UGL REGIONAL LINX

TYPICAL INSPECTIONS & TESTING FOR SIGNALLING APPARATUS

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CRN SC 011

LINKING COMMUNITIES. CONNECTING CUSTOMERS.

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Document Control

Function	Position	Name	Date
Approver	A&E Manager	Lucio Favotto	25.01.2022

Revision	Issue Date	Revision Description
1.1	06.12.2021	UGLRL Operational Standards Template applied
2.0	20.12.2021	First approved and issued UGLRL version
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Summary of changes made from previous version

Section	Summary of change
All	This document is based on the previous rail infrastructure maintainer (RIM). Full revision history is available on request from UGLRL.

1 Introduction

1.1 General

This Specification sets out the requirements for typical inspection and tests for certifying signalling apparatus and the standard procedures and practices for carrying out and recording the inspection and testing.

1.2 Definitions

Signalling definitions are contained in the Signal Engineering Standard CRN SD 032 Glossary of Signalling Terms. Additionally, the definitions from Specification CRN SC 008 Plans, Programs, Documentation and Packages apply to this Specification.

1.3 Applicable Documents

This Specification shall be read in conjunction with the CRN System Safety Manual and associated frameworks, standards, Specifications and elements.

This Specification shall be read in conjunction with companion CRN Infrastructure Engineering Specifications - Signalling:

Specification/Standard	Description
CRN SC 007	Roles, Responsibilities and Authorities
CRN SC 008	Plans, Programs, Documentation and Packages
CRN SC 009	Inspection and Testing Principles
CRN SC 010	Inspection and Testing Procedures
CRN SC 013	Interface Requirements and Procedures for Alterations
CRN SC 012	Standard Forms
CRN SC 006	Signalling Documentation and Drawings
CRN SC 017	Computer Based Interlocking
CRN SP 000	Signalling Maintenance Procedures
CRN SD 032	Glossary of Signalling Terms

This Specification shall be read in conjunction with CRN Infrastructure Engineering Specifications – Signalling for Equipment and Construction:

- As published on the Engineering pages of the CRN Intranet.

Training and Competency Procedures as follows:

- Personnel training, licensing and logbook documents.

Signal Engineering Instructions and Guidelines:

- As issued from time to time and published on the Engineering pages of the CRN Intranet.

2 Signals and MLIs

2.1 Apparatus Inspection

- Check workmanship and physical condition of the signal equipment and installation,
- Check operating environment suitability for safe, reliable operation,
- Verify conformance to the Signalling Plan, Signal Sighting Forms, and Circuit Book inclusive of the following:

Identification Plate	To approved Signal Sighting forms and Signalling Plan
Profile	To approved Signal Sighting Forms, Circuit Book and Signalling Plan
Focus/Alignment	Main aspect, sighting from 200 metres minimum, Subsidiary as required
Site Screens	Fit for purpose
Light system	LED types & colours correct
Transformers	Correct type, rating and voltage taps
Lampcases	Door gaskets fitted, weather-proof, externally light proof, painted black, matte black internally, moisture free, doors open and close freely and lock to good fit
Hoods and Backgrounds	Correct type, painted matte black, back of background painted gloss white
Sighting	Clear with no ambiguity or conflict with other signals or extraneous lighting
Equipment mountings	Secure
Locking	Padlocks and locking devices secure
Signal Post Disconnection Box	Securely mounted, weather-proof, locked, cables properly terminated
White Crosses	Correctly fitted
Signal/Post and Ladder	Correct height, installation, galvanised,
Clearance	Structure gauge, overhead wire,
Signal positioning	Relative to 1500 volt overhead air gap Correct trackside location,
Redundant apparatus	Securely inoperative and recovered.

2.2 Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test, and Circuit Function Test the Signal Light Operating Circuit. Additionally, for alterations refer to CRN SC 013 for requirements.

2.3 Apparatus Function Tests

Check that installed LEDs are operating at the correct voltage setting

- For LED signals with operating circuits wired with other than twisted pair cable, conduct ‘no volts” tests and record the test results on Test Certificate TC 1 (b) or (c)

- Signals fitted with Marker Light: Test to ensure marker light operates with main signal aspects are extinguished or at red
- Check flash rate correct for flashing and pulsating aspects

2.4 System Function Test

Complete remaining tests described under Aspect Sequence test in Specification CRN SC 010 Inspection and Testing Procedures - Clause 9. Record the result of the aspect sequence test as described in CRN SC 008 Clause 3.13.and 3.14.

2.5 Signals Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/1 (a or b) and complete the Test Certificate (TC 1a, 1b or 1c) as applicable provided in CRN SC 012 Standard Forms.

3 Points Machine

3.1 Points Machine Apparatus Inspection: Electric

- Check workmanship and physical condition of the points equipment and installation
- Check operating environment suitable for safe, reliable operation
- Verify conformance to the Signalling Plan, Driver's Diagram, and Circuit Book
- Check that point machine and point rodding is correct type
- Check that point machine is mounted on correct side of track, with correct switch normally closed and correct point number on machine and sleeper
- Check multiple drives, additional detectors
- Check that nuts and fittings are properly secured with split pins opened
- Check that all insulations installed and effective in tie-plates, spreaders, point connections, etc.
- Check that machine and ground connections are adjusted according to the relevant instruction manual
- Check that the ESML lock and crank handle key are to the correct warding and comply with the warding gauge
- Check that the EOL lock and key are the correct warding and comply with the warding guage
- Check that the ESML crank handle has been correctly inscribed
- Check that the EOL key has been correctly inscribed and is fitted with an ID tag
- Check that the ESML is mounted on the side of the hut containing the point contactors and isolating relay (single cut circuitry)
- Check that the EOL housing is mounted on the side of the hut or location containing the control relays
- Check that the ESML is positioned for appropriate physical time delay
- Check that the EOL is positioned for the appropriate physical time delay
- Check that all padlocks are secure
- Check redundant apparatus made securely inoperative and recovered

3.2 Points Machine - Circuit Test: Electric

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function Test all circuits with wires connecting to the points mechanism and associated detector units, and emergency switch machine lock. Strap and Function Test contacts in the external equipment. Additionally, for alterations refer to CRN SC 013 for requirements.

