SIGNALS & COMMUNICATIONS STANDARDS

GENERAL INSTRUCTIONS

Doc # RC-0506-03SIG-01

October 2019

METROLINX

GO TRANSIT SIGNALS & COMMUNICATIONS STANDARDS

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GI Preface

PREFACE

This is the first edition of the GO Transit Signals and Communications Standards – General Instructions.

The purpose of the GO Transit Signals and Communications Standards is to ensure that Metrolinx owned and operated signals and communications systems are constructed and maintained utilizing safe, cost effective and efficient methods to meet project delivery timelines, and meet on-time operational performance goals. Furthermore, a consistent approach in the application of Metrolinx owned signals and communications standards shall reduce disputes during the design and construction phases of a project, enhance the long term safety, reliability and extend the useful service life of the signals and communications systems.

The technical content within the GO Transit Signals & Communications Standards – General Instructions was modified / developed by the Metrolinx Signals & Communications office within Engineering and Asset Management Department of Capital Project Group, which includes specialized subject matter experts.

NOTE

The GO Transit Signals and Communications Standards – General Instructions are intended for use by suitably qualified professionals. It is not a substitute for coordination and compliance with all applicable local codes, standards, manuals, and approvals for fire protection, life safety, and security measures that are part of the planning, design and implementation of a railway.

SUGGESTIONS FOR REVISIONS AND IMPROVEMENT

Suggestions for revision or improvement can be sent to the Metrolinx Signals and Communications office, Attention: Director of Signals and Communications who shall introduce the proposed changes to the Metrolinx Signals and Communications office. The Director of Signals and Communications office ultimately authorizes the changes. Be sure to include a description of the proposed change, background of the application and any other useful rationale or justification. Be sure to include your name, company affiliation (if applicable), e-mail address, and phone number.

GENERAL REQUIREMENTS

The instructions contained herein shall apply to all trackage and rights-of-way owned or operated by GO Transit ("the Railway"), and UP Express, which are divisions of Metrolinx. Where a rule or instruction is in conflict with a law or regulation issued by a government body having jurisdiction, the law or regulation will take precedence over the rule or instruction.

Changes in these standards or practices that do not conflict with Transport Canada standards may be implemented on a phased schedule or program, at the discretion of Metrolinx Signals and Communications.

These standards are effective as of October 30th, 2019.

GI Revision History

GI No.	Subject	Previous Release	Latest Release

GI Contents

GI 302 - Inspecting Cable Housings

GI 303 - Testing for Grounds & Battery Isolation Faults

GI 305 - Storage Batteries

GI 307 - Inspecting and Testing Recording Devices

GI 308 - Electric Lock

GI 309 - Testing Ground Resistance

GI 310 - Testing Highway Grade Crossing Devices

GI 312 - Wire & Cable Resistance

GI 313 - Lightning Arresters

GI 314 - Inspecting Signal Pole Line and Attachments

GI 315 - Testing Approach Locking

GI 316 - Testing Detector Locking

GI 317 - Testing Indication Locking

GI 318 - Testing & Inspecting Movable Bridges

GI 319 - Locking Testing Route Locking

GI 320 - Testing Time Locking

GI 321 - Testing Traffic Locking and Field Blocking

GI 322 - Inspecting and Testing Searchlight Signal Mechanisms

GI 323 - Inspecting and Testing Relays

GI 324 - Supplementary Inspections and Tests

GI 326 - Inspecting and Testing Fouling Circuits

GI 327 - Inspecting and Testing Switch Circuit Controllers

GI 329 - Inspecting and Testing Power Switch Machines

GI 330 - Spring Switches

GI 331 - Testing Time Releases, Time Relays and Timing Devices

GI 332 - Inspecting and Testing Insulated Track Hardware

GI 333 - Testing Track Circuits

GI 334 - Testing and Inspecting Hazard Devices

GI 335 - Vital Software & Hardware

GI 336 - Non-Vital Software & Hardware

GI 340 - ATCS - MCP/BCP Radio

GI 400 - General

GI 401 - Inspecting Foundations

GI 402 - Inspecting Signals Structures

GI 403 - Inspecting Painted Surfaces

GI 404 - Inspecting Gaskets

GI 405 - Inspecting Seals

GI 406 - Inspecting and Testing Wayside Pushbuttons and Panels

GI 407 - Inspecting and Testing Fuses

GI 408 - Inspecting Electrical Contacts

GI 409 - Inspecting Mechanical Equipment

GI 410 - Inspecting Signal Lamps

GI 411 - Inspecting Signal Alignment

GI 501 – Inspecting and Testing Hot Box Detectors

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GI Definitions

1. **Activation Failure:** The failure of an active road crossing warning system to indicate the approach of a train at least 20 seconds prior to the train's arrival at the crossing, or to indicate the presence of the train on the crossing. A failure is considered to be when more than 50% of the flashing lights (not gate arm lights or back lights) are not functioning as intended.
2. **Application Software**: See *Software, Application (Vital).*
3. **Approach Circuit:** A circuit generally used in connection with announcing the approach of trains at a block or interlocking station or to provide initial activation or detection for a road crossing warning system.
4. **Aspect**: The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train; the appearance of a cab signal conveying an indication as viewed by an observer in the cab.
5. **Automatic Block Signal System**: A series of consecutive blocks governed by block signals, cab signals, or both, actuated by a train, or engine, or by certain conditions affecting the use of a block.
6. **Ballast Resistance**: The resistance offered by the ballast, ties, etc., to the flow of leakage current from one rail of a track circuit to the other.
7. **Battery, Control**: The battery at a crossing warning location which provides energy to the controlling devices, such as GCP, motion sensor, or control relay circuitry.

8. **Battery**, **Operating**: A battery, other than a track battery, used to provide energy to a signal system or portion thereof. At a crossing warning location, the operating battery typically provides energy to the lights, bells and gates.

9. **Battery, Track**: A battery connected to the rails and used to provide energy to a track relay.

10. **Battery Ground**: A fault condition whereby a sustained voltage potential exists between a vital energy bus and earth ground, capable of producing current flow in excess of 75 percent of the release value of any relay or electromagnetic device energized by the bus, or any value which affects the proper operation of electronic devices energized by the bus. See also *Vital Energy Bus*.

11. **Battery Isolation Fault**: A fault condition whereby a path exists between multiple vital energy buses which, in combination with another fault, has the potential to bypass one or more failsafe elements in a road crossing warning system or signal circuit. See also *Vital Energy Bus*.

12. **Block**: A length of track of defined limits, the use of which by trains and engines is governed by block signals, cab signals, or both.

13. **Block Indicator**: An indicator used to indicate the condition of a block.

14. **Block Signal:** A fixed signal at the entrance to a block to govern a movement entering or using that block.

15. **Block Signaling**: A method of governing the movement of trains into or within one or more blocks by block signals or cab signals.

16. **Blocking**: An operator-controlled feature which prevents requests for power switch movements and/or clearing of signals.

17. **Bond, Rail Joint**: A metallic connection attached to adjoining rails to ensure electrical conductivity.

18. **Cable Housing**: A housing used for the purpose of terminating wires or cable and/or mounting equipment.
19. **Cab Signal:** An in cab signal indication transmitted from wayside to a movement to inform the operator of a track condition ahead to advance, stop or slow the movement in advance of a restricted situation.
20. **Centralized Traffic Control (CTC):** A system in which CTC rules apply.
21. **Charge, Battery**: The restoration of the active materials in a battery by passing a unidirectional current through it in the opposite direction to that of the discharge.
22. **Charge, Constant Current**: A charge in which the current is maintained at a constant value.
23. **Charge, Constant Voltage**: A charge in which the voltage at the terminals of the battery is held at a constant value. A modified constant-voltage charge is one in which a fixed resistance is installed in the charging circuit to limit the initial current.
24. **Charge, Equalizing**: An extended charge which is given to a storage battery to ensure the restoration of the active material in all the cells.
25. **Charge, Floating**: Maintaining a storage battery in operating condition by a continuous charge at a low rate or primary battery coupled with a rectifier to provide a supplementary source of energy.
26. **Charge, Initial**: A term used in expressing the first charge given a storage battery after it has been set up, also to designate that recommended current applied to electrical apparatus at the beginning of a series of tests.
27. **Charge, Trickle**: A continuous input of current to a storage battery to compensate for internal losses only.
28. **Circuit Controller**: A device for opening and closing electrical circuits.

29. **Circuit Ground:** A fault condition whereby a sustained voltage potential exists between a vital circuit and earth ground, capable of producing current flow in excess of 75 percent of the release value of any relay or electromagnetic device in the circuit, or any value which affects the proper operation of electronic devices in the circuit. See also *Vital Circuit*.

30. **Clearance Point**: The location on a turnout at which specified clearance is provided between tracks.

31. **Closed Circuit Principle**: The principle of circuit design where a normally energized electric circuit which, on being interrupted or de-energized, will cause the controlled function to assume its most restrictive condition.

32. **Common Return Circuit**: A term applied where one wire is used for the return of more than one electrical circuit.

33. **Conflicting Routes**: Two or more routes, opposing, converging, or intersecting, over which movements cannot be made simultaneously without possibility of collision.

34. **Constant Warning Device**: A device used as a part of a road crossing warning system to provide a relatively uniform warning time.

35. **Control Circuit**: An electrical circuit between a source of electric energy and a device which it operates.

36. **Control Point**: A location where signals or other functions or both of a traffic control system are controlled from the control machine.

37. **CROR:** Canadian Rail Operating Rules.

38. **Cross Protection**: An arrangement to prevent the improper operation of a signal, switch, movable-point frog, or derail as the result of a cross in electrical circuits.

39. **Crossing Start**: See *Approach Circuit*.

40. **Cut-Section**: A location other than a signal location where two adjoining track circuits end within a block.

41. **Cut-Section, Relayed**: A cut-section at which the energy supply for one track circuit is supplied through front contacts or through front and polar contacts of the track relay for the adjoining track circuit.

42. **Dead Section**: A section of track, either within a track circuit or between two track circuits, the rails of which are not part of a track circuit.

43. **De-energized Position**: The position assumed by the moving member of an electromagnetic device when the device is deprived of its operating current.

44. **Derail:** A device designed to cause rolling equipment to leave the rails.

45. **Disarranged**: A system has been disarranged when its vital nature has been compromised by the removal and replacement or the disconnection and reconnection of one or more of its vital components. The extent of operational testing the system must undergo as a result, will depend on the degree of disarrangement that has occurred.

46. **Double Wire Line Circuit**: An electrical circuit not employing a common return wire; a circuit formed by individual wires throughout.

47. **Drop-Away (release) Value**: The electrical value at which the movable member of an electromagnetic device will move to its de-energized position.

48. **Electric Lock**: A device to prevent or restrict the movement of a lever, a switch, or a movable bridge, unless the locking member is withdrawn by an electrical device such as an electromagnet, solenoid, or motor.

49. **Electric Lock, Forced-Drop**: An electric lock in which the locking member is mechanically forced down to the locked position.

50. **Executive Software:** See *Software, Executive (Vital*).

51. **Facing Point Move**: The movement of a train over the points of a switch which face in a direction opposite to that in which the train is moving.

52. **Facing Points**: The points of a switch which face traffic approaching in the direction for which the track is signaled.

53. **Failure to Warn**: See *Activation Failure*.

54. **False Activation**: Activation of a road crossing warning system in response to a condition which requires correction or repair of the warning system, either in the control or track circuit. This is a right-side failure of the system, in that it provides notice of warning as is required by fail-safe design techniques.

55. **False Clear**: See *False Proceed*.

56. **False Proceed**: A failure of a system, device or appliance to function as intended, resulting in the display of a less restrictive signal aspect. This is a wrong-side failure of the system.

57. **Fail Safe**: A term used to designate a railway signaling design principle, the objective of which is to eliminate the hazardous effects of a failure of a device, component or system.

58. **Focusing**: Adjusting the position of an electric lamp so as to locate its filament at the focus of a lens or reflector system. (see also: *Signal Alignment*)

59. **Foreign Current**: Foreign electrical current which may adversely affect the operation of a system.

60. **Fouling Point**: The location on a turnout back of the frog at which insulated joints or derails are placed at or beyond clearance point.

61. **Fouling Section**: The section of track between the switch points and the fouling point in a turnout.

62. **Frequently**: When stated as a GI interval, the test or inspection shall be performed each time a reasonable opportunity to do so presents itself.

63. **Ground:** A fault condition whereby an electrical path to earth ground exists which, in combination with another fault, has the potential to bypass one or more failsafe elements in a road crossing warning system or signal circuit. A ground fault may affect entire energy bus (see also *Battery Ground*) or individual circuit (see also *Circuit Ground*).

64. **Highway Grade Crossing Warning System:** An interconnection of various devices and their controls used to indicate the approach and/or presence of a train at a highway grade crossing. Also referred to as a *Road Crossing Warning System*.

65. **In Advance of a Signal**: A term used in defining the territory beyond a signal as seen from an approaching train.

66. **In Approach of a Signal**: A term used in defining the territory to which a signal indication is conveyed.

67. **Indication**: The information conveyed by the aspect of a signal.

68. **Inspection**: A careful and critical examination which may lead to testing in order to confirm uncertain results.

69. **Inspector (Testman)**: A qualified signal person who has passed the inspectors test and whose duties consist of inspection and testing of signal components and signal systems.

70. **Installed**: This term applies whenever equipment or systems are originally installed, replaced or disarranged.

71. **Insulated Rail Join**t: A joint in which electrical insulation is provided between adjoining rails.

72. **Insulation Breakdown**: The resistance offered by the insulation on any current-carrying part or conductor.

73. **Interlocked Route**: A route within interlocking limits.

74. **Interlocking, Automatic**: An arrangement of signals, with or without other signal appliances, which functions through the exercise of inherent powers as distinguished from those whose functions are controlled manually, and which are so interconnected by means of electric circuits that their movements must succeed each other in proper sequence, by train movements over all routes being governed by signal indication.

75. **Interlocking, Manual**: An arrangement of signals and signal appliances operated from an interlocking machine and so interconnected by means of mechanical and/or electric locking that their movements must succeed each other in proper sequence, by train movements over all routes being governed by signal indication.

76. **Leakage Current**: A stray electric current of relatively small value which flows through or across the surface of insulation when a voltage is impressed across the insulation.

77. **Lens**: A glass or similar product, usually circular in shape, designed to collect the rays of light directly from a light source and focus them into a beam of definite shape depending upon the design. It may be clear or colored as required.

78. **Lock, Facing Point**: A mechanical lock for a switch, derail, or movable-point frog, comprising a plunger stand and a plunger that engages a lock rod attached to the switch point to lock the operated unit.

79. **Lock Rod**: A rod, attached to the front rod or lug of a switch, movable-point frog or power derail, through which a locking plunger may extend when the switch points or derail are in the normal or reverse position.

80. **Locking, Approach**: Electric locking effective while a train is approaching, within a specified distance, a signal displaying an aspect to proceed, and which prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable-point frog, or derail in the route governed by the signal, and which prevents an aspect to proceed from being displayed for any conflicting route.

81. **Locking, Detector**: Electric locking effective when a specific section of track is occupied, it prevents the movement of any interlocked or electrically locked switch, movable-point frog, movable bridge or derail within a specific section of track.

82. **Locking, Electric**: The combination of one or more electric locks and controlling circuits by means of which levers of an interlocking machine, or switches or other units operated in connection with signaling and interlocking, are secured against operation under certain conditions.

83. **Locking, Indication**: Electric locking which prevents manipulation of levers that would result in an unsafe condition for a train movement if a signal, switch or other operative unit fails to make a movement corresponding to that of its controlling lever, or which directly prevents the operation of a signal, switch, or other operative unit, in case another unit which should operate first fails to make the required movement.

84. **Locking, Movable Bridge**: The rail locks, bridge locks, bolt locks, circuit controllers, and electric locks used in providing interlocking protection at a movable bridge.

85. **Locking, Route**: Electric locking, effective when a train passes a signal displaying an aspect for it to proceed, which prevents the movement of any switch, movable-point frog, or derail in advance of the train within the route entered. It may be so arranged that as a train clears a track section of the route, the locking affecting that section is released.

86. **Locking, Time**: A method of locking, either mechanical or electrical, which, after a signal has been caused to display an aspect to proceed, prevents until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the operation of any interlocked or electrically locked switch, movable-point frog, or derail in the route governed by that signal, and which prevents an aspect to proceed from being displayed for any conflicting route.

87. **Locking, Traffic**: Electric locking which prevents the manipulation of levers or other devices for changing the direction of traffic on a section of track while that section is occupied or while a signal displays an aspect for a movement to proceed into that section.

88. **MECP**: Ministry of Environment, Conservation & Parks.

89. **Motion Sensitive Device**: A device used to sense the presence, motion and direction of travel of a train. A device used to detect the movement of a train.

90. **Movable Bridge**: That section of a structure bridging a navigable waterway so designed that it may be displaced to permit passage of traffic on the waterway.

91. **Movable Member**: A mechanical device that must be driven into place and properly seated to perform some form of locking or aligning function on a movable bridge. When more than one type of movable member is employed to lock or align different parts of a bridge, they must be fully engaged and detected as locked in a prescribed sequence before trains can be allowed to proceed on signal indication.

92. **Movable-Point Frog**: A frog equipped with points that are movable in the same manner as the points of a switch.

93. **Non-Vital Circuit**: Any circuit the function of which does not affect the safety of train operation.

94. **Nuisance Ringing**: See *False Activation*.

95. **Operating Characteristics**: As applied to electrical apparatus, the measure of the electrical values at which the apparatus operates (drop-away, pick-up, working value, etc.).

96. **Operational Testing**: The service testing of a signal system which verifies that all circuits and apparatus are operating as intended to ensure the safety of train operation.

97. **Opposing Signals**: Signals which govern movements in opposite directions on the same track.

98. **Opposing Train**: A train, the movement of which is in a direction opposite to and toward another train on the same track.

99. **Partial Activation**: The failure of an active road crossing warning system to fully indicate the approach of a train at least 20 seconds prior to the train s arrival at the crossing, or to fully indicate the presence of the train on the crossing, on account of either:

    a. One of two lights is not flashing as intended at a non-gated crossing equipped with a single pair of lights (and the back lights are not visible from the other side of the crossing); or

    b. At gated crossings, a gate arm is not in the horizontal position; or

    c. At gated crossings, any portion of a gate arm with flashing lights is missing.

100. **Phantom Signal**: An aspect displayed by a light signal, different from the aspect intended, caused by a light from an external source being reflected by the optical system of the signal.

101. **Pick-Up Value**: The electrical value at which the movable member of an electromagnetic device will just close its front contacts or visually indicate its energized position.

102. **Pipe Line, Mechanical**: A connection made with pipe, complete with supporting apparatus, which connects an operating lever to an operated unit.

103. **Plunger, Facing-Point**: The part of a facing-point lock which secures the lock rod to the plunger stand when the switch is locked. Lock

104. **Point Detector**: A circuit controller which is part of the switch operating mechanism and operated by a rod connected to a switch, derail, or movable-point frog to indicate the point is within a specified distance of the stock rail.

105. **Pole Changer**: A device by which the direction of current flow in an electrical circuit may be changed.

106. **Positive Protection**: Making provision for the safe operation of trains, with the use of proper operating permits or clearances, or the appropriate flagging procedures.

107. **Relay, Biased**: A relay which will operate to its energized position by current of one polarity only, and will return to its de-energized position when current is removed.

108. **Relay, Code Following**: A relay which will follow or reproduce a code without distortion within practical limits.

109. **Relay, Flasher**: A relay so designed that, when energized, its contacts open and close at predetermined intervals.

110. **Relay, Line**: A relay receiving its operating energy through conductors of which the track rails form no part.

111. **Relay, Magnetic Stick**: A relay, the armature of which remains at full stroke in its last energized position when its control circuit is opened.

112. **Relay, Motor Type**: A relay which operates on the principle of a motor.

113. **Relay, Neutral**: A relay which operates in response to a predetermined change of the current in the controlling circuit, irrespective of the direction of the current.

114. **Relay, Overload**: A relay which operates to open contacts when the current through its control coils exceed a predetermined value.

115. **Relay, Polar**: A relay which operates in response to a change in the direction of current in its controlling circuit and the armature of which may or may not remain at full stroke when its control circuit is interrupted.

116. **Relay, Polarized**: A neutral relay equipped with polar armatures and contacts.

117. **Relay, Power Transfer**: A relay so connected to the normal source of power supply that failure of such source of power supply causes the load to be transferred to another source of power supply.

118. **Relay, Quick Drop-Away**: A relay which, when the controlling circuit is opened or completely shunted, will release quicker than an ordinary relay.

119. **Relay, Quick Pick-Up**: A relay which, when energy is applied, will pick up quicker than an ordinary relay.

120. **Relay, Slow Drop-Away**: A relay which, when the controlling circuit is opened or completely shunted, will release slower than an ordinary relay.

121. **Relay, Slow Pick-Up**: A relay which, when energy is applied, will pick up slower than an ordinary relay.

122. **Relay, Thermal**: A timing relay whose contacts are actuated by the heating effect of current flowing through its controlling element.

123. **Relay, Timing**: A relay which will not close its front contacts or open its back contacts, or both, until the expiration of a definite time interval after the relay has been energized.

124. **Relay, Track**: A relay receiving all or part of its operating energy through conductors of which the track rails are an essential part.

125. **Relay, Vane Type**: A type of alternating current relay in which a light metal disc or vane moves in response to a change of the current in the controlling circuit.

126. **Restoring Feature**: An arrangement on a power-operated switch movement by means of which power is applied to restore the switch movement to full normal or to full reverse position, before the driving bar creeps sufficiently to unlock the switch, with control lever in normal or reverse position.

127. **Right Side Failure**: A failure of a device, component, or system such that the margin of safety afforded by that device, component, or system is not compromised.

128. **Road Crossing Warning System**: An interconnection of various devices and their controls used to indicate the approach and/or presence of a train at a highway grade crossing. Also referred to as a *Highway Grade Crossing Warning System*.

129. **SCIS:** Signals and Communications Inspection System. A means of capturing and recording the results of inspections and tests electronically approved by Metrolinx.

130. **Seasonal**: When stated as a GI interval, the test or inspection shall be performed at the next scheduled site visit after an obvious change of seasons. The GI is not expected to be performed at locations experiencing mild changes of season.

131. **Sectional Release**: A type of route locking in which directional stick relays unlock the route in sections. The purpose is to release switches or other devices in the route after the rear of a train movement has cleared them.

132. **Series Fouling Track Circuit**: The track circuit in the fouling section of a turnout connected in series with the track circuit in the main track.

133. **Shunt**: A by-pass in an electrical circuit.

134. **Shunt Fouling Track Circuit**: The track circuit in the fouling section of a turnout connected in multiple with the track circuit in the main track.

135. **Signal Alignment**: To adjust the mounting of a light unit so as to direct the projected beam toward a specified point. (see also: *Focusing*)

136. **Signal, Approach**: A roadway signal used to govern the approach to another signal and if operative so controlled that its indication furnishes advance information of the indication of the next signal.

137. **Signal, Block**: A roadway signal operated either automatically or manually at the entrance to a block.

138. **Signal, Color Light**: A fixed signal in which the indications are given by the color of a light only.

139. **Signal, Dwarf**: A low signal, usually restricted to a maximum height of 60" above top of rail unless covered by Special Instructions, used as a block or interlocking signal.

140. **Signal, Home**: A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block.

141. **Signal Inspector:** An employee or contractor or otherwise identified by Metrolinx as being responsible for carrying out inspections.

142. **Signal, Interlocking**: A roadway signal which governs movements into or within interlocking limits.

143. **Signal, Opposing**: Roadway signals which govern movements in opposite directions on the same track.

144. **Signal, Searchlight**: A type of color light signal that uses a single lamp with a single lens or lens doublet to display up to three different aspects by placing a color cone or disc between the lamp and lens. The desired color is selected by energizing an electromagnetic mechanism. The aspect displayed is dependent upon the polarity of the applied power. De-energization of the mechanism will cause the signal to display its most restrictive aspect.

145. **Software, Application (Vital**): Software that is written to vitally control the operation of processor based equipment for a specific location. The application logic describes the interlocking logic or functionality implemented in a processor based piece of equipment and is generally specific to a given location or typical field configuration.

146. **Software, Executive (Vital)**: Software that vitally maintains internal operation of the processor based equipment, such as scheduling tasks internal to the equipment, running timers, reading inputs, driving outputs, and performing self-diagnostics. The executive software is generally the same for all installations of a given model of equipment.

147. **Stick Release Timer**: A timing device used in road crossing warning systems, that is activated by the presence of a train on the approach track circuit which, after a preset time, releases the stick relay if the trailing track circuit fails to re-energize after the train exits the circuit.

148. **Surge Protection:** Protection to equipment and personnel from high transient voltages such as those caused by lightning or other abnormal conditions.

149. **Supervisory Officer:** An employee or contractor or otherwise identified by Metrolinx as being responsible for overseeing work to be performed.

150. **Switch-and-Lock Movement**: A device, the complete operation of which performs the three functions of unlocking, operating, and locking a switch, movable-point frog, or derail.

151. **Switch Circuit Controller**: A device for opening and closing electrical circuits operated by a rod connected to a switch, derail, or movable-point frog.

152. **Switch, Dual Control**: A power operated switch also equipped for hand operation.

153. **Switch, Interlocked**: A track switch within the interlocking limits, the control of which is interlocked with other functions of the interlocking.

154. **Switch Point:** A movable tapered track rail, the point of which is designed to fit against the stock rail.

155. **Switch, Power Operated**: A switch operated by some form of energy, usually electrical or pneumatic.

156. **Switch, Sectionalizing**: A switch for disconnecting a section of an electrical circuit from the source of energy.

157. **Switch Shunting Circuit**: A shunting circuit which is closed through contacts of a switch circuit controller.

158. **Switch, Spring**: A switch equipped with a spring device which forces the points to their original position after being trailed through and holds them under spring compression.

159. **Test**: To subject apparatus or systems to specified electrical and/or mechanical conditions designed to verify their state of operation meets acceptable service specifications.

160. **Testman**: See Inspector (*Testman*).

161. **Time Release**: A device used to prevent the operation of an operative unit until after the expiration of a predetermined time interval after the device has been actuated.

162. **Track Circuit**: An electrical circuit of which the rails of the track form a part.

163. **Track Circuit, Coded**: A track circuit in which the energy is varied or interrupted periodically.

164. **Trailing Point Move**: The movement of a train over the points of a switch which face in the direction in which the train is moving.

165. **Trailing Points**: The points of a switch which face away from traffic approaching in the direction for which the track is signaled.

166. **Trap Circuit**: A term applied to a circuit used at locations where it is desirable to protect a section of track but where it is impracticable to maintain a track circuit.

167. **Unrequested Permissive Signal**: In CTC territory, a failure of the code delivery system to function as intended, resulting in the establishment of a route not intended by the RTC.

168. **Vital Circuit**: Any circuit the function of which affects the safety of train operations.

169. **Vital Energy Bus**: A common source of energy for distribution to vital circuits.

170. **Warning System Malfunction**: An activation failure, a partial activation, or a false activation of a road System crossing warning system.

171. **Working Value**: The electrical value at which the movable member of an electromagnetic device will move to its full energized position to provide maximum front contact pressure.

172. **Wrong Side Failure**: A failure of a vital circuit such that the margin of safety afforded by that circuit is compromised.

301(a) - Working with Approved Plans

1. Purpose

1.1. To describe the process which ensures the installation or revision of S&C signal systems is carried out in accordance with approved plans and will not compromise the safety and reliability of the signal system.

2. Requirement

2.1. The installation of, and changes to, signal systems and other assigned equipment shall be made in accordance with approved plans and specifications issued by the Metrolinx or in exceptional cases, as otherwise authorized by Metrolinx.

2.2. CAUTION: Any changes to in service systems must be done with a Metrolinx approved testing plan Refer to GI-301(b)(1) Installation & Commissioning Tests (Conventional) and GI-301(b)(2) Installation & Commissioning Tests (Staged).

3. Approved Plans

3.1. Approved plans are those which have successfully complied with the engineering review and checking process. The marks of approval are the initials of the designer, the checker and the approver which are usually entered in the title block, and the stamp signed and dated by Professional Engineer licensed in the Province of Ontario.

3.2. The approved plan is the authority for the responsible Supervisory Officer to proceed with the installation or modification to the signal system.

3.3. Figure 301(a)- 1 below is an example of a typical title block that usually appears on the bottom right corner of a signal plan. The block has spaces for the initials of the designer (DESIGNED BY), the checker (CHECKED BY), the person responsible for the final approval check (APPROVED BY), and the Professional Engineer stamp.

Figure 301(a)- 1

DRAWN BY: ABC 19/10/01	DESIGNED BY: ABC 19/10/01
CHECKED BY: DEF 19/10/03	APPROVED BY: GHI 19/10/05
SCALE: N.T.S.	FULL SIZE ONLY

4. Plan Types

4.1. There are several types of plans used in conjunction with signal system installations that must be approved by Metrolinx prior to being forwarded to the responsible Supervisory Officer.

Table 301(a)-01

Plan Type	Content
Profile	A horizontally scaled drawing showing signal spacing, switch location, track curvature, and gradient of a section of signaled track.
Board Plan	A scaled drawing showing location of signals, approach length, type and location of signals associated with a specific Highway Grade Crossing Warning System.
Track Plan (T&L)	A double lined track layout showing track connections, signal house location, switch layouts, line and cable runs, and other physical characteristics linking the signal system to the track.
Circuit	Schematic drawings of the circuits and signal apparatus layout associated with a complete signal system or portion thereof.
Route and Aspect	A single lined track layout diagram which correlates each aspect that each signal in the system is designed to display to each route controlled by that signal.

5. Design Errors

5.1. When plans are found to be in error, the employee detecting the error shall report it to the responsible Supervisory Officer, who in turn shall advise Metrolinx that a revision to the plan is required. All design errors shall be recorded in accordance with GI- 301(c) Recording Circuit Wiring and Design Errors.

6. Issuing Revised Plans

6.1. When a design error has been detected, a revision may be re- issued by Metrolinx to the responsible Supervisory Officer by one of these methods.

Table 301(a)-02

Level of Acceptability	Method
Most Acceptable	Metrolinx issues approved revised originals of all plans affected by the change.
Acceptable	Metrolinx issues approved revised electronic copies of all plans affected by the change, followed up as soon as possible with approved revised originals. NOTE: This method should only be used when it is impractical due to time restrictions to deliver approved revised originals.
Least Acceptable	Metrolinx issues via telephone, the necessary information to make the change, followed up as soon as possible with revised electronic copies of all plans affected by the change, approved revised originals and testing procedures. NOTE: This method should only be used: • When it is impractical due to time restrictions to transmit the plan electronically and • When the revision is minor and Metrolinx and the responsible Supervisory Officer in the field agree that the safety of the signal system cannot be compromised using this method.

7. Receipt of Approved Revised Plans

7.1. Regardless of how the approved revised plan set is received, it shall be handled as follows:

a) The responsible Supervisory Officer shall ensure all previously approved plan sets are updated with the approved changes, by either inserting the revised replacement copies and/or making the color code changes on the original plan set.

b) Plans that are being replaced shall be marked from corner to corner with an "X" and also marked with the term "OBSOLETE - DO NOT USE".

c) Obsolete plans shall be destroyed.

8. As Installed Plans

8.1. Refer to GI-301(f) Condition of Plans, and be governed by those instructions.

9. Exceptional Cases

9.1. There will be circumstances when approved plans need not be issued prior to the installation or change to the Signal System. In these cases, other approval methods may be used as authorization for work to proceed. This table gives some examples of these circumstances.

Table 301(a)-03

Circumstance	Example
Approval by letter	A letter from Metrolinx authorizing the installation of "R" markers on intermediate signals is issued to cover work to be completed across the system. Replacement plans may be issued after the work is completed.
Service Bulletin Approved by Metrolinx	A service bulletin authorizing the modification of existing equipment circuitry is issued to cover work at locations identified in the bulletin. The service bulletin may include a typical plan(s) required to make the change.
Approval by the Supervisory Officer in charge of operational testing	The Supervisory Officer in charge of Operational Testing for a project may authorize a minor revision to a previously approved plan when Metrolinx is not immediately available. Every effort must be made to advise Metrolinx of the revision and have it approved as soon as possible. NOTE: A revision shall be considered minor only when it is known the change will absolutely not compromise the safety or integrity of the signal system. The revision shall be followed by appropriate operational testing.

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301(b) - Installation & Commissioning Tests

1. Purpose

1.1. To ensure testing is performed in a logical, systematic manner to ensure the plant operates safely and reliably prior to being placed in service.

2. Requirement

2.1. Before a new installation, change to an existing installation, or replacement equipment is placed in service, a complete Metrolinx approved check and test of the circuits and mechanical features shall be made to ensure the signal system functions as intended.

3. Testing Personnel

3.1. All tests shall be performed by personnel designated by Metrolinx.

4. Test Application

4.1. This table explains the magnitude of the testing required.

Table 301(b)-01

Reason for Testing	Testing Required
New installation.	Tests shall be performed on all equipment.
Revision, alteration or modification to existing systems.	Tests shall be performed on all equipment which could be affected by the revisions, alterations or modifications.
Disarrangement of existing systems.	Tests shall be performed on all equipment which could be affected by the removal/replacement or the disconnection/reconnection of one or more vital components of the signal system, such as when simultaneously disconnecting more than one wire to a signal mechanism.

5. Methodologies

5.1. This table explains the two accepted testing methodologies.

Table 301(b)-02

Testing Methodology	Description
Conventional GI-301(b)(1)	All tests are performed on-site at the time of and immediately preceding the final commissioning.
Staged GI-301(b)(2)	Some tests are performed off-site and/or well in advance of the in-service date. Reduced testing is performed at time of final commissioning.

6. Conditions for Staged Testing

6.1. In order for the staged methodology to be allowed, the following conditions must be met:

a) The vital equipment must be electronic processor based, such as GEO, VPI, Electrologixs, MicroLok, Genrakode, Electrocode, etc., unless the intent is to perform all stages of testing on-site.

b) The vital equipment must have a clear demarcation point, such as a single terminal board, to enable all subsystems on one side of the demarcation point to be tested and validated in isolation.

c) A formal documentation process is followed to eliminate the risk of error when progressing from one testing stage to another.

7. Design Errors

7.1. Any design errors found during testing shall be reported to the Supervisory Officer who shall notify Metrolinx in accordance with GI-301(c) Recording Circuit Wiring and Design Errors. All further testing shall be halted until the Supervisory Officer has consulted Metrolinx to determine what, if any, retesting may be required.

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301(b)(1) - Installation & Commissioning Tests (Conventional)

1. Purpose

1.1. To ensure testing is performed in a logical, systematic manner to ensure the plant operates safely and reliably prior to being placed in service.

2. Test Interval

2.1 Installation & Commissioning Tests are performed at the time of installation, and when any revisions or alterations are made at the location. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Testing Sequence

3.1 This table explains the sequence in which testing shall be performed for conventional installing and commissioning testing.

3.2 All tests must be documented where appropriate, such as on the print or proper form. All tests must be verified by a second employee.

Table 301(b)(1)-01

Step	Test
1	Component check
2	Wire continuity check
3	Circuit breakdown
4	Terminal, connection and contact check
5	Final wire check
6	Operational test

4. Documentation

4.1 Record the results of testing Steps 1-5 on the following forms:

a) For signaling locations: SCP-1209-1

b) For crossing locations: SCP-1210-1

4.2 Step 6 operational tests shall be prepared and documented in accordance with GI-301(e) Signal Installation and Testing Documentation.

5. Step 1 – Component Check

5.1 Cross-reference all installed equipment and/or components to the circuit plan to ensure that they conform to the plan. Check that all components function properly, using the guidelines outlined in the table below.

Table 301(b)(1)-02

Test	Action
Conformance to Plans	• Check size, type and rating. • Check frequency (electronic equipment). • Check contact configuration (relays). • Check that terminals are properly tagged. • Check Software and Hardware revision levels.
Component Functionality	• Check physical mounting is secure. • Remove shipping screws or locking mechanisms from components and equipment in preparation for normal operation. • Set constant voltage chargers to proper voltage and constant current chargers to supply proper charge with the load connected. • Connect batteries to the charging circuits and turn power on. • Check that all timing devices operate within the time limits specified for the device.

6. Step 2 – Wire Continuity Check

6.1 This table explains how to check wire continuity. Use a buzzer or an ohmmeter to test each wire. Perform these tests with circuits de-energized.

Table 301(b)(1)-03

When wire being tested is …	Do this.	Why?
Connected to equipment	• Remove or disconnect equipment (ex. plug-in relay); or • Disconnect wire at the equipment (if necessary).	To ensure that the wire being checked is isolated from other circuits or components and equipment that may cause false continuity readings.

Continued on next page

When wire being tested is ...	Do this.	Why?
Part of an energy loop or string.	• Disconnect the end wires of the loop or string from the energy bus. • Remove or disconnect equipment (ex: plug-in relay). Note - shelf relays require both energy loop wires to be removed from the terminal and held together. • Check continuity from one of the end wires to each contact, and up to and including the other end wire. • If adding or removing wires, check continuity from one of the end wires to the contact before the change, to the contacts changed, and to the contact after the change, and then repeat for the other end wire. • Verify there is no continuity to other energy buses.	To ensure that energy loops or strings are complete and separate from all other circuits.

7. Step 3 – Circuit Breakdown

7.1 This table explains how to perform the circuit breakdown test, which is necessary for the following reasons:

a) To prove that initial wiring and/or wiring changes conform to the plans.

b) To isolate each contact in the circuit to uncover any latent wiring error such as an improperly wired contact, which under specific circumstances could result in a wrong side failure under specific circumstances.

7.2 This test applies to any contact point where electrical energy is transferred from one point to another by means of the contact making or breaking mechanically or electrically. Examples include relays, circuit controllers, push buttons and test links. Note: for most Ansaldo (US&S) relays, each contact can be opened simply by inserting the wide end of the baton under the relay clip.

Table 301(b)(1)-04

Type of Testing	Action
"Pre-validation" of new circuit or portion of circuit (non-live network)	• Place ohmmeter, or buzzer, across the ends of the circuit under test. • Open and close, one by one, each point of electrical contact and observe the circuit responds accordingly. Record that the contacts have been checked by marking them on the circuit plan.
Modified Circuit (insertion of pre-validated portion of circuit into live network)	• Energize circuit(s) under test and monitor the presence of energy in the circuit with a meter or other device. • Open and close, one by one, each point of electrical contact at both ends of the newly inserted circuit, and the adjacent contacts, and observe the circuit responds accordingly. Record that the contacts have been checked by marking them on the circuit plan.
Modified Circuit (no pre-validation)	• Energize circuit(s) under test and monitor the presence of energy in the circuit with a meter or other device. • Open and close, one by one, each point of electrical contact and observe the circuit responds accordingly. Record that the contacts have been checked by marking them on the circuit plan.

7.3 EXCEPTIONS: Soldered connections on relays, such as KP type, which cannot be readily removed, may be checked by operating the relay to the desired contact position or simulating contact presence with the relay removed from the plug board.

7.4 On devices such as relays that employ the use of heel contacts, the heel connection need not be opened. Opening the front and back connection also proves the heel contact.

8. Step 4 – Terminal Connection & Contact Check

8.1 Pull every wire on every connection to ensure that it is properly locked, soldered or crimped.

8.2 Check all terminals to ensure nut or screw connectors are tight, and torqued to specifications if so required by manufacturer.

9. Step 5 – Final Wire Check

9.1 Check all terminals and contacts on all components to ensure they have the correct number of wires and the wiring corresponds to the circuit plan. This step can be performed in conjunction with the circuit breakdown test.

10. Step 6 – Operational Tests

10.1 Operational tests shall be performed prior to a system being placed in or returned to service. All equipment under test shall be directly observed to verify proper operation for all prescribed tests.

Table 301(b)(1)-05

Type of Testing	Action
General	• Ensure all copies of plans coincide with field copies and all revisions have been completed. • Verify completeness of SCP-1209-1 or SCP-1210-1. • Ensure meters and tools are properly calibrated.

Continued on next page

Type of Testing	Action
Signal Aspects	• Ensure the appropriate signs are mounted on all signals and block clearance points (e.g., mileage, limited, absolute). • Ensure all aspects coincide with the route and aspect chart for all possible routes. • Prove each controlled signal, and signals governing approaching movements, are not affected by other controlled signals at the same location which govern any portion of parallel track in the same direction, for all aspects and for all routes (i.e. parallel routes). • Ensure prohibited routes cannot be cleared. • Verify that the security of routes is effective. For example, ensure that a signal cannot be cleared against an incorrectly lined switch. • Ensure light out, stuck mechanism, and false energy circuitry function as intended. • Ensure flasher rates are correct.

Continued on next page

Type of Testing	Action
Interconnection of Signals	• Ensure signals and movements at controlled location under test do not adversely affect signals at adjacent locations. • Ensure signals and movements at controlled location under test do not adversely affect other signals at same location. • Ensure the repeater information of signal under test is effective in control of signals governing approaching movements.
Block Check	• Ensure that each track circuit affecting the route of each signal being tested is effective (by .06 ohm shunt) and indicates to the office. • Verify operation of all fouling circuits. • Verify all coded track codes are effective. • Where multiple relays are used on track circuits, ensure effectiveness of each individually. • Verify operation of switch circuit controllers in the block. • Verify all HD relays within the block. • Ensure crossing cut-outs do not override block check tests. • Prove bypassing of insulated joints.

Continued on next page

Type of Testing	Action
Locking	Perform applicable locking tests in accordance with: • GI-320 Testing Time Locking; • GI-315 Testing Approach Locking; • GI-319 Testing Route Locking; • GI-316 Testing Detector Locking; • GI-317 Testing Indication Locking; • GI-321(a) Testing Traffic Locking[1]; and • GI-318 Movable Bridge Locking.
System Features and GI Inspections and Tests	• Verify all controls and indications between the office and the field work as intended. • Verify office and field recording devices function as intended. • Ensure field blocking, if provided, functions as intended in accordance with GI-321(b) Testing Field Blocking. • Ensure all manufacturer recommended set-up and installation procedures have been performed. • Perform all other Inspections and Tests identified in GI-301(h) Inspecting and Test Intervals under section "At Time of Installation".

[1] In some circumstances, Traffic Locking Tests only need to be performed up to the nearest approach or intermediate location.

11. Recording Results

11.1 Record results on either SCP-1209-1 for signaling locations or SCP-1210-1 for crossing locations.

11.2 Retain a copy in the site log book, file the originals.

11.3 Complete the GI-301(b)(1) Installation & Commissioning Tests (Conventional) test, record results in both SCIS and test forms.

301(b)(2) - Installation & Commissioning Tests (Staged)

1. Purpose

1.1. To ensure testing is performed in a logical, systematic manner to ensure the plant operates safely and reliably prior to being placed in service.

2. Test Interval

2.1. Installation & Commissioning Tests are performed at the time of installation, and when any revisions or alterations are staged at the location. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Testing Sequence

3.1. This table explains the sequence in which testing shall be performed for conventional installing and commissioning testing.

Table 301(b)(2)-01

Step	Test	Location
1	Software Validation	Test Rack
2	House/Case Validation	Wiring Facility
3	Field Pre-Test	Field Site
4	Final Test	Field Site

4. Documentation & Security

4.1. Results from each stage of testing must be documented on form SCP-1209-2 or SCP-1210-1. Details of the state of the equipment at the time the testing was performed shall include:

a) Executive software revision levels

b) Application software revision levels

c) Hardware serial numbers and revision levels

d) Field plans and revision dates

e) Test plan number and revision date

f) Signature of person responsible for performing the tests and date

4.2. A copy of this form (and completed test plans) must be kept with the equipment at all times.

4.3. Prior to starting the next stage of testing, the person responsible for performing the tests shall ensure no undocumented changes have occurred to the equipment since completion of the prior stage, otherwise Metrolinx and the responsible Supervisory Officer shall be consulted to determine what the impact of the changes are, and what additional prior stage tests must be repeated.

4.4. Upon completion of Stage 2, any equipment prone to being damaged in transit, such as vital relays and batteries should be removed, securely packed and shipped separately. The house or case shall then be affixed with a security seal prior to shipping to the field.

4.5. Operational tests shall be prepared and documented in accordance with GI- 301(e) Signal Installation and Testing Documentation.

5. Stage 1 – Software Validation

5.1. The software validation stage includes the most rigorous and exhaustive test plan and is intended to exercise all vital, non-vital, and hardware capabilities. Always ensure the apparent operation of the vital logic is not masked by analogous non-vital logic performing the same checks.

Table 301(b)(2)-02

Type of Testing	Action
Signal Aspects	• Ensure all aspects coincide with the route and aspect chart for all possible routes. • Prove each controlled signal, and signals governing approaching movements, are not affected by other controlled signals at the same location which govern any portion of parallel track in the same direction, for all aspects and for all routes (i.e. parallel routes). • Ensure prohibited routes cannot be cleared. • Verify that the security of routes is effective. For example, ensure that a signal cannot be cleared against an incorrectly lined switch. • Ensure light out, stuck mechanism, and false energy circuitry function as intended. • Ensure flasher rates are correct.

Continued on next page

Type of Testing	Action
Interconnection of Signals	• Ensure signals and movements at controlled location under test do not adversely affect signals at adjacent locations. • Ensure signals and movements at controlled location under test do not adversely affect other signals at same location. • Ensure the repeater information of signal under test is effective in control of signals governing approaching movements.
Locking	Simulate and verify applicable locking tests in accordance with: • GI-320 Testing Time Locking; • GI-315 Testing Approach Locking; • GI-319 Testing Route Locking; • GI-316 Testing Detector Locking; • GI-317 Testing Indication Locking; • GI-321(a) Testing Traffic Locking[1]; and • GI-318 Movable Bridge Locking.
System Features	• Verify all controls and indications between the office and the field work as intended. • Verify office and field recording devices function as intended. • Simulate and verify field blocking, if provided, functions as intended in accordance with GI-321(b) Testing Field Blocking. • Ensure all manufacturer recommended set-up and installation procedures have been performed.

[1] In some circumstances, Traffic Locking Tests only need to be performed up to the nearest approach or intermediate location.

6. Stage 2 – House/Case Validation

6.1. The house/case validation stage involves having the validated software (from Stage 1) loaded into the signal house or case and tested in a shop environment. All functionality is proven up to the demarcation point (usually the entrance board terminals of the house/case).

Table 301(b)(2)-03

Step	Test
1	Component check
2	Wire continuity check
3	Circuit breakdown
4	Terminal, connection and contact check
5	Final wire check
6	Integrity check

6.2. Perform Steps 1-5 in a manner consistent with what is described in GI-301(b)(1) Installation & Commissioning Tests (Conventional). Note that it is not necessary to install the permanent batteries at this time, since this may be done at time of field installation.

6.3. Step 6 - Integrity Check
Prove the integrity of the wiring and signal design functionality of all the equipment in the house/case. Use appropriate signal, switch, and track simulators to prove operation of I/O up to the demarcation point. Use the following guidelines to perform this check;

a) Verify switch functionality (correct motor control, correspondence).
b) Exercise and verify all signal aspects.

c) Verify searchlight repeater circuits respond as intended.

d) Confirm track and line wire circuits produce the correct codes or battery polarities affecting adjacent signals.

e) Exercise peripheral hardware to prove operation (ex: relays, PSOs, ground fault detectors).

f) Verify operation of local control panel by testing all functionality.

g) Simulate office to field code transmissions and verify all controls and indications.

7. Stage 3 – Field Pre-Testing

7.1. Stage 3 testing can begin once the seal has been removed from the house/case and all cables to inactive field equipment have been connected to the entrance board.

7.2. Examples of inactive field equipment include signals that are turned away from the track and switch machines that are disconnected from the points, or otherwise clamped, locked, spiked and providing indication of switch correspondence.

7.3. All equipment prone to being damaged in transit that was shipped separately can be re-installed in the house/case at this time.

a) Ensure all copies of plans coincide with field copies and all revisions have been completed.

b) Verify completeness of SCP-1209-2.

c) Ensure meters and tools are properly calibrated.

d) Perform Steps 1-5 as required in this table, in a manner consistent with what is described in GI-301(b)(1) Installation & Commissioning Tests (Conventional). Perform Step 6 as described on the following page.

Table 301(b)(2)-04

Stage 3 Testing Requirements				
Step	**Test**	**Equipment**		
		House / Case	**External Inactive**	**External Live**
1	Component check	Yes[1]	Yes	N/A
2	Wire continuity check	No	Yes	N/A
3	Circuit breakdown	No	Yes	N/A
4	Terminal, connection and contact check	No	Yes	N/A
5	Final wire check	No	Yes	N/A
6	Operational Pre-test	Yes		N/A

[1] To be performed on batteries and equipment which were shipped separately.

7.4. Step 6 - Operational Pre-test
Perform operational pre-tests as instructed below. It may be necessary to simulate occupancies by code simulation. A record must be kept of what tests could not be effectively performed, so a determination can be made of what subset of these tests need to be performed during Stage 4 testing.

Table 301(b)(2)-05

Type of Testing	Action
Signal Aspects and Interconnection of Signals	• Ensure the appropriate signs are mounted on all signals and block clearance points (i.e. mileage, limited, absolute). • Ensure flasher rates are correct. • Metrolinx and the responsible Supervisory Officer will make a determination as to which of the following Stage 1 tests need to be repeated under field conditions: a) Ensure aspects coincide with the route and aspect charts. b) Prove parallel routes. c) Ensure prohibited routes cannot be cleared. d) Ensure that the security of routes is effective. e) Ensure light out, stuck mechanism, false energy, aspect check, and flasher check circuitry function as intended. f) Ensure signals and movements at controlled location under test do not adversely affect signals at adjacent locations. g) Ensure signals and movements at controlled location under test do not adversely affect other signals at same location. h) Ensure the repeater information of signal under test is effective in control of signals governing approaching movements.

Type of Testing	Action
System Features	• Verify all controls and indications between the office and the field work as intended. • Verify office and field recording devices function as intended. • Simulate and verify field blocking, if provided, functions as intended in accordance with GI-321(b) Testing Field Blocking. • Ensure all manufacturer recommended set-up and installation procedures have been performed.

8. Stage 4 – Final Test

8.1. Final tests shall be performed prior to a signal system being placed in or returned to service. All equipment under test shall be directly observed to verify proper operation for all prescribed tests.

a) Ensure all copies of plans coincide with field copies and all revisions have been completed.
b) Verify completeness of SCP-1209-2.
c) Ensure meters and tools are properly calibrated.
d) Perform Steps 1-5 as required in this table, in a manner consistent with what is described in GI-301(b)(1) Installation and Commissioning Tests (Conventional).
e) Perform Step 6 as described on the following page.

Table 301(b)(2)-06

<table>
<tr><th colspan="5">Stage 4 Testing Requirements</th></tr>
<tr><th rowspan="2">Step</th><th rowspan="2">Test</th><th colspan="3">Equipment</th></tr>
<tr><th>House /Case</th><th>External Tested in Stage 3</th><th>External Not Tested in Stage 3</th></tr>
<tr><td>1</td><td>Component check</td><td>Yes[1]</td><td>No</td><td>Yes</td></tr>
<tr><td>2</td><td>Wire continuity check</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>3</td><td>Circuit breakdown</td><td>No</td><td>No</td><td>Yes[1]</td></tr>
<tr><td>4</td><td>Terminal, connection and contact check</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>5</td><td>Final wire check</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>6</td><td>Operational Test</td><td colspan="3">Yes</td></tr>
</table>

[1] Component settings to be verified as required as live equipment is turned up.

8.2. Step 6, Operational Test
Perform operational tests as instructed in the table below.

Table 301(b)(2)-07

Type of Testing	Action
Signal Aspects and Interconnection of Signals	• Ensure all aspects coincide with the route and aspect chart for all possible routes. • Perform the Signal Aspects and Interconnection of Signals tests which could not be effectively performed in Stage 3 but are required to be tested under field conditions, as determined by the responsible Supervisory Officer and Metrolinx.
Block Check	• Ensure that each track circuit affecting the route of each signal being tested is effective (by .06 ohm shunt) and indicates to the office. • Verify operation of all fouling circuits. • Verify all coded track codes are effective. • Where multiple relays are used on track circuits, ensure effectiveness of each individually. • Verify operation of switch circuit controllers in the block. • Verify all HD relays within the block. • Ensure crossing cut-outs do not override block check tests. • Prove bypassing of insulated joints.

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Type of Testing	Action
Locking	Simulate and verify applicable locking tests in accordance with: • GI-320 Testing Time Locking; • GI-315 Testing Approach Locking; • GI-319 Testing Route Locking; • GI-316 Testing Detector Locking; • GI-317 Testing Indication Locking; • GI-321(a) Testing Traffic Locking[1]; and • GI-318 Movable Bridge Locking.
Inspections and Tests	Perform all other inspections and tests identified in GI-301(h) Inspecting and Test Intervals under section "At Time of Installation".

[1] In some circumstances, Traffic Locking Tests only need to be performed up to the nearest approach or intermediate location.

9. Recording Results

9.1. Record results on the form SCP-1209-2, retain a copy in the site log book and file the originals.

9.2. Complete the GI-301(b)(2) Installation & Commissioning Tests (Staged) in SCIS.

9.3. Create a report of all tests completed during the commissioning of the location, print a copy of the test results and store in the site log book, and file the report.

301(c) - Recording Circuit Wiring and Design Errors

1. Purpose

1.1. To ensure that all design and wiring errors are recorded in a manner which will permit tracking the design and wiring process and permit its regular review, with the intention of minimizing future errors and improving the overall process.

2. Requirement

2.1. Wiring errors detected during testing or while in the process of preparing to test and design errors detected throughout the wiring and testing process shall be recorded in accordance with instructions.

3. Reporting Wiring Errors

3.1. It is the responsibility of all employees to submit details of a wiring error to the responsible Supervisory Officer who shall notify Metrolinx.

4. Correcting Design Errors

4.1. Design errors shall be corrected as described in GI-301(a) Working with Approved Plans.

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301(d) - Performing Vital Circuit Revisions

1. Purpose

1.1. To describe the process which ensures the revision of vital circuits is carried out in accordance with approved procedures and will not compromise the safety and reliability of the signal system.

2. Requirement

2.1. Revisions to signal circuits and equipment shall be performed in accordance with instructions. All work shall be performed only as assigned and directed by the responsible Supervisory Officer.

3. Train Safety

3.1. Prior to making any vital circuit revisions, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Circuit Revision Plans

4.1. Revisions are usually indicated on the plans, and tagged to the field wiring or equipment with temporary tags, by colour code. Red usually indicates "IN", and yellow or blue usually indicates "OUT". When temporary revisions are required, other colour codes may be used on the same plan. The meaning of all colour codes will be shown on the plan.

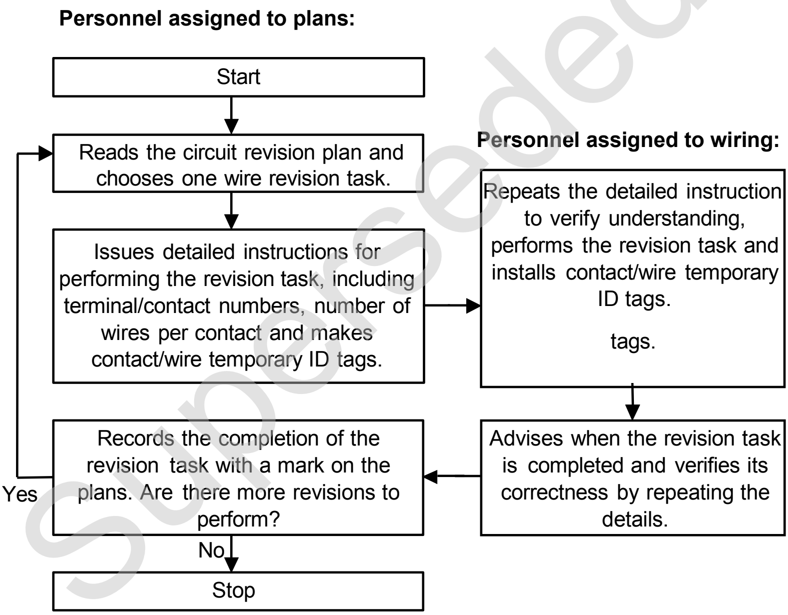
4.2. When more than one set of plans is being used, compare the revision sheets to ensure that they are identical.

4.3. When working with battery feed and energy loops or strings, the wires as shown on the energy distribution pages shall be cross-referenced to those wires shown on the circuit page to ensure that there are no discrepancies.

5. Revision Personnel Duties

5.1. This chart explains the duties of the personnel performing the revisions.

Figure 301(d)-01



6. Revision Methods

6.1. In some cases, it may be impractical to make all wiring and equipment changes during the actual cutover stage. This table explains the basic differences between two approved methods of doing vital circuit revisions, the selection of which will be dictated by local traffic conditions.

Table 301(d)-01

Method	Description
A	All preparatory work on wiring and equipment is performed so as not to contact or interfere with existing live circuitry. Actual revisions are completed during cutover in the final stage prior to operational testing.
B	Most preparatory wiring and equipment revisions are performed in a manner that allows live circuitry to be opened or disconnected one wire at a time and immediately tested to ensure the integrity of the circuit has not been compromised. Wiring designated to be removed is repositioned outside the equipment racks where it can quickly be discarded. The new wiring is set into a permanent position to facilitate quick cutover. It is imperative that maximum control over this process be maintained at all times.

7. Method Authorization

7.1. This table lists the authority and conditions required to implement the method used to perform the revision.

Table 301(d)-02

Method	Authority	Conditions of Implementation
A	Metrolinx	• All approved circuit revision plans have been received, checked and compared to be identical. • Subsequent revisions to the original plan are approved and documented. • Approval to proceed with the revision is obtained from Metrolinx and the Supervisory Officer in charge of the project.
B	Metrolinx	• Method A is impractical due to special circumstances. • All approved circuit revision plans have been received, checked and compared to be identical. • Subsequent revisions to the original plan are approved and documented. • Personnel qualified to revise and test live vital signal circuits are designated to perform the work. • The Supervisory Officer in charge has received approval to proceed with this method.

8. Method "A" Preparation for Cutover

8.1. This table explains the steps required for wiring and equipment revisions in preparation for cutover.

Table 301(d)-03

Step	Action
1	Check the location to be revised for any previous revision tagging. Familiarize yourself with the reason for the previous revision, how it may affect the revision you are about to perform and ensure that it is properly recorded on the plan.
2	Revision wires shown as "IN" on the circuit plans may be put into place but not connected to existing circuitry, however they may be connected to new equipment that are not yet in service. When hanging from equipment racks, they must have exposed bare ends and connectors taped in a manner that will completely insulate them prior to cutover. All wire ends shall be tagged and marked for their location at cutover. New wires run will be recorded on the circuit plan with a mark.
3	Revision wires shown as "OUT" on the circuit plans shall be properly tagged on both ends of the wire and marked on the plan.

9. Method "A" During Cutover

9.1. This table explains the steps required for wiring and equipment revisions during cutover.

Table 301(d)-04

Step	Action
1	Remove all "OUT" wires as they are disconnected, excepting where it may be prudent to re-use an existing "OUT" wire for a new "IN" wire. "OUT" wires which for expediency must be left in the wiring harness during cutover, shall have their connectors cut off and knots tied in both ends of the wire. Such wires shall be continuity tested to ensure that both ends are disconnected and must be removed before the revisions are placed in service.
2	Install any new equipment that could not be installed in preparation for cutover.
3	Test the continuity of each "IN" wire. As each end is connected, place a mark on the circuit plan at the point of connection.
4	Install all wires and equipment and perform tests as outlined in GI-301(b) Installation and Commissioning Tests.

10. Method "B" Preparing for Cutover – Moving Wires

10.1. This table explains the steps required for wiring and equipment revisions during cutover.

Table 301(d)-05

Step	Action
1	Check the location to be revised for any previous revision tagging. Familiarize yourself with the reason for the previous revision, how it may affect the revision you are about to perform and ensure that it is properly recorded on the plans.
2	It is good practice to plug all empty plug board slots, bordering the one being revised, with molded plastic drywall screws to ensure that wires are not inadvertently plugged into the wrong relay plug board slot.
3	Tag one end of the wire to be moved, manually trace it to the other end and tag it. Retrace the wire back to the original end. NOTE: if more than one wire is involved refer to the guidelines in Preparation for Cutover - Moving Wires EXAMPLES.
4	Ensure positive protection is in place to protect train operations while the wire(s) are being moved and tested.
5	Disconnect one end of the traced "OUT" wire, cut the connector off, (if necessary) and ensure the tag remains in place on the end of the wire.
6	Pull the free end back to the connected end, verify both tags in place on the same wire and run the wire outside of the rack back to where it was originally connected.

Continued on next page

Step	Action
7	Replace the connector (if necessary) and make the reconnection at the original contact or terminal. Record the movement of the wire with a mark on the wire on the circuit plan.
8	Perform all applicable tests as required by GI-301(b) Installation and Commissioning Tests.
9	Move and test more wires if time permits, or cancel positive protection.
10	Group, wrap, tag and assemble into bundles all "OUT" wires after they have been moved to the outside of the equipment racks.

11. Method "B" Preparation for Cutover - Moving Wires EXAMPLES

11.1. This table explains the steps required for moving "OUT" wires to the outside of the equipment racks in preparation for cutover when more than one wire at a time is involved. Prior to following these guidelines refer to step 4 of Preparation for Cutover - Moving Wires.

Table 301(d)-06

If this happens ...	Then do this ...
There are two wires in the same contact slot/terminal.	Both must be traced to their other ends and be verified in the plan.
Both wires in the same contact slot/terminal are to be moved to the outside of the equipment rack and the other ends of these wires are single in a contact slot/terminal.	One at a time, disconnect each single end and tag it. Trace it back to the double end and tag it. Move it outside of the equipment rack, run it back to its original location and reconnect.
There are two wires in the same contact slot/terminal and the other ends of these wires also share a contact slot/terminal with another wire.	Trace and tag the double-wired connector to be moved. Disconnect the double-wired connector and cut it off. Move each of the two wires to the outside of the equipment rack and bring the two free ends back to their original location and reconnect them.
It is sometimes more practical to run a new wire(s) outside of the equipment rack to replace existing "OUT" wire(s).	Trace and tag all existing "OUT" wires. Construct and tag the new wire or string complete with connectors. One by one remove the existing "OUT" wire(s) and replace them with the newly tagged "OUT" wire(s) on the outside of the equipment rack.

12. Method "B" Preparation for Cutover - Adding New Wires

12.1. This table explains the steps required for the addition of new "IN" wires to be permanently placed in the equipment racks in preparation for cutover.

Table 301(d)-07

Step	Action
1	Revision wires shown as "IN" on the circuit plans shall be permanently placed in the equipment rack space vacated by the "OUT" wires. "IN" wires must not be connected to existing circuitry at this stage. EXCEPTIONS: • New "IN" wires may be connected to newly installed equipment not yet in service. • New "IN" wires may be connected to existing ENERGY LOOP circuits as instructed in Preparation for Cutover, New Wires into Energy Loops. Follow those guidelines and continue with step 3 below.
2	Install the required connectors on the ends of the wire.
3	ID the connector and tape it in a manner that will completely insulate it from any other piece of material or equipment that it may come in contact with prior to cutover. The temporary ID tag or colored tape used will be the one chosen to indicate an "IN" wire.
4	Each new wire run shall be marked on the circuit plan.

13. Method “B” Preparation for Cutover - New Wires into Energy Loops

13.1. This table explains how to connect new "IN" wires into the existing live energy loops. Follow these guidelines and continue with step 4 above, of Preparation for Cutover - Adding New Wires.

Table 301(d)-08

Step	Instruction
"IN" Wires	New "IN" wires may be connected into that portion of the energy loop that, in accordance with the final revision, is intended to remain intact. New revision connectors attached to those wires will be tagged, taped and left hanging.
"OUT" Wires	"OUT" wires may be isolated from that portion of the energy loop or string that is intended to remain intact and reconnected as a separate "OUT" loop or string back to the same energy bus. EXAMPLE: B10 energy bus will have a loop consisting of "IN" contacts as they will be connected in the final revision and the same energy bus will have another loop wired outside of the equipment rack consisting of "OUT" contacts from the original loop.
Tests	Perform tests as outlined in GI-301(b) Installation and Commissioning Tests.

14. Method "B" During Cutover

14.1. This table explains the steps required for wiring and equipment revisions during cutover.

Table 301(d)-09

Step	Action
1	Remove all tagged "OUT" wires. The wires have been grouped and wrapped into bundles outside of the equipment rack. If during removal of all wires tagged "OUT", the bundle does not come free from the rack due to untagged wire attachments, consult the circuit plan and determine the error.
2	Move any "OUT" wires that have been tagged for reuse to their new connection point.
3	Install any new equipment that couldn't be installed during the preparation for cutover.
4	Remove the insulating tape from new wire connectors and connect them at the position indicated on the ID tag.
5	Perform tests as outlined in GI-301(b) Installation and Commissioning Tests. Remove plug board contact plugs as instructed by the Supervisory Officer.

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301(e) - Signal Installation and Testing Documentation

1. Purpose

1.1. To ensure that all stages of installation and testing are performed in accordance with approved procedures and documented for future reference.

2. Requirement

2.1. Stages of installation and testing of signal systems and apparatus shall be documented, certified and filed in accordance with instructions.

3. Documentation

3.1. Refer to the S&C Codes of Practice for typical forms covering various installation and testing procedures and recommended practices on how to develop and perform Operating Tests.

3.2. Although guidelines are provided to assist in the development of the required operating tests, they may not totally fulfill all requirements. In such cases, contact the responsible Supervisory Officer and Metrolinx for clarification and/or assistance in developing and performing the required tests.

