

TITLE

Long Term Maintenance and Care for Reyrolle C Gear

E. C. Wright 12/10/04

This document is to be used in conjunction with Installation, Operation and Maintenance Schedule IOMS 22. 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 C 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?
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 C gear.

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 joints such as the shrouds in the Busbar and Transformer 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 pickup 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.

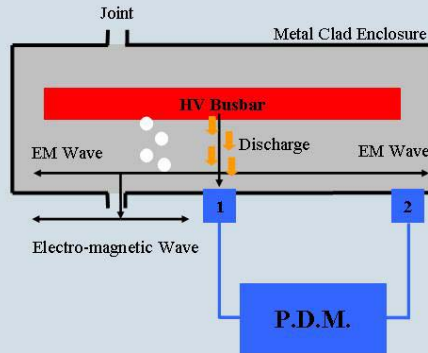
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Partial Discharge Monitoring

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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.



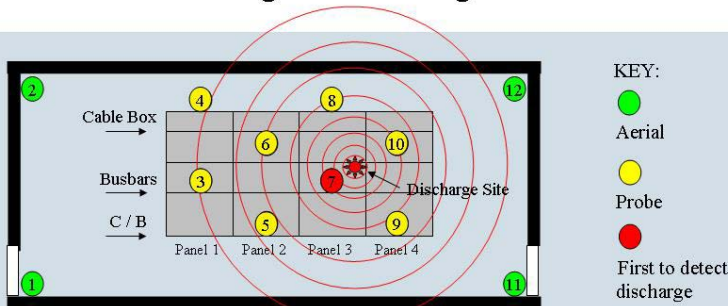
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Partial Discharge Monitoring

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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.

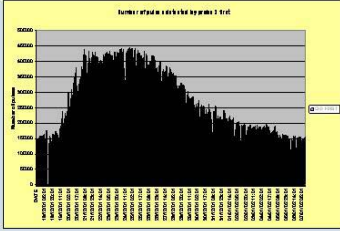
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Our report gives graphical information, explanation and recommendation for repair. Part of the graphical information from a recent report is shown below.

Partial Discharge Monitoring



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.

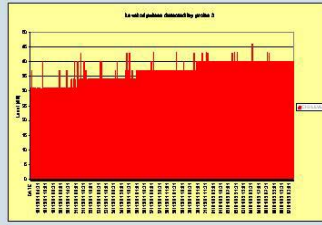
As we can see below, the discharge was getting worse as time went on.

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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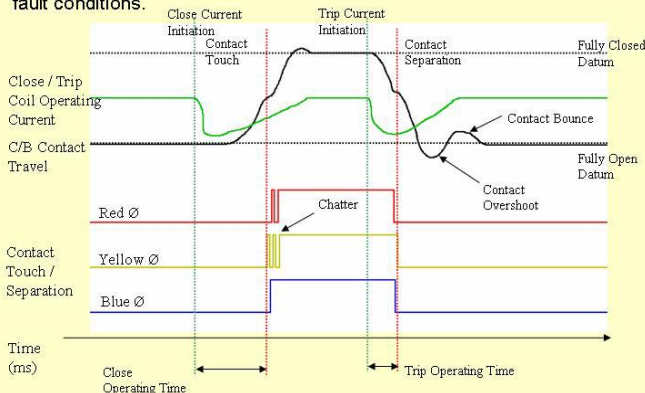
Dynamic Contact and Mechanism Characteristics

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.

Speed Curve



Speed curve analysis allows us to look at the operating characteristics of a circuit breaker in order to determine that it will operate correctly under fault conditions.



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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

Recommended Care Program – Appendix 1

As suggested earlier an alternative program of care to that shown in IOMS 22, 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.

Site Issues – Appendix 3

Retrofit Option – Appendix 4

A Vacuum Interruption Circuit Breaker is available as a Retrofit option for the replacement of oil. This also gives the possibility of up-rating to a maximum of 25kA

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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REFURBISHMENT OF C Gear CB's



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



Interrupter parts inspection during Refurbishment.

