

Sydney Trains



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Engineering Procedure
Signalling and Control Systems

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Inspection and Testing of Signalling: Inspection and Testing Procedures

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Document control

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Summary of changes from previous version

Summary of change	Section
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Updated to include axle counters within the 'Aspect Sequence Test Procedure' section	9.2
Updated to include axle counter Control Table Function Tests	11.5

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1 Introduction

1.1 General

This procedure is part of a suite of inspection and testing of new and altered works requirements as nominated in *PR S 47110 Inspection and Testing of Signalling: Introduction*.

This procedure sets out the requirements of the inspection and testing procedures for certifying new and altered signalling works and the standard procedures and practices for carrying out and recording inspection and testing.

1.2 References

This procedure shall be read in conjunction with *PR S 47110 Inspection and Testing of Signalling: Introduction*.

2 Insulation Testing

2.1 General

The aim of Insulation Testing is to ensure that electrical circuits are adequately insulated from one another and from earths so that circuit functions are not liable to incorrect energisation by electrical leakage currents.

Circuit electric leakage paths to earth can be detected by the use of earth leakage detectors, voltage tests to earth and insulation resistance tester. Visual inspections also assist in detecting damage or deterioration of insulation.

Deterioration in the insulation of circuits from earth or from one another may occur due to ageing, cracking, abrasion or other damage to the insulation, entry of moisture into cables or across insulating surfaces, build-up of dirt and grit, etc. on or across insulating surfaces, distortion or movement of components affecting the clearance between metallic conductor parts, terminal lugs or wire strands shifting into contact with frames, breakdown of surge arresters, line wires coming into contact with trees, deposits caused by rotary contact wear etc.

Perform Insulation Testing to determine the following:

- insulation resistance to earth of electrical equipment, wire conductors, cable cores and cable sheaths
- insulation resistance between cable cores
- insulation resistance between each cable core and the cable sheath.

2.1.1 Insulation Resistance Tester

The Insulation Testing of all installed wiring and equipment associated with Signalling installations, shall be carried out prior to bringing into use any new work and thereafter at regular intervals with a type approved insulation resistance tester with a voltage output of 500 volts D.C. and a current output of no more than 3 milliamps. This can be of the hand generator type or the electronic version. The instrument shall be type approved.

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2.1.2 Regularly Check Insulation Resistance Tester and Earth

Test the insulation resistance tester to ensure correct operation and voltage and current output before commencing the tests and at regular intervals.

Test the test earth immediately prior to performing a series of tests and immediately after the last of the series of tests. Retest if disturbed at any time.

Where a combined bell tester/insulation tester is approved regularly test the insulation tester to ensure it detects an insulation resistance to earth below the stipulated value.

2.1.3 Insulation Test Conditions

Insulation Testing involving external wiring/equipment should be carried out in wet/damp conditions wherever practical.

Record weather conditions at time of test and enter on test certificate.

2.1.4 Insulation Test: Circuits

When Insulation Testing circuits, it is desirable to test the complete circuit as a single test. Refer to Section 2.3.

In approved cases, Insulation Testing of circuit internal wiring may be done at the same time as the Bell Continuity Test, one wire at a time, using an approved combined Bell Continuity/Insulation Tester.

When performed in conjunction with Bell Continuity Tests, any insulation to earth defects in plug-in relays and some other equipment will not be detected as these are removed for the Bell Continuity Tests.

Similarly any insulation breakdown to the equipment case or to frame, but not earth, will not be detected.

This needs to be covered by other means, e.g. earth leakage detection tests on busbars during Circuit Function Tests, individual equipment insulation tests, equipment acceptance tests, or a later test of the complete circuit.

Testing of a complete circuit, with all other circuits connected and working, has the added advantage of possibly detecting an insulation breakdown directly between circuits and not via earth.

2.1.5 Lightning Protection Devices

Prior to testing, all lightning protection devices shall be removed or disconnected to avoid incorrect or misleading readings.

2.1.6 Removal of Solid State Devices

To avoid damage from the 500-volt output of the insulation resistance tester all solid state devices (electronic timers, flashing relays, rectifiers etc.), shall be disconnected or removed prior to testing.

2.1.7 Rotary Contacts

When testing circuits containing rotary contacts or other contacts with bridging segments, the test shall be made with the contact closed to ensure that the segment or bridging piece is in circuit. Faults have occurred where the screw holding the segment to a wooden contact roller has been short-circuited to frame.

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2.1.8 Equipment Case Earths

Point mechanisms and trainstops may be mounted on timbers and insulated from the rails and therefore isolated from earth. All circuits passing through the point machine shall therefore be tested to the case of the mechanism as well as to earth.

Circuits through signal mechanisms, releasing switches, rotary arm contacts etc. shall be similarly tested.

2.1.9 Transformers

When testing circuits containing transformers the primary and secondary wiring shall be individually insulation tested.

2.2 Insulation Testing of Cables

2.2.1 General

Cables are to be tested when terminated at both ends; it being of equal importance that the terminal is free of earth fault, as is the cable.

In a section of open aerial wires, the cable connecting the locations to the aerial at each end of the section, together with the aerials themselves may be treated as a continuous cable.

Similarly, a series of power cables connecting several successive locations may be switched (or linked) through in each location, and the continuity and insulation tests performed as if the cables were one. On new or altered work the polarity shall be proved separately at each location.

Minimum cable insulation values for new cables shall be 60 Megohm.km conductor to earth, 5 Megohm.km sheath to earth and 60 Megohm.km conductor to conductor.

Any failure to attain minimum values for new cables shall be regarded as a fault condition.

Insulation resistance values for cables have been specified at a temperature of 20 °C. The measured value of insulation resistance is temperature dependent. If the measured value is taken at a different temperature it shall be corrected to 20 °C. Temperature correction factors for common insulating materials are tabulated in Specification *SPG 1010 Cables for Railway Signalling Applications - General Requirements*.

The tests shall be carried out in the following order:

- a. Verify sheath arrestors correctly installed and remove prior to tests.
- b. Verify correct cable conductor size and cable insulation has been installed.
- c. Prove integrity of "Test Earth".
- d. Test continuity of each conductor being insulation tested.
- e. Test Insulation between each conductor and all other conductors in the cable and the cable sheath.
- f. Test Insulation between each conductor to earth.
- g. Test Insulation between sheath to earth.
- h. Check correct polarity of all power cable.

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2.2.2 Continuity Test Cable

Continuity shall be checked before Insulation Testing to ensure that the correct wire or cable is being tested, has been correctly terminated and to validate the results of the Insulation Tests, since, if the continuity is not complete, then the insulation tests results will not be correct.

When continuity tests are made on multi-core cables, ensure that each cable core is connected to the correct termination by connecting cable core No. 1 sequentially to every other cable conductor at one end and similarly the continuity tester at the other end.

A low voltage continuity tester is preferable to utilising the insulation resistance tester for continuity testing, as high resistances may not be detected by the insulation resistance tester.

All details of tests are to be noted on the appropriate cable insulation test sheets and signed by the person conducting the testing.

2.2.3 Conductor Insulation Testing

2.2.3.1 Single Series of Tests

With proper preparation, all insulation resistance measurements on a multi-core cable can be completed in a single series of tests:

- a. Ensure that the cable is terminated at both ends, on standard disconnect terminals, and that all links are open at both ends.
- b. Connect the earth terminal of the insulation resistance tester to a suitable Test Earth.
- c. At the end of the cable nearest the Test Earth, connect all conductor cores together on the cable side of the termination links with, for example, a 'daisy-chain' of 4mm plugs looped together.
- d. Prove the continuity of the daisy-chain by checking that each plug tests short-circuit to the No.1 plug.
- e. Alternatively the following tests may be carried out as individual tests for each conductor core, without linking the cores.

2.2.3.2 Individual Tests

2.2.3.2.1 Prove Integrity of Test Earth

Connect the insulation resistance tester, one leg to the test earth, the other leg to one conductor, or to the conductors linked together.

At the remote end of the cable, apply a second earth to the same conductor or conductors.

Prove the test earth by observing a low resistance whenever the remote earth is applied.

Remove the remote earth.

2.2.3.2.2 Insulation Test, Conductor to Earth

Measure the insulation resistance between all conductors linked together and the test earth. If the measured value is too low, test from each conductor individually to the test earth, to identify any faulty conductor or terminal. Record the value. This should be 100 Megohm or at least 60 Megohm.km for a cable longer than 500 metres.

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2.2.3.2.3 Insulation Test, Conductor to Sheath

Measure the insulation resistance between all conductors linked together and the metallic screen (sheath). If the measured value is too low, test from each conductor individually to the sheath, to identify any faulty conductor. Record the value. This should be 100 Megohm or at least 60 Megohm.km for a cable longer than 500 metres.

2.2.3.2.4 Insulation Test, Sheath to Earth

Measure the insulation resistance between the cable sheath and the test earth. Record the value. This should be greater than 10 Megohms, or at least 5 Megohm.km for a cable longer than 500 metres.

2.2.3.2.5 Insulation Test Between Conductors

Insulate each conductor in turn from the daisy chain, and measure the insulation resistance between it and all the other conductors linked together. Record the value obtained. This should be greater than 100 Megohm, or at least 60 Megohm.km for a cable longer than 500 metres.

2.3 Insulation Testing of Complete Circuits

When testing, it is desirable to test the complete circuit in a single test. As an example, the following procedure would be adopted:

- a. Test the insulation resistance tester - when the button is pushed (or the handle is turned on a manual tester) with both leads together a zero reading should be obtained. When the tester is operated with the leads separated an infinity reading should be obtained. Check the battery condition on electronic types.
- b. Connect one lead of the tester to a suitable known earth. The earth should be tested by connecting the other lead to another earth and operating the tester and obtaining a zero reading. The second earth could be obtained by using a screwdriver pushed into the ground.
- c. Carry out necessary Network Rules and Procedures and Signalling Safeworking Procedures before interfering with the signalling.
- d. Check that circuit is completely closed and that all parallel paths are closed.
- e. Remove the fuse and disconnect the negative/common from the bus bar.
- f. Test by immediately connecting the free lead of the tester to the active/positive end of the circuit, operating the tester and noting the reading.
- g. As a check to ensure that the circuit is still complete, tap the negative/common onto a suitable earth connection while operating the tester. A zero reading should be obtained.
- h. Insulation Test between the signal arm contacts and wiring and the signal arm case, between the relay wiring and the relay racks, between points wiring and the points mechanism case, between release switch wiring and the release switch case etc..
- i. If the test reading is below the minimum requirement, the circuit shall be broken up and each individual wire tested until the defect is located. To simplify the testing the circuit could first be broken up into internal and external components. When the defective part of the circuit has been found it is then only a matter of breaking up that part of the circuit.
- j. Similarly, if it is not practical to close the complete circuit for testing, then the circuit shall be wholly tested in separate parts.

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2.4 Testing Busbar Voltage Leak to Earth

A busbar voltage test to earth consists of measuring the voltage from each leg of a supply bus, individually, to earth. Comparison of the result obtained with the nominal bus voltage gives an indication of whether any leakage exists and on which leg of the bus (positive or negative, active or common) it is.

In each case, a significant reading obtained on one leg indicates an earth leakage fault on the opposite leg. The magnitude of the voltage reading, referred to the bus voltage, indicates the degree of the earth leakage fault.

The accuracy of the equivalent earth leakage indicated by the test for each leg of the supply busbar relies on the other leg being at a high resistance to earth.

The measurement shall be carried out with the earth test voltmeters built into normal relay room switchboards, or by using a type approved digital multimeter with a 100 k-ohm test shunt in parallel with its input terminals. These provide a suitable reference resistance against which any earth leakage is compared.

The use of a multimeter directly, without the 100 k-ohm test shunt, will lead to misleading results due to the extremely high input impedance of the Fluke meter.

The test is also misleading if both legs of the busbar have a lower resistance to earth than the meter resistance.

The test will only indicate a leak to earth in circuit wiring and equipment that, at the time of the test, is closed through to the busbar.

If there were no discrete earth leakage points, voltage leak to earth readings would depend on the amount and distribution of circuit wiring connected to each busbar, with alternating current circuits also reflecting capacitive coupling to earth.

Busbar voltage leak to earth tests are most useful where readings are taken and recorded regularly and any significant change investigated. Technical Maintenance Plans stipulate required testing frequencies.

2.5 Localisation of Earth Leakage Faults

When an earth leakage fault on a busbar is detected isolate the circuits on the bus in turn, until the fault clears, in order to find the faulty circuit. Then further isolate sections of the faulty circuit to find the faulty component.

This method is time consuming and involves serious disruptions to working circuits that are in perfectly good order.

An alternative method involves the use of an approved earth 'locater' (e.g. VIGIDI). This injects a low frequency signal between the faulty bus and earth without disruption of the working equipment. A current clip ring tuned to the injected frequency is then used to track the injected fault current from the bus to the earth fault point, without any circuit, even the faulty one, being disconnected.

2.5.1 Busbar Voltage Leak to Earth Measurements

Conversion of Measured Voltage to Equivalent Leakage Resistance Values Using multimeter with 100k-ohm shunt

LEAKAGE VOLTS		% LEAKAGE VOLTS	RESISTANCE (KOHM)
120V BUS	50V BUS		
0.12	0.05	0.1	19980
1.2	0.5	1	1980
2.4	1	2	980
3.6	1.5	3	647
6	2.5	5	380
12	5	10	180
24	10	20	80
42	17.5	35	37
60	25	50	20
72	30	60	13
84	35	70	8.6
96	40	80	5.0
108	45	90	2.2
118.8	49.5	99	0.23

Values Using 120 volt A.C Switchboard Meter (1k ohm per volts; meter resistance 130k-ohm)

LEAKAGE VOLTS		% LEAKAGE VOLTS	RESISTANCE (KOHM)
120V BUS	50V BUS		
0.12	-	0.1	130000
1.2	-	1	13000
2.4	-	2	6000
3.6	-	3	4000
6	-	5	2000
12	-	10	1170
24	-	2-	520
42	-	35	240
60	-	50	130
72	-	60	90
84	-	70	60
96	-	80	30
108	-	90	10

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**Values Using 50 volt D.C. Switchboard Meter
 (2k ohm per volt; meter resistance 140k ohm)**

LEAKAGE VOLTS		% LEAKAGE VOLTS	RESISTANCE (KOHM)
120V BUS	50V BUS		
-	0.05	0.1	140000
-	0.5	1	14000
-	1	2	7000
-	1.5	3	5000
-	2.5	5	3000
-	5	10	1260
-	10	20	560
-	17.5	35	260
-	25	50	140
-	30	60	90
-	35	70	60
-	40	80	40
-	45	90	20
-	47	94	9

2.6 Testing Earth Leakage Detectors

Earth Leakage Detectors are fitted with a push button to provide a test to earth connection.

To test the operation of the Earth Leakage Detector itself, a resistance of value equal to the sensitivity setting of the ELD can be temporarily connected between the supply busbar and the test earth, first one leg then the other. Refer to *SPG 0729 Signalling Power Systems* Section 13.3 for sensitivity settings.

2.7 Power Supply Isolation Test

Isolation between power supplies is checked by measuring for zero voltage between power supply busbars using a digital multimeter with a 100k ohm shunt. This is carried out separately for each busbar normal and emergency supply with the other busbars connected in each case alternatively to their normal supply and, where applicable, to their emergency supply.

With the power supply disconnected, the busbar isolation to earth is checked using an ohmmeter.

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3 Bell Continuity Test

3.1 General

A Bell Continuity Test is carried out on each installed wire from termination point to termination point in accordance with the circuit wiring diagram.

The Bell Continuity Test will not necessarily prove that the wiring takes the path shown nor prove the absence of any incorrect intermediate connections that might provide a false feed or bridge out a function, Therefore a Wire Count and a Null Count shall also be carried out to reveal any wiring anomalies. Otherwise hand tracing of each wire would be needed to verify internal wiring.

3.2 Bell Continuity Test Procedure

Before a Bell Continuity Test is conducted all wiring is to be terminated and all contacts, fuses, links, etc. are to be opened to ensure no alternative paths exist. All plug-in relay connectors are to be locked into their relay base positions.

In the case of shelf type relays that do not have detachable tops, removal of the relay is not practical and the Bell Continuity Test is carried out with the relays de-energised for front contacts and energised for back contacts to ensure that each end of the wire under test is open circuit.

The seals of shelf type relays shall not be broken nor the relay case opened.

With all fuses and links removed shelf relays will be de-energised. To energise a shelf relay for a Bell Continuity Test of wiring to a back contact of that relay a temporary false feed may be used directly across the relay coil terminals provided that the relay and all circuits through the relay are disconnected and booked out of use. Refer to Section 6.1.4 of this procedure "False Feeds". Alternatively the wire may be temporarily removed from the terminal but the disconnection test and reconnection of the wire shall be done as single uninterrupted activity.

The Bell Continuity Tester shall be a low voltage audible alarm that should sound when the Bell Continuity Tester leads are connected across a short circuit wire. The Bell Continuity Tester shall have its own independent power supply. A high resistance or open circuit between the terminated ends of the wire under test should prevent the alarm sounding.

The general procedure for Bell Continuity Testing is as follows.

- a. Place the Bell Continuity Tester leads onto the terminal studs of equipment or into the wire entry side of plug-in relay bases etc. thus enabling a Wire Count to be made at the same time as the Bell Continuity Test.
- b. Start at a logical point e.g., the fuse end of a circuit. Place the first lead of the Bell Continuity Tester at that terminal point. The second lead is to be placed on the terminal at the other end of the wire being tested. An output from the Bell Continuity Tester indicates wire continuity between the two terminals. Where the circuit extends with 2 wires on each termination point, the test may be conducted staying on the first single wire and moving one probe through the series chain to the single termination at the end.
- c. Proceed systematically, Bell Continuity Testing each individual wire through the circuit, including all parallel paths, until the entire circuit or part circuit has been tested, while also conducting a Wire Count on each individual terminal and contact point.

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- d. The method of indicating on the circuit wiring diagrams that the tests have been successfully carried out is shown in *PR S 47112 Inspection and Testing of Signalling: Plans, Programs, Documentation and Packages*.