4. Operational Tests

4.1. The overall responsibility for the preparation and execution of operational tests shall be in accordance with the Metrolinx GI. In all cases, tests must be prepared well in advance of the installation, and be approved by Metrolinx.

5. Certification

5.1. The documents involved in the various processes contain a section, for the employee responsible and accountable for performing or directing the required tests, to certify they have been properly completed.

6. Preparations

6.1. Prepare the necessary operational test documents and submit them to Metrolinx in advance to permit adequate review.

7. Filing

7.1. Forward a copy of the completed test documents to the responsible S&C Supervisory Officer, and Metrolinx.

301(f) - Condition of Plans

1. Purpose

1.1. To ensure that all signal system plans assigned to specific locations contain accurate, up to date information and details pertaining to circuits and equipment, in order to permit the proper maintenance, troubleshooting and testing of those systems.

2. Requirement

2.1. As required for maintenance and testing, plans shall be kept at all road crossing warning system locations, interlockings, automatic signals, and controlled points. All plans shall be legible, correct and up to date. The condition of plans shall be recorded annually in the Signal Tests and Inspection System by the Maintainer.

3. "As Installed" Plan Definition

3.1. A plan that has been updated to reflect the exact configuration of wiring and equipment after a location or system has been tested and commissioned for service and before final As Installed plans have been issued.

4. Marking Up As Installed Plans

a) At project completion, the Supervisory Officer will ensure "As Installed" plans are updated.

b) Keep original hardcopy set at the field location at all times after the location is commissioned.

c) Provide electronic copy to the Metrolinx designated maintenance provider.

d) Provide electronic copy to Metrolinx for document control.

5. Time Limit As Installed Return From Signal Design Engineer

5.1. The Metrolinx authorized Signal Design Engineer shall return at least four sets of all required final As Installed plans (stamped as built plans) and electronic copy to Metrolinx within one (1) month after the location is commissioned.

5.2. The final As Installed plans shall be delivered to the appropriate location as in service plans within one week of receipt.

6. Obsolete Plans

6.1. Plan sets or portions of plans that become obsolete with the receipt of final in service plans issued from Metrolinx shall be destroyed.

7. In Service Plans

7.1. In service plans are the clean set of the final As Installed Plans updated based on the Marking Up As Installed Plans.

7.2. After in service plans have been delivered to the appropriate location, they shall be stored in a manner that will ensure they remain in a legible condition. When in service plans are found to be illegible, the responsible Supervisory Officer must be advised by the end of shift and arrangements made for replacement. Plans that are too faded or those having experienced more than one change in colored pencil are considered to be illegible.

8. Plan Replacement Notification

8.1. Notify the responsible Supervisory Officer if replacement plans are required from Metrolinx.

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301(g) - Maintenance of Vital Tools and Test Instruments

1. Purpose

1.1. To ensure tools and instruments used for work on signal systems and equipment are of approved type, maintained in good working order and are proper calibrated in accordance with instructions.

2. Vital Tools and Test Instruments Definition

2.1. A tool or instrument is considered vital when the task that it performs affects the safety critical aspect of vital signal systems.

2.2. EXAMPLES:

a) An ammeter conveys information to the user that is critical to the adjustment of a track circuit.

b) A crimping tool provides a precision crimped terminal connection that will not break or cause a short to another circuit.

3. Scope

3.1. There are two major categories of tools and instruments covered by this GI:

Table 301(g)-01

Category	Explanation
Crimping Tools	Any tools that are required to provide a precision crimp on a variety of wire connectors such as terminal eyes, relay plug board clips, and wire splice sleeves.
Meters	Any instruments designed to measure electrical values and display them accurately in a digital, or analog mode.

4. Crimping Tools Authorization For Use

4.1. The following basic criteria will apply for crimping tools used for wiring signal facilities containing vital circuits. Tools that do not meet these requirements shall not be used;

a) Only approved crimping tools, as defined in SCP-1003 shall be used for vital circuit wiring.

b) Approved crimping tools used for insulated ring tongue terminals shall be equipped with dies that stamp the terminal or splice with an identification mark that provides an indicator of the quality of the crimp.

c) Crimping tools shall be inspected and tested in accordance with these instructions before being put into service and periodically thereafter.

5. Periodic Test Intervals

5.1. Tools that do not pass inspections and tests shall be tagged in accordance with GI-301(j) Replacing and Tagging Defective in Service Equipment and forwarded for repair or disposal as directed by the responsible Supervisory Officer. Inspections and tests shall be performed as instructed in the table below.

Table 301(g)-02

<table>
<tr><th>When?</th><th>Who?</th><th>What?</th></tr>
<tr><td>When the tool is new and at least once every year.</td><td>An independent test facility or employee so designated by the responsible Supervisory Officer shall perform inspections and tests.</td><td>Complete Tool and Crimp Tests and visual inspections shall be performed and results recorded as directed by the responsible Supervisory Officer.</td></tr>
<tr><td>Before each work session inspect all crimping tools visually.

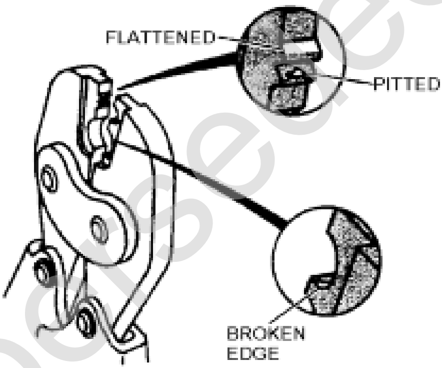
AND

Once during each work session, visually inspect the terminal or splice crimp.</td><td>The user of the tool.</td><td>After visual inspections have been performed.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The tool and crimp pass visual inspection.</td><td>No further testing or recording of results is required.</td></tr>
<tr><td>The tool and crimp do not pass visual inspection</td><td>The tool shall be fully tested and/or repaired by an independent facility or designated employee(s) and test results recorded as directed by the responsible Supervisory Officer.</td></tr>
</table>
</td></tr>
</table>

6. Tool Visual Inspection

6.1. Different tools have different tolerances and inspection criteria. Refer to manufacturer's instructions for specific detailed inspection procedures. This table outlines general inspection procedures that apply to all crimping tools.

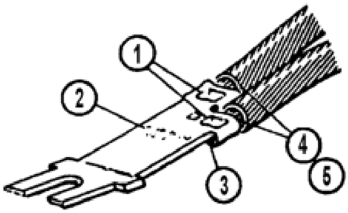
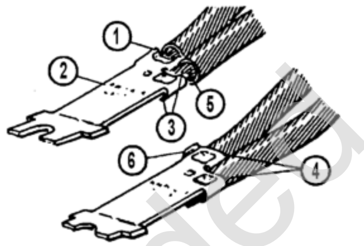
Table 301(g)-03

Inspect	Check
Die Closure Surfaces Inspect the dies for flattened, chipped, cracked, worn or broken areas. Figure 301(g)- 1 illustrates a typical crimping tool head with an inset of the die area.	**Figure 301(g)- 1** 
Bearing Surfaces	Check all bearing surfaces for wear.
Lubrication	Check the tool is lubricated in accordance with manufacturer's instructions.
Pins and Screws	Check that all pins and screws are in place and secured.
Contamination	Check the tool is free of rust, dirt, moisture and excessive oil or grease.
Ratchet	Where provided, check the ratchet assembly moves freely, releases properly and locks as intended.
General Damage	Check the entire tool is free of significant damage.

7. Crimp Visual Inspection

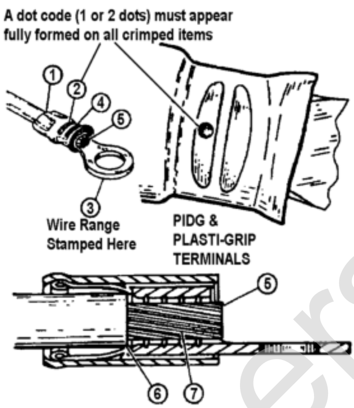
7.1. The condition of a crimp provides a good indication of the mechanical condition of the tool that made the crimp. Terminal or splice crimps shall be examined periodically during the work session to ensure tool and crimp specifications are met. The table below outlines the ACCEPT and REJECT points of relay clip crimps.

Table 301(g)-04

Accept This Crimp	Reject This Crimp
Figure 301(g)- 2 	**Figure 301(g)- 3** 
1) The crimp is centered. It may be slightly off center but NOT off the end of the wire barrel. 2) The wire size matches the wire size stamped on the tool and relay clip. 3) The end of the wire is flush with or extends slightly beyond the end of the wire barrel. 4) The insulation does not enter wire barrel. 5) Wire strands are not nicked or missing.	1) The end of the wire barrel is crimped off. 2) The wire size does not match the wire size stamped on the tool and relay clip. 3) The end of the wire is not flush with, nor does it extend slightly beyond the end of the wire barrel. 4) The insulation has entered the wire barrel. 5) There are nicked or missing strands. 6) There is excessive flash, check for damaged tool dies.

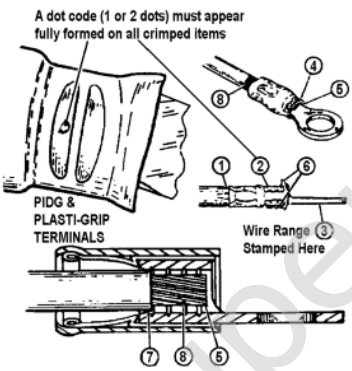
7.2. The table below outlines the inspection characteristics that must be present to form an ACCEPTABLE PIDG and plastic grip terminal crimp.

Table 301(g)-05

Accept This Crimp	Why?
Figure 301(g)- 4  	1) The terminal insulation is in firm contact with wire insulation. 2) The correct color code and tool combination is used and the dot code is fully formed. 3) The wire size is within the wire range stamped under the terminal tongue. 4) The crimp is centered on the wire barrel. 5) The end of the wire is flush with, or extends slightly beyond the end of the terminal wire barrel. 6) The wire insulation does not enter the wire barrel. 7) Wire strands are not missing or nicked.

7.3. The table below outlines the characteristics that are UNACCEPTABLE when inspecting a PIDG or plastic grip terminal crimp.

Table 301(g)-06

Reject This Crimp	Why?
Figure 301(g)- 5 	1) The wire insulation is extruded. 2) The wrong color code and tool combination is used and the dot code is not fully formed. 3) The wire size is not within the wire range stamped on the terminal tongue. 4) The crimp is not centered on the wire barrel. 5) The end of the wire is not flush with, nor does it extend slightly beyond the end of the wire barrel. 6) There is excessive flash or extruded insulation. This could be caused by using the wrong tool, terminal or damaged dies. 7) The wire insulation has entered the wire barrel. 8) There are nicked or missing wire strands.

8. Tool and Crimp Tests

8.1. There are two acceptable methods of testing a crimping tool to determine its ability to produce an acceptable, quality crimp.

Table 301(g)-07

Method	This method will require ...
GO - NO GO	A precision made gauge that measures the die closure surfaces of the tool or the splice sleeve.
Pull Apart	A mechanical force gauge to measure the stress exerted on a wire to terminal or splice connection.

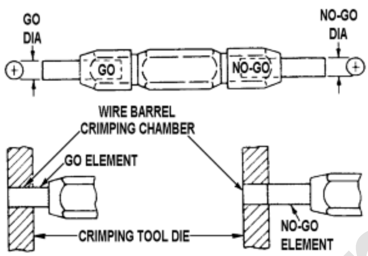
8.2. Whichever method is used will depend on the availability of the different types of gauges and the type of tool requiring testing.

9. GO - NO GO Test Procedure

9.1. This table shows an example of a typical GO - NO GO gauge that can be used to perform periodic tests on crimping tools. Ensure the gauge being used is the one specifically designed for the tool being tested.

Table 301(g)-08

<table>
<tr><th>Gauge</th><th>Test Procedure</th></tr>
<tr><td>This type of gauge tests the tolerances of the crimping chamber on the tool. The NO-GO element is slightly larger in diameter than the GO element.

Figure 301(g)- 6

</td><td>Perform the GO - NO GO test as follows.
1) Perform a visual inspection of the crimping tool and ensure it meets the requirements.
2) Close the tool handles until it is evident the jaws have bottomed; then hold in this position. Do NOT force the jaws beyond initial contact.
3) Align the GO element with the crimping chamber and ensure the element will pass completely through the chamber, as shown in Figure 301(g)- 6, without using force.
4) Align the NO-GO element and try to insert it into the crimping chamber. The element may start entry into the chamber but must not pass completely through as shown in Figure 301(g)- 6.
5) Refer to GO - NO GO Test Results.</td></tr>
</table>

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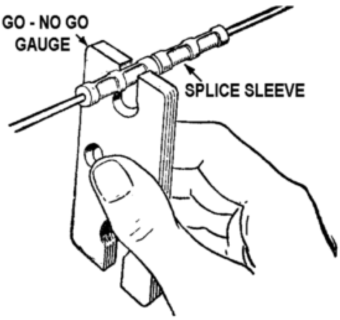
Gauge	Test Procedure
This type of gauge tests the tolerances of the splice sleeve. **Figure 301(g)- 7**  	Perform the GO - NO GO test as follows. 1) Perform a visual inspection of the crimping tool and ensure it meets the requirements. 2) Place the proper splice sleeve onto the proper size wire and crimp it into place. 3) Visually inspect the splice sleeve and crimp(s), ensuring they meet the manufacturer's requirements. 4) Attempt to insert the crimped portion of the splice sleeve into the appropriate slot on the GO - NO GO gauge as shown in Figure 301(g)- 7. Ensure the gauge is held 90 degrees to the splice sleeve. 5) Check the splice sleeve easily enters the slot in the GO - NO GO gauge. If the sleeve does not enter the slot, this indicates the tool is not crimping properly and the crimp must be rejected.

10. GO - NO GO Test Results

10.1. This table describes what action is necessary when the GO - NO GO tests have been completed.

Table 301(g)-09

If ...	Then...
The GO - NO GO gauge indicates the tool is in proper crimping condition.	Record the test results.
The GO - NO GO gauge indicates the tool is not in proper crimping condition but it has adjustment capabilities.	Adjust the tool and repeat the test procedure.
The GO - NO GO gauge indicates the tool is not in proper crimping condition and it does not have adjustment capabilities or cannot be properly adjusted.	Tag the tool in accordance with GI-301(j) Replacing and tagging Defective In-Service Equipment and forward it for repair or disposal as directed by the responsible Supervisory Officer.

11. Pull Apart Force

11.1. This table indicates the minimum amount of force a terminal or sleeve crimped onto a wire must be able to withstand before pulling apart.

Table 301(g)-10

Wire Size (AWG)	22	20	18	16	14	12	10	8	6	4
Pull Apart Force (lbs.)	15	19	38	50	70	110	150	225	300	400
AREMA C&S Manual part 14.1.1										

12. Pull Apart Test Procedure

12.1. This table describes the "Pull Apart" test procedure.

Table 301(g)-11

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Perform a visual inspection of the crimping tool and ensure it meets the requirements.</td></tr>
<tr><td>2</td><td>Place the proper terminal or splice in the proper die on the tool and crimp it to a length of wire of the correct size.</td></tr>
<tr><td>3</td><td>Perform a visual inspection of the crimp and ensure it meets the requirements.</td></tr>
<tr><td>4</td><td>Secure the wire end and attach the mechanical force gauge to the terminal or sleeve.</td></tr>
<tr><td>5</td><td>With the wire and terminal or splice on the same axis, apply a steady pull, with a force exceeding the value shown in the above table by at least 10% for a period of 1 minute.</td></tr>
<tr><td>6</td><td>Repeat steps 2 to 5 for all dies on the tool.</td></tr>
<tr><td>7</td><td>Follow the instructions in this table.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The crimp meets the pull apart force requirement.</td><td>Record the test results as directed by the responsible Supervisory Officer.</td></tr>
<tr><td>The crimp does not meet the pull apart force requirement but the tool has adjustment capabilities.</td><td>Adjust the tool and repeat steps 1 to 7.</td></tr>
<tr><td>The crimp does not meet the pull apart force requirement and it cannot be properly adjusted.</td><td>Tag the tool in accordance with Maintenance Instruction, GI-301(j) Replacing and Tagging Defective In Service Equipment and forward it for repair or disposal as directed by the responsible Supervisory Officer.</td></tr>
</table>
</td></tr>
</table>

13. Meters General

13.1. Each type or model of meter will possess some quality or feature that makes it better suited for a specific application. Sensitivity, range, scale and memory are usually the main issues when choosing a meter to perform a certain task.

13.2. In general, meters can be divided into 3 categories characterized by the method in which they analyze and display electrical information. These categories and some examples are given in this table.

Table 301(g)-12

Category	Example	Best suited for ...
Analog	Bach Simpson TS 111 multi- meter, Triplett Model 2000 test set, or equivalent.	All basic multimeter functions. Particularly good for motor current and ground fault readings in signal systems.
Digital	Fluke 189 multimeter, or equivalent.	All basic multimeter functions. Particularly good for taking accurate readings in electronic systems. Not recommended for measuring grounds.
Storage	Fluke 196C Scopemeter or equivalent.	Capturing triggered events for later retrieval and printing.

14. Meter General Inspections and Tests

14.1. Perform these general inspections and tests before using the meter for a work session.

Table 301(g)-13

Inspect	Check
Carrying Case	Check that the carrying case is in good condition where provided.
Batteries	Check battery condition on meters provided with a battery check function.
Fuses	Check fuses on meters provided with a fuse check function.
Contamination	Check that meters are kept free of dust, grime and corrosive substances.
Leads and Clips	Check that meter leads and clips or probes are in good condition.
Selector Switches	Check that selector switches function properly when in use.
Analog Display	Check that needles on analog meters move freely when in use.
Zero Adjust	Check that zero adjust is properly set on meters provided with that function.

15. Meter Periodic Inspections and Tests

15.1. Perform these inspections and tests at least once every year. Record the test results as directed by the responsible Supervisory Officer.

Table 301(g)-14

Inspect	Check
Batteries	Remove the batteries from the test instrument and: • Visually inspect them for leaks or other damage. • Test their electrical condition.
Fuses	Check that fuses are the correct value, in good condition and spares are placed in the spaces provided for that purpose.
Internal Condition	Open the meter case and check: • Those components are free of dust, moisture or other contamination. • That components do not display signs of overheating. • That components are secure and free from damage.
Air Filters	Check that air filters are clean on instruments so equipped.
Lubrication	Check that potentiometers, rotary switches and other moving parts are properly lubricated where required, in accordance with manufacturer's instructions.
Jacks and Connectors	• Check that jacks and connectors are clean and in good condition. • Check that connector covers where provided are in place and in good condition.

Continued on next page

<table>
<tr><th>Inspect</th><th>Check</th></tr>
<tr><td>Calibration</td><td>Check calibration by using one of the two methods in this table.
<table>
<tr><th>Method</th><th>Instruction</th></tr>
<tr><td>Comparison</td><td>Compare electrical readings on all scales to those on another meter of equivalent type and rating that has been calibrated at an authorized test facility within one year and is known to be functioning properly.</td></tr>
<tr><td>Authorized Facility</td><td>Have the meter calibrated by and authorized facility as directed by the responsible Supervisory Officer.</td></tr>
</table></td></tr>
</table>

16. Bad Order Meters

16.1. Meters found to be defective and requiring repairs that affect the display of information vital to the system being tested shall be immediately removed from service, tagged in accordance with GI-301(j) Replacing and Tagging Defective In Service Equipment and shipped to an authorized repair facility.

17. Authorized Repair Facility

17.1. Defective meters may be repaired by qualified S&C personnel or an independent test facility as directed by the responsible Supervisory Officer.

18. Meter Shipping and Handling

18.1. Meters have components that are fragile and subject to minute changes in mechanical tolerances when subjected to even fairly low levels of impact. Follow these instructions for storage, handling and transporting of such instruments.

a) Meters suspected of being dropped or jarred shall be carefully inspected visually and electrically compared to another properly calibrated meter before being returned to service.

b) Meters shall be stored and transported in a dry environment.

c) Meters shall be shipped in sturdy containers containing shock absorbent material.

19. Specific Instructions and Tests

19.1. Refer to manufacturer's instructions for specific information regarding other inspections, tests and calibration procedures, not covered by this General Instruction.

301(h) - Inspection and Test Intervals

1. Purpose

1.1. To ensure the condition of signal equipment is properly maintained for service by performing initial and periodic inspections and tests as outlined in these General Instructions.

2. Requirement

2.1. Inspections and tests shall be made to ensure equipment is in proper condition for service. The frequency of inspections or tests named herein represents the maximum intervals between inspections or tests.

3. Equipment Condition and Quality

3.1. Equipment shall be installed and maintained in a condition that is safe and suitable for service. The quality of materials and workmanship shall conform to this requirement. Inspections and tests shall verify that condition and quality of signal equipment is kept at a level that will ensure the safety and integrity of the system.

Table 301(h)-01

<table>
<tr><th>If inspections and tests prove that …</th><th>Then …</th></tr>
<tr><td>Equipment is not performing within designed parameters.</td><td rowspan="2">The equipment shall be replaced in kind or with approved equipment of equivalent type or rating.</td></tr>
<tr><td>The physical or operational condition of equipment presents a hazard to the system.</td></tr>
<tr><td>Functional design, physical design or quality of equipment is not considered suitable for the intended application.</td><td>The problem shall be reported to the responsible Supervisory Officer, who will report the results to Metrolinx.</td></tr>
</table>

4. Equipment Definition

4.1. The Term *equipment* refers to any component in a signal system that is considered critical to ensuring the safe and reliable operation of the system.

5. Maximum Interval Limits

5.1. By Regulations, the intervals between periodic inspections and tests stated herein represent the maximum allowable limits. However, some minor latitude in application of these limits may be tolerated for practical considerations in special circumstances, as directed by Metrolinx.

6. Inspector Tests

6.1. When the term *Inspector* is used, it shall also be understood to mean Metrolinx designated Test Person. In addition to the Inspector test intervals explicitly shown herein, an Inspector or designated employee, acting in an inspection capacity, shall be assigned to perform scheduled Maintainer tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period. These tests are identified with superscript [1] in the following tables.

7. Inspection and Test Schedule

7.1. Inspections and tests shall be performed at the time of installation and periodically as shown in this table.

7.2. NOTE: Tests performed at longer time intervals must contain ALL tests performed at shorter intervals for same equipment and not be separated for more than 48 hours.

Table 301(h)-02

GI #	Also Complete	Test	Interval	Employee
Highway Grade Crossing Warning Devices				
310(a)(0)		Crossing Performance Test	Weekly	Maintainer
310(a)(2)	305(a) 303	Battery & Ground Test (Storage)	01M	Maintainer
310(a)(4)		AC and DC mode test	01M	
310(a)(5)		Lights, Signs	01M	
310(a)(6)		Bell	01M	
310(a)(7)		Gates	01M	
310(a)(8)		AC Voltage (AC/DC lit)	01M	
310(a)(9)	313	Controlling Devices	01M	
310(b)(2)		Preemption & AAWS	01M	
310(e)		CW/MS Devices	01M	
310(b)(3)	332(a)	IJ's and Track Connections	03M	Maintainer

Continued on next page

GI #	Also Complete	Test	Interval	Employee
310(b)(4)		Cut-Out circuits	06M	Maintainer
310(c)(1)		Flash rate	12M	Maintainer
310(c)(2)		Flasher Device	12M	
310(c)(3)		Gate Mechanisms	12M	
310(c)(4)		Light Alignment	12M	
310(c)(5)		Lamp Voltage	12M	
310(c)(6)		Battery Load Test	12M	
310(c)(7)		Warning Time	12M	
310(c)(8)	332(a)	Approaches with MS/CW	12M	
310(d)	303, 323(b), 310(a)(9)	Hold/Clear Electrical	48M	Inspector
Fouling and SCC's				
326	332, 333	Fouling Circuits	03M	Maintainer[1]
327(a)		Switch Circuit Controllers	03M	
327(b)		Centering Device	12M	
Power Switches				
329(a)		Switch Obstruction Test	01M	Maintainer[1]
329(b)(1)		Switch Point Pressure	03M	
329(b)(2)		Point Detector Test	03M	
329(b)(3)		General Inspection	03M	
329(b)(4)		Inspecting Switch Rollers	12M	

Continued on next page

GI #	Also Complete	Test	Interval	Employee
329(c)(1)		Indication Circuit Shunt	06M	Maintainer[1]
329(c)(2)		Motor and Overload	06M	
329(c)(3)		Braking	12M	
329(c)(4)		Lock Rod Correspondence Test	12M	
329(c)(5)		Hand Throw Timing & Holding	12M	
329(d)(1)		Selector Lever and Restoral	12M	
329(d)(2)		Lock Box	At Time of Install	Qualified Employee
329(d)(3)		Latchout Self Restoral		
329(d)(4)		Compartment Heaters	Seasonal	Maintainer
Spring Switches				
330(a)	327(a)	Spring Switch Circuit Controller	01M	Maintainer[1]
330(b)		Spring Switch Mechanism	03M	
330(c)		Spring Switch Compression	12M	
Electric Locks				
308(a)		Electric Lock - General	03M	Maintainer
308(b)		Electric Lock - Electrical	48M	Inspector

Continued on next page

GI #	Also Complete	Test	Interval	Employee
Searchlight Signal Mechanisms				
322(a)		SL Visual/ Rocker	06M	Maintainer
322(b)		SL Mechanism Electrical	24M	Inspector
Timing Devices				
331		Timing Equipment	12M	Maintainer[1]
Relays				
323(a)		Visual Inspection	As Required	Qualified Employee
323(b)	323(a)	Relay Electrical	48M	Inspector
323(b)(1)	323(b)	Flasher Relay	48M	
323(b)(2)		PO Relay	48M	
323(c)	323(a), 323(b)	Polar & AC Vane Electrical (*AC Vane, DC Polar & Soft Iron Magnetic Structure*)	24M	
323(d)		AC Centrifugal Electrical (*AC Centrifugal*)	12M	Inspector
Batteries				
305(a)		Storage Battery - General	03M	Maintainer
305(b)	305(a)	Storage Battery - No Stick Release Timer	01M	Maintainer
305(c)		Storage Battery - Load Current	As Required	

Continued on next page

GI #	Also Complete	Test	Interval	Employee
Track Circuits				
332(a)		Track Hardware - Visual	06M	Maintainer
332(b)		Track Hardware - Electrical	As Required	
332(c)		Guard Rail Bond Wires	06M	Maintainer
333(a)		Track Circuits	12M	Maintainer[1]
333(b)	333(a)	Stored Energy Tests	24M	
Electric Locking				
315		Approach Locking	At Time of Install	Qualified Employee
316		Detector Locking		
317		Indication Locking.		
318		Movable Bridge Locking	03M[2]	Maintainer[1]
319		Route Locking	At Time of Install	Qualified Employee
320		Time Locking		
321(a)		Traffic Locking		
321(b)		Field Blocking		
Recorders and Grounds				
303		Grounds & Isolation	03M	Maintainer[1]
307		Recording Devices	06M	Maintainer
309		Ground Resistance	120M	Inspector[3]
312		Wire & Cable Resistance	120M	Inspector

Continued on next page

GI #	Also Complete	Test	Interval	Employee
Electronics				
335(a)		Vital Software Configuration	48M	Inspector
335(b)		Vital Hardware Configuration	48M	
336(a)		NV Software Configuration	At Time of Install	Qualified Employee
336(b)		NV Hardware Configuration		
Miscellaneous				
301(b)		Installation & Commissioning	Refer to GI-301(b)	
301(f)		Condition of Plans	12M	Maintainer
301(g)		Vital Tools and Test Instruments	Refer to GI-301(g)	
301(m)		Other Instructions	Refer to GI-301(m)	
302		Cable Housings	12M	Maintainer
313		Lightning Arresters	Frequently	
314		Signal Poleline	12M	
335(c)		Train ID Loop Sytem	06M	Maintainer
Hazard Detectors				
501(a)		Hot Box Detectors – One Month Test	01M	Maintainer
334(b)		Grade Failure Detectors	06M	

Continued on next page

GI #	Also Complete	Test	Interval	Employee
334(c)		Signal Activating Devices	06M	Maintainer
501(b)		Hot Box Detectors - 6 Month Test	06M	Maintainer
Radio				
340(a)		ATCS – MCP/BCP Radio Test and Calibration	12M	Maintainer

[1] Refer to "Inspector Tests" explanation.
[2] Test every 3 months during navigation season, and immediately before opening of navigation season.
[3] Inspector where GI-312 applies; Maintainer where GI-312 does not apply.

8. Test Intervals of 400 Series GI

8.1. 400 Series GIs have no periodic schedule and are intended to be performed in conjunction with all closely related series tests. They may also be performed whenever qualified employees are passing through a location or working on site for other reasons.

8.2. Results of these inspections shall be recorded in the designated SCIS when there is evidence of non-compliance with an applicable standard or instruction.

9. Inspection and Test Intervals – Exceptions

9.1. Special circumstances may require inspections and tests to be completed more frequently than the interval stated in these General Instructions. Metrolinx will determine the required inspection and test interval in these cases.

Table 301(h)-03

EXAMPLES	
Inspection or Test	**Reason for Increased Frequency**
GI-332(a) Track Hardware – Visual Inspection.	Unusually high train traffic levels increase wear on track components.
GI-305(a) Inspecting and Testing Storage Battery – General.	Frequent AC power failures on territory where constant current rectifiers require frequent adjustment to keep battery charge at an acceptable level.
GI-314 Inspecting Signal Pole line and Attachments.	Extreme weather conditions due to geographic location cause excessive damage to the pole line and attachments.

301(i) - Protecting Train Operations During Signal System Interruptions

1. Purpose

1.1. It is essential that personnel performing work that may interfere with the signal system understand how the interruption at the working point may affect signals in adjacent blocks. Positive protection in accordance with Operating Rules shall be applied whenever there is a risk of affecting train operations, to encompass the entire limits of the area that may be affected. When in doubt, consult the responsible Supervisory Officer.

2. Requirement

2.1. No inspections, tests, repairs or revisions of any signal system or equipment shall be made, without first taking appropriate measures to provide for the safety of all train operations that depend on the normal operation of that system or equipment.

3. Road Crossing Warning System De-activation

3.1. When the normal functioning of a road crossing warning system is circumvented to prevent nuisance ringing on account of track or unattended S&C work, prescribed steps shall be taken, as identified in Codes of Practice, SCP-709 to ascertain that a method of protection is in place to ensure trains are not operated unprotected over the crossing while the warning system is de-activated.

4. Positive Protection Definition

4.1. Positive protection is defined as making provision for the safe operation of trains by use of operating permits or clearances; TOP, or flagging procedures; Rule 42.

5. Protecting Train Movements

5.1. Positive protection shall be provided when the operation of trains is adversely affected by signal system interruption due to inspections, tests, defects, equipment repairs or revisions. The limits of the protection must extend to all portions of the system that may be affected.

5.2. The type of protection applied will depend on the operating requirements for the territory where tests are being performed and the length of time the signal system will be interrupted.

6. Examples

6.1. The following are examples of how positive protection is to be applied for various circumstances.

Table 301(i)-1

If …	Then …
Tests are to be performed on searchlight signal mechanisms at a control location in CTC that cause false aspects to be displayed.	Positive protection shall be obtained up to the next control location in each direction from where the tests are to be performed. The location shall be removed from service on account of false aspects being displayed, which could affect the safe operation of trains.
Tests are to be performed on an OS Track circuit at a control location in CTC that presents the risk of the circuit being opened or shunted.	Positive protection shall be obtained up to the next control location in each direction from where the tests are to be performed on the account of the possibility of suddenly downgrading aspects in front of a train.

Continued on next page

If ...	Then ...
The signal system is going to be interrupted for an extended period of time due to a planned project that requires revision and testing.	The responsible Supervisory Officer shall, well in advance of the interruption, arrange for Planned Work Track Protection with a General Bulletin Order which provides positive protection for trains during the interruption. The plant should also be removed from service, but not until it has been confirmed that the protection is in place.
Relays must be removed from a highway grade crossing warning system (within CTC) for the purpose of performing electrical operating tests in accordance with GI-323 Inspecting and Testing Relays	Ensure the crossing is protected per Codes of Practice SCP-709 and follow de-activation procedures contained therein.
An equipment defect is discovered which may affect the signal system and repairs cannot be readily performed due to extraordinary circumstances.	Immediately obtain positive protection which encompasses the limits of the signal system affected by the defect. Advise the responsible Supervisory Officer who shall arrange for the appropriate method of protection to allow train operations to continue during the interruption.

301(j) - Replacing and Tagging Defective In-Service Equipment

1. Purpose

1.1. To ensure that signal equipment not meeting the requirements of inspections and tests is promptly removed from service and is immediately tagged with the proper documentation so it can be scheduled for repair at an authorized facility or discarded in an appropriate manner.

2. Requirement

2.1. Relays, electric locks, signal and gate mechanisms, electronic devices and other equipment which do not meet requirements of field tests shall be promptly removed from service and tagged as unfit for service.

3. Defective Equipment Removal

3.1. This table explains when equipment that fails inspections and tests shall be removed from service.

Table 301(j)-01

If...	Then...
The requirements of the inspections and tests are not met and the defective equipment does not present an immediate danger to the system. EXAMPLE: A bulging gasket on a searchlight mechanism case is exposing the inner workings to the atmosphere but is not affecting the operation of the mechanism.	Remove the equipment from service as soon as practicable and note the defect and other pertinent information on a repair tag attached to it and report it the responsible Supervisory Officer.
The requirements of the inspections and tests are not met and the defective equipment does present an immediate danger to the system. EXAMPLE: The hold clear device in a highway grade crossing warning device gate mechanism is damaged and will not engage in the hold clear position.	Remove the equipment from service immediately and note the defect and other pertinent information on a repair tag attached to it. Replace the equipment and perform the appropriate inspections and tests. If the equipment cannot be removed from service and replaced immediately, the system or portion of the system affected shall be protected in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption. Advise the responsible Supervisory Officer.

4. Tagging Defective Equipment

4.1. Defective equipment shall be immediately tagged upon removal from service. The type of tag used will depend on where the equipment is going to be shipped for repair, however all tags shall capture the following information:

a. Date of removal from service.

b. Identity of the location the equipment was removed from.

c. Equipment description (model, serial number and bar code number).

d. Circuit application name if applicable (i.e. "GXR", "EA mech").

e. Name of the employee the equipment is to be returned to.

f. A description of why the equipment was removed from service and the specific problem, if known.

4.2. In addition to the tag, the appropriate Metrolinx equipment tracking document is to be filled out and submitted to Metrolinx for tracking purposes.

5. Receiving Repaired Equipment

5.1. When repaired equipment has been received from the repair facility it will have a portion of the repair tag attached to it. This portion of the tag will have at least the repair date and the name of the person that performed the repair documented on it, as illustrated in Figure 301(j)-1.

5.2. The portion of the tag that documents completed repairs shall not be removed from the equipment until it is returned to service. This information may become valuable to the user should the equipment fail at that time.

5.3. Upon receiving repaired equipment, the Metrolinx designated Maintenance Provider must update the appropriate Metrolinx equipment tracking document and submit to Metrolinx for tracking purposes.

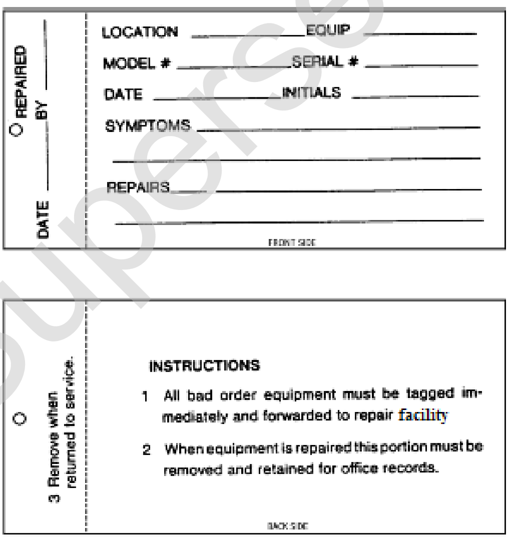
6. Equipment Security

6.1. All defective equipment shall be promptly tagged and placed in a secure area, separated from new or replacement stock equipment, until shipped for repairs.

7. Tag Example

7.1. Figure 301(j)-1 shows an example of a tag that is used for tagging defective equipment prior to being shipped to an approved facility.

Figure 301(j)- 1



7.2. This type of tag can be used to attach to equipment as it is being removed from service in the field. It gives the approved facility enough information to know what the problem is or might be and where to return the equipment when repairs have been completed. It also serves as a record of repair to be kept at the repair facility. A small portion of the tag is returned with the repaired item to advise the user of its condition.

301(I) - Recording Inspection and Test Results

1. Purpose

1.1. To describe the process for recording the results of inspections and tests.

2. Requirements

2.1. Results of inspections and tests made in compliance with these rules shall be recorded using the Metrolinx designated Signals & Communications Inspection System (SCIS). Reports covering inspections and tests shall be submitted promptly in accordance with instructions and shall be noted in SCIS.

3. Inspection Results

3.1. All GI inspections and tests shall be performed as dictated by test intervals. All results of GI inspections and tests shall be recorded in SCIS the day the test was performed. The employee that performs the inspection or test must be the one to record the results into SCIS.

4. Filing Inspection and Test Records

4.1. The designated Metrolinx database shall be the repository for all recorded test and inspection results, with the exception of the 1202-5 Interlocking Test Forms, and any other hard copy forms which may be required by Metrolinx. These hard copy forms are required to be kept and filed at the office of the responsible Supervisory Officer, and as directed by Metrolinx.

5. Distribution and Reporting

5.1. The recorded inspection and test results shall be distributed for filing and reporting purposes as instructed in the following table.

Table 301(l)-01

Employee	Filing & Reporting
Installer	Results of the test performed by Installation shall be recorded in the designated SCIS when the location is modified or placed in service. Refer to GI-301(e) Signal Installation and Testing Documentation for instructions on documenting operational tests.
Maintainer	Results of inspections and tests performed shall be recorded in the designated SCIS.
Inspector	Results of inspections and tests performed shall be recorded in the designated SCIS.

6. Record Retention

6.1. Test records entered in SCIS shall be retained automatically in the system.

6.2. Existing hard copy records shall be retained until the next record is filed but in no case less than one year. There will be cases where these records must be retained for considerably more than one year because the requirements for inspections or tests exceed that limit. This table gives some examples of record retention time limits.

Table 301(I)-02

Retention Time	Example
2 Years	Existing hard copy records associated with 2 year inspection and tests.
4 Years	Existing hard copy records associated with 4 year inspection and tests.
8 Years	Existing hard copy records associated with 8 year inspection and tests.
10 Years	Existing hard copy records associated with 10 year inspection and tests.

301(m) - Other Instructions

1. Purpose

1.1. The General Instructions do not cover all inspections and tests that may be required for certain equipment. This GI explains some other documents that may contain inspection and test requirements, and the process for defining supplementary inspections and tests.

2. Examples

2.1. These are examples of when these General Instructions do not cover all inspections and tests that may be required:

a. New systems or equipment are installed and maintained using procedures provided by the manufacturer.

b. Legacy systems or equipment for which the procedures have not been integrated on a System basis.

c. Instances where the need for a specific inspection or test is not realized until after the equipment has been in service for some time.

3. Alternative Procedures

3.1. In some cases, it may be appropriate to substitute instructions contained in Manufacturer service manuals in place of the specific instructions contained in a General Instruction. This may be allowed if the following criteria are met:

a. All of the objectives of the General Instruction are met by the alternate procedures, and

b. At minimum, an equivalent degree of testing is performed, and

c. The responsible Supervisory Officer has provided to each affected personnel, by email or in writing, a confirmation that the Metrolinx approved alternate procedures may be used, and how they are to be applied, and

d. Notice of alternate procedures has been filed, by email or in writing, with Metrolinx.

4. Other Documents

4.1. Other documents may exist that cover specific instructions on a Regional basis, for emergent conditions, and for new equipment. These include:

a. Service Bulletins – Special inspections may be outlined in a Service Bulletin to cover a specific problem, and may require a one-time, temporary, or permanent periodic procedure.

b. Manufacturer's Instructions – Service manuals (I&M, O&M) may be provided by the manufacturer for new equipment which contain essential tests that must be performed. The responsible Supervisory Officer and Metrolinx shall determine what tests are necessary and create a schedule for them, as guided by GI-335 Inspecting and Testing Vital Electronic Equipment.

5. Supplementary Inspections and Tests

5.1. It is the responsibility of all S&C personnel to bring to the attention of the responsible Supervisory Officer, any inspection or test procedure not currently in place which is known or perceived as being necessary. Metrolinx shall then be advised and will issue the appropriate Special Instructions to all concerned.

6. Recording Supplementary Inspection and Test Results

6.1. As instructed by Special Instructions or Regional Instructions, results of inspections and tests performed on affected equipment shall be recorded in accordance with GI-324 Supplementary Inspections and Tests.

301(n) - Relief from Performing Inspections and Tests

1. Purpose

1.1. To describe conditions that allow personnel assigned to perform an inspection or test be relieved from performing the inspection or test in order to avoid duplication.

2. Requirement

2.1. When required by rule to make inspections or tests within a scheduled period and it can be determined from the inspection and test forms that they have been made by another employee during the required period, the maintainer is relieved of duplicating such inspections or tests.

3. Methods of Relief

3.1. Relief from inspections and tests can be authorized by either of the methods described in this table.

Table 301(n)-01

Method	The maintainer can be relieved of performing specific inspections and tests when ...
Record of Signal Inspections & Tests	The test(s) have already been performed by another employee during that time period and the results have been recorded in SCIS EXAMPLE: The Testman/Inspector has completed the prescribed periodic inspections and tests.
Special Instructions	Relief from inspections and tests are authorized by special instructions issued by Metrolinx.
Switch Temporarily Out of Service	Relief is authorized by the Supervisory Officer in cases where a switch is temporarily removed from service, and the switch points are spiked, clamped, and locked, and only after other conditions in accordance with instructions on the following page have been satisfied and Metrolinx has been notified. All applicable inspections and tests shall be performed when the spike, clamp, and lock are removed in cases where the points have been out of service for a period exceeding the normal inspection and test interval.

4. Spiked, Clamped and Locked Switches

4.1. There are instances where in-service switch points are spiked, clamped, and locked for extended periods of time. Relief from performing the required periodic inspections and tests affected by the position of the switch points may be granted by the responsible Supervisory Officer and Metrolinx providing the following conditions are met.

4.2. NOTE: *This instruction applies ONLY to in-service switches that are* mechanically *secured by a switch stand or switch machine and properly protected with point detection*.

a. The switch points shall be spiked and clamped with an approved clamp, on the closed point and locked with a lock that can be opened only by the S&C Maintainer or personnel designated by the responsible Supervisory Officer.

b. All applicable inspections and tests shall be performed before the switch points are clamped and locked.

c. When switch points are clamped and locked at dual control or power switch locations, the motor control circuit shall be opened so the machine cannot be remotely controlled.

d. The operating authority shall be advised and operating instructions governing train movements over the switch shall be issued.

e. The point clamp and lock shall be inspected at the normal inspection and test interval for that type of location, to ensure they are secure.

f. Relief from performing periodic tests does not extend beyond three months.

301(o) - Installing Unauthorized Equipment and Material

1. Purpose

1.1. To describe the process for approving equipment and material; authorizing service tests and replacing existing in-service equipment used in vital signaling applications. The vital nature of signal systems demand that equipment and material comprising them be proven safe and reliable before being approved for general use.

2. Requirement

2.1. Employees shall not install experimental devices or unauthorized material unless specifically authorized in accordance with instructions.

2.2. All electronic and processor based equipment, including executive and application software, installed on Metrolinx Corridors is subject to a formal safety audit process before it can be considered for use.

3. Equipment and Material Evaluation and Service Tests

3.1. All traditional signal equipment and material are evaluated by Metrolinx S&C Standards & QA for compliance with AREMA, CSA, NEC, ANSI or other applicable standards before they are considered acceptable for use. In situations where there is no prior performance data to refer to, a formal service test shall be conducted to validate the equipment. Procedures on initiating and conducting service tests are explained in the S&C Codes of Practice SCP-1201.

4. Service Test Authorization

4.1. A service test may be initiated with approval of Metrolinx. The service test procedures defined in SCP-1201 are designed to ensure awareness of the test and its results.

5. Service Test

5.1. When authorization has been given to proceed with the service test, follow the instructions defined in SCP-1201.

6. Service Test Notification

6.1. When equipment is installed under service test, the asset in question will have to be added to SCIS.

7. Replacing Existing Equipment

7.1. When it becomes necessary to replace in service equipment or material within a vital signal system, it shall be replaced in kind or with approved equipment of equivalent rating and specification. Replacement shall be followed by all applicable inspections and tests including operational tests when required. The replacement shall be recorded and reported in accordance with GI-301(l) Reporting Inspection and Test Results.

8. Equipment Repair

8.1. Repair to any equipment or material used in a vital signal system shall be done in a manner that restores it to a safety and reliability level consistent with its original condition. Repair shall be followed by all applicable inspections and tests including operational tests when required.

301(p) - Observance of Rules, Standards and Instructions

1. Purpose

1.1. The complexity and safety critical aspect of signal systems mandates that all rules, standards and instructions pertaining to these systems are adhered.

2. Requirement

2.1. Rules, standards and instructions, shall be observed in the installation, inspection, maintenance and repair of signal equipment and systems.

3. Types of Rules, Standards and Instructions

3.1. These are the main types of rules, standards and instructions that Metrolinx presently applies to the installation, maintenance and inspection of signal systems.

Table 301(p)-01

Document(s)	Explanation
Transport Canada Regulations	These are the regulations that govern the installation, maintenance, and testing of railway signal systems in Canada.
S&C Standards – General Instructions (GI)	These provide detail on how to apply safe work practices, and describe in detail how, when and by whom each of the S&C Standard inspection and tests are to be performed.
S&C Standards – Codes of Practice (SCP)	These standards describe the application and installation methods of S&C systems. They represent the recommended practice for a particular type of system or equipment.

Continued on next page

Document(s)	Explanation
AREMA C&S Manual	These are recommended practices set forth by the American Railway Engineering and Maintenance of Way Association.
Service Bulletins	These are instructions that target modifications to specific in-service equipment or systems. Each is assigned a priority level, which dictates the response time required to make the modification.
Manufacture Instructions	These are equipment manuals supplied by the manufacturer, which detail installation and maintenance procedures.
Special Instructions	These are instructions that target a specific area of concern that affects the installation and maintenance of signal systems over the long term.
Policy Letters	Letter/Email, outlining various types of instruction, may be issued when it is impractical to issue permanent instructions in one of the other forms listed in this table. EXAMPLE: A vital circuit problem of a safety critical nature requires immediate action at a local level for a specific site(s).
Policy Reports	These reports contain information resulting from in depth studies and testing of specific portions of signal systems. Their intent is to gather enough information to allow us to formulate effective policies.
Safety Flash / Root Cause Investigation	Letter/Email, identifying a recent incident which resulted, or could have resulted, in personal injury or train accident, usually on account of a failure to follow prescribed procedures or guidelines. The document will re-iterate existing procedures, and may suggest improvements to them, to be followed up with permanent instructions.

Continued on next page

Document(s)	Explanation
Track Standards	The instructions contained in this manual are intended for the guidance of employees subject to the Maintenance of Way Rules. It includes standard practice circulars encompassing installation and maintenance of right of way roadbed, track, wayside signal and communication systems and other general topics.
Operating Bulletins	These are instructions that govern the movement of trains when signal systems are installed, altered or suspended from service.

4. S&C Rules Standards and Instructions

4.1. Rules, standards and instructions are developed and approved by Metrolinx and issued to the user, usually through the office of the responsible Supervisory Officer.

4.2. EXCEPTION: Letters of instruction may be issued from a local level as previously described in "Policy Letters".

5. Electronic Distribution

5.1. All updated rules, standards and instructions are available electronically on the MYLINX intranet site.

5.2. General Instruction books will always be available in booklet format.

6. Responsibility for Filing and Maintenance

6.1. The "Employee", when issued copies of rules, standards or instructions, is responsible for ensuring they are properly filed and updated as new or revised copies are issued. Employees shall make themselves familiar with the contents of such documents and when in doubt concerning their meaning, consult with the responsible Supervisory Officer.

6.2. The responsible Supervisory Officer shall ensure that employees maintain copies of rules, standards or instructions that are vital to the performance of their duties.

7. Responsibility for Revisions, Additions and Deletions

7.1. The need for revisions, additions or deletions to rules, standards and instructions may be initiated from any level of the workforce but shall not be issued without proper approval as previously described in this General Instruction.

7.2. Rules, standards and instructions that have been superseded or rendered obsolete by approved revisions, additions or deletions shall not be destroyed unless directed to do so by the amended instruction or by the responsible Supervisory Officer. Obsolete documents shall be disposed of or recycled.

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301(s) - Tests Not Performed

1. Purpose

1.1. To describe the process for reporting instances where periodic inspections or tests could not be performed within specified time intervals.

2. Requirement

2.1. Periodic inspections or tests that could not be performed within the maximum interval limits shall be reported.

3. Inspection Results

3.1. All results of GI inspections and tests performed shall be recorded in the designated Metrolinx Signal and Communication Inspection System (SCIS) as dictated by test intervals, within two working days but in no case more than five days.

3.2. The appropriate Metrolinx tracking document shall be filed for each specific inspection or test not performed within the maximum interval limit.

4. Approved Paper Document

4.1. Where approved paper documents are used to report instances of tests not performed, a copy shall be provided to the responsible Supervisory Officer within 5 days of the expiration of the maximum interval limit, who shall promptly forward a copy to Metrolinx.

5. Content of Paper Report

5.1. When reporting a test or inspection not performed using paper documents, the following information shall be provided:

a. The location and GI test number.

b. Equipment affected.

c. Date range.

d. Reason(s) for not performing the test.

6. Relief from Performing Inspections and Tests

6.1. It is not necessary to report instances when inspections and tests have not been performed where relief from inspections and tests has been provided in accordance with GI-301(n) Relief from Performing Inspections and Tests.

301(t) - Software Configuration Management

1. Purpose

1.1. This General Instruction explains how software configuration management is to be implemented at Metrolinx. It applies to the software and firmware for all vital processor based equipment used by S&C, which includes signal and crossing systems.

1.2. Software configuration management is an inventory of software at each equipment location. As the equipment ages and experiences modifications, such as upgrades in hardware and software, the inventory should be updated accordingly, providing traceability to previous versions of software.

1.3. One should always be able to determine from the inventory precisely what software is installed at each equipment location in the field.

2. Requirement

2.1. Software configuration management shall ensure that the proper and intended software version for each specific site and location is documented and maintained throughout the life-cycle of the system.

3. Equipment Affected

3.1. This policy is specifically designed to address the software revision control of vital processor based equipment including but not limited to the following:

a. Electronic Coded Track Circuits;

b. Grade Crossing Predictors / Motion Detectors;

c. Processor Based Interlockings/Control Points;

d. Vital timers (electronic);

e. Vital HD interfaces.

4. Reporting System

4.1. The primary reporting system for tracking and recording the status of software revisions is the Metrolinx designated Signals & Communications Inspection System (SCIS).

5. Field inspections

5.1. Field inspections of software revision levels shall be performed whenever equipment is replaced, modified, or disarranged, and periodically as prescribed by GI-335 Inspecting and Testing Vital Electronic Equipment.

6. Office Validation

6.1. Upon completion of authorized installations or modifications, the validation of software revision levels, as recorded in SCIS, shall be performed by the Metrolinx designated Signal Design Office prior to the issuance of "As Installed" field plans.

7. Exception Reporting

7.1. A summary shall be automatically generated on a monthly basis, identifying those locations whose software revision levels have changed in the prior month, as recorded in SCIS. This summary shall be reviewed to ensure no unauthorized software changes have been performed.

8. New Installations

8.1. For new installations, all software revision levels shall also be indicated on the field plans.

9. Software Types

9.1. Software implemented in vital processor based equipment can be grouped into one of two general categories as follows:

9.2. <u>Executive Software</u>: Refers to software used to maintain internal operation of the processor based equipment, such as scheduling tasks internal to the equipment, running timers, reading inputs, driving outputs, and performing self-diagnostics. The executive software is generally the same for all installations of a given model of equipment.

9.3. <u>Application Software</u>: Also referred to as "site specific software", this refers to software that is written to control the operation of the processor based equipment for a specific location. The application logic describes the interlocking logic or functionality implemented in a processor based piece of equipment and is generally specific to a given location or typical field configuration.

10. Approval of Executive Software

10.1. All new or revised executive software shall be approved by Metrolinx, prior to being installed in new field equipment. Installation of non-authorized executive software is strictly prohibited.

11. Approval of Application Software

11.1. All application software must be approved by Metrolinx before it is authorized for use in new field equipment. Installation of non-authorized application software is strictly prohibited.

12. Superseded by Service Bulletin

12.1. Where executive or application software must be upgraded on an urgent basis, a SCIS service bulletin shall be issued for all existing locations where the upgrade is applicable. Authority to install the software is granted by the Metrolinx Approved service bulletin, conditional that all relevant testing requirements are met.

12.2. Upon completion of the upgrade, the new revision levels shall be entered in SCIS for each instance that the new software is installed.

12.3. Where revision levels are shown on the field plans, they shall be marked up and returned to the signal design office for issuance of updated "As Built" field plans.

13. Data Recording

13.1. Each location containing vital processor based equipment shall have the following information captured in SCIS:

a. Subdivision;

b. Mileage;

c. Description.

13.2. Each hardware component of vital processor based equipment, to the detail of printed circuit board or module level, shall have the following information captured in SCIS:

a. Manufacturer;

b. Product Name/Model;

c. Year/Month of Manufacture;

d. Revision Level.

13.3. Each instance of executive and application software installed in vital processor based equipment shall have the following information captured in SCIS

13.4. NOTE: For purposes of consistency, the SCIS term for "checksum" refers to the simple addition of the data bytes residing on a physical memory device, such as an

EPROM. The term "CRC" refers to more sophisticated redundancy checks such as CRC-16.

14. Software Storage

14.1. A secure storage location for master executables (in soft format) and software documentation shall be provided on the corporate network.

14.2. Where the executables must reside on PROMS (or other hard media), they shall be created directly from the master executable prior to testing and placing in service. PROM labeling shall be applied clearly showing the program ID, software version, revision date, checksum and CRC.

14.3. Master executables will be retained for a period not less than 12 months after all copies of the software version have been removed from service.

15. Software Documentation

15.1. All new or revised application software shall be accompanied by the following documentation:

15.1.1. Functional Description: All software functionality (logic and interlocking) implemented in the software release shall be described, and the ladder logic file shall be provided where appropriate.

15.1.2. Changes Summary: A written summary of the changes implemented in this new software release as compared to revisions currently in use. Change details shall include difference reports and recommended testing to adapt the changes.

15.1.3. Compatibility Summary: A complete description of all hardware and software revision levels that this software is compatible with. This should include any jumper, dipswitch or strap settings. Any hardware or software revisions that cannot be used with this software shall also be explicitly described in this document.

15.1.4. User Requirements: A written summary of any and all operational constraints that must be satisfied to ensure safety when using this software.

15.1.5. Checksums: A list of applicable checksums and cyclic redundancy checks.

16. Testing Requirements

16.1. Upon receipt of software, checksum values on PROM (or other hard media) labels shall be compared with the calculated checksums derived by PROM testers or other comparable devices. Where practicable, CRC values shall be verified according to manufacturer's instructions.

16.2. Unless otherwise directed, every field location receiving new or revised software shall be subjected to full operational tests as prescribed by GI-301(b) Installation and Commissioning Tests prior to in-service.

16.3. Field locations receiving replacement software, which is known to be identical in all respects to previously installed software, are not subjected to full operational tests.

16.4. The following examples illustrate when operational testing is required for various circumstances.

Table 301(t)-01

If the following change is being performed…	Then full operational testing is…
A failed CPU is being replaced in kind using the PROMs that were on the original CPU.	Not required. The software is known to be identical.
A failed CPU is being replaced in kind using PROMs that were recently created from the master executable.	Not required, so long as: • The checksum/CRC's on the new PROMs match what is recorded in the software documentation, and • The revision levels and checksums of the new PROMs are identical to those indicated on the failed CPU.
The application software revision level is being upgraded.	Required[1]
The executive software revision level is being upgraded.	Required, unless otherwise directed by Service Bulletin or special instruction.

[1] a portion of operational tests may be performed in advance using test apparatus or simulators, or deemed to be unnecessary by reduced validation procedures, thus relieving the need to perform these tests under live conditions. Relief from performing tests may only be granted, in writing, by Metrolinx.

302 - Inspecting Cable Housings

1. Purpose

1.1. To ensure that cable housings and any equipment contained within them are physically maintained in a condition that will not compromise the integrity of the signal system.

2. Test Interval

2.1. Cable housings and their contents shall be inspected when installed, as required and at least once every year. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Frost Heaving

4.1. At locations with underground cable where frost heaving occurs, post mounted cable housings shall be inspected at least once per year, and more frequently depending upon the level of frost heaving.

5. Cable Housing Definition

5.1. A housing used for the purpose of terminating wires or cable and/or mounting equipment.

6. Cyclic Frost Heaving - Post Mounted Cable Housings

6.1. Cyclic frost heaving is a term used to describe a natural phenomenon that occurs during the winter and spring months. Experience has shown that post mounted cable housings are particularly susceptible to cyclic frost heaving. A post mounted case will lift when the ground freezes but may not return to its original position when the ground thaws. Depending on the accumulated number of frost heave cycles and the amount of lifting which occurs, excessive strain may be applied to internal cable terminations.

7. Inspection for Evidence of Frost Heaving

7.1. Visually check for evidence of lifting at the post or cable conduit at the ground level point by checking natural markings or applied paint lines. If paint lines or soil markings indicate a lift of one inch or more, more frequent inspections are recommended unless the resulting inspection of the cable terminations indicates corrective action is needed immediately.

8. Underground Cable Splices

8.1. In situations with chronic frost heaving problems, consideration should be given to replacing the cable housing with an underground cable splice.

9. Visual Inspection

9.1. Cable housings shall be inspected as described in this table.

Table 302-01

Inspect	Check that…
Cable Entrance	• Sealing compound is properly applied where required. • Conduits are properly clamped and fitted to equipment connection. • Cable fittings are tight and rubber inserts provide a proper seal. • Plates installed to cover cable chutes are properly secured and sealed. • There is no evidence of excessive strain or tension on the entering cables and that all strain relief equipment is functional and properly secured.
Terminals	• No insulation has pulled away exposing excessive bare copper wire on any wire terminations. • All terminals are corrosion free, tight and properly secured to the terminal board, with no excessive strain or wire tension on the terminal.

Table 302-02

Inspect	Check that…
Posts, Poles and Piers	• Post, piers and foundations are in compliance with GI-401 Inspecting Foundations. • Posts, poles are in good condition, properly seated in the ground. Look for evidence of ground heaving or shifting which could result in excessive strain on terminating cables.
Tags	• All tags are properly installed in accordance with the circuit plans.
Equipment	• Equipment in the housing is in good physical condition and securely mounted.
Gaskets	• All gaskets are properly placed and in good condition.
Insulation	• Insulation, where provided, is in good condition.
Vents	• Vent filters, if provided, are clean and allow air to flow freely. • Mechanical moving parts of vents and shutters are operational.
Doors	• Locking mechanisms are operational. • Hinges move freely and are sufficiently lubricated.
Cleanliness	• The housing is free of spilled battery electrolyte, rust and corrosion, dirt, debris, insects and
Moisture	• The housing is free of moisture caused by leaks or condensation.
Paint	• Both interior and exterior painted surfaces are clean and properly painted.
Tools and Material	• There are no tools or any other items that are not specifically required for the maintenance of the equipment contained within the housing. NOTE: Articles stored in the housing shall be placed in a manner which ensures they will not interfere with the safe operation of the system.

303 - Testing for Grounds & Battery Isolation Faults

1. Purpose

1.1. To ensure that there are no grounds, nor combination of grounds and battery isolation faults, which will permit sufficient current flow to affect the release of any relay or electromagnetic device.

2. Test Interval

2.1. Voltage test readings for battery isolation faults and grounds shall be taken for all operating battery or energy busses, such as DC/DC converters and isolated power supplies, when installed, as required by GI-310 Testing Highway Grade Crossing Warning Devices - General and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Other Requirements

4.1. Any isolation fault or voltage to ground readings shall be investigated and repairs made promptly. Results shall be recorded in the SCIS.

4.2. NOTE 1: When repeated non-periodic testing is required due to ongoing planned work ensure circuits are isolated and ground free before leaving location.

4.3. NOTE 2: Inspector shall perform isolation and ground tests before commencing any other tests at a location having an operating bank.

4.4. NOTE 3: All tests prescribed herein shall be performed following any change, addition, or replacement of wiring or apparatus utilizing a signal system operating battery or energy source.

4.5. NOTE 4: All tests prescribed herein shall be performed following exposure of cable to damage from excavation or MOW programs, unless megger tested in accordance with GI-312 Wire & Cable Resistance.

5. Ground Rod Connection

5.1. A valid circuit ground test depends heavily on a good connection between the meter and ground. Before commencing, verify all connections between prime ground terminals and ground rods are secure and in good condition.

6. Track Batteries & Radio Batteries Not Applicable

6.1. Track batteries need not be tested per GI since they are connected directly to the rails, which are in permanent contact with the ground.

6.2. Batteries or energy sources that power radio equipment shall only be tested for battery isolation faults because this equipment is permanently grounded and can be damaged by circuit ground tests.

7. Test Sequence

7.1. Battery ground tests shall be performed prior to battery isolation tests.

8. Test Equipment

8.1. Voltage reading is an indication that a ground *may* exist. The sensitivity of some meters will show voltage to ground when no ground actually exists. For example, high impedance meters, such as the Fluke 189, cannot be relied upon to accurately determine grounded circuits when placed on the voltage scale.

Table 303-01

If ...	Then ...
An S&C 360 Ground Finder instrument is available.	This meter is the preferred test instrument for this application.
A low impedance meter is available, such as a Bach Simpson TS-111B.	This meter is an acceptable instrument for this application.
A high impedance meter must be used for ground tests	Connect a 15,000 ohm resistor in parallel with the meter leads. This effectively converts the meter to low impedance.

8.2. Before applying a voltmeter to the circuit, ensure the meter is set on its highest scale to start the test and then decrease the scale one level at a time until it is determined whether or not a ground may exist.

8.3. Do not attempt to perform ground measurements with two meters simultaneously attached to the same energy source, as the internal resistances of the meters will interfere with each other, which may cause false readings. This includes ground fault detectors, which should be isolated from ground before meter readings are taken.

8.4. Be aware that the S&C 360 Ground Finder may cause MOV lightning arresters connected to vital energy circuits to conduct, which may appear as a ground fault. If this is suspected, the offending MOV arresters should be isolated from ground while performing these tests.

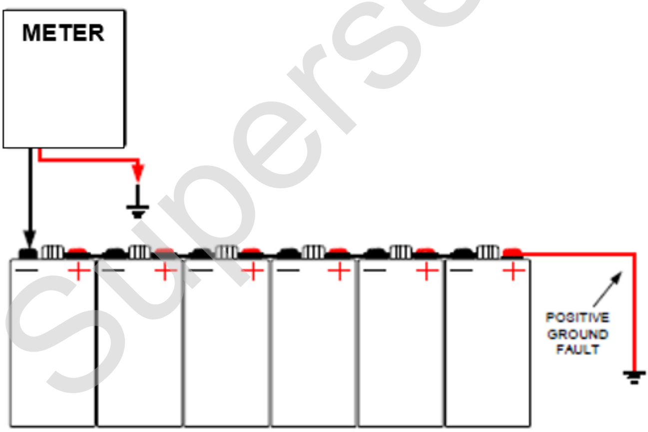
8.5. Before inserting an ammeter into the circuit, ensure the meter is set on its highest scale to start the test and then select the proper scale to determine the ground current.

8.6. WARNING: An ammeter (or S&C 360 Ground Finder in the "Confirm" mode) is effectively a short circuit, and a short circuit applied to a circuit which is suspected of having a battery ground may provide the second path to complete a wrong side failure. Always ensure positive protection in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption is applied if there is any risk of interfering with the safe operation of trains.

9. Polarity Definitions

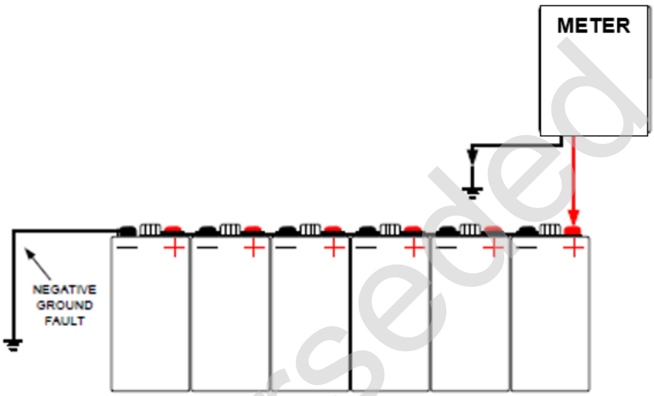
9.1. A positive ground, which is the most hazardous type of ground fault, is said to exist if voltage readings are detected between the negative battery post and ground (with + meter lead on ground).

Figure 303- 1



9.2. A negative ground is said to exist if voltage readings are detected between the positive battery post and ground (with - meter lead on ground).