Contact springs will be replaced



Vent Plate needs replacement.
Vent Plate OK



Moving Contact OK will be cleaned & re-plated if necessary

Contact Damaged, to be Replaced with customer consent.



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APPENDIX 1 – Recommended Maintenance Regime for C gear in service over 25 years.

Interval	Circuit Breaker	Enclosure
25 years	Rebuild Refurbishment	Discharge Monitoring
8 year	Discharge Monitoring Speed Curve Internal Tank Inspection Oil Test Clean and Lubricate	Discharge Monitoring 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)	Clean and Lubricate Touch-up paint if necessary (Discharge Monitoring)
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.	

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TYPES C6T, C8T, AND C9T

TURBULATORS

	TYPES	kV	TURBULATOR	ART No.
C6T	C6T/X1, C6T/X5, C6T/X9	6.6	T77	31A5075
	C6T/X1	11	T78	31A5128
	C6T/X4, C6T/X5, C6T/X9	11	T190	31A7048
	C6T/X10, C6T/X12	6.6	T225	31A8103
	C6T/X10, C6T/X12	11	T229	31A8101
C8T	C8T/X1	10	T190	31A7048
	C8T/X1, C8T/X2, C8T/X3	11	T189	31A7044
	C8T/X3, C8T/X4	10	T192	31A7082
	C8T/X5, C8T/X6, C8T/X7	10 & 11	T229	31A8101
C9T	C9T/X1, C9T/X2	15	T229	31A8101
	C9T/X3	15	T268	31A9038

FIBRE VENT-PLATES FOR TURBULATORS

TURBULATOR	PLATE ART. NOS.				
	1	2	3	4	5
T77	31A5102	31A5102	31A5102	31A5104	—
T78	31A5103	31A5103	31A5103	31A5104	—
T190	31A7047	31A7046	31A7046	31A5104	—
T225	31A8116	31A8116	31A7046	31A8118	31A5104
T229	31A8116	31A8118	31A8117	31A5104	—
T189	31A5102	31A7046	31A7043	31A5104	—
T192	31A5102	31A7046	31A7046	31A5104	—
T268	31A8116	31A8118	31A9034	31A5104	—

MINIMUM RECOMMENDED SPARES

Fibre vent-plates only in quantities similar to contacts.

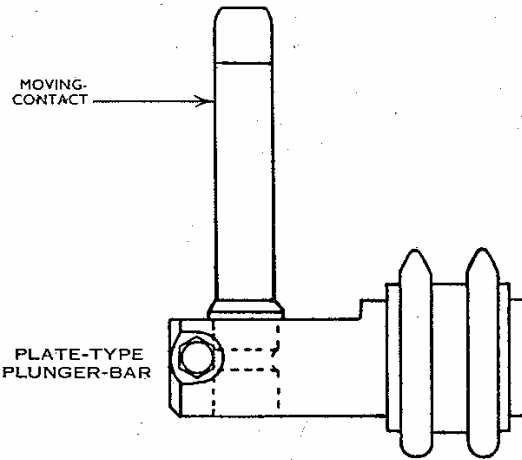
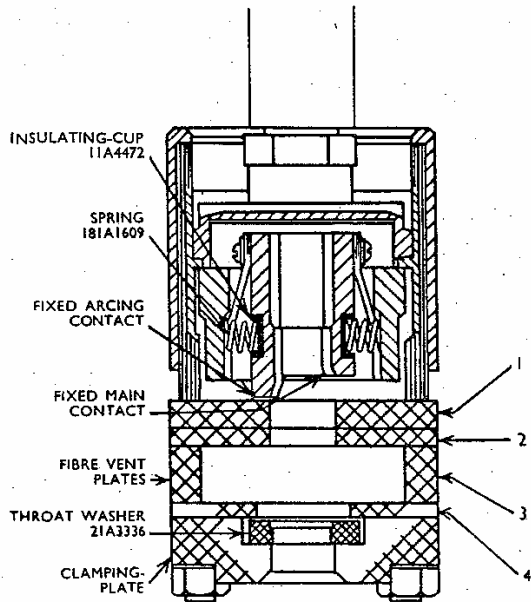
CLAMPING-PLATES FOR TURBULATORS

Art. No. 31A8653 for circuit-breaker with plate-type plunger-bar.
 Art. No. 31A7042Y for circuit-breaker with round-type plunger-bar.

