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Level 2

The Verification and Validation of Electronic Interlockings

Endorsement and Authorisation

For endorsement, authorisation and issue record of this document, please refer to NR/L2/SIG/30014

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Issue record

Issue	Date	Comments
01	September 2014	Initial Issue. Detail extracted from F110.

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 7 March 2015.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 3 (Option Selection) to continue to comply with the issue of any relevant Network Rail standards current when GRIP Stage 3 was completed and not to comply with requirements contained herein, unless stipulated otherwise in the scope of this standard.

Reference documentation

NR/L2/SIG/11201	Signalling Design Handbook
NR/L2/SIG/30014	Signalling Works Testing Handbook
NR/L2/SIG/30014/A100	Selection of Standards for Signalling Testing
NR/L2/SIG/30014/A110	Signalling Works Testing
NR/L2/SIG/30014/B410	Signalling Works Testing Staff Competence Assessment
NR/L2/SIG/30014/C120/TP01	Test Plan form
NR/L2/SIG/30014/C310	Test Certificates and Check Marking and Recording on Test Copies
NR/L2/SIG/30014/E110	Signalling Works Testing Glossary

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Contents

1 Purpose 4
2 Scope 4
3 Flowchart 4
4 Procedure 5
4.1 Control Table Testing 5
4.1.1 Point Interlocking Controls 5
4.1.2 Signal Route Interlocking Controls 14
4.1.3 Preset Shunt Signals 27
4.1.4 Signal Routes with Reduced Overlaps 32
4.1.5 Special Controls 36
4.1.6 Testing of Signal Aspect Controls 36
4.1.7 Testing of Approach Locking 53
4.1.8 Testing of Train Operated Route Release (TORR) 63
4.1.9 Automatic Signals 69
4.1.10 Banner Repeating Signal Controls 69
4.1.11 Automatic Warning System (AWS) Test 70
4.1.12 Train Protection and Warning System (TPWS) Test 71
4.2 Signal Aspect Test 72
4.2.1 Purpose 72
4.2.2 Scope 72
4.2.3 Procedure 72
4.3 Validation – The Principles Test 73
4.3.1 Procedure 73
4.3.2 Validation – Further Considerations 73
4.3.3 Control Table Ticker 74
5 Abbreviations and Definitions 74
5.1 Abbreviations 74
5.2 Definitions 74

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1 Purpose

This document is part of the suite of documents contained within the Signalling Works Testing Handbook, NR/L2/SIG/30014, which together detail the requirements for signalling works testing activities.

The document NR/L2/SIG/30014/D120/TS11-01 “Test Specification for Control Tables and Principles Testing” references this document specifically for Electronic Interlockings.

This Level 2 document sets out the requirements for the Verification and Validation of Electronic Interlockings to be used during signalling works testing. It has been produced as a “best practice” relating specifically to Solid State Interlocking. Testing of other types of Electronic Interlocking may vary.

2 Scope

This Level 2 standard applies to work that meets the selection criteria for NR/L2/SIG/30014/A110 or NR/L2/SIG/30014/A210 as defined in NR/L2/SIG/30014/A100.

3 Flowchart

None

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4 Procedure

4.1 Control Table Testing

Where the Principles Tester has been involved in the development of the interlocking and control system data over several iterations, this could compromise the independence of his position. To ensure this is prevented, a second principles tester shall review the involvement of the original Principles Tester to determine whether his independence has been compromised.

Preparatory Notes:

It is essential when testing Route Interlocking Controls (particularly point controls) to ensure that approach locking or other controls do not mask the tests. In such cases or where any doubt exists measures should be taken to prevent the signal for the route under test becoming approach locked.

The Control Table Test verifies the correct inclusion of the safety-critical and safety-related controls required in the Interlocking system under test. It is imperative that the testing of the one is not masked by the other. For example: where the safety Interlocking system controls are operated from and indicated into the Operators Signalling Display facility via an electronic interface (e.g. Panel Processors, etc.), such interfaces often include non-safety electronic processing between the operating display facility and the Safety interlocking. It is essential in systems using these interfaces that the electronic processing is bypassed or removed during the Control Table test, since the electronic processing often duplicates the safety interlocking and may compromise the integrity of the testing.

As with conventional systems it is essential when testing SSI Route Interlocking Controls (particularly point controls) to ensure that approach locking or other controls do not mask the tests. In such cases or where any doubt exists measures should be taken to prevent the signal for the route under test becoming approach locked. This can be carried out by preventing the signal from clearing (by failing a signal lamp ahead for example) but care must be taken when "ASCON" controls approach lock a signal prior to its clearance and in this case fail a control within this ASCON condition.

By utilising a DWS system the problem of non-vital controls masking vital controls is removed as the system directly tests the validity of the interlocking. By direct observation of the QST requests on the Technicians terminal, the tester can be confident that the vital controls are being directly accessed and hence no masking is taking place.

4.1.1 Point Interlocking Controls

4.1.1.1 General

In order to simplify the test of Point Interlocking Controls the anti pre-selection feature may be made ineffective where the interlocking design permits this to be easily achieved although it is not essential to do so. Removal of the anti pre-selection will enable a call to move locked points to be made and stored such that the points will move to the called position immediately they become free.

For interlocking systems which do not allow the simple removal of anti pre-selection controls, it will be necessary to key the locked points after each phase of the interlocking test (remembering to allow sufficient time for the pre-selection to reset). In these circumstances the attempt to key the locked points should be repeated to double check that the points are not free.

