

Signals & Communications Standards - Codes of Practice

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May 2025



GO TRANSIT SIGNALS & COMMUNICATIONS STANDARDS - CODES OF PRACTICE

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PREFACE

This is the third edition of the GO Transit Signals and Communications Standards - Codes of Practice. The third edition includes general updates based on stakeholder's feedback.

This document is for use by designers, consultants, contractors, maintainers and all others involved in the design, construction and maintenance of Metrolinx Signals and Communications and is intended for suitably qualified professionals familiar with the subject matter. This document applies to all trackage and rights-of-way owned or operated by GO Transit ("the Railway"), and UP Express, which are divisions of Metrolinx.

The technical content within the GO Transit Signals & Communications Standards - Codes of Practice was modified/developed by the Metrolinx Signals & Communications office within the Asset Management and Maintenance Division, which includes specialized subject matter experts.

Suggestions for revision or improvement can be sent to the Metrolinx Signals and Communications office, Attention: Director of Signals and Communications Engineering who shall introduce the proposed changes to the Metrolinx Signals and Communications Engineering office. The Director of the Signals and Communications Engineering office ultimately authorizes the changes. Be sure to include a description of the proposed change, a 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.

These standards are effective as of May 2025

General Requirements

1. Purpose

- 1.1. 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 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 and reliability, and extend the useful service life of the signals and communications systems.
- 1.2. 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.
- 1.3. Where a rule or instruction is conflicting with a law or regulation issued by a government body having jurisdiction, the law or regulation will take precedence over the rule or instruction.
- 1.4. 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.
- 1.5. Refer to GO Transit Signals & Communications Standards – General Instructions for definitions.

SCP Revision History

2. Purpose

- 2.1. The SCP Revisions History shows all the major, or significant revisions that were made in the latest SCP releases, as well as the Initial Release of new SCPs. These changes would be SCP Title changes, section, paragraph, or table additions or deletions, and wording revisions that significantly change the meaning of the instruction.
- 2.2. All grammatical, punctuation, spelling corrections, or minor wording changes that do not affect or change the overall meaning of the SCP will not be shown in the SCP Revision History.

SCP No.	Subject	Previous Release	Latest Release
005	Prohibit track bond lengths greater than 5"	2021/02/25	2025/05/02
013	Updates for Nortrack turnouts	2019/10/30	2025/05/02
302	Add clearance for hydro wires	2021/02/25	2025/05/02
701	Post-incident test conditions updated for clarifications in multi-tracked locations	2019/10/30	2025/05/02
902	Wayside inspection intervals changed from 60 miles to 40 miles	2019/10/30	2025/05/02

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SCP-1205-C	Highway Traffic - Grade Crossing Interconnection
SCP-1208-1	In Service Notification
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SCP-1208-B	
SCP-1209	Signal - Safety Assurance Installation & Commissioning Process Checklist
SCP-1209-1	Testing Certification Form
SCP-1209-2	Staged Testing Certification Form
SCP-1209-3	Signal Safety Assurance Checklist
SCP-1209-4	Signal Plan Transmittal Notice
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SCP-1210-1	GCWS Test Certification Form
SCP-1210-3	GCWS Safety Assurance Checklist
SCP-1210-4	GCWS Plan Transmittal Notice
SCP-1210-5	Grade Crossing Train Movement Data
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SCP-1210-7	Grade Crossing Vehicular Traffic Data
SCP-1210-9	Grade Crossing Warning System - Light Unit Data
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SCP-1250-3	Inspection Audit Form for Wayside Inspection Systems
SCP-1250-4	Inspection Audit Form for New Installations
SCP-1506-A	Power Clearance Form
SCP-1506-B	Order to Operate

001 - Location of Insulated Joints

1. Purpose

- 1.1. Insulated joints are used to define the limits of a track circuit. Their location is important for the safe and reliable operation of the signal system. This practice describes the location of insulated joints to be used for new or replacement installations.

2. Identifying Joint Locations

- 2.1. It is the responsibility of the Metrolinx designated S&C Supervisor to advise the track forces as to the correct location of insulated rail joints.

3. Metrolinx GO Transit Track Standard

- 3.1. Joint installation and maintenance procedures are defined in Metrolinx GO Transit Track Standards.

4. Measurements

- 4.1. Signal measurements are to be made from the center of the mast on which the signal is located, or if there is no mast, from the center of the signal base. In the case of a signal suspended on a bridge, the face of the signal shall be the point from which measurements are made.

5. Effective Joint

- 5.1. The effective joint is the second insulated rail joint passed by the train going in the direction in which the signal under consideration governs, or the second insulated rail joint passed by a train leaving a siding or spur track.
- 5.2. The effective joint must not be located on the approach side of the signal.

6. Rail Running

- 6.1. Every effort should be made to install insulated joints so that all limits specified herein will be maintained after taking into account the effects of rail running.

7. Typical Examples

- 7.1. The examples shown in Figure 001-1: **Cut Sections** to Figure 001-17: **Highway Grade Crossing – Electronic Island Circuit** are used to illustrate typical insulated rail joint locations and other permissible tolerances. Tolerances are permitted to avoid rail cutting or to permit the selection of short rail lengths. No deviations to these shall be made without authority of Metrolinx.
- 7.2. NOTE: Refer to GO Transit Track Standards for the staggering distance of "A" and installation requirements.

Figure 001-1: Cut Sections

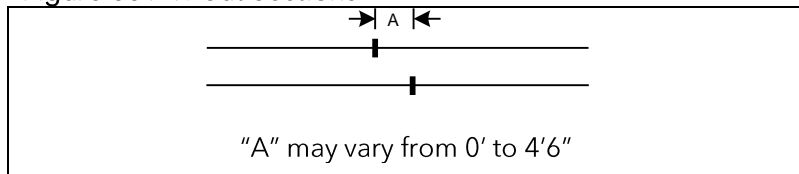
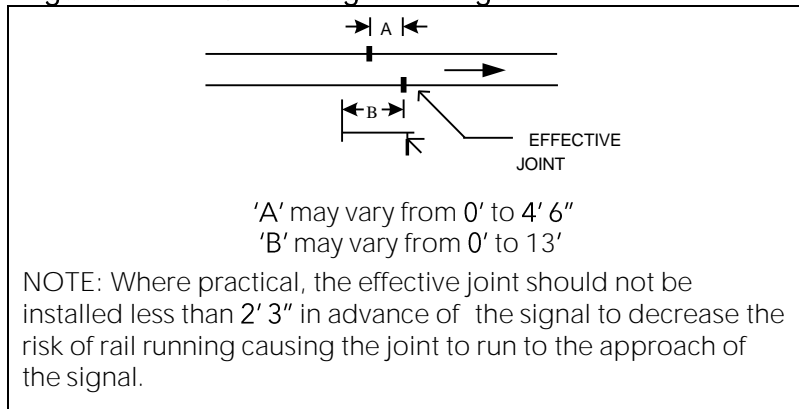


Figure 001-2: Absolute Signals – Single



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Figure 001-3: Absolute Signal – Back to Back

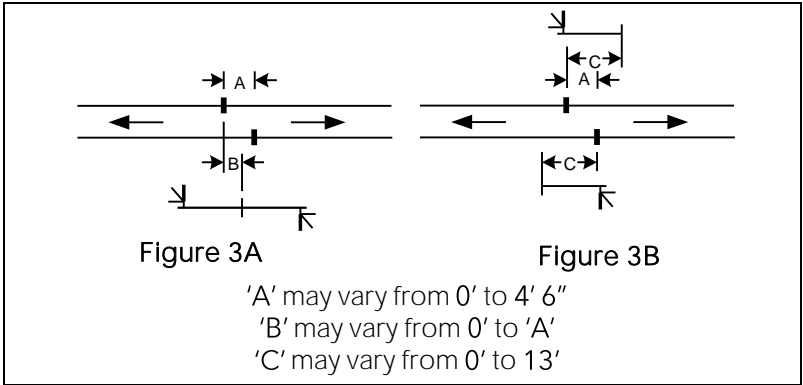


Figure 001-4: Automatic Signal (i.e. Single Approach or Intermediate Signal)

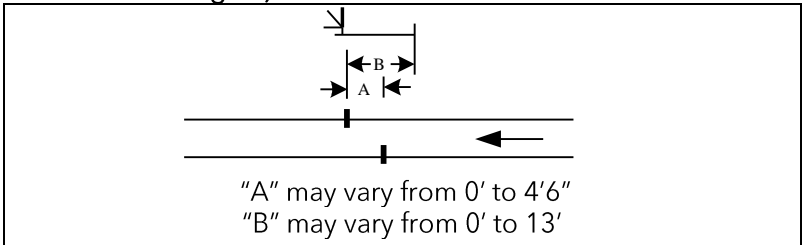
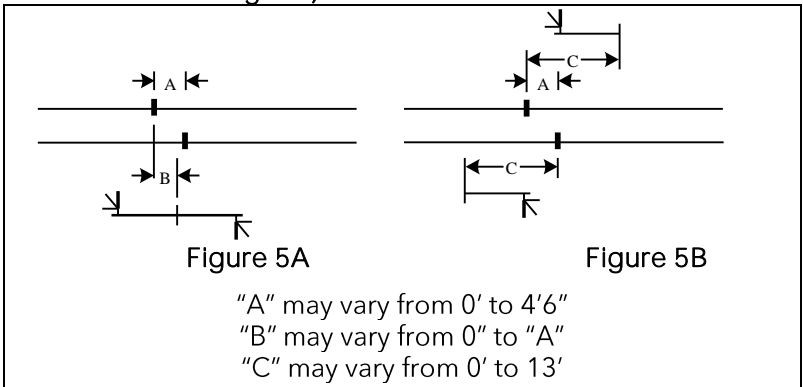
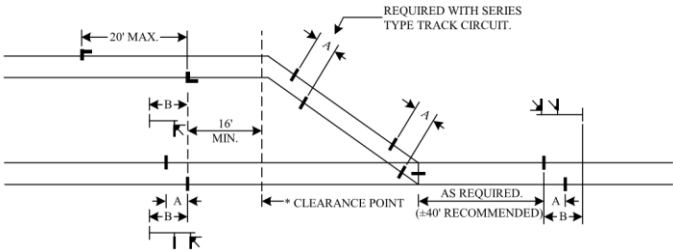


Figure 001-5: Automatic Signal (i.e. Back to Back Approach or Intermediate Signals)



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Figure 001-6: Turnouts with Interlocking Signals

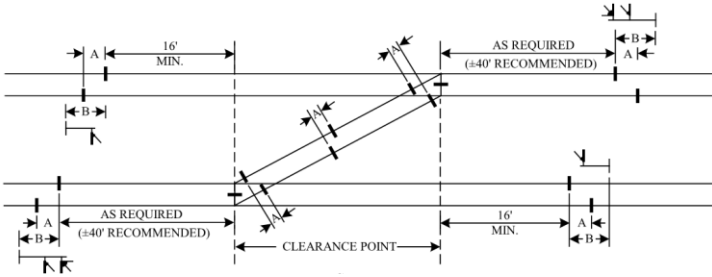


"A" may vary from 0' to 4'6"

"B" may vary from 0' to 5'0"

*Clearance point is at 13'6" between the track centers or at point where tracks run parallel.

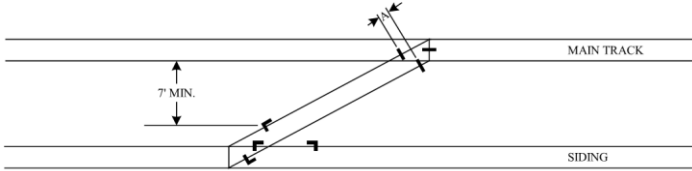
Figure 001-7: Crossover – Main Tacks Interlocked or Non-Interlocked



"A" may vary from 0' to 4'6"

"B" may vary from 0' to 5'0"

Figure 001-8: Crossover – Main Track to Siding Switch
Normally Lined Through on Siding



"A" may vary from 0' to 4'6"

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Figure 001-9: Turnout – With or Without Lifting Block Derail

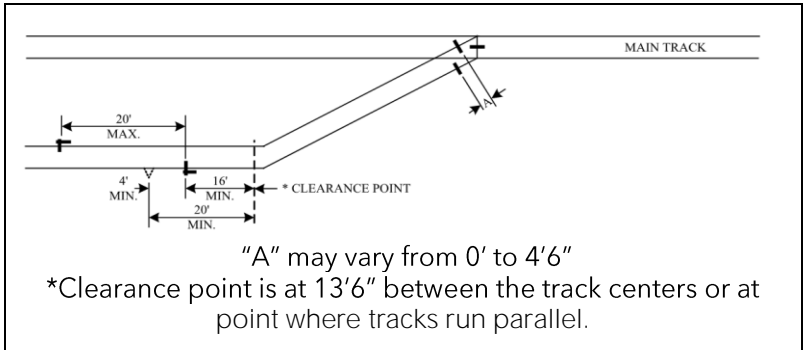


Figure 001-10: Turnout – With Point Derail

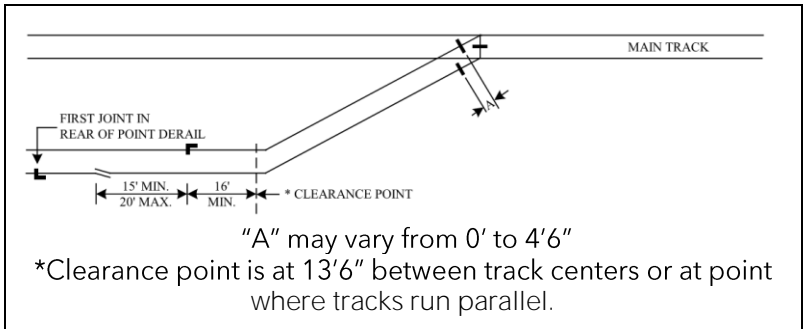
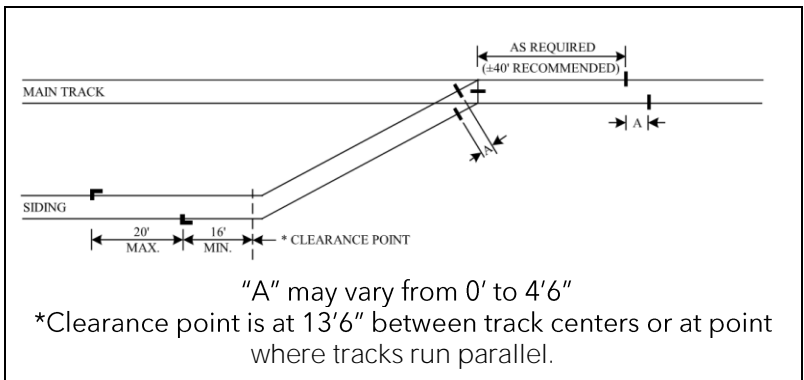


Figure 001-11: Turnout – With Track Shunt



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Figure 001-12: Turnout – Where Fouling Protection Not Used

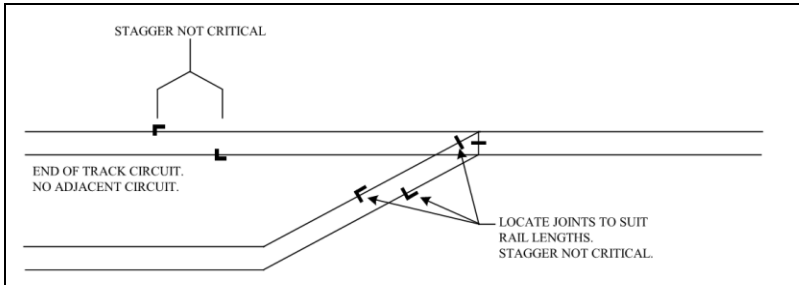


Figure 001-13: Railway Grade Crossing – One Common Rail Track Circuit

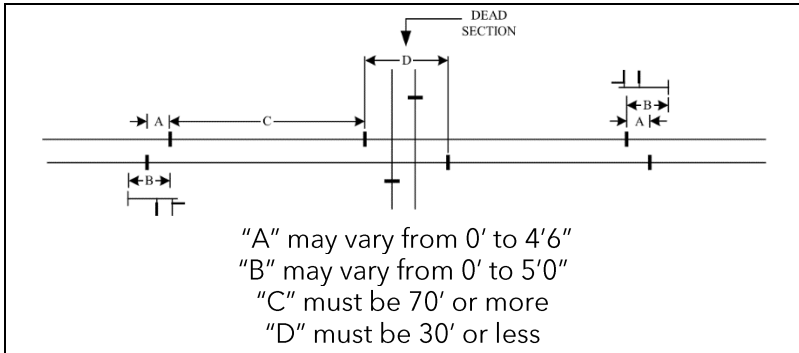
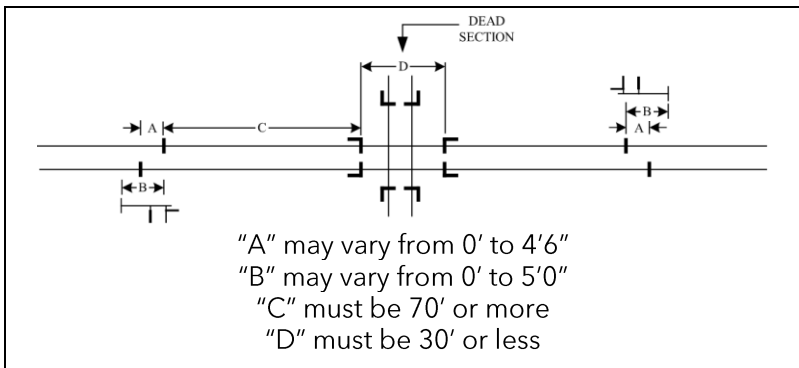


Figure 001-14: Railway Grade Crossing – Double Rail Track Circuit



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Figure 001-15: Railway Grade Crossing – Trap Circuit for Dead Section Greater than 30'

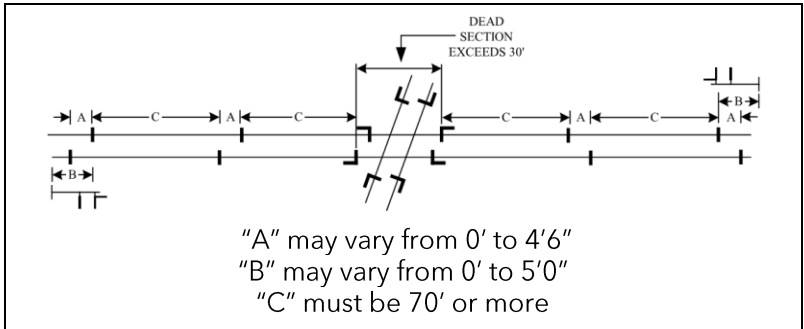


Figure 001-16: Highway Grade Crossing – DC Island Circuit

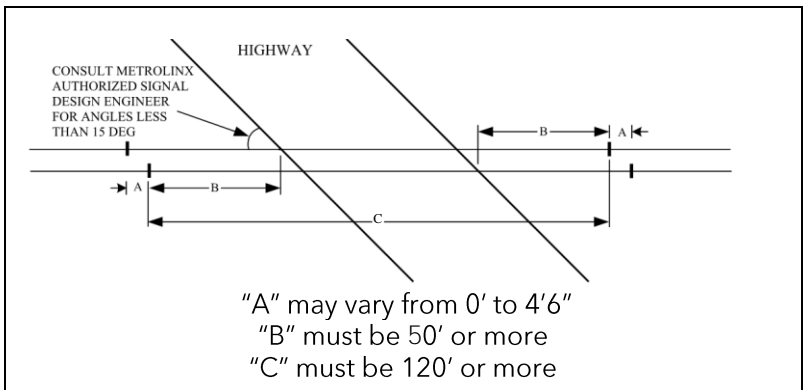
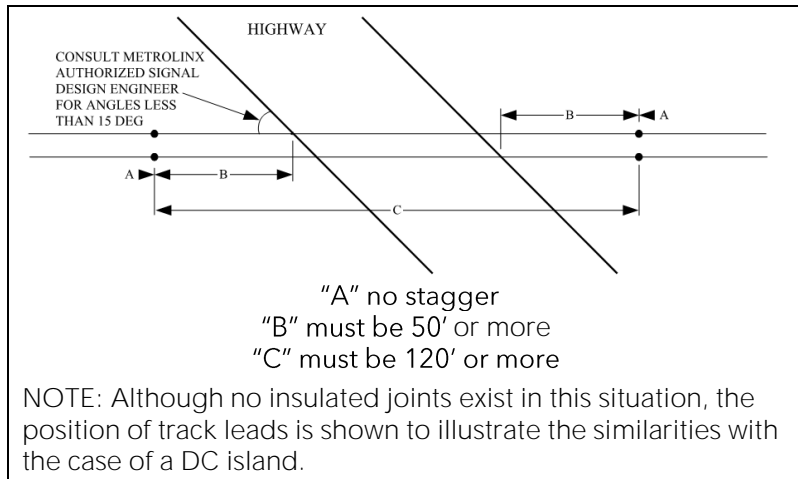


Figure 001-17: Highway Grade Crossing – Electronic Island Circuit



- 7.3. While sectional release is deployed, sometimes it is permitted to install insulated joints fouling the turnout. Such insulated joint application must be approved by Metrolinx. Electric locking shall be so designed that occupancy of any track circuit fouling the turnout must electrically lock the switch until such track circuits and the over switch track circuit are vacant, and route locking / traffic locking are released.