3.3 Points Machine - Apparatus Function Test: Electric

- Isolate point motors by switching to "off" the power isolating switches and ensure that the point motors are unable to operate
- Check that the points are unable to operate with the isolating relay removed or with the normal contactor removed (from reverse) or with the reverse contactor removed (from normal)
- Check and record the running current and the time taken for a complete operation
- Check operation and timing of points cut off timer
- Check clutch setting to relevant instruction manual

- Check that all contacts electrically open and close in correct adjustment when the points are operated to normal and reverse
- Check ESML/EOL key when turned in lock electrically opens and closes the ESML/EOL contacts correctly
- Check the door of the ESML/EOL case cannot be closed with the key in the unlocked position
- Check ESML/EOL operating handle operates the point machine safety cut out switch, disconnecting the points motor
- Check points operate easily under emergency manual operation

3.4 Points Machine - Facing Point Lock and Detection Test: Electric

Using the ESML crank handle or EOL arrangements where provided manually operate the point machine and:

- Verify that when a gauge 4.8mm thick is held between the switch and stock rail at a point approximately 75mm back from the tip of the switch, the detector contacts are visibly open. With sealed micro-switches the detector contacts shall be verified to be electrically open and the respective R-NI or N-RI contacts to be electrically closed. Verify that the detector contacts are made with a gauge of 3.2mm. Detectors fitted on multiple drives should be coarsely adjusted at 6 to 7mm to prove that the whole of the switch has responded to the movement of the drive mechanisms
- For interlocked points machines, verify that a gauge of 3.2 mm inch thick held between the switch and stock rail at a point approximately 75mm back from the tip of the switch, prevents the locking dog entering the notch in the locking slide; verify that a gauge of 1.6 mm allows the locking dog to enter the notch and lock the points
- For Clawlock installations verify that a gauge of 4.8 mm inch thick held between the switch and stock rail at a point approximately 75mm back from the tip of the switch, prevents the locking dog entering the notch in the locking slide; verify that a gauge of 3.2 mm allows the locking dog to enter the notch and lock the points
- Verify that the open switch opens to approximately 114 mm, or as otherwise specified in the particular Points Equipment Manual
- Where machines have accurately marked lock and detector slides - Nippon 1200A, 1211B, 1211C, ensure that misalignment of the mark from the side of the case is equal to the thickness of gauge inserted between the switch and stockrail; - take care to avoid "switch roll" when making this comparison

3.5 Points Machine - System Function Test: Electric

Complete tests described in "Point Correspondence Tests", Clause 8 of CRN SC 010 “Inspection and Testing Procedures”.

3.6 Points Machine - Test Certificates: Electric

Record the results of Points Machine Tests on the Point Operating Test Certificate (TC-6) provided in CRN SC 012 “Standard Forms".

3.7 Points Apparatus Inspection: Mechanical

- Check the workmanship, physical condition, and installation of the points equipment, channel rodding drive, and ground frame
- Check that the operating environment is suitable for safe, reliable operation
- Verify conformance to Signalling Plan, Driver’s Diagram, and Circuit Book

- Check that leading off timbers and cranks are secure (where applicable)
- Check that the ground frame is correctly located relative to the points (where applicable)
- Check that the ground frame is of the correct type and size (where applicable)
- Check that the channel rodding stands and crank stands are secure in the ground and that the run is straight (or evenly curved) and level
- Check that cranks are "on centre" and that compensators are correctly located in the run
- Check that bolts and pins are properly secured and split pins spread
- Check that the FPL casting is secure and cannot move on the sleeper
- Check that "spring", FPL, and detection are correctly adjusted
- Check that the points are not excessively heavy to pull

3.8 Points Circuit Test: Mechanical

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function Test detection circuits. Strap and Function Test the contacts within the detector. Additionally, for alterations refer to CRN SC 013 for requirements.

3.9 Points Apparatus Function Test: Mechanical

- Ensure that there is no more than 20mm escapement available between bobbin and cradle
- Test that the facing point lock plunger travel is at least 190mm and that the plunger clears the lock rod by 15 to 20mm when withdrawn
- Test that movement of the cross slide will break detection before the plunger disengages from the lock rod i.e., at approximately half plunger stroke
- Check that the effort required on the points lever is similar for normal to reverse and reverse to normal

3.10 Points - Facing Point Lock and Detection Test: Mechanical

Operate the points and:

- Verify that when a gauge 4.8mm thick is held between the switch and stock rail at a point approximately 75mm back from the tip of the switch, the detector contacts are visibly open. With sealed micro-switches, the detector contacts shall be verified to be electrically open with a gauge of 4mm. Verify that the detector contacts are made with a gauge of 3.2mm. Detectors fitted on multiple drives should be coarsely adjusted at 6 to 7mm to prove that the switch has responded to the movement of the drive mechanisms
- Verify that a gauge of 3.2 mm inch thick held between the switch and stock rail at a point approximately 75mm back from the tip of the switch, prevents the locking dog entering the notch in the locking stretcher; verify that a gauge of 1.6 mm allows the locking dog to enter the notch and lock the points
- Verify that the open switch opens to 114 mm +2mm -0mm

Note: With a switch opening of 114 mm a mechanical lock will fail to enter, or just bump in, with 1.6mm between switch and stockrail. For mechanical points, switch openings may be increased slightly up to 116mm but must never be less that 114mm.

3.11 Points Test Certificates: Mechanical

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/2 –13/3 and complete the Test Certificate (TC 6) as applicable provided in CRN SC 012 Standard Forms.

4 Ground Frames and Electrical Releases

4.1 Ground Frames and Electric Releases Apparatus Inspection

- Check workmanship and physical condition of the ground frame or electric releasing switch equipment and installation
- Check operating environment suitable for safe reliable operation
- Verify conformance with the Signalling Plan, Circuit Books, Locking Tables and Locking Diagrams
- Check positioning of release switch in relation to ground frame particularly where a physical time delay is required
- Check release switch type, rating and labelling
- Check electric lever lock type, rating and labelling
- Check release switch, electric lever lock for correct voltage, lock positions and force down, where applicable
- Check indicators, repeaters for correct type, rating and labelling
- Check Annett or Fortress keys and lock faces are correctly warded and keys correctly inscribed
- Check the lever nameplates on the mechanical levers
- Check covers secured on mechanical interlocking
- Check redundant apparatus made securely inoperative and recovered

4.2 Ground Frames and Electric Releases Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function Test all circuits connecting to the release switch and/or ground frame. Strap and Function Test contacts in the external equipment. Additionally, for alterations refer to CRN SC 013 for requirements.