***With SSI t**here are two occasions when this facility cannot be used:*

1). When Newton data is present in the interlocking (i.e. When an entrance / exit panel is the final operating product).

2). When testing swinging overlap controls against key locked trailing points (due to the nature of constant key centre controls).

Where the anti-preselection feature cannot be used then the points will need to be attempted to move for each change of FOP data (i.e. for each separate track occupation condition) but the need to attempt the points twice is no longer required as the QST request is the positive result that the interlocking is being accessed.

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4.1.1.2 Point to Point Locking

The following sequence of tests should be carried out to ensure that any point-to-point locking provided is effective:

- Operate points under test normal to reverse and back to normal to prove points are free to move.
- Move the locking points to the position required to apply lock to points under test.
- Check point under test is now locked.
- Move the locking points back to original position.
- Check that the point under test is now free and operate into reverse position.
- Test similarly for converse if it applies, repeating the above commencing with points under test in reverse position.

4.1.1.3 Point Locking by Train Detection

The following sequence of tests should be carried out to ensure that the points are locked when required by the separate occupation / operation of the direct and foul track circuits or other train detection devices:

- Operate points under test normal to reverse and back to normal to prove points are free to move.
- Occupy / Operate track circuit or train detection device.
- Check that the points under test are locked and observe points remain in normal position by placing and retaining the key in the reverse position.
- Clear track circuit or train detection device.
- If anti pre-selection has been disabled then points under test will immediately move to reverse position.
- If anti pre-selection is operational points under test will remain normal with key in reverse position. To verify points are free in this case, move key to centre position, pause to allow anti pre-selection to reset, then move key back to reverse position and observe points move reverse.
- Test similarly if the converse applies repeating above commencing with points under test in reverse position.

The above tests should be repeated separately for both normal to reverse and reverse to normal locking of points under test for each specified track circuit and train detection device.

4.1.1.4 Point Direct Locking by Setting of Signalled Routes

Tests should be made to ensure that every signalled route reading over the points under test when set directly locks the points in the position required for the set route.

The following tests covering all points in the route should be carried out with the interlocking fully operational and no routes set and all point keys in the centre (free) position:

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- Set all points in the route (including overlap) to the position opposite to that required for the route to be set, returning the key to centre position to leave the points free.
- Set the route and ensure all the points in the route (including overlap) move to the position required by the route and opposite to that set above.
- Check that all the points in the route that moved above are now locked by keying each one to the opposite position and observe that they do not move.

The above tests should reveal any timing problems that may exist with the setting of the route. (With all points in the route requiring to be moved, the maximum time to complete the setting of the route will be taken). This will manifest itself in the form of a coded alarm (either major or minor cycle) fault on the technicians terminal.

Tests should be carried out separately on each set of points in the route to ensure that the route set directly locks the points.

However with SSI only the sub route locks the position of the points (as separate route lock does not exist) and are therefore present in the PFM file. This can be checked by examination of the data

4.1.1.5 Point Maintained Locking by Setting of Signalled Routes

Tests should be made to ensure that:

- All points in a signalled route are maintained locked after the train has entered the signalled route and the route having been returned to normal (e.g. Signaller cancelling the route by pulling the entrance button or by 'TORR' facility automatic normalisation).
- The points are maintained locked until the train has passed clear of the points.
- The section of route over the points releases and the points become free immediately the train has passed clear.

It is essential to ensure by a positive check that the set route has been returned to normal before commencing the testing of the maintained locking. This ensures that where the approach locking had been applied when the signalled route was set it has been returned to normal.

The following tests should be carried out to verify the route maintained locking of points.

- With no routes set and all point keys in centre position operate the points to be tested normal to reverse and back to normal to prove they are free to move.
- Set the route and check that the points under test are now locked by applying a call to the opposite position using the point key. Leave point key in the position applying the call if the anti pre-selection is disabled, or place point key in centre if the anti pre-selection is operational.
- Occupy the first track circuit beyond the entrance signal to simulate a train moving through the set route.
- Cancel the set route by pulling the entrance button.

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- Check points under test have not moved to correspond with call on point key (anti pre-selection disabled) or call points to opposite position using key and check points are locked then place key back to centre position (anti pre-selection operational).
- Occupy the next track circuit in the direction of the set route and then clear the previously occupied track circuit. (Note: to ensure the validity of this test it is essential to maintain continuously a track circuit occupied in the route throughout this test until the simulated train movement has passed clear of the points under test).
- Repeat the last three tests detailed above for each separately occupied track circuit in the direction of the set route as far as the track circuit for the section of route prior to the one containing the points under test.

As there is no available means to remove the dead track locking on the points and as such the locking can only be effectively tested up to the previous (non-dead locking) subroute. The only exception to this rule is where anti bobbing protection is present and in this case the last track section can be cleared giving the tester 15 seconds to attempt to move the points (cross referenced to the white lights appearing) following which the points become free.

There is no need with SSI to carry out the tests to prove track dead locking between the signal applying the locking and the actual dead locking tracks over the points. This is backed up by direct observation of the PFM listings which reflects the subroute lock and the actual dead locking tracks.

NOTE Some versions of control tables do not include the points track circuit in the maintained locking entry.