002 - Replacement Intervals for Railway Signal Lamps

1. Introduction

- 1.1. While the life of any incandescent lamp can be affected by the voltage impressed upon it, recent advances in lamp technology have allowed extended re-lamping schedules to be achieved without the need to operate lamps at excessively lower than rated voltage. Approved long life (10 year) bulbs should be used wherever practical.

2. Scope

- 2.1. This practice covers recommended lamp operating voltages and replacement intervals for railway signal service.
- 2.2. This practice does NOT cover lamps used in highway warning system service, NOR does it cover LED lamps.

3. Past Practices

- 3.1. In the past, it was common practice to operate conventional lamps at 80-85% rated voltage, typically at 8.2V. This had the effect of extending the life of a standard 6 month rated 10V 18W incandescent lamp to 24 months for steady lit applications. However, operating the lamp at too low a voltage could affect the integrity of the signal aspect.

4. Long Life Bulb

- 4.1. The approved 10V 18W long life lamp is rated for 100,000 hours continuous use at 10V, or approximately 10 years. It is recommended that the operating voltage be adjusted as close to rated voltage as possible, and in no case be adjusted below 9.0V.

5. Recommended Practice

- 5.1. Use approved 10V 18W extended life lamps where applicable, operated at the applied voltages as prescribed below. The use of halogen bulbs is no longer recommended.

6. Alternative Practice

- 6.1. If approved long life lamps are unavailable, then use previously approved GEMS 10V 18W bulbs, operated at the applied voltages as prescribed in the section below.

7. Operated Voltages

- 7.1. Table 002-01 outlines the recommended operating voltages for the various lamps. Maximum light output is normally required, except in circumstances where spread or deflecting lenses are used.

Table 002-01

If the lamp type is...	And the maximum light is...	Then operate the lamp at...
TLC PG-10V18W-RS	Not necessary	9.0V
	Necessary	9.8V
GEMS 10V 18W	Not necessary	8.1V
	Necessary	9.5V

8. Re-lamping Schedule

- 8.1. Table 002-02 outlines the recommended re-lamping schedule for the various lamps operated in various applications.

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Table 002-02

If the lamp type is...	And operated at...	And...	Then re-lamp every...
TLC PG-10V18W-RS	9.0-9.8V	Steady lit	10 years
		Approach lit	20 years
GEMS 10V 18W	8.1V	Steady lit	2 years
		Approach lit	4 years
	9.5V	Steady lit	8 months
		Approach lit	2 years

9. Decal

- 9.1. It is recommended that a decal be affixed in the housing wherever long life bulbs are installed, indicating the year of installation, and year of scheduled replacement.

003 - Procedures to be followed by S&C Personnel in the Event of an Incident Involving a Signal System

1. Purpose

- 1.1. The purpose of this practice is to provide guidelines for the first employee on scene and to describe investigation criteria in a form that will assist the investigator to comprehensively report the circumstances of an incident and to more readily recognize the causal factors associated therewith. It is intended as a source of reference to supplement practical experience.

2. Scope

- 2.1. This practice recommends the procedures to be followed by S&C personnel in the event of any incident involving a signal system.
- 2.2. It is designed as an aid to S&C personnel on scene and/or responsible for the investigation and reporting of incidents involving signal systems.
- 2.3. No attempt has been made to deal with all the variables associated with incident investigation other than to outline certain guidelines that will provide a point of departure in the total investigative process.
- 2.4. In the event of an alleged wrong side failure, the first employee on scene must secure the equipment involved by means of lock or seal. No employee at the scene shall attempt to repair, resolve or secure logs from any equipment or software alleged in a wrong side signal system failure until authorized by Metrolinx.

3. Standardized Incident Reporting

- 3.1. In addition to reporting consistency, the ultimate value of a standardized system of incident reporting techniques is to produce a uniform data base from which meaningful comparisons of incident information can be made and used to affect preventative and corrective measures.

4. Definition of Incident

- 4.1. The term "Incident" in this practice is defined as "Any damage to equipment or abnormal occurrences such as: alleged false clear aspect displayed; CROR "Stop Signal" violation".

5. Evidence

- 5.1. In the event that equipment is requested as evidence by an outside investigator (Police, Coroner, or other), the request must be referred to Metrolinx BEFORE the equipment is released.
- 5.2. Be sure to record the identification and state of the requested equipment in the presence of Metrolinx before allowing the release of any equipment.

6. Witness Information

- 6.1. Whenever possible, obtain identification, license numbers, etc. of any witness at the scene.

7. Statement to Media

- 7.1. When approached by the media for comments during an incident investigation, it is recommended employees restrict their statement to the following:
- 7.2. "It is company policy for employees not to comment on incidents when there is an ongoing investigation. Please contact Metrolinx".

8. Initial Employee at Scene

- 8.1. The "Initial Employee at scene" is defined as the first qualified Metrolinx designated S&C employee who arrives at the incident scene.

9. Supervisory Notification

- 9.1. The responsible Metrolinx designated S&C Supervisory Officer must be notified immediately. The Supervisor should proceed to the location, assess the situation and advise Metrolinx.
- 9.2. If the responsible S&C Supervisory Officer is not available, another Supervisory Officer must immediately be notified.

10. Metrolinx Designated S&C Supervisory Officer Responsibility

- 10.1. The Metrolinx Designated S&C Supervisory Officer is in charge and is held accountable for the overall coordination of the S&C portion of the investigation, having due regard for on-going investigation of those areas outside the realm of their responsibility. The responsible Supervisory Officer will coordinate all activities in conjunction with the assigned Metrolinx S&C employee.
- 10.2. After preliminary inspection and when work priorities have been determined and set in motion, in conjunction with the assigned Metrolinx S&C employee, other specific staff responsibilities should be established and assigned.
- 10.3. RTC Notification
- 10.4. Any S&C employee who is made aware of a signaling system failure must provide protection to rail traffic as required by General Instruction [GI-301\(i\) Protecting Train Operation During Signal System Interruption](#).

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Table 003-01

If	Then
Employee is unable to contact the RTC	If the situation presents a danger to other movements, follow CROR. If still unable to contact RTC, the employee must attempt to enlist the services of another Metrolinx designated employee to advise either the responsible Metrolinx designated Supervisory Officer or the RTC of the situation.
Employee is able to contact the RTC	The employee shall ensure that the RTC is completely aware of the situation. In the case of any damage to or malfunction of the signal system, the RTC must be fully advised as to the extent the system is affected and the protection required.

11. Protection of the Incident Area

11.1. The S&C employee on scene must ensure that protection is provided in the area of the incident until the track is passable and/or the signal system has been repaired and tested. If necessary, the Metrolinx designated S&C Supervisory Officer shall declare the signal system inoperative.

12. Initial Investigation

12.1. Table 003-02 recommends the testing required depending on the type of incident being investigated.

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Table 003-02

If the Incident	Then
<ul style="list-style-type: none"> • has resulted in personal injury or damage to train equipment. • Is a CROR Stop Signal violation and the signal system is alleged to be at fault. • is an alleged false clear aspect displayed, and no train movement has taken place since the incident. 	<p>After consultation with Metrolinx, the first employee on the scene must, as soon as practicable, record in the presence of a witness (preferably a Police Officer):</p> <ul style="list-style-type: none"> • The position of all relays at the incident location as per Appendix 000B • The aspect(s) displayed by the last signal passed by the train(s) involved in the incident. • In the case of a CROR Stop Signal violation, all of the above information must be obtained at the last approach signal location passed by the train as well as the violation location. • Compile any additional information requested by Metrolinx and the Metrolinx authorized S&C Supervisory Officer.

NOTE: In addition, refer to Metrolinx Investigating Signal Related Incidents, Failures and Interruptions Protocol.

13. Investigation

13.1. Further to the initial investigation, the Metrolinx designated S&C Supervisory Officer must:

- Record all pertinent information leading up to the incident. This should include train movements immediately preceding the incident, previously identical train movements, times, train numbers, crews, weather, visibility and remarks and observations of Railway personnel relating to the incident.
- Compile the information as stipulated in Appendix - 000B.
- Advise the on duty Metrolinx designated S&C Supervisor and S&C Technician at the control center to compile all pertinent data required at the control office as stipulated in APPENDIX 000A.

- 13.2. In addition, if the incident is of unknown cause, the Metrolinx designated Supervisory S&C Supervisory Officer must:
 - a) Advise Metrolinx; and
 - b) Endeavour to duplicate the occurrence by simulating all previous conditions.
- 13.3. If the occurrence cannot be duplicated, perform all tests necessary to check the integrity of the system. A record of such tests should be retained.
- 13.4. If, after having exhausted all means at their disposal to determine the cause of the incident, the investigating officer is unable to determine the cause, Metrolinx shall be advised immediately. Further tests will then be carried out under the direction of Metrolinx.

14. Negligence

- 14.1. If there is any evidence of negligence on the part of the S&C personnel having been a contributing factor to the incident, formal statements must be taken without delay. Any indication of negligence on the part of any other Engineering or Transportation personnel must be reported to Metrolinx.

15. Repairs

- 15.1. Repairs may commence after consultation with Metrolinx and when instructed by the responsible Metrolinx authorized Supervisory Officer. Repairs must be made in accordance with [GI-301\(i\) Protecting Train Operation During Signal System Interruption](#).
- 15.2. All temporary repairs must be authorized by Metrolinx and the responsible Supervisory Officer.

- 15.3. System or equipment repairs shall NOT be made until the following:
- a) It is known that the damage was a result of the incident, or
 - b) Tests are conducted to determine what effect the damage would have had on the normal operation of the system if the damage had occurred prior to the incident.
- 15.4. EXCEPTION: Failing exceptional circumstances or the need to ensure the health and well-being of passengers and employees, S&C personnel shall never remove or move any S&C equipment or material involved in a train incident from the accident site, unless first authorized by Metrolinx and the responsible Supervisory Officer.

16. Defective Equipment

- 16.1. S&C equipment that is suspect or found to be defective must be replaced and tagged as described in [GI-301\(j\) Replacing and Tagging Defective In-Service Equipment](#). The equipment must also be held in a secure location for possible further tests by Metrolinx or as potential evidence.
- 16.2. If it is not possible to transport the equipment without disturbing a particular state of the equipment, it should be moved as little as possible and only to the extent of placing it in a protected environment.

17. Operating Tests

- 17.1. Whenever an installation has been disarranged, complete Metrolinx authorized operating tests must be performed to ensure safe operation before restoring the system to service.
- 17.2. Contact Metrolinx who will arrange for operating tests as outlined in [GI-301\(b\) Installation & Commissioning Tests](#).

18. Final Incident Reports

- 18.1. The Metrolinx designated S&C Supervisory Officer shall submit a report in letter form to Metrolinx.
- 18.2. This report should be supported by:
 - a) All pertinent information.
 - b) A copy of any operating tests performed on the system.
- 18.3. All information to be marked and headed:
 - a) "FOR THE INFORMATION OF THE COMPANY'S SOLICITORS AND THEIR ADVICE THEREON"
- 18.4. The complete report shall be forwarded as follows:
 - a) Original and one (1) copy to Metrolinx.
- 18.5. Interim verbal reports are to be provided as may be required, and in all instances the proper Metrolinx Officers must be kept advised of the situation.
- 18.6. Although incident cause information is time sensitive, it must never be reported on the basis of supposition alone.

19. Accident/ Incident Investigation Protocol

- 19.1. All accidents or incidents do not represent the same potential for loss. The "Railway Accident/Incident Response, Procedure No.: RC-0401001", provides a means to evaluate the potential loss of an accident or incident and to prevent similar recurrences. Refer to this procedure to obtain the evaluation criteria and investigation requirements.

005 - Rail Bonding and Track Connections

1. Introduction

- 1.1. This Code of Practice provides instructions on the proper, and safe application of the approved methods of Rail Bonding and Track Connections.
- 1.2. Rail bonds are used for the connection of electrical circuits from one rail to the next, the three types used are:
 - a) Stanley Pin Brazing bonds.
 - b) Plug type or mechanical bonds.
 - c) Exothermic or welded bonds. While not recommended for any new rail bonding or track connections, they are referenced in this document for removal, or reuse if they are still intact and in acceptable condition.
- 1.3. Track connections differ from rail bonds in the fact they connect the inside signal equipment to the outside railway track via underground track wire, S-8 Bond Strand wire, junction boxes, and are used for:
 - a) Signal and Crossing track circuits and connections.
 - b) Shunt and series fouling circuits.
 - c) Ground connections at flammable liquids or gases installations.
- 1.4. Strict adherence to these instructions on rail bonding and track connections will provide the most effective means of ensuring no damage is done to the rail when applying or removing these track connections.

2. Preferred Method of Bonding and Track Connections

- 2.1. The preferred method of rail bonding and track connections to be used on Metrolinx is the Stanley® Pin Brazing technology. Use of methods b & c in section 1.2 above are subject to Metrolinx approval.

3. Definitions

- 3.1. Plug type or mechanical connections are the first and oldest method for making rail connections. A mechanical connection is made when a hole is drilled in the rail and a metal plug with a wire attached is driven into the rail to complete the electrical connection.
- 3.2. Exothermic or welded connections (Cadwelds) is the term applied to any technology which requires the application of heat to weld or braze the connection wires to the rail.
- 3.3. Stanley Pin Brazing is the latest, and preferred technology for making rail connections. Strictly speaking, the Stanley® Pin Brazing technology is an electronically controlled brazing process; however, some minor exothermic reaction does occur with its application.
- 3.4. Neutral Axis of the rail is an invisible line through the cross-section of the rail, where half of the cross-sectional area is above the line, and half is below the line. On the neutral axis internal rail compressive and tensile stresses are in balance so the effects of vertical bending are essentially eliminated.

4. Martensite

- 4.1. Exothermic bonding generates extremely high heat which can cause martensite, a glass-like substance, to penetrate the steel. This problem becomes more pronounced with successive applications of heat, such as re-bonding in the same position, grinding, or thermite welding, etc.

5. Neutral Axis of Rail

- 5.1. When bonds or track connections of any type are installed on the web of the rail, they must be installed as close as possible to the neutral axis of the rail.

6. Rail Web vs. Rail Head Bonding

- 6.1. Even though it would seem preferable that bonding connections be restricted to the neutral axis of the rail web since this point is considered to be a lower stress area, rail head bonding is recommended at bolted rail joints as this provides for more thorough broken rail detection.

7. Restrictions

- 7.1. Under NO circumstances is ANY TYPE OF RAIL CONNECTION to be performed on:
- a) the base of the rail.
 - b) to the head of a rail outside the confines of a joint bar.
 - c) to the spring wing of a spring rail frog (refer to Figure 005-12).
- 7.2. Never chisel old exothermic weld nuggets from the rail, this will produce micro-fractures in the rail. There is no need to arbitrarily remove exothermic weld nuggets from the rail, just leave them in place. If they MUST be removed, always remove them with an electric grinder or a quick rail cut saw.
- 7.3. Arc welded (Tiger) and oxyacetylene or other gas welded bonds SHALL NOT be used.
- 7.4. The use of bonds around a joint where the bond is greater than five (5) inches is prohibited.

8. Do's and Do not's

- 8.1. Always remember these Do's and Do not's when applying or removing any method of bonding or track connections.

8.2. Do:

- a) be completely familiar with the technology you intend to use, and strictly adhere to this SCP and the manufacturer's instructions.
- b) ensure you are properly dressed and equipped with the required personal protection equipment (PPE). Examples include wearing cotton or woolen garments as most synthetic fabrics melt rather than char when exposed to flame, causing severe burns. Protective footwear with non-slip soles, head protection, hearing protection, eye and face protection, leather gloves, and other clothing and equipment required for this work.
- c) ensure the work area is well ventilated. Avoid breathing the smoke of the Stanley pin brazing reaction by positioning yourself upwind.
- d) be certain that you can achieve good footing in the working area where the connection is being made.
- e) check that all equipment is in good condition.
- f) for the Stanley® Pin Brazing technology, perform the gun calibration test with the lift height adjustment tool prior to beginning each bonding session.
- g) ensure the grinding wheel used is in accordance with the manufacturer recommendations.
- h) ensure the rail surface, and bond to be applied, are clean, dry, and free of contaminants such as grease, oxidation, millscale or rust.
- i) consult the diagrams on the following pages to ensure the right track connection is used and that it is applied correctly.
- j) apply web connections at the neutral axis of the rail.
- k) re-use, if possible, existing Plug type, Cadweld, or Stanley pin brazed bonds or track connections. This can be accomplished by means of crimp sleeves or splices.

8.3. Do not:

- a) be under the influence of any alcohol, drugs, other medications, or chemicals that would impair your judgment.
- b) be unfamiliar with use of the technology you intend to use. If you are not familiar with the use of these technologies, **DO NOT APPLY ANY BONDS OR TRACK CONNECTIONS**, you must advise your Supervisor to schedule a training session for you immediately.
- c) chisel off old Cadweld nuggets or Stanley pin brazed connections. Instead, remove them according to Section 10 for Cadwelds or Section 13.7 for Stanley pin brazed connections below.
- d) under any circumstances, make ANY connections to the base of the rail, or to the head of the rail outside the confines of a joint bar, or to the spring wing of a spring rail frog, refer to Figure 005-11.