Figure 303- 2



10. S&C 360 Ground Finder Instructions

10.1. Follow these instructions when using the S&C 360 Ground Finder.

10.2. NOTE: Never use the meter if the shorted lead reading in the "TEST" mode is greater than 23.0VDC.

Table 303-02

Step	Action
1	Check internal battery by setting to "TEST" mode and shorting the leads together. The meter should read between 22.2 and 23.0V. Replace the battery if less than 22.2V – repair the meter if greater than 23.0V.
2	Check tester operation by setting to "TEST" mode and shorting the leads together. The beeper should beep and the red LED should light and the meter should again read between 22.2 and 23.0V. If the Beeper and/or LED do not work the meter needs repair and cannot be used to perform the tests.
3	Move tester to "CONFIRM" mode and short the leads together. The meter should read greater than 8.0 mA. If the meter does not read greater than 8.0 mA the battery needs replacement or the meter needs repair and cannot be used to perform the tests.
4	Always confirm earth ground prior to beginning tests. Use a track wire as an alternate ground; the reading on the Ground Finder in the "TEST" mode should read between 22.2 and 23.0 VDC.

11. Disconnecting Wires

11.1. When performing these procedures do not open the circuits by disconnecting more than one wire at a time from the terminals, as indicated by *1 in the flow charts. Consult with the responsible Supervisory Officer in cases where it may be necessary to disconnect more than one wire at a time.

11.2. NOTE: Where mechanical disconnects are provided, such as test links, multiple circuits may be opened simultaneously.

12. Battery and Circuit Grounds, S&C 360 Ground Finder

12.1. Perform tests on energy busses only with AC on, then as indicated in this table with AC on, then on energy busses and all circuits leaving the entrance board with AC off, following the flow chart in Figure 303-03. Do not turn AC power off or on while the crossing is activated.

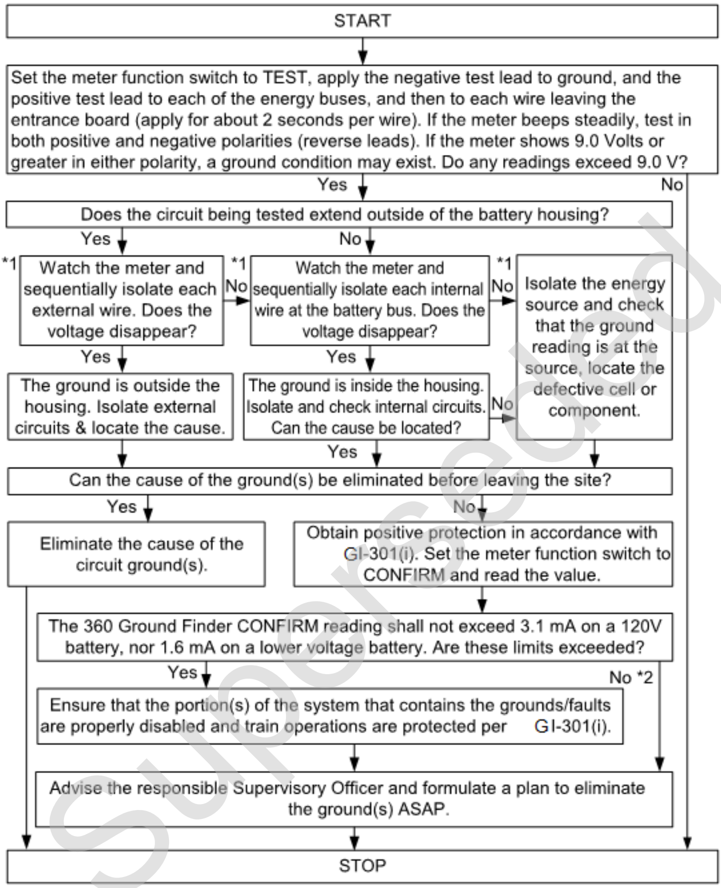
Table 303-03

If location has a…	Then perform additional ground test, by applying the meter between (+) & GND, and between (-) & GND, for the battery supplying energy to the device, with …
Power Switch	The switch machine: • In the normal position. • Traveling between normal and reverse. • In the reverse position.
Gate Mechanism	The gate mechanism: • In the up position. • Traveling between the up and down position. • In the down position.

13. Locating Battery and Circuit Grounds – S&C 360 Ground Finder

13.1. Use this procedure to locate grounds with an S&C 360 Ground Finder.

Figure 303- 3



13.2. Advise Metrolinx of the Ground and the Plan

13.3. *1 - Do not open circuits by disconnecting more than one wire at a time from the terminals unless equipped with test links or unless the Supervisory Officer has been consulted.

13.4. *2 - Consult S&C Distribution Company for equivalent CONFIRM value if the release value of any relay or electromagnetic device in the circuit is less than 4 mA.

14. Circuit Grounds, Conventional Meter

14.1. If using a conventional meter, grounds can only be measured for equipment that is connected to the battery bus at the time of the test. It is not practical to test all circuits due to the fact that all possible circuit configurations would have to be set up and tested individually. Perform the tests as instructed in Figure 303-04 with the AC power on and then off, and also as indicated in this table with AC off. Do not turn AC power off or on while the crossing is activated.

14.2. NOTE: Road Crossing Warning Systems shall be tested with the warning device activated.

14.3. Always confirm earth ground prior to beginning tests. For instance, verify that there is some voltage deflection on the meter when measuring between a DC track circuit lead and the ground test point.

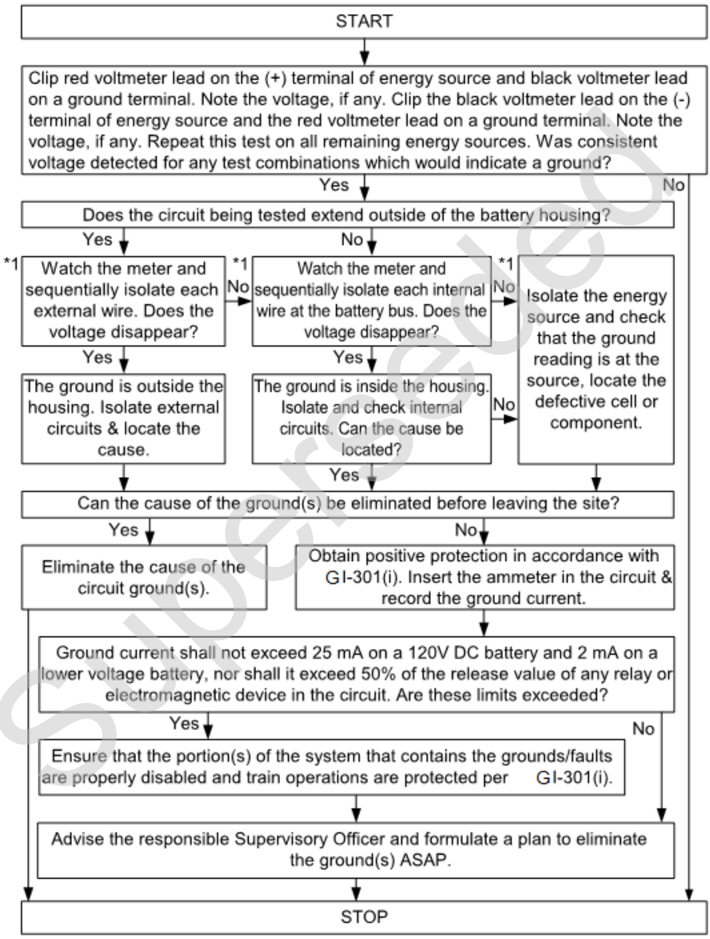
Table 303-04

If location has…	Then follow the battery ground test procedure (Section 15) …
Approach Lighting	With approach lighting circuits energized.
Power Switch	For the switch battery, with the switch machine: • In the normal position. • Traveling between normal and reverse. • In the reverse position.
Gate Mechanism	For the operating battery, with the gate: • In the up position. • Traveling between the up and down position. • In the down position.
A block with traffic normally lined, or can be lined in either direction	With the system in its normal state and traffic lined in one direction. If practical, repeat the test with traffic lined in the other direction. If it is not practical to reverse traffic at the time of the tests, make note of what direction was tested and attempt to do the tests with traffic lined in the other direction at the next test interval.
Cable that may have incurred some damage	Megger test the cable in accordance with GI-312 Wire and Cable Resistance. NOTE: If it is not possible to megger test immediately, circuit ground and battery isolation fault tests must be performed as an interim measure, with all used cable wires energized.

15. Locating Battery Grounds – Conventional Meter

15.1. Use this procedure to locate circuit grounds.

Figure 303- 4



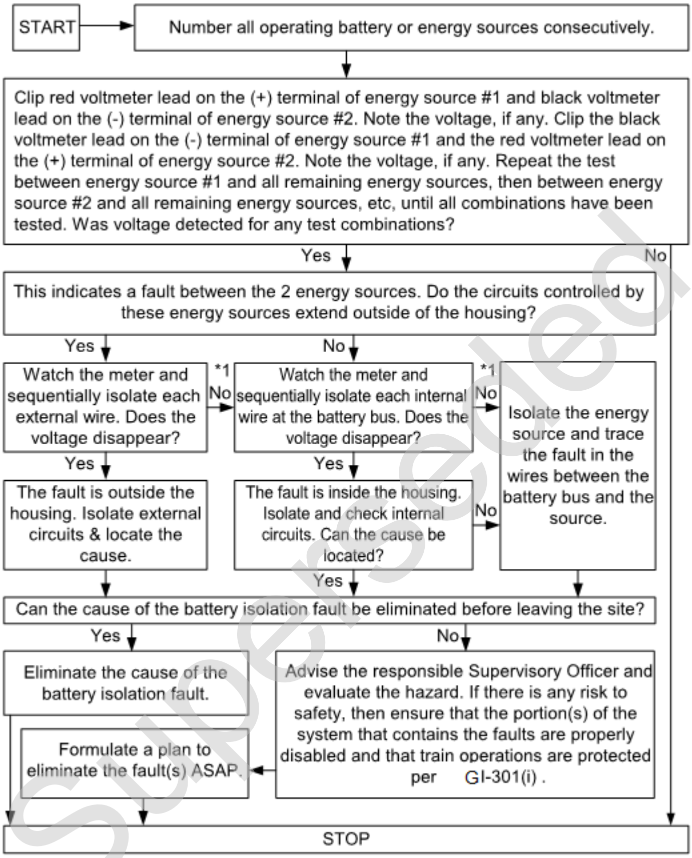
15.2. Advise Metrolinx of the Ground and the Plan

15.3. *1 - Do not open circuits by disconnecting more than one wire at a time from the terminals unless equipped with test links or unless the Supervisory Officer has been consulted.

16. Locating Battery Isolation Faults

16.1. Use this procedure to locate battery isolation. Perform test with AC on.

Figure 303- 5



*1 - Do not open circuits by disconnecting more than one wire at a time from the terminals unless equipped with test links or unless the Supervisor has been consulted.

16.2. Advise Metrolinx of the Ground and the Plan

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305(a) - Inspecting and Testing Storage Batteries – General

1. Purpose

1.1. To ensure that storage batteries are tested in a manner that will allow safe and reliable operation for the maximum life of the battery.

2. Test Interval

2.1. Storage batteries shall be tested when installed, as required by GI-310 Testing Highway Grade Crossing Warning Devices - General and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Personal Safety

4.1. The physical and chemical characteristics of primary batteries can pose a threat to personal safety if not handled properly. Refer to the S&C Codes of Practice, SCP-1401. Be safe and follow the instructions in this table when working with batteries.

Table 305(a)-01

Hazard	Remedy
Explosion	• Keep sparks and open flames away from batteries. • Discharge static electricity in your body to a made ground (if available) before working on batteries.
Body and Eyes	• Wear eye protection. • Wear protective insulating gloves and apron. • Keep clear water or eye solution on hand to wash away electrolyte that may come in contact with eyes or skin.
Accidental Shorting	• Keep electrically conductive tools, equipment and materials away from all battery terminal posts and buss conductors to avoid accidental shorting. • Wrenches and other tools used during maintenance procedures shall be insulated to prevent accidental shorting.

5. Battery and Charger Technologies

5.1. There are many types of batteries and chargers in use at Metrolinx, which are described in greater detail in SCP-1402. For purposes of this GI, it is important to remember that the most common types of batteries in use are Flooded NiCad, VRLA (Valve Regulated Lead Acid), and Flooded Lead Acid.

6. Battery Longevity

6.1. The life of a battery is affected by many variables, the most important of which are the frequency of deep discharges, fluctuation of temperature, and reliability of charger.

7. Visual Inspection

7.1. Follow the instructions in this table when visually inspecting batteries.

Table 305(a)-02

<table>
<tr><th>Inspect</th><th>Check</th></tr>
<tr><td>Electrolyte Level (Flooded NiCad and Flooded Lead Acid Batteries)</td><td>Electrolyte must always cover the plates. The electrolyte should be kept at maximum level so proper water to chemical ratio (specific gravity) will allow the battery to perform at maximum efficiency. Follow the instructions in this table.
<table>
<tr><th>If the battery …</th><th>Check electrolyte level ...</th></tr>
<tr><td>Does not have level indicator lines.</td><td>Covers the plates by no more than ¾ inch.</td></tr>
<tr><td>Has only one level indicator line.</td><td>Covers the plates by no more than ¾ inch and does not rise above the level indicator line.</td></tr>
<tr><td>Has minimum (lower) and maximum (higher) level indicator lines.</td><td>Ranges between the two lines but does not rise above the maximum line.</td></tr>
</table>
If water must be added, use only distilled water. Record amount of water added on Form 1205, unless otherwise directed.</td></tr>
</table>

Continued on next page

Inspect	Check
Battery Terminals	Check that battery terminals and/or lugs and connections are tight. VRLA terminals torque to 100 inch-lbs. Flooded Lead Acid terminals torque to 60 inch-lbs. Ni-Cd terminals torque to 264 inch-lbs.
Ventilation	Check that battery housing vents are open enough to let battery gas escape and fresh air enter. Check that vent filters are clean. Where fans are provided, ensure they are operational.
Corrosion	Check battery terminals and connections for corrosion. Keep terminals clean and repair any damage that may have been caused to connections.
Battery Case	Check the battery case is dry, clean and free of cracks and leaks.
Vent Caps	Check that battery vent caps are closed, clean and are only opened for servicing.
Battery Racks	Check that battery racks: • Are kept clean and dry. • Are arranged so batteries are level. • Are arranged so batteries are properly spaced and ventilated. Provided with rubber matting or trays that are in good condition.

Continued on next page

Inspect	Check
Corrosion Resistant Grease Or Battery Terminal Protector	Check that battery terminals, straps and exposed metal connections are covered with some approved type of corrosion resistant no-oxide grease or battery terminal protector. Avoid smearing grease on battery case. • NOTE: There are many different methods and types of protection in use today. The method used may depend on local conditions. Consult with the responsible Supervisory Officer for further advice.
Terminal Wire Tags	Check that wires connected to battery terminals are tagged with the battery name and terminal polarity as designated by the circuit plan.
Plate Deterioration (Lead Acid)	Check batteries with glass cases (Flooded Lead Acid) for cracked, buckled or broken plates and excessive amounts of sediment lying in the bottom of the case.
Polarity and Capacity	Check that proper polarity is observed for the desired battery configuration and whether all batteries connected in series are of the same ampere-hour capacity. Consult the Supervisory Officer if it is necessary to install cells with dissimilar ampere-hour capacity.

8. Rated Voltage

8.1. The following tables summarize typical rated cell charge and discharge voltages as adjusted for temperature for NiCad, VRLA, and Flooded Lead Acid batteries. It is advisable to use a stick-on thermometer, to indicate block temperature. *These tables are guidelines only* - since there are many brands of batteries in use at Metrolinx, it is advisable to consult the manufacturer's service manuals for more accurate specifications. Note that temperature conversions to Celsius are rounded to the nearest 5°C.

Table 305(a)-03

Ni Cad Battery Block Temperature		**Rated Charge Voltage** (Note 1) AC On	**Start Discharge Voltage** AC Off - 15 Minutes	**End Discharge Voltage** Deep Discharge
°C	**°F**			
-10	16	1.56	1.38	1.07
0	32	1.53	1.35	1.05
10	48	1.50	1.33	1.03
20	64	1.47	1.30	1.01
25	72	1.46	1.29	1.00
30	80	1.44	1.27	0.99
35	96	1.41	1.25	0.97

Table 305(a)-04

VRLA Battery Block Temperature		**Rated Charge Voltage** (Note 1) AC On	**Start Discharge Voltage** AC Off - 15 Minutes	**End Discharge Voltage** Deep Discharge
°C	**°F**			
-10	16	2.42	2.26	1.88
0	32	2.37	2.21	1.84
10	48	2.32	2.17	1.81
20	64	2.27	2.12	1.77
25	72	2.25	2.10	1.75
30	80	2.23	2.08	1.73
35	96	2.18	2.03	1.69

Table 305(a)-05

Flooded Lead Acid Battery Block Temperature		**Rated Charge Voltage** (Note 1) AC On	**Start Discharge Voltage** AC Off - 15 Minutes	**End Discharge Voltage** Deep Discharge
°C	**°F**			
-10	16	2.43	2.17	1.89
0	32	2.35	2.10	1.83
10	48	2.26	2.02	1.76
20	64	2.20	1.97	1.72
25	72	2.18	1.95	1.70
30	80	2.15	1.92	1.68
35	96	2.12	1.90	1.65

9. Battery Readings

9.1. Voltage readings shall be taken at the battery terminals.

9.2. NOTE: At the time of installation this test shall be performed after the battery has received its equalize charge and float charge has been established (refer to SCP-1402 for details on charging techniques).

Table 305(a)-06

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Measure and note the battery block temperature and the AC voltage to the charger of the battery to be tested.</td></tr>
<tr><td>2</td><td>Take a battery voltage reading with the AC power on and note this value as the battery charge voltage. Divide this reading by the number of cells to obtain the cell charge voltage, and record on Form 1205 unless otherwise directed.

<u>For VRLA batteries only:</u> measure individual cell voltages and verify they are within 0.10V of the cell charge voltage, otherwise consider replacing the cell(s). Banks with individual VRLA cells measuring very low voltages (less than 1.90V) require immediate replacement, particularly for crossing locations.</td></tr>
<tr><td>3</td><td>If the battery is charged with a constant voltage rectifier, proceed to Step 4, otherwise note the battery charging current.

<table>
<tr><th>For constant current rectifiers, if…</th><th>Then…</th></tr>
<tr><td>The cell charge voltage is within .03V of the rated charge voltage for the type of battery (after temperature adjustments).</td><td>The constant current rectifier does not require any adjustments. Proceed to Step 4.</td></tr>
<tr><td>The cell charge voltage is not within .03V of the rated charge voltage for the type of battery (after temperature adjustments).</td><td>Correct the constant current rectifier settings. Restart at Step 1.</td></tr>
</table></td></tr>
</table>

Continued on next page

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>4</td><td>

Disconnect the AC power to the charging circuit and allow the battery to discharge with normal current draw (crossing not operating) for 15 minutes.
Take a battery voltage reading and note this value as the start battery discharge voltage.
Divide the start battery discharge voltage by the number of cells to obtain the start cell discharge voltage.
Ensure the calculated cell discharge voltage is not more than .03V below the rated start discharge voltage (see tables). Note: It may be necessary to obtain specific manufacturer rated tables if the values are consistently out of range.
If these values are confirmed to be out of range for the brand of battery being tested, advise the responsible Supervisory Officer and consider performing a deep discharge test to verify actual battery capacity.

NOTE: When performing a deep discharge test, the battery must be discharged to the point where the average cell voltage is at the rated end voltage (see tables). Refer to SCP-1402.</td></tr>
</table>

Continued on next page

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>5</td><td>
<table>
<tr><th>If...</th><th>Then...</th></tr>
<tr><td>The battery is a single cell.</td><td>No other tests are required.</td></tr>
<tr><td>The battery is a 12V block battery (such as Marathon or AGV-PV).</td><td>No other tests are required.</td></tr>
<tr><td>The battery is a bank of cells.</td><td>Measure each individual cell voltage, and verify each is within 0.03V (NiCad) or 0.05V (VRLA, Lead Acid) of the start cell discharge voltage as calculated in Step 4.
If any cells vary by more than this amount, advise the responsible Supervisory Officer and consider performing a deep discharge test to verify actual battery capacity. Alternatively, consider equalizing the battery, then repeating test from Step 1.
NOTE: Always check electrolyte levels before and after applying an equalizing charge (for flooded batteries.</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Reconnect the AC power to the charging circuit.</td></tr>
</table>

305(b) - Storage Battery - No Stick Release Timer

1. Purpose

1.1. To shorten the interval for testing approach circuit storage batteries where stick release timers are not used at highway grade crossing warning systems.

2. Test Interval

2.1. All storage batteries feeding line or track approach circuits to a warning system, configured as described in this table, shall be tested in accordance with GI-305(a) Inspecting and Testing Storage Batteries - General at least once every month.

Table 305(b)-01

Test	Connected To	When there is ...
Track Battery	DC track circuits in dark territory	**No** Stick Release Timer at the Affected Crossing Warning System
Operating Battery	AC/DC (Style C) track circuits	
	Audio Frequency Overlay (AFO) track circuits	
	Line feeding an approach relay or device that functions as a relay in dark territory	

2.2. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Frequency Rationale

4.1. The possibility exists, in some approach circuit configurations, where the approach line or track relay, or device that functions as a relay may fail to restore after a train has trailed from the warning system track circuits. This sets up a lockout condition wherein the approach of another train in the opposite direction will not activate the warning system until the island track is reached. Increasing the frequency of tests will minimize the risk of line or track batteries becoming the cause of a lockout condition.

305(c) - Storage Battery - Load Current

1. Purpose

1.1. To ensure normal and load current are within the acceptable ranges.

2. Test Interval

2.1. Normal and load current shall be measured when installed, as required and after any circuit revisions are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Current Readings

4.1. Measure and record the normal and load current as instructed in this table.

4.2. NOTE: Current readings not required for track circuit batteries.

Table 305(c)-01

Current	System Status	Examples
Normal	Battery circuit(s) operating under typical load, with rectifier de-energized.	• Track circuit not shunted. • Warning device not operating. • Approach lighting signals not lit. • Switch machine(s) not operating.
Load	Battery circuit(s) operating under close to full load with rectifier de-energized.	• Track circuit shunted. • Warning device operating. • Approach lighting signals lit. • Switch machine(s) operating. NOTE: To achieve the most constant heavy load on a switch machine operating battery bank it may be beneficial to obstruct the switch so the machine draws maximum current over a longer period of time.

307 - Inspecting and Testing Recording Devices

1. Purpose

1.1. To ensure that recording devices are functioning properly at all times. These devices can either be a printed circuit board installed in a chassis or a standalone piece of hardware that is meant for data recording only.

2. Test Interval

2.1. Recording devices and associate equipment shall be inspected when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. All Recording Devices

4.1. Perform these checks on microprocessor based data recorders. In some cases, this test may be performed remotely from a central office, for which the Maintainer may record the test as complete after verifying operation with the Network Operations Centre (NOC).

4.2. Such parts that are not in good condition or not operating properly shall be promptly repaired or replaced.

Table 307-01

Inspect	Check
Date and Time	Check the date and time is accurate and adjust if necessary.
Daylight Savings	Check that daylight savings is selected according to the design plans.
Operation	Check the last recorded entry and ensure data is being properly logged.
Download	Check that a log of recorded events can be downloaded.
Inputs	Check the latest downloaded log of recorded events and verify that all of the inputs are receiving data.
Backup Battery	Check the internal backup battery, if equipped, to make sure it is still functioning correctly per the manufactures instructions. For SEAR II and SEAR IIi recorders the backup battery should be replaced every two years during operation or after two months of being powered off.

5. Crossing Recording Devices

5.1. At time of installation, generate a log of recorded events and verify the inputs are correct. A soft or hard copy of this output shall be retained by the Supervisory Officer for a minimum of one (1) year.

308(a) - Inspecting and Testing Electric Locks – General

1. Purpose

1.1. Electric locks shall be routinely inspected and tested to ensure they are in suitable working conditions.

2. Test Interval

2.1. Electric locks shall be inspected and tested when installed, as required and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. General Inspection

4.1. Perform a general inspection of the electric lock housing, electrical components and mechanical equipment as directed in this table.

Table 308(a)-01

Inspect	Check
Housing Door Locks	Check the Trainman's compartment door and Maintainer's compartment door are provided with the proper locks are in good working order.
Door Contact Plunger	If so equipped, check for proper pressure on door contact plunger to prevent the movement of the armature when the door is closed.
Lubrication	Check that mechanical moving parts are properly lubricated in accordance with manufacturer's instructions.
Electric Lock Housing	Check for cracks or other damage that may affect the operation of any part of the electrical or mechanical components.
Housing Door Gaskets	Check the door gaskets on the Trainman's compartment and the Maintainer's compartment are properly placed and in good condition. If door hinge adjustments are provided, ensure they are properly adjusted.
Electrical Contacts	• Check that all electrical contacts are free of dirt, grease and corrosion. • Check contact surfaces for excessive wear. • Check roller cams for excessive wear and movement.

5. Switch Lock Test

5.1. Follow the instructions in this table to ensure the electric lock is mechanically locking the switch points.

Table 308(a)-02

Step	Action	Check
1	Unlock and open the Trainman's compartment door on the electric lock housing.	The banner indicates, "LOCKED".
2	Unlock the switch stand handle and attempt to open the switch with the electric lock in the locked position.	The mechanical locking device prevents the switch from operating.
3	Ensure the electric lock is not conditioned to unlock (i.e. shunt the approach track, traffic not lined). Attempt to unlock the electric lock by moving the operating handle from its normal position to the request position.	The operating handle cannot be moved beyond the intermediate position, and the electric lock does not unlock.
4	Attempt to open the switch.	The mechanical locking device prevents the switch from operating.
5	Condition the electric lock to unlock (i.e. shunt the release track, line traffic).	After about 2 seconds, the banner moves from "LOCKED" to "UNLOCKED".

Continued on next page

Step	Action	Check
6	Continue to move the operating handle counter-clockwise.	The operating handle moves to its full reverse position.
8	Inspect the lock rod.	• Check for damage. • Check the edges of the plunger hole for excessive wear.
9	Restore the switch to its normal position and move the electric lock operating handle to its normal position.	• Check for damage. • Check jam nuts are tight. • The electric lock operating handle moves freely to its normal position. • The banner indicates, "LOCKED". • The plunger extends fully through the lock rod hole.
10	Attempt to open the switch.	The mechanical locking device prevents the switch from operating.
11	Close and lock the Trainman's compartment door.	The system is restored to normal.

308(b) - Electric Lock – Electrical

1. Purpose

1.1. Electric locks shall be routinely inspected and tested to ensure they are in suitable working conditions.

2. Test Interval

2.1. Electric locks (except force drop type) shall be electrically inspected and tested when installed, as required and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Other Requirements

4.1. Tests shall be made electrically, and observation or measurement made of mechanical clearances to maintain values within prescribed limits for field service. Locks that fail to meet such requirements shall be promptly repaired or replaced.

5. Force Drop Type

5.1. Most electric locks in use at Metrolinx are of the force drop type, for which no periodic electrical testing is required. Examples of force drop type electric locks include Ansalso(US&S) models SL-20, SL-21, SL-21A, SL-25, SL-26 and Alstom(GRS) models 9B and 10A.

6. Switch Lock Test

6.1. Perform the general inspection and switch lock tests as prescribed by GI-308(a) Inspecting and Testing Electric Locks - General.

7. Switch Lock Electromagnetic Equipment

7.1. Perform electrical tests on the switch lock electromagnetic equipment in accordance with GI-323(b) Relay Electrical. Refer to manufacturer's specifications for the values of the switch lock electromagnetic equipment.

309 - Testing Ground Resistance

1. Purpose

1.1. To ensure that ground rods or grids, wires and connections provide a sufficiently low resistance path to ground.

1.2. NOTE: These tests should only be performed in dry weather.

2. Test Interval

2.1. Ground resistance tests shall be performed when installed, as required and at least once every ten (10) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

2.2. NOTE: The test does not apply at locations that only have a primary battery installed.

3. Train Safety

3.1. If inspections or tests interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Personal Safety

4.1. The grounding system at a location where there is an AC power service should be considered as electrically "LIVE" unless the system is positively known to be otherwise. Care must be exercised at any time when connecting or disconnecting a made ground or any part of a grounding system. Leakage through arrestors or transformers connected to AC supply lines may cause the voltage on the disconnected grounding system to reach dangerous levels.

5. Direct Reading Testers

5.1. A direct reading ground resistance test meter, such as the Three Point Vibroground, or approved substitute having a self-contained source of energy with a range of at least 0 to 300 ohms shall be used to perform these tests, unless an approved clamp-on tester is used. Manufacturer's instructions for using the instrument must be followed.

6. Clamp-On Testers

6.1. Clamp-on ground meters operate by inducing a current through the ground network, and performing an Ohm's law calculation on the loop resistance. At least two ground rods must be present in the network for this method to work. Note that the utility ground may suffice as the second ground rod for this purpose.

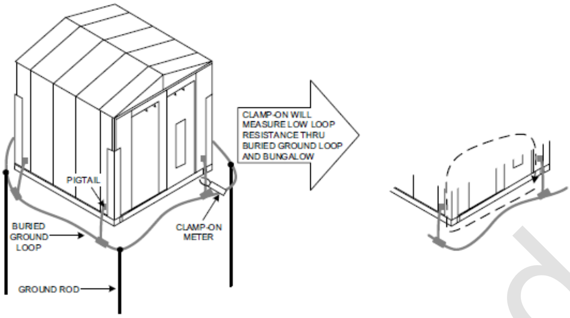
6.2. The ground measurement result will have both ground rod resistances added since this constitutes a series network. For this reason, the actual ground rod value will always be better than the measured result, so long as correct procedures are adhered to. The ground resistance value for maintenance use purposes shall preferably not exceed 25 ohms.

6.3. Clamp-on meters <u>shall NOT</u> be used if a buried copper ground loop is bonded to the house at more than one point and which cannot be detached, unless a measurement can be made on the earth side of the buried ground loop. Refer to the following illustrations.

7. Clamp on Meter Incorrect

7.1. The following illustrates the improper use of a clamp-on ground meter. Note that a low reading will be registered through the buried ground loop and the bungalow itself. The ground rod resistance is not measured at all.

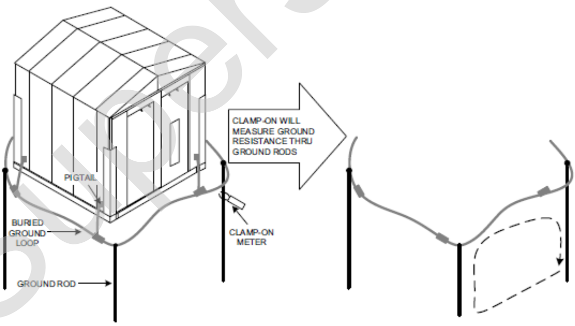
Figure 309-01



8. Clamp on Meter Correct

8.1. The following illustrates the proper use of a clamp-on ground meter. Note that the ground rod paths are effectively measured since the induced current must travel through at least two ground rods to return to the meter.

Figure 309-02



9. Made Ground System – Visual Inspection

9.1. Follow the instructions in this table when performing a visual inspection of all visible parts of a made ground system, where it is practical to do so. All ground wire connections must remain visible or accessible via ground rod well box cover.

9.2. NOTE: The various configurations of made ground systems, from the ground rod to the prime ground bus, are shown in diagram form in SCP- 1102. The portion of the system from the prime ground bus to the equipment is shown in the location circuit plan.

Table 309-01

Inspect	Check
Ground Rod Wire Connections	Check the wire connection(s) to the rod(s) are secure and free of significant damage or corrosion.
Ground Wire Connections on Poles	Check terminations and/or connectors are tight and free of damage and corrosion.
Ground Wires	Check that exposed ground wires are: • Not damaged. • Free of sharp bends or loops.

10. Allowable Ground Resistance Limits

10.1. This table indicates the recommended maximum allowable ground resistance limits at the time of installation and at the time of periodic inspection. If these limits are exceeded and cannot be lowered to an acceptable level in accordance with instructions contained in SCP- 1102, then the responsible Supervisory Officer must be advised.

Table 309-02

Type of Location	Recommended Allowable Ground Resistance	
	Time of Installation	Periodic Inspection
Power Services (main)	10 ohms	25 ohms
S&C Housings	15 ohms	
All Other Locations	25 ohms	

11. Direct Reading Test - Location with Prime Ground Bus

11.1. Follow the instructions in this table when performing the ground resistance test with a direct reading ground resistance test meter.

Table 309-03

Step	Action
1	Disconnect the ground wire(s) at the instrument housing prime ground bus in accordance with instructions in SCP-1102. NOTE: this may temporarily affect the operation of equipment that requires a ground to operate.
2	Connect the test instrument to the ground wire(s), which is connected to the ground rod(s), and follow the instructions contained in the test instrument manufacturer's manual to attain the ground resistance reading. EXCEPTION: Where the test is required at a pole, the test instrument may be connected to the ground wire on the side of the pole.

Continued on next page

Step	Action
3	Reconnect all terminations after the test results have been attained.

12. Direct Reading Test - Location Without Prime Ground Bus

12.1. Follow the instructions in this table when performing the ground resistance test with a direct reading ground resistance test meter at a location not equipped with a prime ground bus.

Table 309-04

Step	Action
1	Isolate the service by opening the first control device upstream from the load center, by locking it and then applying a DO NOT OPERATE tag. Ensure there is no energy at the load center.
2	Disconnect the ground and neutral wires in the load center or surge device enclosure in accordance with instructions in SCP-1102. NOTE: this may temporarily affect the operation of equipment that requires a ground to operate.
3	Connect the test instrument to any exposed ground rod, or wire leading up to ground rod, and follow the instructions contained in the test instrument manufacturer's manual to attain the ground resistance reading.
4	Reconnect the ground and neutral wires in the load center or surge device enclosure.
5	Remove the DO NOT OPERATE tag, unlock and close the control device. Ensure AC power is restored.

13. Clamp on Meter Test

13.1. Follow the instructions in this table when performing the ground resistance test with a clamp-on ground resistance test meter.

Table 309-05

Step	Action
1	Ensure there is more than one ground rod within the grounding network, including service utility grounds. If not, the direct reading method must be used. NOTE: Multiple ground rods located closer than 12 inches to each other should be considered to be a single rod cluster, and as such only one reading can be taken on the cluster.
2	Clamp the test instrument around any ground rod, or around any of the ground wires leading directly to a ground rod, ensuring: • there are no copper bonding points linking the rod/conductor and housing in • between the clamp-on point and earth ground, and • there are not multiple ground conductors at the clamp-on point.
3	Follow the instructions contained in the test instrument manufacturer's manual to attain the ground resistance reading.

Continued on next page

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>4</td><td>
<table>
<tr><th>If the measured reading is…</th><th>Then…</th></tr>
<tr><td>Less than the allowable resistance.</td><td>Record the result. No further testing is required.</td></tr>
<tr><td>Higher than the allowable resistance.</td><td>If additional rods (beyond 2) exist, take one additional reading on the furthest rod, while complying with the conditions in Step 2. Calculate the total resistance by treating both measured resistances in parallel:
$1/R_T = 1/R_1 + 1/R_2$
If the calculated value is still too high, it may be necessary to use the direct reading method.</td></tr>
</table>
</td></tr>
</table>

14. Recording Results

14.1. Measured values shall be recorded in SCIS in the test result field provided. Create a Service Notification as required when results are higher than the allowable limits, and a remedy cannot be readily applied.

310 - Testing Highway Grade Crossing Warning Devices – General

1. Purpose

1.1. This General Instruction contains a variety of testing procedures that are very closely related to one another. The instructions state clearly how and what individual tests must be performed; sequencing and efficient planning of the testing process is left to the discretion of the person performing the tests.

2. Test Interval

2.1. Highway grade crossing signal equipment shall be inspected and tested when installed, modified, and as required. Results shall be recorded in SCIS in accordance with instructions. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Accident, Failure, Damage

4.1. When an automatic highway grade crossing warning system or device fails to operate properly or is damaged, protection shall be provided promptly and maintained until necessary repairs are made. Refer to the Metrolinx Investigating Signal Related Accidents, Incidents, & Failures Protocol in the event of any incident involving a highway grade crossing warning system.

5. Testing Index

5.1. This index outlines all interval tests applicable for a typical grade crossing warning location.

Table 310-01

GI #	Periodic Test	Interval
By Maintainer		
310(a)(0)	Crossing Performance Test	Weekly
310(a)(2)	Battery & Ground Test (Storage)	01M
310(a)(4)	AC and DC Mode Test	
310(a)(5)	Lights, Signs	
310(a)(6)	Bell	
310(a)(7)	Gates	
310(a)(8)	AC Voltage (AC/DC lit)	
310(a)(9)	Controlling Devices	
310(e)	CW/MS Devices	
310(b)(2)	Preemption & AAWS	
310(b)(3)	IJ's and Track Connections	03M
310(b)(4)	Cut-Out Circuits	06M
307	Recording Devices	
310(c)(1)	Flash Rate	12M
310(c)(2)	Flasher Device	
310(c)(3)	Gate Mechanisms	
310(c)(4)	Light Alignment	
310(c)(5)	Lamp Voltage	
310(c)(6)	Battery Load Test	
310(c)(7)	Warning Time	
310(c)(8)	Approaches with MS/CW	
301(f)	Condition of Plans	12M

Continued on next page

GI #	Periodic Test	Interval
By Maintainer		
331	Timing Equipment	12M
333(a)	Track Circuits	
302	Cable Housings	
By Inspector		
310(d)	Hold/Clear Electrical	48M
323(b)	Relay Electrical	
323(b)(1)	Flasher Relay	
323(b)(2)	PO Relay	
335(a)	Vital Software Configuration	
335(b)	Vital Hardware Configuration	
309	Ground Resistance	120M
312	Wire & Cable Resistance	
313	Lightning Arresters	Frequently

310(a)(0) - Inspection and Testing of Crossing Warning Devices (Log Book)

1. Purpose

1.1. This General Instruction is to ensure that crossing warning systems are intact and functioning as intended.

2. Test Interval

2.1. Crossing warning devices shall be inspected and tested weekly. Results shall be recorded in the Crossing Warning System Performance Report Log Book. Refer to GI-301(h) Inspection and Test Intervals for test interval.

3. Train and Public Safety

3.1. The normal functioning of any crossing warning system shall not be interfered with when testing or otherwise without first taking adequate measures to protect the safety of the public and highway traffic that depend upon the normal operation of such systems. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Testing

4.1. The employee assigned to undertake the test will, when road and railway traffic permits, manually operate the rail crossing warning system with the test switch.

4.2. The following checks and observations are required:

a. Observe warning features such as lights, bells and the movement of gates function properly, are intact and positioned to protect highway traffic.

b. Check for broken or damaged lenses and ensure they are not obstructed by debris or snow.

c. Check the signage such as cross bucks and number of tracks signs are intact and fastened properly.

d. Check the structures such as piers and masts are not damaged and are secure.

e. Check the power-off light is on and not flashing.

5. Accident, Failure, Damage

5.1. When an automatic crossing warning system or device fails to operate properly or is damaged, protection shall be provided promptly and maintained until necessary repairs are made. Refer to CROR 103.1(h) and SCP-701 Procedures to be Followed by S&C Personnel in the Event of an Incident Involving a Highway Grade Crossing Warning System.

6. Non-Compliance

6.1. The result shall be considered unsatisfactory if any of the following circumstances are noted for the prior weekly period:

a. The Crossing Warning System Performance Log Book is missing or illegible

b. The test has not been signed-off once each calendar week (Sunday00:01 to Saturday 23:59) or

c. The test has not been signed-off in accordance with this GI.

6.2. If any employee finds the Crossing Warning System Performance Log Book missing or illegible, the employee shall inform Metrolinx and obtain a Log Book. If an employee finds the tests have not been signed off as per instructions, the employee shall inform Metrolinx. In all cases, the employee shall complete the test and sign the Crossing Warning System Performance Log Book.

7. Recording Results

7.1. Record results of the test in the Crossing Warning System Performance Log Book.

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310(a)(2) - Battery & Ground Test (Storage Battery)

1. Purpose

1.1. To ensure adequate battery capacity at the crossing location in the event of a power failure and to verify that no circuit grounds exist on the battery.

2. Test Interval

2.1. Inspections and tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

2.2. NOTE: The testing frequency of this GI is an exception to GI-303 and 305(a) on account of the safety critical role of crossing warning batteries. The operating battery that supplies energy to operate the warning lights, bells, and gates shall be tested at least once a month.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Inspect and test operating and control (O&C) storage batteries in accordance with GI-305(a) Inspecting and Testing Storage Batteries - General. Test for circuit grounds and battery isolation faults in accordance with GI-303 Testing for Grounds & Battery Isolation Faults.

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310(a)(4) - AC and DC Mode Test

1. Purpose

1.1. To ensure that the power transfer between AC and DC modes and test switch functions as intended and the warning device operates in both AC and DC modes.

2. Test Interval

2.1. AC and DC mode tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. AC Levels

4.1. Why are AC voltage levels important at these locations?

a. Significant variations can damage equipment.

b. Improper charging levels may occur.

c. Low AC levels at locations where the lighting circuitry uses a power off relay (POR) without a stick contact may cause the relay contacts to hang midway, cutting energy to the lamps.

5. Power Service Load

5.1. If significant changes are made to the loading of the AC power service, voltage readings shall be taken while batteries are recovering from load testing as described in GI-310(c)(6) Battery Load Test and with all systems operational, to simulate a worst case loading. If modifications are required to bring voltage levels to an acceptable level, they shall be done as soon as practicable. Report the problem to power supplier, the responsible Supervisory Officer and Metrolinx.

6. Test Procedure

6.1. This table describes how to test the warning device in AC and DC mode. Verify the source voltage is within range (108-125VAC or 216-250VAC).

6.2. IMPORTANT: Never turn AC power off or on while the crossing is activated.

Table 310(a)(4)-01

<table>
<tr><th>With AC power ...</th><th>Activate</th><th>Check operation of ...</th></tr>
<tr><td>On</td><td rowspan="2">Test Switch</td><td rowspan="2">• All gate and mast lights.
• Bell(s).
• Gates
• Power off indication light.</td></tr>
<tr><td>Off</td></tr>
</table>

6.3. NOTE: Ensure power is on before leaving the crossing.

310(a)(5) - Lights, Signs

1. Purpose

1.1. To ensure that lights and signs are maintained in a fashion that affords maximum visibility of the warning device for all possible environmental conditions.

2. Test Interval

2.1. Inspections and tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. This table explains how to check visibility and condition of lights and signs.

Table 310(a)(5)-01

Step	Perform this task…	Then do this…
1	Clean light outer roundels, sidelights, reflectors and lamps with a mild cleaning solution and soft cloth or towel as often as is necessary.	• Check for cracks or damage. • Observe that lens deflection/spread is correct and in proper alignment.
2	Clean all signs as often as is necessary.	• Check that signs are visible to approaching traffic. • Replace or repair signs as necessary.
3	Remove any object on Railway property that may obstruct the lights and/or signs from road traffic.	• Check the obstruction removal has improved sightlines. • Report any significant obstructions within the road approach that cannot be removed to the responsible Supervisory Officer.
4	Start the warning device.	• Check the lights for visibility and brightness.

5. Recording Results

5.1. Record the pass or fail of the inspections for the lights and signs in SCIS.

310(a)(6) – Bell

1. Purpose

1.1. To ensure the bell operates in a manner that will adequately warn pedestrian traffic when the warning device is activated.

2. Test Interval

2.1. Inspections and tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. This table explains how to perform the bell operation test. An adjustable bell circuit will have a variable resistor in series with the bell.

Table 310(a)(6)-01

Step	With the AC power…	Proper Operation
1	On and the battery bank controlling the bell fully charged. Does the sound of the bell meet the requirements of proper operation? • If yes, continue with step 2. • If no, continue with the applicable Bell Circuit Tuning Procedure.	The bell shall operate between 100 and 325 strokes per minute and clapper strokes shall be so timed that no one sound wave is broken up by subsequent waves. It shall be audible to pedestrian traffic approaching the immediate area of the crossing.
2	Off and the battery bank voltage leveled off after about 5 minutes. Does the sound of the bell meet the requirements of proper operation? • If yes, restore the AC power and stop the test here. • If no, continue with the applicable Bell Circuit Tuning Procedure.	The bell shall operate between 100 and 325 strokes per minute and clapper strokes shall be so timed that no one sound wave is broken up by subsequent waves. It shall be audible to pedestrian traffic approaching the immediate area of the crossing.

5. Adjustable Bell Circuit Tuning Procedure

5.1. At the time of installation or whenever it becomes necessary to make adjustments to the bell circuit or to the mechanical part of bells so equipped, follow the instructions in this table.

5.2. NOTE: Ensure the operating battery bank is fully charged before starting.

Table 310(a)(6)-02

Step	Action
1	Set the variable resistor in the instrument housing to its minimum resistance value. Ensure the bell operates properly.
2	Check the voltage at the bell terminals and compare that reading to the bell's rated operating voltage. Is it too high? • If yes, go to step 3 • If no, go to step 4.
3	Adjust the variable resistor so the voltage is at the upper rating for the bell. Ensure the bell operates properly.
4	Shut the AC power off, and allow the battery bank voltage to level off for about 5 minutes.
5	Set the variable resistor to reduce the bell voltage by at least 0.5 volts. Ensure the bell operates properly. Does the bell have mechanical settings? • If yes, go to step 6. • If no, go to step 7.
6	Make the mechanical adjustments so the bell operates properly.
7	Restore the resistor to the setting it was before step 5. Turn on the AC power and wait for the battery bank to restore to full voltage. Ensure that the bell operates properly.

6. Non-Adjustable Bell Circuit Tuning Procedure

6.1. At the time of installation or whenever it becomes necessary to make mechanical adjustments to the bell, follow the instructions in this table.

6.2. NOTE: Ensure the operating battery bank is fully charged before starting.

Table 310(a)(6)-03

Step	Action
1	Check the voltage at the bell terminals and ensure that it is within its rated operating range. Does the bell have mechanical settings? • If yes, go to step 2 • If no, go to step 3.
2	Make mechanical adjustments so the bell operates properly.
3	Shut the AC power off, and allow the battery bank voltage to level off for about 5 minutes. Ensure the bell operates properly.
4	Restore the AC power.

310(a)(7) – Gates

1. Purpose

1.1. To ensure the gates are clearly visible to road traffic and they operate as intended.

2. Test Interval

2.1. Gates shall be inspected and tested when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Equipment Manuals

4.1. A copy of the gate mechanism manufacturer's manual must be accessible to be used as a maintenance and testing reference.

5. Hold Clear Device

5.1. Should it become necessary to replace the hold clear device, or make adjustments which could affect the electrical values of the hold clear device, the responsible Supervisory Officer and Metrolinx must be advised prior to the change.

6. Gate Clearance

6.1. Ensure gate clearances for all new installations meet the requirements of the S&C Codes of Practice SCP-704.

7. Torque

7.1. Vertical and horizontal gate arm torque must be checked each time gates are replaced and when repaired, if the repairs affect the weight distribution of the gate arm. The torque adjustment values shall not exceed the gate mechanism manufacturer's recommendations.

8. Test Procedure

8.1. Follow the procedure in this table to check the gates.

Table 310(a)(7)-01

Gate	Check
Movement	Check the gate arms operate uniformly, smoothly and complete all movements without rebound or slap, and are securely held when in the raised position.
Descent Time	Check that the gates start their downward motion after the appropriate descent delay time and that they assume the horizontal position within designed decent time after the signal lights start to operate. Gates failing to meet these requirements shall be adjusted to the design electrical and torque specifications.
Condition	Ensure the gate arm extends across at least 90% of each approaching lane of traffic. Check that the gate arm is not less than 42 inches or more than 54 inches from the crown of the highway surface. Check the condition of the gate arm striping to ensure it is not excessively faded or damaged, and there is not a mixture of vertical and horizontal striping.
Lubrication	Check lubrication of the gate mechanism in accordance with manufacturer's instructions. Ensure the mechanism housing and gate shaft bearings are kept moisture free. Check for signs of rust.
Obstruction	Check for and remove any obstructions that may interfere with the movement of the gates.

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310(a)(8) - AC Voltage (AC/DC Lit)

1. Purpose

1.1. To ensure the crossing will allow safe and reliable operation when either AC or DC lit.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. AC Levels

4.1. Why are AC voltage levels important at these locations?

a. Low levels at locations where the lighting circuitry uses an AC lighting transformer with a power off relay (POR) having no stick contact, may cause the relay contacts to hang midway, cutting energy to the lamps.

b. Low levels may cause lamps to operate at less than 90% rated voltage.

c. Significant variations can damage equipment.

5. Power Service Load

5.1. If significant changes are made to the loading of the AC power service, voltage readings shall be taken while batteries are recovering from load testing as described in GI-310(c)(6) Battery Load Test and with all systems operational, to simulate a worst case loading. If modifications are required to bring voltage levels to an acceptable level, they shall be done as soon as practicable.

6. AC Test Procedure

6.1. This table explains how to perform the AC test.

Table 310(a)(8)-01

<table>
<tr><th>With AC power on and…</th><th>Take AC voltage readings at…</th></tr>
<tr><td>Warning device operating</td><td rowspan="2">The input terminals of the lighting transformer (if applicable) and;
• At the last battery charger in the power loop where all chargers are wired in parallel;
OR
• Each charger, where the chargers are not wired in parallel.</td></tr>
<tr><td>Warning device not operating.</td></tr>
</table>

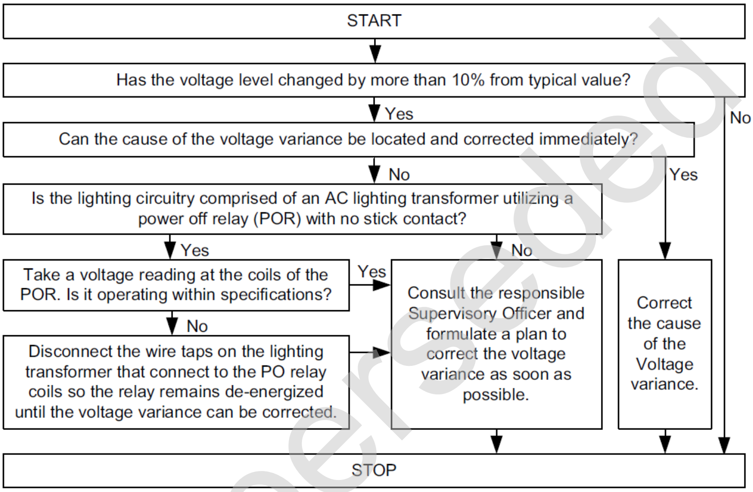
7. Power Off Relay Taps

7.1. At the time of installation and whenever changes are made to the taps on a lighting transformer, ensure the taps to the coils of the power off relay are set to a voltage as close as possible to the rated voltage of the relay.

8. AC Test Results

8.1. This chart explains what to do if the results of the AC test are unacceptable. Typical AC levels should range from 108 to 120 Volts. Slightly more or less may be acceptable, depending on local conditions.

Figure 310(a)(8)-01



310(a)(9) - Controlling Devices

1. Purpose

1.1. To ensure that all or part of the equipment in the warning system has not been rendered inoperative by the testing process and that the warning device is in its normal resting state before leaving the site.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Whenever possible, while performing tests at a crossing warning system, observe the operation of the system during an actual train movement and ensure it functions as intended. After all tests are completed follow the instructions in this table.

Table 310(a)(9)-01

Check that all ...	Are ...
Test Points	Closed. Ensure that all test links (gold nuts) are double nutted. Gold nuts must be of the approved gauge.
Lighting Arresters	Installed and in good condition in accordance with GI-313 Inspecting Lighting Arresters.
Controlling Devices	In a normal resting state. Examples: • Track relays, AFO, MS/GCP indicate Tracks unoccupied. • Stick relays are down. • Circuit controllers are normal. • Cutout circuits are not enabled.
AC Switches and Breakers	On and the power off indication light is lit.
Warning Lights, Bell(s) and Gates (when applicable)	Operational when the test switch is open, with AC Power On and Off. NOTE: To eliminate duplication of tests, perform GI-310(a)(4) AC and DC Mode Test in conjunction with this test.
Instrument Housings	Closed and locked.

310(b)(2) - Pre-emption and Active Advance Warning Signs (AAWS)

1. Purpose

1.1. To ensure that active advance warning signs and/or highway traffic signals are being activated on the approach of trains.

2. Test Interval

2.1. Contacts or devices interconnected with the control of highway traffic signals and Active Advance Warning Signs (AAWS) shall be inspected when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Definition

4.1. These definitions explain the difference between the two types of control used between highway grade crossing warning and highway traffic signal systems.

Table 310(b)(2)-01

Term	Definition
Simultaneous Pre-emption	Notification of an approaching train is forwarded to the highway traffic signal controller upon activation of the grade crossing warning system.
Advance Pre-emption	Notification of an approaching train is forwarded to the highway traffic signal controller for a period of time prior to activation of the grade crossing warning system.

5. Test Procedure

5.1. Activate the controlling device in the highway grade crossing warning system, which in turn activates the highway traffic signals and/or the active advance warning signs. Observe that these traffic signals and/or signs operate as intended. If the road authority has maintenance responsibility for the traffic signals and signs it may be necessary to have their representative on site to assist with the tests and perform maintenance and repairs as required.

6. Malfunction During Testing

6.1. If, in the course of performing these tests, or while investigating a trouble call at the crossing, a problem is discovered with the operation of the preemption or AAWS, Metrolinx, the Supervisory Officer and Road Authority shall be immediately advised, and a plan shall be developed to ensure train and roadway safety at the crossing.

7. Malfunction at Time of Installation

7.1. If the preemption or AAWS cannot be proven to work as intended at time of the road crossing warning system installation, the Road Authority shall be immediately advised, and the warning system shall not be placed in service until a plan is in place to ensure train and roadway safety at the crossing. This plan must be developed by consultation of the responsible Supervisory Officer with Metrolinx.

310(b)(3) - IJ's and Track Connections

1. Purpose

1.1. To ensure that track connections and insulated joints do not deteriorate to the point where they may cause failure of the warning device.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every three (3) months. Refer to GI-301(h) Signal System Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Perform visual inspections of bond wires, track connections, and insulated joints as prescribed in GI-332(a) Track Hardware – Visual Inspection and if conditions warrant, perform electrical tests in accordance with GI-332(b) Track Hardware – Electrical Tests.

5. Track Connection Cables

5.1. It is always more desirable to maintain a low resistance connection from the rail bond to the device at the other end. This is especially true of termination shunts and insulated joint couplers because of their sensitivity to high resistance connections. Install and maintain these devices so that the number of splices, between the device and the bond wire is kept to a minimum.

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310(c)(1) - Flash Rate

1. Purpose

1.1. To ensure the warning device lights alternate at a steady, consistent pace in order to provide maximum intensity and clarity to vehicular and pedestrian traffic.

2. Test Interval

2.1. Flash rate test shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. This table explains how to perform the flash rate test.

Table 310(c)(1)-01

Action	On warning systems	Flashes per minute*	Observe that…
Start the warning device and count the number of times that a set of lights alternates from one light unit to the other.	Prior to May 18, 1983	Not less than 30 nor more than 50. EXCEPTION: Not less than 45 nor more than 65 at locations designed to operate within these limits.	Light units flash alternately and that each remains lit approximately the same length of time during the entire operating time of the signal.
	After May 18, 1983	Not less than 45 nor more than 65.	

*Ensure flash rate is within relay design specifications.

5. Standby Flasher

5.1. The flash rate test shall also be performed on all standby flasher(s).

6. Flash Rate Failure – Flasher Relay

6.1. If the flash rate fails to meet the requirements of the test procedure, check the voltage at the coils of the flasher relay to determine if it satisfies the voltage rating of the relay. Adjust the flash rate or replace equipment as may be necessary.

7. Flash Rate Failure – Solid State Flasher or SSCC

7.1. If the flash rate fails to meet the requirements of the test procedure, check and adjust the programmed rate in the device. Replace equipment as may be necessary.

8. Equipment Replacement

8.1. If it becomes necessary to change equipment that requires wiring to be temporarily disconnected, and in doing so the integrity of the vital circuitry may be compromised, the responsible Supervisory Officer and Metrolinx must be advised prior to the change.

310(c)(2) - Flasher Device

1. Purpose

1.1. To ensure that at least one light is lit on each signal in the event that the flasher relay fails to operate while a train is approaching the crossing.

2. Test Interval

2.1. Flash device test shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. This table explains how to perform the flasher relay tests. This test is not applicable to solid state flashers and SSCC's.

Table 310(c)(2)-01

Step	Action
1	Start the warning device.
2	Open the circuit to the coil of the flasher relay. Examples: • Open the flasher relay disconnect terminal. • Remove one wire from the coil of a shelf type relay. • Open the "E" post on the Alstom(GRS) plug-in type relay. • Insert an extractor into the test point of the Ansalso(US&S) plug-in type relay.
3	Observe that one lamp on each crossarm, in each direction, (on crossarms so equipped), and one lamp on each gate other than the tip light (on warning devices so equipped), is steady lit. NOTE: The gate tip light will always remain steady lit.
4	Close the circuit to the coil of the flasher relay.
5	Observe that all lights are synchronized, alternating and functioning properly.

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310(c)(3) - Gate Mechanisms

1. Purpose

1.1. To ensure that gate mechanisms and hold clear devices are operating properly.

2. Test Interval

2.1. Gate mechanism and hold clear tests shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. This table explains how to perform the gate mechanism and hold clear tests.

Table 310(c)(3)-01

Step	Action
1	Check the operating battery voltage at the gate mechanism terminals to ensure the voltage is within operating specifications with the gate up and the warning device not activated.
2	Check the battery voltage at the mechanism motor terminals during the gate up cycle. Voltage should not drop below 11 volts.

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Step	Action
3	Check motor commutator for cleanliness and condition. • Brush contact area should be fairly smooth and coffee colored. • The length of the brush should exceed the minimum specified in the manufacturer's manual (for example: S40 motor brushes should be changed if they are found to be less than ¾”).
4	Inspect relay and mechanism contacts for proper adjustment and signs of arcing and wear. Observe the mechanism contacts are wiping properly when the gate is in motion.
5	Inspect the buffer and ensure proper clearance adjustment between the top segment gear and the bottom buffer with the gate in the vertical position.
6	Test the hold clear device for proper operation and verify mechanical clearances. Inspect the tooth disc on motor armature or pawl on the hold clear device. If it has become worn or burred, contact the responsible Supervisory Officer and make arrangements for replacement.
7	Check the gate vertical position is not greater than 89 degrees. Local conditions, such as high winds, may warrant the gate be set at slightly less than 89 degrees. The responsible Supervisory Officer will dictate the policy in this regard.
8	Measure the vertical and horizontal torque adjustments and ensure they are in accordance with manufacturer’s instructions.
9	Check that there are no objects that can bind the hold clear device. Objects such as manuals stored in the house, improperly installed cotter pins, etc. have been known to cause binding.

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310(c)(4) - Light Alignment

1. Purpose

1.1. To ensure the warning device lights are conspicuous to vehicular traffic throughout the road approach to the grade crossing.

2. Test Interval

2.1. Light Alignment tests shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Signal System Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. This table explains how to check alignment, focus and visibility. Always perform these tests in daylight hours.

Table 310(c)(4)-01

Test	Explanation
Condition & Voltage	Perform light visibility and condition tests in accordance with GI-310(a)(5) Lights & Signs, and lamp voltage tests in accordance with GI-310(c)(5) Lamp Voltage.

Continued on next page

Test	Explanation
Observe Lights	For each road approach, observe the flashing lights while approaching from the distances recommended in S&C Codes of Practice SCP-706. Verify the lights are properly aligned for vehicular traffic. Proceed to the stop point, in full view of the backlights (where used), look down the track in both directions and confirm that train approach sightlines to 2000 feet are adequate (as guidance, whistle posts are normally placed about 1300 feet from the crossing). Proceed over the crossing observing the backlights until they can no longer be seen.
Pedestrians	Verify some light deflection can provide ample warning to pedestrians.
Light Attributes	• Check that each light unit maintains the same intensity and clarity relative to the other light unit to which it is paired. • Check that each light unit maintains a round, distinctively red light with no major dark spots or distortions. • While approaching the front lights, ensure that as they begin to dim, the backlights begin to come into view and that the front lights remain clearly visible until the backlights are clearly illuminated.
Gate Lights	Ensure all gate lights are clearly visible while performing these tests.
Alignment	Refer to alignment instructions in S&C Codes of Practice SCP-706 if necessary.

310(c)(5) - Lamp Voltage

1. Purpose

1.1. To ensure optimum lamp brilliance for all conditions in either AC or DC mode.

2. Test Interval

2.1. Lamp voltage test shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Lamp Type

4.1. Check that all lamps are properly rated and replace any lamps that are discolored or damaged. Refer to this table if installing or changing lamps.

Table 310(c)(5)-01

Type of Lamp	Application	Lamp Specification
Incandescent[1]	Mast, cantilever and Gate light[2]	10 volt 18 watt
LED[1]	Mast or cantilever	Units must meet TC (2002) specifications.
	Gate light	Metrolinx approved unit

[1] Lighting circuits shall not contain a mix of incandescent and LED lamps on mast and cantilevers.

[2] The use of a 10 volt, 11 or 12 watt bulb is permitted.

5. Lamp Pair Variances

5.1. For each pair of lamp units, investigate the cause if the measured lamp voltages of the left and right lamps vary from each other by 0.2 V or more.

6. Voltage Readings

6.1. Lamp voltage readings shall be taken at time of installation for each lamp unit at the lamp terminals, preferably using a peak/hold meter to measure each lamp. Once in service, it is acceptable to measure lamp voltages at the base of a mast for annual tests, so long as it can be determined that the appropriate nominal lamp rated voltage is at the lamp. Gate lamp readings may similarly be measured from the terminals in the gate mechanism housing.

7. Solid State Crossing Controllers

7.1. To accurately read the lamp voltages on certain solid state crossing controllers, a "true rms AC + DC" multimeter, such as the Fluke 189 digital multimeter, must be used to directly measure the true value.

7.2. If only a conventional multimeter is available, then the value displayed on the meter must be adjusted to obtain the true value. The adjustment value to use depends on the battery type, number of cells, and whether the rectifier is on or off, as shown in these tables:

Table 310(c)(5)-02

Battery String		Adjustment Value (Digital Meter)	
# Cells	**Type**	**AC On**	**AC Off**
10	NiCad	2.2	1.1
11		2.7	2.0
6	VRLA/ Lead Acid	1.5	0.9
7		2.6	2.3

Table 310(c)(5)-03

Battery String		Adjustment Value (Analog Meter)	
# Cells	**Type**	**AC On**	**AC Off**
10	NiCad	1.1	0.5
11		2.4	0.9
6	VRLA/ Lead Acid	0.7	0.4
7		2.1	1.2

7.3. To calculate the true value, add the adjustment value to the measured value. When recording test results, only the true values must be recorded.

EXAMPLE: A TS-111 meter is used to measure lamp voltage on an SSCCIII+ energized from an 11 string NiCad with the AC power off. The measured value is 8.7 V. The true value would be 8.7 V + 0.9 V = 9.6 V.

8. LED Lamp Voltage Test Procedure

8.1. Follow the procedure in this table for checking and making adjustments to Lamp Voltage lighting circuits that consist of only LED lights (gate, mast and cantilever).

Table 310(c)(5)-04

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Check LED voltage is within manufacture specification with AC on. Then perform the load test in accordance with GI-310(c)(6) Battery Load Test and before restoring the AC power, proceed with step 2.</td></tr>
<tr><td>2</td><td>Note the lamp voltage and ensure it has not fallen below the minimum operating voltage.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>Lamp voltage is outside the operating voltage range and the battery has dropped to an acceptable start discharge voltage. Refer to GI-305(a) Inspecting and Testing Storage Batteries - General section Rated Voltages.</td><td rowspan="2">Check for faulty battery.
Check for faulty power supply.</td></tr>
<tr><td>Lamp voltage has dropped below the minimum operating voltage because battery has dropped below the acceptable start discharge voltage</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Restore the AC power.</td></tr>
</table>

Continued on next page

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>4</td><td>If the lighting circuits are not AC/DC lit proceed to step 5. Otherwise, note the AC lamp voltage and ensure it is as close to, but not above, the maximum operating voltage by adjustment of the lighting transformer taps, and then proceed to step 6.

NOTE: When moving lighting transformer taps, ensure the requirements for proper power off relay operation are met. Refer to GI-310(a)(8) AC Voltage (AC/DC Lit) sections Power Off Relay Taps and AC Test Results.</td></tr>
<tr><td>5</td><td>Note the lamp voltage must be within manufacture operating ranges.</td></tr>
<tr><td>6</td><td>Record the results in SCIS, entering the noted voltage in Step 2 as “AC OFF”, and the noted voltage in Step 4 or 5 as “AC ON”, in accordance with this table.
<table>
<tr><th>If the test is being performed...</th><th>Then use a separate measurement screen to record the…</th></tr>
<tr><td>As an annual test.</td><td>Voltages initially found at the furthest lamp for each flasher or mast assembly.</td></tr>
<tr><td>In response to an incident/accident.</td><td>Voltages at each lamp.</td></tr>
<tr><td>At time of installation.</td><td>Voltages as adjusted at each lamp.</td></tr>
</table>
</td></tr>
</table>

9. Incandescent Lamp Voltage Test Procedure

9.1. Follow the procedure in this table for checking and making adjustments to lighting circuits that contain incandescent lights (gate, mast or cantilever).