When the above series of tests for each track circuit in the route reaches the stage where the points track circuit is cleared, ensure that the points under test are now free. Either the points will move immediately to the opposite position (anti pre-selection disabled) or the points can be moved to the opposite position using the point key (anti pre-selection operational).

If a preset / preceding shunt position light signal is present in the set route, it is essential that this signal is prevented from clearing throughout all the above detailed point maintained locking tests. Also throughout these tests attempts should be made to check that the preset route cannot be cancelled (by pulling up the preset shunt entrance button) and that any points in that route cannot become free.

Maintained locking of trailing points in the overlap of the set route should be tested exactly in accordance with the above. Additionally, tests should be carried out to ensure such locking of trailing points is released when the train passing through the route is proved to be at a stand at the exit signal at red. Such proof is usually achieved by occupation of the berth track circuit of the exit signal for a time period determined from the length of the berth track circuit and stated in the control tables.

The following requirements should be proved before locked trailing points in the overlap become free:

- The berth track circuit of the exit signal at red has been occupied for the time stated in the Control tables.

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- The set route up to the exit signal at red has been returned to normal (by signaller cancelling the route by pulling entrance button or by 'TORR' facility having operated).
- All track circuits in the overlap of the set route are clear.
- All track circuits between the entrance signal and the occupied berth track circuit at the exit signal for the set route are clear (no Long Train facilities provided – i.e. berth track circuit of exit signal is of a greater length than the longest train operated).

or

- Where 'Long Train Overlap Release' facilities are provided, the conditions for such release are present as stated in the control tables.

*It is necessary to provide **Long Train Overlap Release** facilities in the following situations:*

- *When the exit signal berth track circuit is shorter than the maximum length of train operated plus 30 yards to allow for the train stopping short of the signal post.*
- *When the entrance and exit signals of the route are closely spaced such that the maximum length train, when at a stand at the exit signal at red, does not clear the track circuits at the entrance signal that permit the route to normalise. Without these track circuits clear the set route will not be returned to normal when the entrance signal button is pulled. This would prevent the release of the route locking of the overlap trailing points when the train had timed to stand at the exit signal.*
- *The 'long train overlap release' provision allows for further track circuit(s) to be occupied in rear of the exit signal short berth track.*

For closely spaced entrance and exit signals the 'long train overlap release' provision enables the approach locking to be specially released on the entrance signal after the berth track circuit of the exit signal has been occupied the time required to bring the train to a stand and all track circuits are occupied between and including the entrance signal approach locking release track and the exit signal berth track.

Long train overlap release provision should be provided only as stated in the approved Control Tables.

The provision should only be made to those routes where it is necessary to permit operating flexibility and extended to the minimum required to cater for the longest train permitted to operate over the line of route.

Where 'time released overlaps' are provided a further test should be made to ensure that the release of the overlap will not occur if the train enters the overlap passing the exit signal at red. This is particularly important where the overlap consists of more than one track circuit and where the overlap trailing points are not within the first track circuit beyond the exit signal.

Because SSI locks down all subroutes and suboverlaps within a particular route at the time of setting and this function is carried out in one minor cycle. (i.e. there is no "cascade" as there is for conventional USR's). For the actual sectional route releasing, the FOP file is utilised which releases each sub route (sub overlap) in turn by a similar method to a USR chain, i.e. each subroute requires the previous subroute free plus its own dead locking track.

Once the FOP file has been tested as part of the initial tests then the tester can gain confidence in the actually locking application i.e. the moment the subroute (overlap) becomes locked to the moment it becomes free and hence release the points.

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With regard to trailing points within the overlap, the sub overlap direct lock needs to be seen plus the timed berth occupied release needs to be seen also. It is essential that where a sub overlap is allowed to “time out” that proof of the originating route normal is also present. This can be tested by running a long train through the route preventing the route from normalising. After the berth track section has timed out, the sub overlap providing the point locking should still be present until the originating button is pulled and the route has normalised.

Where long train release is present then the route relay interlocking method of testing should be utilised.

4.1.1.6 Time of Operation Locking of Facing Points

This point locking occurs where facing points exist in a main signal route overlap a short distance in advance of the exit signal. Where such points exist within the defined distance tests should be made to ensure these facing points are locked in either position when the exit signal berth track circuit is occupied by a train approaching that signal at red.

Such point locking is called ‘Time of Operation Locking’ and is included to prevent a train overrunning the red exit signal reaching the points in mid-position when called to move.

Time of Operation Locking should not be applied when shunt, calling-on or ‘Warning’ class routes are set up to the protecting signal.

The period of time that the berth track circuit must be continuously occupied before the facing points become free should be as specified in the Control Tables.

The tests for Time of Operation Locking in SSI also require proof that the points are free if the berth track timer has run with the originating route overset to be tested for. This ensures that the data has berth subroute free or berth occupied for time rather than suboverlap free within the PFM file.

Verification of ‘Time of Operation’ locking on facing points should be made by carrying out the following series of tests:

- Ensure the facing points are free when no signalled route up to the exit signal is set and the berth track circuit of that signal is occupied.
- Set a main route up to the exit signal and check facing points remain free.
- Simulate passage of train through the set route and check that the facing points remain free for separate occupation of each track circuit up to but excluding the berth track circuit of the exit signal.
- Check that the facing points become locked immediately the exit signal berth track circuit becomes occupied and remain locked with only that track circuit occupied.
- Check that the facing points do not become free until the specified time occupation of the berth track circuit has elapsed.
- Repeat the above series of tests for the same facing points to verify the lock preventing the points being moved to the opposite position to that used initially.