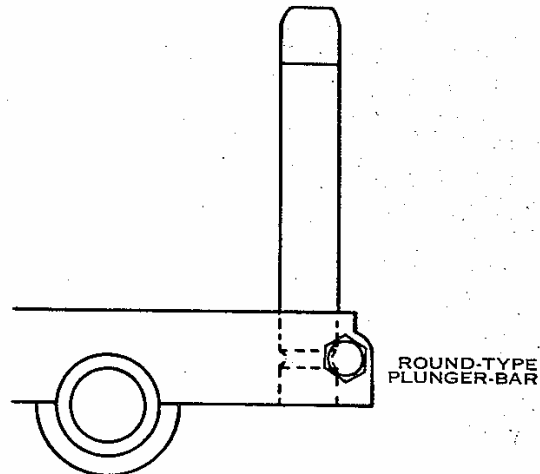
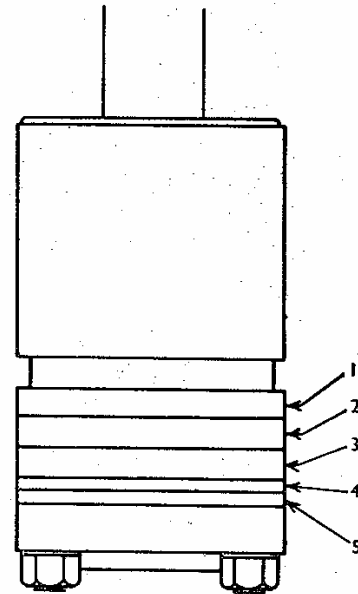
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TYPES C6T, C8T, AND C9T