3.3 Example of Bell Continuity Test

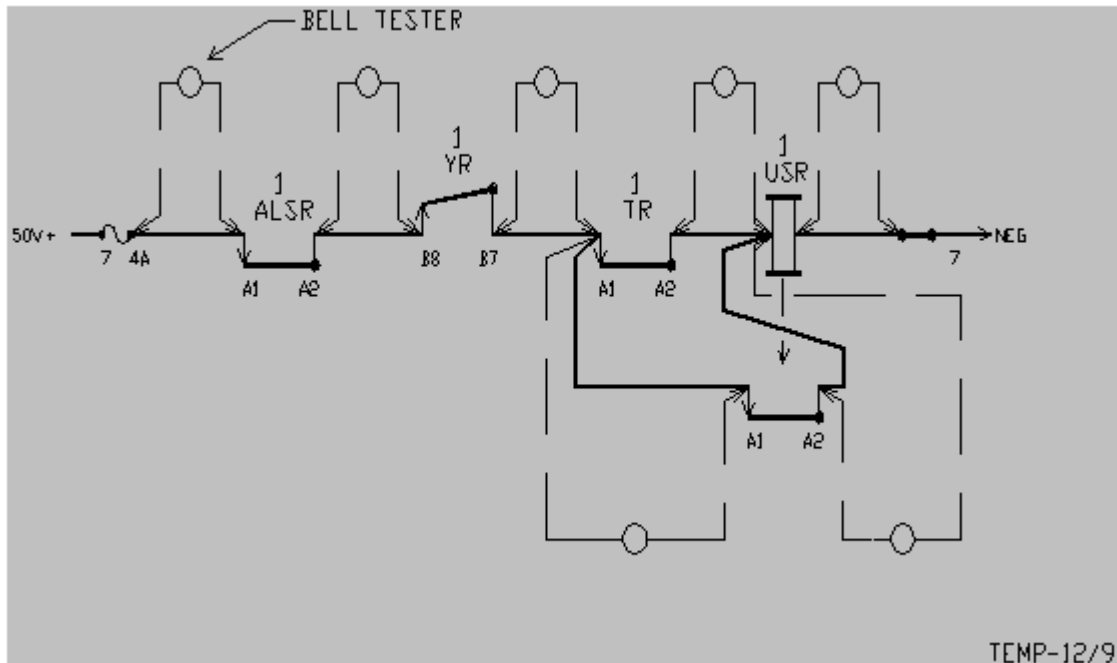


Figure 1

To Bell Continuity Test the example circuit above:

- Remove fuse and negative link pin.
- Remove all plug in relays.
- De-energise shelf relays to open front contacts, energise shelf relays to open back contacts.
- Place one leg of bell set on fuse terminal 7 and other leg on A1 of 1 ALSR. Bell sound indicates continuity of circuit.
- Proceed systematically through the circuit, Bell Continuity Testing each wire between its connection points, until the continuity of all wires is tested.
- Count wires on each individual terminal and contact point, as each wire is continuity tested.

Note:

In plug-in relay installations – bell testing shall be carried out from rear of the relay base.

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4 Wire Count and Null Count

- a. The Wire Count is generally carried out at the same time as the Bell Continuity Test by the same person who is inserting the lead of the Bell Continuity Tester. It may be carried out as a separate exercise.
- b. Examine the apparatus and the corresponding circuit wiring diagram and analysis sheets:
 - Verify the number of conductors terminated at a particular point is as shown on the circuit wiring diagrams.
There should normally be no more than two wires attached to any single termination point in the case of a plug-in relay and one wire in the case of a clamp type terminal. The Wire Count shall include verification of all conductors connecting to a terminal, whether wires, busbars, links or other strapping. Rail mounted fuses should be closely checked to verify the presence or absence of common connections:
 - i. Verify the wiring identification labels correctly identify the termination point of the wire.
 - ii. Check terminations and crimps are correctly made, wires are not trapped under adjacent terminals and spade type crimps are correctly locked into plug boards or terminal blocks.
 - iii. Prior to proceeding with the next test the person who is marking up the circuit books is to complete a documentation check to cross relate the circuit to the information contained in the documentation (contact analysis/fuse/terminal analysis etc.).
 - iv. Once it has been verified that the circuits and analysis documentation are correct and in agreement then testing may proceed.
 - v. The method of indicating on the wiring diagrams and analysis sheets that the tests have been successfully carried out is shown in *PR S 47112 Inspection and Testing of Signalling: Plans, Programs, Documentation and Packages*.

When internal parts of a circuit are tested separately from the external part of a circuit the wire count on both sides of the external cable termination link shall be performed by every person who tests the circuit either side of the cable termination link. That is, by the persons doing circuit testing of the internal wiring, by persons doing circuit testing of the external wiring, and by persons doing through circuit tests.

The wire count on both sides of the external cable termination link shall be recorded on the circuit diagram in the standard manner by the person conducting the circuit testing of the internal wiring and verified by the person conducting the through testing in accordance with Section 7.2.

The person responsible for testing the circuit shall check all wires in vital signalling circuits to be shown as wire counted on the testing copy of the circuit diagram.

When wire counting, all conductors connecting to a terminal shall be checked including bridging, busbars and links.

Wire Counts, Bell Continuity Tests and Insulation Tests shall include the external wiring run to signal head transformer terminals or lamp terminals, to point machine terminals, to trainstop terminals, to releasing switch terminals, to electric lock terminals, to level crossing mechanism terminals, to highway and boom lights terminals and to all operating mechanisms and contact terminals of operating mechanisms.

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Wire Counts, Bell Continuity Testing and Insulation Testing of the internal wiring within equipment mechanisms may be carried out in pre-site tests and factory acceptance tests. Certificates are required.

- c. The Null Count is carried out after the Bell Continuity Test and Wire Count has verified the wiring connecting to the respective terminals.
- d. The documentation to be used shall be the relevant completed analysis sheets that were checked/marked up from the documentation check.
- e. Examine relay bases, other operating equipment terminal assemblies and fuse and terminal racks, and the corresponding analysis sheets:
 - i. Verify that there is no conductor connecting to terminals shown as spare in the contact/fuse/terminal analysis sheets in the circuit book.
 - ii. Verify that there are no contacts/fuses/terminals shown in use in the circuit book analysis sheets that are spare and without connected wires.
 - iii. On the analysis sheets mark the spare contact, fuse or terminal with a tick to indicate the test is successfully completed.

In conjunction with the Bell Continuity Test and the Wire Count, the Null Count, if carried out over the whole installation, provides assurance that there are no 'rogue' connections in the circuits. Null Counts on portion of the equipment in a circuit control area will provide less assurance.

5 Circuit Function Test

5.1 General

The Circuit Function Test is supplementary to the Bell Test and Wire Count and is performed to verify that the fuses, links and controlling devices are effective in controlling the circuit function.

Circuit Function Tests involve energisation of the circuit then energising or de-energising (or removing and replacing) in turn each control device and observing the de-energisation of the circuit function. Specific control contacts are not individually proved.

The fuses and links are also disconnected and reconnected and the circuit function observed.

Part circuits in separate locations can be separately function tested using a voltmeter and a Through Circuit Function Test performed when the parts are interconnected over external cables.

With parallel paths, there can be several combinations of the minimum number of contact closures needed to close the circuit, as well as several combinations of the minimum number of contact openings needed to open the circuit. Rather than test every such combination it is sufficient, in conjunction with a Wire Count, to function test the controls in each and every series path with all other parallel paths open.

The Circuit Function Test will not, in itself, prove that a specific contact is actually in the circuit, particularly if the controlling device has a second contact in another position in the circuit (double switching) or if the controlling device also switches another device that opens the circuit function under test. A Bell Continuity Test and a Wire Count are therefore also necessary to prove compliance with the circuit wiring diagrams.

Even so, these tests will not necessarily prove that the control device contacts are the correct type (back, front, normal, reverse etc.) and will not necessarily prove that they are not shorted out or qualified irregularly.

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This additional verification shall be achieved by separately testing that the specific control contacts are electrically opened and closed by operation of the control device and by inspection that they are the correct types, e.g. plug-in relays tested in a relay test panel and checked against the contact analysis sheets. This is called a Contact Proving Test.

Instead of a Circuit Function Test and separate Contact Proving Test, a Circuit Strap and Function Test can be used to prove that the specific contacts of control devices are effective in controlling the circuit function in accordance with the circuit wiring diagram.

Circuit Function Tests, inclusive of Circuit Strap and Function tests, will not prove that series contacts are wired in the correct sequence or the correct way around (point-armature). The Bell Continuity Test is necessary for this.

The Circuit Function Test Procedure is the same as for the Circuit Strap and Function Test, except that the specific control contacts are not proved by strapping or manual disconnection.

5.2 Circuit Function Test Procedure

- a. Connect a voltmeter across the end function, or the terminals of any outgoing "part circuit".
- b. Test with other circuits energised to provide a high probability of detecting the presence of any false voltages in the circuit under test.
- c. Apply voltage to the ends of the circuit either by inserting the relevant fuses and links or by applying a fused false feed of the correct voltage to the terminals of an incoming "part circuit". The person conducting and certifying the tests shall keep records of any such false feed applied.

Note:

If part of a circuit that does not include the circuit function, is being Circuit Function Test then a through circuit test is also required to prove that 'part circuit' is in the circuit of the function concerned.

- d. Make the circuit operative by energising or de-energising relevant relays and other control devices to close the complete circuit over the specific contacts involved. This may involve temporary false feeds to the control relays and these shall be recorded and strictly controlled.
- e. Open and close in turn each fuse, link and control contact verifying the operation of the circuit under test by observation of the voltmeter and except for outgoing part circuits, the end function.

De-energise (or energise for back contacts) the respective controlling device to open the control contact and check that the end function de-energises and the voltmeter reading drops to zero.
- f. Where controls are wired in parallel, each and every series path through the complete circuit shall be selected in turn and the contacts in that path tested with all alternative paths broken. In each case the controlling contact, fuse or link on either side of the parallel path shall be broken and proved. Parallel paths may emanate from fuses, links or looping.

The texts of Section 6.1.3 and Section 6.1.4 also apply to Circuit Function Tests.

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6 Circuit Strap and Function Test

The Circuit Strap and Function Test is the same as the Circuit Function Test except that it is extended to individually prove the specific contact of the control device is effective in the circuit.

The strap and function test of a circuit assumes that the contacts and terminals shown are the only ones in the circuit; it verifies the wiring arrangements of these contacts by:

- a. Closing each full series path in turn through the circuit with all other contacts open, to energise the function proving that none of the open contacts are in that series path.
- b. Opening each contact in turn in the series path to de-energise the function proving that the contact being opened is in the circuit and not in parallel with any other closed contact in that series path.

If each and every other contact in the location were open during the Circuit Strap and Function Test of a circuit, or part of a circuit, then the tests would also verify that no other contacts were in series within the circuit path being tested.

If each and every other contact in the location were closed during the Circuit Strap and Function Test of a circuit, or part of a circuit, then the tests would also verify that no other contacts were in parallel with any contacts within the circuit path being tested.

The procedure sets out the preferred method of opening and closing each specific control contact during Circuit Strap and Function testing to the circuit wiring diagrams.

Where earth leakage detectors are available connect a temporary audible alarm for the duration of the tests.

6.1 Circuit Strap and Function Test Procedure

6.1.1 Procedure

- a. Carry out Network Rules and Procedures and Signalling Safeworking Procedures and ensure that any and all trackside apparatus affected by the tests are disconnected and booked out of use.
- b. Connect a voltmeter across the end function, or the terminals of any outgoing "part circuit".
- c. Test with other circuits energised to provide a high probability of detecting the presence of any false voltages in the circuit under test.
- d. Apply voltage to the ends of the circuit either by inserting the relevant fuses and links or by applying a fused false feed of the correct voltage to the terminals of an incoming "part circuit". Records of any such false feed applied shall be kept by the person conducting and certifying the tests.

Note:

If part of a circuit, that does not include the circuit function, is being Circuit Strap and Function Tested then a Through Circuit Test is also required to prove that 'part circuit' is in the circuit of the function concerned.

- e. Make the circuit operative by energising or de-energising relevant relays and other control devices to close the complete circuit over the specific contacts involved. This may involve temporary false feeds to control relays and these shall be recorded and strictly controlled.

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- f. Open and close in turn each fuse, link and control contact verifying the operation of the circuit under test by observation of the voltmeter and, except for outgoing part circuits, the end function.

De-energise (or energise for back contacts) the respective controlling device to open the control contact and check that the end function de-energises and the voltmeter reading drops to zero.

Bridge the specific control contact with a test strap to test the presence of that specific contact in the circuit by observing the end function re-energise and the voltmeter reading register the correct voltage.

Note:

If conducting a strap and function test on plug-in relays with the relay removed (i.e. bridging from the front of the relay base) then a contract proving test of the removed relay will also be required. Refer to Section 6.1.6.

- g. Where controls are wired in parallel, each and every series path through the complete circuit shall be selected in turn and the contacts in that path tested with all alternative paths broken. In each case the controlling contact, fuse or link in series on each side of the parallel path shall be broken and proved.

Parallel paths may emanate from fuses, links or looping.

6.1.2 Manually Opening Contacts

The seals of relays shall not be broken on site nor shall contact fingers be broken by inserting an insulation piece e.g. strip of paper or cardboard or a person's finger, within the relay case.

In the case of accessible individual contacts (e.g. rotary contacts, etc.) the tests may be done by manually breaking the specific contact (e.g. separating the contact finger from the band) during the Circuit Strap and Function Test.

Care shall be taken to ensure that this action does not damage, introduce dirt or grease, or upset the adjustment of the contact.

If this method of opening the contact is used it shall also be proved that the control device when operated will electrically open and close the specific contact.

6.1.3 Disconnection of Wires

After certification Bell Continuity Tests and Wire Counts, wires shall not be removed from contact terminals for function testing except as absolutely necessary.

In such a case the removal, test and reconnection shall be done one terminal at a time by the person conducting and certifying the tests.

Wires shall be correctly labelled with the terminal number etc. before removal.

6.1.4 False Feeds

Where temporary false feeds have been applied to carry out this testing they shall be removed at the conclusion of the test and signed for on the record of false feeds applied by the person conducting and certifying the tests. Temporary wiring shall be distinctively coloured and labelled. Only registered test straps are permitted on site.

When testing near working circuits, strict care shall be taken to ensure that any false feed cannot accidentally be applied to affect the working circuits.

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Where practical and relevant, additional security can be obtained using a false feed isolated from any signalling supply in use through a separate transformer or transformer rectifier unit.

6.1.5 Test Straps

- Shall be no less than 450mm long.
- Shall have brightly coloured insulation, preferably orange.
- Shall be numbered in sets.
- Shall be kept in a locked box. The person conducting and certifying the tests shall ensure the safe custody of this box.
- Shall be counted and recorded before the start and at the end of each days testing work to ensure that no straps have been inadvertently left in position.

6.1.6 Plug-in Relays

With plug-in relays, if the relays are removed and straps placed in the relay base from the front to bridge the control contact terminals, the circuit can be closed to energise the end function.

If the straps are opened and closed in turn to correspondingly open and close the circuit function then the contact terminals can be proved to be in circuit. (Proof of the contact terminals would have been covered by the Bell Continuity Test.)

This test, with straps in the front of the relay base, is **NOT** a proper Circuit Strap and Function Test as the contact type (back or front) is not proved and it will not detect any internally missing, wrong or short-circuited contact.

The plug-in relay shall therefore also be tested in a relay test panel (or similar device) to prove that it electrically operates the contacts and that the specific contact concerned is the right type. (Contact Proving Test)

Contact Proving Tests of plug-in relays also involve an inspection of the relay for any signs of damage, foreign matter or defective operation. A signed and dated sticker affixed to the relay case shall signify that the relay has been proved in the relay test panel.

6.2 Example of Circuit Strap and Function Testing

Referring to the worked examples at the end of this section, the circuits have three logic paths and would be Circuit Strap and Function Tested in the following manner. A wire count shall also be done:

- a. Carry out the necessary Network Rules and Procedures and *MN S 40000 Signalling Safeworking Procedures*.
- b. Ensure that the Approach Stick relay and all relays in the circuit are energised (except 71u CONTROL) and that 71 and 84 signals are at stop so that all contacts and links in all paths of the circuit are closed.
- c. Use a voltmeter to observe the correct operating voltage across the Approach Stick relay when energised and zero voltage when de-energised.
- d. Remove and replace No.7 fuse three times noting the Approach Stick relay energise and de-energise accordingly. Check that it is the correct busbar supply.
- e. Disconnect and reconnect No.7 common wire at the busbar three times noting the Approach Stick relay energises and de-energises accordingly. Check that it is the correct busbar supply.

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All Paths Closed

- a. Open and close No.2 contact on 84U banner signal three times noting the Approach Stick relay de-energise and energise accordingly. If it is not possible to open No.2 contact only on 84U signal, open all contacts and use a bridge to strap No.2 contact.
- b. Open and close link terminal LC1 three times noting the Approach Stick relay energise and de-energise accordingly.
- c. Energise 71U Control relay and bridge No.2 back contact three times noting the Approach Stick relay energises and de-energises accordingly. De-energise 71U control relay.

Path 1 Closed

- a. De-energise 54 and 55 Normal Detector relays and open the stick finger contact (No.1) of the Approach Stick relay by disconnecting the wire on the point or armature terminal. Path No.1 is now closed and all other contacts in paths No.2 and No.3 are fully opened.
- b. De-energise M11.65A INDG relay and bridge No. 10 contact three times noting the approach stick relay energise and de-energise accordingly. Re-energise M11.65A INDG relay.
- c. Follow the same procedure in turn for the following contacts in path No.1, S11.70A INDG (No.7), S11.65A INDG (No.4) and S11.65B INDG (No.4).