The above tests should be separately repeated for all other main routes reading up to the exit signal protecting facing points in the overlap to which time of operation locking is applied.

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Routes reading up to the exit signal which are not main routes (e.g. shunt, calling-on or Warning class) should also be set and similar tests carried out as above to verify that these routes do **not** apply time of operation locking of the overlap facing points.

Proof that the points are free if the berth track timer has run with the originating route overset needs to be tested for. This ensures that the data has berth subroute free or berth occupied for time, rather than suboverlap free within the PFM file.

4.1.1.7 Special Controls – Locking of Points Not Directly in the Route

Special controls should be included to lock points that are not directly in the line of the set route to provide the following:

- Overrun Protection by point setting.
- Operating flexibility to permit the setting of parallel moves (e.g. through points which are directly locked by an occupied track circuit in the set route and would be prevented from moving to the position required by the permitted parallel route. Such points must be set to and locked in that position by the set route).

Tests should be carried out to ensure that **all** the required special setting and locking of points outside the line of the route is included to provide the above protection and flexibility.

4.1.1.8 Self-Restored Point Controls

Tests should be made to ensure points fitted with self restoration controls automatically revert to the designated normal position when the specified restoration conditions as stated in the Control Tables apply correctly.

On SSI systems special care should be taken when checking the generation of alarms as detailed below:

- The call on the points to go normal is literally based on the fact that the points have been free for a designed period of time and as such should be tested to ensure no movement prior to that elapsed time.
- The failure indications are based on the failure of the points to make normal detection after they have been called to that position or the failure of the route locking to normalise after the passage of a train.
- That if a failure is generated and then a legitimate route is overset through the points, then the alarm is cancelled. Each individual route must be seen as this functionality is all separately written data.

The tests carried out should ensure self-restored points only drive automatically to the normal position whenever all the following conditions apply:

- The points are not lying detected normal.
- The points are free of locking.
- The specified required time has elapsed since the points became free.

The following tests should be carried out to confirm that:

- After a signal has cleared, the train runs over the points but the route fails to TORR, the route lights are flashing (try for all routes)

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- The track circuits that inhibit the flashing indications do not prime the indications to start for another route (train must traverse the points to initiate flashing)
- The points have auto normalised but failed to detect normal
- Following keying the points reverse, break normal detection, key points normal, there is no flashing indication
- The flashing indication is inhibited when 15 second bobbing protection is in place if going onto an untracked line

Indications may have to be inhibited depending on what the TORR conditions are.

- If flashing starts, it can only be stopped by normal detection being made **or**
- Points route locked reverse
- Points will auto normalise when free after 10 seconds but will move immediately if held by 15 second bobbing protection when a train runs onto an untracked line
- Points will auto normalise if keyed normal & lying reverse
- If points are keyed normal before auto normalising starts (within 10 seconds) if detection fails to make normal, the flashing indication is inhibited

For cross-boundary or split request routes, carry out tests for route setting with normal detection disabled, let points auto normalise and then try all routes that set points reverse to ensure the points are not commanded to go reverse in the first data statement. (Route will not set as auto normalising data will control points normal when they are not cdn).

For points not fitted with automatic self restoration which are required to be manually restored to and maintained normal for trapping protection, tests should be made to ensure the necessary indications and alarms (where provided) operate to alert the signaller to set the points to the normal position whenever all the same three conditions have been regained after use as detailed above for automatic self restored points.

4.1.1.9 Anti Pre-selection of Points

If the above detailed Point Interlocking Controls have been tested with the Anti pre-selection feature made ineffective, this control must now be restored and tested.

If the above detailed point controls have been tested with the Anti pre-selection feature effective, using point key operation from the centre position throughout, then the foregoing tests will have verified the anti pre-selection.

Proof of the re-instatement of the anti-preselection following point tests is not required with SSI as this control is generated via the trackerball and hence confirmation that the control is present is based on the lack of point identity flashing on the signaller's display.

4.1.1.10 Route Setting and Locking by Points

Points should apply a lock to a signal route to prevent that route from setting unless the points are lying in the required position or free to move to that position.

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Signal routes when setting should apply a call to all points required by that route (including those in the overlap and those set for overrun protection and operating flexibility) to move them to the required position when they are free and lying in the position opposite to that required by the route.

The following sequence of tests should be carried out to verify the points lock against the signal route and the calling of the points by the route setting (the tests should be applied separately to each set of points in the route under test):

- Set points under test to the opposite position to that required by the signal route and lock them in this position using point key.
- Set all other points keys in the centre (unlocked) position.
- Try the signal route and check it will not set. Confirm the correct QST request is generated and seen on the technician's terminal.
- Remove lock on points by placing key to centre position, leaving the points lying in opposite position to that required.
- Try the signal route and check that the route calls the points under test to the correct position required by the route. Ensure that the signal route fully sets.
- Cancel the signal route and check points under tests are now free.

The above sequence of tests should be separately repeated for each set of points required by the signal route under test.

4.1.1.11 Incorrect Route Calling of Points

A check should be carried out to ensure that points are called to operate only by routes that require them set to the position called.

During the testing of each signal route verification should be made to ensure that the route when set only calls points to operate as required by the control tables.

