

TITLE

Long Term Maintenance and Care for Reyrolle L42/45T

E. C. Wright 19/08/04

This document is to be used in conjunction with Installation, Operation and Maintenance Schedule IOMS 418. Its aim is to provide guidance for owners of equipment which has been in service more than 25 years.

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Introduction

During normal every day operation, switchgear works well within its design envelope and therefore, even after many years of service, appears superficially to be OK.

Fault clearance however may require the equipment to work at near maximum performance and substandard equipment will be susceptible to significant damage.

To maintain rating capability key components/functions must be in good operational condition:

The above does not indicate that the product has a limited lifespan, in fact the L42T range has proven to be very reliable when well looked after.

We can actually take advantage of the sub-station history of older equipment to design bespoke maintenance, which will not only extend the working life but will reduce the chance of catastrophic damage and can even reduce maintenance costs.

The owner of older equipment (25 years and beyond) should have the information which will allow him to design a maintenance plan to suit his needs. This document will help with that process.

Key Questions

1. How often is the equipment switched?
2. Is this switching duty at full rated current or well below rated current?
3. How often does the system see a fault?
4. What environmental conditions exist within the sub-station? – Is the switchgear dirty or damp or both? (we are concerned here mainly with the primary insulation)
5. Do we know the condition of the primary functional systems of the switchgear –
 - a. Primary Insulation.
 - b. Contacts, Turbulators and Oil.
 - c. The dynamic operating characteristics of mechanism and contacts.

Points 1 to 4 should be available from historical records and we will look later how we will use this information.

Point 5 is actually our recommended starting point. We feel it is logical to make a condition assessment of the equipment, and instigate any repairs prior to introducing a new maintenance regime. Using the condition assessment approach at suitable intervals will also help ensure full rating capability is maintained.

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Condition Assessment

Recommended site testing For condition assessment of Reyrolle L42/45T

Pf Testing of Capacitor Bushings



Speed Curving - In house electronic system
Using original test parameters.



Non-intrusive Discharge



Non-intrusive Discharge Monitoring.

Discharge monitoring is recommended to identify any possible deterioration of filled chambers, surface discharges on primary insulation and similar possible sources.

The system used is non-intrusive. Magnetic probes are attached to the outer skin of the switchgear and are designed to pick up magnetic wave pulses, a phenomenon of electrical discharge. Each probe will pick up a source of discharge but the monitor can determine by time of flight which probe is closest to the source. (see diagrams below) The monitor sweeps the probes approximately every 5 minutes over a period (usually one week) and therefore can determine if the problem is constant, the level and therefore the severity. Recommendations will be given.

Owners of the switchgear can be shown how to transfer monitoring equipment from one board the next and e-mail information to ourselves for analysis.

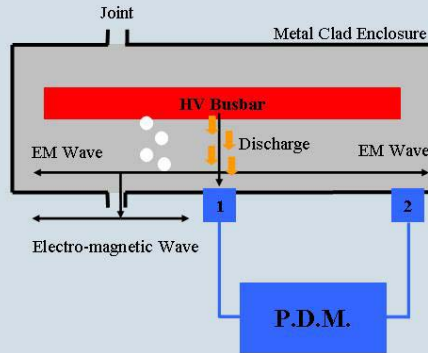
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Partial Discharge Monitoring

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- Charge transferred from HV busbar to earthed enclosure.
- EM waves emanate away from the discharge site.
- EM waves escape through joint in the enclosure and sweep across the surface of the switchgear.
- EM wave detected by the P.D.M.