9. Re-using Cadweld or Stanley Pin Brazed Connections

- 9.1. Whenever possible, and if the lug and connection wire are in acceptable condition, it is preferable to re-use these existing connections by means of a crimp sleeve or splice.
- 9.2. When a connection is no longer needed it should be left in place.

10. Removing Cadweld Nuggets

- 10.1. If it is necessary to remove an old Cadweld nugget on a rail, it must be removed using one of the following approved methods:
- a) Grind off with a 4" electric grinder;
 - b) Grind off with an electric grinder with an 8" x 1" x 1" or 8" x 1/8" x 1" wheel; or
 - c) Cautiously cut the weld off with a 12" quick cut saw, then grind to a smooth finish.

11. Installation of Plug Type Connectors

- 11.1. Installation of Plug type connectors is subject to Metrolinx approval.
- 11.2. Holes must be drilled in the web of the rail as close as possible to the neutral axis of the rail.
- 11.3. A 3/8-inch diameter bonding drill bit must be used. Where the rail is extremely hard, drill bits of a cobalt alloy which are harder than the steel rail, can be used. This hole must be drilled at least 1-1/2 inches, but not more than 2-1/2 inches from the end of the angle bar.
- 11.4. Holes must be drilled in the rail from the same side that the plug type connectors are to be installed from, and at right angle to the rail.
- 11.5. When two holes are needed, or where a new hole must be drilled close to an old hole, they must be at least 1-1/2 inches away from each other.
- 11.6. Do not use water on a drill bit when drilling a hole in the rail as the hole will become contaminated and corrosion could occur. Cutting oil may be used to reduce overheating the drill bit.
- 11.7. After drilling the hole, drive a bond removal punch such as Snap-on # PPC210A or an approved equivalent into the hole to dress it and remove sharp edges, remove the punch, and then plug the connector in.

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- 11.8. Plug type connectors must be driven in straight and be rigidly attached to the rail. Using a 3 lb. bonding hammer, strike the plug type connector until there is a distinct ringing sound indicating that the bond is securely set in the rail.
- 11.9. DO NOT drive the plug type connector too far into the rail. If the plug type connector is driven to the shoulders of the connector it is an indication that the hole is oversized or worn. Replace the drill bit and start again with a new hole.
- 11.10. Plug type connectors should be installed immediately after the hole is drilled. If it is not practical to install the bonds on the same day as they are drilled, fill the holes with grease or, preferably, an antioxidant such as "Burndy Penetrox A" to prevent rust.
- 11.11. In general, plug type connectors should not be installed in inclement weather. If, however it becomes necessary to install a plug type connector in such weather, extreme caution shall be taken to ensure that there is no moisture in the hole, or on the connector pin when installed. To accomplish this, use a small propane torch to dry both the hole and plug type connector thoroughly and then install immediately.
- 11.12. When re-using a hole previously drilled in the rail, the hole must be thoroughly cleaned before the plug type connector is installed. There must not be dirt or moisture in the hole, or on that portion of the plug type connector which enters the hole. Clean and dry the plug type connector, if needed due moisture, use a small propane torch to dry both the hole and plug type connector thoroughly, and then install the connector immediately.
- 11.13. Use a Snap-on PPC210A or approved equivalent starter punch and a hammer to punch out and remove old plug type connectors.



12. Installation of Stanley Pin Brazed Type Connections

12.1. The Stanley Pin Brazing package currently recommended for use on Metrolinx is Stanley Package Pin Brazing Package 41230, which includes the following in Table 005-01:

Table 005-01

Stanley Pin Brazing Package - 41230 Includes:	
Part Number	Description
EP30200	Pin Brazing Unit
BG10100	Pin Brazing Gun
40409	(3) EP30 Batteries
HGE11342	Cordless Grinder
72797	Battery Charger (Grinder)
72798	Lithium Ion Battery
47320	Inverter
35808	Carbide Burr
35812	Carrying Case
35818	Extension Cable for Gun
35819	Extension Cable for Earth Cable

12.2. The Stanley Pin Brazing System uses a special brazing pin with silver solder that has a melting temperature of 1,200 deg F (650 deg C) which is electrically melted down in the cable lug hole, and this creates a brazed silver connection between the cable wire and the rail.

12.3. Where there is a concern that the battery for the Stanley Cordless Grinder HGE11342 will not provide enough capacity for connections to be made, use a gas-powered portable grinder with the appropriate grinding wheel. Note, use only grinding wheels furnished by Stanley, other wheels have shown to leave residues which cause faulty brazing. Keep the grinding wheel clean and free from oil etc. This will be important where there are a lot of bonds to install, and/or where the rail is badly lipped.

12.4. Although permitted, it is not recommended to apply Stanley Pin Brazing connections in excessively cold weather conditions, without taking extra precautions. Because a very cold rail would act as a heat sink and conduct heat away from the melted bond metal very quickly, and possibly reducing adhesion to the rail. To install connections at outside temperatures below -20°C (0°F) you must gently heat the application area with a small propane torch prior to bonding.

12.5. Pin Brazing Procedure

- a) Make sure the battery is fully charged before starting.
- b) Connect the brazing gun power and trigger cables to the unit.
- c) Connect the grounding device cable to the unit. The grounding device will be either a magnet or a modified Vise-grip type of clamp, depending on the equipment supplied.
- d) Grind the brazing and grounding area until you have an even and clean surface. The lip of old, worn rail should be removed where this will interfere with the correct mounting of the rail head bond.
- e) If applying the bond to the rail web where branding (raised lettering) is present, the letters must be ground away taking care not to grind below the rail profile. The ground area should appear to be flat with the normal rail web surface.
- f) Apply only light pressure to the grinding wheel so it will not overheat the rail metal. The grinder should be kept moving so it will not remain on one spot on the rail web or head. Overheating the rail metal can cause the formation of martensite which is very brittle and can lead to cracking and eventual failure of the rail.
- g) Do not mark the rail with a crayon or other residue producing device on the area where a bond is to be applied.

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- h) Attach the grounding clamp on the same rail and on the same side of a rail joint where the pin brazing will be done. Try to attach the grounding clamp within about 1.5 ft (0.5m) from brazing area. The clamp can be attached to the base of the rail. Some of the earlier systems may have been supplied with a grounding magnet rather than a grounding clamp, however these grounding magnets are not recommended because the electrical contact to the rail is not as good.
- i) Adjust the switch for the right pin type; the power will automatically be switched on. Refer to Table 005-02.

Table 005-02

Brazing Pin Type	Adjustment	Notes
8 mm standard	P1	Used for most bonding
8 mm extra silver / threaded	P2	Special Use
9.5 mm	P3	Special Use

- j) Check that the red low-battery light is not on.
- k) Insert a pin holder into the gun if not already installed.
- l) Load the gun with the brazing pin and ceramic ferrule. Make sure you are using correct ferrule and brazing pin.
- m) Make sure to Pin braise in the top of the hole of the bond or cable lug when brazing to a vertical surface.
- n) Carefully press the gun with the ferrule and the brazing pin to the correct location on the rail. Position the gun carefully at the neutral axis of the rail for web bonds, or at the center of the side of the rail head for head bonds. See table above for measurement of the neutral axis of the rail above the bottom of the rail base.



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- o) For the BG10100 Automatic gun, set the wheel in position "0" at the back of the gun. The gun will automatically adjust the right lift level every time you braze.
- p) Hold the gun firmly with both hands and pull the trigger just once. The electronics will finish the brazing process by itself. Be careful not to look at the light flash during the brazing.
- q) After the brazing, hold the gun in place for 3-4 seconds while the braze cools and solidifies.
- r) Remove the gun straight backwards without pulling the trigger.
- s) Knock off the shank of the brazing pin with a hammer.
- t) The brazing is completed. Visually inspect the brazed connection.
- u) Switch off the unit after use. Battery life can be reduced if allowed to become completely discharged. Note: A red light indicates low batteries on the unit, charge them as soon as possible.

12.6. Stanley Pin Braze Products List

For the Stanley Pin Braze products list, with Stanley part number, please refer to the product manuals, or their website.

12.7. Removal of Pin Brazed Connections

- a) Arbitrary removal of the old pin brazed connections is not necessary. Cut off the wire and only remove the rail connection when deemed necessary.
- b) When pin brazed connections must be removed from the rail, do not use a hammer and cold chisel.
- c) They should be removed with a handheld power grinder or a handheld abrasive rail cut-off saw. The connection must be completely removed until only the parent steel material of the rail head remains, and



no burrs or upset metal (metal raised up from the rail surface) are left behind. Avoid removing and/or nicking the parent steel material of the rail i.e. the rail surface must be smooth.

12.8. Bonding of Compromise Joints

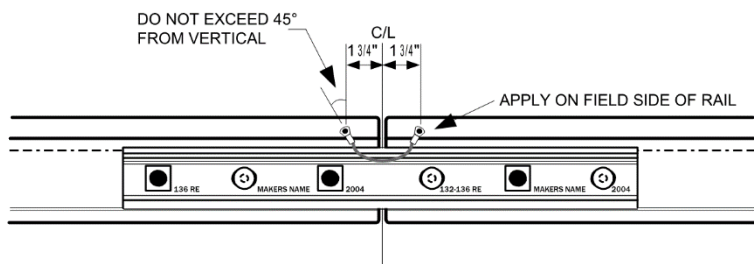
The recommended ways of bonding compromise joints to the rail are:

- a) Using the Stanley Pin-brazing as shown in Section 14.2 Figure 005-02.
- b) Long plug type bonds must not be used to completely bypass the compromise joint without permission from Metrolinx.
- c) Only the field side compromise joint bar shall be bonded to the rail.
- d) The Stanley bond for use with compromise joint bars is Stanley part 35844 with a length of 5-3/4".
- e) The Stanley bond is installed on the side of the joint bar at the same location as a plug type bonding hole would be drilled.
- f) This section also applies where regular (not compromise) joint bars must be bonded at each end to the web of the rail. This might be required in non-signalled territory, or where there is jointed rail and where the head of the rail is so worn that it is not possible to attach a rail head bond.

13. Placement of Head Bonds - Bolted Rail Joints

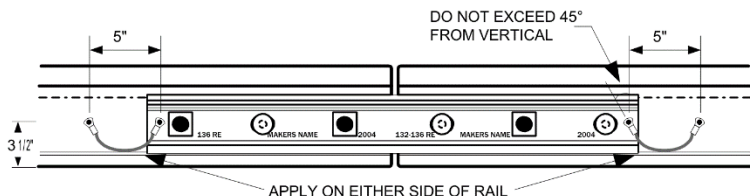
- 13.1. Figure 005-1 illustrates the preferred method of placing a 5 $\frac{3}{4}$ " pin brazing head bond at a non-insulated bolted rail joint.

Figure 005-1



- 13.2. Figure 005-2 illustrates the alternate method of placing 5 $\frac{3}{4}$ " pin brazing head bonds at a compromise non-insulated bolted rail joint bar on standard rail, or where the rail head is too worn to install a head bond.

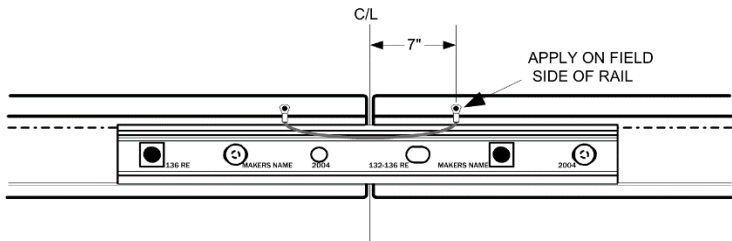
Figure 005-2



14. Placement of Head Bonds - Temporary Rail Joints

- 14.1. Figure 005-3 illustrates the preferred method of placing 16" pin brazing head bonds at temporary rail joints scheduled to be thermite or flash butt welded.

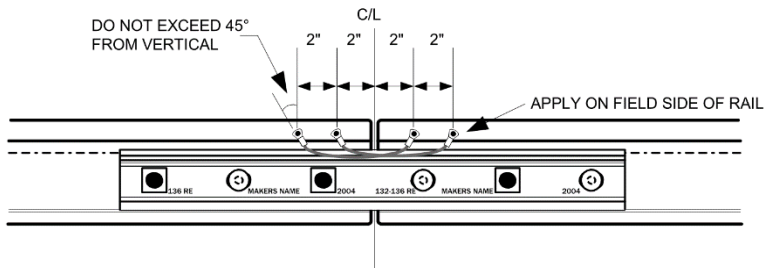
Figure 005-3



15. Placement of Head Bonds - Fouling Circuits

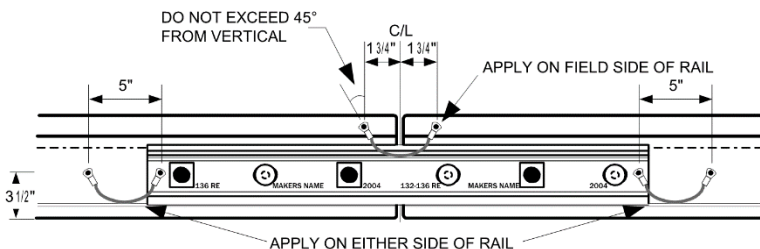
15.1. Figure 005-4 illustrates the preferred method of placing 8" pin brazing head bonds at bolted rail joints inside fouling circuits.

Figure 005-4



15.2. Figure 005-5 illustrates the alternate method of placing 5 3/4" pin brazing head bonds at bolted rail joints inside fouling circuits.

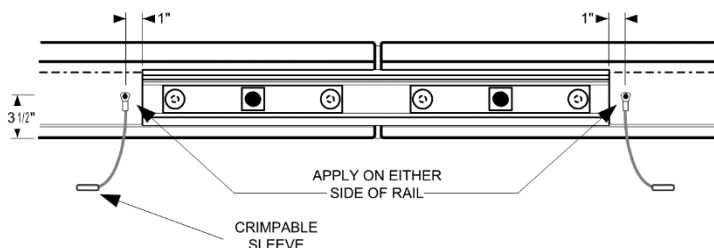
Figure 005-5



16. Placement of Track Connections - Insulated Rail Joints

16.1. Figure 005-6 illustrates the preferred method of placing 5" pin brazing track connections at insulated joints.

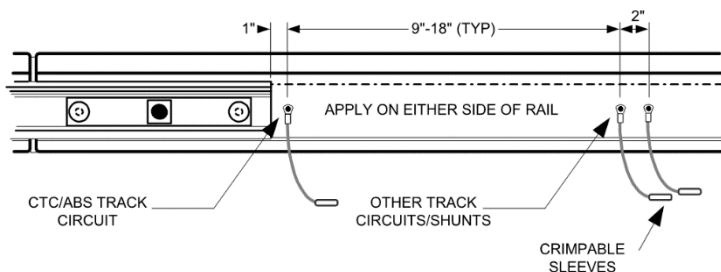
Figure 005-6



17. Placement of Multiple Track Connections - Insulated Rail Joints

17.1. Figure 005-7 illustrates the preferred method of placing multiple 5" pin brazing track connections at insulated joints.

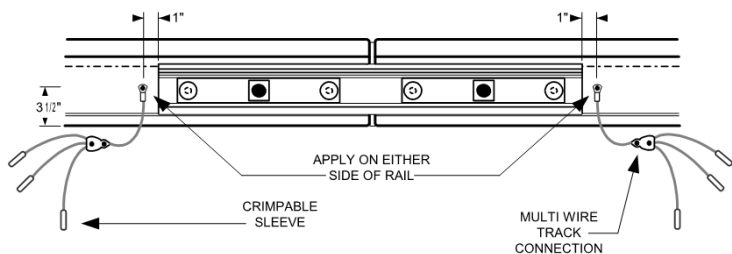
Figure 005-7



17.2. It is acceptable to bond on opposite sides of the rail, however a minimum 1" horizontal offset must be maintained between opposing connections.

17.3. Figure 005-8 illustrates the alternate method of placing multiple 5" pin brazing track connections at insulated joints. Recommend not to use this arrangement but make this connection in the bootleg.

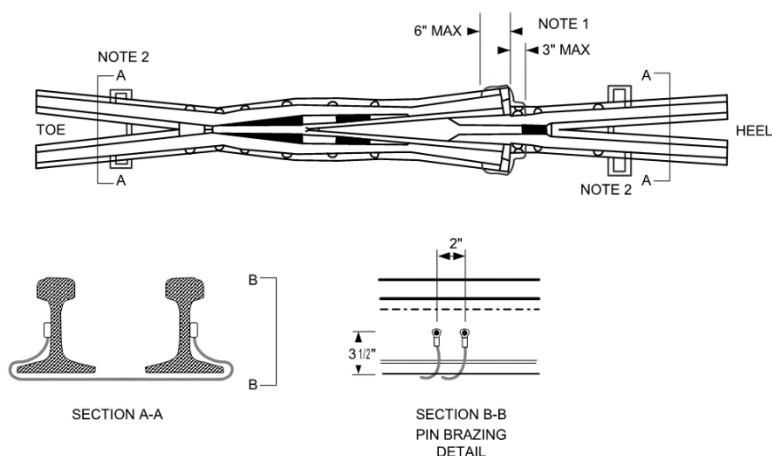
Figure 005-8



18. Placement of Switch Bonds - RBM Frog

18.1. Figure 005-9 illustrates the method of placing multiple switch bonds at rail bound manganese (RBM) frogs.

Figure 005-9



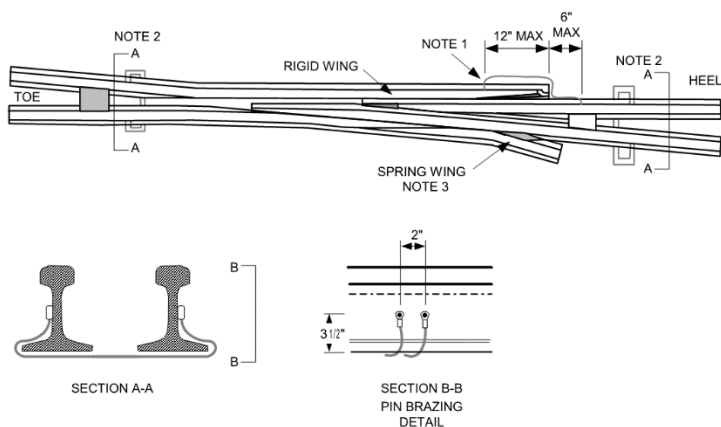
NOTE:

- Apply track connections to web of rail and crimp to short piece of 3/16" bond strand.
- Apply as close as possible to heel and toe filler blocks.