4.3 Ground Frames and Electric Releases Apparatus Function Test

- Check Annett or Fortress lock contacts electrically open and close correctly when the Annett key is turned in the lock
- Operate release switches and ensure that the lock drops and securely locks the lever when de-energised and that the lock proving contact only closes when the lever is locked, physically move around the locking dog to ensure that the locking dog will not ledge on the lock slide
- Check that release switch lock corresponds with the lever controls and operates the release switch normal relay correctly
- Ensure that with the key removed the release switch cannot be normalised
- Check that release switch door cannot close with lever in the release position

4.4 Ground Frames and Electric Releases System Function Test

- Test the mechanical interlocking in the ground frame
- Operate the release switch and frame from the control centre and observe the correct indications on the indicator diagram

4.5 Ground Frames and Electric Releases Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/2 –13/3 and complete the Test Certificate (TC 6) as applicable provided in CRN SC 012 Standard Forms.

5 Track Circuits

5.1 Track Circuit Apparatus Inspection

- Check workmanship and physical condition of track circuit equipment and installation
- Check operating environment suitable for safe, reliable operation. Where applicable - terminals insulated or shrouded: for touch and accidental short circuits
- Verify conformance to the Signalling Plan, Track Insulation Plan and Circuit Diagrams inclusive of the following:
  - Check length and limits of track circuit, position of insulated joints, fouling point clearance, point and other insulations, traction bonds, electrolysis bonds. Check polarity of each rail of D.C. track circuits and Impulse track circuits is as shown on the Track Insulation Plan
  - Check track circuit connections, spark gap arrestor connections, track circuit bonding, traction bonding, electrolysis bonding, including series bonds, parallel bonds, rail joints bonds and bonds in points, crossing and check rails
  - Check loop arrangements and length of track circuit leads
  - Check type, rating, and labelling of track circuit equipment items
- Check that connections to rail secured and terminated
- Check disconnection boxes and track side equipment associated with special track circuits for corrosion and other physical damage, secure mount, and that cables are wired neatly and securely terminated
- Check that insulated rails are free from spurious bonds or earths
- Check fishplates and track fastenings are not bridging out the insulated joint
- Check, on special vertical racking for track circuit equipment, every vacant module position above or below a unit of installed equipment is fitted with all obturation fittings and coding plugs to prevent incorrect insertion of the unit
- Check redundant apparatus made securely inoperative and recovered

5.2 Track Circuit - Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test, and Circuit Function test the track circuit. Additionally, for alterations refer to CRN SC 013 for requirements.

5.3 Track Circuit Apparatus Function Test

- Check that all surge protection and earthing arrangements are installed and connected prior to certification testing
- Record track circuit voltages, currents, and adjustment settings, and check against normal values for the applicable track parameters
- Check double rail alternating current track circuits (50Hz, audio frequency) for equal current in each rail
- Remove the track circuit feed primary fuse and check the track relay for de-energisation and zero voltage

NOTE: Residual voltages across the relay or across the rails shall be further investigated and irregular sources rectified.

Some residual traction DC and traction harmonics would be expected with single rail track circuits, as would some circulating current from other single rail track circuits in the vicinity.

Residual voltages could be caused by unbalance in the track circuit under test or in other track circuits in the vicinity, or by false voltage. Unbalance in track circuits could be caused by high resistance rail connections, rail bonds or "earthy" spark gap connections.

On DC tracks any residual voltage must be less than 30% of the release voltage of the track relay.

- Check that structure spark gap connections are open circuit
- Check rail connections and rail bonds for low resistance volt drop
- Check polarity reversal at block-joints between adjacent track circuits at all extremities, where applicable, using a voltmeter. With AC double rail tracks circuits - additionally bridge one block-joint and observe the track relay pull down (not just release.)
- Conduct drop shunt tests at relay/receiver extremity of the track circuit and fixed minimum shunt tests at all other extremities and at regular intermediate points for compliance with specification shunt values, including between the tuned loops on a jointless track circuit and including all parallel bonded sections. Use non-inductive shunt resistors with rail clamp connections. Shunt tests should be done when the track circuit ballast is dry. Record lowest value on the Track Circuit History Card

5.4 Track Circuit System Function Test

- De-energise the track relay and observe all corresponding track indicating and repeat relays drop away and the track indicator display occupied. Observe track time limit relay energise after set time delay
- Energise the track relay and observe the converse

5.5 Track Circuit Test Certificates

Record the results of apparatus inspection and testing as nominated in the relevant Set to Work and Test and Certify Manual, complete the required Track Circuit Commissioning Master Sheets and Track Circuit History Cards. Further, the requirements set out in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/5 provided in CRN SC 012 “Standard Forms”.

6 Axle Counters

6.1 Axle Counter Apparatus Inspection

- Check workmanship and physical condition of axle counter equipment and installation,
- Check operating environment suitable for safe, reliable operation. Where applicable - terminals insulated or shrouded: for touch and accidental short circuits,
- Verify conformance to the Signalling Plan, Track Insulation Plan and Circuit Diagrams inclusive of the following:
  - Check length and limits of axle counter, position of axle counter wheel detector heads, fouling point clearance, spark gap arrestor connections, traction bonding, electrolysis bonding
  - Check loop arrangements and length of axle counter wheel detector heads leads
  - Check type, rating, and labelling of axle counter equipment items
- Check that connections to of axle counter wheel detector heads secured and terminated
- Check disconnection boxes (GAK) and track side equipment for corrosion and other physical damage, securely mounted and that cables are wired neatly and securely terminated
- Check the axle counter equipment racking in the signal location
- Check redundant apparatus made securely inoperative and recovered

6.1 Axle Counter - Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test, and Circuit Function test the axle counter including the wheel detector heads. Additionally, for alterations refer to CRN SC 013 for requirements.