Often called the "Rogue points call" test and can have limited value where conditional calls are present. A rogue point call test will only detect calls which are specific to the point positions at the time of the call; hence if a point drive is only present with a conditional set of points normal, and these points happen to be reverse then the test will NOT detect this. It can be seen that the potential permutations are too numerous for this type of testing to positively detect all options.

With SSI this test is best carried out as a visual examination of the route command path in the PRR file which lists the point calls (and only those calls) within the route. This can be combined with a cross reference to the "Test" data such that only those points tested available are called. This is essential as there is currently no syntax test within the SSI to prove what the route is testing available is actually what is being called.

4.1.1.11.1 Standard Rogue Point Test

The tester should place ALL points in the interlocking to the normal position and then set the route under test, then note which points are called reverse. This is then repeated with by the tester placing ALL points in the interlocking to the reverse position and then again set the route under test, but this time taking note of which points are called normal. This will indicate if any rogue points are being called by the route.

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4.1.1.11.2 Swinging Overlap Rogue Point Test

With All points NORMAL

- Call all points in the interlocking NORMAL.
- Set the route under test & ensure that only those points, which should be called REVERSE, are called.
- Call the overlap hinge points of the route under test REVERSE & ensure that only those points, which should be called REVERSE by the overlap are called.
- Call overlap hinge point of route under test back to NORMAL & ensure that only those points, which should be called REVERSE by the overlap are called.
- Cancel route under test.

With All points REVERSE

- Call all points in the interlocking REVERSE.
- Set the route under test & ensure that only those points, which should be called NORMAL, are called.
- Call the overlap hinge points of the route under test NORMAL & ensure that only those points, which should be called NORMAL by the overlap, are called.
- Call overlap hinge point of route under test back to REVERSE & ensure that only those points, which should be called NORMAL by the overlap, are called.
- Cancel route under test.

4.1.2 Signal Route Interlocking Controls

4.1.2.1 Route to Route Class Locking

Where different classes of route to the same destination exist from a signal, tests should be made to ensure that locking is present to permit only one route to be set to a particular destination at any one time.

For example, if the shunt class route is set on a signal, the main class route cannot be set from that signal to the same destination until the shunt class route has been fully returned to normal.

In order to test that this route to route locking is present for a signal it is necessary to prevent the route fully normalising when cancelled. Checks should then be made to ensure that no other route of a different class to the same destination can be set from the signal.

The prevention of full route normalisation is to Approach Lock the initial route set before pulling the entrance button. During the period before the Approach Locking has time released, attempt to set the other route(s) from the signal to the same destination as the route set initially. Ensure the routes will not set until the initial route has time released and fully normalised.

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To ensure that the “new” class has not been achieved, the route identity can be directly monitored from the technician’s terminal.

It is essential when trying to set the other route(s) that all the required conditions for these routes are selected such as correct track circuit(s) occupation and appropriate exit button operation.

With SSI the end result is to ensure that the cross locking of the route identities appears in the PRR test of the route. As there is only one route identity, this identity has to be proved unset in the “other” class routes availability.

4.1.2.2 Selection of Class of Signal Route

4.1.2.2.1 Selection of Signal Route Class – General

In order to meet the requirements of Operating Specifications it may be necessary to provide different classes of route from a specific entrance signal to the same destination signal.

Signal Route Class Selection falls into two categories:

- Main or Calling-on Route Class dependent on train occupation of a permitted permissive section of the route.
- Main or Warning Route Class dependent on overlap selected.

The latest standards tend to utilise separate exit buttons and as such separate route requests can be utilised to split the route commands.

If common buttons are used for “Call on” purposes then the data tests for a (“if track clear condition, then process main, else process call on”) which differentiates the two sets of data for the specific routes. As the PRR is only accessed at time of setting then the class of route will remained locked in until the passage of a train or normalisation by the signaller.

As the class is established by registering a class route identity within the PRR, aspect conditions will be processed mutually exclusively within the OPT file.

4.1.2.2.2 Circuit Selection of Main or Calling-on Route Class

The class of route (Main or Calling-on) is established at the time of setting dependent on the state of the track circuit(s) in the section of route where permissive working is authorised.

Tests should be carried out to ensure that:

- The signal for a Calling-on route is not replaced by clearing the ‘permissive track circuits’.
- The permissive working section track circuit(s) are only those specified in the approved Control Tables.
- The Route Class established obeys the state of all the track circuits in the route **at time of setting** as follows:

Main Class set – All permissive working section track circuits clear.

Calling-on Class set – A track circuit occupied in the permissive working section.

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Once a Calling-on Class route has been established the state of the route set cannot be changed by subsequent clearance of all the permissive working section track circuits (i.e. the set calling-on route will not automatically change state to a main class route).

- Similarly, once a Main Class route has been established the status of the route set cannot be changed by subsequent occupation of a permissive working section track circuit (i.e. the set main class route will not automatically change to a calling-on class route).

Where a signal has a main and calling-on route to the same destination tests should be made to verify that a set calling-on class route cannot be changed to a main class (or vice versa) unless the initial route class set is cancelled and fully normalised and the route set again. The class of route should then be established in accordance with the state of the permissive working section track circuits at the time of re-setting.

4.1.2.2.3 Main or Warning Class Route Selection

A Warning Class route is similar to a Main Class route but has a Restricted Overlap. The signal aspect for a Warning Class route is delayed clearing to yellow from red until the berth track circuit has been occupied for the required time.