20. Placement of Switch Bonds - Spring Rail Frog

20.1. Figure 005-11 illustrates the method of placing multiple switch bonds at spring rail frogs.

Figure 005-11



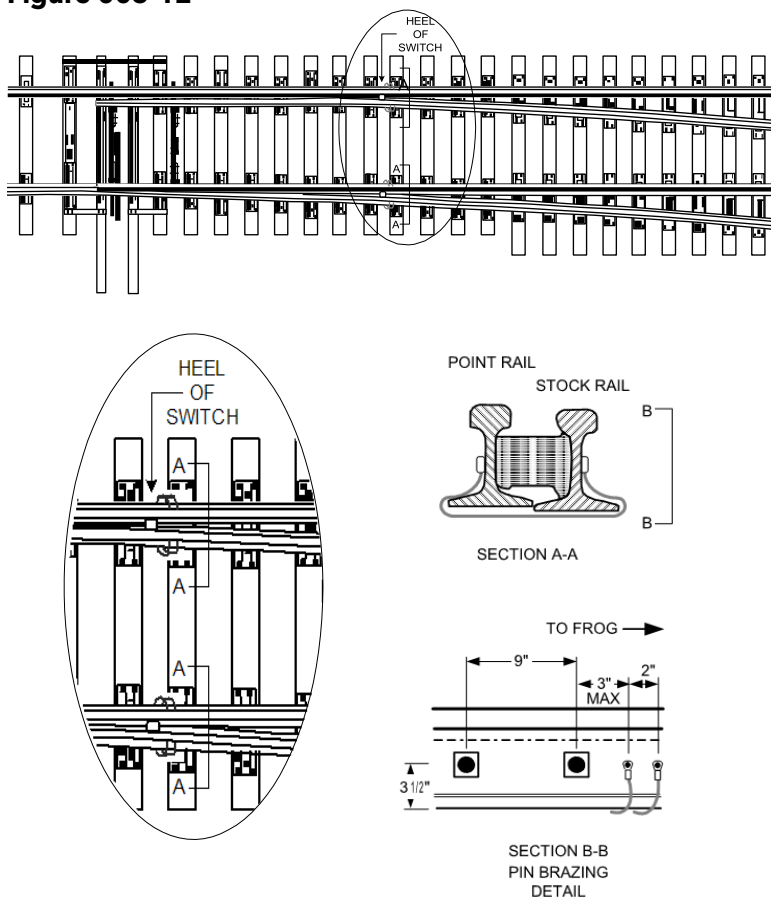
NOTE:

1. Apply track connections to web of rail and crimp to short piece of 3/16" bond strand.
2. Apply as close as possible to heel and toe filler blocks.
3. Never apply track connections to the spring wing.

21. Placement of Switch Bonds - Floating Heel Block

21.1. Figure 005-12 illustrates the method of placing multiple switch bonds at floating heel blocks.

Figure 005-12



007 - Bootlegs and Bond Strand

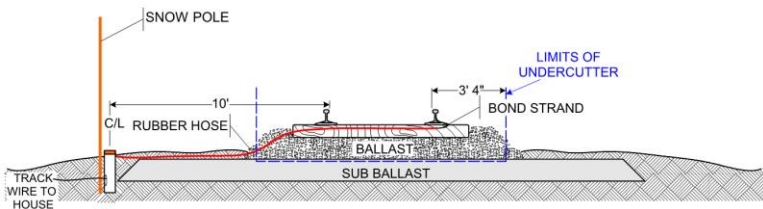
1. Purpose

- 1.1. These instructions are the prescribed methods of installing bootlegs, bond strand and ancillary hardware such as retainer clips, staples, and hoses.
- 1.2. For the safe application of track connections to the rail, refer to [SCP-005 Rail Bonding and Track Connections](#).

2. Bootlegs

- 2.1. Bootlegs are used to house the transition and connections from underground track wire to bond strand. Typically, underground track wire is comprised of #6 twisted pair copper cable which is rated for direct burial. Bond strand, which provides much more flexibility, is comprised of 3/16" (S-8) cadmium bronze wire and is not suitable for direct burial. The bond strand is protected by 5/8" ID rubber hose between the bootleg and rails, as an alternate, 1/2" liquid tight conduit can be used for this purpose.
- 2.2. Where bootlegs are used, they shall be placed at a sufficient distance from the gauge of rail to prevent interference with track maintenance equipment, typically between 8' to 10' from gauge. The bootleg shall be buried to allow only the metal cap to protrude above ground level and shall be marked with a snow pole. Figure 007-1 provides a typical cross section of a bootleg installation.

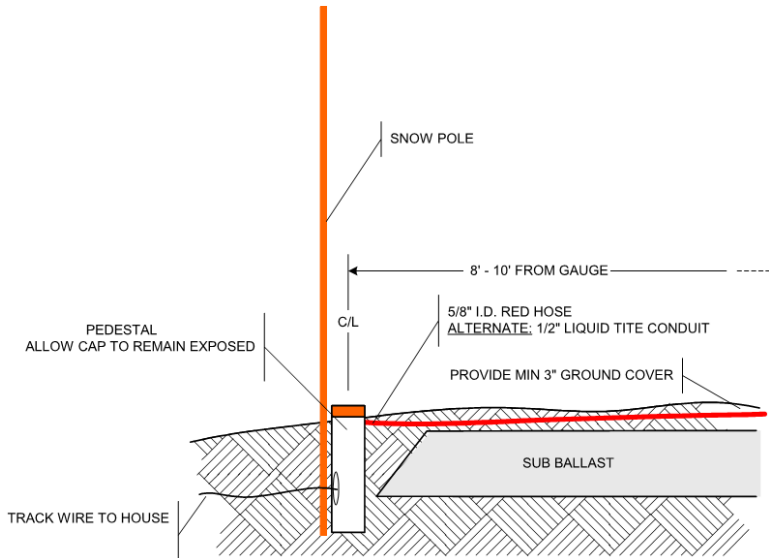
Figure 007-1



3. GO Transit Pedestal (Bootleg Riser)

- 3.1. The GO Transit standard bootleg riser, or pedestal, is designed to accommodate the 4 track leads normally associated with a typical insulated joint location. Always ensure that the bond strand hoses leading to the pedestal are covered with about 3" of ground cover to reduce tripping hazards.
- 3.2. The hose enclosed bond strand wires enter through 4 brass nipples located 3" from the top of the riser. A removable orange metal cap on the top of the riser provides ready access. Figure 007-2: PEDESTAL - BURIAL DETAILS provides additional detail on how to bury the pedestal and hoses.
- 3.3. The use of a snow pole is recommended to provide a visual marker to reduce the risk of damage by equipment.

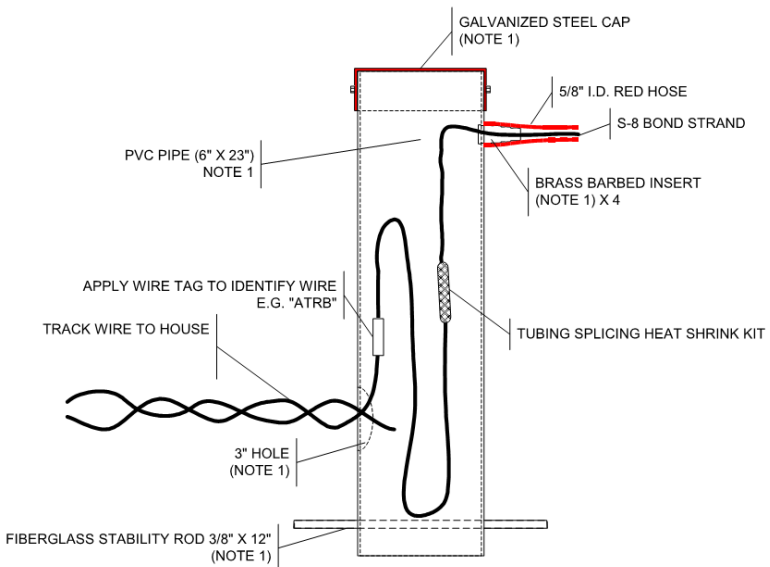
Figure 007-2: PEDESTAL - BURIAL DETAILS



4. Pedestal Wiring Detail

- 4.1. Each bond strand enters the pedestal through one of 4 nipples located 3" from the top of the pedestal. The end of the hose can either be directly coupled to the brass nipple, or in areas prone to damage, each nipple can be removed and the hose extended 2-3" through the hole (which must be reamed to the outside diameter of the hose).
- 4.2. The bond strand is spliced to the track wire, which is labeled with the same nomenclature as used in the case or bungalow. Sufficient slack must be left in the pedestal to allow for ready maintenance. The pedestal wiring details are shown in Figure 007-3: PEDESTAL WIRING DETAIL.

Figure 007-3: PEDESTAL WIRING DETAIL



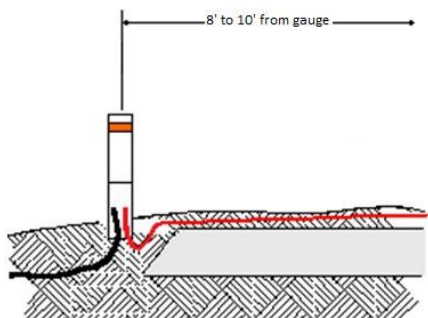
5. GO Transit High Pedestal (Preferred Bootleg Riser)

- 5.1. The preferred GO Transit standard High bootleg riser, or pedestal, is designed to accommodate the 4 track leads

normally associated with a typical insulated joint location. Always ensure that the bond strand hoses leading to the pedestal are covered with about 3" of ground cover to reduce tripping hazards.

- 5.2. The track wires from the Bungalow or case enter through a hole on the bottom end of the riser. Do not coil track wires when laying, especially in the case of AC track circuits. If slack is required, this should be done by laying the wires in an "S" formation.
- 5.3. The four track wires in the 5/8 I.D. rubber hose will also enter the bottom of the high pedestal. Ensure the radii of the curve are sufficient to prevent damage to hose and conductors. The hose shall be rise up a minimum of 6" into the riser. Figure 007-4: HIGH PEDESTAL WIRING INSTALLATION provides additional detail on how to bury the pedestal and hoses.
- 5.4. Each track wire will be identified with an indelible label as per [SCP-1007 Equipment Housing and Apparatus Wiring Standard](#).
- 5.5. The use of a snow pole is optional with the high pedestal as the risk of damage by equipment should be minimized.

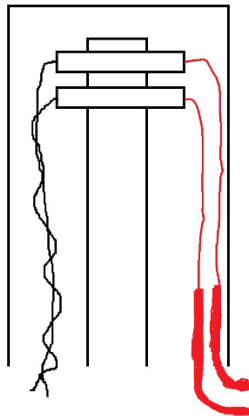
Figure 007-4: HIGH PEDESTAL WIRING INSTALLATION



6. High Pedestal Wiring Detail

- 6.1. Both the bond strand and track wires will enter the pedestal through the side hole near the bottom of the pedestal; the red hose will rise 6" into the lower portion of the pedestal; the bond strand and track wires will be taken to the top of the pedestal and have sufficient slack.
- 6.2. The track wires will be installed on the left side of the terminal block and the bond strand will be installed to the right. The positive side of the track circuits will be attached to the upper most terminal strip for each track circuit. Care must be taken to ensure that the correct nomenclature is used and repeated on each wire from case to track connection. Figure 007-5: High Pedestal Wiring provides additional detail on how to install the wire and hoses.

Figure 007-5: High Pedestal Wiring

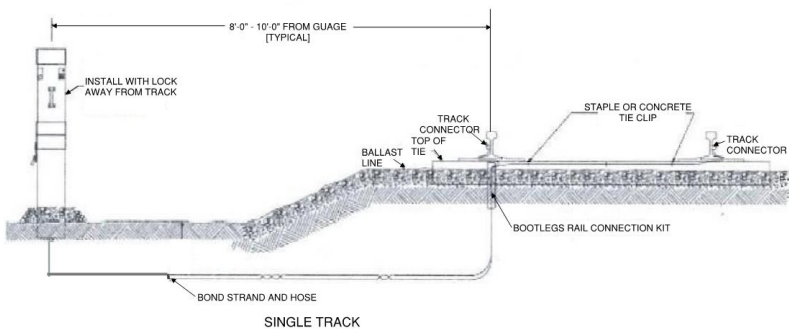


TRACK WIRE SHOWN (IN BLACK) ON LEFT SIDE OF TERMINAL STRIP.
BONDSTRAND SHOWN (IN RED) ON RIGHT SIDE OF TERMINAL STRIP.
TERMINAL HARDWARE REMOVED FOR CLARITY.

6.3. Bootleg Arrangement - Wood Ties

- 6.4. Figure 007-6: Cross Section Typical For High Pedestal Bootleg Installation provides a cross section typical view of a typical bootleg arrangement at a single track insulated joint with wood ties. Any ties to which bond strand wires are affixed should be painted bright orange to provide maximum visibility.
- 6.5. Always ensure there are no rail anchors on the same side of any tie to which the hose is fastened. Remove any offending rail anchors as necessary.

Figure 007-6: Cross Section Typical For High Pedestal Bootleg Installation



7. Track Connections – Wood Ties

- 7.1. Provides detail on how to attach the near-rail track connections for a wood tie application. It is important to ensure that bond strand is tucked neatly against the web of the rail to reduce the likelihood of being damaged by equipment.
- 7.2. Figure 007-8: Track Connections – Far Rail, Wood Tie provides detail on how to attach the far-rail track connections for a wood tie application.

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Figure 007-7: Track Connections – Near Rail, Wood Tie

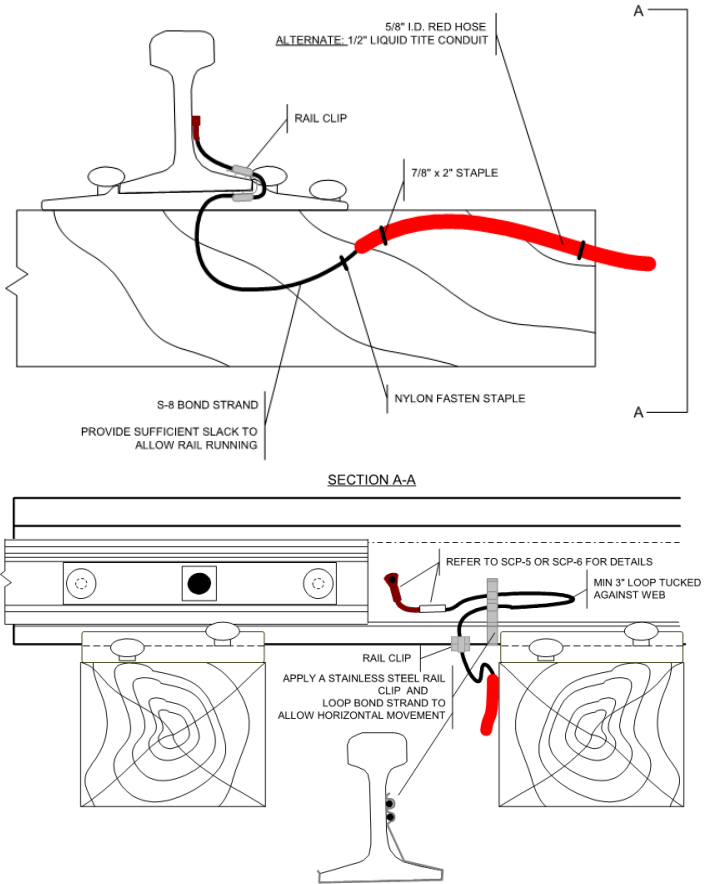
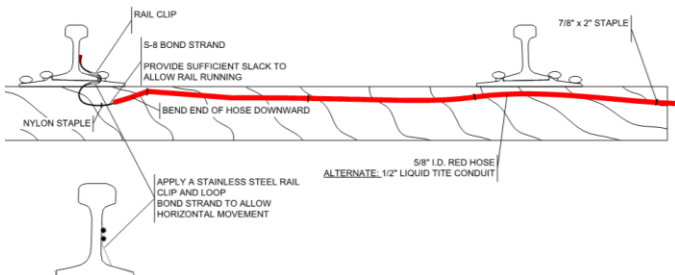


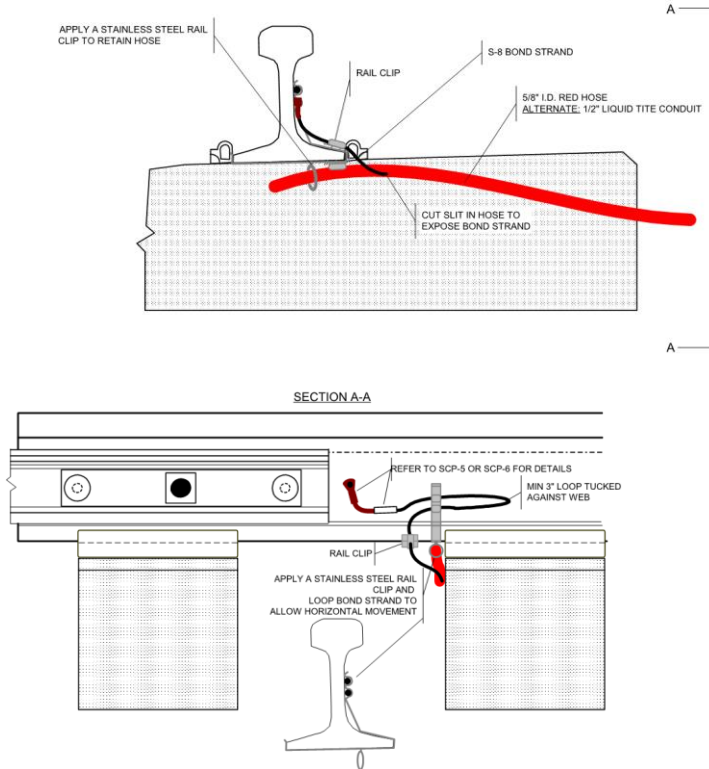
Figure 007-8: Track Connections – Far Rail, Wood Tie



8. Track Connections – Concrete Ties

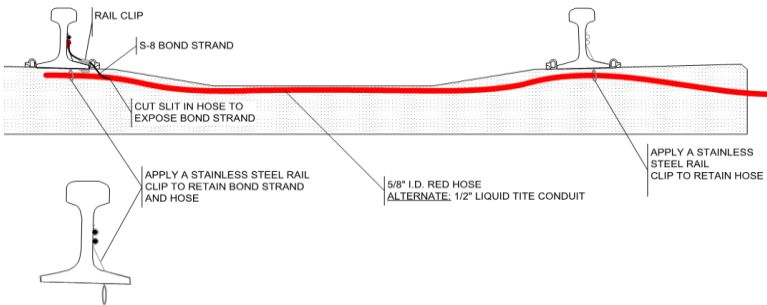
- 8.1. Figure 007-9: Track Connections – Near Rail, Concrete Tie provides detail on how to attach the near-rail track connections for a concrete tie application.

Figure 007-9: Track Connections – Near Rail, Concrete Tie



- 8.2. Figure 007-10: Track Connections – Far Rail, Concrete Tie provides detail on how to attach the far-rail track connections for a concrete tie application.

Figure 007-10: Track Connections – Far Rail, Concrete Tie



9. Use of Rail Clips

- 9.1. The use of rail clips is mandatory and are required to keep the bond strand secure from damage by ballast regulators, tampers, and brooms.
- 9.2. When installing rail connections, always ensure that sufficient slack exists to prevent the rail connection from coming apart on account of horizontal rail running or vertical pumping. This is especially true in cold weather conditions when the portion of the bond strand in ballast can freeze solid with the ballast.

10. Track Connections – Multiple Track Wires

- 10.1. In some instances, additional track connections must be applied on the same side of an insulated joint. Figure 11A illustrates an example of how to apply five separate track connections on the same side of an insulated joint. Note that two bond strand wires can be run through a single hose.
- 10.2. **IMPORTANT:** When applying connections on both sides of the rail, ensure that opposing connections are horizontally offset by a minimum of 1" from each other, while also maintaining a minimum 2" horizontal separation between connections on the same side of the rail.

