



(Minor changes to the previous edition are indicated by ◆ placed before the relevant paragraphs)

Contents	Page		
1. Scope	1	14. Packaging and shipping of completed units	12
2. Reference	1	15. Prescribed methods	12
3. Abbreviations	1	16. Jigs and Gauges	12
4. Definitions	2	17. Equipment identification and documentation	13
5. Introduction	2	18. Record retention	13
6. Usage of item	3	Document history	14
7. Equipment design outline	3	Document index data	14
8. Applicability	4	Attachments	
9. Critical functions	4	1. References	15
10. Performance parameters	6	2. Illustrated parts list	16
11. Equipment configuration	6	3. Critical parameters and settings	23
12. General requirements	6	4. Specification hierarchy	24
13. Overhaul definition	7		

1. Scope

This Specification is written to comply with Engineering Standard 1-202 in defining the requirements for the overhaul of the Circuit Breaker Box (J and K Trainstops), items which are used extensively in the signalling system on the London Underground.

The specification hierarchy which supports these requirements is detailed in Attachment 4 to the Specification.

2. Reference

The text of this document cites other documents that provide information or guidance. These are listed in attachment 1.

3. Abbreviations

The following abbreviations are used in this document:

AC	Alternating current;
BS	British standard;
BSF	British Standard Fine;
C.B.	Circuit Breaker
ch.hd	Cheese-head;
CPS	Critical Parameter or Setting
CR	Criticality rating
DC	Direct current;
DCN	Design Change Notice



dia.	Diameter;
hex	Hexagonal;
in.	Inch;
LU	London Underground
lg	long;
MΩ	Megohm, $1 \text{ M}\Omega = 1 \times 10^6 \Omega$;
Ni pl	Nickel-plated;
Ω	Ohm;
OEM	Original Equipment Manufacturer
rd.hd	Round-head;
sq.hd	Square-head;
V	Volt
WSL	Westinghouse Signals Limited
Zn pl	Zinc-plated.

4. Definitions

The following terms are used in this document:

The Client – The Client is the Infraco representative responsible for administering the contract under which the overhaul work is being performed.

The Contractor – The Contractor refers to the organisation responsible for the delivery of overhauled equipment.

5. Introduction

This specification has been written to detail the overhaul requirements of the Circuit Breaker Box (C.B. Box) used in the style 'J' and style 'K' Trainstops which are used in the signalling system on the London Underground.

The C.B. Boxes are classified as items of vital signalling equipment which means that they are used to perform a safety critical function directly affecting the safe movement of trains. It has been designed to be an ultra reliable piece of equipment whose mechanical and electrical integrity will be relied on throughout its extended working life. It is a mandatory requirement that a C.B. Box that has been overhauled shall have a functional performance, a safety integrity, a reliability, an expected service life in its installed condition and a shelf life equivalent to that of a new item.

Any failure condition which allows a C.B. Box to close a contact when the mechanical conditions dictate that the contact should be open, is classed as a “wrong-side” failure. Wrong-side failures are investigated exhaustively to establish the cause of the failure. Investigations into wrong-side failures will examine materials, processes and the history of overhaul operations to establish the exact cause of the event and to ensure that no other items are likely to suffer a similar failure. An occurrence of a wrong-side failure or a misoperation showing a tendency towards a wrong-side failure, even if no accident or damage is caused, can be extremely costly to investigate and could result in the need to change many units in service.

Items supplied for overhaul will be complete units which usually will have failed in service although some may be in working order. The failure mode of equipments will vary, ranging from simple causes such as wear caused by a long period in service with frequent operation, to items which have suffered severe damage. In the latter case there will be an element of salvage involved in the overhaul process. The equipment will be supplied in an "as found" condition after being removed from its working position on the railway.

The service life of this equipment is 15 years. The shelf life is 3 years.

A general view of a C.B. Box is shown in Figure A.

