

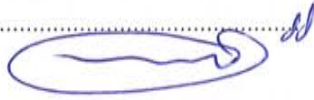
Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

Guidance Note

Signalling Relays (SIGTAN 020)

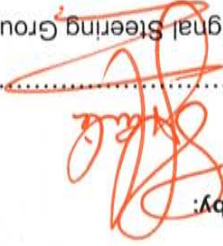
Endorsement and Authorisation

Endorsed by:



J Walker, Working Group Chair

Authorised by:



S Hailes, Signal Steering Group Chair

Accepted for issue by:



M McManus, National Standards Manager

This document is the property of Network Rail. It shall not be reproduced in whole or part nor disclosed to a third party without the written permission of Network Rail.

© Copyright 2011 Network Rail.

Uncontrolled copy once printed from its electronic source.

Published and issued by Network Rail, Kings Place, 90 York Way, London, N1 9AG.



Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

Issue record

Issue	Date	Comments
1	February 1999	First Issue
2	April 1999	Amended to incorporate problems with SGE and Westinghouse relays
3	August 2004	Inclusion of new failure modes and superseded documents listed below– no black lines due to reformat.
4	December 2004	Amended to incorporate problems with rubber sleeving and highlighting the availability of the slow-to-pick Reed Follower relay
5	September 2010	Amended to incorporate problems with moving iron relays, details of new miniature cradle relay for SJ sets, details of oozing GEC coil tape and clarified the types of coils for QNNS1 relays.
6	June 2011	Inclusion of new section 5.4.3 Z Style Relays to Specification BR936.
7	September 2011	Amended Appendix A - DCPMI Relay Types (SGE Relays) to change the limits of minimal d.c. current to operate the relay. (CCMS document number 61408163)

Reference documentation

NR/L2/SIG/11129	Life Management of Signalling Relays and Electro-mechanical searchlight and banner signals
NR/GN/SIG/19265	Signalling Equipment Workshop Engineering Notice (SIGWEN014) Labelling & Signalling Equipment
NR/L2/SIG/17904	Risk Analysis of Signalling Relays
NR/L3/SIG/19272	Signalling Equipment Workshop Engineering Notice (SIGWEN021) Signalling Relays
NR/SIN/100	Type M & AEI-GS Type Z Relays
NR/L2/SIG/10065	Requirement Specification for a Barrier Operation Relay for L.C. Barriers

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

Disclaimer

In issuing this document for its stated purpose, Network Rail makes no warranties, express or implied, that compliance with all or any documents it issues is sufficient on its own to ensure safe systems of work or operation. Users are reminded of their own duties under health and safety legislation.

Supply

Copies of documents are available electronically, within Network Rail's organisation. Hard copies of this document may be available to Network Rail people on request to the relevant controlled publication distributor. Other organisations may obtain copies of this document from IHS (Technical Indexes Ltd) tel: 01344 328039.

Copyright Network Rail

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

Contents

1 Purpose	5
2 Scope	5
3 Abbreviations & Definitions	5
4 General Information	6
4.1 Handling, Storage and Visual Checks	6
4.2 Molten Solder Caused by Overheating	7
4.3 Silver Sulphide Contamination	8
4.4 Unused Holes in Case	8
4.5 Cracked Covers	8
4.6 Warped Covers	9
4.7 Loose Covers	10
4.8 Polar Circuits Fitted With Non-Polar Relays	10
4.9 Interaction Within Twin Armature Relays	11
4.10 Non-Heat-Shrinkable Electrical Sleeving	11
4.11 GEC Relays – Leaking Coil Winding Tape	11
5 Specific Relay Problems	12
5.1 AEI-GRS Type M Relays	12
5.2 Reed Follower Relays	14
5.3 Westinghouse Q Style Relays	14
5.4 GEC-GS, AEI-GS, AEI-GRS, GRS and SGE TYPE Z Relays	16
5.5 SGE Vane Type Relays	18
5.6 Full-Size Plug In Relays	19
5.7 Westinghouse P Series Relays	19
5.8 Moving Iron Relays	19
5.9 Thermal Timers	29
5.10 Contactors	29
5.11 SJ Relay Sets - Geographical Interlocking Units	30
Appendix A - DCPMI Relay Types	32

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

1 Purpose

This document has been prepared to summarise problems affecting railway signalling relays used on Network Rail's Signalling Infrastructure.