Path 2 Closed

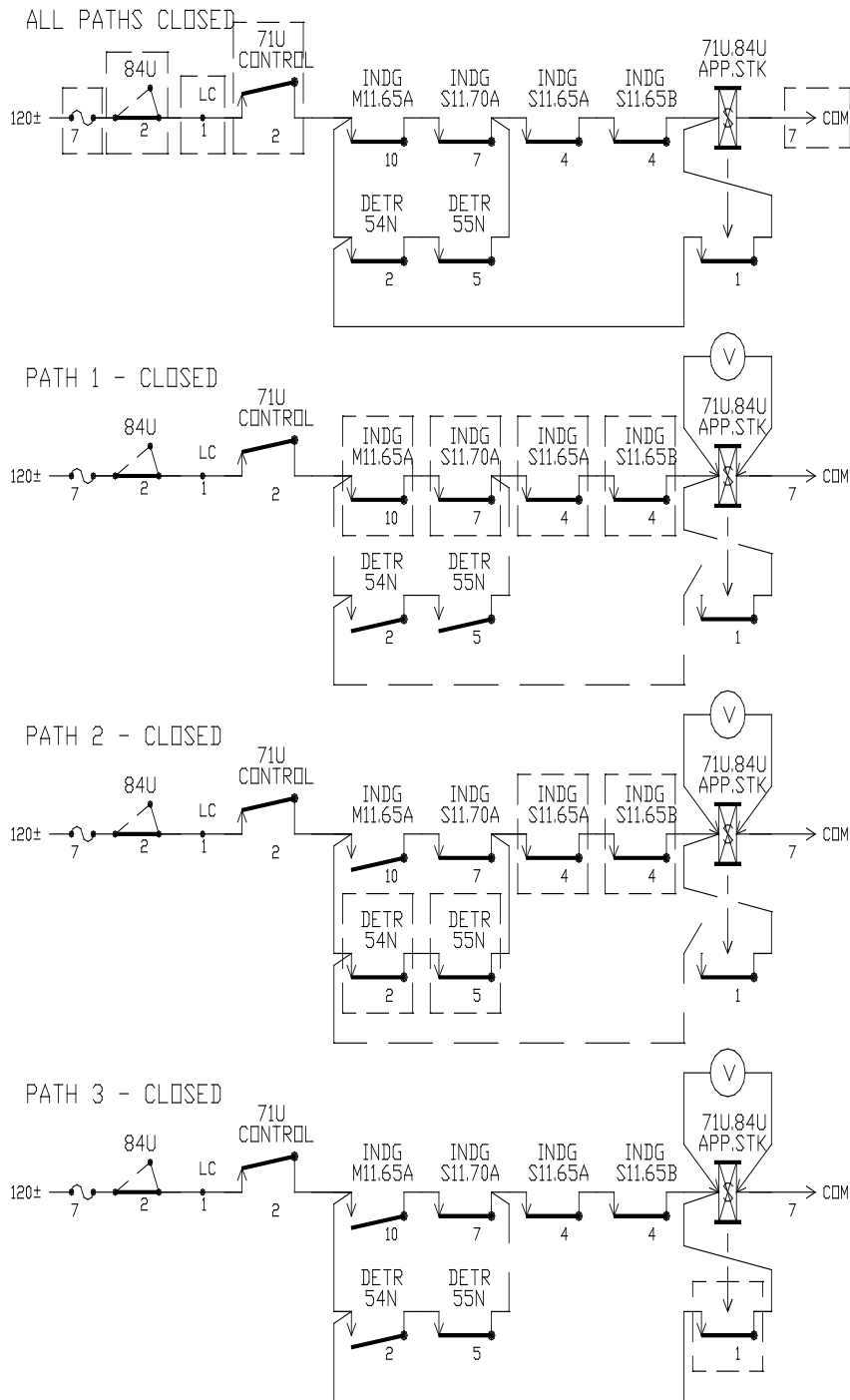
- a. De-energise M11.65A INDG relay, leave the Approach Stick finger opened. Energise 55 Normal Detector relay leaving 54 Normal Detector relay de-energised.
- b. Test path No.2 by bridging No.2 contact on 54 Normal Detector relay three times noting the approach stick relay energise and de-energise accordingly. Re-energise 54 Normal Detector relay.
- c. Follow the same procedure in turn for the following contacts in path No.2, 55 Normal Detector (No.5), S11.65A INDG (No.4), S11.65B INDG (No.4).

Path 3 Closed

- a. De-energise 54 Normal Detector relay, leave M11.65A INDG relay also de-energised to open paths No.1 and No.2. In path No.3 reconnect the wire that had been disconnected from No.1 stick finger contact of the Approach Stick relay.
- b. Test path No.3 by bridging across No.1 stick finger contact noting the Approach Stick relay energise. Remove and replace the fuse to de-energise the Approach Stick relay and repeat test.
- c. Energise M11.65A INDG relay and 54 Normal Detector relay.

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TESTING PROCEDURE EXAMPLE CIRCUIT STRAP AND FUNCTION TEST

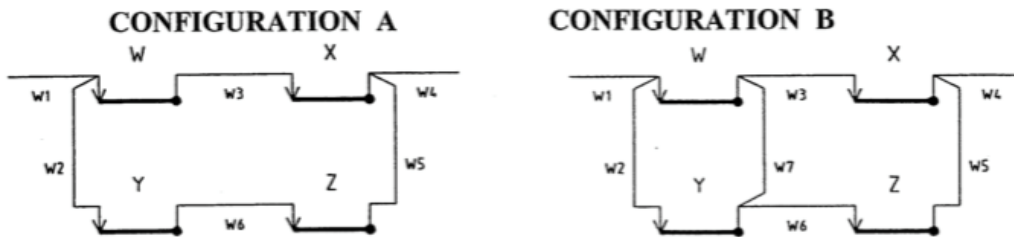


NOTE: IN THIS EXAMPLE, AS CONTACTS 84U (2) AND 71U CONTROL (2) ARE STRAP AND FUNCTION TESTED WITH ALL OTHER CONTACTS CLOSED, IT IS NOT NECESSARY TO RETEST THEM WHEN PATHS 1, 2 AND 3 ARE INDIVIDUALLY STRAP AND FUNCTION TESTED; IN MOST CASES IT IS DIFFICULT TO ENSURE ALL THE OTHER CIRCUIT CONTACTS ARE CLOSED AND THE MORE COMMON APPROACH IS TO REPEAT THE STRAP AND FUNCTION TEST OF 84U (2) AND 71U CONTROL (2) IN EACH SERIES PATH.

Figure 2

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CIRCUIT STRAP & FUNCTION TESTING



TEST	W	X	Y	Z	OUTPUT
1	OPEN	CLOSED	OPEN	CLOSED	A&B OPEN
2	CLOSED	OPEN	CLOSED	OPEN	A&B OPEN
3	OPEN	CLOSED	CLOSED	OPEN	A OPEN / B CLOSED
4	CLOSED	OPEN	OPEN	CLOSED	A OPEN / B CLOSED
5	CLOSED	CLOSED	OPEN	OPEN	A&B CLOSED
6	OPEN	OPEN	CLOSED	CLOSED	A&B CLOSED

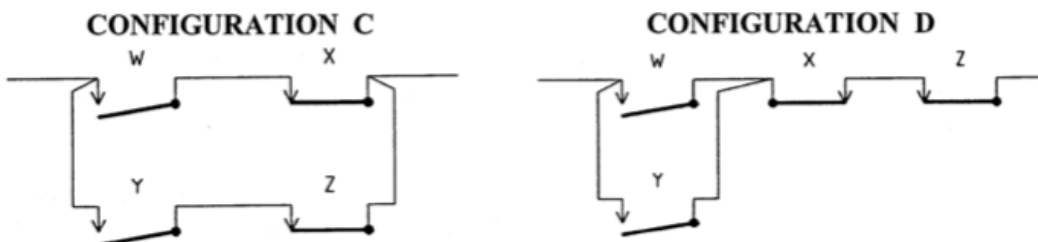
Circuit strap and function tests 1 to 6 prove the contact switching in Configurations A and B.

A wire count and null count in conjunction with the six tests will prove the physical circuit wiring.

Tests 3 and 4 are necessary to prove the presence of wire W7 in Configuration B and the absence of wire W7 in Configuration A (or the absence of an equivalent leakage path).

Tests 5 and 6 with the parallel path open at all contacts, are necessary in conjunction with tests 1,2,3 and 4 otherwise a continuity test is also needed for certification to the wiring diagram.

For example consider the following where tests 5 and 6 are not carried out.



In Configuration C if X is closed and W only is opened to break the top path while circuit testing the bottom path Y - Z, and if Z is closed and Y only is opened to break the bottom path while circuit testing the top path W - X, then, even with a wire count, these tests would not discriminate between Configurations C and D. A bell continuity test is also necessary.

Figure 3

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CIRCUIT STRAP AND FUNCTION TEST

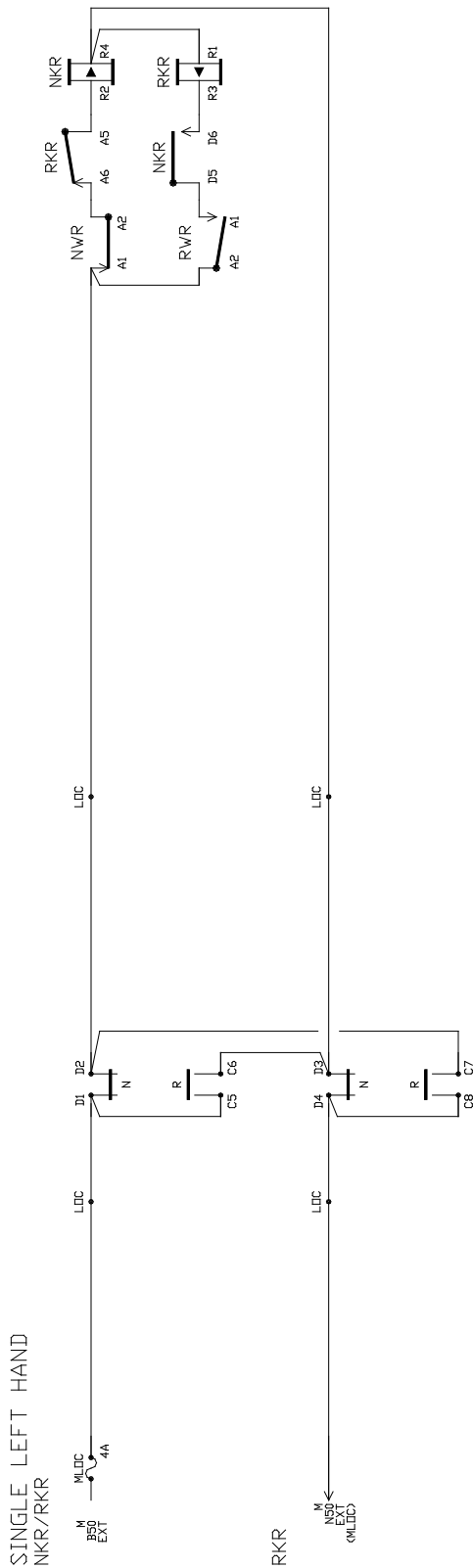


Figure 4

The following illustrates the necessity to function test actual contacts.

The detector relays in the above circuit are de-energised under normal operation when the respective contactor de-energises.

Under the normal sequence of operation, it is therefore not possible to verify that, for example, the NKR relay drop proving contact D6-D5 is not shorted out internally in the relay.

Similarly, under the normal sequence of operation it is also not possible to verify that, for example, one (or both) of the point normal contacts D1-D2 (and/or D3-D4) is not shorted out internally and thus ineffective in open circuiting the NKR relay even if the points do not properly close against the stackrail.

If the NKR relay is removed for circuit testing and the terminals D6-D5 bridged with a strap to close then open the circuit, a defective internal short or weld of the contact would not be revealed.

Similarly, if the points detector contacts were not in place for the circuit testing and the contact terminals bridged with a strap to close then open the circuit, a defective internal short or weld of the contact would not be revealed.

A proper Circuit Strap and Function Test is necessary to reveal the internal contact defects or otherwise a separate Contact Proving test is necessary to supplement the circuit function test.

7 Through Function Tests

7.1 General

Through Function Tests are carried out to prove correct correspondence where circuits extend between locations.

The Through Circuit Function Test is carried out on circuits that operate between locations to prove:

- a. The end function operates as intended through the complete circuit when the correct voltage of the correct polarity is applied to the ends of the circuit.
- b. The circuit internal wiring has been correctly connected to the respective external cables where both have been separately continuity tested, wire counted and insulation tested.
- c. De-energisation of and zero residual voltage across the circuit function when the circuit is opened in turn at the fuse, each link and at each intermediate relay. The test is performed with as many other circuits energised as practical to provide a high probability of detecting the presence of any false voltages in the circuit.
- d. All repeat, indicating and intermediate relays correspond and operate correctly.
- e. Diagram indicators, repeaters and detectors respond correctly.

Through System Function Tests are also carried out to prove correspondence from the operator's control to operation of the trackside apparatus and from the operation of the trackside apparatus back to the operator's indicator panel.

7.2 Through Circuit Function Test Procedure

After circuits internal to locations and the external interconnecting cables have been separately tested, a through test shall be carried out on complete circuits, i.e. circuits that operate between separate locations.

Where earth leakage detectors are available, temporarily connect an audible alarm for the duration of the tests.

This test shall operate and verify the equipment and complete circuit from end to end in a functional manner and shall be carried out for both control and indication circuits as follows:

- a. Energise the circuit to pick up the final control relay and any intermediate relays.
- b. At all the locations involved, disconnect and replace in turn the feed fuse and every link in the circuit, including at the power supply busbar, observing that all relays in the circuit and all indications respond in each case by correctly changing status.
- c. Verify the Wire Count at the fuse and on each side of disconnection links and record on the circuit diagrams.
- d. For polarised circuits the test shall be carried out for each polarity.
- e. Place a voltmeter across the relay coils and observe correct working voltages. Investigate any non-zero voltage when the circuit is opened.
- f. Where circuits cascade the intermediate relay circuits shall also be similarly tested, the final relay under test being observed to respond.
- g. For telemetry systems, prove that each output corresponds with its relevant input.

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- h. Where possible and relevant, carry out tests for each through circuit as a single operation from the point of control to the point of operation and from the point of operation to the point of indication.
- i. The method of indicating on the circuit diagrams that the through circuit test has been successfully completed at each fuse and disconnection link is shown in *PR S 47112 Inspection and Testing of Signalling: Plans, Programs, Documentation and Packages*.

7.3 Through System Function Test

A Through System Function Test shall ensure that when there is a control operated at the control centre it is correctly relayed throughout the system and operates the trackside apparatus, and when there is an indication from the trackside apparatus that it is correctly relayed throughout the system to the control centre. Each relay in the chain and each indication shall be observed to change status in correct correspondence.

Each relay in a chain shall be removed and replaced and the affected relays and indications observed to correctly change status from energised to de-energised to energised.

7.3.1 Axle Counter Track Section Reset

The following Through System Function Tests shall be conducted to prove the operation of the axle counter reset functionality:

- Unconditional Reset Test
Test that unconditional resets via the Technicians terminal or trackside reset facility are only:
 - **enabled** if the Unconditional Reset Enable (URE) is applied on the TMS
and
 - the unconditional reset is achieved for only the intended track section.
- Preparatory Reset Test
Test that preparatory resets via the TMS or the axle counter is:
 - **enabled** for only the intended track section
and
 - successfully reset after the required conditions are met.

8 Points Correspondence Test (incl. Out of Correspondence Test)

- a. It is important that proper planning is carried out before proceeding with the correspondence/out of correspondence test to check that all paths in the detector circuit are tested to ensure any error in the point mechanism and detector, caused by incorrect design or installation is identified by the test.
- b. Ensure all Network Rules and Procedures and Signalling Safeworking precautions have been carried out then close all out going terminals to the point mechanisms, check to see that the relevant fuses are inserted, the points isolation switch is turned on, the machines are operable and all ends of the points are unclipped.
- c. After ascertaining that no personnel are working on any of the points mechanisms or sets of points, check the points detector indicator lights show either normal or reverse and place the controlling lever/key for the points to the detected position.

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- d. Change the position of the points (assuming the points are lying in the normal position) to reverse and back to normal again three times. Pause each time to check that the points are detected in their new position before operating the control lever/key again.
- e. Ask the field Team Leader to describe, geographically which set of points they are standing at and what identification number is marked on the sleepers adjacent to the points mechanism. Then ask the field Team Leader what the lie of the points is by describing which switch is closed and which switch is open standing at the toe of the points looking towards the heel. Check this information by reference to the Track/Signalling Plan and the points detector indicator.
- f. Taking each mechanism in turn, first open circuit each detector contact in turn three times for each position (Normal and Reverse) of the points and check that the respective points detector indicator reflects these actions. With sealed contacts, ensure the respective points detector indicator energises and de-energises whenever each sealed contact device in circuit changes state (i.e. Circuit Function Test).
- g. Prove that the (lock) indication contacts on Nippon machines inhibit the points detection by hand winding the lock to the disengaged position without moving the points. It will be necessary to temporarily bridge the ESML contacts with a strap while this test is carried out.
- h. For conventional EP points prove that the indication box contacts and plunger lock contacts inhibit detection by open circuiting each indication box and plunger lock contact, in turn, for each position of the points.
- i. Prove that the ESML contacts inhibit the points detection and the points power operation for each position of the points when the ESML handle is removed from its box. Check that the crank handle fits into each of the mechanisms so that it relates and that it open circuits the safety cut out switch to disconnect the motor.
- j. Prove that removal of each of the isolating relays inhibits the points detection and the points power operation for each position of the points.
- k. Operate each end of the points onto an obstruction placed between the open switch and stock rail to check the operation and time of the points timer to cut off each mechanism.
- l. On double or multiple ended sets of points an out of correspondence test shall be included. Inhibit one end of the set of points from operating and check that detection is not obtained.
- m. For the purpose of an out of correspondence test, points shall be inhibited by means of electrical or pneumatic isolation that prevent its operation. Examples of isolation are as follows:
 - i. Electric points – removal of the relevant motor operating fuse or link/terminal pin in either the active or common leg of the motor operating circuit or operate the point hand crank cut-out.
 - ii. EP points controlled from A or T unit – turn off motor air slide valve in the A or T unit for the opposite position to what they are in.

Note:

Both wires on the switched side of the A or T unit pressure switch (usually terminals B5-B6 and B7-B8), shall be temporarily bridged in accordance with PR S 40002 for the purpose of out of correspondence testing, to ensure any existing error in the point mechanism and detector circuit is identified during the test which the pressure switch may mask. Refer to Figure 5 for example.