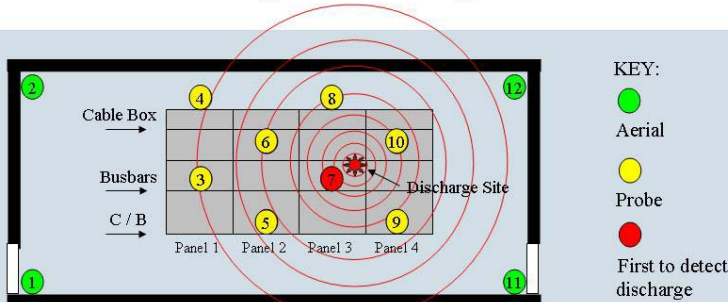
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Partial Discharge Monitoring

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Typical monitoring set-up within a substation (plan view)

- All of the probes detect the discharge from every discharge site on the board.
- The monitor allocates the discharge to the probe at which the discharge arrives first.
- Aerials detect background noise first. Background noise is allocated to aerials.
- The monitor can detect multiple discharge sites within the switchboard.

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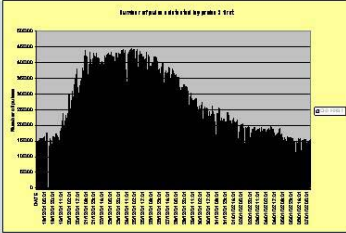
Our report gives graphical information, explanation and recommendation for repair. Part of the graphical information from a recent report is shown below.

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Partial Discharge Monitoring

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This is a graph from one of our recent surveys.

The probe is situated on a cable box.

This discharge was active constantly at a dangerously high level.

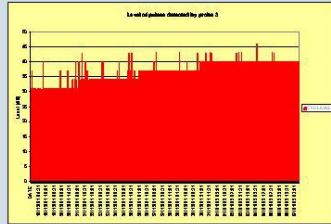
As we can see below, the discharge was getting worse as time went on.

The primary insulation involved here would certainly have failed in the near future if left unattended.

An unplanned outage would have cost this particular customer around £300,000 a day.

This problem would have gone unnoticed if not for the customer requesting a PDM survey.

The cable box was successfully repaired in the shortest time possible. Subsequent PDM surveys have given 'discharge free' results.



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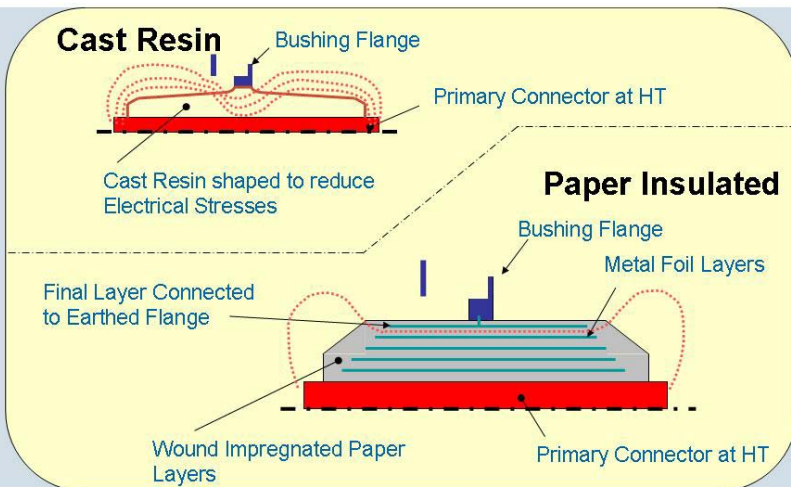
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Power Factor (TAN DELTA) Testing

L42T like many other switchgears designed at the same time or earlier employed paper insulated bushings in primary circuits. These bushings designated as SRBP or ERIP type bushings have technical advantages when compared to the more modern and cheaper cast resin bushings. The advantage is shown diagrammatically below.

Bushing Design

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The metal foil capacitive layers of these bushing, smooth out the electrical stresses and therefore reduce the chances of electrical discharges.

However the paper windings of the bushings can become susceptible with age to moisture ingress or delaminating.

Discharge testing may not pick up longer term deterioration of the insulation.

