for signs of damage. |
| 1.19 | Check heater and thermostat (if fitted) for correct operation. |
| 1.20 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.21 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

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| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires degassing and inspecting/replacing the interrupter). |
| 1.2 | <p>The tasks below which involve degassing and accessing the internal elements of the circuit breaker must be carried out in accordance with the manufacturer's manual. This may require contacting the manufacturer for assistance:</p> <ul style="list-style-type: none"> • De-gas the circuit breaker • Check the condition of the contact system and replace as required. • Replace moisture filter. • Refill with new gas. |
| 1.3 | Carry out tasks in the Minor Maintenance . |

26 SF6, indoor, ABB 11kV HB

26.1 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect air receivers for rust.
- 1.4 Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.
- 1.5 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.6 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.7 Inspect Panel lamps (annunciators) and replace if not working.
- 1.8 Report cyclo reading annually.
- 1.9 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.10 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers
- 1.11 Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.12 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

- 1.1 Test SF6 gas quality (in accordance with **SDI 545** – Acceptable purity limits for SF6 gas)
- Pass Criteria:**
Air (O₂ and N₂): ≤ 3% volume in total

MINOR MAINTENANCE

CF4: $\leq 3\%$ volume in total

H₂O ppmv (dew point): ≤ 470 ppmv ($-28\text{ }^{\circ}\text{C}$)

Mineral oil: ≤ 10 ppmw

Total reactive gaseous decomposition by-products (HF, SO₂, SO₂F₂, SF₄, WF₆): ≤ 2000 ppmv

SF₄ and WF₆: ≤ 100 ppmV

1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Total break time to be <75 ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 75 ms
1.3	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase $< 200\mu\Omega$
1.4	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be $> 1\text{G}\Omega$, and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR $> 1\text{G}\Omega$
1.5	Inspect auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.6	Measure coil resistances.	
1.7	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.8	Check tension of springs.	
1.9	Check security and tightness of fastenings.	
1.10	Examine low voltage wiring and terminals for signs of damage.	
1.11	Check earth connections and confirm tightness.	
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.13	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

- 1.1** This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter):

- Replace the interrupter.

- 1.2** Carry out tasks in the **Minor Maintenance**.

27 SF6, indoor, Schneider or Merlin Gerin 11kV SM6**27.1 Maintenance schedule****A- EXERCISE****EXERCISE**

- 1.1** Trip and close CB electrically.

B- IN-SERVICE INSPECTION**IN-SERVICE INSPECTION**

- 1.1** Inspect the equipment in general and record any defects.

- 1.2** Inspect for moisture or sweating.

- 1.3** Inspect air receivers for rust.

- 1.4** Check gas pressure gauge (where installed) is within acceptable range of gauge limits.
Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.

- 1.5** Inspect HV terminations for corrosion, burning, overheating or other defects.

- 1.6** Carry out infra-red survey on outdoor circuit breaker terminations.

- 1.7** Inspect Panel lamps (annunciators) and replace if not working.

- 1.8** Report cyclo reading annually.

- 1.9** Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.

- 1.10** Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.

IN-SERVICE INSPECTION

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| 1.11 | Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects. |
| 1.12 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |

C- MINOR MAINTENANCE

MINOR MAINTENANCE

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|------|--|---|
| 1.1 | Test and record the "as found" and "as left" open and close timing using CB timing tester. Total break time to be <55ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. | Pass Criteria:
Opening time < 55ms |
| 1.2 | Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance. | Pass Criteria:
Total resistance of each phase < 200μΩ |
| 1.3 | Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ, and compare with commissioning test results (or previous maintenance test results if not available). | Pass Criteria:
IR > 1GΩ |
| 1.4 | Inspect auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects. | |
| 1.5 | Measure coil resistances. | |
| 1.6 | Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins. | |
| 1.7 | Check tension of springs. | |
| 1.8 | Check security and tightness of fastenings. | |
| 1.9 | Examine low voltage wiring and terminals for signs of damage. | |
| 1.10 | Check earth connections and confirm tightness. | |
| 1.11 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. | |

	MINOR MAINTENANCE
1.12	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

	MAJOR MAINTENANCE
	IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.
1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).
1.2	• Replace the interrupter.
1.3	Carry out tasks in the Minor Maintenance .