- iii. EP points controlled from C, D, E, ES, S, or N unit - electrically isolate the solenoid valve for the opposite position to what they are in.

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- n. Where an out of correspondence test is being performed, the test shall be carried out for each and every possible combination of normal and reverse. Refer to Table 1 and Table 2.
- o. **Exception 1:** On CBI installations where separate inputs for each end of points detection are used, then the "field" requirement of an out of correspondence test may be omitted (out of correspondence testing shall still be considered during the data-design testing phase).

Exception 2 At combined point ends where all the switches are mechanically connected together by stretcher rods ensuring all the switches operate in unison and where they are driven by the same motor, then these can be treated as a single end for the purpose of Out of Correspondence Testing. For example: a compound point arrangement - where the A/B end is mechanically connected and operated by the same motor.
- p. The successful completion of each of the tests shall be recorded and signed for in a Work Instruction or Design Integrity Test Plan by the Team Leader who conducts the test.

The following combination applies for two point ends (new installations):

Lever Position	"A" end	"B" end	
N	N	N	Correspondence test
N	R	N	Out of Correspondence test
N	N	R	Out of Correspondence test
N	R	R	Out of Correspondence test
R	R	R	Correspondence test
R	N	R	Out of Correspondence test
R	R	N	Out of Correspondence test
R	N	N	Out of Correspondence test

Table 1

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The following combination applies for three point ends:

Lever Position	“A” end	“B” end	“C” end	
N	N	N	N	Correspondence test
N	R	N	N	Out of Correspondence test
N	N	R	N	Out of Correspondence test
N	N	N	R	Out of Correspondence test
N	R	R	N	Out of Correspondence test
N	R	N	R	Out of Correspondence test
N	N	R	R	Out of Correspondence test
N	R	R	R	Out of Correspondence test
R	R	R	R	Correspondence test
R	N	R	R	Out of Correspondence test
R	R	N	R	Out of Correspondence test
R	R	R	N	Out of Correspondence test
R	N	N	R	Out of Correspondence test
R	N	R	N	Out of Correspondence test
R	R	N	N	Out of Correspondence test
R	N	N	N	Out of Correspondence test

Table 2

An example of applying temporary bridging to pressure switches for the purpose of Out of Correspondence Testing.

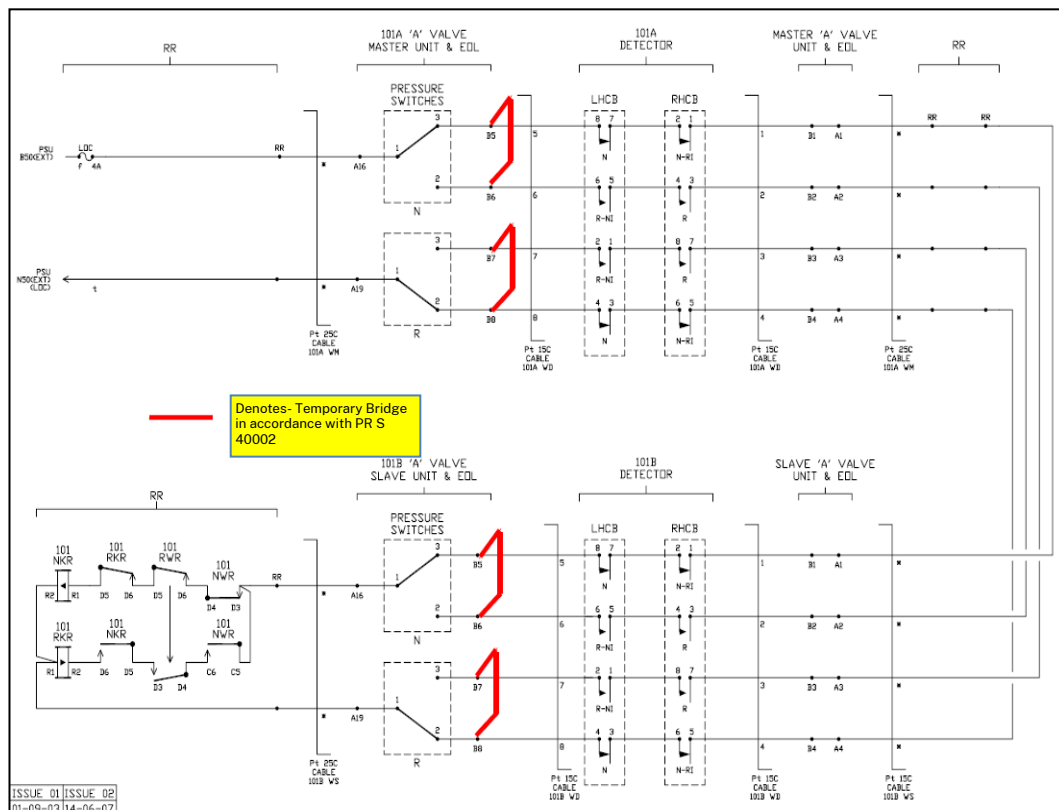


Figure 5

9 Aspect Sequence Test

9.1 General

Aspect Sequence Testing shall check that signal lamps and signal repeaters at control stations, assume the correct colours for various operational sequences and failure conditions.

The Aspect Sequence Testing shall be performed in accordance with Track Plans that provide details of potential routes through the area of track under test, and with any special Aspect Sequence Charts drawn up specifically for the purpose of carrying out this test.

The Engineer conducting the testing shall locate observers at signal locations and a competent officer at the operation control. The Testing engineer shall direct the Aspect test by Radio etc., by having the control centre officer set specified routes and by having the signal observers report the colour aspect of relevant signal lamps. The Test Engineer shall judge the correctness of the responses by reference to the Track Plans and Aspect Sequence Charts.

Lamp Failure conditions shall be simulated.

The Testing engineer shall maintain tight control of the communications and ensure that there is no confusion caused by other radios.

The communications shall also be conducted in accordance with pre-established Question and Answer formats. Noise and talk within the test control centre shall be kept to a minimum while the tests are in progress and the aspect reports in the centre should be on a separate loud speaker.

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9.2 Aspect Sequence Test Procedure

The Aspect Sequence Test is carried out from the control console/signal box by the Testing Engineer whilst the field test team observe the aspects/indications exhibited to the driver. During the Aspect Sequence Test the diagram signal repeater shall also be observed for correct indications.

The field test team shall be positioned so that each signal in the full Aspect Sequence can be observed and reported back to the control console/signal box for each test in the sequence.

The method of reporting aspects from the field shall be in a vertical manner from the top aspect downwards, e.g.:

- "Signal Number, Red over Red over small Green with train stop up", in the case of a double light type of signal.
- or
- "Signal Number, Red over Red marker over small Green with train stop up", in the case of a single light signal.

The Test Engineer shall repeat the signal indication report back to the field and obtain acknowledgment prior to marking the test form.

The use of the words Stop, Caution, Clear, etc. is not permissible.

The reporting of stencil type route indicators shall also include the positional relationship of the indication to the signal.

The reporting of position light and dwarf colour light type of shunting signals shall include the positional relationship of the indications.

The description of turn out indicators in single light indication areas shall include the number of lamps alight and the direction of inclination.

For each route under test, the exit signal shall be cleared to each possible aspect for all routes. The entrance and exit signals and any repeater or co-acting signals shall be continually observed to ensure that only the correct Aspect Sequence is displayed.

Where the entrance signal is located at a junction all exit signals shall be cleared to each possible aspect from which a sequence can be derived.

In single light areas remove the illuminated yellow or green lamp of the signal under test and check that the signal in rear can show no higher aspect than yellow. Check that the lamp proving circuits function correctly and lamp failure is given at the indicator device.

By using a test lamp (i.e. one that has had the main filament deactivated) observe that the changeover relay in the signal head operates correctly and that a filament fail indication is given at the control point.

Test the operation of the train stop proving relay (VCSR) and its control of the signal in rear. Firstly clear the signal and the signal in the rear, shunt the track circuit or occupy the axle counter 'A' track to place the signals to stop but prevent the trainstop arm returning full normal. Remove the shunt or the occupation from the 'A' track and then place a shunt on the track circuit or occupy the axle counter 'B' track and observe signal in rear held at stop until the obstruction is removed and the trainstop arm goes to the full normal position. This test is facilitated by use of a locomotive for Aspect Sequence Testing.

Place the signal at stop and obstruct trainstop arm from normal position and verify that the signal repeater does not indicate normal until the obstruction is removed.

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Similarly operate the signal but prevent the trainstop arm from attaining the reverse position and verify that the diagram signal repeater does not indicate clear until the trainstop obstruction is removed.

Check that at night there are no confusing reflections of signals off structures, e.g. stainless steel cases.

Tests are to be made to prove correct operation of associated equipment e.g. Guard's Indicators, Warning Lights.

In automatic signal sections the Aspect Sequence Test is to include the verification that each track circuit or axle counter track section up to the clearance point replaces the signal to its most restrictive aspect when occupied. With the signal at clear each track circuit shall be shunted then cleared or each axle counter track section shall be occupied then reset. The automatic signal shall be observed to change from green to red to green aspects accordingly.

The successful completion of each of the tests shall be recorded and signed for as nominated in Procedure *PR S 47112 Inspection and Testing of Signalling: Plans, Programs, Documentation and Packages*.

10 Mechanical Interlocking Test

On each occasion that work is carried out on interlocking frames a Mechanical Interlocking Test shall be carried out on all interlocking associated with locking that has been disturbed in addition to testing the alterations.

The Mechanical Interlocking Tests shall ensure that all interlocking between conflicting signals, points, etc. is in accordance with the Locking Tables and Locking Diagrams, and shall encompass procedures that test the relevant locks, releases, conditions and their respective converses.

On new works and major alterations the testing of mechanical interlocking frames should be carried out as a Design Integrity Test working from the track layout plan with an assistant marking off the tests on the Locking Table. Test Engineers shall be suitably licensed by being in possession of the appropriate Interlocking Certificate issued by the Professional Head Signalling and Control Systems.

Where the Testing Engineer is assisted by other personnel pulling the levers, they shall be closely supervised to ensure the correct lever has been tried or moved.

The Test Engineer shall also check:

- a. The box diagram is correct to the working sketch.
- b. The pulling list is correct to the locking table.
- c. Lever name plates are correctly inscribed and fitted.
- d. Catch-rod contacts and lever rotaries operate correctly.
- e. Electric lever locks lock and release tappets effectively.
- f. Inscriptions and wards on all Annett keys, lock faces, etc. are correct.
- g. Annett keys are held captive in Annett locks until releasing arrangements are satisfied.
- h. Annett keys correctly release external locks and are held captive in those locks when the apparatus is operated.
- i. Mechanical detectors/selectors operate and interlock equipment correctly.
- j. Emergency switch machine locks operate and interlock apparatus correctly.

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- k. Cranks, channel iron rodding and signal wire routes are correctly installed and operate correctly.
- l. Mechanical points and signals respond correctly.
- m. Locking covers secured in place prior to interlocking test.
- n. Lever sleeves available and effective.
- o. Redundant locking and keys made inoperative and recovered.
- p. Dummy locking bars are fitted in interlocking boxes where required.
- q. The Inspection and Testing shall be documented on the respective design document/s and form *PR S 40022 FM01 Signal Apparatus – Mechanical/Relay/Route Control Locking Test Certificate*.

11 Design Integrity Test/Function Test to Control Table

11.1 General

This testing is carried out after circuit testing and the Null Count Test has been completed and certified.

A Function Test to Control Tables is a function test of the installed interlocking and controls against the prepared design as set out in the Control Tables. Operational train movements are set up using the passage of trains, or specially arranged light engines, or by progressively dropping track circuits or axle counter track sections to simulate a train. The Test Engineer works from the Control Tables and marks off each successful test.

A Design Integrity Test is a function test of the design to signalling principles and practices. It covers all the operational train movements and all the interlocking and controls that should be listed in the Control Tables; the Design Integrity Test should reveal any deficiency in the Control Tables.

The Design Integrity Test Engineer is a suitably experienced and knowledgeable person who works to the track plan and the operational requirements while an assistant separately marks off each successful test on the Control Tables.

The Design Integrity Test is exactly the same as the Function Test to the Control Tables except that the Test Engineer does not reference the Control Tables.

The engineer performing a Design Integrity Test shall initiate each test without referring to the Control Table. The test proposed should be announced to the assistant so that there is a clear understanding of what is being tested. Once each function has been tested, the engineer assisting shall mark off the Control Table.

The assisting engineer marking off the Control Table shall satisfy themselves that the function test carried out by the engineer performing the Design Integrity Test is exactly what is written in the Control Table.

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11.1.1 **Function Testing Works Where Control Tables Are Not Provided**

For simple new works or alterations where a Control Table does not exist a Design Integrity Test is required to verify that, with train movements, the Signalling operates safely to fundamental signalling principles and practices. In these simple cases, the Commissioning Engineer generally conducts the Design Integrity Test. In more complex cases an authorised Signal Design Engineer who is suitably licensed, experienced and competent carries out the Design Integrity Test.

Testing shall be checked off to an approved / independently checked Design Integrity Test Plan.

11.1.2 **Function Testing to Follow Sign Off of Design Checking**

The extent of function testing outlined herein is based on the knowledge that the design has been carried out to tried and proven standard circuit constructions (or data constructions) etc. and has been independently checked in detail. The breadth and depth of testing would need to be greater for untried or unproven design.

Function testing verifies that the interlocking, control and releasing are as specified in the Control Tables but is difficult to prove that there is no rogue qualification of locking or of controls and this aspect relies on the independent checking of designs to proven Standards and the physical inspection and testing of the installation of the designs.

11.1.3 **Function Testing for Operational Purposes**

The function testing procedures described herein are directed at verifying the safety of the signalling system in meeting the operating requirements.

The Design Integrity Test Engineer should include additional operational tests to check the functionality of the design for all required train movements, including parallel and closely following movements involving more than one train, and to check that no movements are unintentionally locked out or unable to be released, particularly those involving long trains. These operational tests are not described herein.

11.2 **Marking and Signing off the Control Table**

Coloured highlighter pens and indelible pens are to be used for marking off the test copy of the Control Tables.

Where there are to be multiple function Test Engineers, each is to be allocated a different colour at the outset of a testing program.

Each Test Engineer's name is to be printed in a unique designated colour on the front sheet of the Control Tables.

As each function is tested, the Test Engineer is to colour in with the highlighter the locked function to record that it has been satisfactorily tested.

When the detection is tested for points that are "set and locked and detected", then the locked function (already highlighted to designate that it has been tested as "set and locked") is to be marked with an oblique stroke, using an indelible pen in the Test Engineer's colour, to designate that it has been tested as "detected".

Additional oblique strokes may be needed for some cases.

Each page of the Control Table is to be signed off by the Test Engineer/s conducting tests on that page, using their designated colour.

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All sign offs are to be dated.

When the function test to Control Table/Design Integrity Test is completed, the senior signal design engineer shall ensure that each and every function has been recorded as tested and each page has been signed off.

The Senior Signal Design Engineer is to initial each page and sign off the front page of the Control Tables to attest that all tests have been satisfactorily completed and that no tests have been missed.

The Engineer in charge of the function testing is to complete, sign and date the SF S4.304C certificate.

The signed off test copy of the Control Tables is to be stored with the signed off test copies of the circuit books and signalling plans.

11.3 Temporary Test Panel to Simulate the Operation of Trackside Apparatus

Function Testing to Control Tables is normally carried out from the signaller's control console/diagrams that may comprise keyboards, levers, switches/keys or pushbutton controls.

For works of a minor nature the function testing will normally be conducted with the external equipment connected to the relay room, the simulation of train movements being effected by test personnel disconnecting and reconnecting links, etc.. As this activity is likely to be conducted under ATP (As Traffic Permits) conditions, close cooperation with the appropriate network operations representative shall be observed and the safe passage of trains throughout the work area is of paramount importance at all times. Signals and points under test are to be booked out of use and are only to be operated for testing when it is guaranteed that no trains could be affected. The Network Rules and Procedures and Signalling Safeworking Procedures shall be followed.

With major new works, i.e., new Interlockings/signal boxes, the function testing will normally be done as a simulation process. Before the new controls are connected to the external functions such as signals, points and train stops, they may be "turned around" onto incoming indications on the cable terminating links, to simulate the operation of the external equipment by using a temporary test panel with switches wired up for the purpose. These simulated indications shall provide correspondence of track indications, point indications, signal and route indications, trainstop indications, etc..

The circuit design for the temporary test panel shall be checked and approved by the Professional Head Signalling and Control Systems.

Where the controls are "turned around" it should be noted that the final control equipment should be operated wherever possible, signal HR relays, trainstop VR contractors, point N&R contactors etc.:

- a. The actual indication circuits should be used for the returning indications.
- b. Trainstop VNR/VRR relays should be operated from the VR control contractor by temporary wiring, and points NKR/RKR relays should be operated from the points normal and reverse contactors by temporary wiring and centrally located switches.
- c. Local cables to the external apparatus shall be securely open-circuited.

The procedures to be adopted when using temporary wiring such as the wiring used for "turn around" functions are described in *PR S 47116 Inspection and Testing of Signalling: Interface Requirements and Procedures for Alterations* under temporary stage work wiring.

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The installation, testing and removal shall be documented in testing copies of the stage work design provided for that purpose.

When function testing is carried out by simulating the operation of the trackside apparatus then Correspondence Testing is required when the apparatus is connected.

Aspect Sequence Tests are part of Design Integrity Testing/Function Testing to Control Tables, but as the higher aspects are not individually indicated to the operating panel these tests are normally carried out at a later stage with persons observing the actual signal indications on site.

11.4 Testing from a Control Console/Indicator Diagram

Testing from a control console/indicator diagram relies on observing the correct diagram indications in response to controls initiated by the Test Engineer. The Test Engineer shall be alert to any irregular indications on the console or diagram while the testing is in progress.

Correspondence shall first be proved between each of the signals controls and indications and the respective trackside function.