6.2 Axle Counter Apparatus Function Test

- Perform Go/No go test using the approved test gauge on the of axle counter wheel detector heads
- Check that all surge protection and earthing arrangements are installed and connected prior to certification testing
- Check error logs
- Check voltages and currents on the evaluation unit and at the track side connection box

6.3 Axle Counter System Function Test

- Occupy the axle counter section by using the testing plate (PB200) de-energising the FM relay (track up) and energising the P relay (track down) and observe all corresponding track indicating and repeat relays drop away and the track indicator display occupied
- Observe any time limit relay energise after set time delay
- Clear the axle counter section and observe the converse

6.4 Axle Counter I/O Test

Where I/O is transmited through an axle counter cardfile system, each input shall be operated so that both states can be correlated at the output end of the system

6.5 Axle Counter Circuit Test Certificates

Record the results of apparatus inspection and testing as nominated in the relevant Set to Work and Test and Certify Manual; complete the required Axle Counter Commissioning Master Sheets

and Axle Counter History Cards. Further, the requirements set out in Specification CRN SC 008 with tailored Work Instructions.

7 Level Crossing Equipment

7.1 Level Crossing Equipment Apparatus Inspection

- Check workmanship and physical condition of level crossing equipment and installation,
- Check operating environment suitable for safe, reliable operation. Terminals insulated or shrouded: for touch and accidental short circuits
- Verify conformance to the Signalling Plan, Circuit Diagrams and Level Crossing Site Plan, inclusive of the following:

Measure approach distances from warning initiation point to the edge of the road and check calculated warning times at line speed.

Road signs, road markings, train driver warning boards, penalty notice boards	Fitted correctly
Lights, booms, and bells	Fitted correctly
Test and Emergency keys	Identification tags correctly inscribed
Equipment	Type, rating, and labelling correct
Battery and battery charger	Type and rating correct. Ensure batteries fully charged.
Focus	Check near side signals focus and far side signals focus as required by the road traffic approaches
Padlocks	Correct type on emergency box.
Speed Boards	Check installed and correct, where applicable
Redundant apparatus	Securely inoperative and recovered

7.2 Level Crossing Equipment Circuit Testing

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function Test all circuits connecting to the highway signals, booms and bells. Strap and Function Test contacts in external equipment. Additionally, for alterations refer to CRN SC 013 for requirements.

7.3 Level Crossing Equipment Apparatus Function Tests

- Operate equipment
- Check boom ascend and descend times and record
- Check boom gate delay time after initiation of lights and bells operation and record
- Check audible warnings sound when protection initiated and that one cuts out when booms have descended
- Check operating voltage at bell
- Check operating voltage of LED road traffic LEDs
- Check operation of test and emergency keys
- Test low voltage alarms operate at the correct voltage setting and illuminate/extinguish the power supply indicators
- Check test switch operates protection and disconnects the AC power supply from the battery charger

- Check protection operates on batteries alone as well as with battery charger by opening the Test Switch and observing operation and power supply indicators for two minutes
- Check booms fall when power lost

7.4 Level Crossing Equipment System Function Test

- De-energise track circuits /axle counters individually and ensure protection operates
- De-energise track circuits /axle counters in sequential order to simulate a train and ensure protection operates
- Ensure departure track circuits /axle counters do not operate protection and protection clears when the level crossing track is cleared
- Where interlocked signals or MLIs protect the level crossing, ensure protection is not cleared until the replaced signal or MLI has been at stop for the time limit set
- With approach track circuit /axle counter occupied ensure qualifying signal or MLI at stop will not clear until the level crossing protection has operated for the time set
- Check direction sticks operate correctly
- Check remote testing or monitoring equipment operates correctly

7.5 Level Crossing Grade Predictors

7.5.1 Grade Predictors Apparatus Inspection

- Check workmanship and physical condition of the grade predictor equipment and installation
- Check operating environment suitable for safe, reliable operation. Where applicable - terminals insulated or shrouded: for touch and accidental short circuits
- Verify conformance to the Signalling Plan, Track Insulation Plan and Circuit Diagrams inclusive of the following:
  - Check length and limits of grade predictor track circuits
  - Check type, rating, and labelling of grade predictor equipment items
- Check that connections at the grade predictor boot leg riser and to rail including the actual rail connections secured and terminated
- Check boot leg riser and track side equipment for corrosion and other physical damage, securely mounted and that cables are wired neatly and securely terminated
- Check the grade predictor equipment racking in the signal location
- Check redundant apparatus made securely inoperative and recovered

7.5.2 Grade Predictor - Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test, and Circuit Function test the grade predictor circuits. Additionally, for alterations refer to CRN SC 013 for requirements.

7.5.3 Grade Predictor Apparatus Function Test

All connections to the unit must be complete before setup is commenced.

It is important that no trains are present in the approach section during the setup procedure.

The unit must be powered up and following a satisfactory self-test the software versions checked against those shown in the circuit book tabulation.

Each of the items (in the order of the manufacturer's instructions) must be entered in turn for each track using the values shown in the circuit book tabulation.

- The location and road name must be entered
- The time must be set as Eastern Standard Time, daylight saving time is not to be used
- Following entry of all of the application programming data the crossing controls should be in the non-alarm state (crossing open for road traffic and no call placed on external traffic signals)
- Once this condition is reached the history card applicable to the crossing type is to be populated with the actual setup data
- Note if the functions implemented are different to those designed the changes must be approved by the commissioning engineer
- The minimum required warning time must be achieved for each test. Long warning times are to be investigated and adjustments in the design or settings made to minimise these occurrences
- The manufacturers' documentation should be consulted whenever a grade predictor system is commissioned. In the setup for a prediction track or island track; the calibration procedure for the track concerned in the manufacturers' documentation must be followed
- The predictor is to be reset of all functions to default values then all of the values given on the record card or circuit book must be entered. In all cases where a module has to be changed in the predictor or it has been powered down during the commissioning all the setup values must be checked for compliance with the record card for the site. The recalibration or reset of the functions must not be undertaken with a train present

7.5.4 Grade Predictor System Function Test

System Function testing must take place using a light locomotive or the first available train movement to simulate all of the train movements anticipated at the location and documented in the operational specification.

The minimum required warning time must be achieved for each test. Long warning times are to be investigated and adjustments in the design or settings made to minimise these occurrences.

All changes to the design or setup must be approved by the design engineer.