Table 310(c)(5)-05

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Perform the load test in accordance with GI-310(c)(6) Battery Load Test and before restoring the AC power, proceed with step 2.</td></tr>
<tr><td>2</td><td>Note the lamp voltage and ensure it has not fallen below 90% of its rated voltage.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>Lamp voltage has dropped below 90% rated voltage and battery has dropped to an acceptable start discharge voltage. Refer to GI-305(a) Inspecting and Testing Storage Batteries - General section Rated Voltages.</td><td>Adjust the lamp voltage in the range of 9.3 to 9.5 volts.</td></tr>
<tr><td>Lamp voltage has dropped below 90% because battery has dropped below the acceptable start discharge voltage.</td><td>Check for faulty battery.
Check for faulty power supply.</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Restore the AC power.</td></tr>
</table>

Continued on next page

Step	Action
4	If the lighting circuits are not AC/DC lit proceed to step 5. Otherwise, note the AC lamp voltage and ensure it is as close to 100% of its rated voltage by adjustment of the lighting transformer taps, and then proceed to step 6. NOTE: When moving lighting transformer taps, ensure the requirements for proper power off relay operation are met. Refer to GI-310(a)(8) AC Voltage (AC/DC Lit) sections *Power Off Relay Taps* and *AC Test Results*.
5	Note the lamp voltage. It should be at or slightly above 100% of the rate voltage.
6	Record the results in SCIS, entering the noted voltage in Step 2 as "AC OFF", and the noted voltage in Step 4 or 5 as "AC ON", in accordance with this table.

If the test is being performed...	Then use a separate measurement screen to record the voltages.
As an annual test.	Voltages initially found at the furthest lamp for each flasher or mast assembly.
In response to an incident/accident.	Voltages at each lamp.
At time of installation.	Voltages as adjusted at each lamp.

310(c)(6) - Battery Load Test

1. Purpose

1.1. To determine if the operating batteries are capable of supporting the current load of the warning device so the system will not fail when the AC power is off for extended periods of time.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Definition Operating Batteries

4.1. For the purpose of this test, the operating batteries are the batteries that supply the energy to operate the warning device lights, bells and gates. This test is not required for other battery bank applications (such as for crossing control batteries, or wayside signal batteries). Note that combination banks are deemed to be operating batteries.

5. Dummy Load

5.1. It is advisable to use a suitable fan cooled load bank. If one is not available, use a dummy load to draw about 10A from the battery when performing the load test. Ensure wiring to the dummy load is #10 case wire or equivalent.

Table 310(c)(6)-01

Battery Voltage	Dummy Resistor Load Rating
12V	1.2 ohm 120 Watt
16V	1.6 ohm 160 Watt
24V	2.4 ohm 240 Watt

6. Test Procedure

6.1. Perform the following load test on the operating batteries.

Table 310(c)(6)-02

Step	Action
1	Connect a voltmeter to the operating bank being tested. Note the bank voltage.
2	Disconnect the AC power to the charging circuit of the operating battery bank.
3	Apply the dummy load directly to the bank.
4	Allow the battery to discharge for about 30 minutes.
5	Check the individual cells to ensure no cells vary by more than 0.03V (NiCad) or 0.05V (VRLA or flooded lead acid). If so, advise the responsible Supervisory Officer.
6	Remove the dummy load, start the warning device, and check it is functioning properly. EXAMPLE: • Lights illuminated and flashing properly. • Bell(s) operating properly. • Gates operating properly.
7	Restore AC power and stop the warning device.

7. In the Event of Train

7.1. In the event of an approaching train while the test is in progress, the dummy load must be removed and the AC restored. The test may be resumed once the train has passed, however the overall test duration should be increased by the amount of time the AC was restored.

8. Performing Other Crossing Tests

8.1. It is encouraged that other localized crossing tests be performed while allowing the operating battery under test to be discharged, however do not leave the road crossing location unattended in the event that the battery unexpectedly fails under test.

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310(c)(7) - Warning Time

1. Purpose

1.1. To ensure the warning device activates in accordance with the design of the system and in no case provides less than 20 seconds warning time.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Caution

4.1. Do not make adjustments to motion sensitive circuits without first confirming there are no rail-to-rail short circuits. Refer to GI-310(c)(8) Approaches with MS/CW.

5. Termination Shunt Test Procedure

5.1. For constant warning or motion sensing devices where it is practical to do so, each termination shunt must be inspected to ensure it is in good condition and connected to the approach track circuit. If the shunt can be readily disconnected or isolated (i.e. by means of a gold nut), perform the following while using a recording device or the CW/MS display to verify that a higher level can be detected (use a strip chart recorder if the site is not equipped with an electronic recorder).

Table 310(c)(7)-01

Step	Description
1	Note that the “distance” voltage (EZ, ED, RX, or similar) is at its normal level.
2	Disconnect the termination shunt, and verify the "distance" voltage goes to a noticeably higher level.
3	Reconnect the termination shunt, and verify the “distance” voltage has returned to the value noted in Step 1.

6. Design Speed

6.1. Verify that the maximum authorized speed over the crossing is not greater than the design speed shown on the field plans. If so, take immediate steps to ensure trains do not operate over the crossing at greater than design speed, and advise the responsible Supervisory Officer.

7. Minimum Allowed Speed for Warning Time Tests

7.1. When testing the warning time of a crossing, the actual speed of the train must be no slower than 20% or 5mph of the maximum authorized speed. The following tables define the minimum allowed speed for most track speed limits.

Table 310(c)(7)-02

Max Authorized Track Speed (mph)	Min Speed Allowed for Testing (mph)
5	4
10	8
15	12
20	16
25	20
30	25
35	30
40	35
45	40
49	44
50	45
55	50
60	55
65	60
70	65
75	70
79	74
80	75
85	80
90	85
95	90
100	95

8. Minimum Warning Time Distance

8.1. When shunting the approach of a crossing, the location that the shunt is applied is critical. The shunt must be placed at the location that is the minimum distance from the edge of the grade crossing, where train detection by the warning system must occur to assure the intended warning time. The following tables define the shunt distance in feet for most track speed limits and warning times.

8.2. Shunt Distance =1.47 X maximum authorized speed X prescribed warning time

Table 310(c)(7)-03

		Prescribed Warning Time (seconds)									
		20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Max Authorized Speed (mph)	**10**	293	308	323	337	352	367	381	396	411	425
	15	440	462	484	506	528	550	572	594	616	638
	20	587	616	645	675	704	733	763	792	821	851
	25	733	770	807	843	880	917	953	990	1,027	1,063
	30	880	924	968	1,012	1,056	1,100	1,144	1,188	1,232	1,276
	35	1,027	1,078	1,129	1,181	1,232	1,283	1,335	1,386	1,437	1,489
	40	1,173	1,232	1,291	1,349	1,408	1,467	1,525	1,584	1,643	1,701
	45	1,320	1,386	1,452	1,518	1,584	1,650	1,716	1,782	1,848	1,914
	49	1,437	1,509	1,581	1,653	1,725	1,797	1,869	1,940	2,012	2,084
	50	1,467	1,540	1,613	1,687	1,760	1,833	1,907	1,980	2,053	2,127
	55	1,613	1,694	1,775	1,855	1,936	2,017	2,097	2,178	2,259	2,339
	60	1,760	1,848	1,936	2,024	2,112	2,200	2,288	2,376	2,464	2,552
	64	1,877	1,971	2,065	2,159	2,253	2,347	2,441	2,534	2,628	2,722
Max Authorized Speed (mph)	**70**	2,053	2,156	2,259	2,361	2,464	2,567	2,669	2,772	2,875	2,977
	75	2,200	2,310	2,420	2,530	2,640	2,750	2,860	2,970	3,080	3,190
	79	2,317	2,433	2,549	2,665	2,781	2,897	3,013	3,128	3,244	3,360
	80	2,347	2,464	2,581	2,699	2,816	2,933	3,051	3,168	3,285	3,403
	85	2,493	2,618	2,743	2,867	2,992	3,117	3,241	3,366	3,491	3,615
	90	2,640	2,772	2,904	3,036	3,168	3,300	3,432	3,564	3,696	3,828
	95	2,787	2,926	3,065	3,205	3,344	3,483	3,623	3,762	3,901	4,041
	100	2,933	3,080	3,227	3,373	3,520	3,667	3,813	3,960	4,107	4,253

Table 310(c)(7)-04

	Prescribed Warning Time (seconds)									
Max Authorized Speed (mph)	31	32	33	34	35	36	37	38	39	40
5	227	235	242	249	257	264	271	279	286	293
10	455	469	484	499	513	528	543	557	572	587
15	682	704	726	748	770	792	814	836	858	880
20	909	939	968	997	1,027	1,056	1,085	1,115	1,144	1,173
25	1,137	1,173	1,210	1,247	1,283	1,320	1,357	1,393	1,430	1,467
30	1,364	1,408	1,452	1,496	1,540	1,584	1,628	1,672	1,716	1,760
35	1,591	1,643	1,694	1,745	1,797	1,848	1,899	1,951	2,002	2,053
40	1,819	1,877	1,936	1,995	2,053	2,112	2,171	2,229	2,288	2,347
45	2,046	2,112	2,178	2,244	2,310	2,376	2,442	2,508	2,574	2,640
49	2,228	2,300	2,372	2,443	2,515	2,587	2,659	2,731	2,803	2,875
50	2,273	2,347	2,420	2,493	2,567	2,640	2,713	2,787	2,860	2,933
55	2,501	2,581	2,662	2,743	2,823	2,904	2,985	3,065	3,146	3,227
60	2,728	2,816	2,904	2,992	3,080	3,168	3,256	3,344	3,432	3,520
64	2,910	3,004	3,098	3,191	3,285	3,379	3,473	3,567	3,661	3,755
70	3,183	3,285	3,388	3,491	3,593	3,696	3,799	3,901	4,004	4,107
75	3,410	3,520	3,630	3,740	3,850	3,960	4,070	4,180	4,290	4,400
79	3,592	3,708	3,824	3,939	4,055	4,171	4,287	4,403	4,519	4,635
80	3,637	3,755	3,872	3,989	4,107	4,224	4,341	4,459	4,576	4,693
85	3,865	3,989	4,114	4,239	4,363	4,488	4,613	4,737	4,862	4,987
90	4,092	4,224	4,356	4,488	4,620	4,752	4,884	5,016	5,148	5,280
95	4,319	4,459	4,598	4,737	4,877	5,016	5,155	5,295	5,434	5,573
100	4,547	4,693	4,840	4,987	5,133	5,280	5,427	5,573	5,720	5,867

9. Warning Time Test

9.1. For every route within each approach, verify that the warning time is in accordance with the system design by any of the following three methods. If necessary, a different test method may be used for each route.

10. Warning Time Test Procedure – Method A

10.1. Method A must be used for initial installation or major modifications to the warning system.

10.2. With a train activating the system while traveling no slower than the minimum allowed speed for warning time testing, and with a train activating the system while accelerating from stationary towards the crossing from the station platform if it is within the crossing approach, clock and record the actual warning time and obtain the train speed from the train crew or with a radar gun.

10.3. Also monitor the "distance" voltage (i.e. EZ, ED, RX or similar) with a meter, keypad, display or chart recorder, and observe that the voltage decreases smoothly from the point where the train crosses the termination shunt up to the island, and then for bi-directional increases smoothly up to the point where the rear car crosses the receding termination shunt.

11. Warning Time Test Procedure – Method B

11.1. Review historical event time and/or buffer warning time data for the last 10 trains over the route. At least one event must have a train that traveled no slower than the minimum allowed speed for warning time testing. If there are no recorded short warning times, enter the lowest value as the warning time. The same value can be reported for both bidirectional approach tracks only if there is no doubt that train movements in both directions have been recorded. If there is any doubt, or if the historical data otherwise contains invalid warning time data, either of methods "A" or "C" must be used.

12. Warning Time Test Procedure – Method C (Constant Warning and Motion Sensing Devices Only)

Table 310(c)(7)-05

Step	Action
1	Check the EZ/ED/RX level for the track being tested and compare it to previously recorded values.
2	Confirm the total approach length is as designed.
3	Place a 0 ohm shunt at the distance from the crossing where train detection by the warning system must occur to assure the intended warning time. (See table in *Minimum Warning Time Distance*)
4	Measure the EZ/ED/RX level and verify it drops to within its normal range with a 0 ohm shunt applied.
5	Remove shunt and verify the EZ/ED/RX level returned to that noted in Step 1.
6	Place a 0 ohm shunt at a point measured from the crossing, at 90% of the approach track circuit length.
7	Measure the EZ/ED/RX level and verify it drops to within its normal range with a 0 ohm shunt applied.
9	Remove shunt and verify the EZ/ED/RX level returned to that noted in Step 1.

13. Warning Time Test Procedure – Method C (AFO/DC/Style "C" Only)

Table 310(c)(7)-06

Step	Action
1	Place a 0.06 ohm shunt at the distance from the crossing where train detection by the warning system must occur to assure the intended warning time. (See table in *Minimum Warning Time Distance)*
2	Verify that the crossing activates.

14. Main/Standby Configurations

14.1. The programming parameters of standby grade crossing predictors and motion sensors must be verified to be identical to the main units prior to reporting completion of these tests. This does not apply for GCP-4000s.

15. Short Warning Time

15.1. Immediately report any occurrence of short warning time (less than 20 seconds) to the responsible Supervisory Officer. Also report any occurrences where the warning times are consistently lower than the design time (after accounting for reaction times).

16. Island Only Circuits

16.1. For crossings that only have island circuits, enter 0 seconds as the measured warning time and add a comment listing the reason and the rule that protects the crossings.

17. Crossings with Multiple Circuits / Remote Starts

17.1. For crossings with multiple circuits or remote starts, the route tested should list the equipment that would initially activate the crossing for a train traveling at full timetable speed.

18. Recording Results

18.1. Record the route tested, method used, and results of test in SCIS. Add a comment describing the designed warning time, designed track speed, and approach length.

18.2. Every possible route over each approach to the crossing must be tested.

310(c)(8) - Approaches with MS/CW

1. Purpose

1.1. To ensure the constant warning time or motion detector equipment identifies train presence at the maximum distance of each approach to the grade crossing.

2. Test Interval

2.1. Inspections shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Rationale

4.1. A rail-to-rail short circuit within the confines of the grade crossing approach may be interpreted by the detection device as a train, and since it does not move, the warning device will time out. This situation effectively shortens the approach distance to the point where the short circuit occurred.

5. Caution

5.1. Do not make adjustments to motion sensitive circuits without first confirming there are no rail-to-rail short circuits.

6. Visual Inspection

6.1. Walk the track from the crossing to the termination point on each approach and check for the following visually obvious causes of short circuits.

a. Remove foreign objects that threaten to become a path for a short circuit.

b. Clean away rail grindings from rail-to-rail track hardware.

c. Check the general condition of concrete and steel ties and associated hardware such as insulating pads and rail clip insulators.

7. Insulated Track Hardware Test

7.1. Inspect all insulated rail-to-rail track hardware in accordance with GI-332(a) Track Hardware – Visual Inspection and if conditions warrant, perform electrical tests in accordance with GI-332(b) Track Hardware – Electrical Tests.

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310(d) - Hold/Clear Electrical

1. Purpose

1.1. To ensure that electrical values are maintained within specifications.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Mechanism Tests

4.1. This table explains what tests are to be performed by the Inspector.

Table 310(d)-01

Test	Check	How
Hold Clear Device	Electrical values.	In accordance with manufacturer's instructions and specifications. Record electrical values in SCIS in accordance with GI-323(b) Relay Electrical
Motor Control Relay	Electrical values. Check voltage drop across relay contacts when specified on the relay or manufacturer's instructions.	

5. Final Site Check

5.1. Before leaving the site, perform circuit ground and battery isolation fault tests as prescribed in GI-303 Testing for Grounds & Battery Isolation Faults and observe the controlling devices are in the normal state as prescribed in GI-310(a)(9) Controlling Devices.

310(e) - Constant Warning/Motion Sensing Devices

1. Purpose

1.1. To ensure the crossing warning system is operating as intended by inspecting the main receiver signal levels, and verifying operation of the manual transfer where provided.

2. Test Interval

2.1. Tests shall be performed when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Note the following values for the applicable model of warning system. If values deviate from the last calibration values by 20% or more, determine the cause. Perform this test on both the main and standby units, as applicable.

Table 310(e)-01

Warning System	Value	Description
Siemens GCP 4000 Safetran GCP3000 Safetran MS2000	EZ	Track receiver signal level where: 100 = No Train 0 = Train in Island

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Warning System	Value	Description
	EX	Voltage level which varies with approach track impedance where: 100 = Ideal 75 = Nominal 50 = Poor
Safetran GCP3000 Safetran MS2000	Z1	DC voltage representing the EZ value (referenced to COM) where: 6-10 VDC = No Train 0 VDC = Train in Island
	Z2	Check voltage, should be within +/- 0.5V of Z1.
Safetran Model 500/550 Safetran Model 600	E_{DX}	DC voltage which varies with ballast conditions.
	E_{DZ}	DC voltage which varies with approach track impedance.
	ED	Distance Voltage, a DC voltage which is a combination of E_{DX} and E_{DZ}.
	E_{CK}	DC reference voltage.
Safetran Model 62585 Safetran Model 62590 Safetran Model 62660	E_{DX}	DC voltage which varies with ballast conditions.
	E_{DZ}	DC voltage which varies with approach track impedance.
	ED	Distance Voltage, a DC voltage which is a combination of E_{DX} and E_{DZ}.
	E_{CK}	DC reference voltage.
	E_{RC}	Check receiver voltage.

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Warning System	Value	Description
Alstom XP4 Harmon HXP-3 Harmon PMD-3	RX	The value of the distance to the shunt as a percentage of the total train (appears as "R" on TRM Display): 100 = No Train 0 = Train in Island
	PH	Phase angle of the impedance characteristics of the approach circuit. Simultaneous decrease of RX and PH is indicative of deteriorating ballast.

5. Manual Transfer

5.1. Initiate a switch to the standby system, if equipped, and ensure the warning system starts operating, switches to the standby system, and then stops operating within the prescribed time. Repeat the procedure by initiating a switch from the standby to normal system.

6. View History Log

6.1. Analyze the history log from the data recorder or note train and error history from display, if available, and investigate repeating errors.

312 - Testing Wire and Cable Insulation Resistance

1. Purpose

1.1. To ensure that wire and cable insulation is installed and maintained at a resistance level that will not compromise the integrity of the signal system.

2. Test Interval

2.1. Insulation resistance of wires and cables shall be tested when installed, as required and at least once every ten (10) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Additional Requirements

4.1. Test each conductor wire to ground, and wire to wire.

4.1.1. Wires connected directly to track rails, line wires, and case wiring are not covered by this General Instruction.

4.2. When insulation resistance of wire or cable is found to be less than 500 Kohms (500,000 Ohms) wire to wire or wire to ground, advise the responsible Supervisory Officer. Prompt action shall be taken to repair or replace the defective wire or cable, and until so rectified, insulation resistance tests shall be performed and reported annually.

4.3. In no case shall a circuit be permitted to function on a conductor having an insulation resistance to ground or between conductors of less than 200 Kohms (200,000 Ohms) during the period required for repair or replacement. Advise the responsible Supervisory Officer and formulate a plan to eliminate the cause of the fault.

4.4. Operational tests are required if wires are removed from terminals.

4.5. Record resistance measurements (in Kohms) for each wire having a measured value of 500 Kohms or less.

5. Ground Rod Connection

5.1. A valid insulation resistance test depends heavily on a good connection between the meter and ground (earth). Before starting tests, verify the ground bond between the ground rod and housing ground bus is secure.

6. Megger Instrument Settings

6.1. For circuits and equipment operating at voltages up to 250 volts, instruments having a minimum of 250 volts potential may be used, however 600V instruments are recommended. For power cables and other circuits operating at voltages over 250 volts, instruments having a minimum voltage potential of twice operating voltage should be used. Where practical, do not test at potential settings that are needlessly higher than these recommendations.

7. Disconnecting Wires

7.1. Follow these instructions when isolating wires to perform installation and periodic insulation resistance tests wire to wire and wire to ground.

Table 312-01

If Mechanical Disconnects ...	And ...	Then ...
Are provided and wires need not be removed from their termination point(s).		Insulation tests can be performed without conducting operational tests.
Are not provided and only one wire at a time is removed from its termination point(s) and replaced before another wire is removed.	There is no risk of replacing the wire on the wrong terminal.	Insulation tests can be performed without conducting operational tests.
Are not provided and wires need to be disconnected from their termination point(s).	Removing more than one wire at a time from its termination point adds the risk of replacing wires on the wrong terminal.	Insulation tests shall be followed up with operational tests to prove that wires have been restored to their proper termination point(s).

8. Definition of Disconnects

8.1. A device that permits a circuit to be opened or isolated, for testing purposes, which does not require the removal of any wires.

8.2. EXAMPLES:

a. Standard test strap.

b. Insulated test eye.

9. Mechanical Disconnects

9.1. If no mechanical disconnects are provided and there is no choice but to remove cable wires from terminals to achieve isolation, suitable disconnects shall, if practicable, be installed for that purpose during the meggering tests or in conjunction with any repair or replacement of such cables.

10. Megger

10.1. Prior to performing the tests, turn the megger on and ensure it indicates infinite resistance with the test leads separated and that it indicates zero resistance with the test leads connected together.

11. Weather Conditions

11.1. Wet or freezing weather conditions may adversely affect the results of insulation tests. Whenever practicable, these tests should be scheduled to occur in favorable conditions.

12. Lightning Arresters

12.1. If a wire fails the insulation resistance test, verify there are no lightning arresters that may be providing a false reading. If so, temporarily remove the arrester(s) and re-perform the test for that wire. It is acceptable to re-insert the arrester(s) into the circuit if the wire subsequently passes the test and the arrester is otherwise known to be in good condition.

13. Documentation and Reporting

13.1. Results of test shall be recorded in SCIS, where object type EQ_CABLE has fields to identify if any wire(s) in a cable is measured at 500 Kohms or less. "INF" can be recorded for wire(s) in a cable that measure above 500 Kohms. A separate ID field must be filled in with the particulars of the cable for each wire measured at or below 500 Kohms.

13.2. For each wire that tests between 200 Kohms and 500 Kohms, an annual test shall be manually created for that cable in SCIS. Prompt action shall be taken to repair or replace the defective wire or cable.

14. Wire to Ground Test Procedure

14.1. Wire to ground tests can either be performed with wires:

14.2. connected and not isolated, or

14.3. disconnected and isolated.

Table 312-02

If the wire...	Then ...
Is not isolated and a low resistance to ground is detected.	It will be necessary to disconnect and isolate the wire being tested to ascertain whether or not the low resistance to ground actually exists on the wire itself.

Follow this procedure to perform the wire to ground test.

Table 312-03

Step	Action
1	Connect one test lead of the megger to a ground terminal.
2	Turn the Megger on and one by one connect the other test lead to each single conductor or each conductor of a multiconductor cable until all wires have been checked.

15. Wire to Wire Test Procedure

15.1. This test shall be performed periodically, or more frequently as directed by the responsible Supervisory Officer if the wire integrity is at risk of being compromised by factors such as age of the plant, ongoing construction, or local field conditions.

EXCEPTION: This test is not required for single wire conductors or trunking consisting of single wire conductors.

Table 312-04

Follow this procedure to perform wire to wire test with disconnects.	
Step	**Action**
1	Disconnect and isolate all of the wires of the multiconductor cable to be tested.
2	Test each wire of the cable against all other wires in the cable by connecting one test lead to the first wire in the cable, and while operating the megger, progressively touching the other test lead from the second through to the last wire.
3	Keep repeating this procedure by advancing the first test lead to the next wire and progressively touching the other test lead to the remaining wires until the test has been performed for all wire combinations.
4	Reconnect the multiconductor cable wires.

Table 312-05

Follow this procedure to perform wire to wire test without disconnects.	
Step	**Action**
1	Disconnect and isolate only one wire of a multiconductor cable to be tested.
2	Test each wire of the cable against all other wires in the cable by connecting one test lead to the isolated wire in the cable, and while operating the megger, progressively touching the other test lead from the second through to the last wire.
3	Disconnect the test lead and re-connect the isolated wire.
4	Disconnect and isolate the second wire of the multiconductor cable being tested.
5	Repeat the steps in this table, each time advancing the first test lead to the next isolated wire and progressively touching the other test lead to the remaining wires until the test has been performed for all wire combinations.

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313 - Inspecting Lightning Arresters

1. Purpose

1.1. To ensure that adequate surge protection is provided for circuits and equipment.

2. Test Interval

2.1. Tests shall be performed when installed, as required and frequently. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Personal Safety

4.1. Leakage through lightning arresters or transformers connected to AC supply lines could cause the voltage on the grounding system to reach dangerous levels if disconnection of the ground system is attempted.

4.2. Always replace defective arrestors connected to AC supply lines prior to disconnecting or opening the ground system.

5. Primary Surge Devices

5.1. Metrolinx policy is to provide a primary AC surge device at all locations, to be installed adjacent to the AC load center. Many of these devices are equipped with green LEDs to indicate health status. If the location is equipped with such a device, verify that the health LED is steady lit.

5.2. Make arrangements to have the primary surge device replaced as soon as practicable if the health LED is found to be extinguished, or is otherwise indicating failure mode.

5.3. If the primary surge protector is provided with a load center breaker, ensure the breaker is not tripped.

6. Visual Inspection

6.1. Two types of visual inspections may be performed on air gap lightning arresters as directed by this table.

Table 313-01

Type of Inspection	When	Check
Visual Scan (does not require arrester removal)	• When performing periodic tests. • As soon as possible after electrical storm activity. • When entering a location for any other reason.	• Check for signs of arcing or burn marks on arrester covers, discs or discharge electrodes (teeth). • Check that arrester covers are not damaged and are in place. • Check the type of arrester installed is suited to the application in accordance SCP-1101 and the approved circuit plan.
Detailed Inspection (may require arrester removal)	• When visual scan indicates that arresters have fired. • When GI-303 Testing for Grounds & Isolation Faults indicate that arresters are faulty.	• Check that discharge electrodes (teeth) on arresters are pointed upward when arresters are mounted horizontally. • Check that at least 25% of discharge electrodes (teeth) on arresters are not burned back by repeated surge activity. • Check that melted metal particles or other contamination does not bridge discharge electrodes (teeth or discs). • Check the plastic cover on USG type arresters has the open end down when the arrester is mounted vertically.

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314 - Inspecting Signal Poleline and Attachments

1. Purpose

1.1. To ensure that signal poleline is properly maintained and in good condition.

2. Test Interval

2.1. Signal lines and attachments shall be inspected when installed, as required and at least once every year. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Visual Inspection

4.1. Inspect poleline and attachments as described in this table.

Table 314-01

Inspect	Check that ...
Line Wire Sag	All wires are sagged about the same in relation to one another and they do not appear to be inconsistent with sag specifications.

Continued on next page

Inspect	Check that ...
Clearances	Line wire, cable, poles and attachments meet clearance requirements for safe train operations. NOTE: There may be other clearance requirements that have been established to cater for local conditions. Consult with the responsible Supervisory Officer when extraordinary circumstances occur. Supervisors may refer to clearance standards stated in Metrolinx Track Standard and SCP-1005.
Wooden Appliances	Poles, crossarms and insulator pins are properly aligned and in good physical condition.
Guy Wires	Guy wires are properly installed and positioned.
Insulators	Insulators are not broken and are securely attached to firmly mounted pins.
Tie Wires	Line wire is properly tied onto the insulators.
Braces, Bolts, Plates and Lags	Crossarm braces, nuts, bolts, plates and lag screws are properly placed and secure.
Pole Steps	Pole steps are properly spaced, securely fastened and in good repair.
Attachments	Attachments such as junction boxes, transformers and arresters are secured and in good repair. NOTE: Unauthorized attachments such as spikes or signs that create personal safety hazards shall be removed.

Continued on next page

Inspect	Check that ...
Line Wire Condition	Line wire does not display these conditions: • Damaged or missing insulation. • Line wraps. • Improperly crimped or taped sleeves.
Line Drops and Aerial Cable	Line drops and aerial cables do not display these conditions: • Sag is too loose or too tight. • Messenger improperly attached to the pole and cable. • Cable damaged or cracked due to weather deterioration. • Cable grips improperly attached or adjusted.
Ground Wire	Ground wire from the arresters and transformer housing is properly connected and continuous to the ground rod.
Crossarm Markers	Crossarm markers identifying AC signal supply circuits are installed in accordance with the power standards. NOTE: Markers that are properly positioned and attached but are illegible due to weather, surface contamination, fading or other reasons need not be replaced.
Vegetation	Vegetation does not obstruct line wire or pole attachments and is kept free from the immediate perimeter of the pole.

5. Pole Deterioration

5.1. Above ground pole deterioration can be visually inspected annually while performing other inspections in this GI. When any of these conditions are severe enough to present a safety hazard to property, public or employee, steps shall be taken to remove the hazard. If necessary, consult with the responsible Supervisory Officer.

Table 314-02

<table>
<tr><th>Location of Deterioration</th><th>Check</th></tr>
<tr><td>Above Ground Inspection</td><td>Check for the following and perform internal and/or below ground inspections if poor pole conditions warrant.
Impact damage.
Severe splitting or cracking.
Breaks.
Excessive surface rot checks and cracks caused by long-term environmental conditions.</td></tr>
<tr><td>Internal Inspection</td><td>Follow the instructions in this table.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The above ground inspection indicates that poor pole condition may extend internally to the center of the pole.</td><td rowspan="2">Tap the pole with a hammer just above ground level. If the pole sounds hollow, drill a 1/2-inch hole into the center and inspect the shavings for signs of rot.
Plug the hole with a wooden plug when the inspection is complete.</td></tr>
<tr><td>The pole must be climbed to cut away or disconnect wires or cables that will leave it free standing.</td></tr>
</table></td></tr>
</table>

5.2. The frequency of below ground inspection shall be performed as instructed in the table below. When any of these conditions are severe enough to present a safety hazard to property, public or employee, steps shall be taken to remove the hazard. If necessary, consult with the responsible Supervisory Officer.

Table 314-03

<table>
<tr><th>Location of Deterioration</th><th>Check</th></tr>
<tr><td>Below Ground Inspection</td><td>Follow the instructions in this table.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The above ground inspection indicates that poor pole condition may extend below ground level.</td><td rowspan="2">Remove the earth to a depth of 1 foot, all around the base of the pole.
Drive a screwdriver or other sharp instrument into the surface of the exposed area around the pole to determine the extent of surface rot. If significant surface rot is found an “Internal Inspection” shall be performed.
Replace the earth around the base of the pole and if possible, arrange it in a manner that will allow water to drain away.</td></tr>
<tr><td>The pole must be climbed to cut away or disconnect wires or cables that will leave it free standing.</td></tr>
</table>
</td></tr>
</table>

315 - Testing Approach Locking

1. Purpose

1.1. To describe the minimum operational tests required to verify that approach locking features are functioning as intended.

2. Test Interval

2.1. Approach locking shall be tested when installed, as required and when any revisions or alterations are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Timing Equipment

4.1. Refer to GI-331 Testing Time Releases, Timing Relays and Timing Devices for more information regarding testing timing equipment.

5. Definition

Table 315-01

AREMA Communications and Signals Manual of Recommended Practices Part 1.1.1 Definition of Approach Locking		
It is …	**It prevents …**	**It is in effect …**
A type of electric locking.	• The movement of any interlocked or electrically locked switch, movable-point frogs, movable bridge or derail in an established route governed by an absolute (home) signal. • The display of an aspect to proceed by a signal governing movements over a conflicting route.	When an absolute (home) signal, displaying an aspect to proceed, is caused to display its most restrictive aspect, while a train is occupying a pre-defined section of track approaching the signal. NOTE: This initiates a timing cycle that maintains approach locking until a predetermined time interval has expired.

6. Approach or Time Locking at Electric Lock Locations

6.1. Approach or time locking only exists at an electric lock location, if there is a vital timing element at the location itself. If this timing element only becomes effective (upon initiation of an unlock) when one or more approach circuits are occupied, then the type of locking is deemed to be *approach locking*, and this Rule applies.

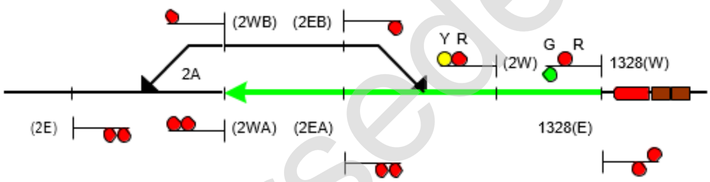
6.2. If this timing element is always effective (upon initiation of an unlock) the type of locking is deemed to be *time locking*, and this Rule does not apply.

6.3. The type of locking at an electric lock location which depends only on the condition of vital HD circuits or vital track codes to allow an unlock is deemed to be *traffic locking*, and this Rule does not apply.

7. Illustration of Approach Locking

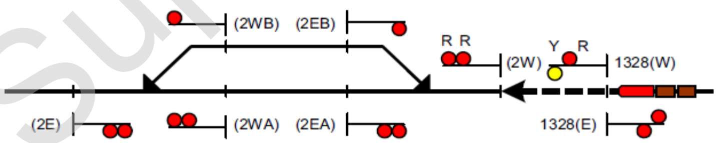
7.1. If this was the original route requested;

Figure 315-01



And the route is cancelled while the train is in this position (i.e. beyond the limits of the approach section);

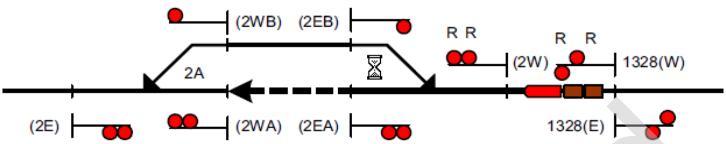
Figure 315-02



Then that portion of the overall electric locking logic which would normally have been maintained by the ASR timing circuit becomes ineffective for the original route requested. A portion of the original route remains electrically locked by *traffic locking* (shown in heavy dotted lines) until the train reaches the home signal.

7.2. However, if the original route is cancelled while the train is in this position (i.e. within the limits of the approach section);

Figure 315-03



Then electric locking, shown on the track diagram as the heavy black line, is maintained by what is referred to as approach locking, while the train is on the approach section and by route locking after the train passes the home signal.

7.3. If the train can stop prior to passing the home signal, electric locking will be maintained by the ASR timing, until the pre-determined time expires.

7.4. NOTE: *Traffic locking* (shown in heavy dotted lines) also continues to maintain electric locking until the ASR time expires.

8. Time of Installation Tests

8.1. There are typically 3 progressive stages of the verification process to perform at time of installation to confirm that *approach locking* is effective. Detailed verification is required in the second and third stages of testing.

Table 315-02

Stage	Verification Process
1	Verify that the approach stick relay (ASR) associated with each home signal and approach locking at the location under test correctly responds to controlling circuitry. Verify that the ASR: • Is correctly responding to detected aspects displayed by the home signal. • Will not reset improperly in response to incorrect track occupancy sequencing. • Will not reset as intended in response to detected movements within the approach section. • Will reset as intended in response to a detected movement passing the home signal. • Responds as intended to its associated timing devices.
2	Verify that each approach relay (AR) at the location under test responds as intended to occupancies within its respective approach section, in accordance with the following: • Simulated occupancy of each track circuit and trap circuit protected dead section in each route within the approach section of each home signal. • Loss of shunt protection on track circuits so protected within the approach section.

Continued on next page

<table>
<tr><th>Stage</th><th>Verification Process</th></tr>
<tr><td>3</td><td>Verify that in each route governed by each home signal, as the home signal displays a permissive aspect, or when approach locking is imposed by canceling the signal while the approach section is occupied, that the:

Request conditioned electric switch machines controlling a switch, movable point frog or derail cannot be operated.
Request conditioned movable bridge cannot be operated.
Request conditioned home signals governing conflicting routes cannot display aspects to proceed.

NOTE: Request conditioned means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.</td></tr>
</table>

9. Periodic Tests - Control Points & Interlockings

9.1. Follow these procedures at time of installation at control points and interlockings.

Table 315-03

Test	Step	Action
Approach Relay	1	Determine the approach relay[1] is de-energized when each track circuit in the approach section is individually shunted with a .06-ohm shunt, and that loss of shunt time and "trap" circuit(s) are operative where provided.
Approach Locking	2	Clear the absolute (home) signal, de-energize the approach relay[1], cancel the absolute (home) signal, verify the timing circuit is in effect, then re-energize the approach relay[1] and verify the timing circuit is not in effect.
	3	After clearing the absolute (home) signal and then canceling it, with the approach relay[1] de-energized, confirm the operating mechanism of any interlocked or electrically locked switch, movable-point frog, movable bridge or derail in the route governed by that signal will not release or operate and signals governing movement over conflicting routes cannot be cleared until the predetermined time interval has expired.
	4	Repeat steps 1 to 3 for each absolute (home) signal and each route approaching the signal.

[1] or device that functions as a relay

10. Periodic Tests - Electric Locks

10.1. Follow these procedures at time of installation at electric locks.

Table 315-04

Step	Action
1	Initiate an unlock and ensure the electric lock immediately unlocks. Ensure control circuits of signals governing movements over the switch are interrupted.
2	Restore the electric lock to the normal, locked position.
3	Individually place a 0.06 ohm shunt across each track circuit within the limits of the approach and entire fouling sections. Ensure the electric lock cannot be unlocked while each shunt is in place until after the predetermined time interval has expired.
4	If so equipped, operate the emergency release and close the electric switch lock door. Ensure control circuits of signals governing movements over the switch are interrupted.
5	Restore the emergency release and apply a new seal. Close the electric switch lock door and ensure control circuits have been restored to normal.

316 - Testing Detector Locking

1. Purpose

1.1. To describe the minimum operational tests required to verify that detector locking features are functioning as intended.

2. Test Interval

2.1. Detector locking shall be tested when installed, as required and when any revisions or alterations are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Definition

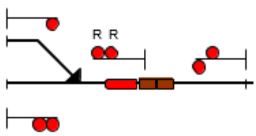
Table 316-01

AREMA Communications and Signals Manual of Recommended Practices Part 1.1.1 Definition of Detector Locking		
It is ...	**It prevents ...**	**It is in effect ...**
A type of electric locking.	The movement of any interlocked or electrically locked switch, movable- point frogs, movable bridge or derail within a specific section of track.	When a specific section of track is occupied.

5. Illustration of Detector Locking

5.1. Consider a train passing a home signal and over a switch while not under signal indication;

Figure 316-01



5.2. *Detector locking* will prevent the switch from throwing while the train is on the OS track.

6. Test Procedures

6.1. Perform these tests for each switch machine in both directions.

Table 316-02

Step	Action
1	Set all signals governing movement over route to "Stop" with no electric locking in effect.
2	Open motor control circuit of an electric switch machine controlling a switch, movable- point frog or derail.
3	Confirm switch machine does not respond to request conditioning[1](account open control circuit).
4	Close switch machine motor control circuit. Confirm switch machine does respond to request conditioning[1].
5	Apply a .06 ohm shunt on the track circuit for the switch, movable-point frog or derail.
6	Confirm switch machine does not respond to request conditioning[1] (account shunted track circuit).

Continued on next page

Step	Action
7	Remove shunt and confirm switch machine does respond to request conditioning[1]. If loss of shunt is provided, ensure this does not occur until it has run the pre-determined time.
8	If the track circuit under test is divided by a trap circuit protected dead section, then: • Apply a .06 ohm shunt on the track circuit. • Confirm trap stick relay(s)[2] (TSR) is down. • Remove shunt to simulate the occupancy vacating the track circuit and occupying the dead section. • Confirm TSR remains down. • Verify switch machine will not respond to request conditioning[1] when, by simulation, the track circuit is vacated and the dead section is occupied. • Reset TSR to simulate removal of occupancy from dead section, using manual reset feature or otherwise by momentarily applying energy to coil circuit. • Verify the switch machine will respond to request conditioning[1] when TSR is reset to simulate removal of occupancy from dead section. • Verify the response of switch machine is sufficiently delayed to indicate that loss of shunt protection is incorporated in trap circuit protection.
9	Apply a .06 ohm shunt on the track circuit with the switch machine in mid-stroke to verify detector locking is effective with switch moving. Remove the shunt and restore the switch.

[1] *Request conditioning* means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.

[2] There may be two stick relays employed in the trap circuit configuration. When such is the case, the term "TSR" refers to both.

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317 - Testing Indication Locking

1. Purpose

1.1. To describe the minimum operational tests required to verify that indication locking features are functioning as intended.

2. Test Interval

2.1. Indication locking shall be tested when installed, as required and when any revisions or alterations are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Definition

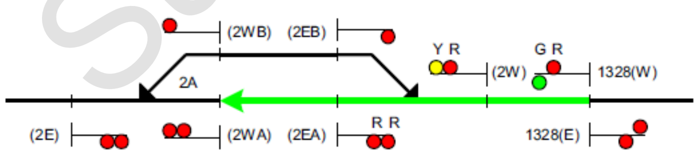
Table 317-01

AREMA Communications and Signals Manual of Recommended Practices Part 1.1.1 Definition of Indication Locking		
It is …	**It prevents …**	**It is in effect …**
A type of electric locking.	• The manipulation of levers or other controlling means that would result in an unsafe condition for a train to make a movement corresponding to that requested. • The establishment of a route when signal, switch, or other operative appliances fail to operate in the proper sequence.	When the operation of a signal, switch or other operative unit, affecting the route requested fails to make the required movement.

5. Illustration of Indication Locking

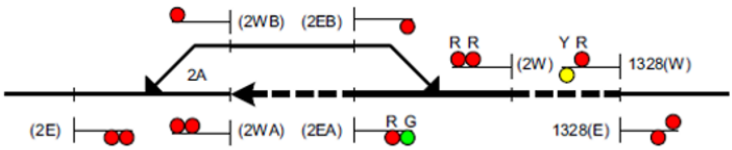
5.1. If this was the original route requested;

Figure 317-01



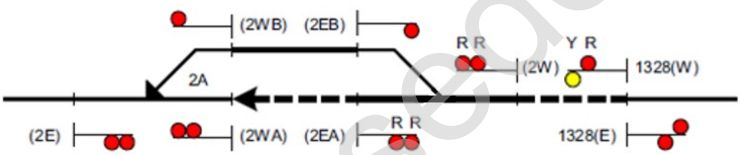
And if an opposing red repeater de-energizes;

Figure 317-02



Then *indication locking* causes the original route to go to Stop. Electric locking for the original route will be maintained by *time locking* or *approach locking* (whichever is applicable);

Figure 317-03



Note that the locking shown in heavy dotted lines is *traffic locking*.

6. Conventional Method

6.1. The conventional testing method must be performed at the time of installation, when any change or modification is made to the locking system, or the locking system has become disarranged for any reason.

7. Indication Locking Types

7.1. Indication locking falls into three primary categories; levers, switches, and signals (applicable for searchlight signals only).

8. Conventional Indication Locking Tests for Levers

8.1. Depending upon the type of electro-mechanical interlocking machine, indication locking of levers prevents the lever from being operated full stroke until the operated unit has properly completed its movement, or prevents the final lever from being operated until all units have properly completed their required movements. Refer to Manufacturer Instructions for testing procedures.

9. Conventional Indication Locking Tests for Switches

9.1. NOTE: For crossover switch applications; line the crossover normal then crank one end of crossover to full reverse. Ensure both normal and reverse switch repeater relays are de-energized. Again align the crossover normal, crank the opposite end of crossover full reverse. Ensure both normal and reverse switch repeater relays are de-energized. Repeat this process in the reverse position for both ends of crossover.

9.2. For all switch applications (including crossover switch applications), perform the following.

Table 317-02

Step	Action
1	With the switch in the normal position, place a ¼" obstruction between the reverse switch point and the stock rail 6-inches from the end of the point.
2	Operate the switch to the reverse position.
3	Ensure that the switch does not indicate reverse.
4	Repeat steps 1-3 for the normal switch position.
5	Repeat steps 1-4 for all switches in each possible
6	Attempt to clear a signal over a route.
7	De-energize the appropriate correspondence relay for each switch in the route, in turn, to ensure that the signal goes from clear to stop each time the appropriate correspondence relay is de- energized, and to ensure that the affected route is timing.
8	Repeat steps 6-7 for every possible route.

10. Conventional Indication Locking Tests for Signals

10.1. These are the requirements for testing indication locking for signals.

Table 317-03

Step	Action
1	Verify each signal with its corresponding relay.
2	Line each route separately without clearing the signal for that route.
3	Open the lock circuit (ASR, MR) by de-energizing the red repeater (RPR, RGPR) or by opening the lock circuit at the contact of the signal control relay (HR-HPR) that would have been energized had the route been cleared.
4	With the lock circuit open, attempt to move each switch in the route by locally energizing the switch control relays (NWSR- RWSR). Ensure switch does not move.
5	Ensure that each opposing signal into the route being tested cannot be cleared by locally energizing the signal control relays (LHSR- RHSR).
6	Energize the lock circuit if applicable.
7	Clear the opposing signal and de-energize the RGPR relay that opposes the one cleared.
8	The cleared signal must go to stop. This proves that if an opposing signal becomes falsely clear, the cleared signal goes to stop.
9	Repeat steps 2-8 for all routes to cover all RGPR, RPR relays.

11. Recording Results

11.1. Record the conventional for the CTC Route in SCIS when installed, when any revisions or alterations are made. ID each leaver, signal, or switch number within the route as indicated on the site plans.

11.2. Record the alternative for the CTC Route in SCIS when Indication Locking can be tested by verifying that neither the software nor the interconnection between the signal equipment and processing unit have been altered. ID all indications that have been verified within the route.

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318 - Testing and Inspecting Movable Bridge Locking

1. Purpose

1.1. To describe the minimum operational tests required to verify that movable bridge locking features are functioning as intended.

2. Test Interval

2.1. Movable bridge locking shall be tested when installed, as required and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Additional Requirements

4.1. Test shall be performed immediately before the opening of the navigation period. A Signal Inspector or designated employee, acting in an inspection capacity, shall be assigned to perform these tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period.

5. Definition

5.1. *Moveable Bridge Locking*: The rail locks, bridge locks, bolt locks, circuit controllers, and electric locks used in providing interlocking protection at a movable bridge.

5.2. *Moveable Member*: A mechanical device that must be driven into place or properly seated to perform some form of locking or aligning function on a bridge. When more than one type of movable member is employed, they must all be fully engaged and detected as locked in a prescribed sequence before trains can be allowed to proceed on signal indication.

6. Contactors

6.1. Contactors may be installed at the end(s) of the movable bridge span where it meets the abutment. Inspect the contactors as instructed in this table.

Table 318-01

Inspect	Check
Contact Fingers	• Check contact fingers are free from damage, corrosion and significant wear.
Contact Springs	• Check contact springs are free from damage, corrosion and significant wear. • Check contact springs apply adequate pressure on the contact fingers.
Lubrication	• Check that contacts are lightly lubricated when required. • Check that mechanical parts of the contactor mechanism are properly lubricated.
Alignment	• Check that contact fingers properly align with contact springs when the contactor mechanism is in the process of engaging and disengaging. • Check there is adequate wiping action between the contact fingers and the contact springs when they are in the process of contacting one another.

Continued on next page

Inspect	Check
Clearance	• Check there is adequate clearance between the ends of the contact fingers on the movable bridge span and the contact springs on the abutment or fixed span when the fingers are fully withdrawn for bridge opening.

7. Bridge Deck Expansion and Contraction

7.1. Expansion and contraction of bridge decks and rails can have a significant effect on any adjustments that may be required. This should be taken into consideration when checking mechanical clearances.

8. Obstruction Parameters

8.1. The bridge lock or lock mechanism shall be checked to ensure it cannot be locked, or indicated as locked, unless these obstruction parameters are met:

Table 318-02

Movable Member	Obstruction Parameter
Rail Locks	Movable rails shall be within 3/8″ of correct surface and alignment with fixed rails on the bridge abutment or fixed span before rail locks can be locked in the fully engaged position. Rail locks shall not indicate as locked unless they are driven to within 1″ of the fully engaged position.

Continued on next page

Movable Member	Obstruction Parameter
Surfacing Wedges	Surfacing wedges shall not indicate as locked unless they are driven to within 1″ of the fully engaged position and movable rails are within 3/8″ of correct surface and alignment with fixed rails on the bridge abutment or fixed span.
Rail Seating (lift span)	Movable rails shall not indicate correct surface and alignment unless they are within 3/8″ of correct surface and alignment with fixed rails on the bridge abutment or fixed span.
Rail Seating (drawbridge)	Same as Rail Seating (lift span). EXCEPTION: In some conditions the 3/8″ surface and alignment parameter may be increased to a maximum of 1/2″ with the approval of the responsible Supervisory Officer. *This exception shall only apply on drawbridges where casting and chair apparatus are used to lift the train wheels over the space where the movable rails meet the fixed rails.*
Other Detection Devices	There are detection devices other than circuit controllers that can also be arranged to detect the position of movable members and bridge seating. Adjustment of these devices shall be tested in accordance with manufacturer's instructions and contacts shall be tested to ensure they are open when movable member or bridge seating is obstructed.

9. Locking Test - Bridge Devices

9.1. At the start of each navigation season, or during the first inspection in a calendar year where navigation is year round, verify that the bridge devices cannot operate when the lock relay, or device that functions as a lock relay, is de-energized.

319 - Testing Route Locking

1. Purpose

1.1. To describe the minimum operational tests required to verify that route locking features are functioning as intended.

2. Test Interval

2.1. Route locking shall be tested when installed, as required and when any revisions or alterations are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Definition

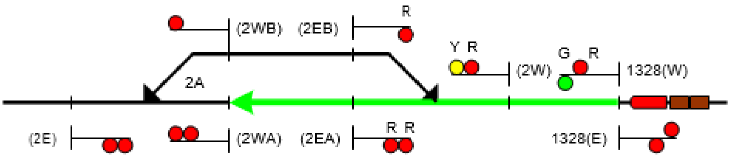
Table 319-01

AREMA Communications and Signals Manual of Recommended Practices Part 1.1.1 Definition of Route Locking		
It is …	**It prevents …**	**It is in effect …**
A type of electric locking.	The movement of any interlocked or electrically locked switch, movable-point frog, movable bridge or derail in a selected route. NOTE: The signal system may be designed to release the locking affecting a section of track within a selected route as it becomes unoccupied.	• When an absolute (home) signal is caused to display an aspect to proceed for a selected route; and • After a train passes such signal, occupies and progresses through the established route; or • When time locking or approach locking is in effect for the selected route.

5. Illustration of Route Locking

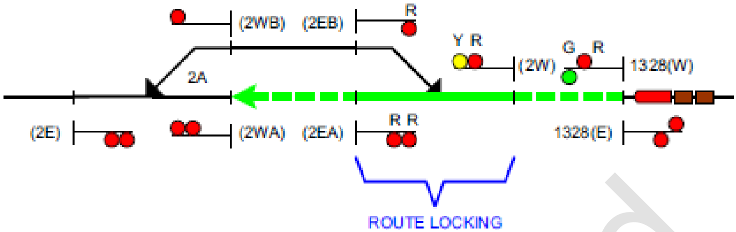
5.1. If this was the original route requested;

Figure 319-01



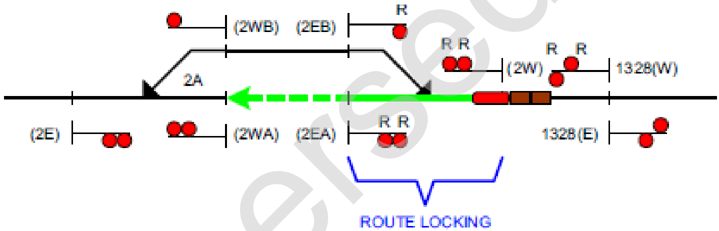
Then *route locking* is in effect once the requested route is established and the home signal is clear;

Figure 319-02



And the *route locking* remains in effect as shown until the train has passed the control point;

Figure 319-03



The locking shown in heavy dotted lines is *traffic locking*.

6. Conventional Test Requirements

6.1. These are the requirements for testing route locking.

a) Determine that loss of shunt time is effective where provided.

b) Determine that "trap" circuit(s) is effective where provided.

c) For each route to be tested, follow these instructions.

Table 319-02

Step	Action
1	Clear the signal for the established route to be tested.
2	With the signal clear, place a 0.06 ohm shunt across the first track circuit beyond the governing signal.
3	Attempt to change the position of each mechanical or power operated switch, hand operated electrically locked switch, movable-point frog, and derail within the route and ensure no movement occurs.
4	Simulate a train movement through the remainder of the route by shunting each successive track circuit in the route to determine that the position of each switch, movable-point frog, movable bridge, and derail, beyond the shunted track circuit, will not release or operate. (Each shunt should remain in place until the next progressive shunt is placed; then the first shunt must be picked up.)
5	Where sectional release locking is provided, determine that the position of each switch, movable-point frog, movable bridge, derail, and facing point lock levers, to the rear of the shunted track circuit will release and operate as the track circuits are sequentially shunted and re-energized through the route. Ensure that each released section provides adequate clearance for any subsequent route that may be cleared over each of the released sections.
6	Repeat steps 1-5 for each absolute (home) signal and all possible routes governed by that signal.

7. Recording Results

7.1. Record the conventional for the CTC Route in SCIS when installed, when any revisions or alterations are made. ID each signal or switch number within the route as indicated on the site plans. Record in the comments field if the route has sectional release.

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320 - Testing Time Locking

1. Purpose

1.1. To describe the minimum operational tests required to verify that time locking features are functioning as intended.

2. Test Interval

2.1. Time locking shall be tested when installed, as required and when any revisions or alterations are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Timing Equipment

4.1. Refer to GI-331 Testing Time Releases, Timing Relays and Timing Devices for more information regarding testing timing equipment.

5. Definition

Table 320-01

AREMA Communications and Signals Manual of Recommended Practices Part 1.1.1 Definition of Indication Locking		
It is …	**It prevents …**	**It is in effect …**
A type of electric locking.	• The movement of any interlocked or electrically locked switch, movable-point frog, movable bridge or derail in an established route governed by an absolute (home) signal. • The display of an aspect to proceed by a signal governing movements over a conflicting route.	When an absolute (home) signal displaying an aspect to proceed is caused to display its most restrictive aspect. NOTE: This initiates a timing cycle that maintains time locking until a predetermined time interval has expired.

6. Approach or Time Locking at Electric Lock Locations

6.1. Approach or time locking only exists at an electric lock location if there is a vital timing element at the location itself. If this timing element is always effective (upon initiation of an unlock) the type of locking is deemed to be time locking, and this Rule applies.

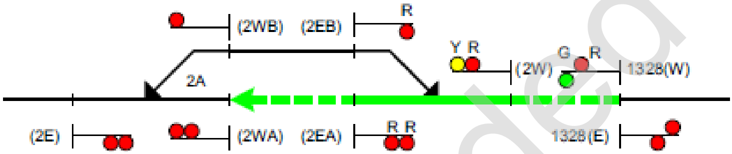
6.2. If this timing element only becomes effective (upon initiation of an unlock) when one or more approach circuits are occupied, then the type of locking is deemed to be approach locking, and this Rule does not apply.

6.3. The type of locking at an electric lock location which depends only on the condition of vital HD circuits or vital track codes to allow an unlock is deemed to be traffic locking, and this Rule does not apply.

7. Illustration of Time Locking

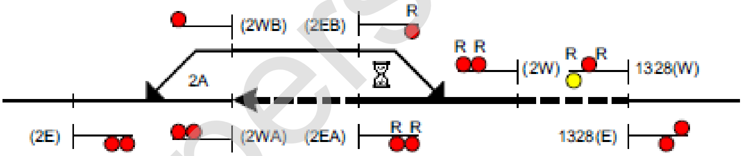
7.1. If this was the original route requested;

Figure 320-01



And the route was cancelled;

Figure 320-02



Then the electric locking that remains in effect as shown by the heavy solid black line is called *time locking*. This remains in effect for a specified period of time. The locking shown in heavy dotted lines is *traffic locking*.

8. Time of Installation Tests

8.1. There are typically 2 progressive stages of the verification process to perform at time of installation to confirm that time locking is effective. Detailed verification is required in the second stage of testing.

Table 320-02

Step	Action
1	Verify that the approach stick relay (ASR) associated with each home signal and approach locking at the location under test correctly responds to controlling circuitry. Verify that the ASR: • Is correctly responding to detected aspects displayed by the home signal. • Will not reset improperly in response to incorrect track occupancy sequencing. • Will reset as intended in response to a detected movement passing the home signal. • Responds as intended to its associated timing devices.
2	Verify that in each route governed by each home signal, as the home signal displays a permissive aspect, or when time locking is imposed by canceling the signal, that the: • Request conditioned electric switch machines controlling a switch, movable point frog or derail cannot be operated. • Request conditioned movable bridge cannot be operated. • Request conditioned home signals governing conflicting routes cannot display aspects to proceed. NOTE: *Request conditioned* means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.

9. Conventional Periodic Tests - Control Points, Interlockings, Spring Switches & Local Control Switches

9.1. Follow these procedures at time of installation and when periodically testing time locking.

Table 320-03

Step	Action
1	After clearing the absolute (home) signal and then canceling it, ensure timing circuit is in effect, then confirm the operating mechanism of any interlocked or electrically locked switch, movable-point frog, movable bridge or derail in the route governed by that signal will not release or operate and signals governing movement over conflicting routes cannot be cleared until the predetermined time interval has expired.
2	Repeat step 1 as required, for each absolute (home) signal and each route governed by the signal.

10. Conventional Periodic Tests - Electric Locks

10.1. Follow these procedures at time of installation and when periodically testing time locking at electric locks.

Table 320-04

Step	Action
1	Initiate an unlock and ensure the electric lock unlocks only after the predetermined time interval has expired. Ensure control circuits of signals governing movements over the switch are interrupted while the timer is operating.
2	Restore the electric lock to the normal, locked position.
3	If so equipped, operate the emergency release and close the electric switch lock door. Ensure control circuits of signals governing movements over the switch are interrupted.
4	Restore the emergency release and apply a new seal. Close the electric switch lock door and ensure control circuits have been restored to normal.

11. Recording Results

11.1. Record the conventional for the CTC Route in SCIS when installed, when any revisions, or alterations are made. ID each time locking circuit within the route as indicated on the site plans.

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321(a) - Testing Traffic Locking

1. Purpose

1.1. To describe the minimum operational tests required verifying that traffic locking features are functioning as intended.

2. Test Interval

2.1. Traffic locking shall be tested when installed, as required and when any revisions or alterations are made. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Definition

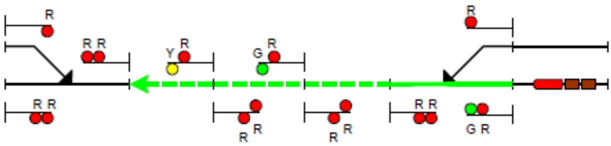
Table 321(a)-01

AREMA Communications and Signals Manual of Recommended Practices Part 1.1.1 Definition of Traffic Locking		
It is ...	**It prevents ...**	**It is in effect ...**
A type of electric locking.	An aspect to proceed from being displayed on a signal governing movements opposing the established direction of traffic.	On a section of track between opposing absolute (home) signals at adjacent controlled locations when the direction of traffic is established or maintained while: • A signal is requested or displays an aspect to proceed into that section of track; or • Any portion of that section of track is occupied; or • Time locking or approach locking is in effect on an absolute (home) signal governing movements into that section of track.

5. Illustration of Traffic Locking

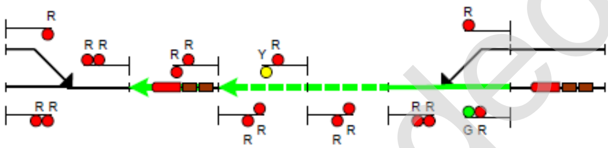
5.1. With a route selected between adjacent control points, traffic locking, shown in heavy dotted lines, will prevent opposing routes from being established into the block;

Figure 321(a)-01



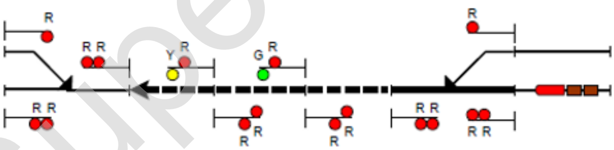
While it may allow following moves to be made into the occupied block;

Figure 321(a)-02



Note that *traffic locking* remains in effect through the block by virtue of *time* or *approach locking* (whichever applies at the home location), and *detector locking*, if the original route is cancelled;

Figure 321(a)-03



6. Time of Installation Tests

6.1. There are typically 5 progressive stages of the verification process to perform at time of installation to confirm that traffic locking is effective. Detailed verification is required in the fourth and fifth stages of testing.

Table 321(a)-02

Stage	Verification Process
1	Verify that the approach stick relay (ASR), or device that functions as the ASR, associated with each home signal at the location under test correctly responds to controlling circuitry.
2	Verify that approach or time locking associated with the absolute (home) signal(s) at the location under test is effective, and that the same security provided by such locking also exists when the signals display an aspect to proceed.
3	When following movements are permitted in either or both directions in a signaled block, verify that all approach/intermediate signals and directional stick relays respond as intended as a simulated movement progresses through the block in each direction. This movement may be executed by simulating progressive occupancy of the approach and trailing track of each approach/intermediate signal, followed by simulation of the movement approaching the next approach/intermediate signal, before removing the last occupancy at the location previously passed. As each track circuit becomes occupied and later vacated, ensure that in response to the movement: • Directional stick relays (or stick indicators) pick up and release as intended. • As each directional stick relay picks up, the opposing stick at the same location remains down. • Approach/intermediate signals governing both directions in advance and in rear of the movement display proper aspects.

Continued on next page

<table>
<tr><th>Stage</th><th>Verification Process</th></tr>
<tr><td>4</td><td>When following movements are permitted in either or both directions in a signaled block, verify that as a simulated movement in each direction is confined to each track circuit immediately adjacent to each approach/intermediate signal, with an appropriate directional stick relay at the same location energized:
A request conditioned absolute (home) signal opposing the movement cannot display an aspect to proceed.
Approach/intermediate signals opposing the movement cannot display aspects other than most restrictive (unless explicitly designed otherwise).
NOTE: Request conditioned means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays, when it is practical to do so.</td></tr>
</table>

Continued on next page

Stage	Verification Process
5	For each available route, have the absolute (home) signal display an aspect to proceed and verify that as a simulated movement passes the signal and is progressively confined to each track circuit or trap circuit protected dead section between the signal under test and the opposing absolute signal at the same location: • A request conditioned absolute (home) signal opposing the movement and located at the opposite end of the signaled block cannot display an aspect to proceed. • Approach/intermediate signals opposing the movement cannot display aspects other than most restrictive. NOTE: *Request conditioned* means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays, when it is practical to do so.

Continued on next page

Stage	Verification Process
Entering Signal	Perform the following when testing an Entering Signal into a signaled block at time of installation: • Establish vital track code or vital H line polarity from both directions (by ensuring all control signals into the block are at Stop and not running time) and verify the Entering Signal clears with the switch reverse. Ensure it remains at red while the switch is moved ¼" (typically) from reverse to full normal - in some locations it will extinguish when the switch is ¼" (typically) from normal to full normal; • Lock the switch reverse and ensure the signal clears, then displays red when vital track code or vital H line polarity is removed from one direction (by requesting a control signal into the block and observing the effect); • Re-establish vital track code or vital H line polarity from both directions, and verify the Entering Signal clears, then displays red when vital track code or vital H line polarity is removed from the other direction (by requesting the opposing control signal into the block and observing the effect). • Re-establish vital track code or vital H line polarity from both directions, and verify the signal clears, then displays red with the application of a .06 ohm shunt on the fouling circuit.

7. Traffic Locking at Electric Lock Locations

7.1. Traffic locking only applies at an electric lock location if it depends solely on the condition of vital HD circuits or vital track codes to allow it to unlock.

7.2. Approach or time locking exists at the electric lock location if there is a vital timing element at the location itself, and this Rule does not apply.

7.3. Perform the following when testing traffic locking at an electric lock.

Table 321(a)-03

Step	Action
1	Establish vital track code or vital H line polarity from both directions (by ensuring all control signals into the block are at Stop and not running time) and verify the electric lock can be unlocked.
2	Restore the electric lock operating handle to its normal position.
3	Remove vital track code or vital H line polarity from one direction (by requesting a control signal into the block and observing the effect) and attempt to unlock the electric lock. Ensure the operating handle cannot be moved beyond the intermediate position, and the electric lock does not unlock.
4	Restore the electric lock operating handle to its normal position.
5	Repeat steps 1-3 while removing vital track code or vital H line polarity from the opposite direction (by requesting the opposing control signal into the block and observing the effect).

8. Other Traffic Locking Functionalities Time of Installation

8.1. There may be variations of traffic locking that allow opposing traffic functionalities such as "Return to Train" movements to be permitted under certain circumstances. Special consideration must be given to these when developing locking tests to ensure they work as intended without compromising safety.

321(b) - Testing Field Blocking

1. Purpose

1.1. To describe the minimum operational tests required verifying that blocking features are functioning as intended.

2. Test Interval

2.1. Field blocking shall be tested when installed, when any revisions or alterations are made and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Blocking Definition

4.1. An operator-controlled feature that prevents requests for power switch movements and/or clearing of signals.

5. Test Requirements

5.1. The blocking feature is enforced by the control machine and where applicable, the field circuitry. These are the requirements for testing control machine and field blocking. Record results on the operational check sheet.

Table 321(b)-01

Blocking Type	Requirement
Signal	After blocking has been applied to a signal, determine the blocked signal cannot be cleared.
Track	After blocking has been applied to a section of track, determine that all applicable absolute (home) signals cannot be cleared into that section of track.
Switch	After blocking has been applied to a switch, determine the blocked switch, cannot be operated.

322 - Inspecting and Testing Searchlight Signal Mechanisms – General

1. Purpose

1.1. To ensure the mechanical and electrical specifications of signal mechanisms are properly inspected, tested and maintained, prior to installation and while in service.