Where verification of locking relies on the absence of a change to the status in response to a test from the control console then the test should be applied at least twice to minimise the possibility of a lack of response due to faulty manipulation or a momentary failure of the non-vital equipment to properly register the control or indication.

Operate keys and buttons slowly and deliberately and, when operating point keys, pause in the centre position for a sufficient time to allow the point free relays to energise.

It is important for Test Engineers to ensure that for any specific locking being tested there is no other condition in effect that would cause the function under test to be locked, including any non-vital locking. For example, when testing route holding, ensure that there is no approach locking also being applied.

The locking of points by another function may be verified to be in effect by observing, with the points key in the centre position, that the points free light becomes extinguished and by attempting, without success, to set the points by operating the points key to the opposite position to that in which the points are lying.

The locking of signal routes by another function may be verified to be in effect by attempting without success, to set the route and clear the signal.

The Test Engineer is to test that each specific element of locking is applied when it should be and is released when all the releasing conditions are satisfied (and not when only some of the release conditions are satisfied).

The Test Engineer is to be alert for any indication of locking additional to that shown in the Control Tables (as this could mask the lack of other locking), and for any conditions that could allow premature or false release of interlocking or false clearance of signals.

The Test Engineer should be watchful for any condition that incorrectly puts signals back to stop, even momentarily.

The Test Engineer should also be watchful for any rail vehicle detection direct locking that should only be applied after a signal has been reversed (approach locking, route holding) or for a given direction of train movements.

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Points and Ground Frame releases are operated individually and checked for the existence of:

- a. Direct track locking.
- b. Locking by signal route.
- c. Route holding.
- d. Any other forms of locking.
- e. Non storage requirements.

Controlled signal routes are cleared in turn and checked against the Control Tables for:

- a. Point setting, locking and detection.
- b. Interlocking with other signal routes.
- c. Rail vehicle detection control of the aspect including the lever stick feature.
- d. Inhibition of the signal lever stick feature when auto working has been selected.
- e. Points sequencing and availability to ensure a new safe overlap is available to an already set and cleared signal when setting a route that changes an already set and established overlap. A check shall be made that previously clear aspects do not have their status changed as overlap swinging is taking place.
- f. Aspect sequence (as part of the simulation testing in MICROLOK II CBI but as part of the testing on commissioning for relay based interlockings).
- g. Where resets are provided on axle counter track sections then checks shall be made to ensure only the correct section is enabled for reset and is reset.

Approach locking is checked for all conditions, i.e. initiation (when cleared or comprehensive), normal release path (passage of train) and timed release path.

In testing large relay installations it may be arranged to "time down" the release timer to approximately 15 seconds to aid the progress of the testing. The process of checking the time release on each of the approach locking relays, in turn, is done towards the end of the function testing phase and the temporary straps used to achieve this are removed and certified as being removed by the Test Engineer.

Checks are made on route holding and sectional release. It is desirable to simulate the worst case situation with the route being held by one track occupied only and never more than two occupied at any one time by the simulated movement of a train.

When checking the release of opposing route holding and the release of overlap points holding, first prove the holding is effective and that it is held until a simulated movement of a train fulfils the release condition. When checking timed releases firstly ensure that the release functions with only the timing track occupied and then repeat the test with all the route holding rail vehicle detection track sections occupied.

This ensures the release will function in the case of a long train occupying more than one-track circuit or axle counter track section at a time.

As in the case of the approach locking timers it may be arranged to "time down" the release timer relay to approximately 15 seconds provided the process of time checking and certification that these straps have been removed is as stated above.

It is essential that all conditional locking and converses be checked.

Further checks are carried out to satisfy any special conditions of the Control Tables for example: intermediate shunt signals, over-setting, automatic route normalising. When testing automatic normalising check that it is inhibited when auto working has been selected.

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11.5 Control Table Function Tests

The procedures for Control Table Function testing is as follows:

1. Operate all points individually and verify rail vehicle detection track section, point to point and any other dead locking controls, together with the non-storage feature.
2. Operate all ground frame and similar releases individually and verify rail vehicle detection track section, ground frame to point/ground frame and any other dead locking controls, together with the non-storage feature where the ground frame is in a controlled signal area.
3. For each controlled signal route in turn:
 - a. In turn, release each ground frame that conflicts with the route and verify that the route cannot be set. Conversely with the route set prove that all ground frames are locked.
 - b. In turn, set and lock each set of points in the route and its overlaps to conflict with the route and verify that the route cannot be set and the points do not move. Conversely with the route set prove that all points are locked.
 - c. Set all points in conflict and return point keys to the centre position then set the route and verify that points move to the required position as the route sets.
 - d. Ensure that signal clears under correct conditions, e.g. approach control and/or main aspect lamp proving where applicable.
 - e. Verify rail vehicle detection track section, signal replacement, point and ground frame detection, lamp of signal ahead and other direct controls.
 - f. Verify the lever stick feature and suppression of this feature for auto working where this is provided and operated.
 - g. Verify the approach locking and approach releasing, by the operation of the relevant rail vehicle detection track sections and by the relevant time delay.
 - h. Verify the controls required for automatic route normalisation of routes, where applicable.
 - i. Verify the route holding and sectional route releasing of points in the route.

By the sequential operation of the rail vehicle detection track sections to simulate a train passing through the route and by operating the relevant point/ground frame keys ensure that the points/ground frames are locked until they are sectionally released by the rear of the train reaching the clearance point. The relevant point/ground frame keys shall be turned from the centre to the conflicting position as each rail vehicle track section is operated.
 - j. Verify the route holding and release of directly opposing signals.

Set each directly opposing route in turn and check that as each rail vehicle detection track section is operated the locking of signals is not released until the simulated movement of a train through the route has fulfilled the release conditions.
 - k. When carrying out tests on signal routes containing swinging overlaps ensure that each overlap sets in accordance with the lie of the facing points in the overlap when that is available or otherwise to an alternative available overlap.

Verify that all overlap controls and route locking and releasing are in accordance with the Control Tables for each possible position of the overlap and during swinging.

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Verify that the overlap can be swung by setting all relevant other routes and by operating the facing point key(s), and verify all controls required for moving from one position to another.

Verify signals are not put to stop when overlap points are swinging.

- l. Ensure for all overlaps, the overlap is maintained ahead of a train in the route until correct release conditions apply.
 - m. Verify automatic setting of overlap facing points to an unoccupied overlap is prevented when the points key is not in the centre position.
 - n. When carrying out tests on signal routes containing preferred overlaps, verify that any special controls on setting or swinging the overlap are observed.
 - o. When carrying out tests on signal routes containing intermediate shunt signals, verify all the special requirements for setting up the route, clearing, replacing and re-clearing the signals and releasing the route.
 - p. Verify the interlocking, controls and indications for signal routes with level crossing protection.
 - q. Verify the conditions for automatic normalisation of points, where applicable.
 - r. Verify the conditions for trainstop suppression in both way signalling, where applicable.
4. For each automatic and semi-automatic signal, verify all controls including the operation of replacement facilities from the control panel where applicable.
 5. Verify the controls for repeating signals, indicator signals and guards indicators.
 6. Verify the controls for level crossing protection.
 7. For all signals with route indicators, verify that the correct route indication is displayed for each route.
 8. Verify correct Aspect Sequence.
 9. Verify any blocking controls for signals, tracks, or points.
 10. Verify emergency half-pilot controls or any staff control on signals.
 11. Verify axle counter track section unconditional and preparatory reset controls.

Note:

Additional testing may be required for computer based interlockings.

12 Inspection and Testing – Communication Protocol

Persons conducting inspections and tests with other personnel shall ensure:

- that all persons communicating inspection or testing messages use agreed terms and pre-established question and answer formats that are unambiguous and clearly understood by those involved
- the status of contacts should be referred to as 'front' or 'back', 'open' or 'closed'
- the status of relays should be referred to as 'up' or 'down'
- the status of points should be referred to as 'left hand switch closed, right hand switch open', 'right hand switch closed, left hand switch open' looking from the toe of the points towards the heel
- the status of trainstops should be referred to as 'up' or 'down'

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- the status of signals should be referred to as the colour of the lights displayed from the top down
- the status of rail vehicle detection track sections should be referred to as 'clear', or 'occupied'
- that the identity of persons communicating inspection and testing messages is clearly established on each occasion
- that results are not recorded until after clear confirmation is received (do not anticipate)
- that testing telecommunications channels are dedicated where practical and are tightly controlled without confusion from other radio channels
- that noise and disturbances at the inspection and test control centre are kept to a minimum
- that requests for information are not phrased in a leading manner and the responses repeat the identification details with the result. For example,
- ask non – leading question
 - Q. What relay is located in grid position C2B11?
 - A. Relay 77ATPR is located in grid position C2B11.
 - Q. How many wires are there on A2 terminal, 77ATPR relay?
 - A. Two wires on A2 terminal, 77ATPR relay.
- do not ask leading question.
 - Q. Are there two wires on A2 terminal 77ATPR relay?
 - A. Yes.

13 Control Systems – Inspection and Testing

For Control Systems Inspection and Testing Procedures and Principles refer to the following documents:

- *PR S 47113 Inspection and Testing of Signalling: Inspection and Testing Principles*
- *ATRIC001006 System Test Plan*
- *ATRIC001007 Build and Release Process*
- *ATRIC001917 ATRICS Computer Configuration Procedure*
- *ATRIC003607 Windows 7 Professional Build Procedure.*

13.1 Testing Methodology

The overall Control Systems testing strategy is to verify the system meets user requirements and functional requirements outlined in the requirements documents. The testing is to be done in three main phases, namely Formal Qualification Test (FQT), Factory Acceptance Test (FAT) and Site Acceptance Testing (SAT). The FQT strategy is to test software and verify functionality. The FAT strategy is to test and verify site data through the in-house test environment and with at site IO correspondence testing. Finally, SAT is to verify that the software and data for a given release works on site.

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14 SSI Equipment: Code of Practice for Checking, Testing and Commissioning

14.1 General

14.1.1 Introduction

For the inspection and testing requirements for a Solid State Interlocking (SSI) signalling installation refer to this section for SSI equipment specific requirements and to the other sections for the conventional requirements.

It includes initial tests carried out by the Data Preparer as a pre-requisite to the Data Read Through by the Independent Data Checker in order to minimise the probability of errors requiring correction after the Data Read Through Check. It also includes tests by the Data Checker to verify that all point's commands have a corresponding point's test as well as significant requirements or complex constructions.

14.1.2 Scope

It should be noted that SSI performs all the interlocking and control functions required by that interlocking, including aspect sequencing and signal lamp controls for both controlled and automatic signals, with the exception of local fringe area controls, local ground frame controls, local level crossing controls etc. The SSI will cater for any interlinking necessary between the functions that it controls and the functions controlled locally.

This section specifies the procedures specific to SSI equipment that are to be adopted to check, test and commission a new, or alter an existing, SSI installation. Sections 14.2, 14.3, 14.4 and 14.5 relate to a new SSI installation and Section 14.6 relates to alterations to an existing SSI installation.

This section does NOT cover the following items:

- Factory acceptance tests of SSI equipment.
- Testing of ancillary systems such as Train Describers.
- Detailed setting up and operating procedures for the specialised test equipment.
- The inspections and tests common to signalling systems with other types of interlocking.

This procedure has been written for the following marks of equipment:

- Mark III Data Link Module (DLM)
- Mark II Multi Processor Module (MPM), Panel Processor Module (PPM) Points Module, Signal Module, Memory Module, Technician's Terminal and Long Distance Terminal (LDT)
- Mark I Memory Module.

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14.1.3 Test Precautions

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All SSI modules contain semi-conductor components and can therefore be easily damaged by wrong connections or high voltages.

Before modules are plugged in, it is essential that all connections and power supply voltages are tested and verified as correct.

It is also essential to ensure that no high voltages are applied to modules during testing, e.g. Insulation Resistance Testing.

False feeds shall not be applied to Trackside Functional Module inputs or outputs.

Before connecting or disconnecting a plug coupler from any SSI Module the power should be removed either by external fuse or by the switch on the Module, if provided.

Additionally, Interlocking MPMs should be disabled by the Technician's Terminal control before powering down. This is to ensure an orderly shutdown of the Module concerned.

When using the On Site Simulator in parallel with the Trackside Functional Modules ensure that the relevant data link cables are disconnected from the interlocking cubicle.

14.1.4 Test Equipment

In addition to normal electrical test instruments the following will also be available:

- a. An SSI Design Workstation that incorporates a simulation system capable of testing the geographical data for single or dual Central Interlockings, by simulating the messages passing to the Central Interlocking under test from its Trackside Functional Modules and from the other Central Interlockings in the Control Centre.
- b. Two colour graphic displays of the track layout are included representing the signaller's Control/Indication Panel (Panel VDU) and the trackside apparatus. (Trackside VDU).
- c. By use of tracker balls that move cursors over the screens, the operator can simulate the operation of push buttons and switches by the signallers and change the state of incoming controls. The consequential effects on outgoing controls and signaller's panel indications can then be observed on the displays. Where appropriate, changes to the incoming controls such as points detection and signal lamp proving are made automatically in response to the corresponding outgoing controls, but the operator may impose simulated failures as required.
- d. A separate monochrome VDU with keyboard (Terminal VDU) is provided to allow access to the standard facilities of the SSI Technician's Terminal for reporting faults, imposition of technician's controls and examination of telegram contents on the trackside and internal data links, the specific contents of signal tracks route and points memory, panel indications and button controls and specific flags.
- e. The simulation makes use of the final data prepared for the PPM, Interlocking MPM and Diagnostic MPM, plus special data prepared for an additional Simulator MPM and for the interface processor that drives the colour graphic displays. The SSI Design Workstation will usually be located at the Sydney Trains design office or on the Contractors premises.
- f. An On-Site Simulator, made up of a Technician's Terminal fitted with a colour graphic display (Trackside VDU) and tracker ball and special Memory Modules and adaptor cables, that are used to convert one of the three Interlocking MPMs in each Central Interlocking into a Simulator MPM. These are used for site or factory testing of a group of Central Interlockings together with the final Control/Indication Panel

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equipment, train describer and other systems. The incoming and outgoing controls are simulated and displayed on the on-site Trackside VDU in the same way as on the Design Workstation simulator system.

- g. The On-site Simulator may be used either to test a single Central Interlocking with the internal data link messages from the others simulated, or to test all the Central Interlockings connected to a single Technician's Terminal with the trackside data link telegrams only being simulated.
- h. Where Interlocking boundary controls are required it is necessary to use a dual workstation configuration consisting of two simulator racks.
- i. It may be necessary to carry out the testing in stages if the whole of the controlled area cannot be represented within the memory of a single colour graphic display.
- j. Facilities are provided to disable one or more of the simulated reply telegrams on the trackside data links, to allow messages to and from the real Trackside Functional Modules (TFM) to be tested.
- k. **Link Telegram Generator (TFM Message Generator)** with flying leads to connect the instrument in between the Trackside Functional Module under test and its free connector.
- l. When so connected the Trackside Functional Module IS NOT isolated from the Data Link Modules and removal of the line protection unit (i.e. Clipit units) is **MANDATORY**.
- m. The unit will operate to exercise the module outputs by means of simulated command telegrams.

THE INSTRUMENTS SHALL ONLY BE ISSUED TO AUTHORISED TESTING PERSONNEL WHO WILL BE RESPONSIBLE FOR THEIR SECURITY WHEN USED ON SITE.

- n. **Data Link Telegram Monitor** that when connected to the data link test points can be used to display the current state of the telegram message bits to or from a particular Trackside Functional Module.
- o. The unit will operate to monitor the reply telegrams as the module inputs are exercised by the Data Link Telegram Generator.
- p. **TFM Tester**, normally located at the Control Centre, that carries out a comprehensive test of all functions of a TFM and also clears the TFM memory so that it can be installed in any Central Interlocking area.
- q. All test instruments shall have insulated clips, prods, etc.

14.1.5 Related Documents

- **SSI 8300 - SSI Design Workstation Users Guide** describes the SSI Design Workstation and the procedures for using the facilities provided.
- **SSI 8002 - Technician's Terminal Handbook**; gives procedure for bringing the Central Interlocking on line, examination of input and output telegrams and signal aspect changes, fault reporting, etc. describes the SSI Simulator and the procedures for using the facilities provided.
- **SSI 8003 - Data Preparation Guide**; describes the rules for data preparation for the Interlocking, Simulator and Diagnostic MPMs and the Panel Processor.
- SSI 8500 - Specification for the Design of SSI Signalling Schemes.
- BR 1990 - Specification for Preparation of EPROMs for Railway Signalling Applications.
- SSI 8150: SSI Software Record.

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14.2 Apparatus Cases – Site Testing

14.2.1 Bell Continuity Test

Whilst the Bell Continuity Test is being carried out all SSI TFM module free connectors, relays and other equipment, such as fuses, shall be removed from their respective bases.

The test should include verification of the address and modifier looping in the Trackside Functional Module free connectors, the Control Centre identity number and of the interlocking/trackside looping of Long Distance Terminals if provided.

Care should be taken to avoid damage to these connectors.

14.3 Interlocking – Pre-Site Design Checking and Function Testing

14.3.1 General

As the operation of a SSI Central Interlocking is determined by the contents of its geographic data memory and not by the wiring of the equipment on site, it is possible to complete the bulk of the functional testing in the design office using the SSI Design Workstation before equipment is delivered to site.

Detailed instructions for use of the Design Workstation facilities are given in SSI 8300 **SSI Design Workstation Users Guide**.

The following summarises the sequence of checks and tests to be carried out when using these facilities to test the geographic data for an SSI Central Interlocking.