7.5.5 Inspection of the track covered by the Level crossing predictor

Prior to the commencement of the set to work the tester must walk so entire length of the approach sections and verify that:

- The track construction is relatively consistent through the length of each prediction track
- Any mechanical joints are correctly bonded out
- All required insulated joints are in place
- All couplers, shunts and dummy loads are in place and of the correct values
- There are no extraneous connections to track or between the rails

7.5.6 Grade Predictor Circuit Test Certificates

Record the results of apparatus inspection and testing as nominated in the relevant Set to Work and Test and Certify Manual; complete the required grade Predictor Commissioning Master Sheets and Grade Predictor History Cards. Further, the requirements set out in Specification CRN SC 008 with tailored Work Instructions

7.6 Level Crossing Equipment Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/6 and complete the Test Certificate (TC 10) as applicable provided in CRN SC 012 Standard Forms.

8 Power Supplies

8.1 Power Supplies Apparatus Inspection

- Check workmanship and physical condition of power supply equipment and installation,
- Check operating environment suitable for safe reliable operation,
- Verify conformance to Signalling Plans and Circuit Diagrams inclusive of the following:
  - Fuses, circuit breakers, surge gas discharge units and varistors: Correct type, rating, and labelling
  - Transformers, rectifiers, resistors and capacitors: Correct type, voltage, and current rating; adjustment arrangements; and labelling
  - Busbars, mains cables, power supply wiring, terminals: Correct type, rating, and labelling
  - Battery: Correct type, capacity, number of cells, state of charge
  - Terminals insulated or shrouded: for touch and accidental short circuits
- Check manufacturer's test certificates and acceptance test certificates for manufactured equipment, where applicable.

8.2 Power Supplies Circuit Testing

Bell Continuity Test, Wire Count, Null Count, Insulation Test. Additionally, for alterations refer to CRN SC 013 for requirements.

8.3 Power Supplies Apparatus Function Test

- Test power supplies to operate correctly providing the correct voltage value, polarity, and voltage regulation over the range of operating conditions. Record values
- Test voltage drop over power supply mains and circuit wires for maximum operating load
- Test each channel of dual power supplies to individually supply the load
- Test un-interruptable power supplies to supply the load conditions when mains power is interrupted
- Test mains failure plants to start up, provide correct voltage and frequency, supply the load, shut down and indicate correctly
- Test battery chargers for correct operation and charging adjustment
- Test batteries for polarity, voltage, state of charge
- Test emergency changeover arrangements operate correctly
- Test power supply indicators and alarms, local and remote, to operate correctly
- Test power supply busbars to be isolated from any other power supply
  - Test power supply busbars to be free from earths. Record bus-bar voltage leak to earth
  - Test earth leakage detectors connected to power supply busbars to operate correctly
  - Check phase relationship between normal and emergency supplies, where applicable

8.4 Power Supplies Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/7 and complete the Test Certificate (TC 7 and TC 9) as applicable provided in CRN SC 012 Standard Forms.

9 Diesel Generators (Mains failure plant)

9.1 Diesel Generators Apparatus Inspection

- Check workmanship and physical condition of the mains failure plant equipment and installation
- Check operating environment suitable for safe reliable operation
- Inspection Detail
- Check that the unit is supplied with the manufacturer's test certificate, and at least one complete copy of the manual, including operating and maintenance instructions and circuit diagrams
- Check that the generating plant is securely fixed to its mounting base, and that mains and indication cables are correctly terminated to the control panel
- On a non-portable system, check that fuel tank and control panel are securely mounted, fuel lines are properly run and connected to tank and engine, and cabling between control panel and motor/alternator is wired according to the manufacturer's wiring diagram
- Check that the fuel tank is full, the starter battery is properly connected and fully charged, and normal mains supply to the control panel is 'on'

9.2 Diesel Generators Apparatus Function Test

9.2.1 Initialisation of plant

- Select Function switch 'OFF' position
- Close Normal mains Circuit Breaker
- Select function switch 'Auto' position

9.2.2 Testing sequence

- Check mains failure function:
  - Open Normal mains Circuit Breaker
  - Check that after normal delay, motor cranks and starts, runs up to speed, then Emergency contractor closes and Emergency mains supply is available
- Adjust alternator output voltage to equal, as near as possible, the measured Normal supply voltage
- Check normal shutdown function:
  - Close Normal mains Circuit Breaker
  - Check that after normal delay, Normal contactor closes, mains supply is available, and after a delay the diesel motor stops
- Check fail to start function:
  - Disconnect lead to engine fuel solenoid
  - Open Normal mains Circuit Breaker
  - Check that engine tries to start 3 times, cranking for about 10 seconds each time, then 'Fail To Start' alarm is displayed
  - Restore fuel solenoid` connection, reset alarm and initialise panel
- Check emergency shutdown function

For each of the following conditions, with the mains failure plant operating, apply the test condition, observe that the plant shuts down and that the correct alarm is displayed, then reset alarm and initialise the control panel:

- Bridge 'low fuel' contact on fuel tank
- Bridge 'engine temperature' contact
- Bridge 'engine oil pressure' contact
- Open generator output Circuit Breaker
- Check remote test function:
  - If the plant is fitted for remote test operation, check that operation and cancellation of the 'remote test' control starts and shuts down the plant as required

9.3 Diesel Generator Test Certificate

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/7 and complete the Test Certificate (TC 7, 8 & 9) as applicable provided in CRN SC 012 “Standard Forms”.

10 Earthing for Surge Protection

10.1 Earthing Apparatus Inspection

- Check the workmanship and physical condition of the earth protection equipment and installation
- Check operating environment suitable for safe, reliable operation
- Verify conformance to Signalling Plans, Circuit books, and compliance to Specification CRN SC 004 “Lightning and Surge Protection” and the Signalling Surge Protection Guidelines, inclusive of the following:
  - Check earth stakes are correct type and correctly installed around buildings
  - Check earth cables are correct type and rating, and correctly labelled, securely terminated, and with a minimum bending radius of 30 cm
  - Check that all earth wiring is isolated from signalling/power cables inside equipment housings (relay rooms/locations)
  - Check that required physical separations are provided between protected and unprotected wiring
  - Check that all earth busbars are remote from other signalling equipment and installed as close as possible to the point where the cables enter the equipment housing (relay rooms/locations). Each earth cable is to be attached separately to the busbar
  - Ensure earths are not connected except as specified
  - Check surge protection equipment type, rating and labelling
  - Check redundant apparatus made securely inoperative and recovered

10.2 Earthing Apparatus Circuit Testing

Bell Continuity Test, Wire Count, Null Count, Insulation Test. Additionally, for alterations refer to CRN SC 013 for requirements.