2. Test Interval

2.1. Searchlight signal mechanisms shall be inspected and tested when installed, as required and periodically to observe their condition and to ensure that they are in suitable condition for service. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. When unplugging, removing wires from, or falsely energizing mechanisms, circuits controlling signals in one or more blocks will be affected. Also, when opening a mechanism housing, external light entering the rear of the housing can create the appearance of a phantom signal.

3.2. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Mechanism Reference

4.1. When installing or changing mechanisms, ensure they are the correct type as designated by the circuit plan.

5. In Service Mechanisms

5.1. In addition to passing a complete visual inspection, the electrical operating characteristics of in service mechanisms must comply with the field requirements listed in this General Instruction.

6. New and Shop Repaired Mechanisms

6.1. New and shop repaired mechanisms must comply with the shop requirements listed in this General Instruction. Verification that these tests have been performed shall be confirmed with the placement of a test label on the outside of the mechanism case. The initials of the tester and the test date shall be recorded on the label, which shall be positioned so as not to interfere with visual inspection of the device.

7. Spare Stock Mechanism

7.1. Serviceable mechanisms which are removed from service and kept in spare inventory must remain inventoried in SCIS and need not be retested according to any prescribed test interval.

8. Mechanisms Placed in Service

8.1. New and shop repaired mechanisms when placed in service for new installations must comply with the shop requirements listed in this General Instruction, and tested accordingly.

8.2. New and shop repaired mechanisms may also be placed into emergency service without reconfirming shop service testing specifications only if there is no doubt that the mechanism has not been placed in service since the manufacture or shop date Perform a complete visual inspection and operational check, and arrange to have the mechanism electrically tested as soon as practicable.

9. Emergency Replacements

9.1. Spare stock mechanisms when placed in emergency service must, in addition to passing a complete visual inspection and operational check, comply with the field requirements listed in this General Instruction, and must be electrically tested in accordance with these instructions at time of replacement.

10. Bad Order Mechanisms

10.1. This table explains when mechanisms are to be removed from service.

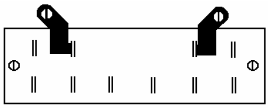
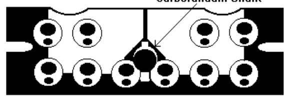
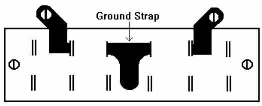
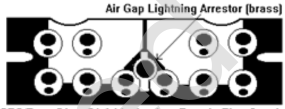
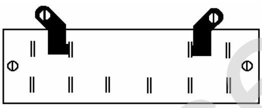
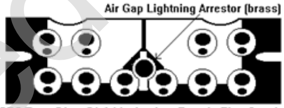
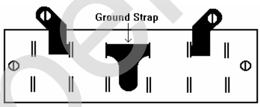
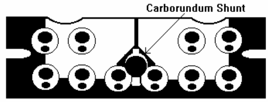
Table 322-01

If the requirements of GI 701(a) or (b) are not met and…	Then do this …
The condition of the mechanism does not present an immediate danger to the system. EXAMPLE: Foreign matter on the inside of the cover not interfering with the operation of the mechanism.	• Remove the mechanism from service as soon as practicable and note the defect on a repair tag attached to the mechanism. • Remove any test labels that may be on the outside of the mechanism case.
The condition of the mechanism does present an immediate danger to the system. EXAMPLE: The spectacle arm sticks when the control terminals are de-energized.	• Remove the mechanism from service immediately and note the defect on a repair tag attached to the mechanism. • If the mechanism cannot be replaced immediately, it shall be arranged so the signal will display its most restrictive aspect, and the system protected in accordance with GI-301(i) Protecting Train During Signal System Interruption until the mechanism has been replaced. • Remove any test labels that may be on the outside of the mechanism case.

11. GRS Plug Couplers

11.1. This table explains how to match GRS SA and SA-1 mechanism male and female plug couplers.

Table 322-02

Instruction	Male Plug Couplers	Female Plug Couplers
These couplers are a designed match.	 GRS Type SA Mechanism Male Plug Coupler	 GRS Type SA Mechanism Female Plug Coupler
These couplers are a designed match	 GRS Type SA or SA-1 Mechanism Male Plug Coupler	 GRS Type SA or SA-1 Mechanism Female Plug Coupler
These couplers can be used together.	 GRS Type SA Mechanism Male Plug Coupler	 GRS Type SA or SA-1 Mechanism Female Plug Coupler
Caution: These couplers cannot be used together because the control circuit will become grounded.	 GRS Type SA or SA-1 Mechanism Male Plug Coupler	 GRS Type SA Mechanism Female Plug Coupler

12. GRS Plug Coupler Contacts

12.1. There is a possibility that GRS type SA or SA-1 male plug coupler contacts may become bent and compressed between the male and female plug couplers if the female plug coupler is improperly installed. This presents a hazard because the contact can touch an adjacent contact between the couplers.

12.2. Whenever it is necessary to remove and replace the female plug coupler, follow the instructions in this table.

Table 322-03

Step	Action
1	Inspect the male plug coupler contacts and ensure they are in good condition.
2	Unlatch the plug coupler retainers and position the female plug coupler gently in line with its male counterpart.
3	Look down, between the two couplers and observe that the male contacts are straight and in place.
4	Carefully press the female plug coupler toward the mechanism in a gradual, even motion while continually ensuring the contacts between the two couplers remain straight until both coupler faces meet.
5	Latch the plug coupler retainers.

13. Spectacle Arm Roundel Arrangement

13.1. This table shows the arrangement of the colored roundels on the spectacle arm as viewed from the rear of the mechanism with the lamp assembly removed.

Table 322-04

US&S Mechanism	GRS/Alstom Mechanism
Y R G	G R Y

14. Mechanism Handling

14.1. Mechanisms have components that are fragile and subject to minute changes in mechanical tolerances when subjected to even fairly low levels of impact. Follow these instructions for storage, handling and transporting mechanisms:

a) Mechanisms suspected of being dropped or jarred must be visually inspected and electrically tested before being placed in service.

b) Shipping screws and ties or blocking must be properly installed on mechanisms so equipped before they are transported.

c) Mechanisms shall be stored and transported in a dry environment.

d) Regardless of the distance to be transported, mechanisms shall be properly packaged before shipment. Use either their original shipping container (if foam packed), or ensure each mechanism is sufficiently wrapped in shock absorbent material and placed in a rigid container.

14.2. NOTE: Mechanisms withheld or removed from service due to an accident or incident, must immediately be tagged as unfit for service and suitably packaged and stored or shipped as per instructions received from the responsible Supervisory Officer.

322(a) - Searchlight – Visual/Rocker

1. Purpose

1.1. To observe searchlight signal mechanisms and ensure they are in suitable working condition.

2. Test Interval

2.1. Visual Inspections of searchlight signal mechanisms shall be performed when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Other Requirements

4.1. Mechanisms not in good condition will be arranged so that the signal will display its most restrictive indication until the mechanism has been replaced.

5. Visual Inspection

5.1. This table explains the visual tests that are to be performed on all in service searchlight mechanisms. It is not intended that the mechanism be removed from the housing for this inspection.

Table 322(a)-01

Step	Action	Observe that ...
1	Inspect the signal housing for physical damage.	• The signal housing is securely fastened. • Housing door and fastenings are in good condition and padlocked.
2	Remove the lamp assembly from the mechanism housing.	• The reflector is clean and in good condition. • The lamp is not darkened or otherwise damaged. • The inner lens is clean and in good condition, and free of chips or cracks. • The spectacle arm and roundels are in good condition, have a clean appearance and are free of rust, moisture, corrosion and foreign matter.
3	Replace the lamp assembly.	• All screws, nuts and terminals are tight. • All wire tags are in place.
4	Look inside the glass cover of the mechanism.	• Visible parts have a clean appearance and are free of rust moisture, corrosion and foreign matter.
5	Check the inside of the signal housing including the cable entrance.	• There is no evidence of contamination or leaking. • Cables and wires are not damaged (pinched, bare wires, cracked insulation, etc.).

Continued on next page

Step	Action	Observe that ...
6	Check the lighting resistor.	• The resistor is securely fastened. • The moveable slide is tight and not arranged in a manner that will allow it to come in contact with the mechanism housing.

322(b) - SL Mechanism – Electrical

1. Purpose

1.1. To ensure the mechanical and electrical specifications of signal mechanisms are properly inspected, tested and maintained, prior to installation and while in service.

2. Test Interval

2.1. Searchlight signal mechanisms shall be inspected and tested when installed and at least once every two (2) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Other Requirements

4.1. Mechanisms that fail to meet these specifications shall be promptly replaced.

5. Visual Inspection

5.1. Perform the six (6) month visual inspection tests as outlined in GI-322(a) Searchlight Visual/Rocker in conjunction with additional tests outlined in this table. If conditions dictate, remove the mechanism from the signal housing for closer inspection.

Table 322(b)-01

Observe that ...	Why?
The gasket material between the glass case and the mechanism is in good condition and is not distorted.	To ensure the gasket is providing a good seal and is not interfering with the moveable working parts of the mechanism.
The mechanism outer lens is clean and in good condition. (Clean if necessary)	To ensure there is no distortion of the light beam and that it produces maximum intensity for the type of lenses being used.
The signal housing inner and outer lenses are clean and in good condition. (Clean if necessary)	
On mechanisms so equipped (US&S), the holes in the glass case for shipping screws are properly plugged.	To ensure that no dust or any other foreign matter can enter the mechanism relay housing.
Contacts appear to be free from foreign matter and in good physical condition.	To ensure that circuits will not fail due to high resistance contacts.
All screws, nuts and binding posts appear to be securely fastened. Verify seals per GI-405 Inspecting Seals.	To ensure that mechanism equipment is properly mounted and secure.

6. Electrical Tests

6.1. This table explains how electrical tests are to be performed. Ensure the mechanism is resting upright while the tests are performed.

Table 322(b)-02

<table>
<tr><th>Step</th><th>Action</th><th>Observe that…</th></tr>
<tr><td>1</td><td><table><tr><th>If the mechanism is</th><th>Then disconnect</th></tr><tr><td>Hardwired</td><td>One wire from the coil and tag it, and open the repeater test links in the case or bungalow.</td></tr><tr><td>Plug Coupled</td><td>The plug coupler.</td></tr></table></td><td>The spectacle arm is in the red position.</td></tr>
<tr><td>2</td><td>Apply initial current to the coils, as specified in the ensuing tables, (+) energy to (+) terminal, and (-) energy to (-) terminal.</td><td>The spectacle arm rotates to the yellow position smoothly and without hesitation, with the counterweight nut finally touching the upper stop nut.

Record the current value in SCIS as Wrk(R-Y).</td></tr>
</table>

Continued on next page

Step	Action	Observe that…
3 (Drop Away)	Gradually reduce the current and watch the arm travel from yellow until it reaches the full red position, with the counterweight nut finally touching the lower stop nut. Compare this current value as instructed in Step 8. Continue to reduce the current and ensure there is no further movement of the arm (otherwise repeat the test). EXCEPTION: Ansaldo(US&S) H2 mechanisms may have very slight additional movement of the spectacle arm below the drop-away point.	The spectacle arm rotates completely, smoothly and without hesitation, which together with a satisfactory drop-away value, indicates the moving parts are free from friction. EXCEPTION: GRS SA-1 mechanism spectacle arm may hesitate during travel. Ensure initial current is applied for 2 minutes, reduce current to approximately 16 mA. The arm should start to move as current is further reduced but in no case less than 10 mA. (Refer to GRS Bulletin E.I. 2232). Record the drop away current value in SCIS as Rev(Y-R).
4	Open the circuit to the coils for 1 second.	There is no further movement of the arm.

Continued on next page

Step	Action	Observe that…
5 (Pick-up)	Reconnect the circuit, with (+) energy to (+) terminal, and (-) energy to (-) terminal. Starting from zero, gradually increase the current, watching the spectacle arm travel from the red position until it just reaches the full yellow position, with the counterweight finally touching the upper stop nut. Compare this current value as instructed in step 8. Continue to increase the current and ensure there is no further movement of the arm (otherwise repeat the test).	The spectacle arm rotates completely, smoothly and without hesitation, which together with a satisfactory pick-up value, indicates that the moving parts are free from friction. EXCEPTION: GRS SA-1 mechanism spectacle arm may hesitate during travel. The arm should start to move after the current is increased from 0.0 A but in no case exceeding 18 mA. (Refer to GRS Bulletin E.I. 2232). Record the drop away current value in SCIS as Rev(R-Y).
6	Reverse the polarity and apply initial current to the coils, as specified in the ensuing tables, (+) energy to (-) terminal, and (-) energy to	The spectacle arm rotates to the green position smoothly and without hesitation.

Continued on next page

Step	Action	Observe that…
7	Repeat steps 3 to 5 for the green position, while maintaining polarities of Step 6.	Make the same observations as stated in steps 3 to 5. Record the Step 3 drop away value as Nor(G-R) and the Step 5 pick-up value as Nor(R-G).
8	Compare the values derived from the tests in Steps 3, 5 and 7 to the requirements of the ensuing Operating Values tables. Record the applicable information and results of tests in SCIS.	Mechanisms not meeting the operating value requirements must be removed from service as specified in Bad Order Mechanisms.
9	Replace the mechanism in the signal housing and install the plug coupler or reconnect the tagged wire. NOTE: Further system tests may be required in accordance with Operational Field Testing instructions.	Plug couplers (where used) are properly locked in place. Terminals are properly tightened. Wire tags are properly installed.
10	Close any repeater test links that may have been opened in Step 1.	-
11	Perform circuit ground and battery isolation fault tests as prescribed in GI-303 Testing for Grounds & Battery Isolation Faults.	No grounds were introduced by the test procedures.

7. Operating Values Shop Requirement

7.1. This table specifies the required operating values for shop testing of searchlight mechanisms with three indications, permanent magnet and contacts.

7.2. NOTE: The resistance of the coils may vary 10%; therefore, the current or voltage may vary accordingly. Current values are shown and reported in milliamps.

Table 322(b)-03

<table>
<tr><th colspan="8">SHOP REQUIREMENTS</th></tr>
<tr><th rowspan="2">Model</th><th>Coil</th><th colspan="2">Initial Charge</th><th colspan="2">Minimum Drop-away</th><th colspan="2">Maximum Pick-up and Working</th></tr>
<tr><th>Ohms</th><th>Volts</th><th>mA</th><th>Volts</th><th>mA</th><th>Volts</th><th>mA</th></tr>
<tr><td rowspan="2">H,
H2 or H5</td><td>250</td><td>11.0</td><td>44</td><td>2.00</td><td>8.0</td><td>5.50</td><td>22</td></tr>
<tr><td>500</td><td>16.0</td><td>32</td><td>3.00</td><td>6.0</td><td>8.00</td><td>16</td></tr>
<tr><td>SA-1</td><td>250</td><td>12.50</td><td>50</td><td>1.88</td><td>7.5</td><td>5.75</td><td>23</td></tr>
<tr><td rowspan="4">SA</td><td>250</td><td>9.00</td><td>36</td><td>2.25</td><td>9.0</td><td>6.00</td><td>24</td></tr>
<tr><td>430</td><td>13.00</td><td>30</td><td>3.14</td><td>7.3</td><td>8.13</td><td>18.9</td></tr>
<tr><td>105</td><td>5.67</td><td>54</td><td>1.34</td><td>12.8</td><td>3.46</td><td>33</td></tr>
<tr><td>380</td><td>11.80</td><td>31</td><td>3.15</td><td>8.3</td><td>7.98</td><td>21</td></tr>
</table>

Per AREMA C&S Manual Part 7.4.1

8. Operating Values Field Requirements

8.1. This table specifies the required operating values for field testing of searchlight mechanisms with three indications, permanent magnet and contacts.

8.2. NOTE: The resistance of the coils may vary 10%, therefore the current or voltage may vary accordingly. Current values are shown and reported in milliamps.

Table 322(b)-04

FIELD REQUIREMENTS							
Model	Coil	Initial Charge		Minimum Drop-away		Maximum Pick-up and Working	
	Ohms	Volts	mA	Volts	mA	Volts	mA
H, H2 or H5	250	11.00	44	1.60	6.4	6.50	26
	500	16.00	32	2.40	4.8	9.00	18
SA-1	250	12.50	50	1.43	5.7	7.00	28
SA	250	9.00	36	1.80	7.2	7.20	29
	430	13.00	30	2.51	5.8	9.76	22.7
	105	5.67	54	1.08	10.2	4.14	39.4
	380	11.80	31	2.25	5.9	8.80	23

Per AREMA C&S Manual Part 7.4.1

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323 - Inspecting and Testing Relays

1. Purpose

1.1. Proper functionality of relays and other electromagnetic equipment is essential to the safety of train operations and safe performance of grade crossing warning systems. Relays and other electromagnetic equipment shall be inspected and tested when installed and periodically to ensure that they are in suitable condition for service.

1.2. Equipment that is not in good condition or otherwise fails to meet requirements shall be promptly replaced.

2. Train Safety

2.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

3. Relay Reference

3.1. When installing or changing any relay or other electromagnetic equipment, ensure it is the correct model and reference number as designated by the circuit plan.

4. Test Instrument Connection

4.1. When testing relays, such as shelf type, that cannot be unplugged from the circuitry without removing wires, follow the instructions in this table.

Table 323-01

If…	Then …
The coil terminal of the relay is equipped with a test eye.	Open the test eye before connecting the test instrument.
The coil terminal is not equipped with a test eye and has circuit wiring attached directly to it.	Remove all wires, and/or any other attachments, from the coil terminal before connecting the test instrument.

5. In Service Relays

5.1. In addition to passing a complete visual inspection, the electrical operating characteristics of in service relays must comply with the field requirements listed in this General Instruction.

6. New and Shop Repaired Relays

6.1. New and shop repaired relays must comply with the shop requirements listed in this General Instruction. Verification that these tests have been performed shall be confirmed with the placement of a test label on the outside of the relay case. The initials of the tester and the test date shall be recorded on the label, which shall be positioned so as not to interfere with visual inspection of the device.

7. Spare Stock Relay

7.1. Serviceable relays which are removed from service and kept in spare inventory must remain inventoried in SCIS and need not be retested according to any prescribed test interval.

8. Relays Placed in Service

8.1. New and shop repaired relays when placed in service for new installations must comply with the shop requirements listed in this General Instruction, and tested accordingly.

8.2. New and shop repaired relays may also be placed into emergency service without reconfirming shop service testing specifications only if there is no doubt that the relay has not been placed in service since the manufacture or shop date. Perform a complete visual inspection and operational check, and arrange to have the relay electrically tested as soon as practicable.

9. Emergency Replacements

9.1. Spare stock relays when placed in emergency service must, in addition to passing a complete visual inspection and operational check, comply with the field requirements listed in this General Instruction, and must be electrically tested in accordance with these instructions at time of replacement.

10. Relay Accessories

10.1. Upon installation, shipping screws, air vent tape, ties or blocking must be removed from the relay, and kept with the relay or stored in a place that can be easily accessed when it is required for moving or shipping purposes.

11. Bad Order Relays

11.1. This table explains when relays are to be removed from service.

Table 323-02

If the requirements of GI-323 (a), (b), (c), or (d) are not met and ...	Then do this ...
The condition of the relay *does not* present an immediate danger to the system. EXAMPLE: Carbon on the inside of the cover that does not interfere with the operation of the relay. EXAMPLE: Relay contacts are worn and pitted.	• Remove the relay from service as soon as practicable and note the defect on a repair tag attached to the relay. • Create a SCIS Notification describing the defect.
The condition of the relay *does* present an immediate danger to the system. EXAMPLE: Moving parts of the relay rubbing against the cover. EXAMLE: Slivers or particles of metal on or near the armature or permanent magnetic extension.	• Remove the relay from service immediately and note the defect on a repair tag attached to the relay. • If the relay cannot be replaced immediately, the system must be protected in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption until the relay has been replaced. • Create a SCIS Notification describing the defect.

12. Relay Handling

12.1. Relays and other electromagnetic equipment may have components that are fragile and subject to minute changes in mechanical tolerances when subjected to even fairly low levels of impact. Follow these instructions for storage, handling and transporting such equipment:

a) Relays suspected of being dropped or jarred must be carefully inspected visually and electrically tested before being placed in service.

b) Shipping screws, air vent tape, ties or blocking must be properly installed on relays so equipped before they are transported.

c) Relays shall be stored and transported in a dry environment.

d) Regardless of the distance to be transported, relays shall be properly packaged before shipment. Use either their original shipping container (if foam packed) or ensure each relay is sufficiently wrapped in shock absorbent material and placed in a rigid container.

12.2. Equipment withheld or removed from service due to an accident or incident, must immediately be tagged as unfit for service and suitably packaged and stored or shipped as per instructions received from the responsible Supervisory Officer.

13. Documentation and Reporting

13.1. Record the applicable information and results of all tests in SCIS.

323(a) - Relays - Visual Inspection

1. Purpose

1.1. Proper functioning of relays and other electromagnetic equipment is essential to the safety of train operations and safe performance of highway grade crossing warning systems. Relays and other electromagnetic equipment shall be inspected and tested to ensure that they are in suitable condition for service.

2. Test Interval

2.1. Relays and other electromagnetic equipment shall be visually inspected when installed, if the bungalow is repositioned or re-aligned, as required and as prescribed by other tests. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Relay Visual Inspection

4.1. This table explains the visual tests that are to be performed on all relays and other electromagnetic devices. It is not intended that the relay be removed from its mounting place for visual tests unless detailed observation is required.

Table 323(a)-01

Observe that ...	Why?
• All screws, nuts and binding posts are securely fastened and lock washers, where used are effective. • Plug-in relays properly seated and locked in the plugboard. • Verify seals per GI-405 Inspecting Seals.	To ensure that equipment is properly mounted, secured, and sealed.
Shipping covers over relay vents are removed and vents are clear of any obstruction on relays so equipped.	To ensure that relays equipped with vents are properly ventilated.
• Plating is not chipped or peeling and parts have a clean appearance and are free of rust, moisture, corrosion and foreign matter, particularly on the armature or pole pieces. • Check that the specification sticker is in place.	To ensure that foreign matter or corrosion does not interfere with the proper operation of the relay armature.
GRS Type K flasher relays do not have less than 10 flash rate adjustment washers on the coil.	Less than 10 washers may set up a condition where the relay contacts will hang open.
US&S FN16 and FN16A flasher relays do not have less than 6 flash rate adjustment washers on the coil.	Less than 6 washers may set up a condition where the relay contacts will hang open.

Continued on next page

Observe that ...	Why?
Conventional shelf type relays (GRS type K or US&S DN11) are loosely secured to the instrument housing mounting board with the use of Ty-wrap(s).	To ensure they do not come off their spring mountings and tip over in the event of sudden impact to the instrument housing.
There is no evidence of moving parts (i.e. indicator arms, contact drivers, armature) coming in contact with the cover or other stationary parts of the relay.	To ensure there is no mechanical interference with the movement of the relay armature.
Contacts are not severely burned or pitted. NOTE: If it is suspected that contacts are burned or pitted to a point where failure of the circuit is a concern, measure their resistance and refer to GI-323(b) Relay Electrical section Contact Resistance DC Neutral Relays, or GI-323(c) DC Polar and AC Vane Relays section Contact Resistance AC Relays. Measure all contacts on the suspect relay. It is recommended that a low-resistance ohmmeter be used to take these measurements.	To ensure that circuits are not in danger of circuit failure due to high resistance contacts.

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323(b) - Relay Electrical

1. Purpose

1.1. Proper functioning of relays and other electromagnetic equipment is essential to the safety of train operations and safe performance of highway grade crossing warning systems. Relays and other electromagnetic equipment shall be inspected and tested to ensure that they are in suitable condition for service.

2. Test Interval

2.1. Electrical tests shall be performed when installed, if the bungalow is repositioned or re-aligned, as required, as prescribed by other tests and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Relay Visual Inspection

4.1. Perform visual inspection tests as prescribed in GI-323(a) Relays – Visual Inspection in conjunction with the tests outlined in this table.

Table 323(b)-01

Observe that …	To ensure that …
During actual operation, the relay has positive drop-away and relay contacts open without retardation of movement due to friction or any other cause.	Contamination is not present that may retard or stop the drop-away of the relay. EXAMPLE: On drop-away, closely observe the action of the neutral armature as it leaves the stop pin (it should move slowly). Sudden armature movement as it leaves the stop pin may indicate that a sticky substance is on the stop pin surface.
Normal front, back and polar contact openings exist in all possible energized and de-energized states.	Contacts are in proper alignment in either the energized or de-energized state. Contacts that are not in alignment may be an indication there is a problem with the contact drivers resulting in improper contact pressures.
Permanent magnet and magnetic extension area is free of foreign material such as slivers or particles of metal.	Foreign materials cannot partially or completely prevent the relay armature from dropping to its de-energized position.
Adequate clearance exists between the cover and moving parts and between visible fixed and moving parts.	The moving parts of the relay (i.e. indicator arms, armature) do not become jammed against stationary parts and create a situation where armature and/or contacts may stick in the wrong position.

Continued on next page

Observe that ...	To ensure that ...
Armatures of relays move freely, are in proper alignment with the pole face and that contacts align with and meet the fixed contact surfaces squarely.	There is no evidence of mechanical binding and that the relay contacts are in good condition and properly aligned to provide optimum performance while in service.

5. DC Relay Coil Polarity

5.1. This table explains how to test the coil polarity of DC neutral and DC biased neutral relays.

Table 323(b)-02

Type	Energy applied to the relay coils	Relay State
DC Neutral Relay	Positive (+) energy to positive (+) coil terminal, negative (-) energy to negative (-) coil terminal.	Energized
	Negative (-) energy to positive (+) coil terminal, positive (+) energy to negative (-) coil terminal.	Energized
DC Biased Neutral Relay	Positive (+) energy to positive (+) coil terminal, negative (-) energy to negative (-) coil terminal.	Energized
	Negative (-) energy to positive (+) coil terminal, positive (+) energy to negative (-) coil terminal.	De-energized

6. Contact Resistance DC Neutral Relays

6.1. The values in this table are a shop requirement only and are to be used as a guideline when visual inspection of in service DC neutral and DC biased neutral relays indicates that severely burned or pitted contacts may lead to circuit deterioration or failure due to high resistance.

Table 323(b)-03

Contact Type	Resistance	
	Front contacts, relay energized to working current or voltage.	Back contacts, relay de- energized.
Metal to metal.	0.03 ohm	0.03 ohm
Metal to carbon.	0.18 ohm	0.36 ohm
Metal to metal impregnated carbon.	0.09 ohm	0.18 ohm
Carbon to carbon.	0.40 ohm	0.80 ohm
Metal impregnated carbon to metal impregnated carbon.	0.20 ohm	0.40 ohm

7. Electrical Tests - DC Neutral Relays

7.1. This table explains how electrical tests are to be performed on DC neutral and biased neutral relays.

a. As the tests are being performed, compare the measured values to the requirements of the table on the following page.

b. If these requirements are not met, the relay must be removed from service as specified in Bad Order Relays.

7.2. Drop-away, pick-up and working values of DC neutral and biased neutral relays must be determined in the normal direction of energization, when energy is applied with the polarity as marked on the relay coil terminals.

Table 323(b)-04

Step	Action
1 (Drop-away)	Apply service current to the coils, as specified in Operating Characteristics for DC Neutral Relays, and gradually reduce current until the armature drops away.
2 (Pick-up)	Open the circuit for one second and apply current to the coils in the same direction. Gradually increase the current until the front contacts just close.
3 (Working)	Increase the current until the armature is against the stop.

8. Operating Characteristics DC Neutral Relays

8.1. This table specifies the required operating values for shop and field testing of tractive armature DC neutral and biased neutral relays.

Table 323(b)-05

Test	Shop Requirements	Field Requirements
Initial charge.	Four times pick-up.	Service working current or voltage.
Drop-away value for relays having iron magnetic structure. NOTE: These relays are no longer in common usage.	Not less than 90% of original marking nor less than 43% of pick-up.	**Track Relays** - Not less than 67% of original marking and in no case less than: • 35 mA for 2 ohm relay • 25 mA for 4 ohm relay **Line Relays** - Not less than 67% of original marking.
Drop-away value for relays having silicon steel magnetic structure.	Not less than 95% of original marking.	**Track Relays** - Not less than 85% of original marking and in no case less than: • 45 mA for 2 ohm relay • 32 mA for 4 ohm relay **Line Relays** - Not less than 67% of original marking.
Normal pick-up value.	Not more than 110% of original marking.	Not more than 110% of original marking.
Normal working value.	Not more than 110% of original marking.	Not more than 110% of original marking.

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323(b)(1) - Flasher Relay

1. Purpose

1.1. To ensure the flasher relay operates at a steady, consistent pace in order to provide maximum conspicuity of the signal being flashed.

2. Test Interval

2.1. Flasher relay tests shall be performed when installed, if the bungalow is repositioned or re-aligned, as required, as prescribed by other tests and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Relay Tests

4.1. All relay tests prescribed by GI-323(b) Relay Electrical must be performed on flasher relay(s) before performing the flasher test. This can be done by disabling the flasher pack to allow electrical operating values to be measured

5. Test Procedure

5.1. All relay tests prescribed in the previous sections must be performed on flasher relay(s) before performing this flasher relay test. This can be done by disabling the flasher pack to allow electrical operating values to be measured.

5.2. This table provides the prescribed flash rates for various applications of flasher relays. Measure and record the actual flash rate in SCIS.

Table 323(b)(1)-01

Application	Location	Flash Rate (fpm)	Duty Cycle
Crossing System	Installed prior to May 18, 1983	Not less than 30 nor more than 50	50%
		Not less than 45 nor more than 65 at locations designed to operate at these limits	
	Installed after May 18, 1983	Not less than 45 nor more than 65	
Wayside Signals	All	Not less than 60 nor more than 70	

323(b)(2) - Power Off (PO) Relay

1. Purpose

1.1. Proper functioning of relays and other electromagnetic equipment is essential to the safety of train operations and safe performance of highway grade crossing warning systems. Relays and other electromagnetic equipment shall be inspected and tested to ensure that they are in suitable condition for service

2. Test Interval

2.1. PO relay tests shall be performed when installed, if the bungalow is repositioned or re-aligned, as required, as prescribed by other tests and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Perform the following test with a variable output AC supply.

Table 323(b)(2)-01

<table>
<tr><th>Step</th><th>Action</th><th>Requirement</th></tr>
<tr><td>1</td><td>Remove lighting transformer from the rectifier circuit.</td><td></td></tr>
<tr><td>2
Pick-up</td><td>Apply a reduced AC voltage at the input to the stack rectifier and gradually increase it until the front contacts just close.</td><td>Not more than 110% of original marking.</td></tr>
<tr><td>3
Normal Working</td><td>Gradually increase the AC voltage from pick-up value until the moving element strikes its normal or front stop.</td><td></td></tr>
<tr><td>4
Drop-away</td><td>Gradually reduce the AC voltage from normal working value until the contacts just open.</td><td>Not less than 90% of pick-up.</td></tr>
<tr><td>5</td><td colspan="2">If the relay fails to meet requirements, ensure the stack rectifier is pinned correctly. If the values still do not meet requirements, remove the relay from the rectifier and re-measure the values using a test rectifier.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The values meet the requirements</td><td>The stack rectifier must be repaired or removed from service.</td></tr>
<tr><td>The values still do not meet the requirements</td><td>The relay must be removed from service as specified in Bad Order Relays.</td></tr>
</table></td></tr>
<tr><td>6</td><td colspan="2">Restore the lighting transformer with the rectifier circuit.</td></tr>
</table>

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323(c) - DC Polar & AC Vane Relays

1. Purpose

1.1. Proper functioning of AC Vane, DC Polar, and soft iron magnetic structure relays are essential to the safety of train operations and safe performance of highway grade crossing warning systems. Relays and other electromagnetic equipment shall be inspected and tested to ensure that they are in suitable condition for service.

2. Test Interval

2.1. DC Polar and AC Vane Relay tests shall be performed when installed, if the bungalow is repositioned or re-aligned, as required, as prescribed by other tests and at least once every two (2) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. AC Vane Relay Visual Inspection

4.1. Perform Relay Visual Inspection tests as prescribed in GI-323(a) Relays – Visual Inspection and 323(b) Relay Electrical paragraph 4 Relay Visual Inspections.

5. Varying Current

5.1. When performing AC Vane relay tests for pick-up, working and drop-away values, vary the energy very slowly to get accurate results.

6. Contact Resistance AC Relays

6.1. The values in this table are a shop requirement only and are to be used as a guideline when visual inspection of in-service AC Vane relays indicates that severely burned or pitted contacts may lead to circuit deterioration or failure due to high resistance.

Table 323(c)-01

Contact Type	Resistance	
	Front contacts, relay energized to working current or voltage.	Back contacts, relay de- energized.
Metal to metal.	0.03 ohm	0.03 ohm
Metal to carbon.	0.18 ohm	0.36 ohm
Metal to metal impregnated carbon.	0.09 ohm	0.18 ohm
Carbon to carbon.	0.40 ohm	0.80 ohm
Metal impregnated carbon to metal impregnated carbon.	0.20 ohm	0.40 ohm

7. Electrical Tests AC Vane Relays

7.1. This table explains how electrical tests are to be performed on AC Vane relays.

7.2. As the tests are being performed, compare the measured values to the requirements of the table on the following page.

7.3. If these requirements are not met, the relay must be removed from service as specified in Bad Order Relays.

Table 323(c)-02

Step	Action
1 Pick-up	Apply a reduced current and gradually increase it until the front contacts just close. NOTE: This test must be performed in both normal and reverse positions for a three-position relay.
2 Normal Working	Gradually increase the current from pick-up value until the moving element strikes its normal or front stop. NOTE: This test must be performed in both normal and reverse positions for a three-position relay.
3 Drop-away	Gradually reduce the current from normal working value until the contacts just open.

8. Operating Characteristics AC Vane Relays

8.1. This table is intended to be used as a guideline for performing the tests. The missing data from this table must be obtained from the manufacturer's instructions to cover the types and specification numbers of relays used.

Table 323(c)-03

Shop and Field Requirements			
Test	**Single Element**	**Two Element**	
		Two Position	**Three Position**
Pick-up (normal direction)	Not more than ...% of original marking.	Not more than ...% of original marking.	Not more than ...% of original marking.
Pick-up (reverse direction)			Not more than ...% of original marking.
Working current or voltage (normal direction)	Not more than ...% of original marking.	Not more than ...% of original marking.	Not more than ...% of original marking.
Working current or voltage (reverse direction)			Not more than ...% of original marking.
Drop-away (normal direction)	Not less than ...% of pick-up.	Not less than ...% of pick-up.	Not less than ...% of pick-up.
Drop-away (reverse direction)			Not less than ...% of pick-up.

9. DC Polar Relay Visual Inspection

9.1. Perform Relay Visual Inspection tests as prescribed in GI 323(a) Relays – Visual Inspection and GI 323(b) Relay Electrical section Relay Visual Inspections. Electrical Tests - DC Polar Relays

9.2. This table explains how electrical tests are to be performed on DC polar relays. Always compare the actual values to the requirements of the table on the following page. If these requirements are not met, the relay must be removed from service as specified in Bad Order Relays.

Table 323(c)-04

Step	Action
1 Neutral Armature Drop-away)	Apply initial current to the coils, in the normal direction, as specified in operating characteristics for polar relays then gradually reduce it until the neutral armature drops away.
2 (Neutral Armature Pick-up)	Open the circuit for one second and apply current to the coils in the same direction and gradually increase it until the front contacts of the neutral armature just close.
3 (Neutral Armature Normal Working)	Gradually increase the current until the neutral armature is against the stop.
4 (Reverse Polar Pick-up and Working)	Increase the current to its initial value and then decrease it to zero. Open the circuit for 1 second and apply current in the reverse direction. Gradually increase the current from zero until the polar armature reverses. At this value the polar armature must go against its stop.

Continued on next page

Step	Action
5 (Neutral Armature Reverse Working)	Increase the current gradually until the neutral armature is against the stop.
6 (Normal Polar Pick-up and Working)	Increase the current to the initial value and then decrease it to zero. Open the circuit for 1 second and apply current in the normal direction, gradually increasing it from zero until the polar armature returns to normal. At this value the polar armature must go against its stop.
7	Increase the energy in the same direction until the neutral armature is against its stop. This value must not exceed that specified for neutral armature reverse working in the operating characteristics for polar relays table.
8	Polar armatures must remain in the last energized position without current in either direction in the coils.

10. Operating Characteristics DC Polar Relays

10.1. This table specifies the required operating values for shop and field testing of DC polar relays.

Table 323(c)-05

Test	Shop Requirements	Field Requirements
Initial charge.	Four times pick-up.	Service working current or voltage.
Drop-away value for relays having silicon steel magnetic structure	Not less than 95% of original marking.	**Track Relays** - Not less than 85% of original marking and in no case less than: • 45 mA for 2 ohm relay • 32 mA for 4 ohm relay **Line Relays** - Not less than 67% of original marking.
Drop-away value for relays having iron magnetic structure	Not less than 90% of original marking nor less than 43% of pick- up.	**Track Relays** - Not less than 67% of original marking and in no case less than: • 35 mA for 2 ohm relay • 25 mA for 4 ohm relay **Line Relays** - Not less than 67% of original marking.
Normal pick-up value.	Not more than 110% of original marking.	Not more than 110% of original marking.
Normal working value.	Not more than 110% of original marking.	Not more than 110% of original marking.
Reverse working value	Not more than 110% of original marking.	Not more than 110% of original marking.
Normal and reverse polar pick-up and working value	Not more than 70% of pick-up of neutral armature.	Not more than 80% of pick-up of neutral armature.

11. Soft Iron Magnetic Structure Relays

11.1. Perform all inspections and tests as outlined in GI-323(b) Relay Electrical on a 2 year interval for soft iron magnetic structure relays.

11.2. These relays are no longer in common usage.

323(d) - AC Centrifugal Type Relays

1. Purpose

1.1. Proper functioning of AC centrifugal type relays is essential to the safety of train operations and safe performance of highway grade crossing warning systems. Relays and other electromagnetic equipment shall be inspected and tested to ensure that they are in suitable condition for service.

2. Test Interval

2.1. Relays shall be inspected and tested when installed, as required, as prescribed by other tests and at least once every one (1) year. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Requirements

4.1. Perform all inspections and tests as outlined in manufacturer recommendations for AC Centrifugal type relays.

4.2. These relays are only used in very limited and specialized applications.

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324 - Supplementary Inspections and Tests

1. Purpose

1.1. To provide a mechanism for recording the results of reportable inspections and tests which are deemed necessary for specialized equipment not already identified in the General Instructions.

2. Test Interval

2.1. As directed by Special Instructions or after one of a kind events such as floods, fire, exposure to excessive vibration, affected equipment shall be inspected and tested to observe its condition and to ensure it is maintained in a safe and suitable condition for service when installed and at defined intervals as necessary. Refer to GI-301(h) Inspection and Test Intervals for typical test intervals.

3. Train Safety

3.1. If inspections or tests interfere with safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Examples

4.1. The following are examples of when these GIs do not cover all inspections and tests that may be required:

a) New systems or equipment are installed and maintained using procedures provided by the manufacturer.

b) Legacy systems or equipment that exist on a Regional basis for which the procedures have not been integrated on a System basis.

c) Instances where the need for a specific inspection or test is not realized until after the equipment has been in service for some time.

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326 - Inspecting and Testing Fouling Circuits

1. Purpose

1.1. To ensure that bond and fouling wires are installed and maintained in a manner that will assure the detection of rolling stock within the fouling section of a turnout.

2. Test Interval

2.1. Fouling circuits on turnouts shall be inspected and tested when installed, following any work or occurrence that can affect the fouling circuit and at least once every three (3) months to ensure that shunt detection functions as intended. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Inspector Tests

4.1. A Signal Inspector or designated employee acting in an inspection capacity, shall be assigned to perform these tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period.

5. Track Circuits

5.1. Due to the fact that fouling circuits can either form all or part of a track circuit, the instructions governing work on track circuits apply. Before starting these tests, refer to GI-333 Testing Track Circuits.

6. Track Hardware

6.1. Faulty track appliances can have a significant impact on the operation of fouling circuits. Refer to GI-332 Inspecting and Testing Track Hardware.

7. Switch Circuit Controllers

7.1. To maximize efficiency, perform these tests in conjunction with GI-327(a) Inspecting and Testing Switch Circuit Controllers.

8. Bonds & Fouling Wires

8.1. All rail joints within the turnout shall be bonded. Other bonds in the frog and switch point area shall be installed as shown in these diagrams.

a) Inspect all bond wires within the confines of the turnout and ensure they are secure and in good condition.

b) Ensure all new track connections are installed in accordance with instructions in SCP-5 and with the bonding procedures per SCP-11.

c) Inspect all fouling wires within the limits of the turnout and ensure they are installed in accordance with SCP-11, are secure and in good condition.

9. Rail Polarity

9.1. At time of installation, and whenever changes are made to the fouling circuit, track polarity readings shall be taken on both sides of each insulated joint to ensure they are according to plan and that polarity is correctly staggered.

10. Shunt Test

10.1. Apply a 0.06 ohm shunt as instructed in Figures 326-1 to 326-4. Observe that the track relay[1] de-energizes each time the shunt is applied.

10.2. When a track circuit is installed, the appropriate track relay[1](s) shall be observed each time a shunt is applied. During periodic testing, where approach lighting is used, the lighting of the signal can be used to verify the state of the track relay[1]. Alternatively, when working alone, the test may be performed as described below. Refer to Section 15 for an explanation of how to calculate the minimum drop away voltage.

Table 326-01

Step	Action
1	Connect a DC voltmeter (or peak meter for coded tracks) to the rails by the insulated joints at the relay[1] end of the track circuit containing the fouling circuit.
2	Note the track (peak) voltage.
3	Place a 0.06 ohm shunt on the rails and observe that the track (peak) voltage drops below the minimum drop away voltage and the track relay[1] de-energizes.
4	Remove meter & shunt from the rails, proceed to the next fouling circuit location and connect the meter to the main track portion of the fouling circuit. Verify the track (peak) voltage is at least 90% of the value noted in Step 2, otherwise this method cannot be used.
5	Apply shunt and observe that the track (peak) voltage drops below the minimum drop away voltage, otherwise, the actual relay[1] must be observed to drop with the shunt applied. Repeat Steps 4 & 5 for each shunt location shown in applicable Figures 326-1 to 326-4.

[1] Or device that functions as a track relay.

10.3. For each figure, the test shunt points are indicated by number, and shunts shall be applied as close to the insulated joints as possible.

10.4. Test shunt number 1 shall be applied directly on the switch points and is required on bolted turnouts to verify the gate bonds on the bolted heel blocks.

11. Crossover Shunt Fouling

11.1. Figure 326-1 illustrates:

a) The typical location of fouling wires, refer to SCP-11 for exact location.

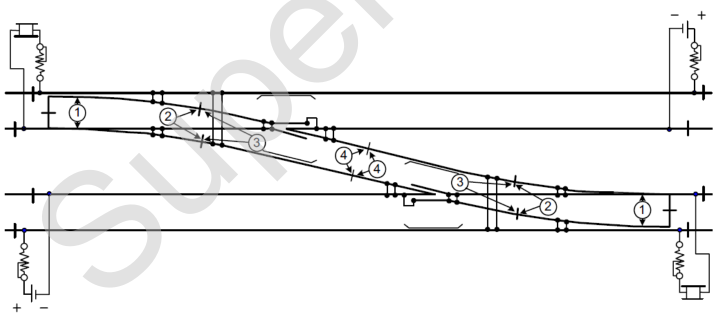
b) The typical location of rail bonds, except at rail joints, refer to SCP-11 for exact location.

c) Typical track polarity.

d) Where 0.06 ohm test shunts are to be applied. Older style crossovers that have the shunt fouling wires placed on the other side of the frog will require that shunts be applied on both sides of the joints at location 2.

11.2. Test shunt number 1 shall be applied directly on the switch points and is required on bolted turnouts to verify the gate bonds on the bolted heel blocks.

Figure 326-1: Crossover Shunt Fouling



12. Turnout Shunt Fouling

12.1. Figure 326-2 illustrates:

a) The typical location of fouling wires, refer to SCP-11 for exact location.

b) The typical location of rail bonds, except at rail joints, refer to SCP-11 for exact location.

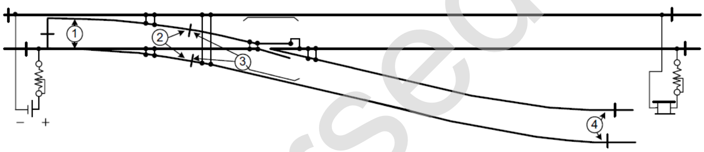
c) Typical track polarity.

d) Where 0.06 ohm test shunts are to be applied.

12.2. Note: Ensure insulated joints at location 4 are a minimum 16' beyond clearance point, as required by SCP-1.

12.3. Test shunt number 1 shall be applied directly on the switch points and is required on bolted turnouts to verify the gate bonds on the bolted heel blocks.

Figure 326-2: Turnout Shunt Fouling



13. Turnout Series Fouling, 2 Relay

13.1. Figure 326-3 illustrates:

a) The typical location of fouling wires, refer to SCP-11 for exact location.

b) The typical location of rail bonds, except at rail joints, refer to SCP-11 for exact location.

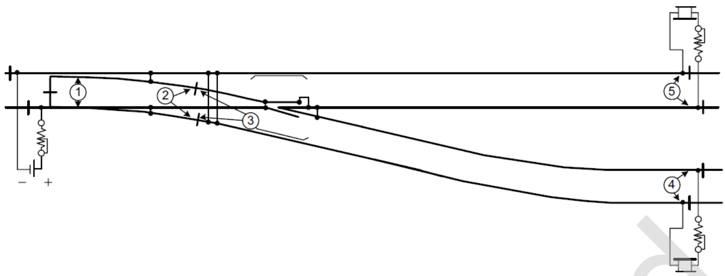
c) Typical track polarity.

d) Where 0.06 ohm test shunts are to be applied.

13.2. Note: Ensure insulated joints at location 4 & 5 are a minimum 16' beyond clearance point, as required by SCP-1.

13.3. Test shunt number 1 shall be applied directly on the switch points and is required on bolted turnouts to verify the gate bonds on the bolted heel blocks.

Figure 326-3: Turnout Series Fouling, 2 Relay



14. Turnout Series Fouling, 1 Relay

14.1. Figure 326-4 illustrates:

a) The typical location of fouling wires, refer to SCP-11 for exact location.

b) The typical location of rail bonds, except at rail joints, refer to SCP-11 for exact location.

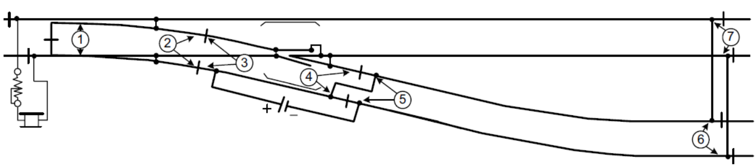
c) Typical track polarity.

d) Where 0.06 ohm test shunts are to be applied.

14.2. NOTE: Ensure insulated joints at location 6 & 7 are a minimum 16′ beyond clearance point, as required by SCP-1.

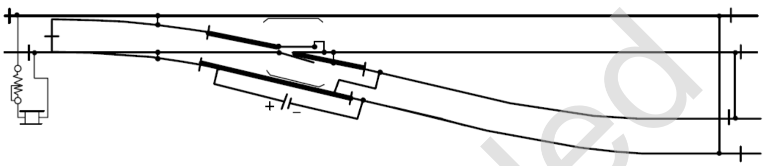
14.3. Test shunt number 1 shall be applied directly on the switch points and is required on bolted turnouts to verify the gate bonds on the bolted heel blocks.

Figure 326-4: Turnout Series Fouling, 1 Relay



14.4. CAUTION: This is not a test. This illustrates the dead section (heavy lines) which can occur if the fouling jumpers in Figure 326-4 are improperly installed. This condition will be detected if test shunts are properly applied as instructed in Figure 326-4.

Figure 326-5: Turnout Series Fouling, 1 Relay (DEAD SECTION EXAMPLE)



15. How to Determine Minimum Drop Away Voltage

15.1. A reference voltage is required when verifying that a 0.06 ohm shunt has sufficiently shunted the track by observation of voltmeter readings. The following procedure can be used to calculate this reference voltage, which is referred to as the *Minimum Drop Away Voltage*.

a) Open the track lead terminals in the bungalow or case.

b) With an ohmmeter, measure and note the resistance of the relay end track resistor in *ohms*, then close the track lead terminals.

c) Based on the track circuit and relay type, refer to this table (for coded track circuits), or the table on the next page (for DC track circuits), and obtain the minimum current value from column 2 of the table.

d) Use Ohm's law to calculate the minimum voltage drop across the resistor by multiplying **Resistance** (Step 2) x **Current** (Step 3).

e) Add the calculated voltage from Step 4 with the minimum relay voltage from column 3 of the table. This is the *minimum drop away voltage*.

15.2. The following table is to be used for Coded Track Circuits.

Table 326-02

Coding Track Circuits Relay	Min PU (A)	Min V (V)
A62-491	.324	0.08
A62-492	.324	0.08
A62-495	.459	0.09
A62-530	.459	0.09
A62-629	.459	0.09
A62-155	.383	0.05
A65-170	.410	0.07
59301150 Group 4	.151	0.05
59301150 Group 6	.171	0.05
59301151 Group 7	.324	0.08
N342560001 (PC250BE)	.610	0.06
N342560002 (PC250BE)	.225	0.07
N322560004 (PC250BAE)	.140	0.04
264821(P4)	.140	0.04
Genrakode	.500	0.15
R-Code	.450	0.45
Electrocode	.440	0.12

15.4. The following table is to be used for DC Track Circuits.

Table 326-03

DC Track Circuits Relay	Min DA (A)	Min V (V)	DC Track Circuits Relay	Min DA (A)	Min V (V)
A62 120 Series	.065	0.13	A62 639 Parallel	.218	0.11
A62 120 Parallel	.130	0.07	A65 300 Series	.047	0.09
A62 155 Series	.195	0.03	A65 310 Series	.046	0.09
A62 260 Series	.063	0.11	A65 320 Series	.054	0.11
A62 261 Series	.044	0.18	PN150 BH Series	.108	0.22
A62 270 Series	.042	0.08	PN150 BH	.216	0.11
A62 271 Series	.030	0.12	PN150 BTR (1 Ω	.112	0.11
A62 275 Series	.064	0.12	PN150 BTR (4 Ω	.059	0.24
A62 275 Parallel	.128	0.06	DN11 (4 point)	.031	0.12
A62 276 Series	.035	0.14	DN11 (6 point)	.034	0.14
A62 276 Parallel	.070	0.07	DN22 BH (0.5 Ω	.145	0.07
A62 290 Series	.030	0.12	DN22 BH (1 Ω	.104	0.10
A62 290 Parallel	.060	0.06	DN22 BH (2 Ω	.072	0.14
A62 293 Series	.060	0.36	DN22 BH (4 Ω	.052	0.21
A62 560 Series	.144	0.03	Siemen CASBO2	.050	0.20
A62 598 Series	.006	0.48			

16. Example on Calculating Minimum Drop Away Voltage

16.1. SWT Circuit with PN150BTR 4 ohm relay is opened and resistance of SWT resistor is measured to be 1.6 Ohms.

a) Step 2: 1.6 Ohms (measured)

b) Step 3: Current value (from table) = .059 Amps

c) Step 4: Calculated value = 1.6 x .059 = .094 Volts

d) Step 5: *Min Drop Away Voltage* = .094 + .24 (from table) = .334 Volts

327(a) - Inspecting and Testing Switch Circuit Controllers

1. Purpose

1.1. To ensure that Switch Circuit Controllers (SCC) are mechanically adjusted and maintained to properly detect the position of the equipment they are attached to so they can meet the electrical requirements of the circuits they control.

2. Test Interval

2.1. SCC's shall be inspected and tested when installed, as required and at least once every three (3) months to ensure that circuits are configured in accordance with the plans for that location. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Scope

4.1. The tests in this General Instruction (GI) apply to circuit controllers connected to switches, movable point frogs and derails. For purposes of simplicity, they shall all be referred to in this GI as SCC's.

5. Weather Conditions

5.1. The electrical and mechanical components of an SCC are susceptible to failure or damage if foreign particles such as water, dirt or other debris are allowed to enter the contact compartment. Except in an emergency, do not leave the compartment cover open during adverse weather conditions. Never leave the cover open when trains are passing.

6. Service Manuals

6.1. For additional information refer to the specific circuit controller service manual.

7. Fouling Circuits

7.1. To maximize efficiency, perform these tests in conjunction with GI-326 Inspecting and Testing Fouling Circuits.

8. SCC Symbols & Nomenclature

8.1. The circuit plan may indicate with Symbols & Nomenclature where SCC contacts are to be adjusted in relation to switch points. If so, follow the instructions in these tables to interpret the circuit plan.

Table 327(a)-01

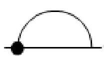
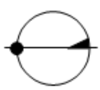
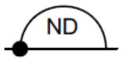
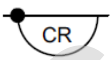
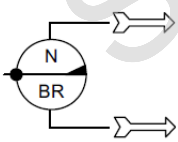
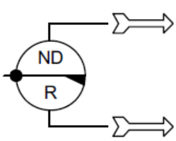
Symbol	Meaning
	Normal contact. The dot indicates the heel contact.
	Reverse contact. The dot indicates the heel contact.
	Normal and Reverse contacts. The contact transfer (shaded triangle) indicates that at the moment one circuit(s) opens due to switch movement it will take slight additional switch movement to close the other circuit(s).

Table 327(a)-02

Nom.	Position of Switch Points
N	Normal
B	¼ inch from Normal
G	1 inch from Normal
C	Center (midway between Normal and Reverse)
H	1 inch from Reverse
D	¼ inch from Reverse
R	Reverse

8.2. NOTE: The normal switch point is typically the point which is closed when the switch is lined for tangent track. The reverse switch point is typically the point which is open when the switch is lined for tangent track.

Table 327(a)-03

Symbol	Meaning
	Normal adjustment. Circuit is OPEN when the normal switch point is ¼ inch or more from normal.
	Reverse adjustment. Circuit is OPEN when the reverse switch point is ¼ inch or more from reverse.
	Circuit is CLOSED between the positions of the normal switch point ¼ inch from normal and reverse switch point in the reverse position.
	Circuit is CLOSED between the positions of the normal switch point in the normal position and the reverse switch point ¼ inch from the reverse position.
	Circuit is CLOSED between the positions of the reverse switch point 1 inch from the reverse position and the reverse switch point in the reverse position.
	Circuit is CLOSED between the positions of the normal switch point in the normal position and the normal switch point 1 inch from the normal position.
	Circuit is CLOSED between the positions of the reverse switch point in the center position and the reverse switch point in the reverse position.
	Circuit is OPEN when the normal switch point is ¼ inch or more from normal.
	Circuit is CLOSED from the moment contact transfers (slightly after the B position) until the reverse point is in the reverse position.
	Circuit is CLOSED from the moment contact transfers (slightly after D position) until the normal point is in the normal position.
	Circuit is OPEN when the reverse point is ¼ inch or more from reverse.

9. SCC Circuit Configuration and Testing Index

9.1. SSC's can be wired in different configurations to suit the type of circuit being used. This table explains what these circuit configurations are and where to locate the applicable tests.

Table 327(a)-04

Circuit Configuration	What does it do?	For test procedures refer to …
Switch Shunting	When the switch is opened, the contacts of the SCC are arranged to place a shunt across the rails. Also referred to as Switch Shunting Circuits.	Section 12
Break (fed one direction)	When the switch is opened, the contacts of the SCC are arranged to open the track or line circuit, where the track or line circuit is fed from one direction.	Section 14
Break (fed both directions)	When the switch is opened, the contacts of the SCC are arranged to open the track or line circuit, where the track or line circuit is fed from both directions.	Section 16
Break and Shunt	When the switch is opened, the contacts of the SCC are arranged to open the track or line circuit and place a shunt on the relay side of the track or line circuit.	Section 18

Continued on next page

Circuit Configuration	What does it do?	For test procedures refer to …
Switch Repeater (WP Circuit)	When the switch is opened, the contacts of the SCC are used to directly control the state of one or more switch correspondence relays.	Section 20
Derail	When the derail is in the derailing position, the contacts of the circuit controller are used to directly control the state of one or more switch correspondence relays.	Section 21

10. Switch Shunting Circuits

10.1. On SCC's employing the use of switch shunting circuits, the circuit plan may provide details as to how SCC contacts are to be wired as shown in Figure 327(a)-1, or the Symbols & Nomenclature method may be used as in Figure 327(a)-2.

Figure 327(a)-1: SCC Circuit Plan – Wiring Details

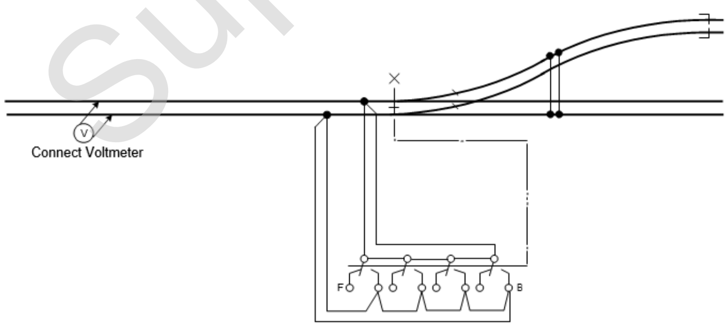
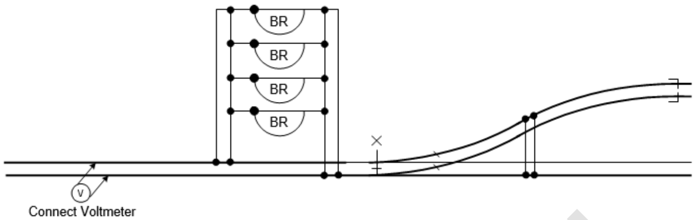


Figure 327(a)-2: SCC Circuit Plan – Wiring Details



11. Shunt Wire Inspection

11.1. In all switch shunting circuit applications, it is critical that shunt wire connections from the SCC to the track be inspected and maintained.

a. Check that shunt wires consist of two separate conductors connected to each rail and extending to the terminals of the SCC.

b. Check that shunt wires are secure, in good condition and properly installed.

12. Switch Shunting Circuits - Test Procedure

12.1. Follow these instructions when performing tests on SCC's used in all switch shunting circuit applications.

Table 327(a)-05

Step	Action
1	If SCC *Symbols & Nomenclature* is used on the circuit plans, locate the circuit controller symbol for the circuit to be tested. Correlate it to the symbol in the SCC *Symbols & Nomenclature* table to ascertain the contact(s) adjustment requirements. In most cases, such as with Figure 327(a)-1 & Figure 327(a)-2, the SCC adjustment will require the reverse contacts to close with a ¼ inch obstruction in the normal point.

Continued on next page

Step	Action
2	Place the appropriate obstruction as determined in Step 1, 6 inches back from the point of switch, and ensure the contact(s) open or close as required.
3	Observe each used contact to ensure proper operation in relation to the switch position as the switch is slowly thrown from full normal to full reverse and back again. The cam must ride on and be in control of the rollers throughout the entire motion.
4	Set the meter to read voltage on low voltage range and place the meter leads on the rails as shown in Figure 327(a)-1 or Figure 327(a)-2, ensuring correct polarity is maintained. The meter should indicate normal rail voltage.
5	Place a 0.06 ohm shunt on the rails and observe and note the meter voltage. Verify with the RTC, or by some other means, that the track circuit is down. This provides a reference voltage for which the track relay is known to be shunted.
6	Remove the shunt. Ensure the rail voltage returns to normal. Verify with the RTC, or by some other means, that the track circuit is up.
7	Open switch points until meter reading just drops to below the reference voltage noted in Step 5, to ensure that the track relay is effectively shunted. NOTE: When more than one contact is used to apply a shunt to the rails, each contact shall be tested individually to ensure sufficient shunting. This can be done by placing insulating material, such as plastic card, between the heel and all shunting contacts, except one, and verifying the rail voltage is below that in Step 5. Repeat for all contacts.

Continued on next page

Step	Action
8	Check opening between stock rail and points with switch gauge. The spacing should be exactly as determined in Step 2 between stock rail and switch point, measured 6 inches from the end of the point. If not, repeat from Step 1.
9	Restore the SCC to normal and perform the visual examination outlined on Section 22.

13. Break Circuits, Fed One Direction

13.1. On SCC's employing the use of break circuits, fed one direction, the circuit plan may provide details as to how SCC contacts are to be wired as shown in Figure 327(a)-3, or the Symbols & Nomenclature method may be used as in Figure 327(a)-4 and Figure 327(a)-5.

Figure 327(a)-3: SCC Circuit Plan – Wiring Details

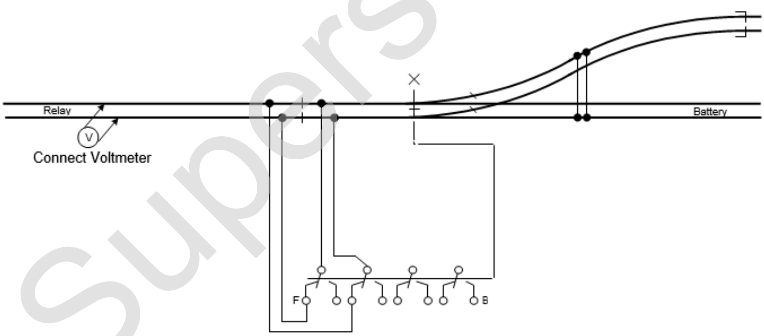


Figure 327(a)-4: SCC Circuit Plan – Symbols & Nomenclature (Track Circuit)

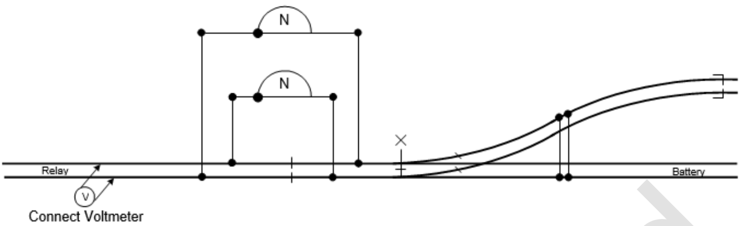
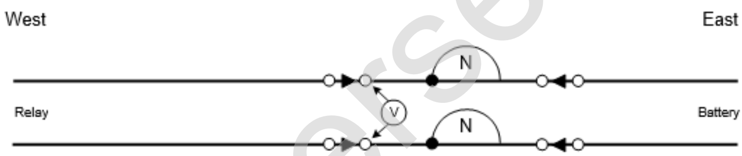


Figure 327(a)-5: SCC Circuit Plan - Symbols & Nomenclature (Line Circuit)



14. Break Circuits, Fed One Direction - Test Procedure

14.1. Follow these instructions when performing tests on SCC's used in all break circuit, fed one direction, applications.

Table 327(a)-06

Step	Action
1	If SCC *Symbols & Nomenclature* is used on the circuit plans, locate the circuit controller symbol for the circuit to be tested. Correlate it to the symbol in the SCC *Symbols & Nomenclature* table to ascertain the contact(s) adjustment requirements. In most cases, such as with Figure 327(a)-3 & Figure 327(a)-4, the SCC adjustment will require the normal contacts to open with a ¼ inch obstruction in the normal point.
2	Place the appropriate obstruction as determined in Step 1, 6 inches back from the point of switch, and ensure the contact(s) just open or close as required.
3	Observe each used contact to ensure proper operation in relation to the switch position as the switch is slowly thrown from full normal to full reverse and back again. The cam must ride on and be in control of the rollers throughout the entire motion.
4	Set the meter to read voltage on low voltage range and place the meter leads on the rails as shown in Figure 327(a)-3 or Figure 327(a)-4, ensuring correct polarity is maintained. The meter should indicate normal rail voltage.
5	Open switch points until meter reading drops to 0V.
6	Place a jumper across each open set of contacts, one at a time, and verify the track voltage remains close to 0V. Remove the jumper before proceeding to Step 7.
7	Check opening between stock rail and points with switch gauge. The spacing should be exactly as determined in Step 2 between stock rail and switch point, measured 6 inches from the end of the point. If not, repeat from Step 1.

Continued on next page

Step	Action
8	Restore the SCC to normal and perform the visual examination outlined on Section 22.
Line Circuit Test	To test any line circuits fed in one direction that are tied into the SCC, perform the following steps instead of Steps 4-8: • Figure 327(a)-5 illustrates a typical line circuit cut through a SCC. In this example, battery is fed from the East direction. • Place the voltmeter as shown and verify that line voltage is present on the SCC. • Place the appropriate obstruction as determined in Step 1, 6 inches back from the point of switch, and ensure that line voltage is no longer present at the voltmeter location shown. • <u>Crosscheck the contacts:</u> Place a jumper across each open set of contacts, one at a time, and verify the line voltage remains close to 0V. Remove the jumper then restore the SCC to normal and perform the visual examination outlined on Section 22.

15. Break Circuits, Fed Both Directions

15.1. On SCC's employing the use of break circuits, fed both directions, the circuit plan may provide details as to how SCC contacts are to be wired as shown in Figure 327(a)-6, or the Symbols & Nomenclature method may be used as in Figure 327(a)-7 and Figure 327(a)-8.