28 SF6, indoor, Yorkshire 11kV YSF6

28.1 Maintenance schedule

A- EXERCISE

	EXERCISE
1.1	Trip and close CB electrically.

B- IN-SERVICE INSPECTION

	IN-SERVICE INSPECTION
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect air receivers for rust.
1.4	Check gas pressure gauge (where installed) is within acceptable range of gauge limits. Note: Potential gas leaks must be investigated using a SF6 leak detection camera. Gas leaks must be repaired where possible and the Network Maintenance Manager notified.
1.5	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.6	Carry out infra-red survey on outdoor circuit breaker terminations.
1.7	Inspect Panel lamps (annunciators) and replace if not working.
1.8	Report cyclo reading annually.

IN-SERVICE INSPECTION

1.9	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.10	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.11	Inspect steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.12	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1	Test SF6 gas quality (in accordance with SDI 545 – Acceptable purity limits for SF6 gas)	Pass Criteria: Air (O ₂ and N ₂): ≤ 3% volume in total CF4: ≤ 3% volume in total H ₂ O ppmv (dew point): ≤ 470 ppmv (- 28 °C) Mineral oil: ≤ 10 ppmw Total reactive gaseous decomposition by- products (HF, SO ₂ , SO ₂ F ₂ , SF ₄ , WF ₆): ≤ 2000ppmv SF ₄ and WF ₆ : ≤ 100ppmV
1.2	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 40ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 40ms
1.3	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase < 200μΩ
1.4	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ, and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ

MINOR MAINTENANCE

1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.6	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.7	Inspect condition of spout orifice safety shutters and operating linkages.
1.8	Inspect truck wheels.
1.9	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.10	Check interlocks.
1.11	Measure coil resistances. Results should be consistent with manufacturer's recommendations.
1.12	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.
1.13	Lubricate mechanism (as required).
1.14	Check tension of springs.
1.15	Check security and tightness of fastenings.
1.16	Examine low voltage wiring and terminals for signs of damage.
1.17	Check that anti-pumping is functioning correctly.
1.18	Check earth connections and confirm tightness.
1.19	Check heater and thermostat (if fitted) for correct operation.
1.20	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.21	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

- 1.1 **IMPORTANT:** Refer to clause 5.4.2 before major maintenance is carried out.

This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).

1.2	• De-gas the circuit breaker. • Replace the interrupters. • Refill with new gas.
1.3	Carry out tasks in the Minor Maintenance .

29 Vacuum, indoor, ABB or Calor Emag 11kV VD4

29.1 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.2 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.4	Carry out infra-red survey on outdoor circuit breaker terminations.
1.5	Inspect Panel lamps (annunciators) and replace if not working.
1.6	Report Cyclo reading annually.
1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.9	Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE		
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 45ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 45ms Variance between phases < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase < 200 $\mu\Omega$
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be >1G Ω and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1G Ω
1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D -Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.6	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.7	Inspect condition of spout orifice safety shutters and operating linkages.	
1.8	Inspect truck wheels.	
1.9	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.10	Check interlocks.	
1.11	Measure coil resistances.	

MINOR MAINTENANCE

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| 1.12 | Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins. |
| 1.13 | Lubricate operating mechanism (as required). |
| 1.14 | Check tension of springs. |
| 1.15 | Check security and tightness of fastenings. |
| 1.16 | Examine low voltage wiring and terminals for signs of damage. |
| 1.17 | Check that anti-pumping is functioning correctly. |
| 1.18 | Check earth connections and confirm tightness. |
| 1.19 | Check heater and thermostat (if fitted) for correct operation. |
| 1.20 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.21 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

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| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter). |
| 1.2 | Replace the interrupter. |
| 1.3 | Carry out tasks in the Minor Maintenance . |