10.3 Earthing Apparatus Function Test

Check that all earths meet the requirements of Specification CRN SC 004 “Lightning and Surge Protection” and the Signalling Surge Protection Guidelines. (Standard location earth – 10 ohms). Main Relay Room (and Locations with CBI or Telemetry) earth busbars -5 ohms. External location earth busbars -10 ohms. Trackside equipment – 75 ohms).

10.4 Earthing for Surge Protection Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 and CRN SC 004 with tailored Work Instructions developed from ITF Checklist 13/7 and complete the Test Certificate (TC 4) as applicable provided in CRN SC 012 “Standard Forms”.

11 Relays

11.1 Relays Apparatus Inspection

Check the workmanship and physical condition of relays and installation,

Check operation environment suitable for safe, reliable operation,

Verify conformance of relays to Circuit Book details and analysis sheets, inclusive of the following:

Relays and bases	Correctly positioned and labelled on the rack,
Relays	Correct type, contact configuration, operating voltage and coil resistance,
Relay labels	Secure, details completed, signed by manufacturers' tester. Overhauled shelf relays also labelled as cycled tested,
Relay bases	Correctly drilled for indexing pins. Relay indexing pins correct for relay type and in correspondence with manufacturer's label,
Detachable tops for shelf relays	Correct type and correctly coded,
Relay base	Correct strapping for time limit relays,
Relay case	Undamaged and relay internally free of foreign matter,
Vane relays	Examine in accordance with maintenance manuals,
All wiring	Properly terminated and secure.

11.2 Relays Circuit Testing

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function Test all circuits with wires connecting to the relay. The includes a check of the relay base strapping for time limit or time delay relays. Strap and Function Test contacts in shelf relays.

11.3 Relays Apparatus Function Test

- Test plug-in relays in an approved relay test panel and fix a signed and dated sticker as nominated to document the contact proving test or apply correct power to shelf relays
- Examine operating movement for correct energisation and de-energisation
- Check contacts electrically open and close in accordance with nameplate contact configuration, when the relay is energised and de-energised
- Test and record pick up, drop away, and working currents on Signal Branch D.C. shelf relays
- Also check time limit relays and time delay relays for correct timing in the relay test panel

11.4 Relays System Function Test

Further test time releasing achieved in circuit only with the conditions for correct operation set up.

11.5 Relays Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed including ITF Checklist 13/10 if applicable provided in CRN SC 012 “Standard Forms”.

12 Wires Cables and Terminals

12.1 Wires, Cables, and Terminals Apparatus Inspection

- Check workmanship and physical condition of wires, cables, and terminal equipment and installation
- Check operating environment suitable for safe, reliable operation
- Verify conformance of wires, cables, and terminations with details in the circuit books and verify compliance with equipment specifications including the following:
  - Check manufacturer's test certificates and acceptance test certificates for manufactured equipment where applicable
  - Check wires and cables for correct conductor size, insulation type, and labelling
  - Check terminals for correct type, rating, and labelling
  - Check that terminals are insulated with appropriate covers
  - Check that wires and cables are neatly run, with insulation undamaged and correctly protected
  - Check that wires are not trapped under adjacent terminals
  - Check that wires and cables are held clear or doubly insulated from metallic surfaces and that all protective grommets in entry holes are fitted correctly
  - Check that wiring runways and cable routes are installed to specification and wires and cables are not under tension, have no tight radius bends, are not bearing heavily on sharp corners, and are not chaffing
  - Check that wire terminating lugs and pins are the correct type
  - Check that all crimped and soldered connections are mechanically sound and that there are no exposed strands of wire
  - Check that terminations are mechanically sound, nuts and screws are tight and that spade type crimps are correctly locked into plug boards or terminal blocks
  - Check that there are no loose, unterminated cables, or wires with exposed conductors
  - Check that cables are correctly supported with cable clamps
  - Check that wiring is tied neatly into looms, where applicable
  - Check that buried cable routes emerge within one metre of the trackside equipment
  - Check that redundant wires, cables, and terminals are made securely inoperative and recovered
  - Check the availability of spare cores and wires, as specified
  - Check that all dirty and clean wiring requirements are met (clean wiring refers to the wiring ex any filter or lightening protection device and dirty wiring the wiring before any filter or lightening protection device)

12.2 Wires, Cable and Terminals Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test all signalling wires, cables and terminals.

12.3 Wire, Cable and Terminals Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/11 and completed the Test Certificate (TC 2A, 2B, 2C) as applicable provided in CRN SC 012 “Standard Forms”.

13 Duplex Locks

13.1 Apparatus Inspection

- Check workmanship and physical condition of equipment and installation
- Check operating environment suitable for safe, reliable operation
- Equipment:
  - Correct type and labelling
- Keys, staffs, and lock faces etc:
  - Correctly warded and inscribed
- Redundant apparatus:
  - Securely inoperative and recovered

13.2 Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function test all circuits connecting to the apparatus. Strap and Function Test contacts in the external equipment. Additionally, for alterations refer to CRN SC 013 for requirements.

13.3 Apparatus Function Test

Check adjustment of contacts to electrically open and close correctly in relation to the position of the key or staff.

Check that keys and staff when operating locks and lock contacts are captive in the lock.

13.4 System Function Test

Check that keys and staffs when withdrawn correctly lock respective function.

13.5 Test Certificate

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008, develop tailored Work Instructions in the style of ITF Checklists and completed the Test Certificates (TC) as generally shown in CRN SC 012 “Standard Forms”.

14 Axle Counter Re-Set Boxes

14.1 Apparatus Inspection

- Check workmanship and physical condition of equipment and installation
- Check operating environment suitable for safe, reliable operation
- Equipment:
  - Correct type and labelling
- Keys, and lock faces:
  - Correctly warded
- Redundant apparatus:
  - Securely inoperative and recovered

14.2 Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function test all circuits connecting to the apparatus. Strap and Function Test contacts in the external equipment. Additionally, for alterations refer to CRN SC 013 for requirements.

14.3 Apparatus Function Test

Check adjustment of contacts to electrically open and close correctly in relation to the position of the key.

Check that the key when operating the lock is held captive in the lock.

14.4 System Function Test

Check that key when withdrawn correctly lock respective function.