Figure 327(a)-6: SCC Circuit Plan – Wiring Details

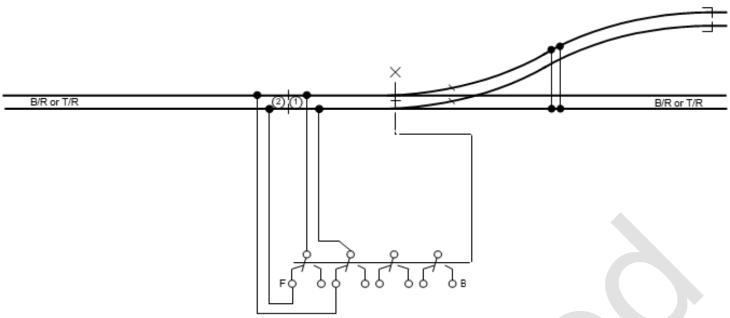


Figure 327(a)-7: SCC Circuit Plan – Wiring Details

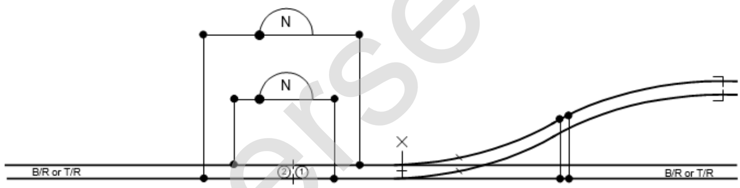
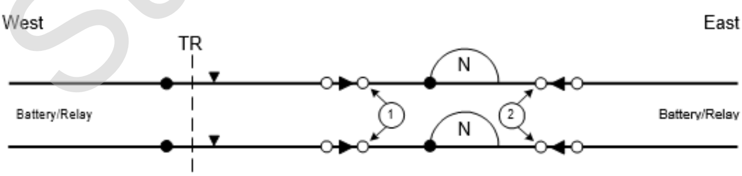


Figure 327(a)-8: SCC Circuit Plan – Wiring Details



16. Break Circuits, Fed Both Directions - Test Procedure

16.1. Follow these instructions when performing tests on SCC's used in all break circuit, fed both directions, applications.

Table 327(a)-07

Step	Action
1	If SCC *Symbols & Nomenclature* is used on the circuit plans, locate the circuit controller symbol for the circuit to be tested. Correlate it to the symbol in the SCC *Symbols & Nomenclature* table to ascertain the contact(s) adjustment requirements. In most cases, such as with Figure 327(a)-6 & Figure 327(a)-7, the SCC adjustment will require the normal contacts to open with a ¼ inch obstruction in the normal point.
2	Place the appropriate obstruction as determined in Step 1, 6 inches back from the point of switch, and ensure the contact(s) just open or just close as required.
3	Observe each used contact to ensure proper operation in relation to the switch position as the switch is slowly thrown from full normal to full reverse and back again. The cam must ride on and be in control of the rollers throughout the entire motion.
4	Set the meter to read voltage on low voltage range and place the meter leads on the rails as shown in location 1 of Figure 327(a)-6 or Figure 327(a)-7, ensuring correct polarity is maintained. The meter should indicate normal rail voltage.
5	Connect a 0.06 ohm shunt across the rails on the other side of the insulated joint as shown in location 2. Note the decreased voltage due to the shunt.
6	Open switch points until the track voltage increases to slightly above normal rail voltage. This is due to the open contacts isolating the shunt and normal load from the meter side of the circuit.

Continued on next page

Step	Action
7	Place a jumper across each open set of contacts, one at a time, and verify the track voltage remains unchanged from Step 6. Remove the jumper then proceed to Step 8.
8	Without disturbing the SCC, place the meter leads on the rails as shown in location 2. Ensure the track voltage is close to that measured in Step 5. Remove the 0.06 ohm shunt.
9	Check opening between stock rail and points with switch gauge. The spacing should be exactly as determined in Step 2 between stock rail and switch point, measured 6 inches from the end of the point. If not, repeat from Step 1.
10	Restore the SCC to normal and perform the visual examination outlined on Section 22.
Line Circuit Test	To test line circuits fed in both directions thru the SCC, do these instead of Steps 4-9: • Figure 327(a)-8 illustrates a typical line circuit cut through a SCC. In this example, when the TR relay drops at the West end, battery will only be fed from the East direction. • Shunt the track circuit and verify that line voltage is present at both voltmeter locations 1 and 2 (since the SCC line circuit contacts should still be made). • Place the appropriate obstruction as determined in Step 1, 6 inches back from the point of switch, and ensure that line voltage is present at only one of the voltmeter locations 1 and 2 (in this example it will only be present at voltmeter location 2).

17. Break and Shunt Circuits

17.1. On SCC's employing the use of break and shunt circuits the circuit plan may provide details as to how

SCC contacts are to be wired as shown in Figure 327(a)-9, or the Symbols & Nomenclature method may be used as in Figure 327(a)-10 and Figure 327(a)-11.

Figure 327(a)-9: SCC Circuit Plan – Wiring Details

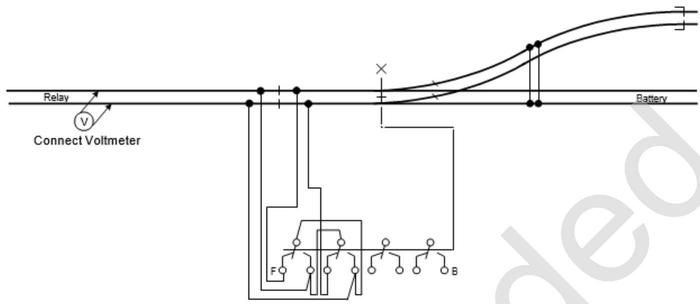


Figure 327(a)-10: SCC Circuit Plan – Wiring Details

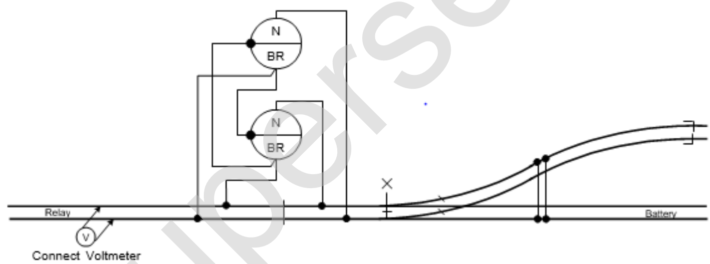
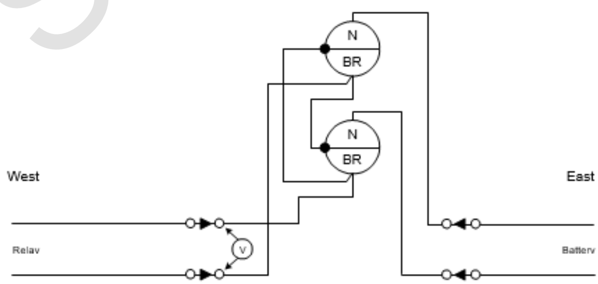


Figure 327(a)-11: SCC Circuit Plan – Wiring Details



18. Break and Shunt Circuits - Test Procedure

18.1. Follow these instructions when performing tests on SCC's used in all break and shunt circuit applications.

Table 327(a)-08

Step	Action
1	If SCC *Symbols & Nomenclature* is used on the circuit plans, locate the circuit controller symbol for the circuit to be tested. Correlate it to the symbol in the SCC *Symbols & Nomenclature* table to ascertain the contact(s) adjustment requirements. In most cases, such as with Figure 327(a)-9 & Figure 327(a)-10, the SCC adjustment will require the normal contacts to open, and the reverse contacts to close, with a ¼ inch obstruction in the normal point.
2	Place the appropriate obstruction as determined in Step 1, 6 inches back from the point of switch, and ensure the contact(s) just open or just close as required.
3	Observe each used contact to ensure proper operation in relation to the switch position as the switch is slowly thrown from full normal to full reverse and back again. The cam must ride on and be in control of the rollers throughout the entire motion.
4	Set the meter to read voltage on low voltage range and place the meter leads on the rails as shown in Figure 327(a)-9 or Figure 327(a)-10, ensuring correct polarity is maintained. The meter should indicate normal rail voltage.
5	Open switch points until meter reading drops to 0V.
6	Set the meter to the ohm setting and verify that the resistance measured is close to 0 ohms.

Continued on next page

Step	Action
7	Temporarily place insulating material, such as plastic card, between each used heel and back contacts, one at a time, and verify that the resistance measured is still close to 0 ohms.
8	Temporarily place insulating material between both used heel and back contacts, at the same time, and verify that some resistance reading can be seen on the meter. (This proves that the contacts were shunting the circuit when the insulating material was not present). Remove the insulating material and meter.
9	Check opening between stock rail and points with switch gauge. The spacing should be exactly as determined in Step 2 between stock rail and switch point, measured 6 inches from the end of the point. If not, repeat from Step 1.
10	Restore the SCC to normal and perform the visual examination outlined on Section 22.
Line Circuit Test	Substitute this step in place of Step 4 for any line circuits that are tied into the SCC: • Set the meter to read voltage on low voltage range and place the meter leads on the relay side of the line circuit as shown in Figure 327(a)-11, ensuring correct polarity is maintained. The meter should indicate normal line voltage. Proceed to Step 5.

19. WP Circuit Controller

19.1. On SCC's employed in switch point WP circuit applications, the circuit plan may provide details as to how SCC contacts are to be wired as shown in Figure 327(a)-12, or the Symbols & Nomenclature method may be used as in Figure 327(a)-13.

Figure 327(a)-12: SCC Circuit Plan – Wiring Details

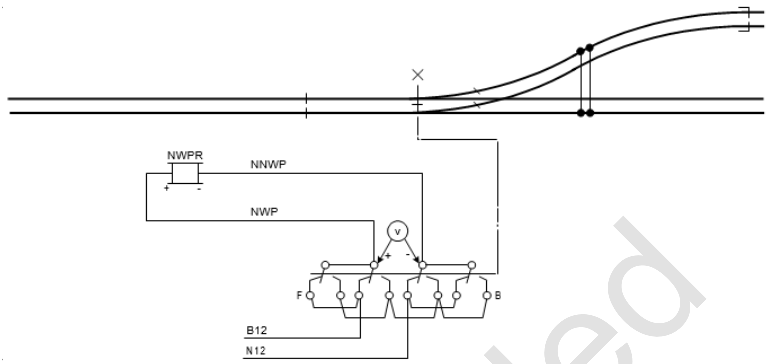
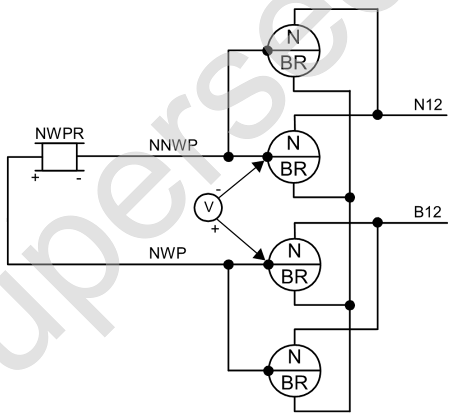


Figure 327(a)-13: SCC Circuit Plan – Wiring Details



20. WP Circuit Controller - Test Procedure

20.1. Follow these instructions when performing tests on SCC's used in a switch point WP circuit application.

Table 327(a)-09

Normal Switch Repeater Controller Circuit	
Step	**Action**
1	Set the meter to read voltage on the 15 volt range.
2	Connect the positive meter lead to the positive heel contact terminal and the negative lead to the negative heel as shown in Figure 327(a)-12 or Figure 327(a)-13. The meter should read approximately 10 volts.
3	Throw the switch point full reverse and ensure meter indicates zero volts.
4	Insert a 3/16-inch gage 6 inches from the end of the point, close the switch point toward normal position, and ensure meter indicates approximately 10 volts.
5	Insert a ¼ inch gage 6 inches from the end of the point, close the switch point, and ensure meter indicates zero volts. Adjust contacts as necessary to ensure values are met.
6	Set the meter to the ohm setting and verify that the resistance measured is close to 0 ohms.
7	Temporarily place insulating material, such as plastic card, between each used heel and back contacts, one at a time, and verify that the resistance measured is still close to 0 ohms.
8	Temporarily place insulating material between all used heel and back contacts, at the same time, and verify that some resistance reading can be seen on the meter. (This proves that the contacts were shunting the circuit when the insulating material was not present). Remove the insulating material and meter.
9	Remove the gauge and restore switch to normal position and perform the visual examination outlined in Section 22.

Table 327(a)-10

Reverse Switch Repeater Controller Circuit
To check the contact adjustment for the reverse switch repeater relay follow the steps above for the reverse switch position.

21. Derail Circuit Controller

21.1. Follow the instructions in the table when performing tests on circuit controllers used in a derail WP circuit application using the illustration in Figure 327(a)-14 as a guide.

Figure 327(a)-14: SCC Circuit Plan – Wiring Details

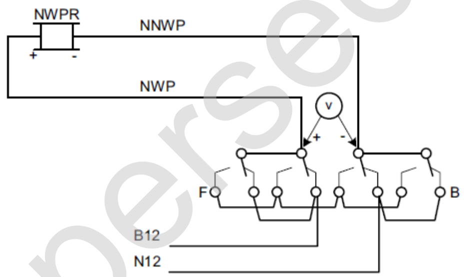


Table 327(a)-11

Step	Action
1	Set the meter to read voltage on the 15 volt range.
2	Connect the positive meter lead to the positive heel contact terminal and the negative lead to the negative heel as shown in Figure 327(a)-14. The meter should read approximately 10 volts.
3	Raise the derail approximately 4 inches above the rail and ensure meter indicates zero volts. NOTE: For an inside switch, insert a ½ inch gauge 6 inches from the end of the normally closed point.
4	Set the meter to the ohm setting and verify that the resistance measured is close to 0 ohms.
5	Temporarily place insulating material, such as plastic card, between each used heel and back contacts, one at a time, and verify that the resistance measured is still close to 0 ohms.
5	Temporarily place insulating material, such as plastic card, between each used heel and back contacts, one at a time, and verify that the resistance measured is still close to 0 ohms.
6	Temporarily place insulating material between all used heel and back contacts, at the same time, and verify that some resistance reading can be seen on the meter. (This proves that the contacts were shunting the circuit when the insulating material was not present). Remove the insulating material and set the meter back to voltage setting.
7	Release the derail and ensure the derail returns to derailing position and that the voltmeter reads approximately 10 volts.
8	Perform the visual examination outlined on Section 22.

22. Visual Inspection

22.1. Visually inspect SCC's as instructed in the following table.

Table 327(a)-12

Inspect	Ensure that ...
Contact Opening	The opening between the movable contact and each stationary contact is not less than 1/16 inch when the switch is full normal and full reverse.
Wiping Action	The wiping action between the movable contact and each stationary contact is not less than 1/32 inch and that contact surfaces meet squarely and are not excessively burned or pitted.
Cleanliness	Contact surfaces are free of dirt, grease and rust. Check the SCC compartment is free of rust, dirt and debris.
Gaskets and Hoses	Cable entrances are sealed where necessary and all gaskets are properly placed and in good condition.
Equipment Wear	Contact surfaces, rollers, cams and bushings are not excessively worn. Check all external connections and attachments from the SCC to the track are properly secured, adjusted and are not worn beyond the point of adjustment capability. EXAMPLE: Nuts tight, lags secured, rods properly adjusted and in good condition and cotter pins in place.
Ventilation	Ventilator screens, where used, are free of dirt and paint.

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Inspect	Ensure that …
Drainage	Adequate water drainage is provided around the SCC and especially under the crank and rod connecting to the switch point.
Ribbons	Ribbons on SCC's so equipped, are properly connected and in good condition.
Terminals and Wires	All terminals blocks are in good repair, terminals are tight, tags are in place and terminal connectors and wires are clear of adjacent terminals and working parts of the SCC.
Forced Contacts	All normally made contacts are forced open and all track shunting contacts are forced closed. NOTE: Movable contacts shall be mechanically forced by the action of the operating cams. The cam must ride on and be in control of the rollers throughout the entire motion.

23. Lubrication

23.1. Check that SCC's and attachments are lubricated as instructed in manufacturer's service manuals.

327(b) - Centering Device Tests

1. Purpose

1.1. Switch Circuit Controller Centering device tests shall be performed to verify the centering device will force the cranks and cams to the center position if there is a break in the connecting rod or switch point.

2. Test Interval

2.1. Centering device shall be inspected and tested when installed, as required and at least once every year to ensure the device is functional. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Centering Device Definition

4.1. A centering device is a mechanism attached to a circuit controller that will force the operating crank and cams of the controller to the center position in the event the connecting rod to the switch points breaks or becomes disconnected.

4.2. NOTE: Circuit controllers shall be equipped with centering devices at new installations or at existing locations when controllers are replaced.

5. Caution

5.1. If the switch throw is improperly adjusted such that it is greater than 5½", the centering device may prevent the switch from throwing to the full reverse position. Ensure proper switch throw adjustments at all switch locations equipped with a centering device.

6. Test Procedures

6.1. Perform the following tests on installed centering devices.

Table 327(b)-01

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td><table>
<tr><th>If the centering device is …</th><th>Then …</th></tr>
<tr><td>Contained in a separate compartment.</td><td>Remove the compartment cover and observe the centering device while tests are being performed.</td></tr>
<tr><td>Contained within the circuit controller compartment itself.</td><td>Open the circuit controller cover and observe the centering device while tests are being performed.</td></tr>
</table></td></tr>
<tr><td>2</td><td>Visually inspect the mechanism of the centering device and ensure that the setscrew is secure, working components are free from wear, corrosion, damage, or obstruction by foreign material.</td></tr>
<tr><td>3</td><td>Disconnect the crank from the circuit controller camshaft.</td></tr>
<tr><td>4</td><td>With a wrench, move the circuit controller crank to the full normal position and then to the full reverse position. When released from both positions, ensure that it assumes a neutral position.</td></tr>
</table>

Continued on next page

Step	Action
5	Observe the contact(s) are open for a normal or reverse closed circuit or closed if the contact(s) form part of a shunting circuit when the crank is released and forced to the neutral position by the action of the centering device.
6	Open switch and reconnect the crank to the camshaft of the circuit controller.
7	Replace compartment inspection covers.

329 - Inspecting and Testing Power Switch Machines

1. Purpose

1.1 This General Instruction details the inspections and tests required to install and maintain all power switch machines in a manner that will ensure the safety and reliability of the signal system.

1.2 NOTE: Many of the test procedures contained in this document are very closely related, and can be performed in sequence or combined with one another, however clear explanation of how the testing is to be performed could only be achieved by dealing with each topic on an individual basis.

2. Train Safety

2.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

3. Inspector Tests

3.1. A Signal Inspector or designated employee, acting in an inspection capacity, shall be assigned to perform these tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period.

4. Scope

4.1. The tests in this General Instruction apply to main track power machines connected to switches, movable point frogs and derails.

5. Weather Conditions

5.1. The electrical and mechanical components of a switch machine are susceptible to failure or damage if foreign particles such as water, dirt or other debris are allowed to enter the compartments. Except in an emergency, do not leave any of the compartment covers open during adverse weather conditions. Never leave covers open when trains are passing.

6. Service Manuals

6.1. Switch machine service manuals shall be kept accessible to the employee performing the tests while on site. Do not keep manuals in the machine.

7. Power Switch Machine Testing Index

7.1. All tests described in this GI must be performed at the time of installation (defined as when installing a switch machine as a complete unit, or when making changes that involve adding, replacing or repairing parts of switch machines already in service), and according to the following index.

Table 329-01

GI Test	Test or Inspection Description	Test Interval (Months)	Applicability			
			Model 5	GM-4000	M-23	Other Models
329(a)	Switch Obstruction	1	Yes	Yes	Yes	Yes
329(b)(1)	Switch Point Pressure	3	Yes	Yes	Yes	Yes
329(b)(2)	Point Detection	3	Yes	Yes	Yes	Yes
329(b)(3)	General Inspection	3	Yes	Yes	Yes	Yes
329(c)(1)	Indication Circuit Shunt	6	Yes	Yes	Yes	Yes
329(c)(2)	Motor and Overload	6	Yes	Yes	Yes	No[2]
329(c)(3)	Braking	12	Yes	No	No	No[2]
329(c)(4)	Lock Rod Correspondence	12	Yes	No	No	No[2]
329(c)(5)	HT Timing & Holding	12	Yes[1]	Yes[1]	Yes[1]	No[2]
329(d)(1)	Selector Lever & Restoral	12	Yes[1]	Yes[1]	Yes[1]	Yes[1]
329(d)(2)	Lock Box	Time of Install	No	No	Yes	No[2]
329(d)(3)	Latchout Self Restoral		No	Yes	Yes	No[2]
329(d)(4)	Compartment Heaters	Seasonal - at time of reconnection				

[1] Test is only required for dual control switch machines.
[2] Test is not required unless specified in Manufacturer's I/M manual.

7.2. In addition, GI-329(a) & (b) must be performed whenever:

a) Severe weather conditions cause track movement affecting the switch, or
b) Repairs have been made to the connecting rods or machine, or
c) Track work such as tamping or lining has been performed, or
d) The pressure on the switch point has been modified.

329(a) - Switch Obstruction Test

1. Purpose

1.1. To ensure that the switch will not lock with a ¼" obstruction between the point and the stock rail and to check the general condition of the lock rods.

2. Test Interval

2.1. Power switch machine obstruction tests shall be performed when installed, as required and at least once every month but with no more then 40 days between tests, to ensure proper maintenance and adjustment. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. General Inspection

4.1. Ensure all mounting bolts, tie-downs, grease fittings, nuts, pins, air vents, rod guards, connecting rods and accessories from the switch machine to the points are secure and in good repair.

4.2. If conditions warrant, lubricate or graphite the switch plates (except for turnouts equipped with Schwihag rollers).

4.3. Ensure adequate and appropriate ballast levels in all cribs, providing space for throw rods to move where applicable. All excess ballast that could interfere with switch point movement should be swept clear.

4.4. On machines where the lock rod notch areas cannot be properly inspected either visually or by feel, the rods shall be annually removed and inspected for wear and proper lubrication.

4.5. Ensure that all the moving rods and their parts are at least ¾" from the tie and 2" the above ballast.

Table 329(a)-01

When	How
At Installation	• Remove the lock rods from the machine and check for wear. • Check the condition of wear plates when applicable. • Clean, lubricate and reinstall the lock rods. Replace worn parts if necessary.
Scheduled Inspection	• Observe the movement of the lock and point detector rods while the machine moves between normal and reverse. • Check for lock rod wear. • Check the condition of wear plates by ensuring there is no excessive vertical movement of point detector or lock rods. • Lubricate the rods if necessary. • If dual control, hand throw the machine back and forth and verify that excessive force is not required to throw the points.

5. Worn Rods

5.1. Broken or bent lock rods must never be repaired and returned to service. They shall be immediately discarded.

6. Test Procedure

6.1. Perform the obstruction test as instructed in the following table. If performing the 3 month test, only execute this test after the Point Detector Tests in GI-329(b)(2) Point Detector Test.

Table 329(a)-02

Step	Action
1	Place a ¼ inch obstruction gauge against the stock rail on the open point side, 6 inches back from the point of switch.
2	*Throw* (see discussion, next paragraph) the point to the side the obstruction gauge is on. Observe the operation of the lock rods and locking bar while the switch is moving and until it is stopped. Verify the correspondence relays for the switch being tested are de-energized. If the switch uses lock rods, verify the 1/4 inch displacement[1] of the lock rod has prevented the locking bar from traveling through the lock rod notch.
3	Repeat steps 1-2 for the normal position.
4	Verify switch locks electrically in both reverse and normal positions and verify correspondence with the RTC.

[1] In some yard applications a 3/4" obstruction may be permitted - consult the responsible Supervisory Officer.

7. Power or Hand Crank

7.1. Hand cranking the machine will preserve the integrity of the lock rod when performing the obstruction test, however if there is any question as to the ability of the stock rail to resist rolling, then the machine should be powered over. Be guided by the condition of the turnout and by direction of the responsible Supervisory Officer when deciding how to throw the machine for this test.

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329(b)(1) - Switch Point Pressure

1. Purpose

1.1. To ensure that switch points and stock rails are secure and properly adjusted and that point pressure and clutch adjustment are adequate.

2. Test Interval

2.1. Switch point pressure tests shall be performed when installed, as required and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Perform the test as instructed by this table. Take immediate remedial action if movement of the switch machine on the head blocks is noticed. Advise the responsible Supervisory Officer if excessive movement of the stock rail is observed.

4.2. NOTE: Test on all makes/models of switch machines other than yard switches that do not have lock rods.

Table 329(b)(1)-01

Step	Action	Check
1	Place an obstruction of ½" or greater in the open reverse point, 6 inches back from the point of switch and power the switch machine over.	• There is no excessive movement in the stock rail when pressure is applied. • There is no movement of the switch machine on the head blocks. • The clutch (if equipped) slips for about 7-10 seconds[1] before overload.
2	Request the switch back to the original position.	The overload releases and the machine locks up in the original position.
3	Repeat steps 1-2 for the normal open point.	Steps 1 and 2.
4	Without any obstructions, hand throw (dual control) or crank (single control) the machine until the reverse switch point just meets the stock rail.	• The switch moves freely in transit. • For dual control machines, the hand throw lever has partially entered the lever stand[2].
5.a	FOR DUAL CONTROL MACHINES: Continue to apply pressure to the lever until it is horizontal and fully latched into the lever stand.	That only a very slight amount of physical exertion is required.

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Step	Action	Check
5.b	FOR SINGLE CONTROL MACHINES: Continue to crank the machine to the end of the stroke.	The effort required to crank the machine increases only slightly after the point meets the stock rail.
6	Repeat steps 4-5 for the normal point.	Restore dual control machines to POWER position when done.

[1]Overload time may be increased to 20 seconds at certain electronic interlocking locations.

[2]The GM-4000 has about 3" of play at the end of the stroke and may fall into the stand.

5. Switch Point Pressure – CTS-2 Only

5.1. This table describes additional tests required for CTS-2 switch machines.

Table 329(b)(1)-02

Step	Action	Check
1	Place a load cell on stock rail as instructed in the manufacturer's Installation and Maintenance Manual and power the switch over.	Verify that the pressure is between the manufacturer recommended 2,500 and 3,800 lbs.
2	Request the switch back to the original position.	Switch returns to normal position.
3	Repeat steps 1-2 for the opposite point.	Steps 1 and 2.

6. Switch Point Pressure – Yard Switches Without Lock Rod Only

6.1. Before performing this test ensure the switch moves freely and is properly adjusted, surfaced and lubricated. The results of this test can be affected by the condition of the switch and track structure. This test requires the use of a pressure gauge such as the 225480-001 from J&A Industries, or equivalent.

6.2. Exercise extreme caution when performing this test.

6.3. NOTE: Yard switches that do not meet these specifications shall be taken out of service or replaced immediately.

Table 329(b)(1)-03

Step	Action
1	Attach the spring switch compression gauge by placing the hooked end over the head of the stock rail on the open point side with the pump and plunger aligned to fit between the bolts attaching the throw rod clip to the point.
2	Pump up sufficient pressure to slightly open the closed point.
3	Insert a thin shim (0.003 to 0.005 inch) between the stock rail and the closed point and release the pressure on the compression gauge pump. Check the shim is firmly held between the point and stock rail.
4	Pump up sufficient pressure to just allow the shim to be easily pulled free from between the point and the stock rail.
5	Observe the pressure reading on the gauge. The reading should be about 1500 pounds of pressure but in no case shall be below 1000 pounds of pressure.
6	Release the pressure on the gauge, remove it from the rail, throw the switch in the opposite direction and repeat steps 1 to 5.

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329(b)(2) - Point Detector Test

1. Purpose

1.1. Power switch machine point detector tests shall be made to ensure the switch will not indicate correspondence with a ¼" obstruction.

2. Test Interval

2.1. Power switch machine point detector tests shall be performed when installed, as required and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Methods

4.1. There are 2 prescribed methods for testing point detector adjustments:

a) Method I requires that the lock rod be floated, and can be performed at all locations where there is sufficient play in the layout to allow the machine to lock with a ¼" obstruction with the lock rod floated.

b) NOTE: *"Floating" the lock rod means loosening the lock rod nuts such that the lock rod will not be effective during the test, so as to exercise the point detector rod independently*.

c) Method II simulates the ¼" obstruction by means of a special gauge, and is not as vigorous a test as Method I. This test may be the only choice available where there is insufficient play in the layout to allow the machine to lock with a ¼" obstruction with the lock rod floated, such as at new turnouts or on Class 5 track.

5. How to Verify Correspondence

5.1. It is permissible to verify the position of the correspondence relays by measuring the voltage on the correspondence terminals of the switch machine (except at time of installation, when the actual relays must be observed).

5.2. Different voltage polarities and nomenclatures (NWP/WP, NWP/RWC, NWC/RWC) may be used for the correspondence circuits. Refer to the field plans to ensure a full understanding of which terminals to measure, and the expected voltages to observe when the switch machine is locked, and when it is in transit or otherwise obstructed.

6. Determining Lock Rod Type

6.1. A wide notch lock rod will provide a total gap of 3/8" between the locking dog and the edges of the lock rod notch, whereas a narrow notch lock rod will only provide a total gap of 1/8". It is acceptable to use either types of rods, however the lock rod adjustment procedure varies between the two.

7. Point Detector Test Method I (All Switch Machines)

7.1. The purpose of this test is to ensure that the switch will stay out of correspondence when a 1/4" obstruction prevents the switch point from closing. This test can be performed on all types of switch machines.

7.2. NOTE: Layouts that are very tightly maintained may not have enough play to allow this test to be performed. If so, use Method II (next page) instead.

Table 329(b)(2)-01

Step	Action
1	Crank open the switch point and place a ¼" obstruction gauge between the reverse switch point and the stock rail 6" from the point end.
2	Float the reverse lock rod to allow the switch to lock and power the switch to the reverse and locked position. Verify that the locking bar has completed its full motion.
3	Verify that the machine is locked and that the contacts just break (open), and the correspondence relay for the switch being tested is de-energized. If not, adjustment of the detector rod will be necessary.
4	Remove the obstruction and crank the machine to the reverse and locked position and verify that the indication contacts are closed.
5.a	If the machine is equipped with a narrow notch lock rod, adjust the reverse lock rod bolts so the lock dog is centered in the lock rod notch, and secure the nuts. Go to Step 6.
5.b	If the machine is equipped with a wide notch lock rod (some Model 5 machines), insert a 1/8" obstruction gauge between the reverse switch point and stock rail 6" from the point end. Adjust the lock rod so that the effective side of the notch is snug against the lock dog, and secure the nuts. See note below.
6	Repeat steps 1-5 for the normal position.
7	Perform the Obstruction Test as described in GI-329(a) Switch Obstruction Test.

7.3. NOTE: If the switch machine experiences temporary loss of correspondence under the weight of trains, it may be necessary to adjust the machine to lock at less than the 1/8" amount specified in Step 5.b. This can be done by partially cranking the machine to allow the locking bar to be just free of the lock rod, then tightening the lock rod nuts a small amount so that the locking bar is just foul of the lock rod with the 1/8" obstruction still in place. Remove the obstruction, crank the switch closed, and verify that the machine locks up and that the correspondence relay is up.

8. Point Detector Test Method II

8.1. Depending on the type of machine, perform the applicable point detector test.

Table 329(b)(2)-02

Switch Machine Type	Proceed to Paragraph…
M-23	9
Model 5	10
GM-4000	11
Other	Consult Manufacturer's Instructions

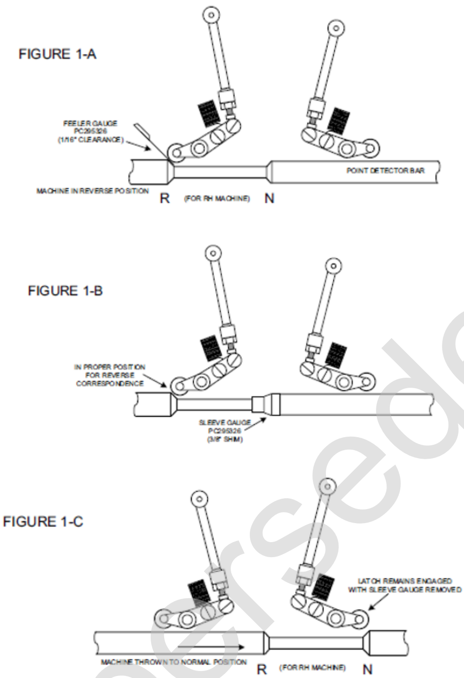
9. Point Detector Test Method II - M-23

9.1. The purpose of this test is to ensure that the switch will stay out of correspondence when a 1/4" obstruction prevents the switch point from closing. This test is applicable only to M-23 switch machines, and also tests the latchout capability.

Table 329(b)(2)-03

Step	Action
1	With the switch machine on power and in the reverse position, verify the machine is mechanically locked and the appropriate correspondence relay is up.
2	Place feeler gauge PC 295326 in the space between the roller and bevel of the point detector bar as shown in 1-A of Figure 329(b)(2)- 1 and ensure the space conforms to the thickness of the feeler gauge. If it does not, adjustment of the point detector bar will be necessary.
3	Remove the feeler gauge and place the sleeve gauge PC295326 tight against the bevel on the normal side of the detector bar (as shown in 1-B of Figure 329(b)(2)- 1).
4	While holding the sleeve gauge in place, power the switch machine to the normal position. Verify the latch becomes engaged (an audible click should be heard), the indication contacts open and the correspondence relays are down.
5	Lift up and release the latch. Remove the sleeve gauge as shown in 1-C of Figure 329(b)(2)- 1, and ensure the latch remains engaged, the indication contacts remain open about 1/16", the contacts are pressing up against the shunt strip, and the correspondence relays are down.
6	Disengage the latch (see Figure 329(b)(2)- 1 and ensure the indication contacts close and the appropriate correspondence relay picks up.
7	Repeat steps 1 to 6 with the switch machine in the normal position and powering over to the reverse position.
8	Perform the Obstruction Test as described in GI-329(a) Switch Obstruction Test.

Figure 329(b)(2)- 1: Placement of Feeler and Sleeve Gauge.



10. Point Detector Test Method II - Alstom (GRS) Model 5

10.1. The purpose of this test is to ensure that the switch will stay out of correspondence when a 1/4″ obstruction prevents the switch point from closing. This test is applicable only to Alstom (GRS) Model 5 switch machines.

Table 329(b)(2)-04

Step	Action
1	Remove the detector rod guards from the machine and hand crank it to the full reverse position. Verify the machine is mechanically locked & the appropriate correspondence relay is up.
2	Loosen track side nuts on the detector rod more than ¼" at the detector rod lug (see Figure 329(b)(2)- 2).
3	Push the detector rod toward the switch machine, place ¼" point detector rod gauge (GRS P85-1216 or equivalent) between the detector rod lug and machine side nuts and tighten track side nuts against the rod lug.
4	Verify the point detector contacts are open about 1/16", as shown in Figure 329(b)(2)- 4, and the correspondence relays are down. Adjust the point detector rod if the contact openings are either too small or large.
5	Loosen the track side nuts, remove the gauge and tighten the track side nuts taking care not to disturb the machine side nuts.
6	Hand crank the machine to the full normal position and ensure the machine is mechanically locked & the appropriate correspondence relay is up.
7	Loosen the machine side nuts on the detector rod more than ¼" at the detector rod lug.
8	Push the detector rod toward the track, place ¼" point detector rod gauge between the detector rod lug and the track side nuts and tighten the machine side nuts against the rod lug.
9	Verify the point detector contacts are open about 1/16", as shown in Figure 329(b)(2)- 4, and the correspondence relays are down. Adjust the point detector rod if the contact openings are either too small or large.

Continued on next page

Step	Action
10	Slightly loosen the machine side nuts, remove the gauge and retighten the machine side nuts, taking care not to disturb the track side nuts. Verify the machine is mechanically locked and the appropriate correspondence relay is up. Replace the detector rod guards on the machine.
11	Perform the Obstruction Test as described in GI-329(a) Switch Obstruction Test.

10.2. These diagrams illustrate contact arrangement and placement of the point detector gauge when performing the Method II point detector tests for the Alstom (GRS) Model 5 switch machines.

Figure 329(b)(2)- 2: References for Point Detector Test

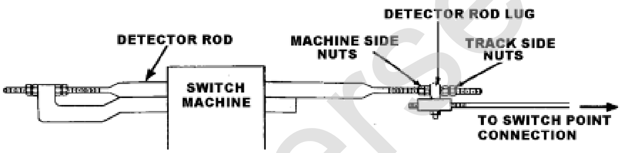


Figure 329(b)(2)- 3: GRS Point Detector Rod Gauge P85-1216

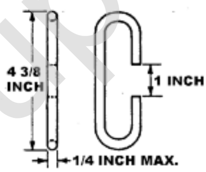
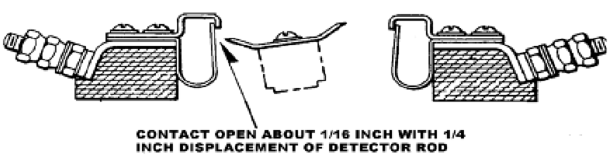


Figure 329(b)(2)- 4: GRS Switch Machine Point Detector Contacts.



11. Point Detector Test Method II - GM-4000

11.1. The purpose of this test is to ensure that the switch will stay out of correspondence when a 1/4” obstruction prevents the switch point from closing. This test is applicable only to Alstom (GRS) GM-4000 switch machines, and also tests the latchout capability.

Table 329(b)(2)-05

Step	Action
1	Position rod spoon (¼” end) into necked down portion on the track side of the point detector rod as shown in Figure 329(b)(2)- 5. Operate the machine to the track side and locked position.
2	Verify with a meter that the track side indication contacts are open, and the latch-out dog remains disengaged. If not, adjust the position of the point detector rod at the lug end by adjusting the “Connecting Rod Nut” until the contacts just open and the latch-out dog remains disengaged as shown in Figure 329(b)(2)- 6.
3	Throw the switch over then position rod spoon (3/8” end) into necked down portion on the track side of the point detector rod as shown in Figure 329(b)(2)- 5. Operate the machine to the track side and locked position.
4	Ensure the LED on the track side point detector switch module is OFF and the latch-out dog is engaged. If not, adjust the position of the point detector rod at the lug end by adjusting the “Connecting Rod Nut” until the LED turns off and the latch-out dog engages and then repeat from Step 1.
5	Remove the spoon gauge and verify the latch remains engaged, the indication contacts remain open, and the LED stays off.

Continued on next page

Step	Action
6	Tighten and lock "Connecting Rod Nuts" and release latch-out condition by pushing end of latch-out dog and verify the indication contacts close.
7	Position rod spoon (¼" end) into necked down portion on the field side of the point detector rod. Operate the machine to the field side and locked position.
8	Verify with a meter that the field side indication contacts are open and the latch-out dog remains disengaged. If not, adjust the position of the point detector rod by adjusting the "PD Rod Adjusting Nut" until the contacts just open and the latch-out dog remains disengaged as shown in Figure 329(b)(2)- 6.
9	Throw the switch over then position rod spoon (3/8" end) into necked down portion on the field side of the point detector rod. Operate the machine to the field side and locked position.
10	Ensure the LED on the field side point detector switch module is OFF and the latch-out dog is engaged. If not, adjust the position of the field detector rod at the lug end by adjusting the "PD Rod Adjusting Nut" until the LED turns off and the latch-out dog engages, then repeat from Step 7.
11	Remove the spoon gauge and verify the latch remains engaged, the indication contacts remain open, and the LED stays off.
12	Tighten and lock "PD Rod Adjusting Nut" and release latch-out condition by pushing end of latch-out dog.
13	Perform the Obstruction Test as described in GI-329(a) Switch Obstruction Test.

Figure 329(b)(2)- 5: GM-4000 Point Detector Rod Adjustment Components

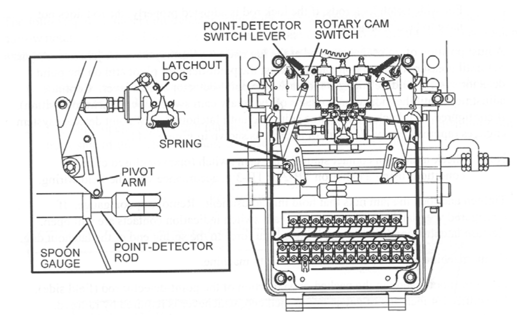
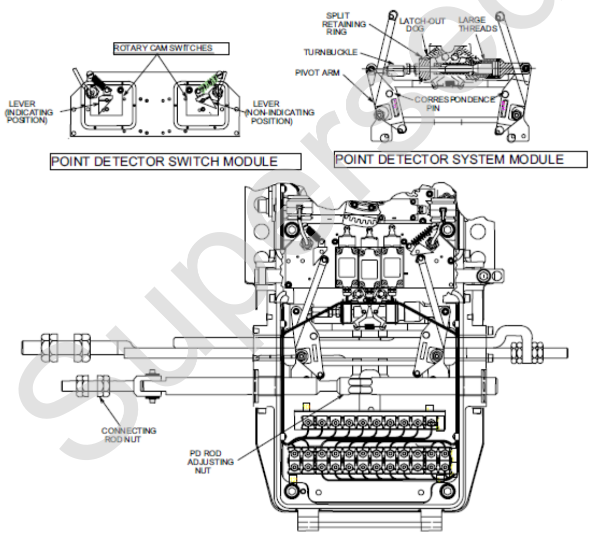


Figure 329(b)(2)- 6: GM-4000 Point Detector Modules



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329(b)(3) - General Inspection

1. Purpose

1.1. To ensure that mechanical and electrical tolerances of power switch machines and turnout hardware are properly maintained.

2. Test Interval

2.1. A general switch machine and turnout inspection shall be performed when installed, as required and at least once every three (3) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. General Inspection

4.1. Check the following, and report track hardware deficiencies to the responsible Supervisory Officer for resolution with the maintenance provider's Track Supervisor.

a) Rail braces are tight without excessive wear at the plate under the rail.

b) Switch points are relatively flush with edge of the gauge plate on the first headblock tie. Improperly aligned points may:
   i. cause the connecting rods to bind and create excessive wear to lock and detector rods;
   ii. cause the switch to bind and create excessive stress on the throw bar.

c) Gauge and connecting rods are not rubbing on the underside of the rail.

d) Circuit controller, selector lever and crank contacts are wiping properly and are not excessively burned or pitted. Burned or pitted contacts may require adjustment, cleaning or replacement.
e) Refer to General Instruction GI-409 Inspecting Mechanical Equipment and perform inspections as required.
f) All terminal nuts and connections are tight.
g) Terminal wiring and connections are free of contamination such as grease and oil.
h) Terminal wiring does not interfere with the mechanical workings of the switch machine.

5. Lubrication

5.1. Lubrication of switch machines shall be performed as instructed in manufacturer's service manuals.

329(b)(4) - Inspecting Switch Rollers

1. Purpose

1.1. To ensure that switch points remain off all the switch plates at all times when switch points are in motion.

2. Test Interval

2.1. Switch rollers shall be inspected when installed, as required and at least once every year. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. General Inspection

4.1. Check to see that switch points are not resting on the switch rollers when in full normal or reverse correspondence. When throwing the switch confirm that all switch rollers are moving freely and that the switch points are not in contact with the switch plates.

4.2. NOTE: Caution should be considered during inspections and adjustments. The protection against switch throwing by RTC must be provided.

5. Definition

5.1. Vertical Lift Height (VLH) – Height that the rollers lift the switch rail off the switch plate. A minimum of .5 mm gap shall be maintained between the rail and the switch plate. This prevents the rail from riding on the switch plates and making the switch easier to throw.

5.2. Horizontal Position Offset (HPO) – The distance the roller is set from the rail when the switch is in the closed position. This is to prevent damage to the rollers when a train passes over the switch.

5.3. Preferred VLH – The distance between the rail and the switch plate next to the first single roller, while the switch in the fully open position.

5.4. Measured VLH – The distance between the rail and the switch plates next to the first single roller, while the switch positioned on top of the roller.

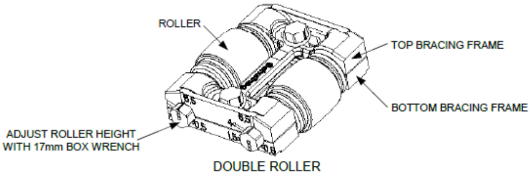
5.5. NOTE: These terms are only used for adjusting the first single roller near the switch points.

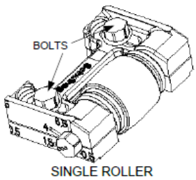
6. Switch Rollers

6.1. If so equipped, switch rollers must be inspected to ensure they roll freely when the point moves over them. No additional steps are necessary if both points remain off all the switch plates at all times, otherwise adjustments may be necessary.

6.2. NOTE: Never lubricate rollers.

Figure 329(b)(4)- 1: Schwihag Switch Rollers.





7. Adjustments

7.1. Adjustment procedures for rollers require that 2 measurement criteria be maintained for each roller set; the Vertical Lift Height and Horizontal Position Offset. Adjustments to both of these are simple to do and require only feeler gauges, 17 mm wrench, and a 17 mm box torque wrench.

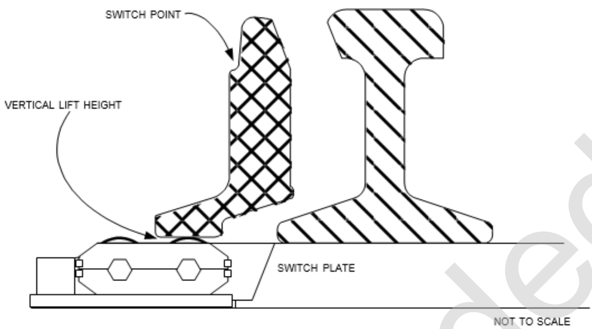
7.2. NOTE: The VLH is always adjusted first, except on new installations. Then verify the HPD is set correctly. After that follow the steps to complete the adjustment of the rollers.

8. Measuring Vertical Lift Height (VLH)

8.1. To measure the vertical height for a particular roller, move the switch point so it rests on the roller. With the appropriate feeler gauges, measure the gap between the bottom of the switch point and the switch plate, as illustrated in Figure 329(b)(4)- 2. This is referred as the Vertical Lift Height (VLH).

8.2. NOTE: VLH should be the same height throughout, except for the first single roller preventing the switch point from falling between rollers on the first double roller. If adjustment is needed out side the range of the switch roller, check the remaining rollers for adjustment or inspect the track layout for possible repairs.

Figure 329(b)(4)- 2: Measuring Vertical Lift Height (VLH)

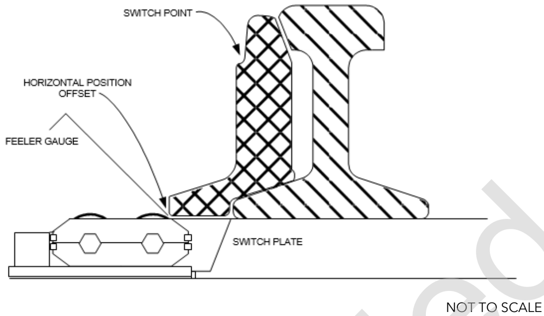


9. Measuring Horizontal Position Offset (HPO)

9.1. The measurement for the horizontal positioning of the roller is taken by placing a feeler gauge between the roller and the rail foot, with the point in the closed position, as illustrated in Figure 329(b)(4)- 3. This is known as the Horizontal Position Offset (HPO).

9.2. The HPO should be adjusted to be 1 mm more than the gap between the bottom of the switch point and the switch plate when the switch point is in the closed position (i.e. not sitting on the roller). In the case when there is no such gap, the HPO would simply be 1 mm.

Figure 329(b)(4)- 3: Measuring Horizontal Position Offset (HPO)



10. Adjusting Switch Rollers

10.1. Adjustment of the rollers is necessary when the switch point can be seen to rest on one or more switch plates. Follow these procedures when readjustment is necessary on a roller. Unless new installation then verify the HPO first and then proceed with the steps below.

10.2. NOTE: This procedure does not apply to the first single roller near the switch points.

Table 329(b)(4)-01

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Ensure the switch point is in the closed position for the roller in question.</td></tr>
<tr><td>2</td><td>Move the switch point and ensure contact is made with the rollers. With the rail point directly on the rollers, measure the VLH.

NOTE: If this is a new installation set switch rollers as follows. Set the first roller height to 3 mm (double roller), or 3.5 mm (single roller), and the second roller height to 4 mm (refer to the markings on the bracing frame).</td></tr>
<tr><td>3</td><td>Adjustments may be required if the rollers still do not roll, or if the VLH is approaching the outer limits (i.e. less than 0.5 mm or more than 6 mm).
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The rollers still do not roll;</td><td>Loosen the bolts and adjust height using 17 mm box wrench (use the markings on the bracing frame to aid in the height adjustment). Retighten the bolts with 50 ft-lbs torque and repeat steps 3-4 until the proper height is attained.</td></tr>
<tr><td>The VLH is > 6 mm or < 0.5 mm;</td><td>Check on the remaining rollers for incorrect height adjustments. If the problem is local to 1 or 2 rollers, inform the Track Supervisor that there may be other problems with the switch, such as point upsweep, surfacing, etc.</td></tr>
</table>
</td></tr>
</table>

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Step	Action
4	Verify all other rollers continue to roll properly, if not re-adjust as necessary.
5	With the appropriate feeler gauge, verify the HPO between the first roller and the rail foot. If it is incorrect, loosen the bolts and re-position the bracing frames. Retighten the bolts with 50 ft-lbs torque.

11. Adjusting Switch Rollers (First Single Roller Near Switch Points)

11.1. Adjustment of the rollers is necessary when the switch point can be seen to rest on one or more switch plates. Follow these procedures when adjustment is necessary on the single roller closest to the switch points. This roller is provided to ensure the narrow foot of the switch point remains fully supported as the point travels between the rollers at the switch point.

Table 329(b)(4)-02

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>1</td><td colspan="2">Ensure the horizontal position of the single roller is such that the center of the roller is in line with the midway position of the double rollers closest to the point (this should be about 2-3/4" from the foot of the rail). If not, loosen the bolts, and re-position the bracing frames. Retighten the bolts with 50 ft-lbs torque.</td></tr>
<tr><td>2</td><td colspan="2">Move the switch point to the open position and take the preferred VLH measurement. Move the switch point so that it sits directly over the roller and take the measured VLH.</td></tr>
<tr><td rowspan="4">3</td><td colspan="2">Compare the preferred VLH measurement to the measured VLH measurement and follow the steps below.</td></tr>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The preferred VLH measurement matches the measured VLH measurement.</td><td>Adjustment is completed for this single roller.</td></tr>
<tr><td>The preferred VLH measurement does not match the measured VLH measurement.</td><td>Adjust this single roller and re-measure the measurements until they match.</td></tr>
</table>

12. Final Check

12.1. With the switch point in the open position (i.e. on the rollers) check for a minimum of 0.5 mm gap between the switch point and the switch plate on all plates between the head block ties and the heel block. If the switch point is still resting on a switch plate, re-adjust the height of the rollers nearest the plate in question.

329(c)(1) - Indication Circuit Shunt

1. Purpose

1.1. Indication contact shunt strips are provided to ensure the indication circuit is shunted while the switch machine is in transit so as to prevent inadvertently energizing the repeater circuits if any extraneous energy is present.

2. Test Interval

2.1. Indication contact shunt strips shall be performed when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedures (Single Machine)

4.1. Perform the test as indicated below when testing an individual switch machine.

Table 329(c)(1)-01

Step	Action
1	Verify the machine is in correspondence, then open all disconnects to the correspondence relay circuits in the instrument housing, including battery.
2	Connect an ohmmeter to the switch machine side of the disconnects in the instrument housing and observe that no shunt is present on the field side of the relay circuit.
3	Power the switch machine over in each direction and observe on the meter that a shunt is present when the machine is unlocked and in transit.
4	Close the disconnects that were opened in Step 1 and verify correct correspondence.
5	Where shunt contacts are visible, visually inspect the action of the contacts as they are shunted and ensure shunt straps or bar are secure and properly placed.

5. Test Procedures (Multiple Machines)

5.1. Multiple switches used in a crossover are usually configured such that the correspondence battery energy is fed to one switch (usually designated as the “B” machine) while the correspondence relay circuits are wired to the other switch (usually designated as the “A” machine). Intermediate wiring is provided between the switches.

Table 329(c)(1)-02

Step	Action
1	Verify both machines are in correspondence, then open the correspondence relay circuits (typically WP/NWP, or NWC/RWC) and switch correspondence energy circuits (typically B12/N12, or B10/N10) in the instrument housing.
2	Connect an ohmmeter to the switch machine side of the disconnects in the instrument housing and observe that no shunt is present on the field side of the relay circuit (typically WP/NWP, or NWC/RWC).
3	Power only the “A” switch machine over in each direction and observe on the meter that a shunt is present when the machine is unlocked and in transit.
4	With the “A” switch machine in the normal and locked position, power only the “B” switch machine over in each direction and observe on the meter that a shunt is present when the machine is unlocked and in transit.
5	Power only the “A” switch machine to the reverse and locked position, then power only the “B” switch machine over in each direction and observe on the meter that a shunt is present when the machine is unlocked and in transit.
6	Close the disconnects that were opened in Step 1 and verify correct correspondence.
7	Where shunt contacts are visible, visually inspect the action of the contacts as they are shunted and ensure shunt straps or bar are secure and properly placed.

6. Additional Test - M-23

6.1. With the machine in the normal position, operate by hand throw lever or crank until the normal indication contacts are open and the inside contact is against the shunting strip. Check that the lock rods remain engaged with the locking bar and the machine is not yet unlocked. Repeat with the switch in the reverse position.

329(c)(2) - Motor & Overload

1. Purpose

1.1. To ensure proper operation of motor and overload.

2. Test Interval

2.1. Motor and overload shall be inspected and tested when installed, as required and at least once every six (6) months to ensure proper operation. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Commutator and Brushes - M-23 &Model 5

4.1. Inspect the motor and verify the condition of the commutator and brushes for M-23 and Model 5 switch machines.

a) Check the commutator is smooth and free of grease and oil.

b) Check the commutator end of the armature, the brush holders and the sides of the brushes are free of carbon dust.

c) Inspect brushes for wear or damage. If brushes are removed from the holder, replace them in the same holder, keeping brush wear surface oriented to follow rotation of commutator.

d) Check that brushes slide freely in their holders and seat fully on the commutator.

5. Overload and Clutch Slip Test - M-23 & Model 5

5.1. The clutch in a power switch machine is designed to slip when an obstruction is present between the switch point and the stock rail. The clutch in a Ansaldo(US&S) machine also slips slightly at the end of each stroke to cushion the gear train. Perform the overload and clutch slip test as instructed in this table for M-23 and Model 5 switch machines.

Table 329(c)(2)-01

Step	Action
1	Insert an ammeter in the motor circuit for the direction the switch machine is to be thrown. Set the meter to at least the 30 Amp scale. Use a clamp-on current probe if the meter is not equipped with a 30 Amp scale.
2	Place an obstruction of more than ½" or more between the open point and the stock rail, 6 inches back from the point of switch.
3	Power the switch machine over and observe the motor circuit current on the ammeter.
4	Verify that the clutch slips close to the current specified in the Overload Current table.
5	After the switch has overloaded, request to power it back to the original position and verify that the overload releases and the machine locks up in the original position.
6	Repeat steps 1 to 5 for the opposite switch move.

6. Using a Clamp-On Current Probe

6.1. It is acceptable to use a clamp-on current probe when measuring overload current. To assist in making this measurement, a temporary jumper may be placed in series with the motor circuit, with the amp probe clamped around the jumper to measure the current through the jumper. For example, the jumper may be placed across the crank contacts while the switch is in the crank position.

6.2. CAUTION: Since the motor may turn even if the hand crank is left inserted while the jumper is left in place, which could result in serious personal injury. Use jumper of adequate length to keep hands away from switch machine.

7. Overload Current Table

7.1. This table illustrates preferred overload current for the various types of switch machines.

Table 329(c)(2)-02

Switch Machine Model	Current (amps)
Model 5D • 24 to 32 VDC, high speed • 110 VDC, high speed	 18 12
Models 5E, 5F, 5G & 5H • 24 to 32 VDC • 110 VDC	 18 to 20 12 to 14
Model M3 & M23 with permanent magnet motor. • 110 VDC, 189:1 gear ratio • 20 VDC, 528:1 gear ratio • 20 VDC, 360:1 gear ratio	 14 12 23
Model M3 & M23 without permanent magnet motor. • 110 VAC, 189:1 gear ratio • 110 VDC, 189:1 gear ratio • 20 VDC, 528:1 gear ratio • 20 VDC, 360:1 gear ratio	 12 12 12 20

8. Overload Timeout and Motor Limit Switches-GM-4000

8.1. The GM-4000 is not equipped with a clutch, however there is a 5 second overload time-out. For 24V machines, the machine may drop out before the overload time-out is activated if the motor voltage is not adequate. Perform the test as prescribed in this table to ensure that the time-out feature is operating as intended.

Table 329(c)(2)-03

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Place an obstruction of ½” or more between the open point and the stock rail, 6 inches back from the point of switch.</td></tr>
<tr><td>2</td><td>Power the switch over and observe the overload LED on the amplifier module.</td></tr>
<tr><td>3</td><td><table>
<tr><th>If the overload LED …</th><th>Then…</th></tr>
<tr><td>Turns ON after 5 seconds and the motor shuts down.</td><td>The overload time-out is OK.</td></tr>
<tr><td>Remains OFF and the motor shuts down before 5 seconds.</td><td>The voltage at the motor is likely dropping below 13V. An additional booster cell should be added to the battery string.</td></tr>
<tr><td>Either remains OFF without shutting down the motor, OR, the LED turns ON after an inappropriate interval.</td><td>The overload time-out circuit is defective. Change out the amplifier module.</td></tr>
</table></td></tr>
<tr><td>4</td><td>Request the switch powered back to the original position and check the overload releases and the machine locks up in the original position.</td></tr>
</table>

Continued on next page

Step	Action
5	Using the hand crank, verify there is an additional ¼ to ½ turn rotation beyond the point where the motor limit stopped the throw.
6	Verify that the cam bar lock block is a ¼" beyond the lock rod towards the motor end of the machine.
7	Verify that binding isn't present and the machine can be easily shifted from power to hand. If binding is present, back-off the appropriate motor limit cam on the hand throw spur gear.
8	Repeat steps 1 to 7 for the opposing switch move.

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329(c)(3) – Braking

1. Purpose

1.1. To ensure switch machine braking features are in suitable working condition.

2. Test Interval

2.1. Switch machine braking features shall be inspected and tested when installed, as required and at least once every twelve (12) months to ensure proper operation. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i)Protecting Train Operations During Signal System Interruption.

4. Snub Rectifier

4.1. The Model 5 machines are equipped with a snub rectifier circuit to provide motor braking at the end of the throw. This prevents unwanted rotation in the recoil direction.

a) Power the machine to the opposite position and observe the motion of the armature at the end of the throw. Ensure that it stops without recoiling in the opposite direction.

b) Repeat the test by powering the machine back to the original position.

5. Outboard Brake

5.1. Perform this test on machines equipped with an outboard brake.

5.2. NOTE: This test is applicable to Model 5 switch machines only.

Table 329(c)(3)-01

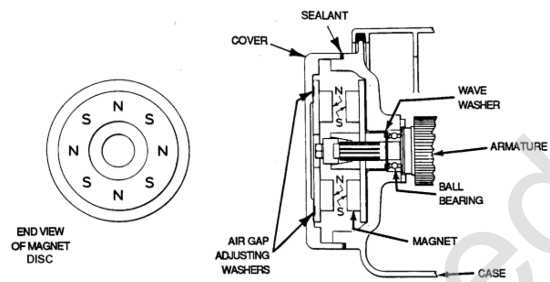
Step	Action	Indication
1	Insert the hand crank and without releasing the brake, try to crank the machine in a direction to open the switch points. This should require a great deal of effort compared to Step 2.	This indicates the brake shoes are holding the motor shaft from turning freely.
2	Insert the hand release lever, release the brake and continue to crank the machine. This should require far less effort than cranking the machine in Step 1.	This indicates that the brake shoes are released from the motor shaft.
3	Visually inspect the condition of the brake shoes and mechanism. • Check for wear and damage. • Check that brake shoes and drum are not contaminated with grease or oil.	

6. Magnetic Detent

6.1. The magnetic detent is comprised of several opposing magnetic poles alternately arranged on two discs, one moveable and mounted on the end of the motor armature shaft and the second permanently mounted and arranged in parallel to the first. As the armature turns and opposing poles meet, a holding effect occurs. The slower the rotation the greater the holding effect. The magnetic detent is designed to hold the motor armature from turning whenever energy is removed from the motor.

6.2. To test this feature, on machines so equipped, hand crank the machine very slowly and check the magnetic holding effect can be felt through the cranking action.

Figure 329(c)(3)-01: Magnetic Detent, Model 5 Switch Machines.



329(c)(4) - Lock Rod Correspondence

1. Purpose

1.1. To ensure proper operation of lock rod arms.

1.2. NOTE: This test is applicable to Model 5 switch machines only.

2. Test Interval

2.1. Lock rod arms shall be inspected when installed, as required and at least once every twelve (12) months to ensure proper operation. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Lock Rod Arm Inspection

4.1. Model 5 switch machines have lock rod arms and contact arm rockers as shown in Figure 329(c)(4)- 1. These are critical for ensuring open point detection in the event of a broken rod. Inspect these components and ensure that lock rod arms are of the approved type and mounting bolts or screws are tight. IMMEDIATELY replace any non-approved lock arms that are found.

5. Rocker Inspection

5.1. On some style rockers, check that the rocker screw holding the rocker in place is tight and the rocker is secure as shown in Figure 329(c)(4)- 2. New style rockers have no screw because the rocker forms part of the casting of the contact arm.

6. Wear Plate Test

6.1. Position the machine to the midstroke position, and with a feeler gauge, measure the gap between the bottom of the rocker and the top of both lock rod arms as illustrated in Figure 329(c)(4)- 2. If the gap is 3/16" (.180") or more, the lock rod wear plates must be replaced. There are 2 styles of wear plates; the old style switch machines have shim type wear plates, while the newer style machines have "puzzle box" type wear plates.

6.2. IMPORTANT: Wear plates must always be replaced on both sides of the switch machine at the same time, which requires that 2 replacement sets be provided per switch machine.

7. Lock Rod Arms & Contact Yoke Rocker

Figure 329(c)(4)- 1: Illustration of Lock Rod Arms

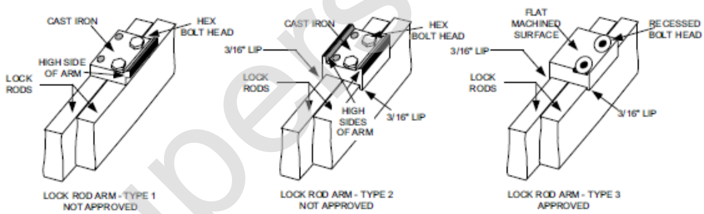
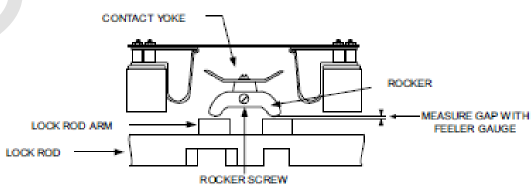


Figure 329(c)(4)- 2: Illustration of Rocker on Lock Rod Arms



8. Rocker Test

8.1. Inspect the rocker, and if it is 1/8″ thickness verify it lines up with the lock rod arms, as seen from above. If there is any doubt, perform the following test to ensure the lock rod arms are effective. If this test fails, the contact yoke must be adjusted or replaced with a ¼″ thickness rocker immediately.

Table 329(c)(4)-01

Step	Action
1	Throw the machine to the reverse locked position, ensuring correspondence is made.
2	Disconnect the point detector rod, throw the switch to the normal locked position. Ensure the contact yoke remains in the neutral position.
3	Throw the machine to the reverse locked position and reattach the point detector rod.
4	Throw the machine to the normal locked position, ensuring correspondence is made.
5	Disconnect the point detector rod, throw the switch to the reverse locked position. Ensure the contact yoke remains in the neutral position.
6	Throw the machine to the normal and locked position and reattach the point detector rod.
7	Perform GI-329(a) Switch Obstruction Test, GI-329(b)(1) Switch Point Pressure, GI-329(b)(2) Point Detector Test and GI-329(b)(3) General Inspection to ensure correct adjustment.

329(c)(5) - Hand Throw Timing & Holding Force

1. Purpose

1.1. To ensure the hand throw mechanism on dual control switch machines hold the closed switch point secure through the interaction of the main crank and the throw bar with the machine in the hand position.

2. Test Interval

2.1. Hand throw timing and holding force tests shall be performed by when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Warning

4.1. A dual control switch machine must be properly timed. If any test indicates timing is incorrect, there is risk of derailment after the machine has been thrown by the hand-throw lever and before it has been thrown by power.

5. Lever Stands Test

5.1. Test lever stands on all dual control switch machines as directed in this table.

Table 329(c)(5)-01

Step	Action	Check
1	Observe the condition of the lever stands.	• They are securely mounted to the ties. • Check for wear, damage or loose parts. • Locks are provided for both lever stands, in good condition and secured by chain.
2	Remove the switch locks and place the selector lever in the POWER position.	The selector lever fits snugly into the stand without having to use excess force.
3	Attempt to throw the switch with the hand throw lever.	The switch cannot be thrown with the hand throw lever.
4	Lock the lever stand. Step on the release pedal of the lever stand and try to pull the selector lever free of the stand.	The selector lever does not come free of the lever stand. If there is considerable movement of the selector lever while locked in the stand and some minor wear is observed on the lever or the stand, proceed with Step 5.
5	If instructed to by Step 4, step on the release pedal of the lever stand and try to pry the selector lever free of the stand with a small pry bar.	The selector lever does not come free of the lever stand.

6. Timing Test Procedure

6.1. This test is applicable to all dual control switch machines. When testing GM-4000 switch machines, while the machine is in mid-throw, place an obstruction in front of the lock rod notch to prevent the locking dog from clearing the lock rod.

