



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

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1. Scope

This Specification is written to comply with Engineering Standard 1-202 in defining the requirements for the overhaul of both variants of Style QN6 Relays 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. References

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

References to British Standards or standards in other standards systems shall be taken to include the words 'or equivalent'.

3. Abbreviations

The following abbreviations are used in this document (if from a published source this is indicated):

CPS	Critical Parameter or Setting
DCN	Design Change Notice
LU	London Underground
OEM	Original Equipment Manufacturer
WSL	Westinghouse Signal Limited

4. Definitions

The following terms are used in this document (if from a published source this is indicated):

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.

Front Contact – A front contact provides a very low resistance (short circuit) electrical connection between two terminals of the relay when the relay is in an energised state.

Back Contact – A back contact provides a very low resistance (short circuit) electrical connection between two terminals of the relay when the relay is in a de-energised state.

5. Introduction

This specification has been written to detail the overhaul requirements of Style QN6 Signal Relay which is used in the signalling system on the London Underground.

The Style QN6 Relay, is classified as an item of vital signalling equipment which means that it may be used in the most critical safety circuits directly authorising the movement of trains. It has been designed to fail-safe principles and manufactured to exacting tolerances to ensure that it fulfils its safety role throughout a very extended life. It is a mandatory requirement that a relay 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 relay.

Any failure condition which causes

- the relay to behave as though it is in an energised state without the required voltage being present at the energising terminals of the relay
- any front and any back contact to be closed simultaneously, or
- any contact or coil to have an electrically conductive path to any other contact or coil or core

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 relays in service.

Figure A below shows a general view of a Style QN6 relay.

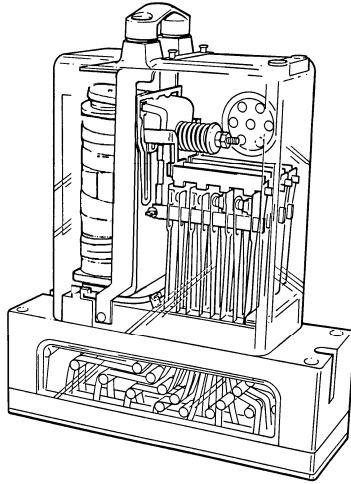


Figure A – General view of a Style QN6 relay

Items supplied for overhaul will be complete units which may be in working order or may have failed in service. The failure mode of items will vary, ranging from simple causes such as open circuit contacts, 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 returned for overhaul in an 'as found' condition after being removed from its working position on the railway.

The service life of this equipment is 10 years. The shelf life is 3 years.

6. Usage of item

The Style QN6 relay has been designed as a safety critical relay used to directly authorise the movement of trains on the London Underground.

The relays are generally used in pairs with two relays operating in tandem to provide one signalling function. The status, energised or de-energised, of each relay of the pair is continuously monitored to check that they are both in the same state. If at any time they are detected to be out-of coincidence then an alarm condition will be initiated.

The relays are used to switch 100 volt A.C. circuits where their function is to implement the relay logic associated with the operation of the signal system. The circuits controlled by the relays will ultimately result in a clear signal being displayed to the driver of a train or a code authorising a train to proceed being sent to the safety equipment controlling an automatically driven train.

Two variants of the Style QN6 relay are covered by this specification as detailed in Section 8.

7. Equipment design outline

Key design features of all Style QN6 relays are that they have been designed to include:

- Construction that is designed to be, as far as is practicable, fail-safe in operation
- A combination of contact materials, pure carbon and silver, that are non-weldable

The relay is based on the design produced to meet British Railways Specification No. 930 for a miniature tractive armature D.C. neutral relay. The connection arrangements differ significantly in so far as the QN6 utilises screwed connections to make the electrical connections to the relays in place of the plug-in connections used on the British Railways version.

8 front contacts and 8 back contacts are provided all with independent connections.

8. Scope

This specification applies to the following relay variants.