Up to and including C6T/X4 & C8T/X1



C6/TX5, C8T/X3, & C9T/X1 onwards

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TYPES C5T AND C7T

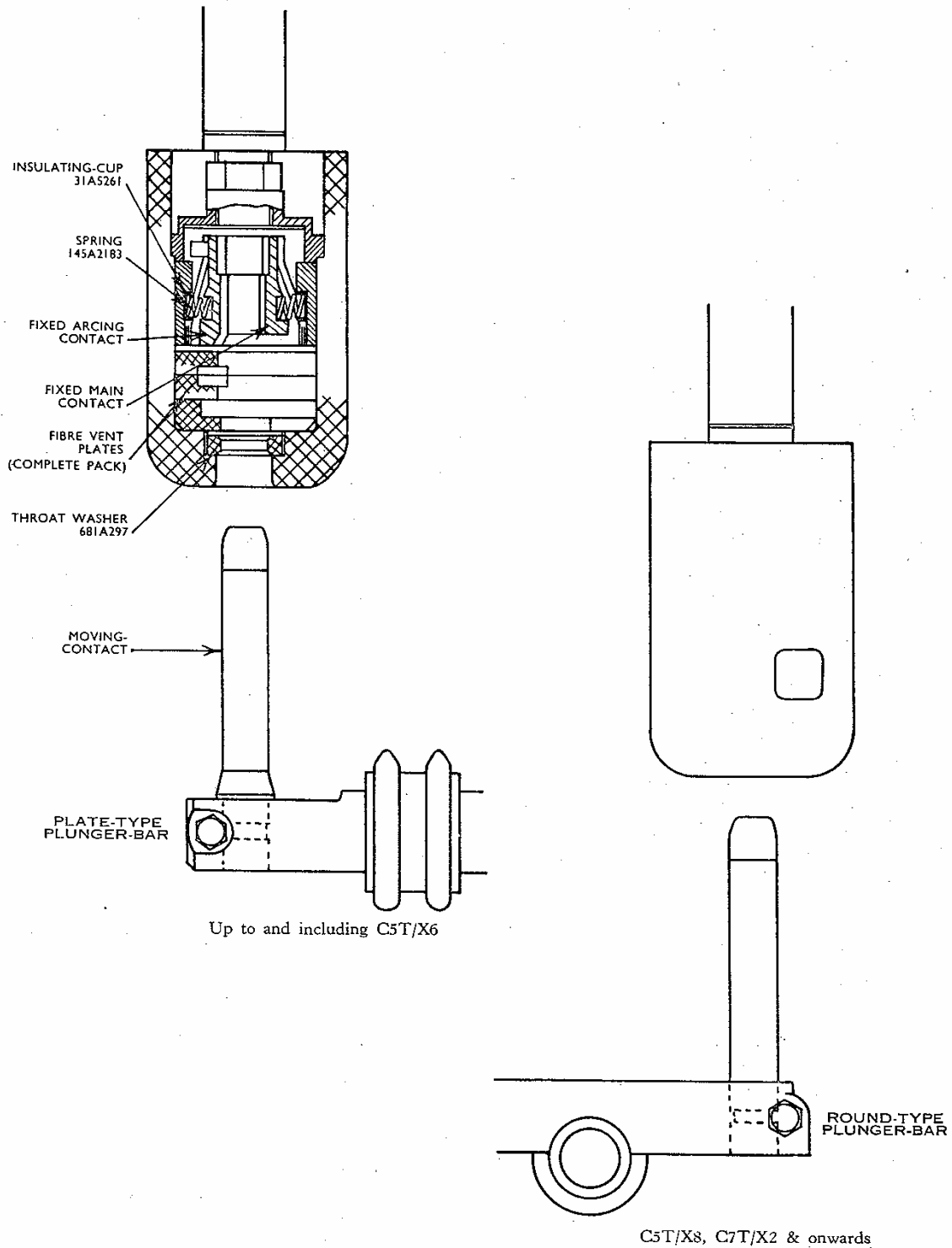
TURBULATORS

	TYPES	kV	TURBULATOR	ART No.
C5T	C5T/X2, C5T/X6, C5T/X8	6-6	T175	681A294W
	C5T/X2, C5T/X6, C5T/X8	11	T176	681A295W
	C5T/X10	6-6 to 11	T195	681A294U
	C5T/X12	11	T194	681A295U
	C5T/X10U, C5T/X15, C5T/X16	6-6 to 11	T262	31A8986
C7T	C7T/X2, C7T/X3, C7T/X6 C7T/X7	11	T195	681A294U
		11	T262	31A8986

FIBRE VENT-PLATES FOR TURBULATORS (PACK COMPLETE)

TURBULATOR	ART No. OF PACK COMPLETE	NO. PER CIRCUIT-BREAKER
T175	681A303Y	6
T176	681A304Y	6
T194	31A7151Y	6
T195	681A613Y	6
T262	31A8987	6

TYPES C5T AND C7T



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TYPES C6T, C8T, AND C9T

CONTACTS

Types C6T/X1, C6T/X4, C8T/X1 (Plate-type plunger-bar)	ART No.	No. PER CIRCUIT-BREAKER
Fixed main contact (400A and 600A)	21A3920	18
Fixed main contact (800A and 1200A)	21A5292	18
Fixed arcing contact	21A3740X	6
Moving contact (400A and 600A)	31A6473Y	6
Moving contact (800A and 1200A)	31A7927	6
Contact-cluster (400A and 600A)	21A4066Y	6
Contact-cluster (800A)	21A5322	6
Contact-cluster (1200A)	31A7960	6

Types C6T/X5, C6T/X9, C6T/X10, C8T/X3, C8T/X4, C8T/X5, C8T/X3, C9T/X1 (Round-type plunger-bar)	ART No.	No. PER CIRCUIT-BREAKER
Fixed main contact (400A and 600A)	21A3920	18
Fixed main contact (800A and 1200A)	21A5292	18
Fixed arcing contact	21A3740X	6
Moving contact (400A and 600A)	31A7322	6
Moving contact (800A and 1200A)	31A7924	6
Contact-cluster (400A and 600A)	21A4066Y	6
Contact-cluster (800A)	21A5322	6
Contact-cluster (1200A)	31A7960	6