6.2. CAUTION: When performing tests that attempt to pry a closed point open, do not be in a position where you may be struck by the lever if it rapidly swings upward during the test.

Table 329(c)(5)-02

Step	Action
1	Unlock the lever stand, place the selector lever in the HAND position, and throw the switch away from its original position. Do not allow the hand throw lever to be thrown far enough to be engaged by the locking mechanism of the lever stand. It should be felt that the hand throw mechanism is holding the switch points just before the hand throw lever is fully in the latch stand.
2	Keep the hand throw lever just high enough to obstruct the locking mechanism of the lever stand. If need be, place a spacer between the hand throw lever and lever stand to keep the lever in that unlocked position.
3	Using a lining bar, pry the closed switch point away from the stock rail. *Use caution when prying point in case pry bar suddenly releases.* **Ensure that the switch points do not open.**
4	Slowly raise the hand throw lever until it is felt the hand throw mechanism has released its hold of the switch points. Make note of the angle of the lever in relation to the horizontal plane of the machine, when the mechanism releases.

Continued on next page

Step	Action
5	Continue to throw the switch to the opposite position it was placed in Step 1. Follow the same instructions pertaining to how far to throw the lever. Repeat Steps 2 to 4.
6	Check the hand throw lever angles noted for both directions in Step 4 is approximately the same on both sides. This indicates the hand throw mechanism is properly timed. Switch machines that are not properly timed must be corrected immediately.
7	Ensure that the hand throw lever is horizontal and level in the lever stand for both positions before leaving the site.

7. Additional Timing Test - GM-4000

7.1. In addition to the test prescribed in the previous section, verify the timing of GM-4000 switch machines by performing the test prescribed in this table.

7.2. NOTE: The GM-4000 has locking in the hand throw position.

Table 329(c)(5)-03

Step	Action	Check
1	Place the selector lever in the HAND position.	Verify the Remote/Local LED on the amplifier module goes out after the selector lever is moved out of the POWER but before it is moved into the HAND position – preferably midway.
2	Hand throw the machine to the opposite side.	For each position, the hand throw lever must enter the appropriate latch stand. The cam bar locking block must protrude out beyond the lock rod ¼″ toward the motor end of the machine.
3	Hand throw the machine back to the original side.	
4	Restore the machine to the POWER position.	-

329(d)(1) - Selector Lever & Restoral

1. Purpose

1.1. To ensure proper operation of the selector lever and the switch restoral functionality.

2. Test Interval

2.1. Selector lever and restoral tests shall be performed when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Selector Lever Test

4.1. Verify correct operation of the selector lever by performing the following test.

Table 329(d)(1)-01

Step	Action	Check
1	-	The position of the switch and the appropriate correspondence relay is up.
2	Move the selector lever from the POWER to the HAND position.	The correspondence relay is down.
3	Move the selector lever back to the POWER position and power the machine to the opposite side.	The position of the switch and the appropriate correspondence relay is up.
4	Repeat step 2.	The correspondence relay is down.
5	Place the selector lever in the POWER position.	

5. Restoral Test

5.1. This test shall be performed at all dual control switch machine locations equipped with:

a) Thermal overload relay, or;

b) Overload timer c/w lever sensing circuitry (FACK).

5.2. This test need not be performed at locations equipped with overload timers that do not have lever sensing circuitry.

Table 329(d)(1)-02

Step	Action	Check
1	Place the selector lever in the HAND position and hand throw the machine to the opposite side.	-
2	Place the selector lever in the POWER position.	The machine restores to its original position and locks up.
3	Power the machine over.	The machine completes its stroke and locks up.
4	Repeat steps 1 and 2 for the other direction.	The machine restores to its original position and locks up.

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329(d)(2) - Lock Box

1. Purpose

1.1. To ensure correct orientation of the lock box.

2. Test Interval

2.1. The lock box shall be inspected when installed and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

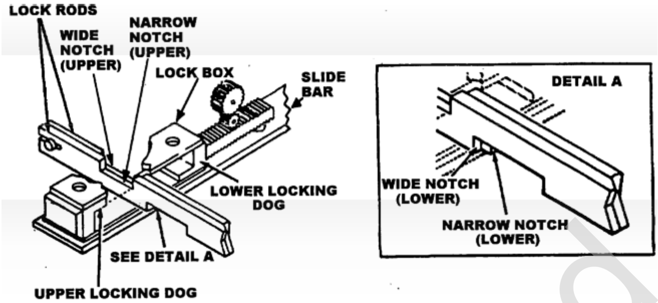
3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Lock Box

4.1. The lock rods in a Ansaldo (US&S) machine are assembled so the locking dog enters the narrow notch first during the final movement of the slide bar while in the process of locking up. Observe the movement of the lock rods in relation to the lock box, normal and reverse, as illustrated.

Figure 329(d)(2)- 1: US&S Lock Box



4.2. NOTE: This test is applicable for M-23 switch machines only.

329(d)(3) - Latchout Self Restoral

1. Purpose

1.1. To ensure switch machine latchout self-restoral features are in suitable working condition.

2. Test Interval

2.1. The latchout self restoral tests shall be performed when installed and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Latchout M-23

4.1. At time of installation, perform the test described in this table for M- 23 switch machines.

Table 329(d)(3)-01

Step	Action	Check
1	With the switch machine on power and in the normal position	The machine is mechanically locked and the appropriate correspondence relay is up.
2	Pry the roller, on the normal side of the detector bar, up and away from the bar until the latch engages as shown in GI-329(b)(2) Point Detector Test – 1-C of Figure 329(b)(2).	The indication contacts are open and the correspondence relays are down.
3	Disengage the latch.	The indication contacts close and the appropriate correspondence relay picks up.
4	Power the switch machine to the reverse position.	The machine is mechanically locked and the appropriate correspondence relay is up.
5	Repeat steps 2 to 4 for the reverse position.	

5. Latchout Self Restoral

5.1. Whether or not the restoral feature is enabled depends on local conditions and the policy of the responsible Metrolinx Signal Specialist or Designate.

5.2. The latchout self restoral feature can be enabled on GM-4000 machines by removing the jumper between terminal block TB-1, posts 9 and 10. It is recommended that GM-4000 self restoral be enabled.

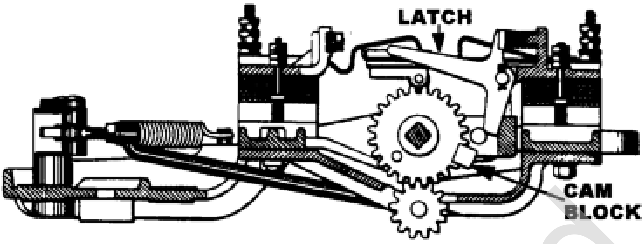
5.3. The latchout self restoral feature can be disabled on Ansaldo (US&S) machines by removing the cam block from the circuit controller shaft gear as illustrated in Figure 329(d)(3)- 1. Verify the condition of the latchout self-restoral on Ansaldo (US&S) machines by performing the test described in the following table:

5.4. NOTE: This test is applicable for M-23 and GM-4000 switch machines only.

Table 329(d)(3)-02

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Pry the roller up and away from the point detector bar until the latch is latched.</td></tr>
<tr><td>2</td><td>Power the machine over to the locked up position and observe the action of the latch mechanism during this process.</td></tr>
<tr><td>3</td><td>Check the latch operates as described in this table.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>The cam block is removed</td><td>The latch will not restore to the unlatched position. It will have to be restored manually.</td></tr>
<tr><td>The cam block is not removed.</td><td>The latch will restore to the unlatched position on the next switch call.</td></tr>
</table></td></tr>
<tr><td>4</td><td>Repeat steps 1 to 3 for the machine in the opposite direction.</td></tr>
</table>

Figure 329(d)(3)- 1: Cutaway Side View of US&S Circuit Controller Mechanism



6. Latchout Verification Test

6.1. The latchout verification test for Ansaldo (US&S) and GM-4000 switch machines shall be performed at the time of installation, note the Model 5 machines do not have a latchout feature.

6.2. This test simulates a switch run through condition and is designed to ensure the latch on a newly installed machine functions properly.

Table 329(d)(3)-03

Step	Action	Check
1	With the switch machine on power and in the normal position.	The machine is mechanically locked and the appropriate correspondence relay is up.
2	Pry the roller, on the normal side of the detector bar, up and away from the bar until the latch engages.	The indication contacts are open and the correspondence relays are down.
3	Disengage the latch.	The indication contacts close and the appropriate correspondence relay picks up.
4	Power the switch machine to the reverse position.	The machine is mechanically locked and the appropriate correspondence relay is up.
5	Repeat Steps 2 to 4 for the reverse position.	Check steps 2 to 4 for the reverse position.

329(d)(4) - Compartment Heaters

1. Purpose

1.1. To ensure proper operation of compartment heaters.

2. Test Interval

2.1. Compartment heaters shall be inspected at time of reconnection, monthly during winter condition and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Inspection

4.1. At time of reconnection, and monthly during severe winter conditions (temperatures consistently below 0° C / 32° F), perform the following:

a. Verify the heater is in good condition.

b. Check voltage level is correct at the terminals of the heater.

   i. NOTE: Heaters may be AC or DC.

c. Without actually touching the heater check that it is emitting heat.

   ii. CAUTION: Some heaters can become sufficiently hot to burn the skin.

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330 - Inspecting and Testing Spring Switches

1. Introduction

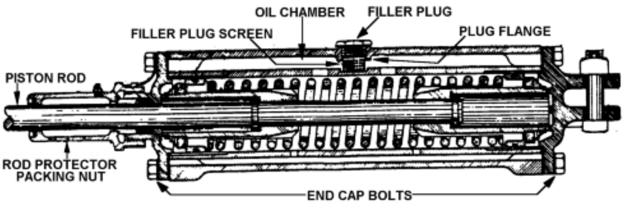
1.1. A spring switch mechanism is both a mechanical and hydraulic device.

Table 330-1

Mechanical	Mechanical action is provided by way of a compressed spring. With the switch in the normal position the spring exerts a pressure of approximately 1100 pounds at the point. When a trailing movement forces the switch points open the spring is further compressed and a pressure of approximately 2200 pounds is exerted at the point. When the train has trailed free of the switch points the pressure exerted by the spring restores the point to the normal position.
Hydraulic	The mechanism housing is filled with oil and by design is intended to buffer the spring return after the train wheels no longer exert pressure against the point. This action keeps the switch point open after a set of wheels has passed and until the next set of wheels applies pressure to the points. When the last set of wheels has passed, the hydraulic buffer action will allow the switch to restore very slowly until it reaches its last inch of throw where the hydraulics are bypassed and the switch point snaps closed.

1.2. This diagram depicts some of the main parts of a spring switch mechanism

Figure 330-01



2. Inspector Tests

2.1. A Signal Inspector or designated employee, acting in an inspection capacity, shall be assigned to perform these tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Personal Safety

4.1. There will be a minimum of 1100 pounds pressure against the switch stand handle when it is in the normally locked position. This pressure will increase to 2200 pounds or more as the obstruction and switch restoral test is performed.

4.2. CAUTION: As the switch stand handle is lifted from the locked position the pressure may cause the handle to fly up and away from the locking notch. Be prepared, apply firm footing and stand away from the direction the handle will swing when released.

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330(a) - Spring Switch Circuit Controllers

1. Purpose

1.1. To ensure that circuit controllers attached to spring switches are mechanically adjusted and maintained to properly detect the position of switches so they can meet the electrical requirements of the circuits they control.

2. Test Interval

2.1. Spring Switch Circuit Controllers shall be inspected and tested in accordance with GI-327(a) Inspecting and Testing Switch Circuit Controllers when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Test shall be performed monthly in accordance with GI-327(a) Inspecting and Testing Switch Circuit Controllers.

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330(b) - Spring Switch Mechanism

1. Purpose

1.1. To ensure that spring switch mechanism will allow trains to trail through a closed switch point and restore and hold the point in its original position after the trailing move is completed.

2. Test Interval

2.1. Spring Switch mechanism shall be inspected when installed, after any work or occurrence which could affect the adjustment, and by the Maintainer at least once every three (3) months, inspect mechanism to observe that it operates properly. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Visual Inspection

4.1. Follow the instructions in this table to perform visual inspection tests on spring switch mechanism.

Table 330(b)-01

Inspect	Check
Piston Rod	Check the piston rod is straight, free from damage and is not corroded where it may pass through the packing nut and do damage to the packing.
Switch	Check the switch moves freely, is properly lubricated and free of debris.
Clearance and Drainage	Check that adequate clearance exists between the spring switch mechanism and the ballast and ties so it can move freely in all seasons. Provide proper drainage for the mechanism and its attachments.
Packing Nut	Check the packing nut is tight. NOTE: The packing nut should be tight enough to prevent leakage of oil out of the cylinder but must not be so tight that it will bind the piston rod. Sufficient pressure can be applied when tightening the nut by hand if the packing is in good condition.
Nuts and Bolts	Check all mounting bolts, nuts, pins and cotter keys and ensure they are secure and in good repair.
Switch Throw	Measure the switch throw at the first rod and ensure it does not exceed 4 ¾".
Grease	Check that mechanisms equipped with a rod protector packing nut are filled with grease and ensure a film of grease covers the exposed portion of the piston rod.
End Caps	Ensure end cap bolts are secure and lock washers are installed.

5. 1/4" Compression Test

5.1. Follow these instructions when performing the ¼" compression test.

Table 330(b)-02

Step	Action
1	Open the switch so that no pressure is applied to either the normal or reverse point.
2	Mark the piston rod at the point where it protrudes from the packing nut or rod protector.
3	Place the switch in the full normal position and check the piston rod has traveled ¼ inch from the mark.
4	Repeat steps 1 to 3 for the switch points in the reverse position.

6. Switch Restoral Test

6.1. Follow these instructions when performing the switch restoral test. This test will require a 4" obstruction (block) that can easily be knocked out from between the switch point and stock rail with the point under pressure.

Table 330(b)-03

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Open the switch with a hydraulic track jack between the point and stock rail, then place a 4” block between the normal point and the stock rail flush to the end of the point, then remove the jack. Exercise extreme caution.</td></tr>
<tr><td>2</td><td>Knock the block out from between the point and the stock rail.
Check the switch restores to the normal position slowly until it reaches its last inch of throw where it snaps closed.
Measure the total time it takes for the switch to restore full normal after the block is knocked out. The total time shall not be less than 10 seconds nor more than 20 seconds (usually 10 to 12 seconds).</td></tr>
<tr><td>3</td><td>Repeat Steps 1 to 2 for the reverse point.</td></tr>
<tr><td>4</td><td>Check the spring switch mechanism for oil leaks. Pay special attention to the gaskets and bolts holding the end caps on the housing. Also check the area around the packing nut and filler plug.<table><tr><th>If…</th><th>Then…</th></tr><tr><td>Oil leaks are evident.</td><td>Tighten, repair or replace the part that is leaking.
Check the oil is at its proper level.
Restart at Step 1 to ensure the mechanism is within specifications.</td></tr></table></td></tr>
<tr><td>5</td><td>Remove the filler plug and screen and check the oil level is at the bottom of the plug flange. Check the oil is clean and clear.</td></tr>
</table>

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330(c) - Spring Switch Compression Gauge Test

1. Purpose

1.1. To ensure that spring switches are working properly.

2. Test Interval

2.1. Spring switch compression gauge test shall be performed when installed, as required and at least once every year. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Oil Change

4.1. Ensure the oil is changed out prior to beginning this test.

5. Test Procedure

5.1. Before performing this test ensure the switch moves freely and is properly adjusted, surfaced and lubricated. The results of this test can be affected by the condition of the switch itself. Exercise extreme caution when performing this test.

5.2. Note: Spring switch mechanisms that do not meet these specifications shall be taken out of service or replaced immediately. In some jurisdictions, spring switch mechanisms shall be replaced annually, as directed by Metrolinx.

Table 330(c)-01

Step	Action
1	Attach the spring switch compression gauge by placing the hooked end over the head of the stock rail on the open point side with the pump and plunger aligned to fit between the bolts attaching the throw rod clip to the point.
2	Pump up sufficient pressure to slightly open the closed point.
3	Insert a thin shim (0.003 to 0.005 inch) between the stock rail and the closed point and release the pressure on the compression gauge pump. Check the shim is firmly held between the point and stock rail.
4	Pump up sufficient pressure to just allow the shim to be easily pulled free from between the point and the stock rail.
5	Observe the pressure reading on the gauge. The reading should be about 1100 pounds pressure but in no case shall be below 1000 pounds pressure.
6	Continue to pump up the pressure until the open point is within 1 inch of the stock rail. The pressure reading on the gauge should not be less than 2200 pounds.
7	Release the pressure on the gauge, remove it from the rail, throw the switch in the opposite direction and repeat steps 1 to 6.

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331 - Testing Time Releases, Time Relays and Timing Devices

1. Purpose

1.1. To ensure that time releases, timing relays and timing devices are maintained at not less than 90 percent nor more than 110 percent of the predetermined time interval, which shall be shown on the plans.

2. Test Interval

2.1. Time releases, timing relays and timing devices shall be tested when installed, as required and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. GI-323 Relays

4.1. Refer to GI-323 Inspecting and Testing Relays and perform visual inspection tests in conjunction with these tests.

5. Inspector Tests

5.1. A Signal Inspector or designated employee acting in an inspection capacity, shall be assigned to perform these tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period.

6. Seals

6.1. When timing equipment seals are broken to make timing adjustments, the seals must be replaced immediately after the adjustments are completed. Refer to GI-405 Inspecting Seals.

7. Timing Circuits General

7.1. At the time of installation, a complete operational test shall be performed on timing equipment and associated circuitry. Periodic testing need only ensure the timing equipment itself is set to within 90 to 110 percent of the time value noted on the circuit plan.

8. Thermal Relay Definition

8.1. A thermal relay is a timing relay whose contacts are actuated by the heating effect of current flowing through its controlling element.

9. Thermal Relay Timing Test

9.1. Follow the instructions in this table to test the time interval for thermal relays.

Table 331-01

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td><table><tr><th>If the circuit…</th><th>Then…</th></tr><tr><td>Has an adjustable resistor in series with the heating coil of the thermal relay.</td><td>Check the voltage at the heating coil of the thermal relay is set for the rated voltage of the relay when the circuit is energized. Proceed to Step 2.</td></tr><tr><td>Does not have an adjustable resistor in series with the heating coil of the thermal relay.</td><td>Proceed to Step 2.</td></tr></table></td></tr>
<tr><td>2</td><td>Consult the circuit plan, energize the thermal relay circuit in the manner it would normally be energized and measure the time interval.</td></tr>
<tr><td>3</td><td>Observe the check contact returns to the de-energized or "cool" position at the completion of the full time cycle.</td></tr>
<tr><td>4</td><td>Check the time interval is not less than 90 percent nor more than 110 percent of the time noted on the circuit plan.

Does the time interval meet this requirement?
• YES: Stop the test here.
• NO: Proceed with Step 5</td></tr>
<tr><td>5</td><td>Wait 10 minutes for the thermal element to cool and repeat steps 1-4. If adjustments are necessary, contact responsible Supervisory Officer.</td></tr>
</table>

10. Timing Relay Definition

10.1. A timing relay is a relay which will not close its front contacts or open its back contacts, or both, until the expiration of a definite time interval after the relay has been energized.

11. Motor Timer Test

11.1. Follow the instructions in this table to test the time interval for motor timer relays.

Table 330-02

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Consult the circuit plan, energize the motor timer relay circuit in the manner it would normally be energized and measure the time interval.</td></tr>
<tr><td>2</td><td>Observe the mechanical action of the motor timer while in operation and check that it operates smoothly and contacts return to their normal position at the completion of the time cycle.
<table><tr><th>If…</th><th>Then observe that…</th></tr><tr><td>Two or more motor timers are connected in series.</td><td>Each consecutive relay starts its timing cycle immediately when the relay preceding it makes its front contacts and that all contacts return to their normal position at the completion of the total time cycle.</td></tr></table></td></tr>
<tr><td>3</td><td>Check the time interval is not less than 90 percent nor more than 110 percent of the time noted on the circuit plan.

Does the time interval meet this requirement?
YES: Stop the test here.
NO: Proceed with Step 4</td></tr>
<tr><td>4</td><td>If adjustments are necessary, contact the responsible Supervisory Officer.</td></tr>
</table>

12. Electronic Relay and Timing Device Test

12.1. NOTE: Refer to manufacturer's instructions regarding the operation of electronic relay or other timing devices, such as the ST-1A-X Stick Release Timer used in Highway Grade Crossing Warning Devices. These instructions shall be accessible to the employee performing the tests.

12.2. Also follow the instructions in this table to test the time interval for electronic relays and other timing devices.

Table 330-03

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Consult the circuit plan, energize the electronic relay or timing device in the manner it would normally be energized and measure the time interval.</td></tr>
<tr><td>2</td><td>Follow the instructions in this table.
<table>
<tr><th>If the relay or device…</th><th>Then…</th></tr>
<tr><td>Is provided with an LED to indicate its operating mode.</td><td>Observe the LED is either ON or OFF as designed. Proceed to Step 3.</td></tr>
<tr><td>Is not provided with an LED to indicate its operating mode.</td><td>Proceed to Step 3.</td></tr>
</table></td></tr>
<tr><td>3</td><td>Check the time interval is not less than 90 percent nor more than 110 percent of the time noted on the circuit plan.

Does the time interval meet this requirement?
• YES: Stop the test here.
• NO: Proceed with Step 4</td></tr>
<tr><td>4</td><td>If adjustments are necessary, contact the responsible Supervisory Officer.</td></tr>
</table>

332 - Inspecting and Testing Insulated Track Hardware – General

1. Purpose

1.1. To describe the method of inspecting and testing bond wires, track connections and insulated track hardware in order to maintain the safety and reliability of the system and prevent track circuit failures.

2. Test Interval

2.1. Track hardware inspections and tests shall be performed when installed, as required and periodically. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Other Applicable Maintenance Instructions

4.1. Track hardware inspections and tests may be performed in conjunction with all applicable tests described in Maintenance Instructions:

a. GI-310(c)(8) Approaches with MS/CW.
b. GI-326 Inspecting and Testing Fouling Circuits.
c. GI-333(a) Track Circuits.

5. Results of Tests

5.1. Results of these inspections and tests shall be recorded in SCIS. When there is evidence that current is leaking through insulated track hardware, it should be considered a warning that failure or a breach of system integrity is imminent. Immediate action should be taken to correct the defect as soon as possible. Defects that will impede the safe and reliable operation of the signal or crossing warning system, which cannot be immediately corrected, shall be reported immediately to the responsible Supervisory Officer and Metrolinx.

332(a) - Track Hardware - Visual Inspection

1. Purpose

1.1. To describe the method of inspecting bond wires, track connections and insulated track hardware in order to maintain the safety and reliability of the system and prevent track circuit failures.

2. Test Interval

2.1. Bond wires, track connections, insulated joints and other insulated track hardware shall be inspected when installed, as required and at least once every six (6) months, unless more frequently required by GI-310(b)(2) IJs and Track Connections. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Insulated Joint Visual Inspection

4.1. Follow the instructions in this table when inspecting insulated joints. Inspections that indicate insulated joint breakdown is imminent shall be electrically tested in accordance with GI-332(b) Track Hardware - Electrical. Refer to S&C Codes of Practice SCP-8 for more details on inspecting insulated joints.

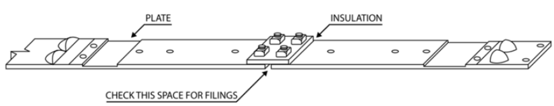
Table 332(a)-01

Inspect	Check
Insulated Joint Location	Check that insulated joints are installed and maintained in accordance with S&C Codes of Practice, SCP-1.
Spikes	Check insulated joints are properly spiked and spike heads are reversed.
Concrete Tie Clips	Check rail clips, when used at insulated joints, are properly installed, the proper type and separated from the rail by the proper insulating device.
Insulated Joint Track Standards	Check that insulated joints are installed and maintained in accordance with Metrolinx Track Standards. NOTE: When replacing rails or other track equipment, track connections or bonds shall not be installed until the track is safe for train operation.
Plates and Ties	Check that ties are properly spaced and that no steel ties or tie plates are located under insulated joint rail ends.
Steel Slivers or Filings, Battered Rail Ends	Check that rail ends are square and the endpost space is not bridged by steel slivers, filings or rail runover.
Bolts	Check all bolts are properly installed and nuts are securely tightened.
Tamping	Check ties are properly tamped. Whenever possible, watch for excessive pumping action of the joint and ties when trains pass.
Insulation	Check that insulating material is not burned, excessively weathered, broken, displaced or missing.
Epoxy Joints	Check epoxy joints have not been burned or melted due to fire or maintenance welding.

5. Insulated Rods, Plates, Ducts, or Pipe Lines - Visual Inspection

5.1. Follow the instructions in this table when inspecting insulated rods, plates, ducts, or pipe lines. Hardware that indicates insulation breakdown is imminent shall be electrically tested in accordance with GI-332(b) Track hardware - Electrical.

Table 332(a)-02

Inspect	Check
Snow Melter and Snow Blower Ducts	• Check that insulating gaskets, ferrules and bolts are secure and in good condition. • Check there is adequate space separating the rail and cross ducts so electrical current cannot be passed from one to the other.
Insulation	• Check that insulating material is not burned, excessively weathered, broken, displaced or missing.
Bolts	• Check all bolts are properly installed and nuts are securely tightened.
Steel Slivers or Filings	• Check the insulated areas of the rods, plates, pipe lines or ducts are not contaminated with filings or bridged by steel slivers. **Figure 332(a)-1: EXAMPLE** 

6. Bond Wires and Track Connections - Visual Inspection

6.1. Follow the instructions in this table when inspecting bond wires and track connections. Hardware that does not meet the requirements of these inspections or present the risk of imminent circuit failure shall be replaced or repaired immediately.

Table 332(a)-03

Inspect	Check
Mechanical Type Track Connections	• Check track connections that employ the use of studs or clamps are secure, corrosion free and in good condition.
Plug Type Track Connections	• Check plugs are not bent or damaged to the extent they may become loose. • Check plugs are not driven into the rail all the way up to the shoulder of the plug. • Check single plugs installed in the web of the rail at joints are not more than 2 inches from the end of the angle bar and additional plugs are installed as close as practicable.
Exothermic Track Connections	• Check that welds are secure and free from significant damage. • Check that no portion of the formed terminal within the confines of the weld is exposed. NOTE: Refer to the S&C Codes of Practice SCP-5 and manufacturer's instructions.

Continued on next page

Inspect	Check
Bond Wires	• Check that bond wires are not frayed or significantly damaged, and that they are installed in a manner that will minimize the risk of damage from track maintenance equipment. • Check that bootlegs are properly installed and in good condition. NOTE: Refer to the S&C Codes of Practice SCP-7.
Spikes, Anchors and Rail Clips	• Check that spikes, anchors and rail clips do not interfere with bond or bootleg wires.

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332(b) - Track Hardware - Electrical

1. Purpose

1.1. To describe the method of testing bond wires, track connections and insulated track hardware in order to maintain the safety and reliability of the system and prevent track circuit failures.

2. Test Interval

2.1. Insulated joints, insulated gauge plates and rods, other rail-to-rail insulated track hardware, and snow melter ductwork shall be tested when installed and when the results of visual inspections dictate. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Instruments

4.1. The following test instruments are recommended to perform tests on insulated track hardware.

a. Short Finder (refer to manufacturer's instructions), or

b. Joint Checker (refer to manufacturer's instructions), or

c. Construct a test meter by wiring a 1.5 V dry cell, 4 ohm resistor, and ammeter and test probes in series (current leakage is detected when more than 0.020 Amps are detected by the ammeter).

5. Insulation Condition

5.1. Always perform tests in dry conditions, except when troubleshooting. If performing in wet conditions, factor the possible effects of moisture on the test results before condemning any insulated track hardware.

6. Testing Front Rods, Switch Rods, Gauge Rods, Pipe Line Insulation, Gauges Plates, and Insulated Ductwork

6.1. Perform these tests at the time of installation and when results of GI-332(a) Track Hardware - Visual Inspection indicate insulation breakdown is imminent. Tests shall be performed when insulation is dry.

Table 332(b)-01

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Remove surface rust and dirt from metallic parts where contact will be made with test probes.</td></tr>
<tr><td>2</td><td>Test the insulation on both sides as shown on the typical diagrams depicted in Figure 332(b)- 1, Figure 332(b)- 2 & Figure 332(b)- 3.</td></tr>
<tr><td>3</td><td>Follow the instructions in this table.
<table>
<tr><th>If…</th><th>Then…</th></tr>
<tr><td>Current leakage is detected.

NOTE: If practicable, when current leakage is detected, the insulated track hardware should be isolated from ground or other current path and retested.</td><td>Insulation should be renewed as soon as possible.</td></tr>
<tr><td>Current leakage is not detected.</td><td>No action is required.</td></tr>
</table></td></tr>
</table>

6.2. Insulation tests to front rods, switch rods, gauge rods, pipeline, gauge plates and ductwork shall be performed as depicted in the diagrams below:

Figure 332(b)- 1: Switch Rod

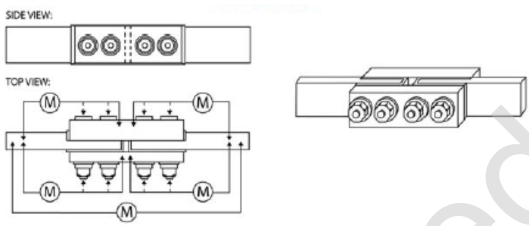


Figure 332(b)- 2: Gauge Plate – Flat Insulating Plate Style

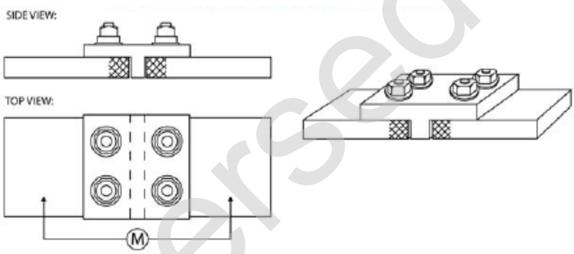
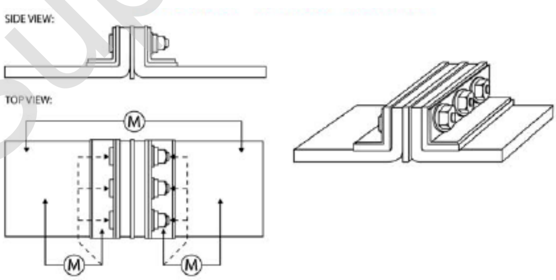


Figure 332(b)- 3: Gauge Plate – Turned Up End Style



7. Testing Insulated Joints

7.1. Perform these tests at the time of installation and when results of GI-332(a) Track Hardware - Visual Inspection indicate insulation breakdown is imminent. Joints may be tested by using either the current or voltage method as described in these tables or by more thorough methods as described in S&C Codes of Practice SCP-8. Tests shall be performed when insulation is dry.

7.2. NOTE: *This test is not applicable in Microcode territory – refer to next section*.

Table 332(b)-02

<table>
<tr><th colspan="2">Current Method</th></tr>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Insert an ammeter in series with the track battery connected to a track circuit adjacent to the insulated joints to be tested, as illustrated in Figure 332(b)- 4.</td></tr>
<tr><td>2</td><td>Ensure the track circuit is unoccupied and note the current value.</td></tr>
<tr><td>3</td><td>Place a zero ohm shunt between points "B" and "C".</td></tr>
<tr><td>4</td><td>Follow the instructions in this table.
<table><tr><th>If…</th><th>Then this indicates that…</th></tr><tr><td>The current value increases.</td><td>Insulated joint "Y" is leaking current and should be repaired or changed as soon as possible.</td></tr><tr><td>The current value does not change.</td><td>Insulated joint "Y" is not leaking current and no action is required.</td></tr></table></td></tr>
<tr><td>5</td><td>Remove the zero ohm shunt.</td></tr>
<tr><td>6</td><td>Place a zero ohm shunt between points "D" and "E" and repeat steps 4 and 5 for testing insulated joint "X".</td></tr>
</table>

Figure 332(b)- 4: Current Method of Testing Insulated Joints

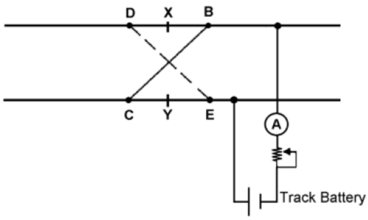
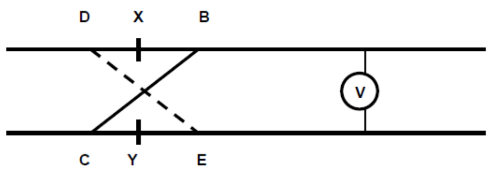


Table 332(b)-03

<table>
<tr><th colspan="2">Voltage Method</th></tr>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Connect a DC voltmeter across the rails on a track circuit adjacent to the insulated joints to be tested, as illustrated in Figure 332(b)- 5.</td></tr>
<tr><td>2</td><td>Ensure the track circuit is unoccupied and note the voltage value.</td></tr>
<tr><td>3</td><td>Place a zero ohm shunt between points "B" and "C".</td></tr>
<tr><td>4</td><td>Follow the instructions in this table.
<table>
<tr><th>If…</th><th>Then this indicates that…</th></tr>
<tr><td>The voltage value decreases.</td><td>Insulated joint "Y" is leaking current and should be repaired or changed as soon as possible.</td></tr>
<tr><td>The voltage value does not change.</td><td>Insulated joint "Y" is not leaking current and no action is required.</td></tr>
</table></td></tr>
<tr><td>5</td><td>Remove the zero ohm shunt.</td></tr>
<tr><td>6</td><td>Place a zero ohm shunt between points "D" and "E" and repeat steps 4 and 5 for testing insulated joint "X".</td></tr>
</table>

Figure 332(b)- 5: Voltage Method of Testing Insulated Joints



8. Testing Insulated Joints – Microcode Territory

8.1. Insulated joint tests in Microcode territory shall be performed at the time of installation and when results of GI-332(a) Track Hardware – Visual Inspection indicate insulation breakdown is imminent. Perform the test with the method below, or by more thorough methods as described in S&C Codes of Practice SCP-8. Tests shall be performed when insulation is dry.

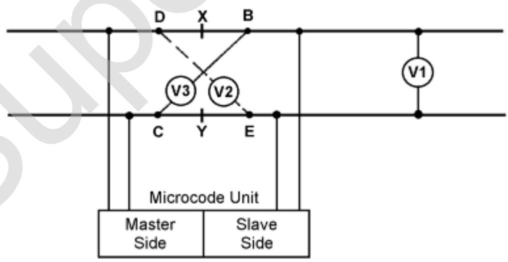
Table 332(b)-04

Step	Action
1	Turn off the power to the Microcode unit. NOTE: This action will render the track circuit on the Master side electrically dead and input pulses will continue to be received on the Slave side track circuit.
2	Connect an AC voltmeter across the rails on the Slave side track circuit at "V1", as illustrated in Figure 332(b)- 6.
3	Ensure the track circuit is unoccupied and note the voltage value.
4	Disconnect the AC meter from "V1" and connect it at "V2".

Continued on next page

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>5</td><td>Follow the instructions in this table
<table>
<tr><th>If Voltage is…</th><th>Then this indicates that…</th></tr>
<tr><td>Detected</td><td>Insulated joint "X" is leaking current and should be repaired or changed as soon as possible.</td></tr>
<tr><td>Not detected</td><td>Insulated joint "X" is not leaking current and no action is required.</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Disconnect the AC meter from "V2" and connect it at "V3".</td></tr>
<tr><td>7</td><td>Repeat step 5 for the testing of insulated joint "Y".</td></tr>
<tr><td>8</td><td>Disconnect the meter and turn on the power to the Microcode unit.</td></tr>
</table>

Figure 332(b)- 6: Testing Insulated Joints in Microcode Territory



332(c) - Guard Rail Bond Wires

1. Purpose

1.1. In some locations, guard rails are bonded in order to ensure broken rail protection in the event of failure of the guard rail insulation pad. These bond wires must be inspected and tested to maintain the safety and reliability of the system and prevent track circuit failures.

2. Test Interval

2.1. Where guard rail bond wires are installed, they shall be tested when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Guard Rail Bond Wires

4.1. Guard rails that are bonded shall be installed as depicted in Figure 332(c)-1. With this bonding arrangement, if a guard rail becomes shorted to its adjacent running rail, the track circuit is shunted, thereby providing detection. Guard rails within crossing approach circuits shall not be bonded; this is to avoid creating a potential short warning time.

5. Testing Guard Rail Bond Wires

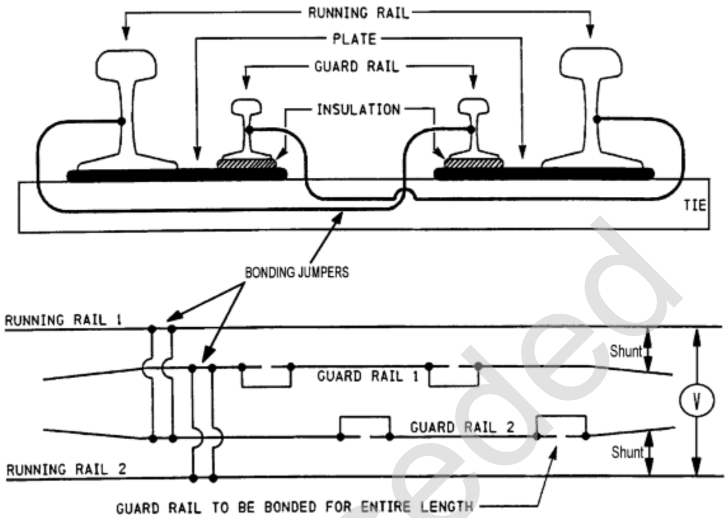
5.1. Guard rails which are bonded shall be installed and tested as depicted as instructed below.

Table 332(c)-01

Step	Action
1	Connect a voltmeter across the running rails as shown in Figure 332(c)- 1 and note the voltage.
2	Place a zero ohm shunt across guard rail 1 and running rail 1 at the opposite end of the guard rail from where the bonding jumpers are installed, as shown in Figure 332(c)- 1.
3	Observe the running rail voltage has dropped significantly. This indicates that all bonds are in place, thereby causing a short circuit to occur between running rails 1 and 2.
4	Remove the shunt and repeat steps 1 to 3 with the shunt placed across guard rail 2 and running rail 2.
5	Disconnect the voltmeter.

5.2. NOTE: Guard rails may not be mounted on a common plate to the running rail as shown in Figure 332(c)- 1. This bonding configuration applies, regardless of the method used to secure the guard rails to the ties.

Figure 332(c)-1: Guard Rail Bonding Diagram



333 - Testing Track Circuits – General

1. Purpose

1.1. To ensure that track circuits function within specific parameters, in accordance with approved design plans, adjustment tables, or manufacturer's recommended practices.

2. Test Interval

2.1. Traffic circuits shall be tested when installed, when any revisions or alterations are made and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Inspector Tests

4.1. A Signal Inspector or designated employee acting in an inspection capacity, shall be assigned to perform these tests on a periodic interval, as directed, thereby relieving the Maintainer from performing the tests for that period.

5. Tools

5.1. This table identifies the equipment required to adjust and test track circuits.

Table 333-01

Tool	Explanation
Test Shunts 0.06 ohm	• Test shunts shall be checked to ensure they maintain a resistance of 0.06 ohms. • Shunt rail clamps shall be maintained in such a manner that when clamped to the rail, no resistance will be added between the clamp and the rail.
Circuit Adjustment Shunts	Shunts required for making track circuit adjustments shall be checked to ensure they are the approved resistance value for the system being adjusted. These shunts shall be approved by Metrolinx.
Meters	• Meters used for track circuit tests or adjustments shall be an approved, properly calibrated meter in good working order. • "Low resistance ohm meters" should be used when very accurate resistance adjustments are necessary. • "Peak" meters should be used for measuring coded track circuit pulses. • "Built-in" receiver current meters are acceptable for measuring receive current for electronic track circuit systems so equipped.

6. Measuring Track Parameters

6.1. In addition to performing an annual 0.06 ohm shunt test on all track circuits, it is important to annually observe the receive current of all DC and DC coded track circuits, including 75 code, Electrocode, Electrologix, GEO, Genrakode, Microcode and R-Code. In some other situations, such as with GCP/MS crossing approach circuits, “distance” voltage readings must be taken. Refer to instructions specified in GI-310(e) Constant Warning/Motion Sensing Devices in these situations.

6.2. When measuring current for DC coded track circuits, it is important to use a peak meter to store the peak current value measured over the duration of several code periods.

7. Adjustment Values

7.1. The prescribed method of adjusting track circuit parameters is to use the method as described in SCP-4.

8. Checking Adjustments

8.1. Track circuit adjustments shall be checked and revised in conformance with procedures defined in SCP-4, and “At time of installation” shunt tests prescribed in GI-333(a) Track Circuits shall be performed, when:

a. Rail size changes.

b. Rail changes to CWR or bonded from bolted.

c. Switches are installed, removed or circuit length changes.

d. Deteriorating ballast conditions will no longer allow the circuit to function properly.

e. Significant changes are made to the track structure such as undercutting or large scale replacement of ties, ballast or insulating devices.

f. Significant length has been added to or deleted from the track leads.

g. Design changes to the system affect the track circuits.

h. Insulated joints are changed.

i. Track batteries are changed.

j. Relays are changed that have contacts within the track circuit. In track circuits where contacts of relays or other controlling devices form part of the circuit, it must be determined that their contact resistance value is according to specification, or as low as possible, before track circuit adjustments are made. If a track circuit contains more than one set of contacts (ex. switch circuit controller), adjustments must be checked using all contacts and the final adjustment made using the contacts with the lowest resistance. Contacts that are not contained in a sealed case may be cleaned to achieve the lowest resistance possible.

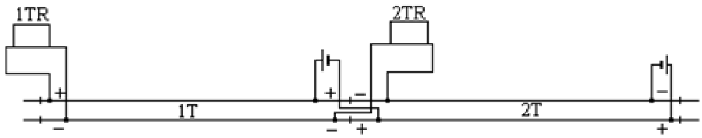
9. Track Connection Test

9.1. When performing work that risks accidentally swapping track connections, a 0.06-ohm shunt test shall be performed on all affected track circuits after track leads are connected to the rails.

9.2. Improperly connecting track leads between adjacent track circuits may result in a circuit that will fail to detect the presence of a train.

9.3. CAUTION: This is not a test. This diagram illustrates what can happen when two track lead connections are disarranged. It is provided to emphasize the importance of following proper test procedures whenever track connections are installed, replaced or reconnected.

Figure 333- 1



9.4. With no trains present both the 1TR and 2TR relays are connected in series and energized by the 1T and 2T batteries, which are also connected in series.

9.5. When 2T track is shunted by a train, both relays will remain energized by 1T battery and the train will go undetected.

10. Track Polarity

10.1. Polarity swaps in signal systems that depend on correct track polarity to control signal clearing may result in false proceed indications. When performing work that risks accidentally changing polarity, such as moving track connections or changing track batteries, follow the instructions in this table.

Table 333-02

Step	Action
1	Check track polarity is correct in accordance with the approved plan.
2	Perform 0.06 ohm shunt tests on all affected track circuits.
3	Perform further operational testing as directed by the responsible Supervisory Officer.

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333(a) - Track Circuits

1. Purpose

1.1. To ensure that track circuits are able to effectively detect the presence of trains and broken rails, regardless of changing external conditions that may affect the circuits.

2. Test Interval

2.1. Track circuits shall be tested when installed, unless otherwise required by GI-333(b) Stored Energy Tests and at least once every twelve (12) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Insulated Track Hardware

4.1. Before performing tests or making adjustments to track circuits, track appliances shall be inspected and repairs made where necessary, in accordance with GI-332 Inspecting and Testing Insulated Track Hardware.

5. General Adjustment Principles

5.1. Track circuits shall be maintained such that the track relay, or device that functions as a track relay, shall:

5.2. Be properly energized during wet weather or minimum ballast resistance conditions, and shall

5.3. Assume its most restrictive state when a shunt of 0.06 ohms is applied to the rails during dry weather or maximum ballast resistance conditions.

6. When to Schedule Tests

6.1. Shunt tests shall be performed in dry ballast conditions whenever possible, since in these conditions inter-rail voltage is more likely to be normal or above normal, resulting in maximum current flowing in the circuit.

7. Circuit Adjustments

7.1. Limiting resistor(s) shall not be removed from a track circuit, nor reduced below minimum specified value, nor shall electronically-driven track circuits be set to a higher power output from the original setting, without the approval of Metrolinx and the responsible Supervisory Officer. Adjustments or alterations to track circuits shall be made in accordance with approved practices as defined in SCP-4 or in accordance with approved published track adjustment tables.

8. Electronic Coded Track Circuits

8.1. Refer to documents identified in GI-335 Inspecting and Testing Vital Electronic Equipment or Manufacturer's instructions on additional testing that may be required for electronic coded track equipment.

9. IMPORTANT: PSO Track Circuits & Microtrax or MicroLoc II Track Circuits

9.1. PSO Track Circuits

9.1.1. When testing or calibrating PSO track circuit, the following instructions shall be followed in addition to the Manufacturer's instructions.

9.1.2. PSO track circuits shall be calibrated during normal dry ballast condition. If it is necessary to calibrate the PSO track circuit under wet or frozen ballast condition, it shall be checked and recalibrated under normal dry ballast conditions.

9.1.3. After calibrating the PSO track circuit, the receive signal level shall be 500 or greater.

9.1.4. When calibrating PSO track circuits, start with the low transmit level. If the required receive level is not achieved after calibration, raise the transmit level to high and recalibrate to achieve the required receive level.

9.1.5. If the PSO track circuit is not used for train detection in a CTC or crossing system, for example, as an overlay track circuit for hand throw switch position detection, calibrate as follows: Set the transmit level to the highest level and use a 0 ohm shunt to calibrate to provide the best receive signal level.

9.2. Microtrax or MicroLoc II Track Circuits

9.2.1. When testing Microtrax or MicroLoc II track circuits, ensure the shunt test is applied for at least 30 seconds and that the track circuit does not recover anytime during this interval.

10. Shunt Test

10.1. Crossing warning devices equipped with motion sensing or constant warning approach circuits shall be tested by applying a 0.06 ohm shunt at least 100’ from the island circuit track leads and verifying that the crossing activates.

10.2. For AC crossing island circuits, apply a 0.06 ohm shunt and leave it applied for at least 75 seconds and ensure the warning system starts and remains activated the whole time. Also place the shunt on the inside of the island receiver rail connections, and test for both normal and standby equipment where applicable, using the island light-out indicator, if so equipped and known to be functioning.

10.3. Perform the shunt test as instructed in this table for all other track circuits.

Table 333(a)-01

When one or more track relays or devices that function as a track relays exist in the same track circuit, each and every relay or device shall be observed to ensure it is de-energized or in its most restrictive state when ...	**When is this test performed?**
A 0.06-ohm shunt is applied to the rails at the relay or device end of the circuit. Refer to documents identified in GI-326 Inspecting and Testing Fouling Circuits.	At time of installation, and during periodic testing.
A 0.06-ohm shunt is applied to the rails at the battery or transmitter end of the track circuit.	At time of installation.
A 0.06-ohm shunt is applied to the rails at the IJ on the branch where there are no track relay or device functions as track relay exists.	At time of installation.
The battery (energy source) is disconnected from the circuit.	At time of installation.

11. Current Check (Steady DC and DC Coded Track Circuits)

11.1. For DC and DC coded track circuits, check the normal receive current at the track relay, or device that functions as a track relay. Record the result in SCIS as the "RCV-ADJ" value, and compare the reading to previous readings, ensuring this value has not changed appreciably[1].

11.2. If the current reading appears abnormally high, perform the following:

a. Check that the receive current at the track relay, or device that functions as a track relay, with a 0.06 ohm shunt applied to the rails, is less than 85% of the minimum drop-away (DC track) or pick-up (coded track) value for the track relay. Record the result in SCIS as the "SHUNT" value.

b. If conditions are wet, check the normal transmit current at the battery end. Record the result in SCIS as the "TRM-ADJ" value, and ensure it does not exceed the maximum[1].

[1] Refer to discussion in Paragraph "Adjustment Values" on GI-333 Inspecting and Testing Track Circuits - General for advice on interpreting these results.

12. Crossing Island Circuits

12.1. When applying the .06 ohm shunt on crossing island circuit, leave it applied for at least 75 seconds and ensure the warning system starts and remains activated the whole time. For electronic island circuits, place the shunt on the inside of the island receiver rail connections, and test for both normal and standby equipment where applicable, using the island light-out indicator, if so equipped and known to be functioning.

13. Rust

13.1. Where the head of the rail is covered with rust or any other material to such an extent that it may interfere with proper shunting of the track circuit, the employee shall notify Metrolinx and the responsible Supervisory Officer.

13.2. Where the head of the rail is covered with rust or any other material which is known to interfere with proper shunting of the track circuit, and which cannot be immediately removed, the employee shall take action to protect train movements, notifying the RTC, Metrolinx and the responsible Supervisory Officer of action taken.

14. Loss of Shunt Sensitivity

14.1. In the event of an investigation where it is suspected that a loss of shunt may have occurred, a multi-resistance shunt, such as the Safetran model TS-4, can be used to determine the actual shunt sensitivity for the track circuit.

Table 333(a)-02

Step	Action
1	Apply the multi-resistance shunt across the rails, at the highest resistance setting.
2	Systematically reduce the resistance in small increments, until the track relay drops. Note the remaining shunt resistance as the *Shunting Sensitivity*.
3	Apply a separate 0 ohm shunt across the rails to keep the track relay de-energized, and increase the resistance in the multi-resistance shunt in a small increment, then remove the 0 ohm shunt so only the multi-resistance shunt remains applied to the rails.
4	Systematically repeat Step 3 until the track relay picks up. Note the total shunt resistance applied at the time the track relay picks up as the *Loss of Shunt Sensitivity*.

15. Pipeline Cathodic Protection

15.1. Pipeline companies employ the use of cathodic protection to minimize corrosion of steel pipe. A cathodic rectifier connected directly to the pipe produces a DC voltage of approximately 2.5 volts and a current of approximately 250 milliamps. At locations where this type of circuit is used, crossing under the railway roadbed or running parallel to the track, conditions may be such that some of this energy becomes stored in the track structure. Where this is suspected for steady DC track circuits, perform the tests prescribed in GI-333(b) Stored Energy Tests preferably in wet weather when foreign current is likely to be at or near its maximum.

16. Power Line AC Induction

16.1. At locations where high tension AC power lines or buried cables run parallel to or cross the track at an angle less than 45 degrees, excessive amounts of AC voltage may be induced into the rails. This induction increases with distance. To counteract this effect, additional insulated joints, electronic coded track circuits, or 60 Hz chokes may be installed.

16.2. Additional precautions shall be taken to ensure that AC induced voltage does not increase to a level where personal safety and signal system safety becomes a factor.

16.3. This table explains the action to be taken if maximum allowable limits of induced AC voltage on the rails are exceeded for conventional (steady DC and 75 rate DC code) track circuits, or GCP/MS and HXP/PMD crossing approach circuits.

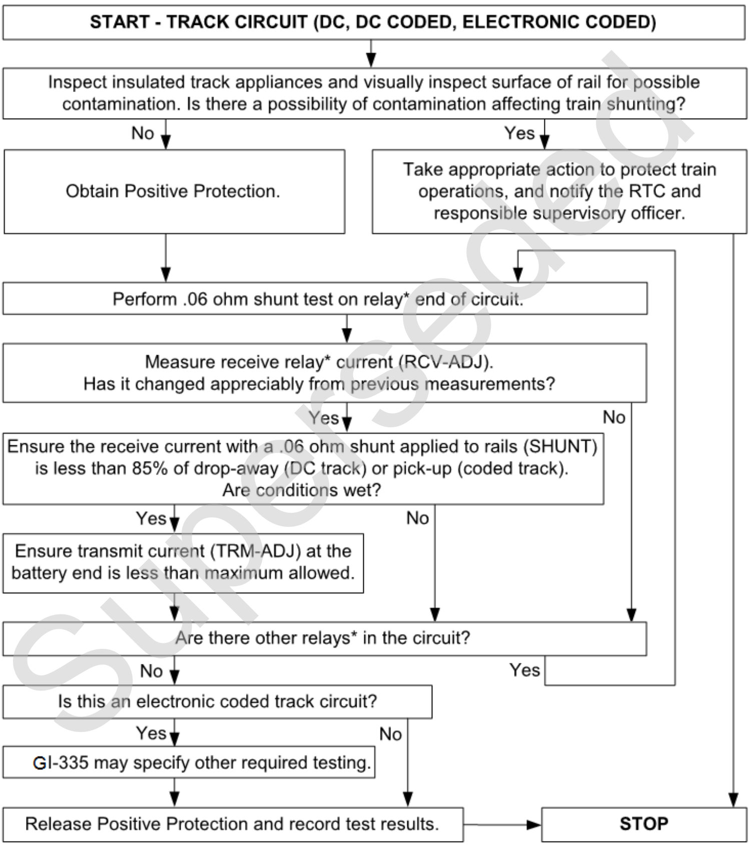
Table 333(a)-03

<table>
<tr><th>If AC voltage exceeds ...</th><th>Then do this ...</th></tr>
<tr><td>25 volts to ground on any of the rails on either side of the insulated joints.</td><td rowspan="2">1. Test the insulated joints in accordance with GI-332(b) Track Hardware – Electrical and make repairs if necessary.
2. Inspect arrestors on the affected track circuits in accordance with GI-313 Inspecting Lightning Arresters.
3. If item 1 is not responsible for the excessive voltage, report the incident to the responsible Supervisory Officer for advice on how to mitigate the problem.</td></tr>
<tr><td>60 volts across any of the insulated joints.</td></tr>
</table>

17. Test Track Procedure Flow Chart

17.1. Use this flowchart for periodically testing DC, DC coded, and electronic coded track circuits in accordance with these instructions.

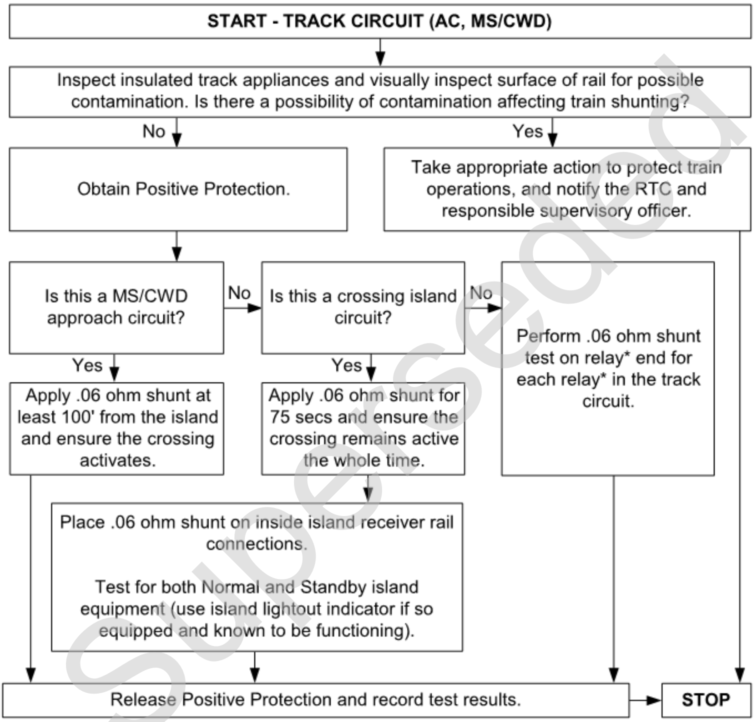
Figure 333(a)-1



* or device that functions as a relay

17.2. Use this flowchart for periodically testing AC track circuits and MS/CWD approach circuits in accordance with these instructions.

Figure 333(a)-1



* or device that functions as a relay

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333(b) - Stored Energy Tests

1. Purpose

1.1. To ensure that the track structure and its insulating components are physically maintained to a standard where stored energy due to rail-to-tie breakdown will be kept to a minimum and not adversely affect operation of the track circuit.

2. Test Interval

2.1. Steady DC track circuits with concrete ties and other track circuits subject to stored energy shall be tested when installed, as required and at least once every two years to determine the effects of stored energy. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Applicability of Tests

4.1. These tests shall also be performed for the following situations:

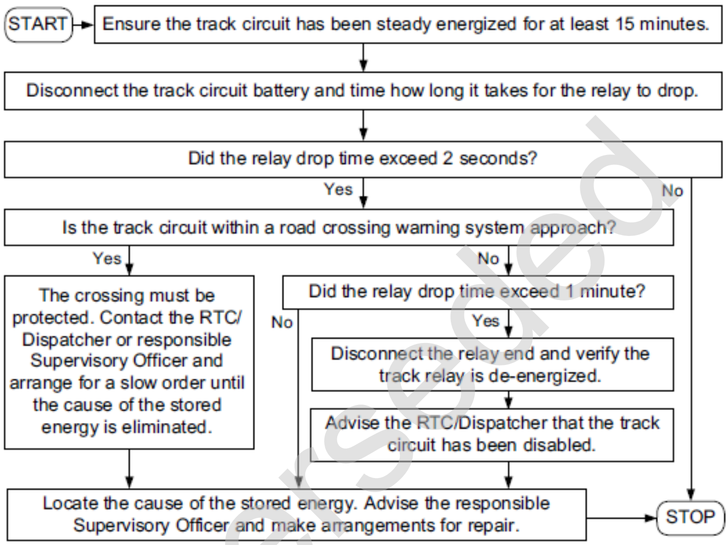
a. On all steady DC track circuits where foreign energy is known to exist as prescribed by GI-333(a) Track Circuits Pipeline Cathodic Protection, or

b. At road crossings that employ the use of concrete slabs, where road salt is used, as prescribed by the responsible Supervisory Officer.

5. Relay Drop Away Test

5.1. Perform this test procedure for each affected track circuit:

Figure 333(b)-1



6. 0.06 Ohm Shunt Test

6.1. When applying GI-333(a) Track Circuits on track circuits that qualify for GI-333(b) Stored Energy Tests, the 0.06-ohm shunt shall be applied at both battery and relay ends of the circuit.

6.2. EXCEPTION: On center fed track circuits, apply the shunt at one relay end, observe the relay at the opposite end becomes de-energized. Repeat this test from the opposite relay end. It is not necessary to apply shunt at the center feed point (battery).

7. Relay Drop Away & 0.06 Ohm Shunt Tests, One Man Test

7.1. In most cases, these tests will have to be performed by two people in communication with each other. However, if there are line circuits in the system being tested that are broken by track relay contacts, one employee may use them to remotely monitor the state of the track relay. Before performing this test, it must be known the track circuit has been continuously energized for at least 15 minutes.

Table 333(b)-01

Step	Action
1	Open the appropriate line disconnects (if available) at the track circuit battery end.
2	Place a voltmeter on the line in the direction of the track circuit that is being tested and observe the line voltage.
3	Disconnect the battery to the track circuit and note the length of time it takes for the line voltage to drop to zero. This is the drop-away time of the track relay at the other end of the circuit (refer to the flow chart to determine if it is acceptable).
4	Re-connect the battery to the track circuit and wait 15 minutes for any stored energy that may be present to build up in the track structure.
5	Repeat Step 3 to ensure the track relay did not drop for some other reason.
6	Re-connect the battery to the track circuit.
7	Perform the 0.06-ohm shunt test in accordance with GI-333(a) Track Circuits and observe that the line voltage drops to zero.
8	Ensure that all disconnects are restored to normal and proceed to the relay end of the circuit and perform the 0.06 ohm shunt test in accordance with GI-333(a) Track Circuits.

334(b) - Inspecting and Testing Grade Failure Detectors

1. Purpose

1.1. To observe the conditions of Railway Grade Failure Detectors and ensure they are maintained in a safe and suitable condition for service.

2. Test Interval

2.1. Railway grade failure detectors (washout detectors) shall be inspected and tested when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Electrical Isolation

4.1. In cases where a railway grade failure detector uses a DC-DC converter or an individual battery to power an external sensor (such as a "wire and rail" detection system), this source shall be considered an operating battery and shall be tested as prescribed by GI-303 Testing for Grounds & Battery Isolation Faults.

5. Wire and Rail Detection System

5.1. Systems composed of a wire running through holes in sections of buried rail shall be tested as outlined in the following table.

Table 334(b)-01

Step	Action
1	Contact the RTC and request authorization to activate the railway grade failure detector. *Activating the railway grade failure detector may affect the signal system. Ensure the RTC has a clear understanding of how the signal system will be affected.*
2	Disable the Talker/Radio sub-system to prevent false alarm messages.
3	Open the trip wire circuit at the battery source, and ensure that the washout detector relay (WOD) de-energizes and using a voltmeter confirm a reading of 0 Volts. If the system has a visual indicator light, ensure the indicator light illuminates.
4	Re-enable the Talker/Radio system, return the system to service, and advise the RTC.

6. Mercury Switch Testing

6.1. Samples of railway grade failure detector mercury switches shall be tested, with sample sizes as directed by Metrolinx.

Table 334(b)-02

Step	Action
1	Contact the RTC and request authorization to activate the railway grade failure detector. *Activating the railway grade failure detector may affect the signal system. Ensure the RTC has a clear understanding of how the signal system will be affected.*
2	Disable the Radio/Talker system to prevent false alarm messages.
3	Verify the operation of the hazard detector relay: • Open control circuit (test links) • Ensure the WOD relay de-energizes • Close the control circuit
4	At the selected switch enclosure, connect the leads of a voltmeter on the relay side of the mercury switch being tested.
5	Remove the mercury switch from its clip, tilt it, and confirm the voltmeter reads 0 V.
6	Repeat steps 4 and 5 for all sample mercury switches to be tested. If any mercury switch in the sample is found to be defective, replace it, and increase the sample size of the switches being tested.
7	It will be necessary to reset the WOD relay stick circuit upon completion of the test.
8	Re-enable the Radio/Talker system, return the system to service, and advise the RTC.

334(c) - Signal Activating Devices

1. Purpose

1.1. To describe the tests required to ensure that hazard detectors are installed and maintained in a condition to reliably warn trains against potentially unsafe track and equipment defects.

2. Test Interval

2.1. Hazard detectors which activate the signal system shall be inspected and tested when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Electrical Isolation

4.1. In cases where a signal activating hazard detector uses a DC-DC converter or an individual battery to power an external sensor, this source shall be considered an operating battery and shall be tested as prescribed by GI-303 Testing for Grounds & Battery Isolation Faults.

5. Hazard Detector Examples

5.1. Hazard Detectors which activate the signal system may include one or more of the following:

a. Washout Detector

b. High Water Detector

6. Hazard Detector Testing

6.1. The hazard detector shall be tested to ensure it correctly activates the signal system. Other tests may be required as prescribed by manufacturer instructions and/or Metrolinx instructions.

Table 334(c)-01

Step	Action
1	Contact the RTC and request authorization to activate the hazard detector. Ensure the RTC has a clear understanding of how the signal system will be affected.
2	Activate the hazard detector.
3	Ensure the correct relay is de-energized, and that the applicable block repeater or track circuit repeater relay is de-energized. If the system is equipped with an indicator light, ensure the indicator light is illuminated.
4	Contact the RTC and ensure the correct indication is displayed on the panel.
5	Return the system to normal operation.

335 - Inspecting and Testing Vital Electronic Equipment

1. Purpose

1.1. To ensure that vital electronic equipment function safely and reliably and adjustments are maintained within the parameters of these and other instructions.

2. Train Safety

2.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

3. Equipment Affected

3.1. This instruction is specifically designed to address the software and hardware components of vital processor based equipment including but not limited to the following:

a. Electronic coded track circuits;

b. Grade crossing predictors / motion detectors;

c. Solid state crossing controllers;

d. Processor based interlockings/control points;

e. Vital timers (electronic);

f. Audio frequency overlay (AFO), when used in a vital application;

g. Phase shift overlay (PSO), when used in a vital application;

h. Vital HD interfaces.

4. Equipment Used in Vital and Non-Vital Applications

4.1. Certain equipment, such as PSO track circuits, may be deployed in either vital applications (i.e. crossing start circuit), or non-vital applications (i.e. annunciating circuit). Such equipment shown in the table below must be defined with application specific SCIS object types, so the appropriate GI tests are applied to it, and should be so defined whether it is self-contained or in a chassis.

Table 335-01

Application	Component	Applicable GI
Vital Crossing	Software	GI-335(a)
	Hardware	GI-335(b)
Vital CTC	Software	GI-335(a)
	Hardware	GI-335(b)
Vital Equipment	Software	GI-335(a)
	Hardware	GI-335(b)
Non-Vital Equipment	Software	GI-336(a)
	Hardware	GI-336(b)

5. I/M Manuals

5.1. Service or instruction manuals shall be kept accessible to the person performing the tests while on site.

6. Module Definition

6.1. For purposes of this General Instruction, the term module is used to refer to an electronic circuit consisting of an assembly of electronic components, usually comprising a printed circuit board.

7. Module Data Documentation

7.1. Due to the wide variety of vital electronics presently in use, it is critical that control mechanisms be in place to ensure maximum safety and reliability. For this reason, historical data on every module shall be recorded. At the time of installation and whenever vital electronic modules or chassis are revised, replaced or periodic inspections and tests are performed, these events shall be recorded in SCIS.

8. Equipment Handling

9. Electronic modules may have components that are fragile and subject to minute changes in mechanical and electrical tolerances when subjected to even fairly low levels of impact or static electricity. Follow these instructions for storage, handling and transporting such equipment.

   a. Electronic equipment suspected of being damaged must be carefully inspected visually and electrically tested before being place in service.

   b. Electronic equipment shall be stored and transported in a dry and dust free environment.

   c. Electronic equipment shall be stored and transported in static free bags.

   d. Regardless of the distance to be transported, electronic equipment shall be properly packaged before shipment. Use either the original shipping container or ensure it is sufficiently wrapped in shock absorbent material and placed in a rigid container.