30 Vacuum, indoor, GEC 11kV SBV**30.1 Maintenance schedule****A- EXERCISE****EXERCISE**

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|-----|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|-----|---------------------------------|

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.4	Carry out infra-red survey on outdoor circuit breaker terminations.
1.5	Inspect Panel lamps (annunciators) and replace if not working.
1.6	Report Cyclo reading annually.
1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.9	Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 60ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 60ms Variance between phases to be < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance. Pass Criteria: Total resistance of each phase < 200$\mu\Omega$
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be $\geq 1G\Omega$ and compare Pass Criteria: IR > 1GΩ

MINOR MAINTENANCE

with commissioning test results (or previous maintenance test results if not available).

1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D -Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.6	Measure primary isolating contact wear and replace if $\geq 4\text{mm}$.	Pass Criteria: primary isolating contact wear $< 4\text{mm}$
1.7	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.8	Inspect condition of spout orifice safety shutters and operating linkages.	
1.9	Inspect truck wheels and clean or lubricate as necessary.	
1.10	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.11	Check interlocks are operational (if accessible).	
1.12	Measure coil resistances.	
1.13	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.14	Lubricate mechanism (as required).	
1.15	Check tension of springs.	
1.16	Check security and tightness of fastenings.	
1.17	Examine low voltage wiring and terminals for signs of damage.	
1.18	Check that anti-pumping is functioning correctly.	
1.19	Check earth connections and confirm tightness.	
1.20	Check heater and thermostat (if fitted) for correct operation.	

MINOR MAINTENANCE

- 1.21 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
- 1.22 Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

- 1.1 This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).
- 1.2 Replace the interrupter.
- 1.3 Carry out tasks in the **Minor Maintenance**.

31 Vacuum, indoor, Reyrolle 11kV LMVP

31.1 Maintenance schedule

A- EXERCISE

EXERCISE

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.4 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.5 Inspect Panel lamps (annunciators) and replace if not working.
- 1.6 Report Cyclo reading annually.

IN-SERVICE INSPECTION

- 1.7** Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.8** Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.9** Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.10** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

Test and record the "as found" open and close timing using CB timing tester.

1.1

	X5, X6, X8	RPM1, RPM5	RPM9
Closing time (ms)	55±10	32±5	35±5
Opening time (ms)	37±7	26±5	25±5
Phase variance time (ms)	<1	<1	<1

An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.

Pass Criteria:

Type X5, X6, X8: Opening time = 37ms±7

Closing time = 55ms±10

Type RPM1, RPM5: Opening time = 26ms±5
Closing time = 32ms±5

Type RPM9: Opening time = 25ms±5

Closing time = 35ms±5

All types: Variance between phases < 1ms

1.2

Test and record the total resistance of each phase using CB micro-ohm meter. Contact resistance ($\mu\Omega$):

- X5: 70±7
- X6: 38/38±5
- X8: 25/25±4
- RPM1: 58±6
- RPM5: 25/25±4
- RPM9: 68±7

Compare with commissioning test results (or previous maintenance test results if not available).

Pass Criteria:

Type X5: Total resistance of each phase = 70 $\mu\Omega$ ±7

Type X6: Total resistance of each phase = 38 $\mu\Omega$ ±5

Type X8: Total resistance of each phase = 25 $\mu\Omega$ ±4

Type RPM1: Total resistance of each phase = 58 $\mu\Omega$ ±6

Type RPM5: Total resistance of each phase = 25 $\mu\Omega$ ±4

MINOR MAINTENANCE		
		Type RPM9: Total resistance of each phase = $68\mu\Omega \pm 7$
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be $>1G\Omega$ and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR $>1G\Omega$
1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.5	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.6	Clean insulators, top plate and bushing stems. Apply recommended lubricant to bushing stems.	
1.7	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.8	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste, deterioration of silver plating or other defects.	
1.9	Inspect condition of spout orifice safety shutters and operating linkages. Clean spout orifice and lubricate linkages where necessary.	
1.10	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.11	Lubricate operating mechanism (as required).	
1.12	Check tension of springs.	
1.13	Check the tightness of nut that secures the spring charge limit switch. If loose, tighten the hardware the limit switch hardware and secure them with a lock nut.	
1.14	Check security and tightness of fastenings.	
1.15	Inspect truck wheels.	