The class of route (Main or Warning) is established by operation of the appropriate route exit function for either a Main Class (Full Overlap) or Warning Class (Restricted Overlap). Tests should be carried out to verify that only the correct route class is established for the exit function operated.

4.1.2.2.4 Stepping Up of Warning Class Route to Main Class Route

Where a Warning Class route facility exists, tests should be made to ensure that the Warning Class route steps up to a Main Class route whenever a forward route is set on the exit signal providing a full overlap for the initial Warning Class route set.

A check on the 'stepped-up' route should be made to confirm that:

- The delayed yellow control has been released.
- The full overlap is locked and maintained when the forward route set ahead of the exit signal is cancelled and fully normalised.

With the Warning Class route under test set and no forward route set on the exit signal a check should be made to ensure the portion of the full overlap ahead of the restricted overlap limit is free of all locking.

With the Warning Class route under test **not** set, select and set a forward main route ahead of the Warning Class route (i.e. set a main route from the exit signal of the warning route). Now set the warning route under test (using the correct warning exit function) and check that immediately upon setting the warning route set has stepped up to a main class route. This is verified by cancelling the forward route initially set from the exit signal and (when this route has fully returned to normal) observing that the warning route set has a locked full overlap. This proves that the warning route has 'stepped up' to a main route and maintained the Main status even though the set forward route that caused the step up in status has been cancelled / normalised.

If the controlled signal (on which Main and Warning Class routes exist) is equipped with an individual automatic working facility which applies to the Warning Class route and it is set to work in automatic mode for that route then it shall step up to a main

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route whenever a full overlap is provided by the forward route setting as specified above. Tests should be made to verify this as above with the warning route set in automatic mode.

In addition a further test should be made to ensure that the warning route set in auto-working mode **steps down** to Warning Class only, after the passage of each train, with it in a 'stepped up' to Main Class state. This is because the forward route set for the passing train had provided the warning route with a full overlap state. A check should be made to ensure the 'stepped down' Warning Class state is retained when the forward route is not set again after the passage of the train. Observations should be made to ensure when the forward route is not set again that the route 'stepped down' to Warning Class status has the delayed yellow control re-applied and only a locked restricted overlap displayed.

A check on the 'stepped up' route should be made to confirm:

- The main route to be available - not barred by technician's control.
- The signal is at RED and has not been OFF as a Delayed Yellow - i.e. still free of approach locking.
- It has to be ready to clear - i.e. all aspect controls including foul conditions available except the tripping condition (so that a train in the route with the exit off will prevent route step up).
- The additional overlap controls required by a main aspect have to be clear.
- A route must be set from the exit & the exit signal stick must be set.

On stepping up:

- The new limits for the overlap will be set (note if this can swing each forward route must be functioned to correspond new overlaps limits).
- Additional aspect controls have to be tested.
- Test full O/L is not held by warning route set in rear.
- Test full O/L is timed off leaving ROL with Warning in rear after Main route.

Aspect sequence:

- A warning route will have a full aspect sequence relative to the condition of the exit, but on aspects better than yellow will not have additional aspect controls required by the main route overlap.

Automatic working:

- A warning route on auto will work similar to the main in that all the aspect controls are in except the stick.
- On auto the warning will step up to a main, if the conditions are correct and then step down following the passage of a train (i.e. the warning route reselected on "TISP").
- If auto working is selected after the route has stepped from warning to main, the signal will continue to work on main until cancelled.

With SSI the step up of the route from Warning to Main can be split into two sections:

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The controls for allowing the step up should prove the same conditions as for Route relay interlockings and these appear in the OPT file within the RSU data:-

Full overlap available

Outer signal has not cleared for the Warning route

There is no train between the outer signal and the inner signal.

The forward route is set

The inner signal stick set and button not pulled

Main route not barred on tech's terminal.

With SSI the actual route completely changes state to the Main Class rather than just "conning" the Warning Class into thinking it's a Main Class route (as is the case with relay interlockings).

This effectively makes testing easier with SSI because all of the ASCON conditions plus the approach locking, TORR, replacement controls etc will have been tested under the main route conditions so the tester only needs to prove that the actual route identity has swapped to a main class.

If the Warning route has Auto facilities then step down controls have to be provided. This acts in reverse to the step up control whereby the route class reverts to a Warning Class once a train has been proved to have entered the route and released the approach locking. (This action is carried out in the outer signal's RSU data).

4.1.2.3 Directly Opposing Route Locking

4.1.2.3.1 Directly Opposing Route – Definition

A 'directly opposing route' to the route under test is a route which:

- *Applies in direct opposition to and along the line of the route under test; OR*
- *Applies in direct conflict in the same direction along the line of route under test (e.g. a shunt signal in advance of the main signal capable of acting as an Independent or Facing Shunt); AND*
- *When set would not require any points to be lying in the position opposite to that required by the route under test.*

4.1.2.3.2 Directly Opposing Route Direct Locking

The following sequence of checks should be made to ensure that any directly opposing routes (as defined above) directly lock the route under test.

In the test procedures below, when attempts are made to set the route under test against the already set Directly Opposing route, it should be verified that the attempt to set the route under test has correctly registered. Where this is not possible, it is recommended that each attempt to set the route under test should be repeated.

Where the interlocking design includes route anti pre-selection circuitry this feature may be used to establish a request that continuously tries to set the route under test. Repeated route setting attempts are thus not required.