Types C6T/X12, C8T/X7, C9T/X2, C9T/X3 (Round-type plunger-bar and self-aligning contacts)	ART No.	No. PER CIRCUIT-BREAKER
Fixed main contact (400A and 600A)	31A9012	18
Fixed main contact (800A and 1200A)	31A9009	18
Fixed arcing contact	31A9008	6
Moving contact (400A and 600A)	31A7322	6
Moving contact (800A and 1200A)	31A7924	6
Contact-cluster (400A and 600A)	31A9014	6
Contact-cluster (800A)	31A9015	6
Contact-cluster (1200A)	31A8573	6

Contact-spring	181A1609	24 per circuit-breaker
Moulded insulating-cup for spring	11A4472	24 per circuit-breaker

MINIMUM RECOMMENDED SPARES

Home Orders	1/10 of total switchboard requirements
Overseas Orders	1/5 of total switchboard requirements
Quantities to be to the nearest complete panel		

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TYPES C5T AND C7T

CONTACTS

Types C5T/X2, C5T/X6 (Plate-type plunger-bar)	ART No.	No. PER CIRCUIT-BREAKER
Fixed main contact (400A and 600A)	31A5263Y	18
Fixed main contact (800A)	681A725Y	18
Fixed arcing contact	31A5262	6
Moving contact (400A and 600A)	21A3050X	6
Moving contact (800A)	21A5328Y	6
Contact-cluster (400A)	31A5258	6
Contact-cluster (600A)	31A5867	6
Contact-cluster (800A)	681A724	6

Types C5T/X8, C5T/X10, C5T/X15, C5T/X16, C7T/X2, C7T/X3, C7T/X6, C7T/X7 (Round-type plunger-bar)	ART No.	No. PER CIRCUIT-BREAKER
Fixed main contact (400A and 600A)	31A5263Y	18
Fixed main contact (800A)	681A725Y	18
Fixed arcing contact	31A5262	6
Moving contact (400A and 600A)	31A7321	6
Moving contact (800A)	31A9068	6
Contact-cluster (400A)	31A5258	6
Contact-cluster (600A)	31A5257	6
Contact-cluster (800A)	681A724	6

Contact-spring	145A2183	24 per circuit-breaker
Moulded insulating-cup for spring	31A5261	24 per circuit-breaker

For arc-furnace circuit-breakers

Fixed arcing-contact	681A802	6 per circuit-breaker
Moving contact (400A and 600A)	31A7873	6 per circuit-breaker

MINIMUM RECOMMENDED SPARES

Home Orders 1/10 of total switchboard requirements
 Overseas Orders 1/5 of total switchboard requirements
 Quantities to be to the nearest complete panel

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MISCELLANEOUS

TANK GASKETS

For all types of C5T and C7T circuit-breakers Art. No. 31A3510
 For all types of C9T circuit-breakers and the following
 selector-type circuit-breakers: C6T/X11, C6T/X12,
 C8T/X6, C8T/X7 Art. No. 31A8205
 For all C6T and C8T circuit-breakers except those
 included above Art. No. 31A3485
 RECOMMENDED SPARES 1 per circuit-breaker

TRIP-COILS

D.C.		A.C.		UNDER-VOLTAGE RELEASE	
Voltage	Art. No.	Amp.	Art. No.	Voltage	Art. No.
20-24	35A5561	2.5	35A5560Y	55V. 25 cycle	35A3972
30	35A5562	5	35A5559Y	110V. 50 cycle	35A2885X
110	35A5563			110V. 60 cycle	35A6895
200-260	35A5564			220V. 50 cycle	35A2884X

SPRING-RELEASE COIL (QM)

Coil used is the same as for d.c. tripping

CLOSING COIL (MO) FOR CIRCUIT-BREAKERS	C5T & C7T	C6T, C8T, C9T
110V.d.c.	75A124	85A189
220/230V.d.c.	75A135	85A214

CONTACTOR COILS (MO)

2 per circuit-breaker

110V.d.c. 6034A28
 200/250V.d.c. 6034A21Y

RECOMMENDED SPARES 1 of each per 10 panels

CONTACTOR CONTACTS

Fixed and moving 6034A4 (4 per circuit-breaker)