It is anticipated that this document will develop to become a controlled repository for providing advice and information on signalling relay problems. This document should be read in conjunction with any other issued special instructions requiring action to be taken with certain types / manufacturers relays or relays which have been serviced between certain dates. This document seeks to clarify, and assist with the identification of, those conditions identified as requiring special attention.

Any problems identified through special investigation, or brought to the attention of the infrastructure owner by other means will be risk assessed and, where required, specific instructions will be produced detailing the action required.

2 Scope

This document applies to electromechanical relays that form part of the infrastructure based railway signalling control system which are used in safety critical or safety related applications. Additional information will be added as necessary to align this document with the special instructions referred to above.

It does not address the general personnel and system safety measures necessary for working with signalling equipment.

3 Abbreviations & Definitions

Full Operate	The condition of the relay when it is energised, all front contacts are closed and the armature has completed its designed travel
Functional Test	The test carried out to demonstrate the equipment fulfils its purpose, to be performed for each circuit affected by the equipment
Non-pegging indicator	That indicator that shows the state of the line beyond the Signaller's control area
Pegging	The Signaller operating the block instrument commutator to one of three positions
Replace (also Replacing, Replaced, Replacement)	The process by which a relay or associated components is removed from the working railway signalling control system and substituted by one of equivalent function
Test to Specification	A test to check that the equipment meets all of the intended operating parameters

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

BCR	Block Control Relay
BSR	Block Stick Relay
DCPMI	d.c. Polar Moving Iron
(LC) SR	Line Clear Stick Relay
ND	Normal De-energised (A contact that is made in the normal position with no voltage on the relay coils. Note: usually the normal contact is the left-hand contact of the relay seen from the front via its viewing window.)
RD	Reverse De-energised (A contact that is made in the reverse position with no voltage on the relay coils. Note: usually the reverse contact is the right-hand contact of the relay seen from the front via its viewing window.)
SIGTAN	Signalling Equipment Technical Advice Notice
SIGWEN	Signalling Equipment Workshop Engineering Notice

4 General Information

4.1 Handling, Storage and Visual Checks

All relays shall be handled carefully. Accidentally dropping or knocking a relay can dislodge components, such as adjustment cards, whilst leaving the relay apparently undamaged. When relays are sent either for investigation following an incident or allegation, where possible the original packing should be used and a shock detector fitted to the package (available free-issue from Atkins Rail). These measures help to prevent transit damage and in the case of relays sent for investigation, makes sure that vital evidence is undisturbed. In cases of major incident relays should be carefully packaged and transported by hand.

Relays sent for servicing should also be packaged carefully, preferably using original packaging.

The following conditions, which render the relay unusable, can be identified by careful visual examination:

- Flaking plating on relay internal framework and components
- Prototype relays or relays of suspect origin
- Ill fitting or warped / yellowing, damaged / cracked or loose covers
- Damaged or broken adjustment cards
- Misalignment or mechanical damage to contact stacks which may have occurred in transit

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

- For GEC, AEI-GS, AEI-GRS, GRS and SGE 'BR 930' style relays check that lifting card retainers are fitted
- Presence of foreign bodies inside relay
- Defective or missing labelling
- Presence of Silver Sulphide contamination
- Defective or missing seals
- Severe contamination, water
- Heat damage
- Case distortion
- Physical damage (other than cosmetic)
- Unused holes in case.

Shelf Type relays shall be additionally checked for:

- Stray metallic debris on the top of the relay.
- Wiring in poor condition.
- Lack of protective insulators fitted to terminals.
- Damaged casing, including glass panels.
- Defective insulation on wiring to Remax top (where fitted).

Relays exhibiting any of the above conditions shall be returned to a Service Agent for servicing or disposal as appropriate.

Relays can be stored for up to 3 years before action is required prior to inserting them into operational use. Where relays have been stored for over 3 years and up to 10 years, a *functional test* should be performed. Relays stored for 10 years or more require a full *test to specification* or to be sent for *servicing*.

4.2 Molten Solder Caused by Overheating

When current passes through a contact, heat is generated. Where the current is high enough, the heat can melt the solder that secures the contact to the spring. Very occasionally, this has run down and formed a bridge to the next contact. See Figure 1.