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Figure 007- 11: Illustration of Five Track Connections on One Joint End

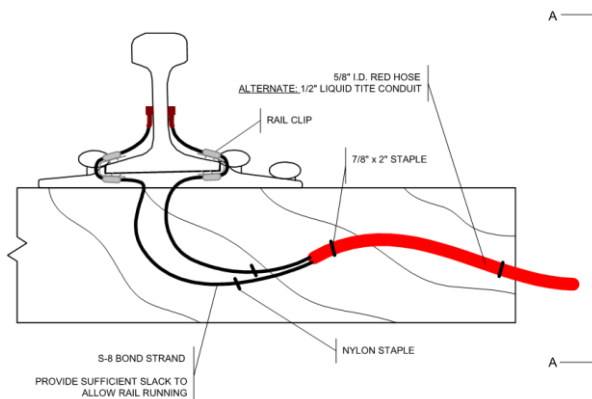


Figure 11A

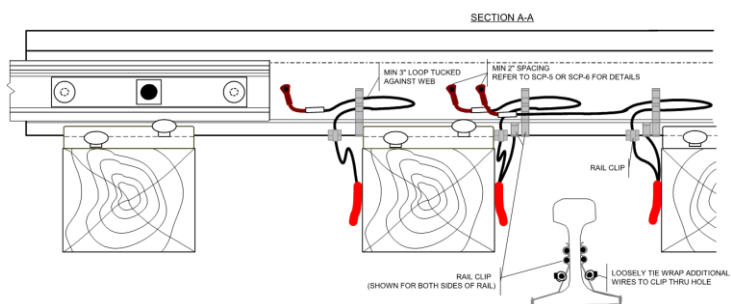


Figure 11B

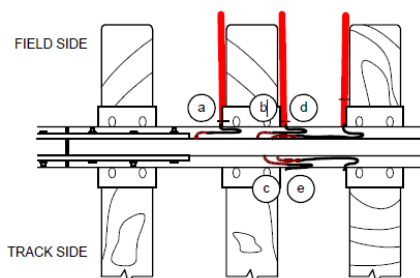
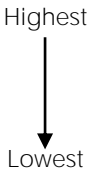


Figure 11C

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10.3. When applying multiple track connections to the same side of an insulated joint, the highest priority location is "a" - this should always be assigned to the track circuit which can detect broken rail conditions. The priorities decline in the order b, c, d, and e. Follow the standard assignment in Table 007-01 for deciding which circuit to apply at which point on the rail (referring to Figure 007-11C for rail locations).

Table 007-01

Order of Preference	Application
	CTC Track Circuit
	Wide Band Shunts
	Narrow Band Shunts
	GCP Transmit/Check Rcv
	GCP Receive
	Other

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008 - Inspection and Maintenance of Insulated Joints

1. Purpose

- 1.1. These Codes of Practice provides instructions on the prescribed methods of inspecting and maintaining insulated joints.
- 1.2. Insulated joints are used to establish the limits of a track circuit and to prevent current from flowing between adjacent ends of two adjoining rails. Their condition is essential to the integrity and reliability of track circuits.

2. Applicable Standards

- 2.1. Refer to the following applicable standards when performing insulated joint inspections:
 - a) [SCP-001 Location of Insulated Joints](#)
 - b) [GI-332 Inspecting and Testing Insulated Track Hardware - General](#)
 - c) [GO Transit Track Standard RC-0506-02TRK](#)

3. Prioritizing Repair/ Replacements

- 3.1. Identifying and prioritizing the repair or replacement of insulated joints is not trivial and requires a fair degree of professional judgment. The intent of this document is to provide the tools to assist qualified S&C personnel to make informed decisions in regard to the condition of insulated joints.

- 3.2. Insulated joints found to be defective should be categorized with the following priority codes:
- a) **Urgent:** Track circuit is expected to fail soon unless the joint is changed or repaired. Repairs or replacement should be made within 72 hours; in the meantime, a TSO or positive protection will be necessary if it is also determined that safe train operations are compromised.
 - b) **Near Urgent:** Track circuit reliability is compromised but is unlikely to fail unless a second insulated joint failure occurs. Repairs or replacement should be made within 30 days; in the meantime, the condition of the adjacent joint should be monitored regularly.
 - c) **Priority:** Track circuit reliability is not immediately compromised; however some degradation of the insulated joint has been noted. Repairs or replacement should be planned; in the meantime, the condition of the affected joint should be monitored regularly.

4. Recording Inspection Results

- 4.1. It may be helpful to record the results of each insulated joint inspection on Form [1208-A](#) for future reference. This can provide baseline values to assist in determining when degradation of the joint has occurred.
- 4.2. When insulated joints are replaced, measured electrical values for both the original and replacement joints can be recorded on Form [1208-B](#). For best results, values should be taken before and after the joints are in-track (this applies for both the original and replacement joints). It is also useful to record what defects were found with the original joint after its removal.

5. Visual Test Procedures

- 5.1. Follow these general procedures when visually inspecting an insulated joint. Refer to section "Types of Insulated Joints" for an explanation on different types of insulated joints.

- a) If rail head battering (rail overflow) is within 1/16" of making contact, arrange to have the joint slotted.
 - i. NOTE: General slotting procedures are described in paragraph "Slotting Insulated Joints" at the end of this document.
- b) Arrange to have missing or damaged end posts replaced.
- c) Arrange to have missing or broken bolts replaced. Standard "square head" track bolts are not permitted on insulated joints.
- d) For glued joints, ensure the longitudinal rail movement in the insulated bar area does not exceed 3/8".
- e) For poly-insulated joints, ensure the insulation is not worn such that bare metal of the joint bar can make contact with the rail or spike.
- f) Ensure non-insulated plates are not within 2" of the end post.
- g) Advise the Metrolinx (Track) Specialist of any of the other following track deficiencies:
 - i. Ties under joint missing or defective,
 - ii. Spikes driven against and facing toward the joint bars,
 - iii. Missing anchors in the vicinity of the joint,
 - iv. Ballast that requires tamping.
- h) Refer to Tables in section "Interpreting Test Results" for guidance on prioritizing repair or replacement of the joint.

6. Types of Insulated Joints

- 6.1. There are 4 main types of insulated joints (refer to RC-0506-02TRK):
 - a) Glued joints, "pre-bonded"
 - b) Poly-insulated joint

- c) Armor insulated
 - d) Regular
- 6.2. Of these, the two predominant types in use at Metrolinx are the glued joints (see [Figure 008-1: Glued Joints](#)) and poly-insulated (see [Figure 008-2: Poly-Insulated Joints](#)).

Figure 008-1: Glued Joints

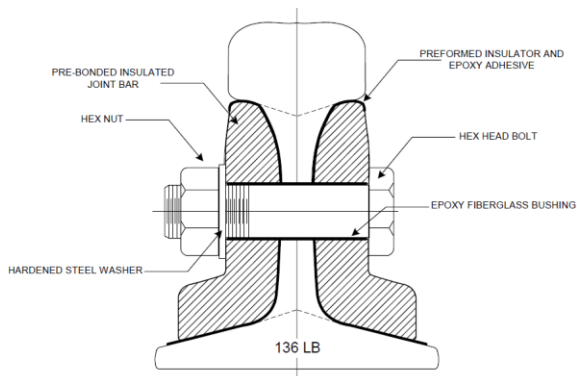
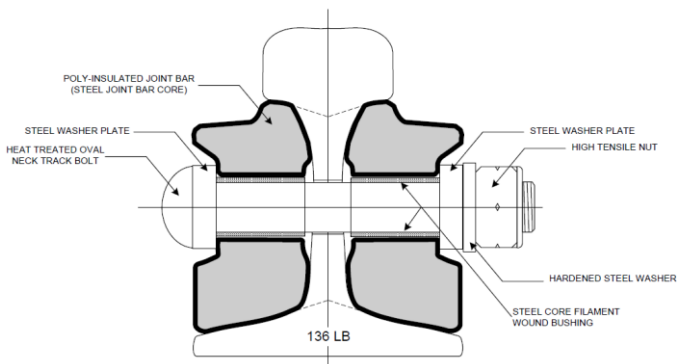


Figure 008-2: Poly-Insulated Joints



7. Electrical Test Instruments

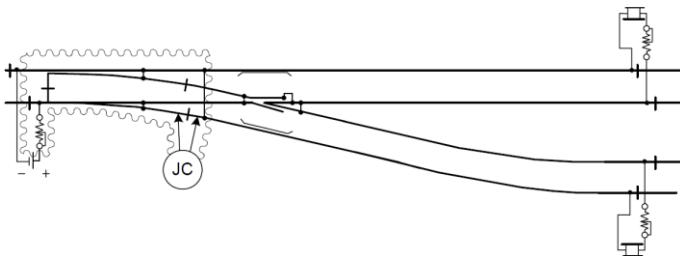
- 7.1. The following test instruments are approved for electrically testing insulated joints:
- a) S&C Distribution Model 324- preferred
 - b) Chambers Model 11-A- used on WC

- c) Harmon IJC Model 1501A – discontinued by GETS
 - d) Battery/Resistor test meter as prescribed by [GI-332\(b\) Track Hardware - Electrical](#)
- 7.2. It is critical to use professional judgment when interpreting the results of test instruments. Many perfectly good, insulated joints have been needlessly replaced in the past on account of improper interpretation. This causes needless expense to Metrolinx and undermines the credibility of S&C personnel.

8. Erroneous Readings

- 8.1. There are a number of special circumstances which can lead to erroneous results. For example, consider the joint checker placed at the turnout joint for a typical OS Track as shown in [Figure 008-3: Insulated Joint In Turnout Section of OS Track](#).

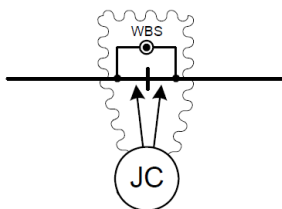
Figure 008-3: Insulated Joint In Turnout Section of OS Track



- 8.2. It can be readily seen, by the representation of the signal waveform, at low frequencies, the OS track battery will provide a path that will cause the joint checker "JC" to interpret a degraded joint. In this case, opening the battery circuit will lead to more accurate test results. It should also be obvious that each of the two track relays will have the same effect (although they may be located further away).
- 8.3. Note that the effects of these problems are greatly reduced when testing at higher frequencies, such as the 24 kHz setting on the S&C Model 324 short finder.

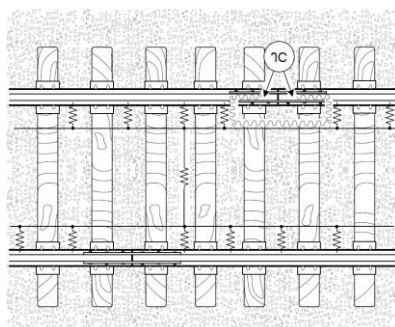
- 8.4. There are a number of special circumstances which can lead to erroneous results. For example, consider the joint checker placed at a joint having a wide band shunt as shown in [Figure 008-4: Insulated Joint With Wide Band Shunt](#):

Figure 008-4: Insulated Joint With Wide Band Shunt



- 8.5. It can be readily seen, by the representation of the signal waveform, the wide band shunt will provide a path that will cause the joint checker "JC" to interpret a degraded joint. In this case, disconnecting one side of the wide band shunt will lead to more accurate test results. It is not usually necessary to do this for narrow band shunts and IJC's when testing at 24 kHz.
- 8.6. Another condition which may lead to erroneous results is poor ballast conditions. The diagram in [Figure 008-5: Insulated Joint With Low Ballast Resistance](#) provides an illustration of how poor ballast (represented by low resistance network of resistors) can cause the joint checker "JC" to interpret a degraded joint.

Figure 008-5: Insulated Joint With Low Ballast Resistance



- 8.7. If poor ballast is suspected, determine ballast benchmarks by comparing the measured values for several insulated joints in the vicinity – if the values are all poor but close to one another, it is unlikely that any joints need replacing. However, if the measured value for one joint varies substantially from the rest, then it is probably indicative of a bad joint.
- 8.8. Other special circumstances may exist if other AC signals are present on the rail, such as audio overlay and motion sensing signals, which can cause some test equipment to erroneously detect degraded insulated joint conditions.
- 8.9. Finally, bear in mind that a single failed insulation joint may cause erroneous measurements to be seen when testing nearby joints. Arrange to replace or repair the joint with the worst reading prior to taking action on nearby joints.

9. Electrical Test Procedures

- 9.1. Follow these general procedures when electrically testing an insulated joint:
 - a) Always perform tests in dry conditions, unless troubleshooting.
 - b) Proceed to the next step if testing insulated joints in OS tracks or that are part of AC propulsion track circuits. Otherwise, use either method as prescribed by [GI-332\(b\) Track Hardware - Electrical](#). If no voltage or current changes are detected, no additional testing is required for that joint. If noticeable changes are detected, proceed to the next step.
 - c) Ensure the prescribed operating procedures for the test equipment being used are understood.
 - d) Verify that the test equipment is properly calibrated.
 - e) Ensure test probe connections are in good condition. The file type probes are recommended for providing good conductivity.

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- f) Isolate any track circuit equipment that may interfere or otherwise promote incorrect readings (refer to paragraph "Erroneous Readings").
- g) Electrically measure for conductivity between rail head and the joint bar as well as the track bolts for each side of the joint.
- h) Electrically measure for conductivity between rail heads on opposite sides of the joint.
- i) Restore all equipment that had been isolated as instructed in step f.
- j) Refer to the Tables in section "Interpreting Test Results" for guidance on prioritizing repair or replacement of the joint.

10. Interpreting Test Results

10.1. Final determination on insulated joint condition must be made by factoring the results of both visual and electrical tests. Interpretation of electrical test results should be based on the criteria in Table 008-01 below.

Table 008-01

Electrical Condition	Harmon IJC 15 Meter Scale	S&C Dist Co. 24 kHz Scale	Battery/Resistor Per GI-332(b)
Pass	Greater than 5	Less than 4	Less than 100 mA
Marginal	3 - 5	4 - 6	100 - 200 mA
Fail	Less than 3	Greater than 6	Greater than 200 mA

10.2. Once the electrical condition has been determined, proceed to assign a defect priority, if applicable, based on the type of track circuit, as described in the Table 008-02.

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Table 008-02

Inspection	Condition	Track Circuit Type - Priority Code		
		AC Propulsion	OS Track	Other
Electrical Rail Head to Joint Bar/Bolt	Marginal <i>(From Table 008-1)</i>	Near Urgent	Priority	--
	Fail <i>(From Table 008-1)</i>	Urgent	Near Urgent	Priority
Electrical Rail Head to Rail Head	Marginal <i>(From Table 008-1)</i>	Urgent	Near Urgent	Priority
	Fail <i>(From Table 008-1)</i>	Urgent	Urgent	Near Urgent
Visual (Refer to Section 5)	Battered Rail Ends	Urgent	Urgent	Near Urgent
	Missing End Post	Urgent	Urgent	Near Urgent
	Missing/Broken Bolts	Near Urgent	Near Urgent	Priority
	Glued Joint - 3/8" Long, Rail Movement	Near Urgent	Near Urgent	Priority
	Poly Joint - Worn Insulation	Near Urgent	Near Urgent	Priority
	Non-Insulated Plate within 2" of End Post	Near Urgent	Near Urgent	Priority
	Other Track Deficiencies	Priority	Priority	--

¹AC propulsion system comprised of impedance bonds, reserved for future.

11. Slotting Insulated Joints

11.1. When the slotting of an insulated joint is required, perform the following:

- a) Remove all rail end overhang.

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- b) Bevel both rails to provide a 45° bevel around the entire rail head, as shown in Figure 008-6 & Figure 008-7.
- c) Clean all filings away from the end post.
- d) Use 100% silicone to fill in the missing end post material. Additional information on slotting located in RC-0506-02TRK.

Figure 008-6: Bevel Rail Ends 45 Degrees with Slotting Joints

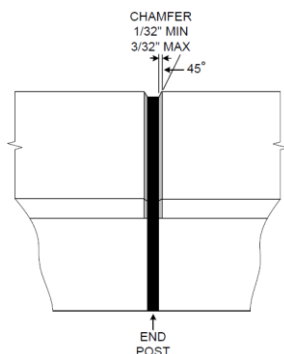
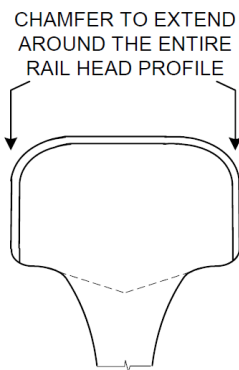


Figure 008- 7: Bevel Around Entire Head Profile



009 – Switch Point Layouts

1. Purpose

- 1.1. The purpose of this SCP is to describe the various types of switch point layouts, their part numbers, and drawing layouts on Metrolinx property.

2. SCP-009 Table Contents

- 2.1. The Tables below summarize the part numbers, description of the parts, and drawings numbers for each type of switch point layout.

Table 009-01: GTS Reference

Drawing	Drawing Title	Description
GTS-2115	M23 Layout Concrete Layout	Complete Layout, Bill of Materials for switch rods
GTS-2116	#20 Switch Rotary Assist Layout for Concrete Turnout	Complete Layout, Bill of Material for Rotary Assist and Hollow switch ties

- 2.2. Design details as mentioned related to switch rods, hollow ties for rods and rotary assist assembly shall be considered from both drawings GTS 2115 and GTS 2116 for all #20 concrete tie layouts.