HIGH-VOLTAGE V.T. FUSE

C5, C6, C7, C8 23A336X
 C9 297A30

RECOMMENDED SPARES 1 set of 3 for each 5 panels

LOW-VOLTAGE V.T. FUSE

Fuse Wire—29 S.W.G. 2 ft per 5 panels

INDICATING LAMPS

RECOMMENDED SPARES 2 per 10 panels

INDICATING-LAMP FUSES

Fuse Wire—31 S.W.G. 2 ft. per panel

OIL-FILLED CURRENT-TRANSFORMER-CHAMBER

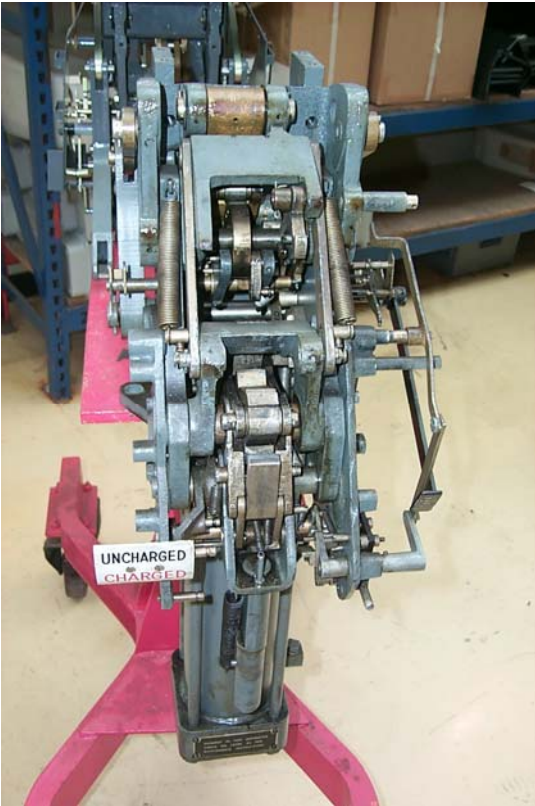
RECOMMENDED SPARES 1 complete set of gaskets per 5 panels

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Appendix 3 – Site issues

Wear on latches of high operation units may make the mechanism unstable. Refurbishment of mechanisms will cure this is problem.



Before Refurbishment



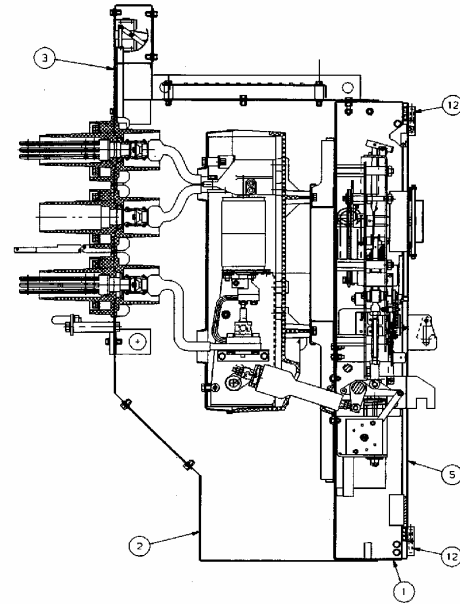
After Refurbishment

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Appendix 4 – Retrofit

- ▷ 12kv, 1250A RATING, UP TO 485 MVA
- ▷ FULL ASTA CERTIFICATION,
- ▷ BASED ON EXISTING PRODUCT,
- ▷ SINGLE OR DUPLICATE BUS.



- ▷ LOW MAINTENANCE CIRCUIT BREAKER,
- ▷ IMPROVED FAULT RATING,
- ▷ ENHANCED TELECONTROL,
- ▷ MINIMUM SYSTEM DISRUPTION,
- ▷ MODERN TECHNOLOGY PROTECTION,
- ▷ DRAWINGS UPGRADED TO CAD,
- ▷ NO PRIMARY CABLE WORK OR CIVIL WORKS