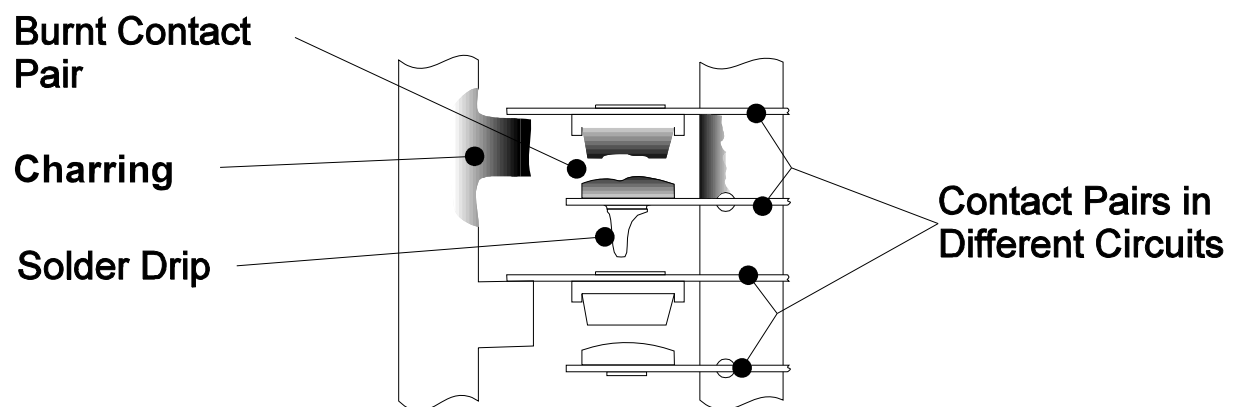


Figure A.1

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

4.3 Silver Sulphide Contamination

Silver Sulphide crystals can grow on the contacts. These look like black iron filings on a magnet and are electrically conductive, see Figure 2. If they build up sufficiently, they could bridge contact pairs together. The cause of the problem is a chemical reaction between sulphur vapour (given off from the rubber insulation of coil connecting wires, or rubber pads between coil and relay frame, due to operating heat) and silver contacts.

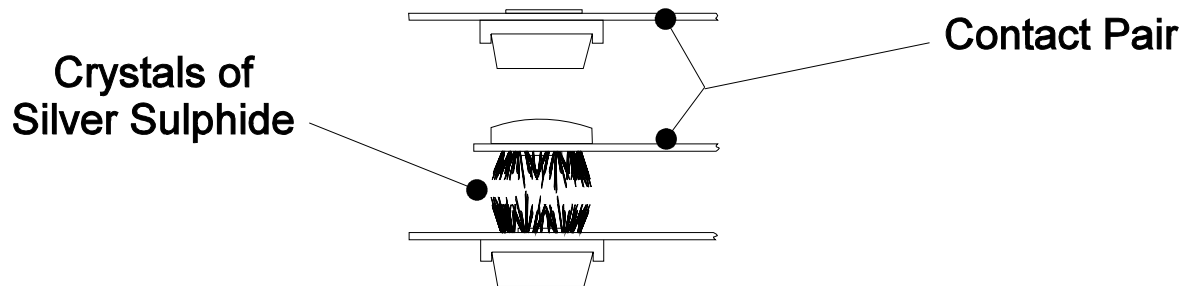


Figure A.2

Silver Sulphide has been observed in Westinghouse Q style (BR930) relays made between 1966 and 1970. Later relays used different (sulphur-free) insulation. Once any sulphur present in the rubber has dissipated the problem should not occur again. Relays made during this period which have been serviced should have had the offending wire / pads replaced. Silver Sulphide contamination has also been found in SGE full size plug-in relays and shelf type relays.

Some relays had a partial on site service to get rid of the silver sulphide problem and were marked with a blue dot. Over the years, however, dots may have fallen off. Any relays serviced will be okay and have had their dot removed.

4.4 Unused Holes in Case

Until 1980, it had been the practice to label the relay case with its function (e.g. 123HR).

The danger of doing this was that if a relay was swapped the labels could sometimes be moved with it. The practice now is to fix the label to the rack.

GEC-GS secured the label to the relay cover with two small self tapping screws. These screws should be left in place so that insects and dirt can not enter the relay. They should not be tightened too much or the cover may crack. Screws which are too long have been found to restrict the operation of the armature and cause irregular operation.

4.5 Cracked Covers

Some relays made by Tyers, Zone Controls and AEI-GS, were manufactured without adequate internal support for the handle. Consequently, sustained or prolonged pressure on the handle by the retaining clip has caused their covers to crack.