14.5 Test Certificate

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008, develop tailored Work Instructions in the style of ITF Checklists and completed the Test Certificates (TC) as generally shown in CRN SC 012 “Standard Forms”.

15 Warning Lights, Guards Indicators, Buffer Stop Lights, Illuminated Notice Boards and Point Indicators.

15.1 Apparatus Inspection

Check workmanship and physical condition of equipment and installation,

Check operating environment suitable for safe, reliable operation,

Verify conformance with Signalling Plan and Circuit Book including the following:

Check standard clearances and secure mounting

Equipment type	Rating and labelling
LED	Type, rating and labelling
LED	Voltage
LED focus	Colour, visibility and illumination
Redundant apparatus	Securely inoperative and recovered

15.2 Circuit Test

Bell Continuity Test, Wire Count, Null Count, Insulation Test and Circuit Function Test all circuits connecting to the apparatus. Additionally, for alterations refer to CRN SC 013 for requirements.

15.3 Apparatus Function Test

Check operation.

15.4 Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008, develop tailored Work Instructions in the style of ITF Checklist 13/1 (a or b) and complete the Test Certificate (TC 1a, 1b or 1c) as applicable provided in CRN SC 012 Standard Forms.

16 Telemetry and Panel Processor Testing

16.1 General

Testing of Telemetry and Panel Processor systems shall be in accordance with Construction Specification Signalling Electronic Systems Verification CRN SP 005. The testing shall include the tests identified in the following sub-sections.

16.2 Physical Configuration Audit

- Check drawings against as-built system
- Check for correct versions of hardware and software
- Check that all hardware (including spares), software, firmware, and documentation has been installed and/or delivered to the appropriate person
- Check that the physical aspects comply with Specification CRN SE 001

16.3 Start-up/Shut-down Tests

- Check that the system starts up correctly, reliably, without errors, and without manual intervention, and in the time specified in Specification CRN SE 001
- Check that the system can be shut-down without harm
- With the system powered down check that there is an indication that the system is not operational and that all indications and controls are off

16.4 Disruption Tests

Disrupt power, disrupt communications lines, reset modules, cause a normal/emergency power change-ever etc to determine if the system is likely to require maintenance intervention to restore the system to normal operation. Maintenance intervention should not be required due to events that could be reasonably expected to occur during normal operation.

Check that the system indicates a warning or failure as appropriate during each disruption.

16.5 Arbitration Tests

For dual systems check manual and automatic change-over for correct operation. Check that there is a seamless change-over.

For dual systems check that the standby system does not store indications or controls that are no longer current.

16.6 Correspondence Tests

- For dual systems correspondence tests shall be conducted on both sides unless a well documented justification can be supplied as to why it is not necessary
- Perform a 100% correspondence of all inputs and outputs. Where processing of Inputs/Outputs is performed by the system then the functionality of the processing shall be tested

16.7 Maintenance Facilities

Check each of the maintenance facilities provided for correct operation.

16.8 Fault Finding Procedure Test

Assume or simulate a failure of the system. Then use the fault finding procedure to find and correct the failure.

16.9 General System Requirements

- Measure each of the performance parameter (indication, control, control and indication, start up, recovery) response times and confirm that they are in accordance with specification CRN SE 001 and any particular specification
- Check the self-test and failed module isolation facilities
- Check that the system operates for a 24 hour period without any systems errors and a maximum of 2 data communications errors

16.10 Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/15 and on the appropriate test documentation similar to the Test Certificates (TC) as applicable provided in CRN SC 012 “Standard Forms”.

17 Control Console and Indicator Diagram

17.1 Control Console/Indicator Diagram Apparatus Inspection

- Check workmanship and physical condition of panel, wiring, fittings, and finish
- Check face-plate layout, inscriptions, colours, fittings correct to design
- Check positioning of console/diagram is geographically and ergonomically correct
- Check doors, hinged sections, drawers are free moving and properly secured
- Check internal equipment and wiring secured
- Check type, size, colour, rating and labelling of all fittings, equipment and wiring correct to specification
- Check Manufacturers Test Certificates and Acceptance Test Certificates for manufactured equipment, where applicable

17.2 Control Console/Indicator Diagram Circuit Testing

Bell Continuity Test, Wire Count, Insulation Test and Circuit Function Test all wiring, electrical switches, indicators and alarms within the console/diagram. Additionally, for alterations refer to CRN SC 013 for requirements.

17.3 Control Console/Indicator Diagram Apparatus Function Test

- Check all lamps, LED's, LCD's, CRT's and alarms operate correctly when energised at the correct voltage and polarity, including flashing supplies
- Check all pushbuttons, keys etc electrically open and close correctly when operated
- Check cooling system operates effectively, where provided

17.4 Control Console/Indicator Diagram System Function Test

Test all controls, indications and alarms operate correctly in correspondence with the signalling apparatus.

17.5 Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/16 and on the appropriate test documentation similar to the Test Certificates (TC) as applicable provided in CRN SC 012 “Standard Forms”.

18 Location cases and Relay Rooms

The apparatus within disconnection boxes, location cases, walk-in huts, and relay rooms is inspected and tested as shown on other sheets for those individual items of equipment and circuits.

18.1 Location Case/Relay Room General Apparatus Inspection

- Check workmanship and physical condition of the structure and installation, including the foundation
- Check operating environment for safe, reliable operation of housed equipment
- Verify conformance to Specification and to Signalling Plan and Circuit Book
- Check identification plates on locations correspond with the Signalling Plan and Circuit Diagrams and other relevant drawings
- Check positioning, alignment in accordance with Signalling Plan, Detailed Site Surveys and clear of the alignment of catchpoints, derails and non-interlocked points
- Check retaining wall, if required
- Check handrails, ladder cages, if required
- Check rubbish or combustible material can not accumulate at the location
- Check clear of watercourses, drains, roadways. Check access is clear
- Check protective rails or posts provided, where required
- Check protected against corrosion as specified
- Check structure clearance including when doors are open
- Check doors move freely and door stops and fasteners work correctly
- Check that location is water proof, dust proof, fire proof and vandal resistant
- Check cable entry and exit to specification and check cables properly clamped
- Check insect/rodent screening effectively installed
- Check ventilation is adequate
- Check heat sensitive equipment is not mounted above heat producing equipment
- Check rack mounting secure and equipment securely mounted
- Check equipment layout agrees with profile drawing
- Check all rack positions and equipment correctly labelled
- Check that all terminals and wiring is insulated, properly shrouded, and labelled
- Check documents to remain in the location are available and in good order
- Check the fire rating is as specified and that the fire detection and fire fighting equipment installed as specified
- Check that there are no sharp edges or protrusions that could cause injury
- Check that correct locks are properly fitted
- Check in-built test equipment
- Check that all equipment is installed
- Check equipment accessibility for maintenance

- Check spare space to accommodate additional equipment
- Check lighting effectiveness
- Check clear of train driver's line of sight to signals and, at level crossings, clear of road vehicle driver's line of sight of approaching trains

18.2 Circuit Testing

Bell Continuity Test, Wire Count, Null Count, Insulation Test. Additionally, for alterations refer to CRN SC 013 for requirements.