MINOR MAINTENANCE**1.16** Check interlocks.**1.17** Measure coil resistances.**1.18** Check indicating lamp operation.**1.19** Examine low voltage wiring and terminals for signs of damage.**1.20** Check that anti-pumping is functioning correctly.**1.21** Check earth connections and confirm tightness.**1.22** Check heater and thermostat (if fitted) for correct operation and setting.**1.23** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.**1.24** Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.**D- MAJOR MAINTENANCE****MAJOR MAINTENANCE****IMPORTANT:** Refer to clause 5.4.2 before major maintenance is carried out.**1.1** This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).**1.2** Replace the interrupter.**1.3** Carry out tasks in the **Minor Maintenance**.**32 Vacuum, Indoor, Schneider 11kV HWX****32.1 Maintenance schedule****A- EXERCISE****EXERCISE****1.1** Trip and close CB electrically.**B- IN-SERVICE INSPECTION****IN-SERVICE INSPECTION****1.1** Inspect the equipment in general and record any defects.

IN-SERVICE INSPECTION	
1.2	Inspect for moisture or sweating.
1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.4	Carry out infra-red survey on outdoor circuit breaker terminations.
1.5	Inspect Panel lamps (annunciators) and replace if not working.
1.6	Report Cyclo reading annually.
1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.9	Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE					
1.1	Carry visual inspection for wear, corrosion and loose components				
1.2	Perform manual and electrical opening and closing checks.				
1.3	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 45-50ms and closing time to be <45- 50ms.Phase variance to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 75ms				
1.4	Test and record the contact resistance of each phase using CB micro-ohm meter. Compare with commissioning test results (or previous maintenance test results if not available). <table border="1"> <tr> <td rowspan="3">Contact Resistance (HWX/HWX-2)</td><td>400/630/800 A < 51 ($\mu\Omega$)</td></tr> <tr> <td>1000/1250 A < 44($\mu\Omega$)</td></tr> <tr> <td>1600/2000A <35/32 ($\mu\Omega$)</td></tr> </table> Pass Criteria: 400/630/800 A CB: Total resistance of each phase < 51$\mu\Omega$ 1000/1250 A CB: Total resistance of each phase < 44$\mu\Omega$ 1600A CB: Total resistance of each phase < 35$\mu\Omega$	Contact Resistance (HWX/HWX-2)	400/630/800 A < 51 ($\mu\Omega$)	1000/1250 A < 44($\mu\Omega$)	1600/2000A <35/32 ($\mu\Omega$)
Contact Resistance (HWX/HWX-2)	400/630/800 A < 51 ($\mu\Omega$)				
	1000/1250 A < 44($\mu\Omega$)				
	1600/2000A <35/32 ($\mu\Omega$)				

MINOR MAINTENANCE		
		2000A CB: Total resistance of each phase < 32μΩ
1.5	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ, and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.6	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.7	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.8	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.9	Inspect condition of spout orifice safety shutters and operating linkages.	
1.10	Inspect truck wheels.	
1.11	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.12	Check interlocks.	
1.13	Measure coil resistances.	
1.14	Examine operating mechanism for defective parts, for example commutator, worn brushes and loose brush retainers.	
1.15	Check tension of springs.	
1.16	Check security and tightness of fastenings.	
1.17	Examine low voltage wiring and terminals for signs of damage.	
1.18	Examine circuit earth switch and connections, clean and re-lubricate if required.	
1.19	Check heater and thermostat (if fitted) for correct operation.	