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

The cracks start near the base of the handle and usually spread across the top and down the sides of the cover. One cover was found almost split in half.

The cracking occurs owing to the sudden shock caused when a tight fitting relay retaining clip is 'snapped' into position in the handle's clip recess. The continuing pressure from the clip then causes the cracks to spread. See Figure 3.

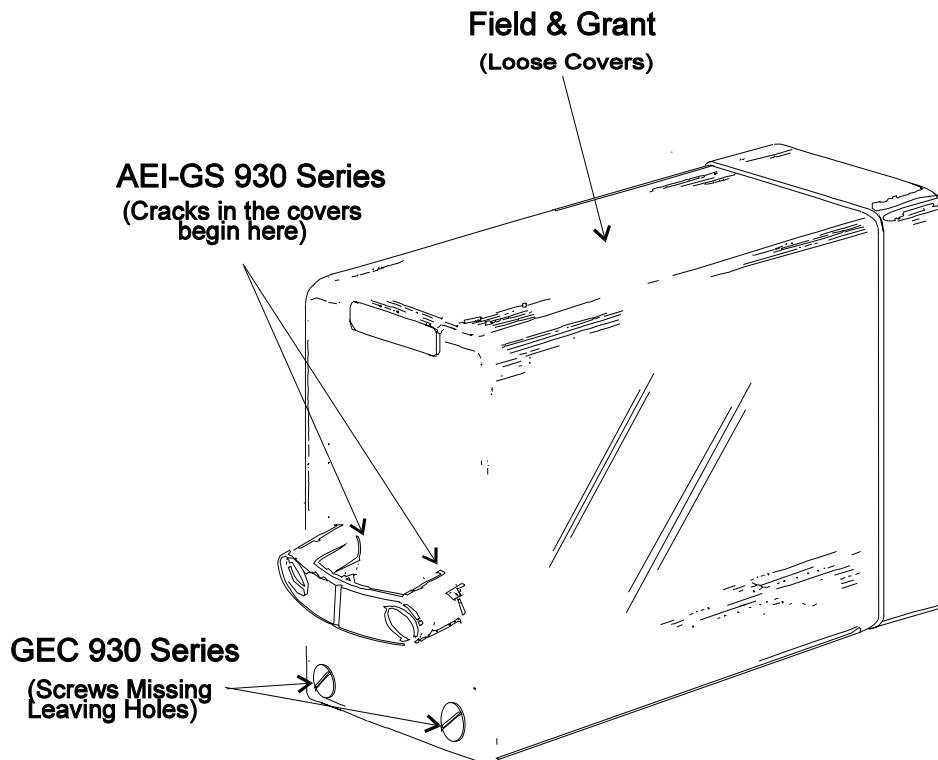


Figure A.3

It is also possible for the plastic casing to crack as a result of chemical reaction with orthophthalate plasticiser released from the PVC sheathing of the coil connection wires following hot conditions. This contamination has been found in BR935 relays and is visible as a misty, oil-like coating inside the relay case. It can also result in high resistance contacts and may irritate sensitive skin. Unless the relay case is damaged this condition does not generate a safety risk.

4.6 Warped Covers

Some relay covers have been found to be distorted by high temperature. This effect is most likely to be seen on covers enclosing twin relays where both relays can be energised simultaneously for prolonged periods. The heat produced if the bus-bar voltage is higher than the nominal can exceed the design levels. The relay should be changed where this effect is so pronounced that the cover might affect the relay's operation.

Westinghouse P series relays were manufactured with cellulose acetate covers. These are particularly prone to distort inwards, accompanied by yellowing discolouration and a distinctive vinegar smell. Affected relays should be reported to your manager so that servicing can be arranged.

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

The side windows in some SGE Full-size plug-in relay covers have also been found to be similarly affected. Remedial action should be arranged as appropriate.

4.7 Loose Covers

Field & Grant relays have been found with damaged or displaced adjustment cards (also known as 'combs' or 'bankers'). They have been bent out of position or broken. The cause has been traced to loose covers which can move sufficiently, relative to the base, to push on the adjustment card. The damage is caused by the cards being trapped between the cover top and the heavy coil and core assembly.

Even quite minor shocks, such as that caused by dropping the relay, whilst still within its foam packaging, can be sufficient to move the cover and damage the cards. The cover should be held firmly against the relay base.