It is vital that this sequence of actions is followed, to ensure that the geographic data in the EPROMs in the final SSI modules is identical to the data tested on the Design Workstation:

- a. Enter the geographic data into the Design Workstation and compile it to generate object code. Correct any errors detected by the SSI 8300 compilers.
- b. Make two backup copies of the geographic data and store these separately. Check that the Interlocking MPM object code and source code are equivalent by means of the Interlocking data decompiler.
- c. The information entered into the Design Workstation shall be checked by a second person, comparing the listings generated by the data compilers and the scheme design database against the Control Tables and signalling plans (see Section 14.3.2). When checking the Interlocking MPM and Panel Processor data, the cross-references listings produced by the data analysis program may be used as an aid.
- d. Download the data into the simulation system and then verify this data stored on the Design Workstation against a floppy disc backup.
- e. Then carry out the initial tests specified in Section 14.3.3.
- f. These initial tests are intended to ensure that all the basic facilities have been provided in the data and that the simulator data provides the necessary facilities to allow formal testing to proceed.
- g. Throughout the initial tests specified in Section 14.3.3 and the formal tests in Sections 14.3.5 to 14.3.8 keep the Terminal VDU and the PC Logger operational, to ensure that the operator is made aware of equipment faults, data timing problems and to allow any unusual incidents to be analysed. It is not necessary to keep the data files as a permanent record.
- h. Using the simulation system, carry out the formal tests specified in Sections 14.3.5 to 14.3.8.

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- i. When the tests are complete the geographic data stored on the Design Workstation should be verified against the backups to ensure that no corruption has taken place during the tests.
- j. It is recommended that verification should also be carried out whenever the data is reloaded into the simulation system, so as to minimise the retesting required should data corruption be subsequently detected.
- k. If errors are detected at any stage in the checking and testing process, make the necessary data corrections and recompile incrementing the sub version number **and use the data comparison program to produce a list of the areas where the amended data differs from the backup.**
- l. Then make a new set of backups and repeat the checks and tests carried out so far on the data areas where changes have taken place, before continuing with the next stage.
- m. When all testing is complete, program and label two sets of master EPROMs from the data and verify these against the backups.
- n. The EPROM checksums should be recorded and the EPROMs and backups stored for use when programming production EPROMs.
- o. Production data EPROMs may now be programmed, labelled and verified. If necessary program EPROMs may also be programmed, labelled and verified.
- p. The EPROMs may now be inserted into the Memory Modules.
- q. The following items should be checked to SSI 8150, the SSI Software Record and Central Interlocking Software Record (CISR) and Installed SSI Software Record (ISSR)
 - i. Program EPROM labels
 - ii. Bipolar PROM labels
 - iii. Data EPROM labels
 - iv. Memory Module links
 - v. Memory Module front panel label information.

The program issue and data version and sub version number should be added to the Memory Module front panel label and recorded as specified in SSI 8150. The module should now be sealed.
- r. Trackside layout pictures for use with the Technicians Terminal should be recorded onto the appropriate storage medium. Use is via the on-site technician's terminal PC Logger.
- s. Of the above, d) and e) are testing functions and the remainder are design functions.

14.3.2 Geographic Data Check

In accordance with Section 14.3.1 the following checks are required as part of the design function:

Checking is to start on the basis that the following source documents are available and have been checked as correct:

- a. Scheme Plan
- b. Signalling Plan
- c. Control Tables
- d. Location Plan

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- e. TFM Schedules
- f. Sub-route/overlap Plans
- g. Map Search Plan(s)
- h. Internal Data Link Schedules
- i. Panel Multiplex Allocation Schedules
- j. Data Link Network Plan.

In all the following checks, compliance with the latest issue of SSI 8003 Data Preparation Guide and Supplement, including Amendments, and Sydney Trains Supplements where applicable, shall be established:

- a. Check all identities to the Scheme Plan, Control Tables, Sub-route/overlap Plans and Panel Multiplex Allocation Schedules.
- b. Check the IPT data file to the TFM and Internal Data Link Schedules.
- c. Check the PFM data file to the Scheme Plan, Control Tables and Sub-route/overlap Plans.
- d. Check the FOP data file to the Scheme Plan, Control Tables, Sub-route/overlap Plans and back check to the identities to ensure that all items have data when required.
- e. Using the Design Workstation UNIX screen editor “vi” command: \ search for all latch identities and check them against the identity listing to ensure that they are set and unset in the correct sequence, and when not required are unset.
- f. Check the PRR data file to the Scheme Plan, Control Tables, Sub-route/overlap Plans and Internal Data Link Schedules.
- g. It is imperative to ensure that all point commands have a corresponding point test and that these comply with the Control Tables.
- h. Using the Design Workstation UNIX screen editor “vi” check that all points have a separate points test and command and that this is incorporated into the same panel route request and in the same part of the panel route request where there are multiple parts.
- i. Firstly, use the UNIX screen editor “iv” command: \ search to check that all point cnf or crf tests are in the if part of a panel route request where (point) cn, (point) cr or @(point) QN, or @(point) QR are included in the **then** part of the panel route request.
- j. The above check is **MANDATORY** for all points and is to be recorded on the listing and signed off.
- k. Check the MAP data file to the Map Search Plan(s).
- l. Check the OPT data file to the Scheme Plan, Control Tables, Map Search Plan(s), TFM and Internal Data Link Schedules.
- m. Check Panel Processor PBK File to the Panel Request Identity (QST) File and the Control Tables to ensure correct button sequences and that all buttons and point switches are included.
- n. Check Panel Processor POD File to the Panel Request Identity (QST) File and ensure all point switches are included.
- o. Check all Panel Processor Files to ensure that all indications are included and not duplicated in a conflicting manner.
- p. Check the diagnostic DIA data file to the Data Link Network Plan

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- q. Check that the data timing constraints as defined in SSI 8003, supplement No. 10, are complied with. Set all possible routes on the simulator at once and using a CRO on the simulator rack check the maximum and minimum major cycle time on one of the TCP links and record on the CISR form.
- r. Check that the data check sheets are completed and signed off.

14.3.3 Initial Tests

These initial tests are to be carried out by the Data Preparer prior to the Data Read Through Check and prior to a formal functional test to the Control Tables as detailed in Section 14.3.5.

Using the Design Workstation facilities apply the following tests:

- a. Verify each track section indication with no routes set.
- b. Operate all points individually and check correspondence of detection and the correct operation of the out-of-correspondence indicator light.
- c. Operate and cancel all ground frames and other releases and verify operation and indications.
- d. Operate and cancel each signal route and check correspondence of signal and route indications. By sequentially occupying track sections in the route and overlap, verify the track section indications. Verify the correct operation of the route entrance button indications.
- e. Verify each incoming slot or similar release.
- f. Operate and verify all Level Crossing controls and indications.
- g. Operate and verify all Block controls and indications.
- h. Verify any other ancillary indications.
- i. Verify that points sequence correctly when required and points do not sequence when not required, as detailed by the Control Tables.
- j. Check that the signal does not "blip" under point sequencing conditions.
- k. Check that the points sequence with the required route set or after the train is in the route and has not been timed to a stand. When the train has been timed to a stand, check that the points will set with no sequencing.
- l. Set a route forward of a route previously set and check that the points sequence as applicable. When the forward route is unset check that the trailing points in the overlap remain locked. Repeat the test for the same routes with the points set to the required position prior to the test and check that the forward route sets without the overlap points moving.
- m. Verify that on power up, overlap points will not be set by routes until the points control bits have been set.
- n. This test is carried out prior to any other tests commencing after a down load on the technician's terminal (AI53).
- o. With the technicians terminal in monitor mode, monitor the specific points telegrams and verify that, with no point control bit's set (points keyed to centre), routes that have points in the overlap will not set.
- p. Then verify that the points will set after the points centre bit is set by keying the points to normal and again by keying the points to reverse.
- q. Verify that point detection is proved in the appropriate route indications.

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- r. Verify that detection of facing points in the overlap is proved in the signal route only when the points are set to avoid a conflicting route. When so set and locked, verify that if detection is lost, both signals are replaced.
- s. Verify that detection of trailing points is proved in the signal route only when the overlap is set over these points and not when an alternative overlap is set.
- t. Verify overlap maintenance conditions.
- u. During these tests the Terminal VDU should be put into the monitoring mode to record changes to signal aspects, point detection and track sections, and the correct response should be verified.

14.3.4 Input and Output Telegram Tests

Using the Design Workstation facilities exercise each allocated input and output telegram bit in turn on the internal and trackside data links and verify:

- a. Correspondence between the Schedule of Telegram Data and the telegram contents displayed on the Terminal VDU.
- b. That the correct indication is displayed on the Trackside VDU.
- c. That, where appropriate, the correct indication is displayed on the Panel VDU.

Where an internal data link telegram is used to transfer request codes for route locking across interlocking boundaries check that all the correct request and acknowledgment codes are passed between the interlocking under test and the simulator that represents the other Interlockings in the Control Centre.

14.3.5 Functional Tests

Using the Design Workstation facilities, (i.e. the Panel VDU to operate functions, the Trackside VDU to change input telegram bits and to check telegram outputs and the Terminal VDU to monitor the change of state of signals, points and train detection equipment and to check telegram bits where specified) carry out function tests in accordance with, Section 11 (Design Integrity Test/Function Test to Control Table) and additionally as follows, to verify the correct and safe operation of all interlocking and control functions to the Control Tables and signalling plans:

- a. When required set all points controlled by the interlocking to their normal position and with all point keys in the centre position set the route and verify that the only points called reverse are those required by that route. Similarly set all points controlled by the interlocking to their reverse position and with all point keys in the centre position set the route and verify that the only points called normal are those required by that route.
- b. Using the Terminal VDU (set in the signal aspect-monitoring mode) and the Trackside VDU, carry out an Aspect Sequence Test for all main signals to verify that the correct aspect and route indication is displayed under all conditions. For all position light signals verify that the correct route indication is displayed for each route where applicable.
- c. For linking with adjacent Interlockings via a Trackside Functional Module or via the internal data link, the controls in any outgoing message should be exercised and verified by observing the output displayed on the Trackside VDU. Incoming controls should be operated from the Trackside VDU and their effect on the interlocking under test verified. It may be convenient to do this when carrying out other tests previously specified. The actual individual controls that make up the incoming message will be verified either by the on-site testing or when the geographic data for the adjacent interlocking is tested. The controls and indications for interlinking with level crossings should also be verified in this manner.

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14.3.6 Design Integrity Test

Refer to Section 11 of this procedure.

14.3.7 Technician's Control Tests

Verify the correct response to the technician's restrictive controls to the Interlocking via the Technicians Terminal, i.e.:

- a. Track section Occupied - One for each track section. When applied it occupies the track section or holds it occupied.
- b. Points Disabled - Two per set of points viz., "points disabled at normal" and "points disabled at reverse". When the normal control is applied the points cannot be moved from the normal to the reverse position. When the reverse control is applied the points cannot be moved from the reverse to the normal position. Routes can be set over disabled points if the point control is in the correct position or is free to move to that position.
- c. Route Prohibited - One per signal route or ground frame release. When applied the route or ground frame release cannot be set.
- d. Aspect Disconnected - One per signal. When applied the signal is held at its most restrictive aspect for all routes.
- e. Temporary Approach Control - One per signal. When applied all routes from the signal require the specified conditions to obtain a proceed aspect.
- f. Interlocking Disabled - One per interlocking. When applied all signals are commanded to their restrictive aspect for all routes.

Using the Terminal VDU apply each technicians control in turn and verify the correct response.

14.3.8 Fault Reporting Tests

Verify that the correct response is displayed on the Terminal VDU for each fault capable of being recorded on the Technician's Terminal, i.e.:

- a. Signal lamp failure for each aspect.
- b. Signal lamp first filament failure for each aspect.
- c. Point detection failure normal or reverse.
- d. Points fail to respond to call.
- e. Point contactor fault.
- f. Special miscellaneous faults e.g. earth leakage detectors,
- g. Loss of reply telegrams from each individual Trackside Functional Module.
- h. Simultaneous loss of reply telegrams from all Trackside Functional Modules in each location.
- i. Simultaneous loss of reply telegrams from groups of Trackside Functional Modules to simulate possible breaks in data links and power supplies.
- j. Simultaneous outward data link faults on groups of Trackside Functional Modules to simulate repeater faults.

Where diverse routing of data links is provided tests i) and j) should be carried out separately for the A and B data links.

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14.3.9 Temporary Data Changes to Assist Testing

To be provided as follows:

- a. Interlocking - generally to be discouraged but there may be a case for conditioning out trainstop normal and reverse mechanical failure conditions in input file, but this is only to be done prior to the function test in Section 14.3.5. Any alterations shall, when finalised, be dealt with as a modification in accordance with Section 14.6.
- b. Panel Processor - there may be a case for additional button identities to overcome limitations of the Design Workstation VDUs where entrance and exit buttons cannot be seen simultaneously on the Panel VDU. This may involve either adding a second exit button closer to the entrance button or using a single button to set each route.

14.3.10 Interlinked Design Workstation Simulations Systems

The previous sections are based on testing the data for one Central Interlocking at a time and thus cross boundary functions between Central Interlockings shall be re-tested as Through Functions on site as described in Section 14.5.7. If two simulation systems are available these can be linked together via their internal data links to enable cross boundary functions to be through tested in the design office.

14.4 Control Centre – Site Testing

As for conventional Interlockings

14.5 On-site testing

14.5.1 General

During the pre-site testing of the geographical data all the interlocking and controls performed by each interlocking have been functionally tested and **THERE IS NO NEED TO REPEAT THIS ON SITE.**

Similarly the allocation of all incoming and outgoing telegram bits to Trackside Functional Modules, between Central Interlockings and to and from the Control/Indication Panel have been verified as correct to the specified schedules.

The purpose of the on-site testing is therefore to verify that all on-site installation work has been carried out correctly, that the complete system functions correctly within the Control Centre and from the Control Centre to the lineside equipment, and the correct operation of all local fringe area controls that are not included in the Central Interlockings.

Before TFMs are installed or transferred to a different Central Interlocking they are to be checked on the TFM Tester.

14.5.2 Cables

When Insulation Testing and Continuity Testing the data link cables, the data link modules and terminating resistors shall be disconnected. Polarity tests are required on these cables.

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14.5.3 Trackside Functional Modules

- a. Check that existing working circuits are fully isolated from the internal apparatus case circuits before the apparatus case power supply is livened up or any SSI modules are plugged in. Any links that are provided for closing trackside equipment cables in use to the SSI equipment at the commissioning stage shall either be removed or positively secured in the open position by a means that can be readily inspected.
- b. Disconnect links of all cables to trackside equipment and to other trackside locations and carry out the following tests:
 - i. Connect the Data Link Telegram Generator and Monitor units to each TFM in turn and exercise in turn each working telegram bit.
 - ii. Verify that the correct output is obtained in accordance with the Schedule of Telegram Data using a voltmeter connected across the end.
 - iii. Function or the outgoing terminals to the end function.
 - iv. For Point Modules, it should be noted that when one points operating output is energised a voltage also appears on the other points operating output. The outputs should therefore be loaded with an 820 ohm, 25 watt resistor connected across the outgoing terminals to each points operating unit, which reduces the non-energised output to not more than 30 volts. It should also be noted that due to a pair of small de-coupling capacitors acting as a voltage doubling circuit the points operating output can be over 300 volts on no load but should produce the correct 120-140 volts when loaded.
 - v. In the limited number of cases where relay contacts (generally back contacts) are present between the module output and the end function then these contacts shall not be broken when the energised output is connected to the end function. The contacts may be tested to an open circuit output by substituting a voltmeter for the end function and then operating the relay to break the contacts and strapping them.
 - vi. For Points Modules check that the timed motor feed cut off operates correctly by withholding the relevant detection input and check that the motor supply is re-activated if the detection input is broken.
 - vii. Connect the Data Link Telegram Generator and Monitor units to each TFM in turn and exercise each working input and verify correspondence with the Schedule of Telegram Data. Each input should be operated by operating the relevant relays etc. and each contact should be broken and strapped, thus proving to the wiring diagrams. Where external functions are not yet connected they should be simulated by placing a strap across the relevant incoming terminals, while lamp proving inputs should be simulated by connecting lamps or resistors across the outgoing terminals.
 - viii. For Signal Modules verify that the red retaining outputs are activated when no data link signal is supplied to the module.
 - ix. When carrying out the tests specified in i) and ii) above, the Data Link Telegram Generator (TFM Message Generator) and the Data Link Telegram Monitor should be connected directly or indirectly to the data links in accordance with the manufacturer's instructions.
 - x. This arrangement with the Data Link Telegram Generator does not automatically isolate the test instrument and the TFM under test from the data links, so isolation manually is necessary.
 - xi. Before using the Data Link Telegram Generator it is essential to isolate the Generator and the location from the transmission lines by opening the disconnection links on the line termination units for both local data links A and B and by disconnecting any long line data links A and B.

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- xii. The isolation shall be checked by connecting a Data Link Telegram Monitor to the internal side of each data link connection point to check that there are no incoming telegrams and by observing that all TFM RX Data lights have been extinguished.
- xiii. Before using the Data Link Telegram Generator check that it is correctly connected to the internal side of the data link transmission lines disconnection point.
- xiv. Failure to observe these precautions may result in TFMs in other locations inadvertently responding to telegrams from the Generator and possibly moving points and clearing signals.
- xv. It should be noted that although the test instrument is only connected to one data link the replies from the TFMs are sent back on both data links.
- xvi. Data Link Telegram Generators shall only be issued to authorised testing personnel who will be responsible for their security when used on site.

14.5.4 Data Links

When the trackside data link system is completed the following items should be checked:

- a. That all line termination resistors and lightning protection units have been connected.
- b. That all links and fuses are in place and intact.
- c. That the red power lamp is illuminated on all Data Link Modules.
- d. If long line links are being used then check that the following six indications are illuminated on all Long Distance Terminals: - Power, System, PCM TX Clock, PCM RX Clock, PCM RX Line, PCM Tx Line.

The four PCM indications indicate that the Long Distance Terminal is connected to a functioning telecommunications interface.

Set up and test the data link transmission system at an early stage, particularly where data link repeaters or diverse routes are involved, or where Long Distance Terminals and PCM are involved.

The Data Link should be tested using a Data Link Telegram Monitor and an oscilloscope. The oscilloscope should be earth free and shall not require a 240-volt supply. A storage oscilloscope is recommended. The trigger for the oscilloscope is provided by a dedicated output from the Data Link Telegram Monitor. The oscilloscope is used to measure the signal across the pairs of each data link in turn.

Measurements should be taken at all ends of all link sections and on both sides of any repeaters. The data link print outs are to be retained and added to the testing documentation.