MINOR MAINTENANCE

- | | |
|-------------|---|
| 1.20 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.21 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

- | | |
|------------|--|
| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter). |
| 1.2 | Replace the interrupter. |
| 1.3 | Carry out tasks in the Minor Maintenance . |

33 Vacuum, indoor, Siemens 11kV 3AF**33.1 Maintenance schedule****A- EXERCISE****EXERCISE**

- | | |
|------------|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|------------|---------------------------------|

B- IN-SERVICE INSPECTION**IN-SERVICE INSPECTION**

- | | |
|------------|---|
| 1.1 | Inspect the equipment in general and record any defects. |
| 1.2 | Inspect for moisture or sweating. |
| 1.3 | Inspect HV terminations for corrosion, burning, overheating or other defects. |
| 1.4 | Carry out infra-red survey on outdoor circuit breaker terminations. |
| 1.5 | Inspect Panel lamps (annunciators) and replace if not working. |
| 1.6 | Report Cyclo reading annually. |

IN-SERVICE INSPECTION

1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.9	Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- PD TEST

	PD Test
1.1	Test resin enclosed switchgear and contact arm discharge using UltraTEV Plus+ PD device. Pass Criteria: TEV reading is less than 20dB

D- MINOR MAINTENANCE

	MINOR MAINTENANCE
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be <60ms with a closing time < 75ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 60ms Closing time < 60ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance. Pass Criteria: Total resistance of each phase < 200$\mu\Omega$
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be >1GΩ, and compare with commissioning test results (or previous maintenance test results if not available). Pass Criteria: IR > 1GΩ
1.4	Check vacuum integrity using VIDAR test. Refer to Section 6.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection Pass Criteria: No flashover

MINOR MAINTENANCE		
	of personnel from x-ray emission when testing a single interrupter.	
1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.6	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.7	Inspect condition of spout orifice safety shutters and operating linkages.	
1.8	Inspect truck wheels.	
1.9	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.10	Check interlocks.	
1.11	Measure coil resistances.	
1.12	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.13	Lubricate operating mechanism (as required).	
1.14	Check tension of springs.	
1.15	Check security and tightness of fastenings.	
1.16	Examine low voltage wiring and terminals for signs of damage.	
1.17	Check that anti-pumping is functioning correctly.	
1.18	Check earth connections and confirm tightness.	
1.19	Check heater and thermostat (if fitted) for correct operation.	
1.20	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.	
1.21	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.	

E- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

- 1.1 This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).
- 1.2 Replace the interrupter.
- 1.3 Carry out tasks in the **Minor Maintenance**.

34 Vacuum, indoor, Siemens 11kV 3AH**34.1 Maintenance schedule****A- EXERCISE****EXERCISE**

- 1.1 Trip and close CB electrically.

B- IN-SERVICE INSPECTION**IN-SERVICE INSPECTION**

- 1.1 Inspect the equipment in general and record any defects.
- 1.2 Inspect for moisture or sweating.
- 1.3 Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.4 Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.5 Inspect Panel lamps (annunciators) and replace if not working.
- 1.6 Report Cyclo reading annually.
- 1.7 Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.8 Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.9 Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.10 Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE		
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 65ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 65ms Variance between phases < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase < 200μΩ
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.6	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.7	Inspect condition of spout orifice safety shutters and operating linkages.	
1.8	Inspect truck wheels.	
1.9	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.10	Check interlocks.	
1.11	Measure coil resistances.	
1.12	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.13	Lubricate operating mechanism (as required).	

MINOR MAINTENANCE

- | | |
|------|---|
| 1.14 | Check tension of springs. |
| 1.15 | Check security and tightness of fastenings. |
| 1.16 | Examine low voltage wiring and terminals for signs of damage. |
| 1.17 | Check that anti-pumping is functioning correctly. |
| 1.18 | Check earth connections and confirm tightness. |
| 1.19 | Check heater and thermostat (if fitted) for correct operation. |
| 1.20 | Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly. |
| 1.21 | Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections. |

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

- | | |
|-----|--|
| 1.1 | This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter). |
| 1.2 | Replace the interrupter. |
| 1.3 | Carry out tasks in the Minor Maintenance . |