10. NOTE: Modules withheld or removed from service due to an accident or incident must immediately be tagged as unfit for service and suitably packaged and stored or shipped as per instructions received from Metrolinx and the responsible Supervisory Officer.

335(a) - Vital Software Configuration

1. Purpose

1.1. To ensure that vital electronic equipment function safely and reliably and adjustments are maintained within the parameters of these and other instructions.

2. Test Interval

2.1. Verify the executive and application software revision levels when installed, as required and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Software Configuration Management

4.1. The procedures outlined in this instruction conform to Metrolinx software configuration management program which is described in greater detail in GI-301(t) Software Configuration Management.

5. Software Revision Levels

5.1. Software must be compliant with the minimum acceptable software as per released Service Bulletins and/or Metrolinx software revision level references.

6. Signal Plan Validation

6.1. Verify that the software installed at the location matches the software indicated on the signal plans, by comparing the software checksum and/or CRC. If software is not shown on the plans or does not match what is installed at the location, a request is to be sent to Metrolinx to have the software validated and the signal plans updated.

7. Inventory Validation

7.1. Check the data fields described below against the software indicated on each EPROM, or other flash memory tag installed at the location. SCIS Software can be viewed from the download file off of some of the newer chassis.

Table 335(a)-01

Field Name	Description
Manufacturer	The manufacture of the equipment that the software is installed in.
PROM	The model number of the PROM or flash chip the software is installed on, enter unknown if unable to find correct model number.
Application Name	This field is not critical, to be filled out with what the parent application of the equipment is used for and the location it is installed in.
Mfg. Date (YYYY)	If it is known, the year of manufacture should be entered in format yyyy (for example "2004").
Mfg. Date (MM)	If it is known, the month of manufacture should be entered in mm for exam le "09”.
Serial Number	Serial number of the software, if known. If not known enter XXXX.
Software CRC	The CRC number of the software.
Software Program ID	The software program identification.
Software Version	The version level of the software.
Software Checksum	The software checksum.

335(b) - Vital Hardware Configuration

1. Purpose

1.1. To ensure that vital electronic equipment function safely and reliably and adjustments are maintained within the parameters of these and other instructions.

2. Test Interval

2.1. Inspect vital hardware and verify board revision levels when installed, as required and at least once every four (4) years. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. General Inspection Procedures

4.1. Perform these general inspections on all vital electronic equipment to ensure the proper circuit and equipment configuration as designated on the circuit plans is correct.

a. Check the circuit plans and ensure that circuit module types are correct and located in the proper slot.

b. Verify seals on the modules per GI-405 Inspecting Seals.

c. Check that all assigned frequencies used for motion sensing circuits are correct according to the circuit plan.

d. At time of installation only, verify that any chassis identification strapping is configured to match the application.

5. Revision Levels

5.1. Inspect each module and ensure the revision level is correctly identified in SCIS, and any other record(s) designated for that purpose.

5.2. Any module may have undergone one or more revisions. The method of marking the revision will be designated by the manufacturer and is explained in the applicable documentation. Modules with multiple revision levels may have a minimum acceptable level for in service use.

5.3. EXAMPLE: Module XYZ has been revised 5 times. The levels are designated as A, B, C, D, and E. The minimum acceptable revision level approved by Metrolinx is level "C". Therefore, levels A and B must not be used and level C or higher may be used.

Table 335(b)-01

What do you do if…	Answer
You have a module that is below minimum acceptable revision level?	It shall be tagged explaining why it is unfit for service and shipped to the responsible Supervisory Officer for disposal or upgrade.
You must replace a module that has a marked revision level on it, and all you have to replace it with is the same type of module with no revision marking?	The unmarked module cannot be used unless it is known that it meets the minimum acceptable revision level criteria.

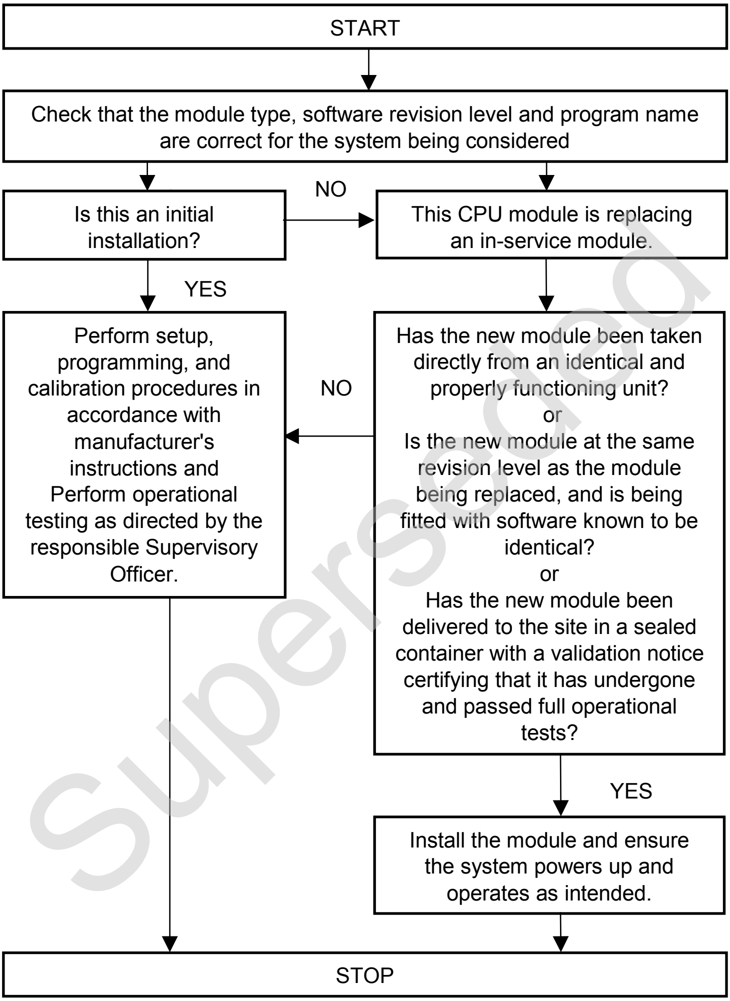
Continued on next page

What do you do if...	Answer
You are not sure what the minimum acceptable revision level is?	Look for the required information in the electronic inventory. If in doubt contact the responsible Supervisory Officer for further advice.
You don't know which marking on the module indicates the revision level?	Refer to Manufacturer's Instruction that deals with that specific type of system.

6. CPU Installation or Replacement

6.1. The central processing unit (CPU) module of any processor-based vital electronic equipment contains the program necessary to control all or a portion of the system it forms a part of. It is imperative that full operational tests be performed to ensure the integrity of the system is protected any time a CPU module is installed or replaced in accordance with this flowchart.

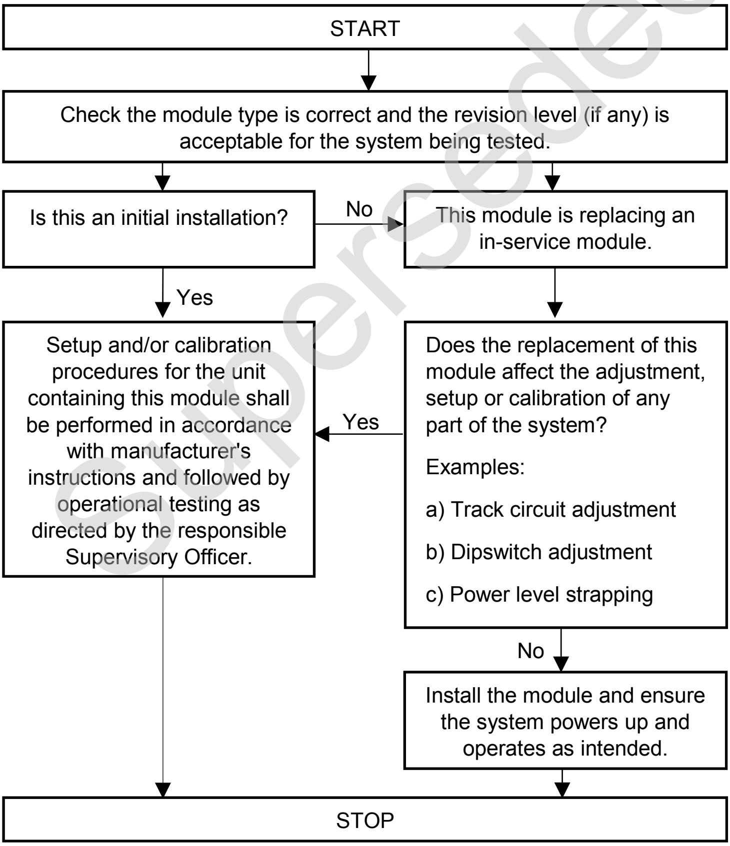
Figure 335(b)- 1



7. Module Installation or Replacement

7.1. When vital electronic modules other than CPUs have to be installed or replaced, several factors have to be taken into consideration before the system can be declared safe for service. This flow chart is a guideline to supplement specific instructions contained in manufacturer's instructions. Whenever it becomes necessary to install, revise or change a vital module, follow this guideline and related instructions.

Figure 335(b)-2



8. OEM Specific Test Procedures

8.1. Follow the instructions outlined in the applicable manufacturer's I/M manual, at the times specified. Ensure the I/M manual being referred to is the latest revision level, otherwise obtain a more recent revision from the manufacturer.

335(c) - Train ID Loop System

1. Purpose

1.1. To ensure proper operation of the Train ID loop system and verify the Train ID loops are working as intended and only for the correct UP Express train consists.

2. Test Interval

2.1. Train ID loop system shall be tested when installed, as required and at least once every six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Personal Safety

4.1. Damaged components which may not necessarily compromise the system may pose dangers to personal safety. In these cases, arrangements shall be made to repair the system correctly.

5. General Inspection Procedures

5.1. Perform these general inspections on all Train ID loop equipment to ensure the circuitry and equipment configuration as shown on the circuit plans are correct.

a. Check the circuit plans and ensure that circuit module types are correct and located in the proper location.

b. Verify any seals on the modules per GI-405.

c. Check that all assigned frequencies used for sensing circuits are correct according to the circuit plan.

d. At time of installation only, verify that any chassis identification strapping is configured to match the application.

6. Testing

6.1. Obtain the following information:

a. Downloads from the Train ID console using the manufacturers provided software *HCS-V AssistS*.

b. Reading of four digit “run/line number” transmitted by the vehicle borne unit.

c. Corroborating evidence by downloading record from the signal system GEO unit.

7. Alternative Testing

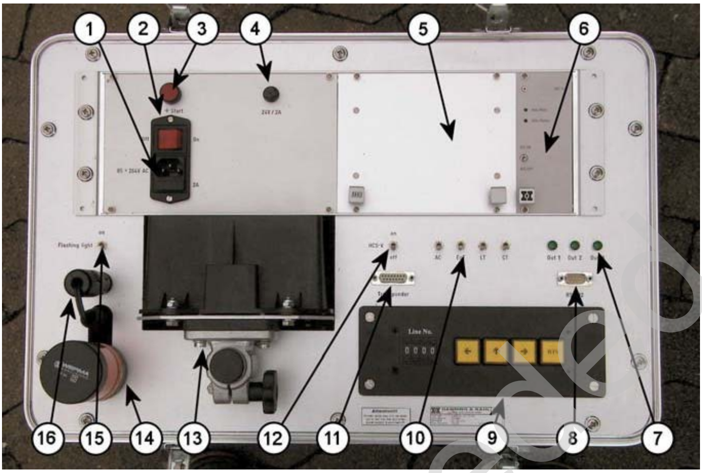
7.1. Before starting this test, ensure that the test box is fully charged using the following procedure.

7.2. NOTE: Charging takes approximately 12hours.

Table 335(c)-01

Step	Action
1	Open the lid of the device.
2	Take the mains cable out of the bag in the lid of the case.
3	Connect the testing device to the socket with cable.
4	Switch the mains voltage change over switch (2) to ON.
5	Switch on the accumulator charging stage (6).
6	Ensure Switches 12 and 15 are off.
7	The LED on accumulator charging stage (6) lights up. Green implies the accumulator is charged.
8	After 12 hours charging, switch the mains switch off.
9	Change the switch on the accumulator stage to OFF.
10	Ensure that all switches are in the off position or at 0.
11	Disconnect for the hydro socket, store in bag in lid.
12	Close lid if not in use, Test box is good for 5-6 hours of testing.
13	If not needed the accumulator can be left connected to power source to ensure readiness when needed.

Figure 335-1



1. Socket for non-heating apparatus with 2 Ampere fusible cut-out
2. Mains voltage switch
3. Switch-on button
4. Fusible cut-out DC 24 V, 2 Ampere
5. Accumulator stage
6. Accumulator charging stage
7. LED display of the control panel outputs
8. Interface RS232
9. Control panel HCS-R-BG
10. Toggle switch to switch control panel control inputs
11. Plug-in point for transponder HCS-V-T
12. Toggle switch to switch control panel operating voltage on and off
13. Transponder HCS-V-T with attachment element
14. Flashing light
15. Toggle switch to switch flashing light on and off
16. "Flashing light" socket with connector inserted

8. Setting the Height for The Transponder

8.1. Set the height of the test rig transducer to 15cm or 6" from Top of Rail to simulate the height of the Car borne transducer.

9. Setting Up the Test

9.1. Transponder (Red box) has a transponder and an extension piece to enable test transponder to be set at a height equivalent of the car borne transponder.

a. Manipulate the test transponder so that it is above the installed receiver loop.

b. Confirm the measured height against recorded height.

c. Raise or lower as required and tighten the transducer retaining clamp.

d. Install the flashing light onto the top of the tube.

e. Input the run/line number provided (Rail Equipment) in to the test box and download the recorded evidence with a laptop at the console.

10. Rail Car-Borne Equipment

10.1. Test carried out by the Rail Equipment Maintenance at Willowbrook prior to revenue service.

Table 335(c)-02

Interval	Task	Reference
6 months	Inspect all plugs and screw connections are tight.	77 / 81
6 months	Inspect all cable connections are tight and intact. Replace as necessary.	77 / 81
12 months	Perform function test.	77 / 81
5 years	General overhaul (function test) by H&K	77 / 81
	Ensure bottom of transponder housing is within 5.9 - 11.8" (150 - 300mm) above TOR.	74 / 81
	Ensure no electrically conductive materials within a radius of 15.7" (400mm) surrounding transponder.	73 / 81

Reference Document: Train ID - DMU Transponder

336 - Inspecting and Testing Non-Vital Electronic Equipment

1. Purpose

1.1. To ensure that non-vital electronic equipment functions reliably and adjustments are maintained within the parameters of these and other instructions.

2. Train Safety

2.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

3. Equipment Affected

3.1. This instruction is specifically designed to address the software and hardware components of non-vital processor based equipment including but not limited to the following:

a. Audio frequency overlay (AFO), when used in a non-vital application;

b. Phase shift overlay (PSO), when used in a non-vital application;

c. Stick release timers;

d. Non-vital timers (electronic);

e. Electronic code units;

f. Wayside inspection systems;

g. Hazard detector systems;

h. MCP/BCP radio.

4. Equipment Used in Vital and Non-Vital Applications

4.1. Certain equipment, such as PSO track circuits, may be deployed in either vital applications (i.e. crossing start circuit), or non-vital applications (i.e. annunciating circuit). Such equipment shown in the table below must be defined with application specific SCIS object types, so the appropriate GI tests are applied to it, and should be so defined whether it is self-contained or in a chassis.

Table 336-01

Application	Component	Applicable GI
Vital Crossing	Software	GI-335(a)
	Hardware	GI-335(b)
Vital CTC	Software	GI-335(a)
	Hardware	GI-335(b)
Vital Equipment	Software	GI-335(a)
	Hardware	GI-335(b)
Non-Vital Equipment	Software	GI-336(a)
	Hardware	GI-336(b)

5. I/M Manuals

5.1. Service or instruction manuals shall be kept accessible to the person performing the tests while on site.

6. Module Definition

6.1. For purposes of this General Instruction, the term *module* is used to refer to an electronic circuit consisting of an assembly of electronic components, usually comprising a printed circuit board.

7. Equipment Handling

7.1. Electronic modules may have components that are fragile and subject to minute changes in mechanical and electrical tolerances when subjected to even fairly low levels of impact or static electricity. Follow these instructions for storage, handling and transporting such equipment.

a. Electronic equipment suspected of being damaged must be carefully inspected visually and electrically tested before being place in service.

b. Electronic equipment shall be stored and transported in a dry and dust free environment.

c. Electronic equipment shall be stored and transported in static free bags.

d. Regardless of the distance to be transported, electronic equipment shall be properly packaged before shipment. Use either the original shipping container or ensure it is sufficiently wrapped in shock absorbent material and placed in a rigid container.

7.2. NOTE: Modules withheld or removed from service due to an accident or incident must immediately be tagged as unfit for service and suitably packaged and stored or shipped as per instructions received from Metrolinx and the responsible Supervisory Officer.

336(a) - Non-Vital Software Configuration

1. Purpose

1.1. To ensure that non-vital electronic equipment function reliably and adjustments are maintained within the parameters of these and other instructions.

2. Test Interval

2.1. Verify the software revision levels when installed and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Inspection

4.1. Check the program identifier and revision level which are labeled on the EPROM(s), or other flash memory tag(s), on all processor based modules is the same as that indicated in SCIS, and any other record(s) designated for that purpose.

Table 336(a)-01

SCIS Field Name	Enter
Manufacturer	Safetran, Harmon, GETS, Alstom, US&S etc.
Mfg. Date (YYYY)	The year that the program revision was compiled.
Mfg. Date (MM)	The month that the program revision was compiled.
Model/Type	The type of media (PROM, EPROM, Flash etc.
Application Name	Depends on Manufacturer.
Software Program ID	Depends on Manufacturer.
Software Version	Depends on Manufacturer.
Software Checksum	Depends on Manufacturer.
Software CRC	Depends on Manufacturer.
Serial Number	Depends on Manufacturer.

336(b) - Non-Vital Hardware Configuration

1. Purpose

1.1. To ensure that non-vital electronic equipment functions reliably and adjustments are maintained within the parameters of these and other instructions.

2. Test Interval

2.1. Inspect non-vital hardware and verify board revision levels when installed and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. General Inspection Procedures

4.1. Perform these general inspections on all non-vital electronic equipment to ensure the proper circuit and equipment configuration as designated on the circuit plans is correct.

a. Check the circuit plans and ensure that circuit module types are correct and located in the proper slot.

b. Check that all assigned frequencies are correct according to the circuit plan.

c. Verify that any chassis identification strapping is configured to match the application.

5. Revision Levels

5.1. Inspect each module and ensure the revision level is correctly identified in SCIS, and any other record(s) designated for that purpose.

5.2. Ensure the module is at the minimum acceptable level for in service use prior to installation.

5.3. EXAMPLE: Module XYZ has been revised 5 times. The levels are designated as A, B, C, D, and E. The minimum acceptable revision level approved by Metrolinx is level "C". Therefore levels A and B must not be used and level C or higher may be used.

340(a) - ATCS – MCP/BCP Radio Test and Calibration

1. Purpose

1.1. To ensure that the ATCS data radio communications (MCP/BCP operating CTC control point locations) function within its specific parameters, in accordance with approved design specifications, plans and manufacturers recommended practices.

2. Test Interval

2.1. Radio transmit and receive parameters shall be tested when installed, replaced after repair or when any revisions or alterations are made and as required. Beyond these situations the testing must be made at YEARLY intervals.

3. Train Safety

3.1. These tests and calibrations will interfere with the safe and efficient operation of train movements. Before commencing any work ensure that both the RTC and GTCC are advised. Approximately one hour or more of non-operational time should be requested.

4. Equipment Safety

4.1. RF energy can be dangerous. Ensure any personal are at least 4 feet from any antenna in operation and never touch an RF connector's center conductor which is connected to a radio or duplexer. RF power can produce painful burns on contact when the radio transmits.

5. Tools

5.1. This table identifies the equipment required to adjust and test the Radio equipment, Radio Frequency Test Set, calibration certified, FM transmit and receive modes to levels of 50W. Transmission mode capable of generating RF modulated/unmodulated from 0 to 5 uV in 0.1 increments.

5.2. Reception mode capable of receiving FM RF signals and displaying frequency error and deviation.

5.3. In-line RF Wattmeter, calibration certified, capable of measuring up to 900 Mhz forward and reverse power, optional VSWR.

5.4. VOM Meter – standard voltage ohm meter used to measure supply voltage to radio

5.5. Laptop computer configured to run SIEMENS "XCMMAINT" terminal software,

5.6. Note: for MCP use the application "MCM II Config:v1.17.41.01", BCP use the application "BCM II Config::1.11.0.10"

5.7. appropriate DB-9 RS-232 cables for connection to either WCPU-2 (MCP) or BCM-2 (BCP) controllers

6. Table of ATCS Radio Frequencies

Table 340(a)-01

Channel	Frequency
Channel 1	896.8875 / 935.8875 Mhz
Channel 2	896.9375 / 935.9375 Mhz
Channel 3	896.9875 / 935.9875 Mhz
Channel 4	897.8875 / 936.8875 Mhz
Channel 5	897.9375 / 936.9375 Mhz
Channel 6	897.9875 / 936.9875 Mhz

7. Measuring Receiver Performance

7.1. Using the Frequency table note for each ATCS frequency pair the lower frequency is designated as the MCP TX frequency while the higher one is the BCP TX frequency. The ATCS network operates on a half-duplex system. As an example the channel pair 896.8875 / 935.8875 – first frequency is TX for MCP, RX BCP: second frequency is RX MCP, TX BCP.

Table 340(a)-02

Step	Action
1	Connect laptop running the applicable XCMMAINT application to the Safetran Controller (WCPU II or BCM II), place the radio into "SERVICE" mode using command SERV (Note: site will no longer be in operational mode).
2	Using the RF test set inject the RX frequency, 1Khz tone at a deviation of 1.2Khz into the RF connector of the radio (for BCP connect to ANT port of duplexer).
3	Measure and record RF level which produces a 12dB SINAD reading (speaker). Level should be 0.35 uV or less
4	Optional: disable 1 kHz tone on test set. Measure and record RF level which produces 20dB Quieting (speaker). Level should be 0.45 uV or less
5	At terminal, issue commands "COS = ENABLE" and "SL = ENABLE" to allow display monitoring of radio COS ON/OFF states.
6	With RF test set still connected measure and record minimum RF level which toggles COS state. Level should be 0.35 uV or less.

8. Measuring Transmitter Performance

8.1. Follow the following procedures for measuring the transmitter performance:

a. Issue command "ERT $ 11111111 00000000 11111111 00000000" then "PTT=1", this now keys up transmitter and modulates with a digital data source.

b. Measure and record Transmitter Frequency Error, reading should be within 300 Hz of carrier frequency

c. Measure and record Transmitter Deviation, reading should be about +/- 1.1 kHz

d. Notes: Frequency error is adjusted by using the Radio Service Software, Deviation is adjusted by using the RADIO GAIN OUT setting on the XCMMAINT software.

e. Unkey radio using "PTT=0", disconnect Test Set and connect Wattmeter between radio and polyphaser

f. Re-key radio, Measure and record Transmitter Forward Power , reading should be between 25 – 30 Watts.

g. Measure and record Transmitter Reverse Power, reading should be less than 10% of forward power

h. Un-key radio and move Wattmeter between PolyPhaser and antenna

i. Re-key radio, measure and record Transmitter Forward Power, should be approximately same as step 6)

j. Measure and record Transmitter Reflected Power, should be approximately same as step 7

k. Measure and record VSWR, no reflected power = 1.00 (ideal), not to exceed 1.92 (10% reflected)

l. Un-key radio, reconnect all RF cables to original state, Issue “TEST” command which resets controller placing system back into operational state.

9. Final Checks

9.1. Follow the following procedures for performing the final checks:

m. Measure and record Supply Voltage to radio, both in TX and RX conditions

n. Ensure all RF connectors are finger tight only. Do not use any tools to tighten.

o. Ensure data is being exchanged between MCP/BCP & Control Centre.

400 - General

1. Introduction

1.1. The 400 series General Instructions describe the inspections which verify that specific equipment within a signal system is installed and operating in accordance with specifications and standards.

2. Series Characteristics

2.1. The series 400 General Instructions exhibit two basic characteristics that distinguish them from the other series instructions. This table explains these characteristics.

Table 400-01

Characteristic	Explanation
Does Not Have a Periodic Schedule	These tests have no periodic schedule and are intended to be performed in conjunction with all closely related series tests. They may also be performed whenever qualified employees are passing through a location or working on site for other reasons. EXAMPLE: Paint or signal structure condition may be checked while passing through or waiting at a location for trains to pass. EXAMPLE: Gasket inspection is very closely related to many tests, such as switch machines and circuit controllers. Therefore, they may be checked when performing the relevant tests for that type of equipment.
Reporting	Results of these inspections shall be recorded in the designated SCIS when there is evidence of non-compliance with an applicable standard or instruction.

401 - Inspecting Foundations

1. Purpose

1.1. To ensure that foundations used to support housings or other signal structures are properly leveled and in good condition. Foundations shall be properly installed and maintained in good condition. Foundations that present a hazard to the signal system or personal safety due to poor condition shall be promptly repaired or replaced

2. Test Interval

2.1. Foundations shall be inspected at time of installation and routinely when inspecting other elements of equipment with foundations. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Visual Inspection

4.1. Visually inspect foundations as described in this table

Table 401-01

Inspect	Check
Level	Check that foundations are level. This is important for two reasons. • Vital signal equipment such as relays, mechanisms and batteries may not function properly when they are not level. • Structures, especially tall ones, undergo unnecessary stress when they are not level. This may present a hazard to the system or personal safety. NOTE: When leveling nuts are provided, ensure the structure or housing mounted on the foundation is level.
Nuts and Bolts	Check that nuts, bolts and washers are properly installed and in good condition.
Clearance	Check that foundations maintain proper clearance to track in accordance with Metrolinx Track Standards.
Plates and Conduits	Check that base plates and cable conduits are in good condition.
Metal Foundations and Retaining Walls	Check for bends, twists, broken welds, rust or other damage that may contribute to foundation failure.

Continued on next page

Inspect	Check
Concrete Foundations and Retaining Walls	Check for cracks or deterioration that may contribute to foundation failure.
Wood Foundations and Retaining Walls	Check for rot and other damage.

402 - Inspecting Signals Structures

1. Purpose

1.1. To describe the process for inspecting signal structures and associated attachments. Signal structures and all associated attachments shall be properly installed, adjusted and maintained in proper condition. Such equipment that is not in proper condition shall be promptly adjusted, repaired or replaced.

2. Test Interval

2.1. Signal structures shall be inspected at when installed, as required and routinely when inspecting other elements of equipment with signal masts or structures. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Visual Inspection

4.1. Signal structures and attachments shall be inspected as described in this table.

Table 402-01

Inspect	Check
Level	Check that masts are vertically level and ladder platforms and hand railings are horizontally level.
Masts and Attachments	Check that masts and attachments are properly installed in accordance with standard plans and are free from significant damage.
Lenses, Roundels, Reflectors and Lamps	Check that lenses, roundels, reflectors and lamps are: • Cleaned as often as is necessary to ensure good visibility. • Free of significant scratches, cracks or other damage. Check that deflecting/spread lenses or phankills (where used) are correctly arranged to properly deflect/spread light.
Signal Head Backgrounds	Check that signal head backgrounds are properly mounted. Where mounting spacers are supplied, ensure their length positions the background so it is relatively flush with the ring that supports the outer lens and hood.
Ladders, Platforms and Hand Railings	Check that ladders, platforms and hand railings are properly installed, and free from significant damage.
Number Plates and Markers	Check that number plates and markers are clean, in good condition, and numbers, letters or symbols are legible with sufficient reflectability.
Signal Location	Check that signals are properly placed in relation to insulated joints in accordance with SCP-1.

Continued on next page

Inspect	Check
Inductive Power Grounding	Check that signal structures equipped with grounding equipment designed to mitigate inductive interference from nearby high voltage power lines are properly installed.
Clearance	Check that signal structure clearances are properly maintained in accordance with: Metrolinx Track Standards and SCP-704.
Signal Units	Check that signal units governing train movements in the same direction on the same structure are of the same type and manufacturer. EXCEPTION: Color-light marker type units presently in service with searchlight units governing movements in the same direction may remain in service until it is practicable to have them changed to inoperative searchlight units.
Structure Support	• Check that mast bases are properly installed and secured to the foundation. • Check that foundations and ladder bases (where used) are firmly ground mounted.

5. Signal Alignment

5.1. Refer to GI-411 Inspecting Signal Alignment, when alterations or adjustments have been made to signal structures that affect signal alignment.

6. Unauthorized Attachments

6.1. Signal structures and attachments shall be installed in accordance with approved standard plans. No unauthorized attachments shall be placed on a signal mast or structure.

403 - Inspecting Painted Surfaces

1. Purpose

1.1. To ensure that signal equipment requiring paint is kept in a clean, functional and serviceable condition. Surfaces requiring paint shall be painted when installed and thereafter properly maintained. Painted surfaces that are in poor condition or cannot be adequately cleaned, shall be promptly repainted.

2. Test Interval

2.1. Painted surfaces shall be inspected at time of installation and routinely when inspecting other elements of equipment with painted surfaces. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Paint Manufacturer's Instructions

4.1. Metrolinx uses a variety of paints for different applications. The type of paint chosen for a particular application will depend on the manufacturer's specifications. Paint shall be applied in accordance with manufacturer's instructions.

5. Visual Inspection of Equipment

5.1. Visually inspect the following equipment and ensure that paint is not applied to their surfaces.

a. Lenses.

b. Gaskets.

c. Ventilating screens.

d. Concrete foundations.
e. Aluminum surfaces.
f. Cotter pins and other pins used for connecting mechanical equipment.
g. Adjustable screws, threads of screw jaws and other adjustable equipment whose function may be hindered by the application of a layer of paint.
h. Cedar or chemically treated wood.

6. Visual Inspection of Painted Surface

6.1. Ensure that painted surfaces are generally kept in good condition. Consideration should be given to cleaning and/or repainting when any of the following conditions exist.

a. Paint is excessively weathered.
b. Rust is coming through the paint.
c. Paint is chipped, cracked or peeled.
d. Paint is covered with grease, grime or graffiti.

7. Light Reflection

7.1. Aluminum and white colored paint is generally used because of its light reflection qualities. The amount of light reflected depends on the condition of the painted surface, especially how clean it is. Special consideration should be given to this factor when inspecting aluminum or white colored containers or housings that contain electronic equipment or substances that are temperature sensitive.

8. Paint Color

8.1. Ensure that signal equipment is painted the proper color in accordance with AREMA C&S guidelines.

404 - Inspecting Gaskets

1. Purpose

1.1. To ensure that gaskets attached to housings and other equipment provide a weather tight seal. Gaskets shall be properly installed and maintained in good condition. Gaskets that are not in proper condition shall be promptly repaired or replaced.

2. Test Interval

2.1. Gaskets shall be inspected when installed, as required and routinely when inspecting other elements of equipment with gaskets. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Visual Inspection

4.1. Gaskets shall be inspected as described in this table.

Table 404-01

Inspect	Check that gaskets ...
Seal	Provide a weather tight seal.
Contamination	Are not covered with paint, oil or grease.
Condition	Are not significantly dried out, cracked, deteriorated or damaged so they do not accomplish their intended function.
Secure	Are properly attached to the housing or equipment.
Adjustment	Attached to covers or doors that have adjustment capabilities are properly fitted.

405 - Inspecting Seals

1. Purpose

1.1. To ensure that the mechanical seals designed to restrict access and/or identify possible tampering of safety critical equipment are properly installed.

2. Test Interval

2.1. Seals shall be inspected at time of installation and when periodic tests are performed by the Maintainer and Inspector, in accordance with the General Instructions listed in this table.

Table 405-01

GI #	Title
308	Inspecting and Testing Electric Locks
318	Testing and Inspecting Movable Bridge Locking
322	Inspecting and Testing Searchlight Signal Mechanisms
323	Inspecting and Testing Relays
331	Testing Time Releases, Timing Relays and Timing Devices
335	Inspecting and Testing Vital Electronic Equipment

2.2. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Procedure

4.1. Follow the instructions in this table when inspecting seals.

Table 405-02

<table>
<tr><th>Inspect</th><th>Check</th></tr>
<tr><td>Excess Seal Wire</td><td>Check there is no slack or excess seal wire that may come in contact with electrical terminals, contacts or other equipment.</td></tr>
<tr><td>Broken Seal Wire</td><td>Check that seal wires are not cut or broken.
<table>
<tr><th>If seals are found broken on…</th><th>Then…</th></tr>
<tr><td>electric locks,
emergency releases.</td><td>Ensure the equipment is in good condition.
Replace the seal.</td></tr>
<tr><td>time releases, including vital electronic timers.</td><td>Test the time release in accordance with GI-331 Testing Time Releases, Timing Relays and Timing Devices.
Replace the seal.</td></tr>
<tr><td>relays,
signal mechs,
other vital electronic boards.</td><td>Report the incident to the responsible Supervisory Officer to determine what additional testing is required before replacing the seal.</td></tr>
</table></td></tr>
<tr><td>Tight Crimp</td><td>Check the sealing piece provides a tight crimp that will not allow the seal to be removed without cutting or breaking it.</td></tr>
</table>

5. Notifications

5.1. Create (and close) a SCIS Notification on the associated equipment record whenever a seal defect is found and corrected.

6. Breaking Seals

6.1. Seals may be broken on electric locks, time releases and emergency releases to make inspections or adjustments but shall be immediately replaced and sealed.

406 - Inspecting and Testing Wayside Pushbuttons and Panels

1. Purpose

1.1. To ensure the mechanical and electrical components of pushbuttons, panels, switches, key releases, and levers function in a safe and reliable manner.

2. Test Interval

2.1. Wayside pushbuttons, panels, switches, key releases and levers, shall be inspected when installed, as required and routinely when inspecting other elements containing pushbuttons, panels, switches, key releases or levers. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Test Procedure

4.1. Perform tests as instructed in this table.

Table 406-01

When …	Do this …
Lights are provided on a panel or key release to detect the condition of a track circuit.	Check the appropriate light indicates a track occupancy as intended.
Lights are provided on a panel or key release to indicate the condition of a signal or route.	Check the appropriate light(s) properly indicates the signal or route when clear and at stop.
Lights are provided on a panel or key release to indicate the position of a switch.	Check the light properly indicates the position of the switch Normal and Reverse.
Pushbuttons, switches, key releases, or levers are provided.	Check the pushbutton, switch, key release, or lever performs its intended function.

5. Visual Inspection

5.1. Perform visual inspections on pushbuttons, panels, switches, key releases, and levers as instructed in this table.

Table 406-02

Inspect	Check
Gaskets	Check that door gaskets on pushbutton/ switch/ key release housings are properly placed and in good condition.
Housing Door Locks	• Check that locks are in good condition. • Check that locks are a type that are suitable to the purpose of the equipment EXAMPLE: Highway Grade Crossing Warning Device test switches have a lock that restricts access to employees only.
Posted Instructions	• Check that instructions posted in pushbutton, switch, key release, or panel housings are legible. • Check that components such as lights, pushbuttons or switches are properly tagged or labeled so their intended function or indication cannot be misinterpreted.
Contacts	Check that exposed contacts on pushbuttons, key releases, and switches are clean, free of corrosion, not worn and pitted.
Knife Switches	Check that screws, bolts and wire terminals on knife switches are properly positioned and tight.
Pushbutton Mechanical Action	• Check the pushbutton spring causes the pushbutton to fully return to its normal position when the button is fully depressed then released. • Check that the double action pushbuttons function properly.
Key Releases	Check that the key movement moves freely and without obstruction.

6. Remote Warning Device Activator

6.1. Perform this test on warning systems that are equipped with a remote warning device activator.

6.2. NOTE: The remote control device is designed to operate from a short distance of approximately 200 feet or less.

Table 406-03

Step	Action	Result
1	Check the time setting on the electronic activation device in the instrument housing.	Note the time.
2	Go to the opposite side of the road from the instrument housing to a point where equipment would stop before crossing the road. Point the remote control at the antennae and push the button to activate the warning device.	The warning device starts and then stops after a pre-determined time interval.
3	Compare the amount of time the warning device operates to the time setting on the electronic activation device	They should be the same.
4	Go to the same side of the road as the instrument housing to a point where equipment would stop before crossing the road. Point the remote control at the antennae and push the button to activate the warning device.	The warning device starts and then stops after a pre-determined time interval.
5	Repeat step 3.	Same as step 3.

407 - Inspecting and Testing Fuses

1. Purpose

1.1. To ensure that signal circuits and equipment are properly protected from current overload.

2. Test Interval

2.1. Inspect fuses when installed, as required and routinely when inspecting other elements involving fuses. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption

4. Installation and Replacement

4.1. Fuses shall be installed in accordance with approved plans or manufacturer's instructions and replaced in kind when required. When necessary to replace a fuse, it shall be replaced with a similar fuse of equivalent rating.

5. Testing Fuses

5.1. Whenever the integrity of a fuse is in question, it may be tested by one of two methods described in this table.

Table 407-01

Method	Explanation
Visual	When the fuse link is or can be exposed, check: • The link is complete; and • The link is the proper rating.
Electrical	After checking the fuse is properly rated: • An ohmmeter may be used to test the continuity of the fuse itself; or • A voltmeter or ammeter may be used to test the fuse's integrity within the circuit.

408 - Inspecting Electrical Contacts

1. Purpose

1.1. To ensure the electrical contacts of relays and other controlling devices operate as designed, in a manner that is conducive to the safety and reliability of the system.

2. Test Interval

2.1. Electrical contacts of relays shall be inspected at time of installation and routinely when inspecting other elements of equipment with electrical contacts. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption

4. Caution

4.1. Electrical contacts shall not be altered, bridged, bypassed or caused to close or open by means other than the intended design, unless authorized and directed by the responsible Supervisory Officer.

5. Visual Inspection

5.1. Electrical contacts of relays and other controlling devices shall be properly installed and maintained as described in this table.

Table 408-01

Inspect	Check
Equipment Position	Check that equipment containing electrical contacts is properly mounted so the action of the contacts is not adversely affected by improper positioning of such equipment. EXAMPLE: Relays are not tilted or turned upside down.
Alteration	Check that contacts are not bent or otherwise altered from their original design. EXCEPTION: Some types of electrical contacts may be bent or altered in accordance with manufacturer's instructions.
Adjustment	Check that electrical contacts equipped with field adjustment capabilities are properly adjusted.
Cleanliness and Wear	Check that electrical contacts kept in unsealed compartments are kept clean and in good condition.
Bridging and Bypassing	Check that electrical contacts are not bridged or bypassed. EXCEPTION: Contacts may be bridged or bypassed IF authorized AND as directed by the responsible Supervisory Officer.

6. Other General Instructions

6.1. There are several other General Instructions that refer to specific inspections or tests related to electrical contacts. These instructions are listed in this table.

Table 408-02

General Instruction	Title	Subtitle (label)
GI-308 (a)	Inspecting and Testing Electric Locks	General Inspection
GI-310(c)(3)	Testing Highway Grade Crossing Warning Devices	Gate Mechanisms, Test Procedure
GI-318	Inspecting and Testing Movable Bridge Locking	As defined by Special Instructions
GI-322 GI-322(b)	Inspecting and Testing Searchlight Signal Mechanisms	GRS Plug Coupler Contact
		Mechanism Visual Inspection
GI-323 (a)	Inspecting and Testing Relays	Relay Visual Inspection
GI-327 (a)	Inspecting and Testing Circuit controllers	Switch Shunting Circuits
		Break Circuits, Fed One Direction
		Break Circuits, Feb Both Directions
		Break and Shunt Circuits
		WP Circuit Controller
		Derail Circuit Controller
		Visual Inspection
GI-329(b)(3) GI-329(c)(1)	Inspecting and Testing Power Switch Machines	General Inspection
		Indication Circuit Shunt Test
GI-333	Testing Track Circuits	Checking Adjustments

409 - Inspecting Mechanical Equipment

1. Purpose

1.1. To describe the requirements for inspecting mechanical connections to track or signal equipment. Such equipment that is not in proper operating condition shall be promptly repaired or replaced.

2. Test Interval

2.1. Mechanical equipment such as pipelines, cranks, rods, pins, switch rollers and associated equipment shall be inspected when installed and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption

4. Visual Inspection

4.1. Visually inspect mechanical connections as described in this table.

Table 409-01

Inspect	Check
Alignment and Adjustment	Check that pipelines, rods and associated components are in good condition, properly aligned, centered and adjusted.
Clearance	• Check that pipelines and rods that pass underneath the rail are clear of the rail base by at least ½”. • Check that all movable equipment is installed in a manner that will not risk obstruction of movement from outside factors such as ballast, rail equipment or environmental conditions.
Lubrication	• Check that grease fittings are properly installed on equipment so equipped. • Check that equipment is properly lubricated as required. NOTE: Whenever necessary, parts shall be cleaned before lubrication is applied.
Threads	Check that threads are kept in serviceable condition and lubricated when necessary.
Cotter Pins	Check that cotter pins are: • The proper size; • Placed in every hole provided for that purpose; • In good condition; and • Properly installed.
Bearings, Bushings, and Movable Parts	Check that bearings, bushings and movable parts: • Are free of significant damage and wear; • Are kept clean; and • Operate freely.

Continued on next page

Inspect	Check
Wear	Check that cranks, pins, and other movable points of connection do not contribute to significant lost motion to the system as a whole, due to excessive wear in moving parts.
Lock Nuts	Check that lock nuts designed to keep adjustable equipment secure, are properly tightened.
Pipe Carriers	Check that pipe carriers are firmly mounted on ties or foundations and rollers move freely.
Foundations (footings)	Check that foundations (footings) are secure and in good condition.

5. Rods and Pipe Line Insulation

5.1. Refer to GI-332 Inspecting and Testing Insulated Track Hardware, for information related to inspecting and testing mechanical connecting equipment containing insulation.

410 - Inspecting Signal Lamps

1. Purpose

1.1. To describe the procedures required to obtain optimum light quality and maximum lamp life which contributes to the safety and reliability of signal systems.

2. Test Interval

2.1. Lamps and sockets shall be inspected when installed, as required and when replaced in accordance with instructions. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Visual Inspection

4.1. When required, visually inspect lamps as described in this table.

4.2. WARNING: Do not attempt to handle or clean halogen lights while lit, or still hot, as glass explosion may result.

Table 410-01

Inspect	Check
Type and Rating	Check that lamps are of the proper type and rating for the system they are being used in.
Glass Imperfections	Check the lamp glass is free of imperfections that may cause significant light distortion.
Filament	Check the filament is in good condition and is centered in the bulb.
Corrosion	Check all metal parts of the lamp are free of corrosion.
Lamp Socket	Check the lamp socket is free of corrosion and holds the lamp firmly in place.
Discoloration	Check the lamp glass is free of discoloration from excessive heat or other causes.
Cleanliness	Check that lamps are clean.
Damage	Check that lamps are free from damage.

5. Lamp Voltage

5.1. Lamp voltage adjustment parameters depend on the type of system the lamps are used in. Follow the instructions in the table below when checking or adjusting lamp voltages.

Table 410-02

Signal System Type	Instructions
Wayside Signals	Refer to SCP-2
Highway Grade Crossing Warning System	Refer to GI-310(c)(5) Lamp Voltage.

6. Lamps

6.1. When it becomes necessary to replace lamps due to failure follow these instructions.

a. Lamps shall be replaced in kind.

b. When lamps are placed in service they shall be lighted and signal aspect observed to ensure proper alignment in accordance with SCP-706 and GI-411 Inspecting Signal Alignment.

c. Wayside signal lamps shall be checked for type and voltage rating in accordance with SCP-2 or as directed by the responsible Supervisory Officer.

7. Lamp Disposal

7.1. Lamps containing mercury must be recycled at an MECP permitted recovery facility. A shipping document (bill of lading) and the vendor agreement with the recovery facility must be retained on file, as per O. Reg. 347 requirements. While in storage and awaiting shipment to a recycling or waste processing facility, bulbs and other such wastes must be stored in a secure manner to prevent breakage and exposure to the environment. Bulbs crushing is not permitted, unless a specific risk assessment and safety procedure have been developed and an exposure testing program is in place.

411 - Inspecting Signal Alignment

1. Purpose

1.1. To describe the procedures required to ensure signal light housings are properly aligned.

2. Test Interval

2.1. Signal alignment shall be inspected when installed and as required. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Signal Sightline Obstruction

4.1. Remove obstructions that interfere with the visibility of signals.

Table 411-01

If the obstruction ...	Then ...
Is minor in nature and can be easily removed.	Remove the obstruction, secure and prevent discharge to the environment while in storage for disposal, and dispose or recycle to the highest feasible level of material recovery, or otherwise in accordance with Metrolinx Environmental Policies.Check the signal sightline and make adjustments to the signal alignment if necessary.
Proves to be a major obstacle.	Report the obstruction problem to the responsible Supervisory Officer.

5. Before Checking Alignment

5.1. Prior to checking signal alignment:

a. Ensure lamp voltage is adjusted in accordance with GI-410 Inspecting Signal Lamps.

b. Ensure the requirements of GI-410 Inspecting Signal Lamps, section Visual Inspection are met.

6. Highway Grade Crossing Signal Alignment

6.1. Refer to GI-310(c)(4) Light Alignment and SCP-706 for alignment procedures.

7. Wayside Signal Alignment

7.1. Exact adjustment criteria must be made on a site specific basis since there are many factors such as terrain, signal location, track layout, height, etc., which must be taken into consideration when inspecting signal alignment. However, there are characteristics that must apply to all locations in the interest of achieving the best alignment possible under any circumstance. Follow signal alignment inspection procedures as instructed in this table.

Table 411-02

Test	Explanation
Inspection Hours	These inspections shall be performed during daylight hours.
Alignment Distance	Refer to SCP-12 for determination of alignment distances for various curvatures of track.
Observe Light Characteristics	While observing the lights on a signal, watch for these characteristics. NOTE: When inspecting alignment, it is recommended that all lights be checked in the red position to maintain a consistent brilliance. • Check that each light or group of lights arranged to convey a signal indication maintains the same clarity relative to each other light in the group throughout the viewing range of the signal. • Check that each light unit maintains a round, distinctively red light with no major dark spots or distortions. • While approaching the lights from the long range alignment point, check that the light continuously maintains sufficient clarity right up to the signal. Where downward or upward deflecting lenses or roundels are provided for close-up viewing, check that aspect color clarity is maintained in the transition from long range to close range. The close-up lens or roundel should provide a clearly visible aspect up between 50 -100 feet from the signal and in some cases, depending on track and signal configuration, closer than 50 feet. Refer to SCP-12 for more information.

501 - Inspecting and Testing Hot Box Detector Systems

1. Purpose

1.1. This General Instruction details the inspections and tests required to maintain all Hot Box Detectors (HBD) in a manner that will ensure the safety and reliability of train movements.

2. Train Safety

2.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

3. Weather Conditions

3.1. The electrical and mechanical components of track mounted hardware are susceptible to failure or damage if foreign particles such as water, dirt or other debris are allowed to enter the compartments. Except in an emergency, do not leave any of the compartment covers open during adverse weather conditions. Never leave covers open when trains are passing.

4. Service Manuals

4.1. HBD service manuals and plan sets shall be kept accessible to the employee performing the tests while on site.

5. HBD System Testing Index

5.1. All tests described in this GI must be performed at the time of installation (defined as when installing a HBD system as a complete unit, or when making changes that involve adding, replacing or repairing parts of the HBD system), and according to the following index.

Table 501-01

GI Test	Component	Test Description	Test Interval (Month)
501(a)	Track	Adequate Track Condition (*no floating rail, loose spikes, or pumping > 1"*).	1
501(a)		Adequate Drainage Around Equipment.	1
501(a)		Box Anchors or MSR Tie Plates Installed 100' in each Direction of Site.	1
501(a)		Ice Deflectors Installed and Secured - Annually in Fall *(if required)*.	6
501(b)		Proper Signage Installed.	6
501(a)	Bearing Scanners	Scanner to Ballast Clearance *(4" minimum from bottom of scanner)*.	1
501(a)		Ballast Blockers are Installed and Secure (*where installed*).	1
501(a)		Scanners Clear of Track Hardware (*1" minimum from tie plates, rail clips, etc*).	1
501(a)		Scanner to Tie Clearance (*1" minimum*).	1
501(a)		Scanner Deflectors Installed and Secured (50 ft-lb) (*not applicable for STC*).	1

Continued on next page

GI Test	Component	Test Description	Test Interval (Month)
501(a)	Bearing Scanners	Scanner Rail Mount Secured (*no more than 50 ft-lb of torque*).	1
501(a)		Clean Lens, Mirror, and Debris from Scanners.	1
501(a)		Tighten All Connections between Scanners and Bungalow.	1
501(a)		Mouse Screens Installed (*not applicable for STC*).	6
501(a)		Rail to Scanner Impedance (*Minimum 1 MΩ*).	6
501(a)		Calibrate Scanners (*not applicable for DHP*).	6
501(a)		Tighten Pyro/Bolometer Block (*not applicable for STC*).	6
501(a)		Scanner Alignment Check.	6
501(a)	Transducers	Secured to Rail (*non-metal impact test*).	1
501(a)		Gate Transducers with a Metal Object to Confirm System Activation.	1
501(b)	DED	Polarity Check on Gating (A and B) Transducers.	6
501(b)		Confirm Gating (A and B) Transducer Spacing.	6
501(a)		Full Movement of Paddle Allowed.	1
501(a)		Paddle Requires Significant Force to Activate.	1

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GI Test	Component	Test Description	Test Interval (Month)
501(a)	DED	Replace Damaged Panels.	1
501(a)		Paint Panels so new DED Marks can be Distinguished.	1
501(b)		Tighten All Terminals Internal to DED.	6
501(b)		Confirm Paddle Height (*0.5" to 1.5" below head of rail*).	6
501(b)		Check/Adjust Contact Opening (*1- 3/4" paddle movement*).	6
501(a)	Hot Wheel Scanners Hot Wheel Scanners	Scanner Mount Secured (*Rail Mounted only - tighten to no more than 50 ft-lb*).	1
501(a)		Heaters Functioning Properly (*scanner warm to touch*).	1
501(a)		Clean Lens and Debris from Scanners and Sun Filters.	1
501(a)		Tighten All Connections between Scanners and Bungalow.	1
501(b)		Calibrate Scanners (*not applicable for DHP*).	6
501(b)		Scanner Alignment Check.	6
501(a)	Bungalow	Bungalow Clean and Free of Rodents.	1

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GI Test	Component	Test Description	Test Interval (Month)
501(a)	Bungalow	Confirm DC Voltages (*within +/- 5% of nominal voltage*).	1
305(a)		Test Battery as per GI-305(a).	3
501(b)		Confirm Alarm Threshold Settings (*Standalone sites only*).	6
501(b)		Tighten All Connections on Equipment and Terminals in Bungalow.	6
501(a)		Temperature Sensor is correctly reading the ambient temperature.	1
501(a)	Test Tape	Complete with All Specifications Satisfied.	1

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501(a) - Hot Box Detector – One Month Test

1. Purpose

1.1. To ensure that all HBD sites are compliant with S&C Standards and operate as intended.

2. Test Interval

2.1. Hot Box Detector tests shall be made to ensure proper maintenance and adjustment when installed, as required and at least once every month. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Recording Results

4.1. Record the inspection or test results for the Hot Box Detector system in SCIS.

5. Test Procedure

5.1. Test must be performed whenever:

a. Severe weather conditions cause track movement affecting the HBD, or
b. Repairs have been made to the chassis, scanners or dragger, or
c. Track work such as tamping or lining has been performed, or
d. The HBD has falsely stopped a train.

Table 501(a)-01

Component	Test/ Inspection	Check that…
Track	Adequate Drainage	Improvements should be made to increase the flow of water away from equipment if any signs of pooling are present. Water sitting below scanners and around DEDs will cause problems during all seasons. If these exist, arrangements need to be made with the track department to bring conditions up to GO Transit Track Standard.
Track	Track Condition	Floating rail, loose spikes, and rail pumping of more than 1" are unacceptable track conditions. If these exist, arrangements need to be made with the track department to bring conditions up to GO Transit Track Standard. If ice breakers for dragging equipment detectors are installed, check the quality and replace if necessary. Check that 1 mile to WIS site signs are installed.
Track	Box Anchors or MSR Tie Plates Installed 100' Before and After Site	This is important to keep horizontal rail movement to a minimum and equipment spacing correct. Arrangements should be made with track department to install box anchors per Metrolinx Track Standard if none are present.

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Component	Test/ Inspection	Check that…
Bearing Scanners	Scanner to Ballast Clearance	There should be at least 4" from the bottom of a scanner to the top of the ballast. All debris, snow, and foreign objects need to be removed to prevent scanners from bottoming out.
Bearing Scanners	Ballast Blockers around Scanners	Ballast blockers are important to prevent ballast from moving under scanners. If not present at site, proper arrangements need to be made to have them installed (*at applicable sites)*.
Bearing Scanners	Scanner Clear of Track Hardware	Any track hardware less than 1" away from a scanner needs to be removed or adjusted. Contact with this hardware causes electrical interference which can result in false stops and equipment damage.
Bearing Scanners	Scanner to Tie Clearance	Scanners must be at least 1" away from surrounding ties. Scanners with less than 1" clearance from a tie can be impacted from horizontal rail movement during passing trains.
Bearing Scanners	Heaters Functioning Properly	Scanners should always be warm to the touch during cool months. If not, all connections in line with the internal heaters should be checked. If no issues are found, the corresponding scanner should be sent in for repair.

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Component	Test/ Inspection	Check that…
Bearing Scanners	Scanner Rail Mount Secured	Confirm that no movement is possible from loose rail clamps. The only allowable movement should be from the rubber shock mounting between scanner and rail clamps. Clamps should be tightened to no more than 50 ft-lb.
Bearing Scanners	Scanner Deflectors Installed and Secured	Deflectors need to be installed and tightened to rail at no more than 50 ft-lb.
Bearing Scanners	Clean Lens, Mirror, and Debris from Scanner	Dirty optics result in lower heat readings and increase the chance of missing a hot bearing. Optics should always be cleaned prior to a system calibration. Optics should be cleaned gently with water or mild solution of dishwashing liquid.
Bearing Scanners	Tighten All Connections between Scanners and Bungalow	Ensure all connections are tight and that all cables are in good shape. Intermittent connections impact scanner functionality and cause false readings. **The GETS scanner connections including set screws should especially be checked and tightened**.

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Component	Test/ Inspection	Check that…
Transducer	Transducer Secured to Rail	Scanner shutters should NOT open when any of the transducers are lightly struck with a non-metal object (i.e. wooden handle). If this occurs, the transducer should be tightened to 21-25 lb-ft and tested again. If failure still occurs, the manufacturers have recommended removing any rubber grommets in line with the mounting bolts. A transducer should then be replaced if missing or odd axle counts still occur.
Transducer	Gate All Transducers and Ensure Scanner Shutters Open	Swipe a metal object over every transducer and ensure the scanner shutters open with each swipe. Once the shutters have opened, wait roughly 10 seconds for them to close before swiping next transducer. If a transducer is not functioning as intended, all wiring should be checked. If no wiring faults are found, the transducer will need to be replaced.

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Component	Test/ Inspection	Check that…
Dragging Equipment Detector	Full Movement of Paddle Allowed	All snow, ice, track hardware, and foreign objects should be removed so paddle can make full movements to both sides. Ensure that paddle cannot catch on track spikes or clips when pushed over completely in both directions.
Dragging Equipment Detector	Paddle Requires Significant Force to Activate	Paddles that move without significant force are more susceptible to false activations. This problem can be resolved by completing the Product Improvement Announcement 08- 005 (Excessive dragger play) issued by GE.
Dragging Equipment Detector	Replace Damaged Panels	Panels are considered damaged when they are severely deformed and/or cannot be re-secured to detector.
Dragging Equipment Detector	Paint Scarred Panels	Painted panels are useful when distinguishing between false activations and real activations.
Hot Wheel Scanners	Hot Wheel Scanners Mounted Securely	Pedestal mounted scanners should be tight with no allowable movement. For rail-mounted scanners, the only allowable movement should be from the rubber shock mounting between the scanner and rail clamps. Clamps should be tightened to no more than 50 ft-lb.

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Component	Test/ Inspection	Check that…
Hot Wheel Scanners	Clean Lens and Debris from Scanners and Sun Filters	Dirty optics result in lower heat readings and increase the chance of missing a hot wheel. Optics should always be cleaned prior to a system calibration. Optics should be cleaned gently with water or mild solution of dishwashing liquid. Ensure that the sun filter is properly installed, clean, and in good condition.
Hot Wheel Scanners	Tighten All Connections between Scanners and Bungalow	Ensure all connections are tight and that all cables are in good shape. Intermittent connections impact scanner functionality and cause false readings.
Bungalow	Bungalow Clean and Free of Rodents	Ensure that no evidence of life is present and that all possible entrances into bungalow are sealed.
Bungalow	Confirm DC Voltages	All applicable DC voltages must be within +/-5% of the nominal voltage.

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Component	Test/ Inspection	Check that…
Bungalow	Temperature sensor is reading the correct ambient temperature	At the time of install / replacement, the temperature sensor needs to be calibrated to the ambient temperature and have an accuracy of +/- 4 degrees Fahrenheit or +/- 2 degree Celsius. Place a thermometer beside the temperature sensor on the outside of the bungalow to get the ambient temperature reading. Existing temperature sensors must be checked to ensure the ambient temperature is correct. Verify the site temperature reading with a thermometer. If the temperature is not within tolerance, recalibrate or replace the unit.

6. Monthly Test Tape

6.1. The following procedure is for completing a test tape. Below are the steps that should be followed to ensure that the HBD system is working as intended.

6.2. NOTE: The heat source (calibration assistant, function simulator, etc.) should be placed on each scanner being tested for at least 40 axles (about 10 seconds).

Table 501(a)-02

Step	Action
1	Setup heat source, let it reach proper temperature: • DHP – set to 130° F above ambient. • STC – 140°/130° F depending on model. • GETS – automatically sets to 130° F or tells user what temperature to set heat source to.
2	Place heat source on the North/East BEARING scanner.
3	Start test train • STC and DHP systems - turn "Gating" switch on. • GETS – close test nut.
4	Kick DED over 3 times in one direction.
5	Move heat source to South/West BEARING scanner.
6	Kick DED over 3 times in other direction.
7	If site has hot wheel scanners, move heat source to North/East WHEEL scanner.
8	If system has two wheel scanners, move heat source to South/West WHEEL scanner.
9	End test tape • STC and DHP systems – turn "Gating" switch off. • GETS – wait for test tape to terminate, loosen test nut.

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<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>10</td><td>Contact call desk or check WIM (VFR) to confirm that the test tape was received and the following conditions are satisfied:

Test tape should show North/East Rail heat first followed by the South/West rail (this confirms the scanners are wired to the correct channel).
Bearing and Wheel heats must read between conditions in table below.
No more than 1.0mm of heat differential between bearing scanners.
At least 6 DED activations are present.

<table>
<tr><th></th><th>North/East Bearing Avg</th><th>South/West Bearing Avg</th><th>North/East Wheel Avg</th><th>South/West Wheel Avg</th></tr>
<tr><td>GETS</td><td>11-13 mm</td><td>11-13 mm</td><td>60-90° F</td><td>60-90° F</td></tr>
<tr><td>STC</td><td>9-11 mm</td><td>9-11 mm</td><td>60-90° F</td><td>60-90° F</td></tr>
<tr><td>DHP</td><td>10-12 mm</td><td>10-12 mm</td><td>>60° F</td><td>N/A</td></tr>
</table>
</td></tr>
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501(b) - Hot Box Detector – 6 Month Test

1. Purpose

1.1. To ensure that all HBD sites are compliant with S&C Standards and operate as intended.

2. Test Interval

2.1. Hot Box Detector tests shall be made to ensure proper maintenance and adjustment when installed, as required and at least once six (6) months. Refer to GI-301(h) Inspection and Test Intervals for all test intervals.

3. Train Safety

3.1. If inspections or tests will interfere with the safe operation of trains, ensure that positive protection is applied in accordance with GI-301(i) Protecting Train Operations During Signal System Interruption.

4. Recording Results

4.1. Record the inspection or test results for the Hot Box Detector system in SCIS.

5. Test Procedure

5.1. Test must be performed whenever:

a. Severe weather conditions cause track movement affecting the HBD, or
b. Repairs have been made to the chassis, scanners or dragger, or
c. Track work such as tamping or lining has been performed, or
d. The HBD has falsely stopped a train.

Table 501(b)-01

Component	Test/Inspection	Check that…
Bearing Scanners	Mouse Screens Installed and in Good Condition (not applicable for STC)	These are important to keep animals out of scanners. Because of the internal heaters, animals have been found living in scanners during colder months. Damaged or missing screens need to be replaced or installed. NOTE: DHP Mouse screens should not be field installed. These must be installed and calibrated by ERC.
Bearing Scanners	Rail to Scanner Impedance	Electrical connections between the rail and scanner cause electrical interference, resulting in false readings. If the impedance is less than 1MΩ, the scanner mount needs to be replaced and sent in for repair. The procedure for doing this test is as follows: • Remove scanner grounding and disconnect scanner cable. • Impedance reading between rail and scanner should NOT be less than 1MΩ on multimeter. Replace scanner grounding and connector scanner cable appropriately.

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Component	Test/Inspection	Check that…
Bearing Scanners	Calibrate Bearing Scanners (not applicable for DHP)	This process is to ensure that the scanners are reading accurate heat values. The instructions for this procedure can be found in the appropriate manuals listed below. NOTE: DHP Bearing Scanners cannot be field calibrated.
Bearing Scanners	Tighten Pyro / Bolometer Block (not applicable for STC)	Tighten the internal block. This block has a tendency to become loose under normal operation. When these blocks are not secure they vibrate against the scanner housing and cause false readings.
Bearing Scanners	Scanner Alignment Check	Check the scanner alignment to ensure it has not changed under normal operation.
Hot Wheel Scanners	Scanner Alignment Check	Check the scanner alignment to ensure that the scanners are reading heat at the right point on the wheels. The instructions for this procedure can be found in the appropriate manuals.
Wheel Scanners	Calibrate Hot Wheel Scanners (not applicable for DHP)	This process is to ensure that the scanners are reading accurate heat values. The instructions for this procedure can be found in the appropriate manuals.
DED	Tighten All Terminals Internal to DED	Check all double nut connections internal to the dragging equipment detector. These have a tendency to become loose from heavy vibrations on the rail.

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Component	Test/Inspection	Check that…
DED	Confirm Paddle Height	All DED panels should be 0.5″ to 1.5″ below height of rail. Outside paddle types may need to be replaced with inside paddle types to achieve required height.
DED	Check/Adjust Contact Opening	DED should activate when tip of paddles travel 1¾″ relative to the rail. If DED activates more than ¼″ before or after this mark, contacts need to be re-adjusted.
Transducer	Polarity Check on Gating (A and B) Transducers	The following procedure for doing this test is as follows: • Using a metal object, lower it down to one of the inner transducers. The scanner shutters SHOULD open. • Leave the object on the transducer until the shutters close (about 10 seconds). • Raise the object up. The shutters SHOULD NOT open, if so, the transducer polarity should be checked. A reverse polarity will cause bearings to be only partially scanned with minimal heat recorded. NOTE: This procedure is not applicable for new Progress Rail uHBD3 units with amber LED lights on the HBD box.

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<table>
<tr><th>Component</th><th>Test/Inspection</th><th>Check that…</th></tr>
<tr><td>Transducer</td><td>Gating (A and B) Transducer Spacing</td><td>Ensure that the spacing between the magnetic centers of the A and B transducers is 24”. If not exact, this measurement can fine tuned in software (by 0.1” increments). Instructions can be found in the appropriate manuals.</td></tr>
<tr><td>HBD Chassis</td><td>Confirm Alarm Threshold Settings (Standalone sites only)</td><td>Alarm thresholds should match table below depending on the location of the site. This applies to standalone sites (no office communications) only as the office sets the alarm thresholds for online sites.
<table>
<tr><th></th><th>Absolute HB</th><th>Diff HB</th><th>Hot Wheel</th></tr>
<tr><td>Mainline Canada</td><td>15mm</td><td>8mm</td><td>558°F/ 309°C</td></tr>
<tr><td>Branchline Canada</td><td>12mm</td><td>6mm</td><td>558°F/ 309°C</td></tr>
<tr><td>GO Train Sites</td><td>15mm</td><td>10mm</td><td>558°F/ 309°C</td></tr>
<tr><td>TP105</td><td>15mm</td><td>8mm</td><td>558°F/ 309°C</td></tr>
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Component	Test/Inspection	Check that…
Radio	Radio Volume	After a train simulation, confirm that message can be heard clearly with adequate volume. If there is a volume issue, all systems have the capability of adjustment. Test for a "polite" talker. Simulate a busy channel by holding PTT open on a handheld radio. Ensure that the HBD does not delay radioing its talker message. If it does delay, the Squelch input should be checked for reverse wiring and the Squelch timeout should be set to 1 second (GETS units).
Bungalow	Test AC Power	Ensure that the voltage is stable at no less than 110VAC with a 20 Amp load.
Bungalow	Tighten All Connections on Equipment and Terminals in Bungalow	Ensure all connections are tight and that all cables are in good shape. Intermittent connections impact detector and scanner functionality and can cause false readings.