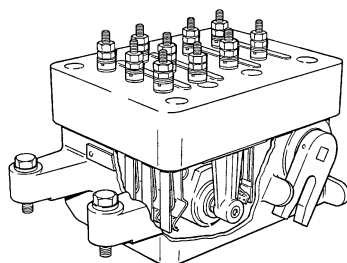


Fig. A General view of a C.B. Box

6. Usage of item

A C.B. Box is installed in each style 'J' and 'K' trainstop to operate electrical contacts which reflect the operating position of the Trainstop. A trainstop is either '**ON**' (trip-arm head is raised) or '**OFF**' (trip-arm head is lowered).

For ease and speed of maintenance, the C.B. Box is a site exchangeable component of the Trainstop. To enable this to be possible, all electrical connections to the trainstop must be made in such a manner that there can be no possibility of the wiring being replaced in the wrong position. To achieve this, the connections to the C.B. Box are made via a moulded end on the 10-core cable which attaches to the trainstop.

Three independent circuits are provided to detect the trainstop being in the '**ON**' condition and another two independent contacts detect the trainstop being in the '**OFF**' condition.

Three captive screws fitted with spring washers are used to secure the C.B. Box in position in the trainstop. The operating lever of the box has an open end with a tapered lead in so that it connects with the actuating arm in the trainstop without the need for any tools.

7. Equipment design outline

Design features built into the C.B. Boxes include:

- Construction that is designed to be ultra reliable in operation

- Standardised mechanical interface that allows fitting complete items into trainstops on site with the minimum of adjustments.
- An electrical interface designed to allow site connection to be made to the contacts via a moulded end on the 10-core cable used to connect between the trainstop and the fixed lineside wiring.
- An ability to re-furbish the main wearing components without the need to scrap major items.

Three independent pairs of '**ON**' contacts and two independent pairs of '**OFF**' contacts are provided, all worked from a common cam. The cam is operated by a lever which is itself operated from a main shaft operated by the Operating Lever.

Each pair of contacts consist of two phosphor bronze springs with keeper and backing plates. Each contact spring is fitted with a silver contact tip.

The unit is sealed with a cork gasket between the insulated top plate and the cast iron box and all recesses in the top plate for fixing screws are filled with silicone sealant to make the unit resistant to moisture ingress.

Oil retaining bearings are used throughout to make the unit maintenance free throughout an extended service life.

8. Applicability

This specification applies to the following item.

Item	Stores List No.
Circuit Breaker Box (for 'J' and 'K' trainstops)	14s22

The Illustrated Parts List, Attachment 2 to this document, forms part of this specification.

9. Critical functions

Critical Functions of the C.B. Box are defined to be:

Ultra-reliable Operation: The equipment has been designed to be a highly reliable item which will work in a hostile environment where it is mounted on the track-bed and therefore subject to high levels of vibration.

High Integrity Electrical Switching Properties: Although not to a fail-safe design, the electrical contacts are designed to be ultra-safe in breaking the currents to which they are subjected. The mechanical integrity of the components of the contacts is paramount in achieving the desired performance from the equipment. The component parts of the contacts and their attachment to the box requires to be to the highest standard achievable.

Electrical Safety. Satisfactory earthing and bonding of the C.B. Box is crucial to ensure that leakage paths to the case or other extraneous metalwork in the event of faults do not give rise to electric shock hazards or to a loss of vital system integrity.

The ability of the item to meet the critical functions listed above throughout its life depends on many factors, not all of which are immediately obvious to people not familiar with all aspects of the design, overhaul and use of the equipment. To ensure that the significance of certain of the detailed requirements is understood and complied with, a number of Critical Parameters or Settings have been designated throughout the text.

Attachment 3 to this Specification lists all the Critical Parameters or Settings [CPS], a reference to the section from which the requirement originates and provides a Criticality Rating of the importance of each CPS item.

The Criticality Rating is based on the severity of the consequence if there is a deviation of the subject parameter from the value specified. Numerical values have been assigned to various levels of the Criticality Rating (CR) according to the following table.