The failure modes of these bushings, moisture ingress or conversely drying out, can take a long time to develop. Discharge testing may only pick this up as the failure is well advanced. - Obviously too late!

The L42T paper insulated bushings have built in test points, which with the aid of specialist test equipment, allows us to measure some of the fundamental ac characteristics of its insulation system.

Comparing the readings obtained for pf, capacitance, charging current and resistance, against our database for new, maintained or refurbished bushings, allows us to make an informed assessment of condition.

Typically we should be able to see if there is deterioration and how advanced, therefore avoiding catastrophic failure.

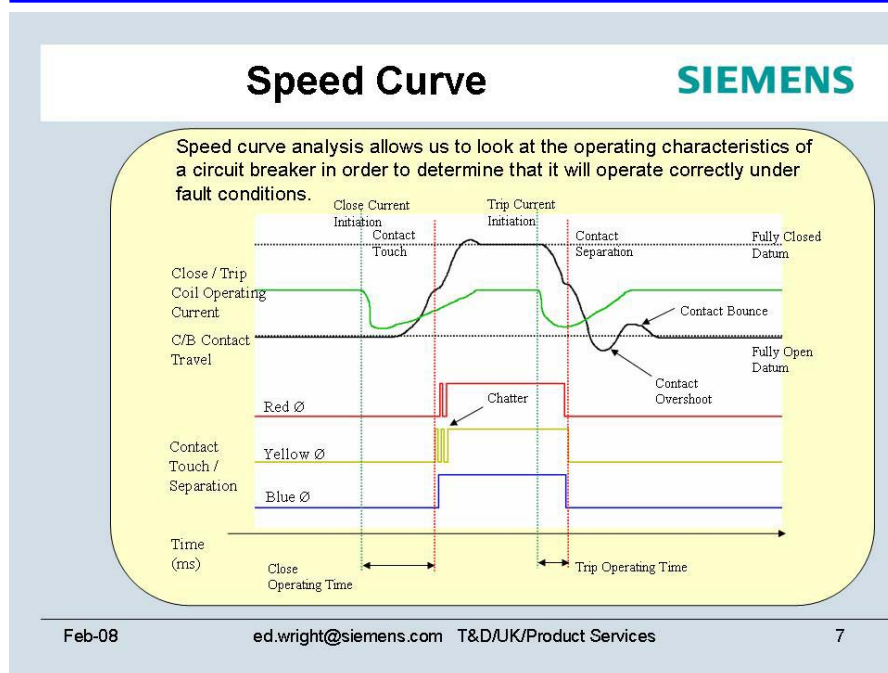
In most cases bushings can be repaired and therefore the life expectancy of the switchgear is increased dramatically.

Dynamic Contact and Mechanism Characteristics

When a circuit breaker design passes its short circuit and mechanical operations type tests, certain dynamic characteristics are recorded and used as a profile in all subsequent routine production tests. In other words every production circuit breaker should have the same rating capability. A typical speed curve is shown below.

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The above test combined with visual inspection of Contacts and Turbulators plus resistance and Oil tests will confirm rating capability.

Oil analysis should measure –

- Breakdown Strength
- Moisture Content
- Acidity

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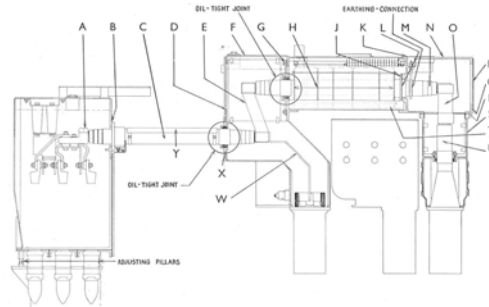
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VA TECH REYROLLE PRODUCT SERVICES

REPAIRS, OVERHAUL, REFURBISH L42/45T

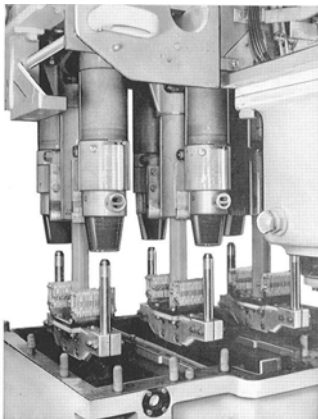
Recommendations

- Discharge Monitoring
 - General insulation health check.
- Pf testing
 - Key check for busbar, orifice & CB insulators.