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Table 009-02: SCP-9 Drawing Reference

Page	Drawing Title	Part Number	Description
1	Model M-23 Layout - Non Dapped Tie Layout Using Switch Plates	GT899183X	Entire Kit
		GT899183-001X	Panelization Kit
		GT899183-002X	Field Switch Machine Kit (New Construction)
		GT899183-003X	Field Switch Machine Kit (Maintenance)
2	Model M-23 Far Point Layout Non Dapped Tie Layout Using Switch Plates	GT899183-005X	Entire Kit
		GT899183-001-01	Panelization Kit
		GT899183-002-02	Field Switch Machine Kit (New Construction)
		GT899183-003-03	Field Switch Machine Kit (Maintenance)
3	M-23 Dapped Tie Layout	GT899052X	Entire Kit
		GT899052-001X	Entire Kit Without Tie Straps
		GT899052-002X	Entire Kit Without Tie Straps & Junction Box
4	M-23 Dapped Tie Layout Using Switch Plates	GT899154X	Entire Kit
		GT899154-001X	Panelization Kit
		GT899154-002X	Field Switch Machine Kit-(New Construction)
		GT899154-003X	Field Switch Machine Kit (Maintenance)

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Page	Drawing Title	Part Number	Description
5	M-23 Non Dapped Split Point Derail Tie Layout Using Switch Plates	GT899335X	Entire Kit
		GT899335-001X	Panelization Kit
		GT899335-002X	Field Switch Machine Kit-(New Construction)
		GT899335-003X	Field Switch machine Kit (Maintenance)
6	Alstom Model 6 Electric Switch Non Dapped Tie Layout	GT999336X	Entire Kit
		GT999336-001X	Layout Without Junction Box
7	Alstom Model 6 Electric Switch Machine Dapped Tie Layout	GT999142X	Entire Kit
		GT999142-001X	Layout Without Junction Box
8	Alstom Model 5 Non Dapped Tie Layout Using Switch Plates	GT999146X	Entire Kit
		GT999146-001X	Panelization Kit
		GT999146-002X	Field Switch Machine Kit-(New Construction)
		GT999146-003X	Field Switch Machine Kit (Maintenance)
9	Alstom Model 5 Non Dapped Far Point Tie Layout	GT999146-005X	Entire Kit
10	Alstom Model 5 Dapped Tie Layout Using Switch Plates	GT999109X	Entire Kit
		GT999109-001X	Panelization Kit
		GT999109-002X	Field Switch Machine Kit-(New Construction)
		GT999109-003X	Field Switch Machine Kit (Maintenance)

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Page	Drawing Title	Part Number	Description
11	Alstom Model 5 Dapped Tie Layout	GT999025X	Entire Kit
		GT999025-001X	Entire Kit Without Tie Straps
		GT999025-002X	Entire Kit Without Tie Straps & Junction Box
12	Alstom Model 5 Non Dapped Layout Using Switch Plates	GT999335X	Entire Kit
		GT999335-001X	Panelization Kit
		GT999335-002X	Field Switch Machine Kit-(New Construction)
		GT999335-003X	Field Switch Machine Kit (Maintenance)
13	Alstom Grandmaster Non Dapped Layout Using Switch Plates	GT999148X	Entire Kit
		GT999148-001X	Panelization Kit
		GT999148-002X	Field Switch Machine Kit-(New Construction)
		GT999148-003X	Field Switch Machine Kit (Maintenance)
14	Alstom Grandmaster Non Dapped Layout Using Switch Plates	GT999108X	Entire Kit
		GT999108-001X	Panelization Kit
		GT999108-002X	Field Switch Machine Kit-(New Construction)
		GT999108-003X	Field Switch Machine Kit (Maintenance)
15	Alstom Grandmaster Dapped Layout Using Switch Plates	GT999071X	Entire Kit

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Page	Drawing Title	Part Number	Description
16	Alstom Model Switch Layout Applied to 9B Electric Lock	GT899137- 001X	Near Point Connection
		GT899137- 002X	Far Point Connection
17	Rail Mounted Switch Circuit Controller Layout with Front Rod Assembly	899137-003X	Near Point Connection
		899137-004X	Far Point Connection
18	Rail Mounted Switch Circuit Controller Layout Without Front Rod Assembly	899137-005X	Near Point Connection
		899137-006X	Far Point Connection
19	Tie Mounted Switch Circuit Controller Layout Without Front Rod Assembly	899138-003X	Near Point Connection
		899138-004X	Far Point Connection
20	Tie Mounted Switch Circuit Controller Layout With Front Rod Assembly	899138-001X	Near Point Connection
		899138-002X	Far Point Connection

010 – Helper Rod Layouts

1. Purpose

1.1. The purpose of this SCP is to describe the various types of Helper road layouts, their part numbers, and drawing layouts on Metrolinx property.

2. SCP-010 Table Contents

2.1. The Tables below summarize the part numbers, description of the parts, drawing numbers for each type of Helper Rod layout.

Table 010-01: SCP-010 Drawing Reference

Page	Drawing Title	Part Number	Description
1	#20 Switch Rotary Helper Rod Layout	GT798021X	Entire Layout
2	#20 Switch Helper Rod Layouts Assembled Booster Rod	GT799001X-20-01	Left Hand Layout
		GT799003X-20-01	Right Hand Layout
		GT799001X-20-01	Bill of Material Left Hand Layout
		GT799003X-20-01	Bill of Material Right Hand Layout
3	#20 Switch Helper Rod Layout	GT799001X-20	Left Hand Layout
		GT799003X-20	Right Hand Layout
		GT799001X-20	Bill of Material Left Hand Layout
		GT799003X-20	Bill of Material Right Hand Layout

Continue on Next Page

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Page	Drawing Title	Part Number	Description
5	#16 Switch Helper Rod Layout Assembled Booster Rods	GT799002X-16-01	Left Hand Layout
		GT799004X-16-01	Right Hand Layout
		GT799002X-16-01	Bill of Material Left Hand Layout
		GT799004X-16-01	Bill of Material Right Hand Layout
6	#16 Switch Helper Rod Layout	GT799002X-16	Left Hand Layout
		GT799004X-16	Right Hand Layout
		GT799002X-16	Bill of Material Left Hand Layout
		GT799004X-16	Bill of Material Right Hand Layout
7	#12 Switch Helper Rod Layout	GT799001X-12	Left Hand Layout
		GT799003X-12	Right Hand Layout
		GT799001X-12	Bill of Material Left Hand Layout
		GT799003X-12	Bill of Material Right Hand Layout
8	#10 Switch Helper Rod Layout	GT799001X-10	Left Hand Layout
		GT799003X-10	Right Hand Layout
		GT799001X-10	Bill of Material Left Hand Layout
		GT799003X-10	Bill of Material Right Hand Layout

Note: Refer to both drawings GTS 2115 and GTS 2116 mentioned in SCP 009 as rotary assist assembly is provided as an integrated part of #20 concrete tie layouts.



011 – Rail Bonding and Fouling Circuits

1. Purpose

- 1.1. The purpose of this document is to define the proper location of bonds and fouling jumpers on turnouts in territories with track circuits. Fouling circuits provide shunt detection, and in many instances broken rail detection.
- 1.2. The location of fouling jumpers depends on the track circuit application required (e.g. signalled or non-signalled territory), which also determines whether track shunting only or broken rail detection can also be provided.
- 1.3. This document prescribes the location of bonds and fouling jumpers for the various types of turnouts.

2. Definitions

- 2.1. **Bonding:** A term used to describe the method of ensuring electrical continuity from one rail to the next.
- 2.2. **Fouling Circuit:** The track circuit in the fouling section of a turnout and, connected in parallel with the track circuit in the main track.
- 2.3. **Fouling Jumpers:** Fouling jumpers are used to electrically connect the lead rails in parallel with the main track rails.

3. Location of Insulated Joints

- 3.1. Refer to [SCP-001 Location of Insulated Joints](#) for recommended location of insulated joints on turnouts for various applications.

4. Bond and Track Connections

- 4.1. The type and installation criteria for bonds and track connections used for the bonding and fouling circuits shall be in accordance with [SCP-005 Rail Bonding and Track Connections](#).

5. Signal Design Schematic Drawings

- 5.1. Metrolinx authorized signal design schematic drawings are produced for a variety of track circuit layout applications. These will depict turnout fouling circuits which specify the type of fouling circuit required, for example, multiple relay type, shunt type, or series type.
- 5.2. For details on the proper location of bonding and fouling jumpers, refer to the examples provided in the Figures below.

6. Types of Fouling Circuits

- 6.1. Table 011-01 describes the various types of fouling circuits used throughout Metrolinx and their typical application.

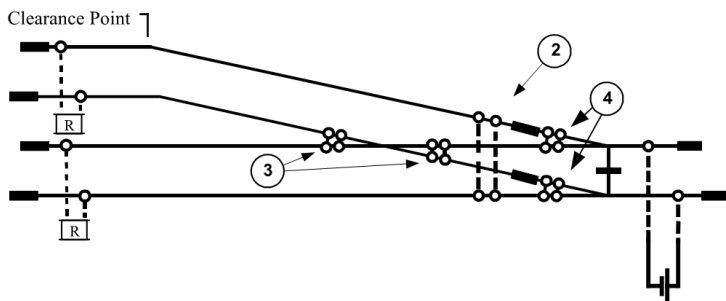
Table 011-01

Type	Description	Application	Refer to...
Multiple Relay Fouling	Fouling jumpers are arranged to connect the lead rails in parallel with the main track rail. A second relay is used to provide broken rail detection on the lead portion of the turnout.	Prescribed method used for signalled track circuits on turnouts with power operated switches.	Figure 011-1
Shunt Fouling	Fouling jumpers are arranged to connect the lead rails in parallel with the main track rail to ensure train shunt detection ONLY on the lead portion.	Crossovers and hand throw turnouts on signalled track. Turnouts within a Grade Crossing Warning System (GCWS) on non-signalled track.	Figure 011-2 Figure 011-5 Figure 011-6 Figure 011-3A Figure 011-3B
Series Fouling	Fouling jumpers are arranged to provide shunt detection and broken rail detection by connecting the lead and main track rail sections in series.	Former method used for signalled track circuits on turnouts with power operated switches.	Figure 011-4

7. Multiple Relay Fouling Circuit

7.1. Figure 011-1 depicts the bonding and fouling wire arrangement for a Multiple Relay Fouling circuit, used for signalled OS track circuits on turnouts with power-operated switches.

Figure 011-1: Multiple Relay Fouling Circuit



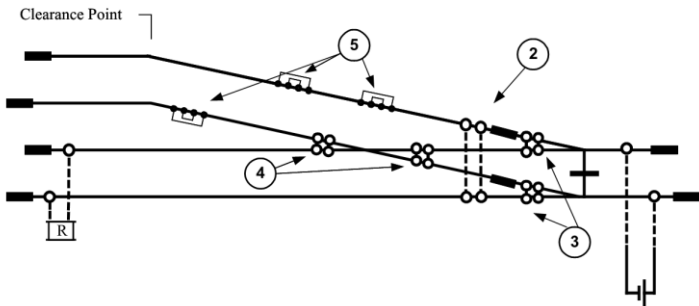
NOTES:

1. ■ Denotes insulated joints.
2. Refer to Installation of Fouling Jumpers section for installation details.
3. Refer to Frog Bonding section for installation details.
4. Refer to the Switch Point Bonding section for installation details.

8. Shunt Fouling

8.1. Figure 011-2 depicts the bonding and fouling wire arrangement for a typical Shunt Fouling circuit used on hand throw turnouts on signalled tracks.

Figure 011-2: Shunt Fouling



NOTES:

1. ■ Denotes insulated joints.
2. Refer to Installation of Fouling Jumpers section for installation details.
3. Refer to Switch Point Bonding section for installation details.
4. Refer to Frog Bonding section for installation details.
5. All joint bars in the lead portion of the turnout shall be double bonded

9. Shunt Fouling – GCWS Non-Signalled Track

- 9.1. Figure 011-3A depicts the bonding arrangement required when a turnout on non-signalled track is located within the approach of a GCWS and is within 300 feet of the center of the road.
- 9.2. Figure 011-3B depicts the bonding arrangement required when a turnout on non-signalled track is located within the approach of a GCWS but is 300 feet or more from the center of the road.

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Figure 011-3A: Shunt Fouling – GCWS Non-Signalled Track Within 300 Feet

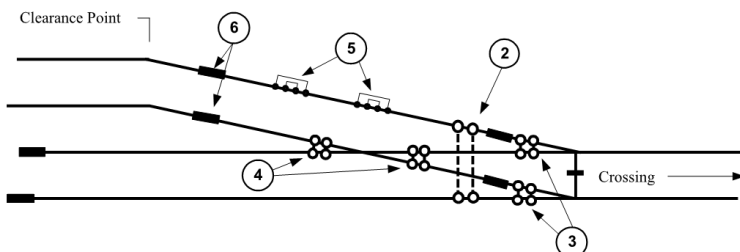
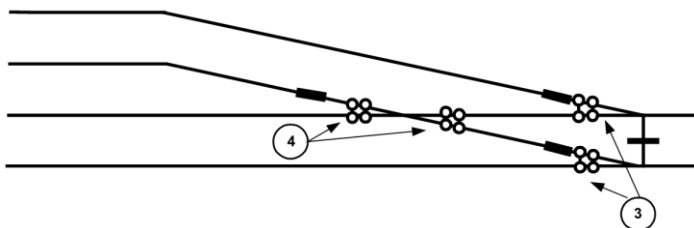


Figure 011-3B: Shunt Fouling – GCWS Non-Signalled Track More Than 300 Feet



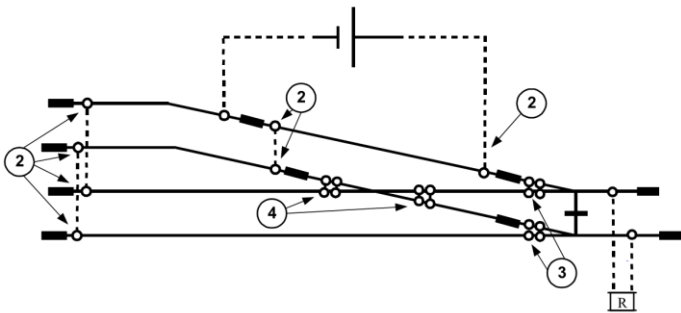
NOTES:

1. ■ Denotes insulated joints.
2. Refer to Installation of Fouling Jumpers section for installation details.
3. Refer to Switch Point Bonding section for installation details.
4. Refer to Frog Bonding section for installation details.
5. All joint bars in the lead portion of the turnout shall be double bonded.
6. The effective joints shall be located within the clearance point of the turnout.

10. Series Fouling

10.1. Figure 011-4 depicts the bonding and fouling arrangement for a typical series fouling circuit on signalled track. Series fouling circuits have been used in the past but should NOT be used for new installations.

Figure 011-4: Series Fouling



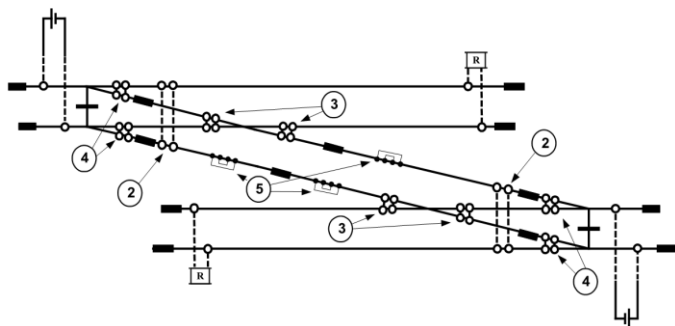
NOTES:

1. ■ Denotes insulated joints.
2. Refer to Installation of Fouling Jumpers section for installation details.
3. Refer to Switch Point Bonding section for installation details.
4. Refer to Frog Bonding section for installation details.

11. Shunt Fouling at a Crossover Between Main Tracks in Signalled Track

11.1. Figure 011-5 depicts the bonding and fouling wire arrangement for a typical shunt fouling at a crossover between main tracks in signalled tracks.

Figure 011-5: Shunt Fouling at a Crossover Between Main Tracks in Signalled Track



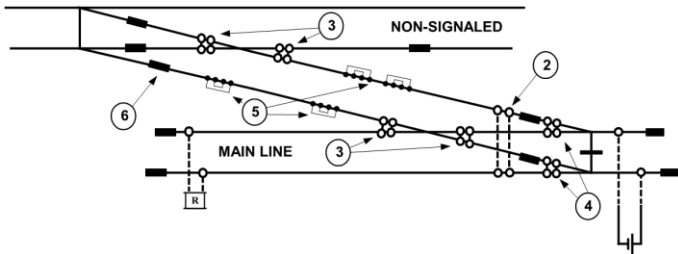
NOTES:

1. ■ Denotes insulated joints.
2. Refer to Installation of Fouling Jumpers section for installation details.
3. Refer to Frog Bonding section for installation details.
4. Refer to Switch Point Bonding section for installation details.
5. All joint bars in the lead portion of the turnout shall be double bonded.

12. Shunt Fouling at a Crossover Between Main Tracks in a Non-Signalled Track

12.1. Figure 011-6 depicts the bonding and fouling wire arrangement for a typical shunt fouling circuit at a crossover between main tracks and non-signalled siding tracks.

Figure 011-6: Shunt Fouling at Crossover Between Main Track in Non-Signalled Track



NOTES:

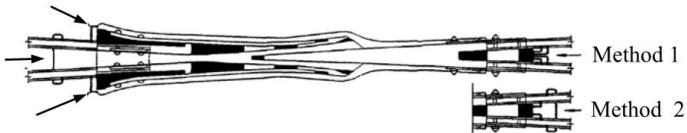
1. ■ Denotes insulated joints.
2. Refer to Installation of Fouling Jumpers section for installation details.
3. Refer to Frog Bonding section for installation details.
4. Refer to Switch Point Bonding section for installation details.
5. All joints in the signalled portion of the turnout shall be double bonded.
6. If the hand throw switch located on the non-signalled portion of the turnout is NOT equipped with a Switch Circuit Controller, the effective joint must be located so the clearance point is at least 13'-6" from the signalled track.

13. Frog Bonding

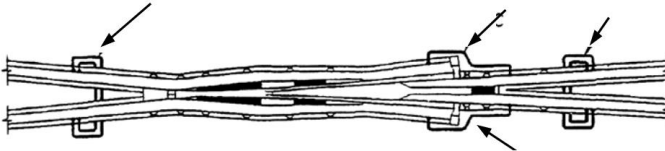
13.1. The arrows on the following diagrams indicate the preferred location of bonds on various types of frogs. Either method 1 or method 2 can be used on the self-guarded Manganese Frog.

Figure 011-7: Frog Bonding

Self-Guarded Manganese Frog



Rail Manganese Frog

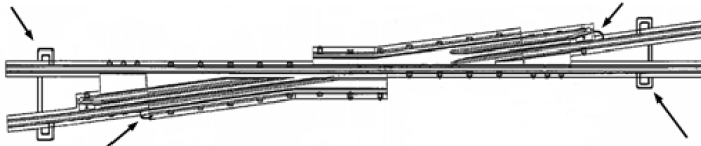


Note: Not required on Jointless Boltless Manganese (JBM) Frogs

Spring Manganese Frog



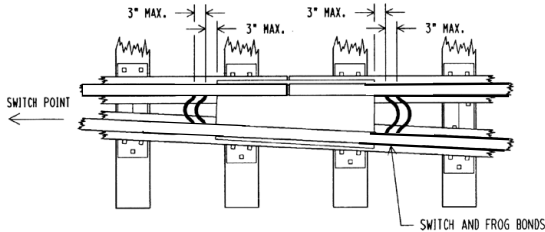
Nortrak Jump Frog



14. Switch Point Bonding at a Bolted Heel Block

14.1. Figure 011-8 indicates the location of bonds on a bolted heel block.

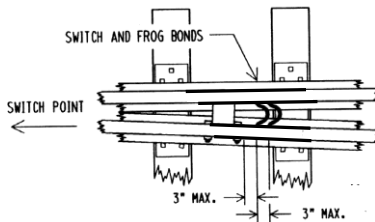
Figure 011-8: Switch Point Bonding at a Bolted Heel Block



15. Switch Point Bonding on a Floating Heel Block

15.1. Figure 011-9 depicts the preferred location of bonds on a floating heel block.

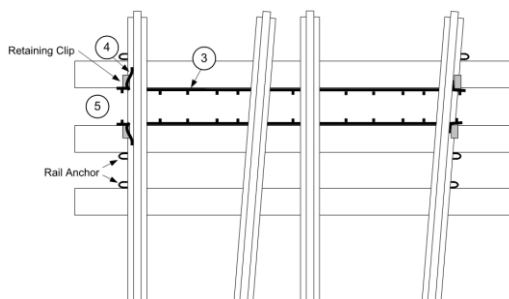
Figure 011-9: Switch Point Bonding on a Floating Heel Block



16. Installation of Fouling Jumpers

16.1. Figure 011-10 depicts the installation of fouling jumpers for turnouts.

Figure 011-10: Installation of Fouling Jumpers on Turnout



NOTES:

1. Fouling jumpers shall be S-8 bond strand wire and crimpable track connectors and placed in 5/8" I.D. red rubber hose, as an alternate, 1/2" liquid tight conduit can be used for this purpose.
2. Fouling jumper connections shall be applied to the neutral axis of the rail, as close as possible but no less than 3" from the insulated joint bar.
3. Jumper wires shall be stapled along the inside edge of the tie using 7/8" x 2" galvanized staples for the hose, 1 nylon staple for the S-8 wire. Hose shall be placed 1" below the top of the tie as shown above. To prevent electrical short circuits staples shall not be installed closer than 3" from tie plates or track spikes.
4. The S-8 wire shall be clipped to the rail using rail clips.
5. Rail anchors that interfere with the installation of the jumper wire shall be removed.