- Prevent the aspect clearing on the entrance signal of the directly opposing route to be tested. This is to ensure the directly opposing route does not

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become approach locked that would mask the verification of the presence of the direct locking.

- Set the Directly Opposing route.
- Attempt to set the route under test and verify that it is locked.
- Cancel the directly opposing route by pulling the entrance button and observe that the route is fully normalised.
- Set the route under test and verify that it will now set.
- Cancel the directly opposing route and then reinstate the aspect clearing.
- Repeat the above sequence of tests for each Directly Opposing route.

For the majority of cases the route will have to be attempted manually. Unlike route relay interlockings, this attempt does not need to be tried for each change of state provided the FOP file tests have been carried out during the initial tests. The lock function just needs to be seen at the pen-ultimate lock condition to the free condition. (i.e. attempt with a train on the last locking track and then repeat after moving onto the track beyond the opposing signal). By ensuring that that relevant sub route which provides the lock is present within the opposing signals PRR then this can be compared to all routes diverging from that last sub route lock and hence reduce the testing time dramatically.

As with the point locking controls, the need to see the direct route lock is not required as in reality it is not present in the PRR file. As all sub routes are locked within the same minor cycle, there is no need to prove the opposing route normal (the only exception being within the first sub Overlap if time out controls are present) as the only lock provided is the route locking (sub route free).

Where back to back signals exist (i.e. there are no track sections between opposing signals) then the route identities have to be cross locked as there is no alternative.

Where indirect route locking is present then again it should be proven that it is the last locking sub route that is present within the PRR test data and as such reduce the time taken to test the indirect opposing locking.

Where the opposing route is subject to direct overlap locking which is capable of timing out then two conditions must be tested:

Proof of the last sub overlap free.

This can be tested by running a train to the extent of the overlap and attempting the route prior to the overlap timing out.

Proof of the berth time out sub route free.

As the sub overlap locking is removed after time, the berth time out sub route must be present to maintain the opposing lock once the overlap has timed out. This control can be omitted if the opposing route is permissive.

There is no need to carry out individual track tests within the opposing route to ensure that the route still sets as the sub route mesh within the FOP file is a “Free” condition only as the sub routes can only be locked as part of the PRR command.

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4.1.2.3.3 Directly Opposing Route Maintained Locking

Tests should be made to ensure that the lock applied to the route under test by a Directly Opposing route is maintained by the route locking when the train passes into the Directly Opposing route and the Direct Locking has been removed. The Direct Locking is removed when the Directly Opposing Route has been cancelled and fully normalised after the complete train has entered the Directly Opposing Route and passed clear of the entrance signal.

The following sequence of checks should be made to ensure that the route locking of the Directly Opposing route maintains a lock on the route under test until the train movement passing through has moved clear of the entrance signal of the route under test or where applicable has timed to a stand.

Repeating the attempts to set the route under test (to guard against failure of the entrance circuitry to register) and use of the route anti pre-selection circuitry should be utilised, as detailed at the beginning of 4.1.2.3.2.

- Prevent the aspect clearing on the entrance signal of the Directly Opposing route (to ensure any Approach Locking does not mask verification of these tests as detailed in 4.1.2.3.2).
- Set the Directly Opposing route.
- Attempt to set the route under test and verify that it is locked.
- Occupy the first track circuit beyond the entrance signal to simulate a train moving through the set route (i.e. the Directly Opposing route).
- Cancel the set route by pulling the entrance button and check positively that the route has normalised (to ensure Direct Locking removed).
- Attempt to set the route under test and verify that it is maintained locked.
- Occupy the next track circuit in the direction of the set route and then clear the previously occupied track circuit. *(Note: to ensure the validity of this test it is essential to continuously maintain a track circuit occupied in the route throughout the test until after the maintained lock has been released on the route under test).*
- Repeat the two tests detailed immediately above for each separately occupied track circuit in the direction of the set route up to and including the last track circuit before reaching the entrance signal of the route under test or before reaching the berth track circuit of the exit signal of the set route (whichever is reached first).
- When the simulated train movement through the set route reaches the entrance signal of the route under test first, the track circuit beyond the route entrance signal should be occupied, and the previously occupied track circuit in the set route cleared.
- Try to set the route under test and check that this route now sets fully and the maintained lock applied to it by the set (i.e. Directly Opposing) route has correctly been released. (The route under test will have set immediately the track circuit in the above test was cleared if a stored request was present – Route Anti pre-selection removal facility used).

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- Cancel the route under test by pulling its entrance button and verify that both routes are fully normalised.
- When the simulated train movement through the set route reaches the berth track circuit at the exit signal first, occupy the berth track circuit and then clear the previously occupied track circuit in the set route.
- Where the lock applied to the route under test **is released** after the simulated train movement through the set route has timed to a stand occupying the exit signal berth track circuit, verify the maintained lock applied to the route under test is not released until the berth track circuit has been occupied the specified time.