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REPAIRS, OVERHAUL, REFURBISH L42/45T



Recommended site checks

- Pf test for insulators.
- Check oil condition.
- Check condition of contacts.
- Check condition of Turbulators.
- Speed Curve tests.

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Recommended Care Program – Appendix 1

As suggested earlier an alternative program of care to that shown in IOMS 418 should be introduced when the equipment has been in service longer than 25 years.

Spares for normal maintenance needs – Appendix 2

These spares are recommended for the normal wear and aging of the equipment.

Factory based Overhaul

When site based maintenance procedures cannot achieve consistent and correct circuit breaker operation. Our factory based overhaul service is designed to bring a circuit breaker back to full rating capability with the minimum work. This is achieved by a process of an initial test and inspection to establish work to be done and an agreement with the customer to proceed.

Traveler circuit breakers can be made available to reduce outage times.

Factory based Rebuild-Refurbishment

This process described below is recommended for circuit breakers older than 25 years. The process is a complete rebuild with replacement of key components and wiring which achieves an almost “As New” result. The end result not only re-establishes rating but dramatically extends the working life of the equipment.

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L42/45T Refurbishment

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REFURBISHMENT

- ⇒ Increase Life
- ⇒ Up-rate possible
- ⇒ Traveler CB's
- ⇒ Fast Turn Round

REFURBISHMENT SCOPE OF WORK

- ⇒ Pre-work CB Inspection & Test
- ⇒ Oil Testing,
- ⇒ Internal Inspection,
- ⇒ Full Strip Down To Carcass,
- ⇒ 100% Component Inspection,
- ⇒ Replacement of All springs,
- ⇒ Rebuild & Rewire,
- ⇒ Re-Test.
- ⇒ Re-Install

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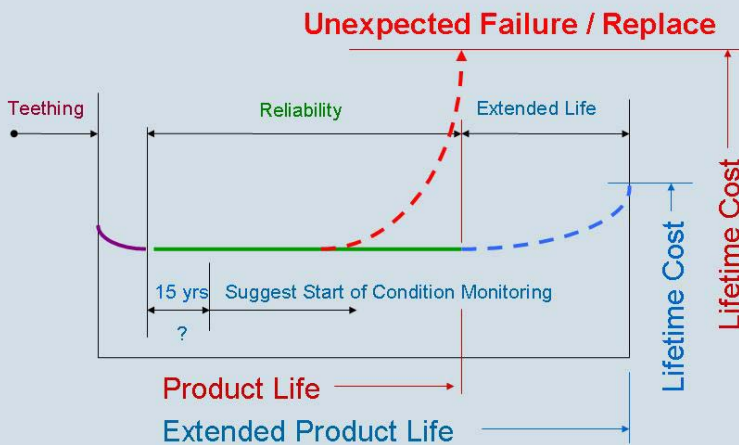
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Recommendation to achieve Life Extension and Low Cost of Ownership.

The process recommended in Appendix 1, a combination of Refurbishment, Condition Assessment and Bespoke Maintenance will extend the working life of the equipment. The logic of this is shown diagrammatically below. The process of targeted or bespoke maintenance also has the potential to reduce maintenance cost.