012 - Wayside Signal Alignment Procedures

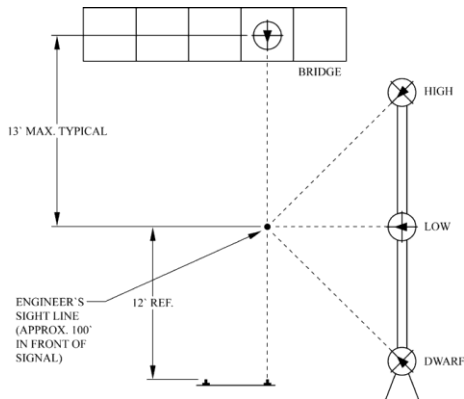
1. Purpose

- 1.1. The purpose of these instructions is to describe the proper method to align wayside signals to ensure that maximum visibility is provided to approaching trains.
- 1.2. This document contains instructions for the alignment of wayside signals. It is applicable to searchlight and color light signals, for both incandescent and LED applications.

2. Alignment of Hot Spot (Close-up Prism, If Equipped)

- 2.1. CAUTION: Do not begin alignment procedures until all necessary precautions have been taken to ensure the safety of train operations in accordance with [GI-301\(i\) Protecting Train Operations During Signal System Interruptions](#).

Figure 012-1: HOT SPOT SIGNAL ALIGNMENT



- 2.2. The engineer's eye is approximately 12 feet above the track level and over the right-hand rail. It is suggested that a suitable target be employed as a sighting objective. From the signal to approximately 100 feet from the signal the aspect should be visible to the engineer by aligning the hot spot (close-up prism).
- 2.3. NOTE: LEDs do not come equipped with a hot spot lens (close-up prism), however approximately 100 feet from the signal the aspect should be visible and must be checked.

3. Procedures

- 3.1. Inspect structure before light unit inspection for safe condition.
- 3.2. Inspect light units for defects which could affect light output.
- 3.3. Verify proper bulb and lens are in place.
- 3.4. Determine focal point in advance of the signal and mark for future viewing.
- 3.5. Signals higher than 15 feet above the rail shall be aligned slightly downward.
- 3.6. Adjust signal head to the focal or alignment point (engineer's side of the track) using peep sight (sighting device) and verify in the field from the focal point. The recommended alignment point (the distance from the signal to which the signal head must be focused) is shown in the Table 012-01 & Table 012-02 and is equivalent to the SSD (Standard Sighting Distance) defined in the Signal Sighting Distance Design Standard, RC-0506-03SIG-04).
- 3.7. If the actual achievable sighting distance for a given signal is between the SSD and MSD (Minimum Sighting Distance), then the alignment point shall be set at the actual achievable sighting distance.

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Table 012-01 Alignment Points Outside USRC

MPH	Ft. Per Sec	Alignment Point (ft)
10	15	500
15	22	500
20	29	588
25	37	735
30	44	882
35	51	1029
40	59	1176
45	66	1323
50	74	1470
55	81	1617
60	88	1764
65	96	1911
70	103	2058
75	110	2205
80	118	2352
85	125	2499
90	132	2646
95	140	2793
100	147	2940
105	154	3087
110	162	3234

Table 012-02 Alignment Points Within The USRC

MPH	Ft. Per Sec	Alignment Point (ft)
10	15	500
15	22	500
20	29	500
25	37	550
30	44	660
35	51	770
40	59	880
45	66	990
50	74	1100
55	81	1210
60	88	1320

4. Deflecting or Spread Covers

- 4.1. If it is necessary to direct a signal across a curve the proper cover lens must be used as directed by the Metrolinx/authorized Signal Specialist.

5. Signals on Curves

- 5.1. Alignment across a curve shall only be done with a deflecting or spread cover lens that is aligned with the main beam directed across the curve so that the entire track within the signal's range falls inside of the beam. Deflecting or spread cover lens shall not be used on tangent track that has 2000 feet or more of tangent track in advance of the signal even if there is a curve preceding the tangent track.

6. Multiple Unit Signal Heads

- 6.1. Multiple signal heads shall be balanced for intensity and alignment so far as practicable. Align the top signal head to the furthest focal point and lower heads incrementally closer, such that the end result is to not cross light beams.
- 6.2. EXAMPLE: The signal heads must be appropriately aligned relative to one another to avoid the undesirable situation where a red may appear dim above a green that appears bright.

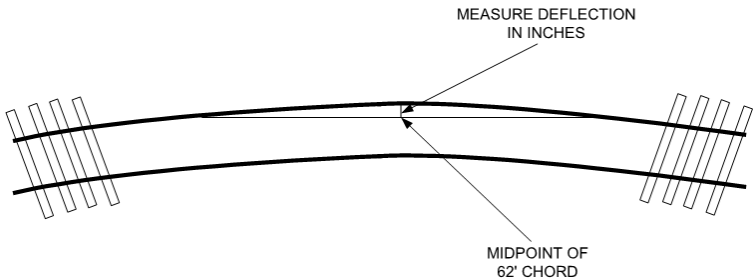
7. Measuring Track Curvature

- 7.1. The following procedure should be used to determine the track curvature.
- 7.2. Refer to track profile or follow steps below.

Table 012-03

Step	Action
1	Place a 62' chord on the outside rail (inside gauge) along the curve as shown in Figure 012-2.
2	Measure the deflection (in inches) between the inside gauge of rail and the midpoint of the 62' chord.
3	Take several (at least three) such measurements at different points along the curve, and average the deflection measurements (in inches).
4	The curvature (in degrees) of the track is equal to the average deflection calculated in Step 3 (in inches).

Figure 012-2: CURVATURE MEASUREMENT



8. Illustration of Different Track Curvatures with Different Lens Applied

- 8.1. In this section, the Figures 012-3 to 012-7 illustrate that different lenses provide different field of views to accommodate different track curvatures, which produce different sighting distances and targets. Figure 012-8 illustrates the vertical main beam alignment.
- 8.2. The cases listed below are for information as the installation drawings identify which lenses to be used for the associated signal sighting distances.

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Figure 012-3: 1° TRACK CURVATURE WITH 10° DEFLECTING LENS

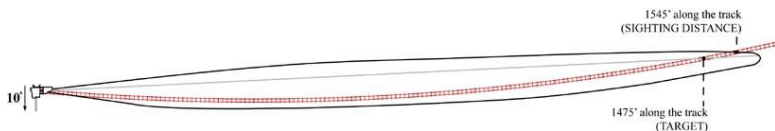


Figure 012-4: 2° TRACK CURVATURE WITH 10° DEFLECTING LENS

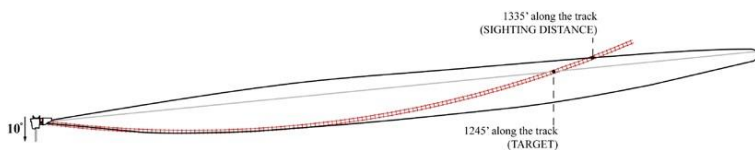


Figure 012-5: 4° TRACK CURVATURE WITH 20° DEFLECTING LENS

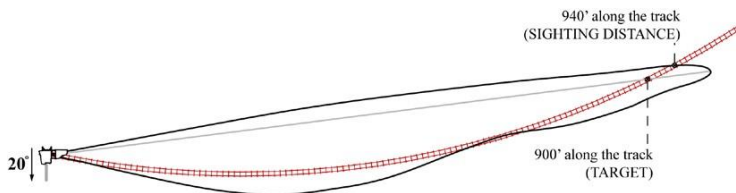


Figure 012-6: 6° TRACK CURVATURE WITH 20° DEFLECTING LENS

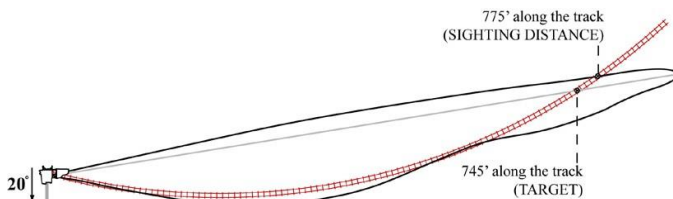


Figure 012-7: 8° TRACK CURVATURE WITH 30° SPREAD LENS

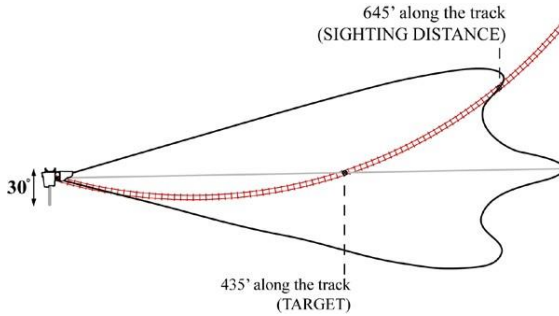
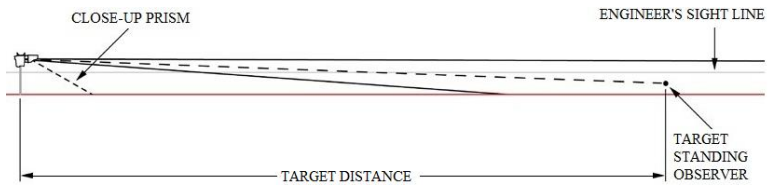


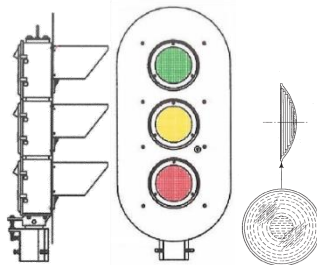
Figure 012-8: VERTICAL MAIN BEAM ALIGNMENT FOR ALL TYPES OF UNITS



9. Signal Types

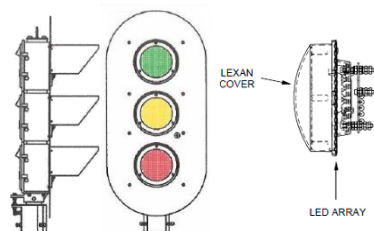
9.1. This section provides information about the existing signals that are being used in Metrolinx Territory.

Figure 012-9: INCANDESCENT COLOUR LIGHT SIGNAL (COLOURLIGHT LENS WITH A 40° HOT SPOT.)



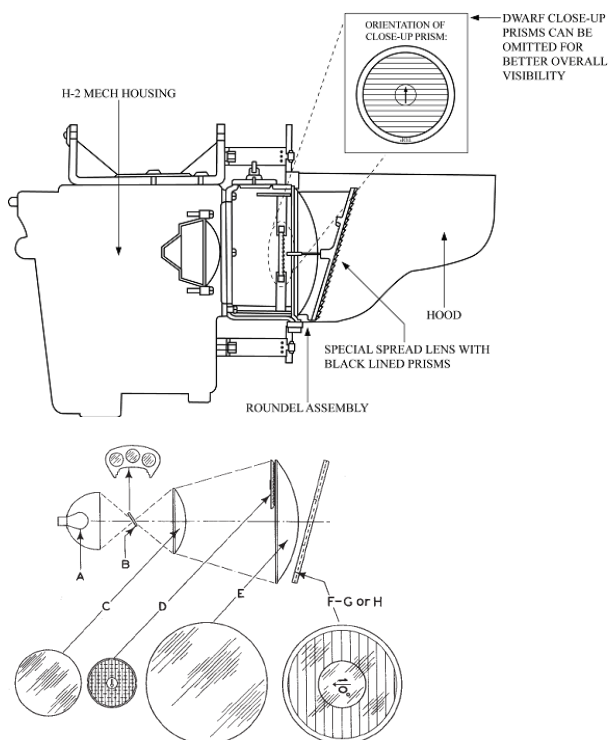
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Figure 012-10: LED COLOUR LIGHT SIGNAL



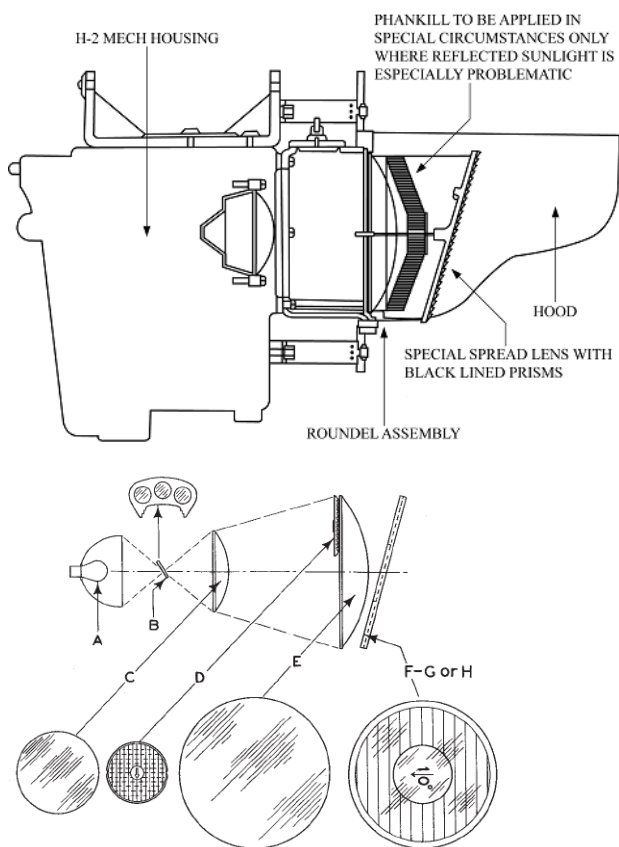
10. US & S Type Signals

Figure 012-11: US&S TYPE H-2 LOW MAST SIGNAL



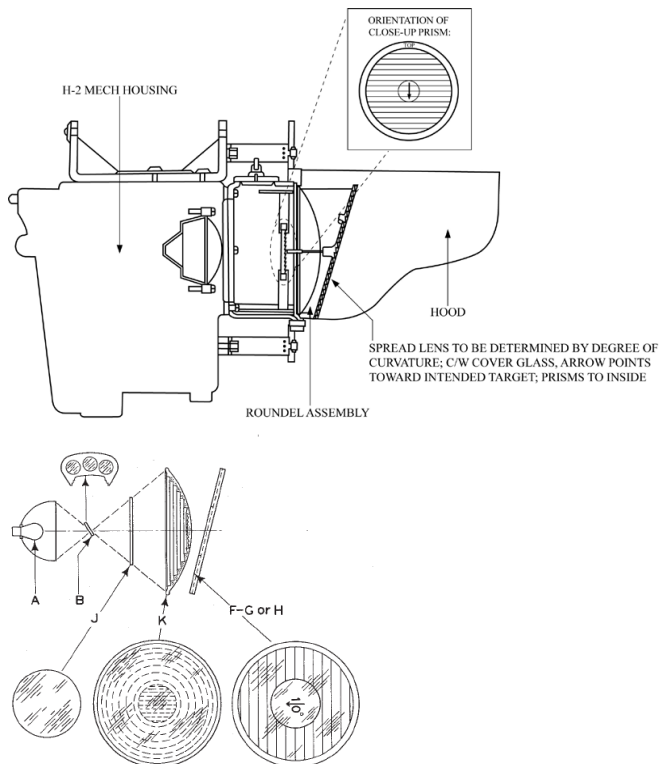
GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Figure 012-12: US&S TYPE H-2 LOW MAST SIGNAL WITH PHANKILL



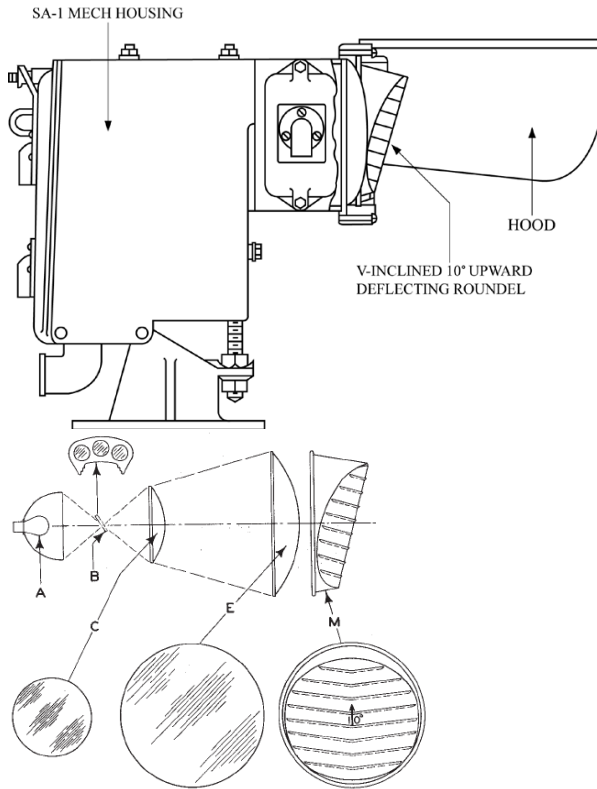
GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Figure 012-13: US&S TYPE H-2 HIGH MAST SIGNAL