18.3 Test Certificates

Record the results of apparatus inspection and testing as nominated in Specification CRN SC 008 with tailored Work Instructions developed from ITF Checklist 13/17 and on the appropriate test documentation similar to the Test Certificates (TC7, 9) as applicable provided in CRN SC 012 “Standard Forms”.

19 Computer Based Systems

19.1 General

The particular requirements for the inspection and testing of computer based systems, interfaces and associated telecommunications systems shall be developed, documented and agreed at the Inspection and Testing Planning phase of the Works.

Testing of Computer Based Systems has two separate aspects. Firstly the Signalling functionality, and secondly the technical aspects of the system. This section is intended to cover the second aspect. Testing of the Signalling functionality is covered elsewhere in this specification.

The technical aspects of Computer Based Systems shall be tested in accordance with the relevant parts of CRN Specification Signalling Electronic Systems Verification CRN SC 005. The testing shall include the testing identified in the following sub-sections.

Manufacturers of Computer Based Systems will already have their own inspection and test plan and testing procedures, which shall be accepted by the Principal Signal & Comm. & Network Control Engineer, as providing the same level of testing, as required by this specification.

19.2 Aspects to be tested

The testing of Computer-Based systems shall ensure that the following aspects are covered:

- The system has been validated as suitable for its intended use
- The particular use of the system does not exceed any of its design limits
- The physical configuration design is correct
- The physical system is installed and configured in accordance with the particular design, using accepted system software and, hardware versions with the correct version of the application data
- The system interfaces (both internal and external) have been fully considered, and tested, including failure modes
- Application data has undergone a complete integrity test by an independent person
- The application data has undergone a complete inspection by an independent person
- Each hardware module has been tested
- Vital communications link error rates
- Event logger operation and functionality
- Non Standard interfaces
- Electromagnetic compatibility, and immunity
- Surge protection
- Vital Blocking
- Reliability
- Maintainability
- Correspondence testing
- Through testing
- Response time and performance criteria have been met

19.3 Testing of modified installations

19.3.1 Hardware modifications (or replacements)

When Hardware modifications (or replacements) are made the system shall be inspected and tested to confirm that it is correctly configured and the correct version of the application data is installed,

The system shall then be retested in accordance with the manufacturer's written recommendation as approved,

19.3.2 System Software modifications

When System Software modifications are made the system shall be retested in accordance with the manufacturer's written recommendation as approved,

19.3.3 Application data modifications

When Application data modifications are made the changes to the applications shall be identified and documented. The impact of the changes on those parts of the system that will not change (with special attention paid to any interfaces) shall be analysed and documented.

19.4 Test Certificates

The changes and any impacted aspects of the system shall be fully tested.

The system shall be then tested in accordance with the manufacturers written recommendations, as approved.

Record the results of apparatus inspection and testing adapted from the manufacturers requirements or as nominated in Specification CRN SC 017 "Computer Base Interlocking", CRN SC 008 with tailored Work Instructions developed in the style of ITF Checklist 13/18 and on the appropriate test documentation similar to the Test Certificates (TC) as applicable provided in CRN SC 012 "Standard Forms.

20 Signalling Design Checking

20.1 General Requirements to be checked

- Signals positioned to protect risks and clearly visible to train drivers
- Adequate braking distances for longest braking trains from warning signal indications to stop signals and to restricted speed turnout points
- Signal indications stepping in appropriate sequence approaching stop signals and turnout signals
- Appropriate overlap distances beyond stop signals to clearance points
- Adequate level crossing warning distances for fastest train
- Track circuit lengths greater than longest wheelbase and track circuit 'dead zones' shorter than the shortest wheelbase
- Point and plunger detection of facing points and trap points in signal controls
- Indication locking
- Track control extending to clearance points, including insulated joints clear of points and crossovers
- Track locking (approach locking and route holding)(overlap maintenance)
- Interlocking between conflicting signals, points, and level crossings
- Correctly determined time limits (on stop signals and/or track circuits) for releasing track locking, conditionally clearing trainstops, conditionally reducing overlaps
- Correct release arrangements, (not activated by power supply interruptions, bobbing track circuits, intermittent defects, failed track repeat relays)
- Correct positioning of release equipment (eg. release switches, EOL’s, ESML's, duplex locks), where reliance is placed on a physical delay time between obtaining the release and operating points equipment
- All interlocked signals replaced and held at stop by points emergency operating facilities
- Fail safe, high reliability design of vital equipment and circuits, with appropriate back proving
- Correct separation between vital and non-vital equipment and circuits
- Reliable power supplies to colour light signals and to level crossing highway signals
- Correct track circuit and traction bonding design including polarity reversal
- Trainstops as required
- Wiring to Standard Circuit Designs
- Correct discrimination of fuse sizes, circuit breaker ratings
- Operational Requirements satisfied
- Integrity, reliability and maintainability aspects at all interfaces e.g. impulse tracks on poor ballast, new type less tolerant point machines on old points layouts, computer based interlocking interfaces to relay Interlockings (timing aspects), power supply changeovers
- Traffic patterns, to ensure track circuits in all signal routes will be traversed frequently to keep the rail surfaces clean
- Circuit design to ensure no relay race, lock out, back EMF problems, and no circuit paths through other functions in series if open circuits occur in normal return paths

- Adequate protection and/or immunity from electromagnetic or electrostatic interference, lightning and power surges, earth leakage, overheating, external power supply polarity/phasing changes