Health Check – Cost of Ownership

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Up-Rating and Mechanism Up-Grades

A rating plate is fitted to each circuit breaker, on this plate the circuit breaker type is typically shown as 33L42T4/X5. Up-rating is possible as follows –

X2	750MVA	No up-rate possible
X3	1000MVA	No up-rate possible
X5	750MVA	Up-rate to 1143MVA possible
X6	1000MVA	Up-rate to X7 (1500MVA) possible
X9	1000MVA	Up-rate to X7 (1500MVA) possible
X7	1500MVA	Up-rate to X8 (1734MVA) possible

Some early mechanisms can shows signs of unstable trip latches. Mechanism overhaul or up-grading to later revision status, where possible, will help overcome this problem –

X2	overhaul only option.	
X3	overhaul only option.	(801A142Y)
X5	Up-grade	(801A327)
X6	No problem already up-graded	(801A327Y)
X9	No problem already up-graded	(801A622)
X7	No problem already up-graded	(801A629)
X8	No problem already up-graded	

New Cable Box Designs for Polymeric Cables

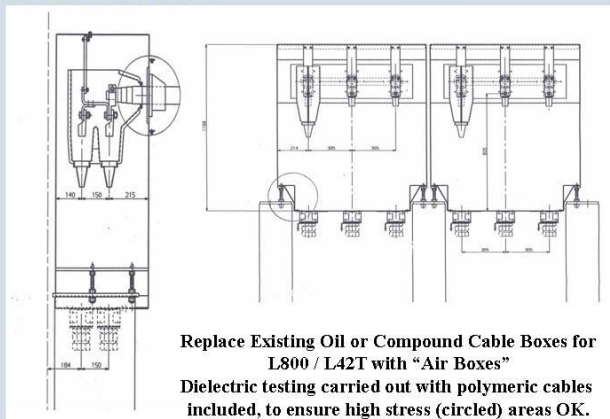
A number of special cable box designs have been tested for customers wishing to fit polymeric cables to L42/45T.

Two concepts are employed –

- Dry termination in new cable box.

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Product Enhancement



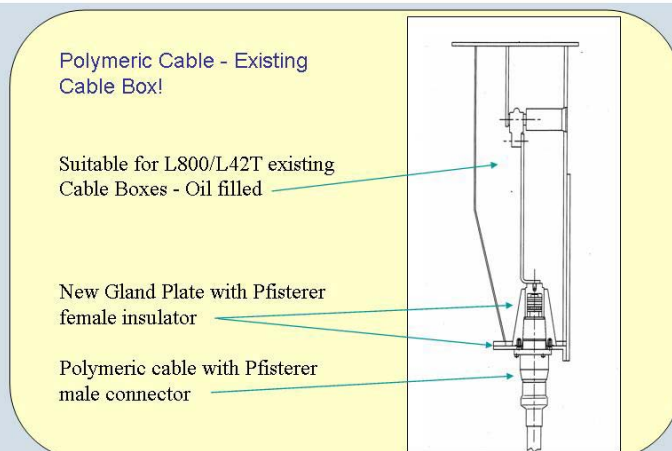
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- Ppfisterer system using existing cable box body with new gland plates

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APPENDIX 1 – Recommended Maintenance Regime for L42/45T in service over 25 years.

Interval	Circuit Breaker	Enclosure
25 years	Rebuild Refurbishment	Discharge Monitoring Pf testing
8 year	Discharge Monitoring Pf testing Speed Curve Internal Tank Inspection Oil Test Clean and Lubricate	Discharge Monitoring Pf testing Clean and Lubricate Touch-up paint if necessary
4 year – Only required for poor environments (8 year report may suggest additional tests)	Clean and Lubricate (Discharge Monitoring Pf testing)	Clean and Lubricate Touch-up paint if necessary (Discharge Monitoring Pf testing)
Every 2000 operations at low system current.	Clean, lubricate and inspect mechanism.	
Every 2000 operations at high system current.	Clean, lubricate and inspect mechanism. Internal Tank Inspection Oil Test.	
After Fault	Internal Tank Inspection	
Yearly if CB not operated	Electrical Close & Trip several times.	