35 Vacuum, indoor, Tamco 22kV VW2**35.1 Maintenance schedule****A- EXERCISE****EXERCISE**

- | | |
|-----|---------------------------------|
| 1.1 | Trip and close CB electrically. |
|-----|---------------------------------|

B- IN-SERVICE INSPECTION**IN-SERVICE INSPECTION**

- | | |
|-----|--|
| 1.1 | Inspect the equipment in general and record any defects. |
| 1.2 | Inspect for moisture or sweating. |

IN-SERVICE INSPECTION

1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.
1.4	Carry out infra-red survey on outdoor circuit breaker terminations.
1.5	Inspect Panel lamps (annunciators) and replace if not working.
1.6	Report Cyclo reading annually.
1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.9	Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE

1.1	Test and record the "as found" and "as left" open and close timing using CB timing tester. Opening time to be < 30ms and closing time to be < 60ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 30ms Closing time < 60ms Variance between phases < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase $\leq 200\mu\Omega$
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1G Ω , and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1G Ω
1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover

MINOR MAINTENANCE

1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.6	Measure primary isolating contact wear and replace if beyond wear limit.
1.7	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect condition of spout orifice safety shutters and operating linkages.
1.9	Inspect truck wheels and clean or lubricate as necessary.
1.10	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.11	Check interlocks are operational (if accessible).
1.12	Measure coil resistances.
1.13	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.
1.14	Lubricate mechanism (as required).
1.15	Check tension of springs.
1.16	Check security and tightness of fastenings.
1.17	Examine low voltage wiring and terminals for signs of damage.
1.18	Check that anti-pumping is functioning correctly.
1.19	Check earth connections and confirm tightness.
1.20	Check heater and thermostat (if fitted) for correct operation.
1.21	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.22	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE**MAJOR MAINTENANCE**

IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.

- 1.1** This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).
- 1.2** Replace the interrupter.
- 1.3** Carry out tasks in the **Minor Maintenance**.

36 Vacuum, indoor, Siemens 11kV SIMOPRIME**36.1 Maintenance schedule****A- EXERCISE****EXERCISE**

- 1.1** Trip and close CB electrically.

B- IN-SERVICE INSPECTION**IN-SERVICE INSPECTION**

- 1.1** Inspect the equipment in general and record any defects.
- 1.2** Inspect for moisture or sweating.
- 1.3** Inspect HV terminations for corrosion, burning, overheating or other defects.
- 1.4** Carry out infra-red survey on outdoor circuit breaker terminations.
- 1.5** Inspect Panel lamps (annunciators) and replace if not working.
- 1.6** Report Cyclo reading annually.
- 1.7** Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
- 1.8** Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
- 1.9** Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
- 1.10** Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE		
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 65ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results.	Pass Criteria: Opening time < 65ms Variance between phases < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance.	Pass Criteria: Total resistance of each phase < 200μΩ
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ and compare with commissioning test results (or previous maintenance test results if not available).	Pass Criteria: IR > 1GΩ
1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter.	Pass Criteria: No flashover
1.5	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.	
1.6	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.	
1.7	Inspect condition of spout orifice safety shutters and operating linkages.	
1.8	Inspect truck wheels.	
1.9	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.	
1.10	Check interlocks.	
1.11	Measure coil resistances.	
1.12	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.	
1.13	Lubricate operating mechanism (as required).	

MINOR MAINTENANCE	
1.14	Check tension of springs.
1.15	Check security and tightness of fastenings.
1.16	Examine low voltage wiring and terminals for signs of damage.
1.17	Check that anti-pumping is functioning correctly.
1.18	Check earth connections and confirm tightness.
1.19	Check heater and thermostat (if fitted) for correct operation.
1.20	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.21	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.	
1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).
1.2	Replace the interrupter.
1.3	Carry out tasks in the Minor Maintenance .

37 Vacuum, indoor, Hawker Siddeley 11kV VMH12

37.1 Maintenance schedule

A- EXERCISE

EXERCISE	
1.1	Trip and close CB electrically.