Where there is relative movement between the cover and base of a relay, it should be changed.

4.8 Polar Circuits Fitted With Non-Polar Relays

Although not the result of a relay fault itself, a misleading and potentially serious condition can result from the use of non-polar relays in polar circuits. The fitting of an incorrect relay type can stem from incorrect specification at the design stage, or inadequate controls applied to replacing in service relays followed by inadequate testing. Obviously the risks of an error are higher if the relay is of a type where the polar and non-polar variants are of the same size.

The risk of this particular problem is that it may go undetected for some considerable time, ultimately leading to a wrong-side failure condition following a power interruption or other disconnection of the circuit.

Investigation of a reported panel indication fault revealed that when the panel switch was 'ON' the relevant signal was indicated as 'OFF' and vice versa. Observation of the signal aspect confirmed an indication failure.

The fault only became apparent following a power failure and was traced to a BR960 style QNN1 relay, code 212. This relay performed the HPPZR / HPPR function within what appeared to be a pole change-over circuit.

Examination revealed that it was operating out of synchronisation with the HPR relay.

Although installed as per the site diagram the use of a neutral non-biased relay appeared inappropriate for use in a pole change-over circuit.

Subsequent testing of this relay and one installed at the same time in a similar circuit revealed that the small amount of stored magnetism left in the relay's iron circuit will be biased towards the polarity of the previous feed.

If the next feed is of the same polarity the particular relay will pick quicker or vice versa. In either case the relay will appear to operate as a biased relay but the wrong relay may operate.

After a power failure or interruption of the feed to the relay coils both relays involved in any such circuit will have an opportunity to loose all stored magnetism and the next relay to pick becomes a chance event.

A similar situation was discovered during a recent investigation of a cable fault. In this case the indication was found to be out of correspondence with the signal lever.

Ref:	NR/GN/SIG/19020
Issue:	7
Date:	03/09/2011
Compliance date:	n/a

A BR960 twin relay, configured with cross-proving, will switch in sympathy with a pole changing circuit, but, as explained above, interruptions to the power supply, high resistance or disconnections are likely to upset the sequence.

Although these particular relays were used for indication there is a possibility that non-polar relays could have been specified as final function relays in pole changing circuits.

Even in this application this type of failure is potentially serious because it tends to occur after a power supply failure. The resultant misleading indication given to the signaller once the supply is restored could lead to mistakes being made when dealing with a disrupted service.

The inclusion of these two scenarios is aimed at assisting with the understanding of what may happen in such circumstances, how it may be presented as a failure such that any similar cases may be identified and remedial action initiated.

4.9 Interaction Within Twin Armature Relays

Twin armature relays manufactured to BR961 are required by specification clause 18.2(c) to permit either coil of the relay to operate within specified limits regardless of the state of the other coil. It has been identified that this is not always the case. Whilst not a safety risk, any unexpected behaviour (for example, abnormal operation of one 'half' when other 'half' energised) of this type of twin relay may be due to this design deficiency. Relays found exhibiting this problem should be replaced with one which is compliant with the specification.

4.10 Non-Heat-Shrinkable Electrical Slewing

When using sleeving it is important that the material from which it is manufactured does not react with other materials. In the past Servicing Agents have used black PCP (rubber) sleeving and unfortunately this can react with other plastic-based materials close-by. Consequently Servicing Agents have now been instructed to use only brown coloured silicone rubber sleeving. Silicone rubber does not have the compatibility problems of PCP and this includes e.g. rubber, PVC and polyethylene. This sleeving is normally only in contact with other materials in "non-safety" relay sets (e.g. SJ sets, "Post Office" sets).

With regard to existing equipment, a Preliminary Risk Assessment concluded that there was a slight risk of signal replacement functions not operating and this could be particularly serious if the signal concerned was being used to protect an automatic level crossing. Consequently it is recommended that when carrying out any inspection checks these functions should be given priority. It should be stressed however, that the risk in relation to this hazard was judged to be remote and these checks are purely precautionary. Any other item of equipment found to be exhibiting insulation sleeving degradation should be removed and sent for servicing.

4.11 GEC Relays – Leaking Coil Winding Tape

GEC relays have been found to have bubbling / leaking coil winding tapes (as shown in figure 4). Whilst this is unsightly as long as there is no contamination on the core face it presents no risk to the operation of the relay.