The oscilloscope should be set to permit comfortable viewing of signals between half a volt and six volts peak to peak. A time base of 5ms will capture a single message, while 10ms will generally capture an outward message and a reply, 50ms will capture two to four pairs of messages and 750ms will normally capture a complete set of 64. Reply messages will have different amplitudes from each other and from outward messages.

Use the oscilloscope to check the following:

- a. No message has an amplitude greater than 6 volts.
- b. No message from the Central Interlocking has an amplitude less than 1 volt.

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- c. No message from a TFM that has to pass the measuring point to reach the Central Interlocking has an amplitude less than 1 volt.
- d. All messages are the same length.
- e. The amplitude does not vary within any message.
- f. There are no sudden spikes within or without messages.

Report any discrepancies to the senior testing engineer for further investigation.

14.5.5 Central Interlocking

The visual examination should include:

- a. For each Central Interlocking verify that the information on the Memory Module labels, including spares if available, is correct to the CISR.
- b. For each Central Interlocking verify that the hard-wired identity and version numbers correspond with those shown on the ISSR.
- c. For each Central Interlocking that contains Long Distance Terminals verify that the Control Centre identity number and interlocking/trackside looping is correct.
- d. Check the modification state for all SSI Modules, including spares if available, is as specified on the ISSR.
- e. Check the Installed SSI Software Record (ISSR) is complete and signed off.

14.5.6 Central Interlocking Site Tests using the Technicians Terminal

- a. The Technician's Terminal configuration and clock should be set up.
- b. The trackside data links should be unplugged from each Central Interlocking and replaced by temporary 47-ohm line loading resistors. Alternatively if long line links are being used then unplug the connector from the Central Interlocking to the telecommunications interface. Power up each Central Interlocking and check that all the relevant lights on all the modules are illuminated and that the signaller's panel indications display their expected state when no reply telegrams are being received from the trackside (i.e., track section occupied, points out-of-correspondence, signals out, etc.).
- c. Use the Technicians Terminal to start each Central Interlocking and check that the "Normal Working Failed" indication is extinguished. Then disable and re-enable each of the 3 Interlocking MPMs in turn checking that the system lights on the remaining modules remain illuminated.
- d. Disable and switch off the bottom Interlocking MPM in each Central Interlocking cubicle and fit it with a Memory Module and adaptor cables to convert it into a Simulator MPM, simulating reply telegrams on the trackside data links. When the Simulator MPMs have been switched on, use the Technician's Terminal to enable the simulated reply telegrams and check that the panel indications now display track sections clear, points detected normal and signal lamps alight.
- e. Ensure that the Technician's Terminal is connected to its Trackside VDU and tracker ball and load the Trackside VDU geographic data from disk via the PC Logger. Check the correct operation of all indications and controls on the signaller's panel, (i.e., repeat the initial tests 14.3.3 a to h). With a large multiple interlocking installation, this testing may have to be carried out in stages due to the limited area that can be displayed on the Technician's Terminal Trackside VDU.
- f. Check that the panel indications and controls continue to work normally with components in each of the duplicated Panel Processor/Panel Multiplex channels disconnected in turn. Turn off both PPMs and check the correct operation of the panel indications and the associated "PMUX Failure" alarm.

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- g. Simulate a variety of faults and check the Technician's Terminal fault reports and signalman's alarms. Test the other functions described in the Technician's Terminal manual, including a selection of technician's controls on each Central Interlocking, and the facility for remote access via a modem. Sample logging disks recorded on the Technician's Terminal should be removed for analysis to check that the PC Logger is working correctly. The analysis should be carried out using the PC at the Central Interlocking/Control Centre where one is provided for this purpose. The PC Logger in the Technicians Terminal should then be kept operational throughout any subsequent testing.
- h. Disconnect the Technician's Terminal from each Central Interlocking in turn and check that a non-critical alarm is generated.
- i. Check that both PPMs in each Central Interlocking are sending information to the Train Descriptor Control System, and carry out sample tests to ensure that this information is being correctly interpreted.
- j. Verify the correct operation of the Central Interlocking to the signaller's Emergency Signal Replacement control(s).

14.5.7 Through Testing – Internal Data Links

- a. Where interlocking or control functions cross the boundary between two of the Central Interlockings, then all the controls in these functions should be tested in accordance with Sections 14.3.5 and 14.3.6 to ensure that the Central Interlockings work together to achieve the required operation, including those already verified within each Central Interlocking individually during the pre-site tests using the Design Workstation. This will not apply if these functions have already been through tested in the design office as described in Section 14.3.10.
- b. A selection of the controls passed between each pair of Central Interlockings should be tested with each internal data link disabled in turn, to prove that this has no effect on normal operations.

14.5.8 Through Testing – External Functions

- a. Ensure that all TFMs are disabled by removal of their power supply fuses, and then connect the Central Interlockings to their trackside data links or to their long line links, as appropriate. Ensure that the data links have been tested in accordance with Section 14.5.4. If Long Distance Terminals are in use then check that the indications listed in Section 14.5.4 are illuminated.
- b. In each location, check that the command telegram from the correct Central Interlocking for each of the TFMs in the location can be received on both data links using the Data Link Telegram Monitor connected to the location test point and that the telegram contents match those observed at the Central Interlocking/Control Centre using the Technician's Terminal.
- c. For each TFM in turn, disable the simulated reply telegram from the Simulator MPM and then insert the TFM power supply fuse in the location and check that, after a 10 second power up delay, the received data light is illuminated. At this point the three data indications lights, together with the other six in Section 14.5.4, of Long Distance Terminals (if provided) should be illuminated both at the Central Interlocking and in locations. Carry out a Through Functional test for all TFM outputs and inputs from the Control/Indication Panel to the trackside function, (e.g. signals, points, track circuits, ground frames, etc.), checking the data link telegram contents using the Data Link Telegram Monitor in the location and the Technician's Terminal at the Central Interlocking/Control Centre. During this test any individual control that is external to the SSI should also be verified. Where it is not possible to connect the external function until commissioning, then the through test should be carried out up to the apparatus case external cable links, using simulated loads if necessary, and the tests should then be completed at commissioning. It is not

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necessary to test the internal logic within the SSI that has already been verified as part of the pre-site tests using the Design Workstation. However, the internal logic should be re-tested in conjunction with the external controls where TFMs are used as the interface to adjacent control/auto areas, ground frames, level crossings, etc.

- d. In the location, disable each of the DLMs (or LDTs) in turn and check that the TFM connected to it continues to operate normally and reports the loss of messages in the correct reply telegram status bit. This should be checked using the Data Link Telegram Monitor in the location and the Technician's Terminal at the Central Interlocking/Control Centre. With both DLMs (or LDTs) disconnected, check that the TFM disables its output interfaces (and, if a Signal Module, maintains any most restrictive aspects) and the panel indications indicate the most restrictive state of the TFM inputs. Check that the Technician's Terminal reports the loss of reply telegrams correctly.
- e. Complete, as far as possible, any outstanding items from the Design Integrity Test concerned with interface areas.
- f. When all tests involving a particular TFM have been completed the TFM power supply fuse shall be removed. Where the TFM feeds external equipment the outgoing links shall be disconnected unless it is safe to leave the equipment joined through, e.g. a new signal fitted with a hood.
- g. When all through testing of external functions on a particular interlocking has been completed the power supply fuse for each TFM controlled by that interlocking shall be inserted and the system shall, as far as possible, be left working so that it may be monitored for failures.

14.6 Testing alterations to a working installation

14.6.1 General

The detailed methods adopted to carry out alterations to a working SSI installation will depend on the scope and nature of the work involved. The following sections are therefore intended to specify the requirements for the principal elements involved and variations may be required to cater for local conditions.

A special case arises when a large new SSI installation is to be commissioned in stages. At each intermediate stage it will be necessary to interlink with an existing signal box or boxes. The Interlockings concerned should first be designed to perform their final functions and tested in accordance with the pre-site tests in Sections 14.2, 14.3 and as far as possible, the on-site tests in Section 14.5. The alterations necessary to accommodate the stage work can then be dealt with in a manner similar to that used for alterations to a working installation as specified in this Section. Since the SSI where the stage work is required will not normally already have been commissioned then the requirements can be relaxed accordingly such that alterations may be carried out and tested prior to commissioning.

When the stage work is removed the final Memory Modules will replace the stage work Memory Modules in the Central Interlocking, with the hard-wired interlocking version number in the Interlocking cubicle amended to match the new data. Commissioning test requirements will then apply to that section of the installation that was not previously working plus those areas amended to cater for the stage work.

Where a working installation is being modified with the installation of an additional Central Interlocking, this shall not be connected to the internal data links and Technician's Terminal until commissioning. Temporary 47-ohm line resistors should be connected to the additional Central Interlocking in place of the internal data link cables. The tests on the additional Central Interlocking described in Sections 14.5.6 and 14.5.8 may be carried out using a spare Technician's Terminal and a Simulator MPM fitted with an adaptor cable

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allowing it to simulate the internal data link telegrams as well as those from the trackside data links. The tests described in Section 14.5.7 shall then be carried out as part of the commissioning, together with tests on the alterations to the working Interlockings.

14.6.2 Geographical Data

From the original source code for each Central Interlocking prepare a revised set of geographic data to reflect the modifications required. Then carry out a comparison of the original and edited source codes to identify the areas that need to be checked and re-tested as described in Section 14.3.

The revised geographic data shall contain an updated version number. When the alterations are commissioned the new Memory Modules will replace the existing Memory Modules in the Central Interlocking, with the three hard-wired interlocking version numbers in the Interlocking cubicle amended to match the new data.

14.6.3 Control/Indication Panel

The method adopted to alter the Control/Indication Panel will depend on the type of panel and the complexity of the amendments but the problems will be similar to those encountered with a conventional interlocking. Any new internal panel wiring can be tested prior to commissioning but alterations to the functions allocated to the panel multiplex controls and indications can only be carried out at commissioning.

14.6.4 External Functions

14.6.4.1 Cables

As for Section 14.5.2.

14.6.4.2 Trackside Functional Modules

As for Section 14.5.3.

14.6.4.3 Data Links

Extensions to the existing system should be connected under a local possession and line termination resistors re-positioned as required. The altered portions of the system should then be checked in accordance with Section 14.5.4.

14.6.4.4 Through Testing

On completion of the above tests the new equipment and circuits may be connected to the working system under a local possession where it is safe to do so, e.g. connect new TFMs to Data Link Modules where spare TFM addresses have been used.

For each new connected TFM, insert the power supply fuse and check that, after a 10 second power up delay, the received data light is illuminated. Then carry out a Through Functional Test for all TFM inputs from the trackside functions to the Central Interlocking using the Data Link Telegram Monitor in the location and the Technician's Terminal at the Central Interlocking/Control Centre. Through testing of TFM inputs to the Control/Indication Panel and of TFM Outputs requires the installation of revised geographic data in the Central Interlocking. This shall await a complete possession at the commissioning or at a previous rehearsal.

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For each new connected TFM in the location, disable each of the DLMs in turn and check that the TFM continues to operate normally and that the correct status is reported in the reply message at the Technician's Terminal. With both DLMs disconnected, check that the TFM enters the red retaining state and that the correct status is reported in the reply message at the Technician's Terminal. **Note** that the Technician's Terminal will not produce fault reports for these tests, as the diagnostic MPM data has not yet been updated. A local possession will be required where an existing TFM is connected to the same DLM as a new TFM.

14.6.4.5 Commissioning

When all changeover work has been completed the relevant procedures specified in this procedure should be applied to all new or altered equipment and circuits.

14.7 Documentation and Certification

14.7.1 General

A complete set of approved and independently checked documents for the work to be tested shall be provided for the exclusive use of testing personnel. It shall be printed on paper of a distinctive colour or marked by colour patch. All changes, additions and deletions shall be indicated on the documents.

The set of documents will usually consist of:

- a. Signalling Plan/Location Plan
- b. Control Tables
- c. Sub-route/overlap Plans
- d. Map Search Label Plans
- e. TFM Schedules
- f. Geographic Data for the Interlocking MPM, PPMs and Diagnostic MPM
- g. Central Interlocking Status Record (CISR)
- h. Control Centre and Apparatus Case Wiring Diagrams
- i. Cable Schematic Diagrams
- j. Data Link Network Plan
- k. Internal Data Link Schedules
- l. Panel Multiplex Allocation Schedules
- m. Panel Faceplate and associated Wiring Diagrams
- n. Installed SSI Software Record (ISSR).

14.7.2 Recording Tests

The test copy of the Control Tables, TFM Schedules, Circuit Diagrams and the Panel Multiplex Allocation Schedules will normally be used to record tests.

All other inspection and testing not recorded on such sheets will be recorded on documents as described in the Inspection and Testing Specifications.

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14.7.3 Central Interlocking Status Record (CISR)

The Test Engineer shall be in possession of the relevant CISR(s) with the Progress Record signed to confirm that the data is ready for testing before commencing pre-site or on-site testing of the interlocking. This shall apply to the initial testing and to any subsequent testing that may be required for corrections or alterations.

The Test Engineer shall add his own details to the Identification of Initials Section of the CISR and then fill in the relevant sections of the Progress Record as tests are completed.

14.7.4 Equipment or System Failures

During testing note and report any odd or erratic system behaviour, it could be very important.

Analyse the Technician's Terminal Disks if any oddities or serious failures occur. Make sure that the PC Logger is functioning correctly.

If a TFM appears to have an output or input interface failure, or it is found to have "gone to sleep" then first power it down and up and ensure that it is receiving the correct data. If the fault recurs then the TFM should be removed for repair. Always record these events in the test log book.

Always fill in the SSI failure report form for **EVERY** module failure and add relevant comments in the remarks space since this may provide valuable information to help identify the fault.

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Appendix A SSI Testing Flowchart

SCHEME PLAN – CHECKED

CONTROL TABLES – CHECKED

TRACKSIDE FUNCTIONAL MODULES TELEGRAM SCHEDULES – CHECKED

DATA LINK NETWORK PLAN - CHECKED

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LOCATIONS			INTERLOCKINGS
Location area plans - checked Location wiring diagrams - checked			Sub-route/overlap plans - checked. Map search plans - checked. Internal data link schedules - checked. Panel multiplex allocation schedules - checked.
PRE-SITE TESTING			
Visual examination of equipment. Wire count. Bell Continuity Test.	As for a relay installation.	Equivalent to relay room and signal box wiring diagrams plus any signal controls in locations.	Interlocking Data - checked. Panel Processor Data - checked. Diagnostic Data - checked. Simulator Data - checked.
ON-SITE TESTING			PRE-SITE TESTING
Megger Test all cables for earth and continuity. Visual examination of case and equipment. Wire count of all external and inter-case cable terminations. Bell Continuity Test of all inter-case wires. Check bus bars are free from earths.	Disconnect all Modules. As for a relay installation.	Equivalent to proving a test rig.	Exercise all controls and indications to verify the simulation system. Exercise all allocated input and output telegram bits on the internal and trackside data link and verify correspondence with the schedule and the indications displayed on the simulator VDUs.
Using the special test instruments exercise each trackside functional module output and input up to the end function or to the outgoing links including a strap and function test of any relay contacts. Verify each input to the schedule of telegram.	Equivalent to a strap and function test.	Equivalent to function test of a relay room with a test rig on the outgoing links plus auto signal controls and Aspect Sequence check on all signals.	Functional Test of all interlocking and controls to the Control Tables and signalling plans.
Check that the data link network is functioning correctly		Equivalent to testing disconnection links and temporary approach control.	Test the technician's controls.
Disable all trackside functional modules by removing their power supply fuses.			Verify each fault report capable of being recorded on the technician's terminal.
			Program, label and verify the EPROMS complete, check and seal the memory modules.

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			ON-SITE TESTING
			Interlocking room wiring diagrams - Checked.
			Visual examination of equipment. Check that information on memory module label is correct. Verify each central interlocking hardware identity and version numbers and when applicable, the control centre identity number. Continuity test on all internal cables. Check bus bars free of earth.
		Equivalent to a through test between the panel and the interlocking.	Convert each central interlocking to the simulation mode and check the correct operation of all indications and controls on the signaller's panel or VDU.
			Check a selection of technician's terminal fault reports and signaller's alarms.
		Equivalent to a through test between adjacent relay rooms.	Carry out a through test on all functions which cross interlocking boundaries using the internal data links. All controls to be tested again if only previously through tested on the design workstation. Prove that communication is possible with each link in turn disconnected.