B- IN-SERVICE INSPECTION

IN-SERVICE INSPECTION	
1.1	Inspect the equipment in general and record any defects.
1.2	Inspect for moisture or sweating.
1.3	Inspect HV terminations for corrosion, burning, overheating or other defects.

IN-SERVICE INSPECTION	
1.4	Carry out infra-red survey on outdoor circuit breaker terminations.
1.5	Inspect Panel lamps (annunciators) and replace if not working.
1.6	Report Cyclo reading annually.
1.7	Inspect bushings for cracks, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect Current transformer housing (dead tank CB) for cracks/degradation of current transformer covers.
1.9	Inspect Steelwork/hardware for rust, corrosion, poor paintwork condition or other defects.
1.10	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.

C- MINOR MAINTENANCE

MINOR MAINTENANCE	
1.1	Test and record the "as found" open and close timing using CB timing tester. Opening time to be < 60ms. Variance between phases to be < 2ms. An "as left" test is to be performed after all mechanism tasks are completed. Compare the "as found" with "as left" test results. Pass Criteria: Opening time < 60ms Variance between phases < 2ms
1.2	Test total resistance through each pole using a 100A micro ohm meter. Contact resistance must be ≤ 200 micro ohms. Record the resistance. Pass Criteria: Total resistance of each phase $\leq 200\mu\Omega$
1.3	Test and record the "as found" and "as left" IR between phases (CB closed and earth all other phases) of CB. Insulation resistance results must be > 1GΩ, and compare with commissioning test results (or previous maintenance test results if not available). Pass Criteria: IR > 1GΩ
1.4	Check vacuum integrity using VIDAR test. Refer to Section 7.4, D – Minor Overhaul, Item 1.36 or E-Major Overhaul, Item 1.31 for information about test voltage. Note: Refer to the manufacturer's information in the CB manual or AS 2981 - 2008, if no information available in the CB manual, for the guide for protection of personnel from x-ray emission when testing a single interrupter. Pass Criteria: No flashover
1.5	Check the interrupter's wear indicator. The snatch gap must be > 1mm. Pass Criteria:

MINOR MAINTENANCE

snatch gap > 1mm

1.6	Inspect primary isolating, secondary isolating and/or auxiliary contacts for discolouration, overheating, damage to contacts and springs, loss of conductive paste or other defects.
1.7	Inspect bushing stems for cracks, scratches, treeing, tracking, visible effects of corona or other defects.
1.8	Inspect condition of spout orifice safety shutters and operating linkages.
1.9	Inspect truck wheels.
1.10	Check the racking mechanism. Grease moving parts with recommended grease, including the worm gear and guide rails, wind the carriage up and down to check an even coating of grease.
1.11	Check interlocks.
1.12	Measure coil resistances.
1.13	Examine operating mechanism for defective parts, for example, worn pivot points, circlips, split pins, cotter pins, shaft pins.
1.14	Lubricate operating mechanism (as required).
1.15	Check tension of springs.
1.16	Check security and tightness of fastenings.
1.17	Examine low voltage wiring and terminals for signs of damage.
1.18	Check that anti-pumping is functioning correctly.
1.19	Check earth connections and confirm tightness.
1.20	Check heater and thermostat (if fitted) for correct operation.
1.21	Confirm the nameplate data that has been recorded in SAP. Capture the nameplate data that not been recorded or incorrectly entered in SAP and update accordingly.
1.22	Before leaving carry out final Inspection for any defects, loose connections and accidental open /short circuit connections.

D- MAJOR MAINTENANCE

MAJOR MAINTENANCE	
	IMPORTANT: Refer to clause 5.4.2 before major maintenance is carried out.
1.1	This is necessary to confirm that the condition of the circuit breaker warrants intrusive maintenance (that is, requires replacing the interrupter).
1.2	Replace the interrupter.
1.3	Carry out tasks in the Minor Maintenance .