Criticality Rating (CR)	SAFETY RELATED CRITERIA	RELIABILITY RELATED CRITERIA
10	Life critical – sole dependence Occurrence of this deviation alone may lead to an incident causing death or injury.	
8	Life critical – shared dependence Occurrence of this deviation, together with a second deviation which is potentially latent (i.e. not self announcing), may lead to an incident causing death or injury.	
7	Life critical – contributory Occurrence of this deviation increases the probability of an event which may lead to an incident causing death or injury.	Service critical – sole dependence Occurrence of this deviation alone may lead directly to an incident causing major service delays, and indirectly to the danger of a life threatening incident through enforced use of manual rules for operating the railway.
6		Service critical – shared dependence Occurrence of this deviation, together with a second deviation which is potentially latent (i.e. not self-announcing), may lead directly to an incident causing major service delays, and indirectly to the danger of a life threatening incident through enforced use of manual rules for operating the railway.
5		Service critical – contributory Occurrence of this deviation, increases the probability of an event which may lead to major service delays, and indirectly to the danger of a life threatening incident through enforced use of manual rules for operating the railway.
1	Not life critical	Not service critical

The criticality rating provides a scale of the importance of achieving the specified parameter and therefore of the care needed in designing the process or processes that will lead to the parameter being achieved. The design of the process or processes that will lead to the parameter being met are the responsibility of the Contractor and they shall be designed and documented in accordance with the requirements of Engineering Standard 1-202, Signalling equipment overhaul.

10. Performance parameters

Performance parameters applicable to the C.B. Boxes are defined and quantified below.

10.1 Contact resistance

Contact Resistance shall be measured with between 0.1 and 1 Amp (AC or DC) flowing through the contact.

The Contact Resistance calculated from the volt drop measured between terminal posts of closed contacts shall be no greater than 0.5 Ω .

10.2 Insulation resistance

The Insulation Resistance between any item forming part of the contact arrangement and any other metallic part of the equipment shall be greater than 50 M Ω when measured at 1000 V DC.

11. Equipment configuration

An Illustrated Parts List is provided as Attachment 2 to this document, comprising an itemised list and associated exploded assembly drawings to describe the equipment as identified in Section 8 of this specification. The Illustrated Parts List contains all relevant drawing numbers.

A convention of using the figure number followed by the item number has been adopted in this document to uniquely refer to specific components where necessary. Thus, item 1-26 is the Camshaft.

Unless specifically noted, drawings and figures used in this Specification are for reference only.

12. General requirements

12.1 Compliance with specification

No departures from the requirements of this Specification shall be permitted (either permanently or temporarily) without compliance with the relevant change control procedures.

Neither equivalence of process nor substitution of materials shall be recognised by the Client in receiving work performed against this specification. The Client shall have the immutable expectation that equipment overhauled to this version of the specification shall be 100 % compliant with the specification herein.

12.2 Workshop environment

There are no special conditions associated with the overhaul work detailed in this specification.

Calibrated test equipment shall be used to carry out all measurements specified.

12.3 Calibre of staff

Any staff involved in the overhaul process shall be competent in the tasks they carry out and the overhauling contractor shall demonstrate this in accordance with the requirements of Engineering Standard 1-203, Competence of personnel working on signal and control systems

12.4 Operator accountability

Process control documentation is required to be completed by identified certified (stamp holding) operators and inspectors throughout the overhaul process. Each certified operator and inspector shall possess a uniquely numbered stamp which is traceable to the owner. Only competent operators shall be provided with a stamp. Records of the issue and withdrawal (if appropriate) of every stamp shall be kept and shall be made available to the Client on request. The retention period of these records is required to be indefinite.

13. Overhaul definition

13.1 Full overhaul

C.B. Boxes are generally left in service until they fail.

A full overhaul, including repair or replacement of failed component(s) will be performed on each item returned to the workshop.