The release of the maintained lock applied to the route under test after elapse of the track circuit occupation time is indicated by the extinction of the overlap route lights (for set routes which have overlaps).With SSI the sub-overlaps can be directly monitored on the Tech's terminals

- Further tests should be made to ensure that the maintained lock applied to the route under test and the overlap route locking of the set route will not release after the berth track circuit has been occupied the specified time unless the following conditions are all also satisfied:
- All track circuits in the overlap of the set route are clear (required to ensure the train movement timed to a stand at the exit signal of the set route has not passed that signal and entered the overlap).
- The Directly Opposing Route (the set route) has been fully returned to normal.
- The sectional route locking of the set route has been released from the entrance signal up to and excluding the berth track circuit of the exit signal (where no long train facility is included).
- Long train facilities may be provided where required and should be verified as specified in the control tables. The overlap route locking of the set route will release for trains timed to a stand at the exit signal which are longer than the berth track circuit by excluding proving clear the track circuit(s) in rear of the berth track circuit back towards the entrance signal of the set route as far as necessary to accommodate the maximum length train operated. (Reference should also be made to 4.1.1.5 notes on 'Long Train Overlap Release' facilities that similarly apply here.)
- Where the lock applied to the route under test is not released after the simulated train movement through the set route has reached the berth track circuit of the exit signal, tests should be made to ensure that:
- The lock applied to the route under test by the set route is not time released irrespective of the length of time the berth track circuit at the exit signal is occupied.
- The lock applied to the route under test is not released until the route locking of the set route is fully normal (i.e. the complete route including overlap has sectionally released with all track circuit sections clear).

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- Repeat the above sequence of tests for each Directly Opposing route.

When the 'Maintained Locking' tests have been completed for all opposing routes, the Route Anti pre-selection removal facility (if available and used) should be reinstated and a test made to verify that unavailable routes cannot be pre-selected.

Further tests should be made to verify that the maintained lock applied to the route under test by the track circuits occupied above is genuine route locking (i.e. the track circuits occupied only apply the lock when a route is set). This is verified by the following series of tests:

- With the Directly Opposing route unset and verified normal.
- Occupy each track circuit separately in the direction of route from the entrance signal of the Directly Opposing route up to and including the last track circuit before the route under test entrance signal or the Directly Opposing route exit signal whichever is reached first.
- For each individually occupied track circuit ensure the route under test will set and is not directly locked by the occupied track circuit. (Cancel the route under test and verify the route has returned to normal before changing the occupied track circuit).

The above series of tests should be repeated for each Directly Opposing route which exists relative to the route under test.

4.1.2.4 Indirectly Opposing Route Locking

4.1.2.4.1 Indirectly Opposing Route Locking – Definition

An 'indirectly opposing route' to the route under test is a route which:

- Applies in the opposite direction to the route under test; AND
- When set does not 'directly oppose' the route under test because it requires at least one set of points in the opposite position to that required by the route under test; AND
- When normalised, after a movement has entered the route and passed clear of and released from locking all points not set in the position required by the route under test, leaves the remaining route locked portion of the opposing route effectively 'directly opposing' the route under test as defined in 4.1.2.3.1.

4.1.2.4.2 Indirectly Opposing Route Maintained Locking

Tests should be made to ensure that the indirectly opposing route as defined above when set applies a lock on the route under test. This lock should be maintained by the directional route locking of the opposing route movement after it has passed clear of and released the locking of all points which for the opposing route were not set in the position required for the route under test.

The following sequence of checks should be made to ensure that the route under test is maintained locked by all the indirectly opposing routes which apply to it, until the opposing movement has passed clear of the entrance signal of the route under test or where applicable timed to a stand. (It should be noted that the complete sequence of tests to verify the maintained route locking should be carried out for a

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specific indirect opposing route, and then repeated separately for the other opposing routes where more than one such routes exist):

- Prevent the aspect clearing on the entrance signal of the selected indirectly opposing route (relative to the route under test) – to ensure any Approach Locking does not mask the verification of these tests as detailed in 4.1.2.3.2.
- Set the selected indirectly opposing route.
- Attempt to set the route under test and verify that it is locked.

Route Anti pre-selection removal facilities as described in 4.1.2.3.2 should be used for this test where available – such a facility is an advantage for this maintained locking test as the stored request continuously trying to set the route under test removes the need to attempt twice to set this route at each stage of the test (i.e. for each position of the train moving through the route).

The remaining tests detailed below are written assuming no Route Anti pre-selection removal facility is available. When the instructions ask for an attempt to set the route under test to be made, two attempts should be made as detailed and for the reasons given in 4.1.2.3.2 unless a stored call has been applied to the route under test.

- Occupy the first track circuit beyond the entrance signal of the selected indirectly opposing route to simulate a train moving through the route.
- Cancel the selected opposing route by pulling the entrance button and check positively that the route has returned to normal.
- Attempt to set the route under test and verify it remains locked.
- Occupy the next track circuit in the direction of the selected indirectly opposing route and then clear the previously occupied track circuit. (Note: to ensure the validity of this test it is essential to continuously maintain a track circuit occupied in the set opposing route throughout the test until after the maintained lock applied to the route under test has been released.)
- Repeat the two tests detailed immediately above for each separately occupied track circuit in the direction of the selected indirectly opposing route up to and including the last track circuit before clearing the points set and locked by the set opposing route in the opposite position to that required by the route under test.
- When the simulated train movement clears the track circuit through and locking the above detailed points, these points should now be free. Before attempting to set the route under test the points should, immediately upon becoming free, be keyed to the opposite position (i.e. into the position required by the route under test). Return the points key to the centre/unlocked position.
- Now attempt to set the route under test and verify that it remains locked (by the Route Locking of the selected indirectly opposing route).
- Occupy the next track circuit in the direction of the selected opposing route and then clear the previously occupied track circuit.
- Attempt to set the route under test and verify it remains locked.

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