<p>In each location check the correct operation of both data links. Connect each trackside functional module in turn to the data links and conduct a thorough functional test of all TFM outputs and inputs from the Control/Indication Panel or VDU through to the end function, if possible, or otherwise to the location outgoing links. Monitor the data link telegram content at the location and at the central interlocking.</p> <p>It is not necessary to re-test the internal logic already tested on the design workstation except where interfacing with adjacent relay controlled areas, level crossings, etc.</p> <p>Check that each trackside functional module will operate on each data link alone and verify fault reports when each data link is disconnected.</p>	<p>Equivalent to a Through Functional Test from the Control/Indication Panel to the end function.</p>
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COMMISSIONING	
<p>Restore each central interlocking from the simulation mode to the normal mode and replace all trackside functional module power supply fuses.</p> <p>Complete the Through Functional Tests where it was not possible to test prior to commissioning.</p> <p>In all cases tests should be carried out to ensure that all trackside equipment is operating correctly e.g., set all signal routes and verify that the correct aspects and route indications are displayed. Set all points normal and reverse and check correspondence between the detection and correct lie of the points on site, shunt each track circuit at each extremity and verify the indication, occupy and reset each axle counter track section and verify the indication, release and operate each ground frame, etc.</p>	<p>As for a relay installation.</p>

STATUS	BITS	SIGNAL MODULES		POINTS MODULE	
	S4	Data Link B (=1 if received data OK)		Data Link B (=1 if received data OK)	
	S3	Data Link B (=1 if received data OK)		Data Link A (=1 if received data OK)	
	S2	Output Interface (=1 if not red ret)		Output Interface (=1 if both OK)	
	S1	Input Interface (=1 if no faults)		Input Interface (=1 if no faults)	
	S0	Not used		Motors (=1 if no motor fault)	
	D7	Lamp proving (CP1)	(=1 if adequate current detected)	Y Detected Normal	(=1 if detection made)
	D6	Lamp proving (CP2, 3 or 4)	(=1 if adequate current detected)	Y Detected Reverse	(=1 if detection made)
	D5	Input 5	(=1 if input made)	X Detected Normal	(=1 if detection made)
	D4	Input 4	(=1 if input made)	X Detected Reverse	(=1 if detection made)
D3	Input 3	(=1 if input made)	Input 3	(=1 if input made)	
D2	Input 2	(=1 if input made)	Input 2	(=1 if input made)	
D1	Input 1	(=1 if input made)	Input 1	(=1 if input made)	
D0	Input 0	(=1 if input made)	Input 0	(=1 if input made)	

Table 3: Allocation of Message Data and Status Bits in Messages between SSI Central Interlockings and Trackside Functional Modules

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BITS		SIGNAL MODULE	POINTS MODULE (See note (iii))
D A T A	D7	Output 7 (=1 if o/p to be switched on)	Valve 3 (=1 if points Y to be norm)
	D6	Output 6 (=1 if o/p to be switched on) (See note (ii))	Valve 2 (=1 if points Y to be norm)
	D5	Output 5 (=1 if o/p to be switched on) (See note (ii))	Valve 1 (=1 if points X to be norm)
	D4	Output 4 (=1 if o/p to be switched on) (See note (ii))	Valve 0 (=1 if points X to be norm)
	D3	Output 3 (=1 if o/p to be switched on) (See note (ii))	Not used
	D2	Output 2 (=1 if o/p to be switched on) (See note (ii))	Not used
	D1	Output 1 (=1 if o/p to be switched on) (See note (ii))	Not used
	D0	Output 0 (=1 if o/p to be switched on) (See note (ii))	Not used

Table 4: Output Telegram: Central Locking to Trackside Functional Module

Notes:

- i) Output telegram status bits are not used and are ignored by all Trackside Functional Modules.**
- ii) A Signal Module can be configured by external wiring to control flashing signal aspects on outputs 5 & 6. In this module outputs 6 & 1 may not be used and outputs 2-7 are controlled by output telegram bits D2-D7 in the usual way, except that output 6 will flash if D1 is set in addition to D6 and output 5 will flash if D0 is set in addition to D5. Outputs 1 and 0 are controlled by /D6 and D5, thus providing sufficient current to maintain filament switching relays during the flashing of outputs 6 & 5.**
- iii) A Points Module can be configured such that motor output 1 can be associated with set Y or X. Motor outputs 3 and 2 are associated with set Y and 0 with X. Motor outputs are energised when their associated set's valves are energised and both motor and valve outputs stay energised until correct detection is made, up to a maximum of 8 seconds energisation.**

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Appendix B Solid State Interlocking Test Certificate – TC11 – 1 of 2

PLACE: _____
 DESCRIPTION OF WORK: _____
 SIGNALLING PLAN No: _____
 MASTER TEST CERTIFICATE No: _____

SHEET: No. of

INTERLOCKING NAME _____ VERSION NO. _____
 CENTRAL INTERLOCKING STATUS RECORD SERIAL NUMBER _____

P R E - S I T E T E S T S		REF	INITIALS	DATE	REMARKS
	Initial Tests	14.3.1 14.3.3			
	Input and Output Telegrams	14.3.1 14.3.4			
	Function Test to Control Tables	14.3.1 14.3.5			
	Design Integrity Test Except Interface Areas	14.3.1 14.3.6			
	Technicians Controls	14.3.1 14.3.7			
	Fault Reporting	14.3.1 14.3.8			
	Temporary Data Changes Restored and Tested	14.3.1 14.3.9			
	Cross Boundary Functions with other SSIs Tested	14.3.1 14.3.10			
	Cross Boundary Functions with other SSIs Tested	14.3.1 14.3.10			

O N S I T E T E S T S		REF	INITIALS	DATE	REMARKS
	Central Interlocking Initial Tests	14.5.6			
	Through Test-Internal Data Links	14.5.7			
	Through Test-External Functions	14.5.8			
	Commissioning Tests				
Complete Design Integrity Test for Interface Areas	14.5.7, 14.5.8,				

**RECORD DETAILS OF TESTS ON APPROPRIATE DOCUMENTS
 DATE AND INITIAL EACH SECTION ABOVE WHEN COMPLETE**

TEST ENG 1: _____

TEST ENG 2: _____

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Appendix C SSI Data Link System Test Certificate – TC11 – 2 of 2

PLACE: _____

DESCRIPTION OF WORK: _____

SIGNALLING PLAN No: _____

MASTER TEST CERTIFICATE No: _____

SHEET: No. _____ of _____

SSI DATA LINK SYSTEM IDENTITY

LOCATION OF TESTS	TEST	REF.	INITIALS	DATE	REMARKS
	Maximum amplitude	14.5.4 a)			
	Minimum amplitude from CI	14.5.4 b)			
	Minimum amplitude from TFM's	14.5.4 c)			
	Uniform message length	14.5.4 d)			
	Steady message amplitude	14.5.4 e)			
	No spikes	14.5.4 f)			
	Maximum amplitude	14.5.4 a)			
	Minimum amplitude from CI	14.5.4 b)			
	Minimum amplitude from TFM's	14.5.4 c)			
	Uniform message length	14.5.4 d)			
	Steady message amplitude	14.5.4 e)			
	No spikes	14.5.4 f)			
	Maximum amplitude	14.5.4 a)			
	Minimum amplitude from CI	14.5.4 b)			
	Minimum amplitude from TFM's	14.5.4 c)			
	Uniform message length	14.5.4 d)			
	Steady message amplitude	14.5.4 e)			
	No spikes	14.5.4 f)			
	Maximum amplitude	14.5.4 a)			
	Minimum amplitude from CI	14.5.4 b)			
	Minimum amplitude from TFM's	14.5.4 c)			
	Uniform message length	14.5.4 d)			
	Steady message amplitude	14.5.4 e)			
	No spikes	14.5.4 f)			

DATE AND INITIAL EACH SECTION ABOVE WHEN COMPLETED

NAME

SIGNATURE

TEST ENG 1: _____

TEST ENG 2: _____

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*****CENTRAL INTERLOCKING STATUS RECORD (CISR)*****

*** PART 1: TITLE BLOCK ***

CONTROL CENTRE/SIGNAL BOX

NAME: xxxxxx xxxxxx xxx

Identity No.:

SCHEME/INTERLOCKING

Scheme Directory Name: xxxxxxxx x.x

Interlocking Identity Number Range:

Interlocking Mnemonic: xxxx

Interlocking Identity Number:

CENTRAL INTERLOCKING STATUS RECORD (CISR)

Serial No.: **RAC**/xxx/xx/xx

Date/Time Created:

Previous CISR Serial No.: **RAC**/xxx/xx/xx

CISR as printed: N/A

Producer ()

Checker ()

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***** PART 2: PROGRESS RECORD *****

	Initials	Date
Reasons for New CISR:-	()	(/ /)

All Required Data Changes Prepared, data tried in DWS Simulation System, Last Change Records completed, data compiled and I/L data de-compiled without error, CISR completed, backups made and data passed to Checker.	()	(/ /)
All Independent Data Checks completed and: -		
(a) returned to Producer to correct data errors in accordance with error lists	()	(/ /)

or		
(b) no errors found; data ready for pre-site tests.	()	(/ /)
All Pre-site Data Testing completed and:-		
(a) returned via Checker for correction for data errors in accordance with error lists	()	(/ /)

or		
(b) no errors found, data EPROMS may be produced.	()	(/ /)
Data EPROMS and Memory Modules prepared and ready for on-site testing as defined in the Installed SSI Software Record.	()	(/ /)
All on-site Data Testing completed and:-		
(a) returned via Checker for correction of data errors in accordance with error lists	()	(/ /)

or		
(b) no errors found and data ready for commissioning.	()	(/ /)
Commissioned	()	(/ /)
Withdrawn From Service.	()	(/ /)

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***** PART 3: VERSION DETAILS & PRODUCTION/CHECKING RECORD *****

OBJECT CODE DETAILS

Type of data:	Date/Time:	Identifier:	Compiler/Device Checksum:
Interlocking MPM	x/x/xx xx:xx:xx	Issue G	xxxx
Panel PM	x/x/xx xx:xx:xx	Issue G	xxxx
Diagnostic MPM	x/x/xx	Issue G	N/A
Simulator MPM	x/x/xx	Issue G	xxxx
Interface Proc.	x/x/xx	Issue G	N/A

IDENTITY FILES

Item:	Date/Time:	Produced:	Checked:
ACM	x/x/xx xx:xx:xx	()	()
BUT	x/x/xx xx:xx:xx	()	()
ELT	x/x/xx xx:xx:xx	()	()
FLG	x/x/xx xx:xx:xx	()	()
IND	x/x/xx xx:xx:xx	()	()
PTS	x/x/xx xx:xx:xx	()	()
QST	x/x/xx xx:xx:xx	()	()
ROU	x/x/xx xx:xx:xx	()	()
SIG	x/x/xx xx:xx:xx	()	()
TCS	x/x/xx xx:xx:xx	()	()

GEOGRAPHIC DATA FILES

Item:	Date/Time:	Produced:	Checked:
MAP	x/x/xx xx:xx:xx	()	()
PFM	x/x/xx xx:xx:xx	()	()
IPT	x/x/xx xx:xx:xx	()	()
PRR	x/x/xx xx:xx:xx	()	()
FOP	x/x/xx xx:xx:xx	()	()
OPT	x/x/xx xx:xx:xx	()	()
PSD	x/x/xx xx:xx:xx	()	()
PPD	x/x/xx xx:xx:xx	()	()
PTD	x/x/xx xx:xx:xx	()	()
POD	x/x/xx xx:xx:xx	()	()
PBK	x/x/xx xx:xx:xx	()	()
DIA	x/x/xx xx:xx:xx	()	()
SIM	x/x/xx xx:xx:xx	()	()

INTERLOCKING SPECIFIC DATABASES

Item:	Date/Time: Mod. Rec. Date/Time	Produced:	Checked:
TFM Schedules Identities	x/x/xx xx:xx:xx	()	()

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PICTURE FILES

Item:	Date/Time:	Produced:	Checked:
signaller.pic1	x/x/xx xx:xx:xx	()	()
trackside.pic2	x/x/xx xx:xx:xx	()	()
Techterm.pic2	x/x/xx xx:xx:xx	()	()
Picture Linking to Identities	()	()	()
Picture Linking to TFM Schedules		()	()

SCHEME SPECIFIC (COMMON) DATABASES

Item:	Date/Time: Mod. Rec. Date/Time:	Produced:	Checked:
Cent. Interlg.	x/x/xx xx:xx:xx	()	()
IDL Telegrams		()	()
IDL Requests		()	()

SSI DESIGN WORKSTATION USED TO CREATE CISR

Software Iss/Rev: **SSI 8310-G** (cifer)

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***** PART 4: NON SCHEME SPECIFIC SOURCE DOCUMENTS *****

Item(s) current and used by	Producer	Checker:
SSI DATA PREPARATION GUIDE SSI8003		
Year of issue 19/06/1991 Issue L	()	()
Subsequent Amendments: 91/1 - 91/8	()	()
CODE OF PRACTICE FOR THE DESIGN OF SSI SIGNALLING SCHEMES SSI8500		
Issue:	()	()
Subsequent Amendments:	()	()
SIGNALLING DESIGN HANDBOOK		
Issue:	()	()

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***** PART 5: SCHEME SPECIFIC SOURCE DOCUMENTS *****

Item:	Number:	Issues:	Producer:	Checker:
Scheme Plan			()	()
Scheme Plan Overlays:			()	()
			()	()
			()	()
			()	()
			()	()
			()	()
Numbering Plan			()	()
Location Plan			()	()
Data Link Network Plans			()	()
Power Cable Plans			()	()
Panel Faceplate			()	()
Panel Multiplex Schedules			()	()
Control Tables			()	()
Sub-route/Sub-overlap Plans			()	()
Map Search Plans			()	()
Other Documents:				
ARS route lists			()	()
VDU displays			()	()
Error List from:				
Data Checking			()	()
Pre-site Testing			()	()
On-site Testing			()	()
Other Lists Defining Changes:			()	()
			()	()
			()	()
			()	()

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***** PART 6: PROGRAMS TO BE USED WITH DATA *****

Program:	Reference/Issue:
Technician's Terminal	SSI4301-Dx
Panel PM	SSI4302-Ex
Interlocking MPM	SSI4303-Dx
Diagnostic MPM	SSI4306-Cx
Simulator MPM	SSI4307-Cx

Program/DWS Software Issue/Data Compatibility
Check to SSI8003-CMP: See Note 1 pt 8

Producer:
()

Checker:
()

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***** PART 7: COMPATABILITY OF RELATED SYSTEMS *****

System:	Issue/Version:	Producer:	Checker:
Adjacent Central Interlockings:		()	()
		()	()
		()	()
Fringe Signal Boxes:		()	()
		()	()
		()	()
		()	()
IECC:		()	()
Level Crossings:		()	()
		()	()
		()	()
		()	()
		()	()
		()	()
Ground Frames:		()	()
		()	()
		()	()
		()	()
Other Systems:		()	()
		()	()
		()	()
		()	()
		()	()
		()	()

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***** PART 8: APPENDIX FOR COMMENTS AND ADDITIONAL ITEMS *****

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***** PART 9: IDENTIFICATION OF INITIALS *****

Initials	Name	Signature	IWMP/Contractor	Location

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SOLID STATE INTERLOCKING HARDWARE RECORD

CONTROL CENTRE :

INTERLOCKING NAME :

MODULE DETAILS	
MODULE TYPE :	.....
SERIAL NO. :	.....
MODIFICATION STATE :	.....
DATE INSTALLED :	.....
LOCATION INSTALLED :	.....
MODULE ADDRESS :	.....

FAILURE RECORD	
DATE OF FAILURE :	.....
FAILURE DETAILS :	.....
DATE REMOVED :	.....
REPLACED BY SERIAL NO. :
DATE SENT FOR REPAIR :
DATE RETURNED FROM REPAIR :

MODIFICATIONS
.....
.....
.....
.....
.....

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INSTALLED SSI SOFTWARE RECORD

CONTROL CENTRE: CISR/ISSR SERIAL NO:

INTERLOCKING INTERLOCKING
 NAME (MNEMONIC): IDENTITY NO:

CONTROL CENTRE
 IDENTITY NO:

INTERLOCKING CUBICLE & TECHNICIAN’S TERMINAL DETAILS

EQUIPMENT	BR SPEC OR MARK	PROGRAMME EPROMS				COMPATIBLE MODIFICN STATES OF MODULE
		REFERENCE NO ISSUE	DEVICE CHCKSM	DEVICE POSITION	INDICATED EXTERN BY	
Technician’s Terminal		SSI4301-.....	.....	IC12 IC20	Terminal Display	N/A
Panel Processor Module (PPM)	1908A	N/A	N/A	N/A	N/A	.....
Multi-Processor Module (MPM)	1905A	SSI4304-..... SSI4305-.....	.....	IC102/6 IC110	Modification St. .....	.....
Memory Module PPM	1911A-.....	SSI4302-.....	.....	IC5	Front Label	.....
I/L MPM	1911A-.....	SSI4303-.....	.....	IC5	Front Label	.....
DIA MPM	1911A-.....	SSI4306-.....	.....	IC5	Front Label	.....
SIM MPM	1911A-.....	SSI4307-.....	.....	IC5	Front Label	.....

MEMORY MODULE FOR	DATA EPROMS		MEMORY MODULE RECORD			
	REFERENCE : INTERLOCKING MNEMONIC-TYPE-VERSION SUBVERSION	DEVICE CHCKSM	QTY INC SPS	MF’R	MANUFACR’S SERIAL NUMBER	EPROMS INSTALLN CHECKED BY
PPM	.....PAN-.....	.....	.....	.....	.....	.....
I/L MPM	.....-INT-.....	.....	.....	.....	.....	.....
DIA MPM	.....-DIA-.....	.....	.....	.....	.....	.....
SIM MPM	.....-DIA-.....	.....	.....	.....	.....	.....

* Printed name & signed initials of checker

The Interlocking mnemonic is the name as defined on the SSI Design workstation and used on Data EPROM labels. Data EPROM position is IC4 and the Data Reference is indicated externally on MM front label. The number of spaces for Memory Module serial numbers provided on this form is not an indication of how many, including spares, are required: these are as laid down by the Maintenance Authority.

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INSTALLED SSI SOFTWARE RECORD

CONTROL CENTRE: _____ CISR/ISSR SERIAL NO: _____
 INTERLOCKING NAME
 (MNEMONIC):

HARD WIRED INTERLOCKING VERSION NUMBER

This is based on the I/L MPM Data Version Number, divided by eight and the remainder converted in a three-bit binary number. For each bit at zero, a loop is then required in the 50 way connectors for all three I/L MPMs.

V. No	BIT	MOST SIGNIFICANT	MIDDLE	LEAST SIGNIFICANT
Rmdr				
Biny	LOOP	v to x	z to BB	DD to FF
REQUIRED (Y / N)				
INSTAL CHK# (TICK)	..... NO CHANGE	OR	..... TOP MPM	..... MIDDLE MPM
				..... BOTTOM MPM

Example : 19 divided by 8 gives remainder 3, binary 011; hence loop v to x

COMPATIBLE AND ALLOWABLE ASSOCIATED EQUIPMENT

EQUIPMENT	BR SPEC	PROGRAMME		MODIFICATION STATES
		REF NO.	ISSUE	
Signal Module	1902A	SSI4311	..... to .....	..... to
Points Module	1901A	SSI4312	..... to .....	..... to
Long Dist Term	1906	SSI4330	..... to .....	..... to
Data Link Module	1904A	N/A	N/A	..... to

Note : Compatibility of this equipment with Interlocking Cubicle equipment Hardware and Software is specified in SSI8150. ‘Allowable’ refers to additional constraints on equipment choice defined by local conditions or requirements.

DATA MASTERS HELD BY :

RECORD PREPARED BY : **CHECKED BY :**

AT OFFICE : **DATE :** / /

INSTALLATION CHECK OF # ITEMS :

CHECKED BY : **DATE :** /

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