No item returned after failing in service shall be overhauled until the failure report has been reviewed and accepted by the Client in accordance with a defined arrangement agreed with the Client.

Unless stated to the contrary, all processes detailed in this specification shall be performed for each overhaul.

13.1.1 Dismantle

The C.B. Box shall be dismantled in a manner that shall not damage or shorten the life of any component that is required to be re-used. The life of all recyclable components is indefinite.

The items listed below shall be discarded and replaced with new items at every overhaul.

Circular Nuts (1-14)	Asset Plate (2-47)	Washers (all)
Circular Nuts (1-50)	Split Pins (all)	Nuts (all)
Flanged Bearings (2-42 and 2-43)	Inner Contact Assemblies (1-10)	Outer Contact Assemblies (1-11)
Cork Gasket (1-3)	Oilite Bushes (1-21)	Oilite Bushes (1-32)
Terminal Screws (1-8, 1-9, 1-12)		

Centre Cams not to the current design shall be discarded.

The Operating Lever shall be left pinned to the Main Shaft until the need to remove it is determined at the examination stage.

13.1.2 Cleaning

The following shall be implemented after the unit has been dismantled in accordance with Section 13.1.1 above.

All components shall be cleaned and degreased using a technique suitable for that component. A 'suitable technique' shall not cause short term or long term degradation to the component and shall not leave undesirable residues on the component which will affect the performance of the item when it forms part of an overhauled item.

13.1.3 Examination and gauging

All components shall be examined for the effects of excessive or unusual wear, general damage, damage caused by misuse or age, electrical arcing or tracking or overheating. All thread forms shall be checked for signs of over-tightening. Items exhibiting damage that will not be corrected by the specified re-furbishing processes shall be discarded.

All occurrences of excessive or unusual wear or damage shall be catalogued and reported to the Client. Signs of electrical tracking or arcing shall be treated as excessive wear.

The subject items of such reports and as much of the unit from which they were removed as possible, shall be saved in their as near as original condition after being discovered and shall be clearly tagged and identified and shall be made available for Client inspection if so desired.

It is critical that **only** those components specified for refurbishment should be reclaimed after failing the wear tolerances specified.

Items not meeting the examination criteria shall be discarded if there is no refurbishment process detailed for it in this Specification.

Major components and items with specific examination criteria are listed below.

All component parts set aside for use at assembly shall be to a current approved design. Modification schemes may have been commenced which may not yet have been fully implemented. Units submitted for overhaul may not be to the current build standard. Some components may therefore require to be modified or discarded.

13.1.3.1 Box (Item 2-1)

The general condition of the Box shall be checked. No items shall exhibit signs of cracking or have damaged corners.

All Boxes shall be suitable for fitting flanged bushes, in accordance with drawing BS40783.

Holes for fixing screws (items 1-4) shall have threads in good condition to a depth of at least $\frac{5}{16}$ in. The faces of the bosses inside the box for the fixing screws shall be at least $\frac{1}{16}$ in. recessed from the top face of the box.

The top face of the box shall be flat and undamaged, sufficient to allow the cork gasket to form a good seating between the box top and the Top Plate (1-2).

The Operating Arm restraining lugs shall be complete and undamaged.

13.1.3.2 Cam Shaft (Item 1-26)

The Cam Shaft shall be straight to within 0.015 in. and be free from evidence of severe rust pitting. The threaded ends of the shaft shall be in good condition (free from rust damage).

The bearing surfaces shall be unpitted and be of a minimum acceptable diameter of 0.185 in.

13.1.3.3 Operating Arm and Main Shaft Assembly (Items 2-48 and 2-41)

The Operating Arm shall be securely fixed to the Main Shaft.

The minimum acceptable diameter of the small bearing surface of the Main Shaft is 0.373 in.

The minimum acceptable diameter of the bearing surface of the Operating Arm is 0.747 in.

The maximum width of the parallel portion of the slot in the Operating Arm is 0.442 in.