Item	Stores List No.
Style QN6 Relay – Track	55-S-197
Style QN6 Relay - Line	55-S-167

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

9. Critical functions

Critical Functions of the Style QN6 Relay are defined to be:

High Integrity Electrical Insulation: All electrical wiring and insulating components are designed to maintain their integrity throughout the life of the equipment. No failure mode is allowed to compromise electrical isolation between any part of the contact arrangement or the energizing coil or core of the equipment.

Non-weldability of contacts: The contact materials are specified to be a pair of materials (silver and pure carbon) that have been proven to have a very low probability of welding. The composition of the carbon contact is critical to maintain this design goal.

Freedom from mechanical binding: The design of the relay has taken into account the absolute need for the front contacts to open when the voltage at the control winding terminals is below the minimum drop-away value. To this end, components are larger than would be expected on normal commercial relays and clearances between components have been kept as large as practical and in most cases can be visually seen from outside the relay when it is in its operating position.

Electrical Safety. Satisfactory earthing and bonding of the Relay 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

10.1 Pick-up and drop-away parameters

The relays shall operate to the conditions detailed in Table 1 below.

RELAY TYPE	PICK-UP	DROP-AWAY	RATED VALUE
100 V. A.C. LINE	≤ 0.63 AMP	≥ 0.44 AMP	1.00 AMP
100 V. D.C. TRACK	≤ 38 VOLTS	≥ 15 VOLTS	100 VOLTS

Table 1. Table of operating parameters

10.2 Contact pressure

The contact pressure between each pair of front contacts shall be 28 – 38 grams with the relay energised to the maximum pick-up parameter given in Table 1 (see section 10.1).

The contact pressure between each pair of back contacts shall be 28 – 38 grams with the relay de-energised.

10.3 Contact Resistance

The contact resistance of each pair of closed contacts, with 0.1Amps flowing through the contact from a 50 volt A.C. source, shall be $\leq 0.25\Omega$.

10.4 Insulation Resistance

The insulation resistance between all parts of the electrical circuits and the iron core of the relay shall be at least 100 M Ω when measured at 1000 V DC.

The insulation resistance between any parts of insulated circuits shall be at least 100 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 both variants of 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 1-5 is the Handle Support.

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

The silver and carbon contacts are sensitive to contamination from handling. The carbon contacts are prone to absorb grease and soap residues from the skin if touched with bare hands. Lint-free protective gloves shall be worn by operators when handling carbon and silver contacts.

The relay is susceptible to the ingress of contaminants. All work on QN6 Relays shall be conducted in an area in which no contaminants are generated or are allowed to circulate. A contaminant may be generated by filing, sanding, sawing, cleaning or any other similar operation.

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 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

A full overhaul will be performed on relays which generally will have been in service for their full service life or which will have been removed from service as a result of a failure.

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.

The Serial Number of each relay, as given on the Nameplate (item 1-6), shall remain as the identity of the relay throughout the overhaul and shall be the number by which the overhauled relay is known. Note that this is not the usual practice applied when overhauling signal relays.

13.1.1 Dismantle

The relay 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.

Components that are riveted together shall be left attached to each other until the examination process determines if any parts need removing to allow replacement to be effected.

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



Cap Seal (1-10)	Cover Sealing Ring (1-16)	Adjustment Card (1-23)
Operating Arm (1-24)	Contact Spring Ass'y (1-30)	Contact Spring Ass'y (1-31)
Lead Seal (1-63)	Neoprene Washer (1-14)	Connector Strips (all) (1-28)
	Operating Arm Pin (2-42)	

NOTE: All Contact Spring Assemblies (items 1-30 and 1-31) shall be examined before discarding them. Items shall be examined for evidence of melting, re-flowing of the solder joint or gross wear of the carbon or silver contact. These effects are considered to be 'unusual wear' and shall therefore be notified to the Client in accordance with the requirement called for in section 13.1.3 of this Specification.

13.1.2 Cleaning

The following shall be implemented after the relay 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 nor shall any solvent used leave undesirable residues on the component which will affect the performance of the component when it forms part of an overhauled unit.

Any test label attached to the Cover shall be removed using a solvent or physical means that does not degrade the surface finish of the component.

13.1.3 Examination

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 in re-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.