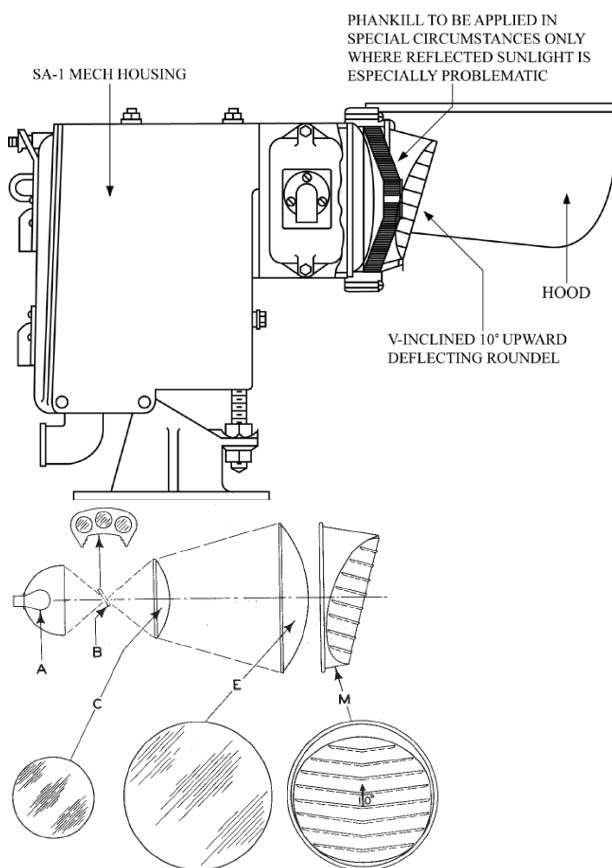
11. GRS Type Signals

Figure 012-14: GRS TYPE SA-1 LOW MAST SIGNAL WITH COMPOUND LENS



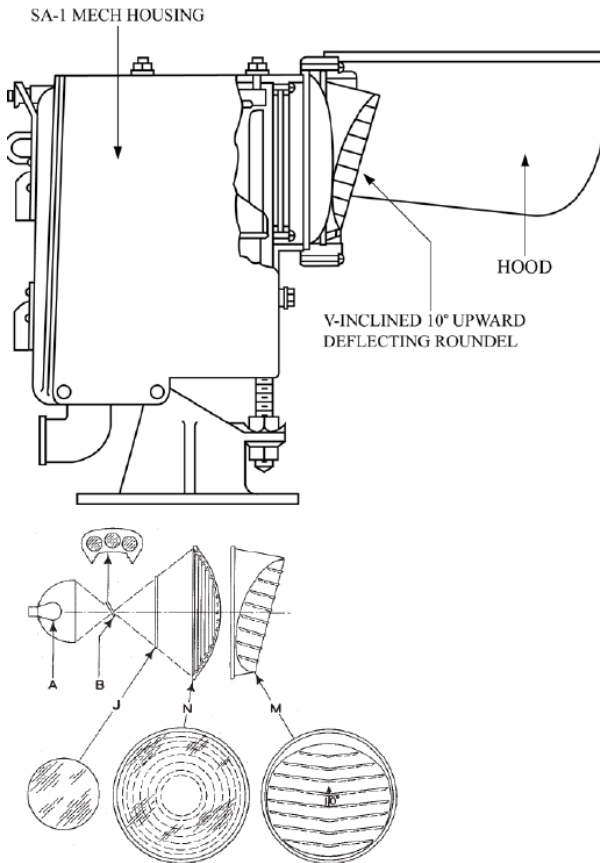
GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Figure 012-15: GRS TYPE SA-1 LOW MAST SIGNAL WITH
COMPOUND LENS WITH PHANKILL



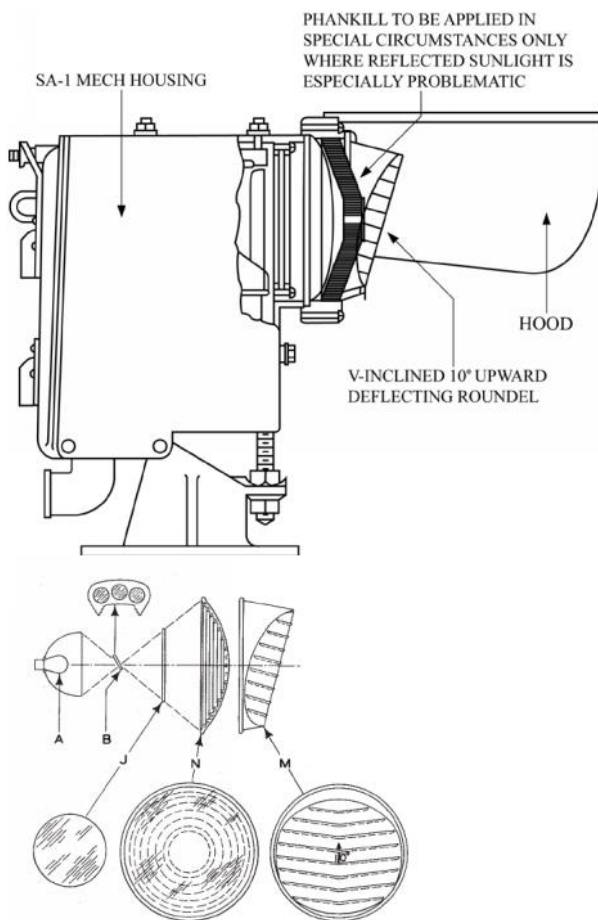
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Figure 012-16: GRS TYPE SA-1 LOW MAST SIGNAL WITH STEPPED LENS



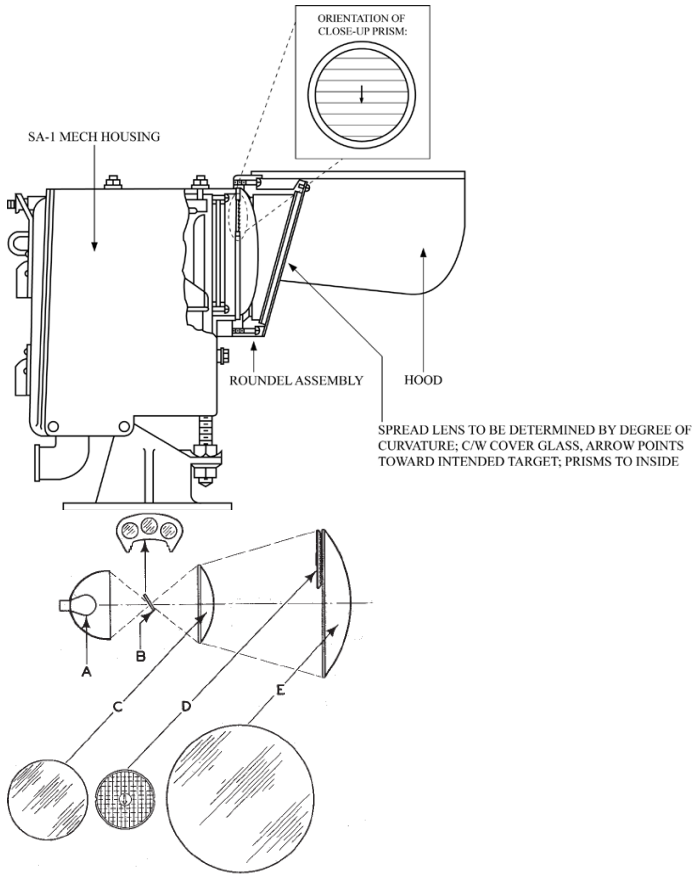
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Figure 012-17: GRS TYPE SA-1 LOW MAST SIGNAL WITH STEPPED LENS WITH PHANKILL



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Figure 012-18: GRS TYPE SA-1 HIGH SIGNAL OR MARKER LIGHT

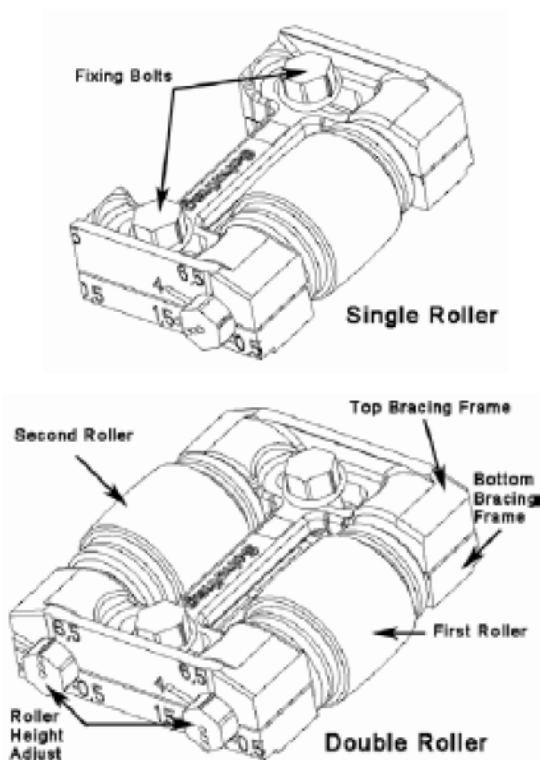


013 - Switch Roller Setup and Adjustment

1. Purpose

- 1.1. To ensure that switch points remain off all the switch plates at all times when switch points are in motion.



Figure 013-1: Schwihag Switch Rollers



2. Adjustments

- 2.1. Schwiag rollers typically require two adjustments: the Vertical Lift Height (VLH) adjustment and the Horizontal Position Offset (HPO) adjustment. Adjustments are always made with the switch position closed.

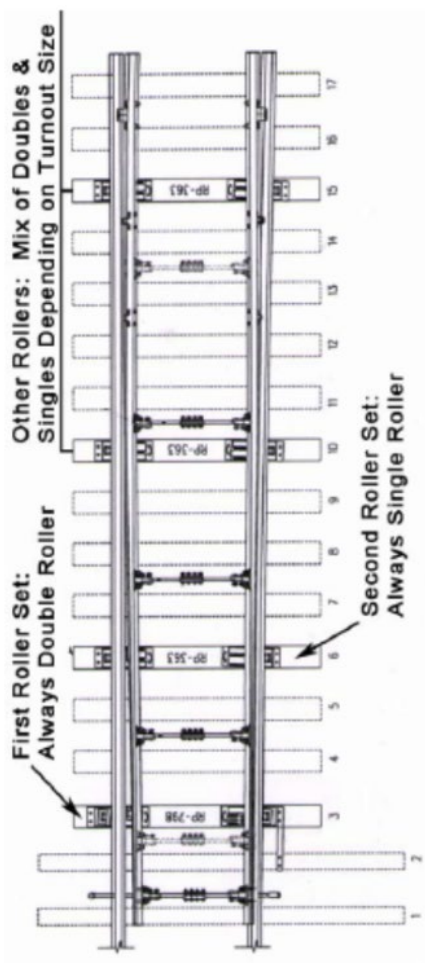
Table 013-01

Adjustment Type Description	Image
The VLH is the height in millimetres that a roller lifts the base of the switch point up off the switch plate.	
The HPO is the measurement in millimetres between the first roller and the edge of the switch point.	

3. Roller Design are Turnout Specific



- 3.1. Schwiag-equipped turnouts will have a varied number of double and single roller sets dependent upon the size of the turnout. Please follow instructions from the slip manufacturer, an example shown in Figure 013-2.

Figure 013-2



4. Required Tools

Table 013-02

Required Tools	Image
<ul style="list-style-type: none"> • a 17-mm wrench • a 17-mm socket • a box torque wrench (100 lb. Capacity) 	
<ul style="list-style-type: none"> • a set of feeler gauges <p>NOTE:</p> <ul style="list-style-type: none"> • Hole = 1 mm • Notch = half mm 	

4.1. **IMPORTANT:** Always begin with a visual inspection of the switch points and verify that they fit properly against the stock rail. If they do not, correct the problem before adjusting the Schwihag rollers.

5. Four Adjustment Scenarios

5.1. There are four adjustment scenarios:

- a. Setting up rollers in a newly installed turnout;
- b. Adjust rollers in an existing turnout;
- c. Setup switch point rollers for Nortrak #12 turnout with hollow steel ties; and
- d. Set up switch point rollers for Nortrak #16 turnout with hollow steel ties.

Figure 013-3: New Rollers



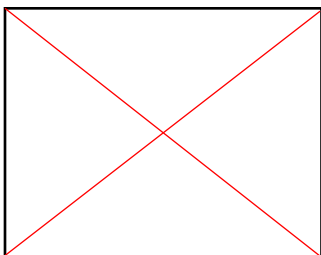
Figure 013-4: Existing Rollers



5.2. The following sections provide the steps for carrying out the adjustments for all four scenarios.

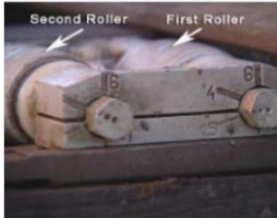


Note: In the following sections, pictures overlaid with a red cross are examples of incorrect installations.

Figure 013-5: Example of incorrect installation








6. Setting Up Rollers

Table 013-03




Step	Action
1	<p>Beginning with the first double roller set, verify that the first roller is set at a Vertical Lift Height of approximately 3 mm and that the second roller is set at a Vertical Lift Height of approximately 4 mm.</p> 
2	<p>With the points closed, determine the correct Horizontal Position Offset - to the nearest half mm, and identify which gauge fits easily between the base of the switch point and the switch plate. If your half mm gauge does not fit, the measurement is considered to be zero.</p> 
3	<p>Loosen the two fixing bolts. Add 1 mm to the measurement determined in Step 2, select that gauge, and insert it between the first roller and the edge of the rail. If the Step 2 measurement was zero, you would select the 1 mm gauge.</p> 

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Step	Action
4	Slide the rollers forward until the gauge is snug and hand tighten the fixing bolts. 
5	Alternatively, tighten and then lock down each fixing bolt with 50 ft-lbs. of torque. 
6a	Check the first single roller for the proper height setting (3 to 3.5 mm). 
6b	Then, verify that it is correctly centred on the gap between the first and second rollers of the first double roller set.  







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Step	Action	
7	Repeat Steps 1 to 5 for all the remaining rollers.	
8a	When all the rollers have been properly set up, throw open the points and verify that you have a minimum of a half mm gap between the switch point and every switch plate.	
8b	If you do not have the minimum clearance, raise the nearest roller as per Steps 1 to 5.	
9	When everything looks properly adjusted, power or hand throw the points back and forth and verify that every roller actually turns.	
End of Table		

6.1. IMPORTANT: Never raise rollers more than absolutely necessary. As a guideline, increase in half mm increments until you achieve the required lift. Rollers raised higher than necessary cause extra strain on switch motors and turnout components.

7. Adjusting Existing Rollers

Table 013-04

Step	Action
1	<p>Throw open the points, and using your half mm gauge, check for minimum clearance between the switch point and every switch plate. Mark those locations that do not have the minimum clearance.</p> 
2	<p>At those marked locations, make your adjustments. First, raise the rollers to the minimum amount necessary.</p> 
3	<p>Measure the gap.</p> 
4	<p>Check the HPO on all rollers and adjust if necessary as per Steps 3 and 4 of Table 013-03.</p> 
End of Table	

7.1. NOTES:

- a. If any one roller, unlike all the others, requires an adjustment that is at either extreme, either 0.5 mm or 6.5 mm, then you may have a switch component or track surfacing problem, and the Metrolinx designated Track Supervisor should be informed.
- b. Schwihag rollers are dry rollers and do not require any lubrication. Also, due to these rollers' effectiveness in reducing friction, the addition of graphite is no longer necessary.
- c. Reference [GI-329\(b\)\(4\) Inspecting Switch Rollers](#) for the testing procedures of the switch rollers.

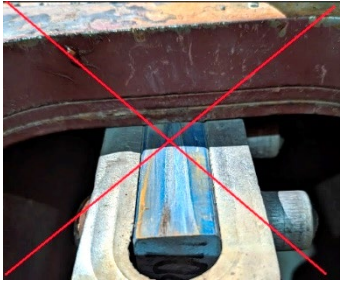

8. Switch Point Roller Setup Recommended Practice for Nortrak #12 Turnouts with hollow steel ties.

Table 013-05

Step	Action
1	<p>Make sure that the Closed switch point is sitting freely (no point clamps, no track jacks, etc. are applied) and there is minimum to no gap between the machined portion of the switch point and the stock rail as specified in GO Track Standard Articles 13.4.10, 17.5.1(d).</p> <p>(To achieve proper settlement of the switch point on the stock rail's base, gauge rod setup and stock rail layout may need to be verified. Additional tools like lining bars, prybars, track jacks, etc. may be used to overcome friction to assist the point motion towards the stock rail.)</p>
2	<p>Ensure there are no solid contaminants between the switch point, tie plates and the stock rail extending to the heel of the switch point.</p>




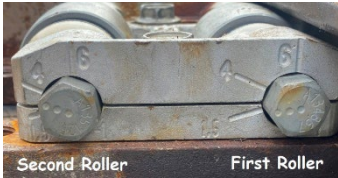


GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Step	Action
3	<p>Make sure that there is a vertical clearance of about 1/8" between the top of the gauge rods on a closed point side and static elements of the switch layout. If this tolerance is less than 1/16", then proper vertical lift might not be achieved without gauge rods rubbing against static layout elements.</p> 
4	<p>Loosen the two fixing bolts holding rollers assemblies to the tie plate using a 17mm socket wrench.</p> <p>Remove bolts and roller assembly, and inspect threads in the tie plate. Clean all solids (contaminants, like sand, stone chips or ice) that may have accumulated in threaded holes and roller pockets.</p> <p>Severely rusted threads must be re-tapped to reduce thread friction; otherwise, even with proper torque applied during fastening, it may not be enough to secure roller assemblies in place.</p> 

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Step	Action
5	<p>On the first roller assembly, set the Vertical Lift Height (VLH) position on the dials to 2.5 for the first roller and 3.5 for the second roller.</p> <p>From Table 329(b)(4)-01.</p> <p>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).</p> 
6	<p>Except for the first single roller assembly, set up the initial Horizontal Position Offset (HPO) for 1.5 mm.</p> <p>For the first single roller assembly, insert a 1.5 mm feeler gauge between the roller assembly and the switch point's base and gently slide the assembly toward the switch point, while maintaining slight pressure to the top plate until there are no gaps on either side of the feeler gauge.</p> 

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Step	Action
	<p>Ensure the roller assembly is properly seated in the tie plate's channel.</p> <p>Make sure that roller VLH dials do not rotate. If dials moved repeat Steps 5 and 6.</p>
7	<p>Tighten holding bolts using a 17 mm socket and a torque wrench applying 50 ft-lbs. of torque.</p> 
8	<p>On the second double roller assembly, set the VLH position on dials to 2.5 for the first roller and 3.5 for the second roller.</p>  <p>Perform Step 6 and Step 7.</p>
9	<p>Set the first single roller VLH position on a dial to approx. 3.5.</p>  <p>Perform Step 6 and Step 7.</p>
10	<p>Set the second single roller VLH position on a dial to approx. 2.5</p>  <p>Perform Step 6 and Step 7</p> <p>Setting up this roller too high may lead to significant arching of the</p>

**GO TRANSIT SIGNALS & COMMUNICATIONS
CODES OF PRACTICE**

Step	Action
	point over the first single roller, rendering it irrelevant.
11	Operate the switch to the opposing position and perform Steps 4 to 10 on rollers for the second switch point.
12	<p>Operate the switch by hand a couple of times and observe that witch points move smoothly, without noticeable jerking and that minimal effort is required to move points in mid-stroke.</p> <p>Jerking may be caused by some rollers VLH being to high, gauge rod rubbing or insufficient lift of the point between the heel and the last roller.</p> <p>If rod rubbing is significant, then all rollers VLH could be dialled down by approximately 0.5 mm.</p>
13	<p>Operate the switch by hand and verify that all rollers are rotating when switch points are moving over them (the apex of the second roller in the second double roller assembly may never be reached by the point, thus never rotate).</p> <p>If one of the rollers did not rotate, measure the gap between that roller and the bottom of the base of the Open point. If the gap is 1 mm or less, adjust the roller gently up, just enough to start rolling when the point moves over it. (It may be easier to do so when the</p>



**GO TRANSIT SIGNALS & COMMUNICATIONS
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Step	Action
	<p>Opening point has just reached the apex of the roller in question).</p> <p>If the gap is more than 1 mm, then either one of the neighbouring rollers is set up too high or switch's track elements may have defects, or the track layout is not exactly flat.</p>
14	<p>For each switch point, verify a minimum of 0.5 mm gap between the switch point in the Open position and every switch plate between rollers. If some plates have a lesser gap, gently dial the nearest roller VLH up just to achieve a minimum of 0.5 gap mentioned above.</p> <p>It is also recommended to have at least a 0.5 mm gap between the bottom of the Open switch point and tie plates on a portion from the last roller assembly to approximately halfway to the switch point's heel.</p>
15	<p>For each roller assembly, verify that HPO is at least 0.5 mm wider than the gap between the fully Closed point's base and a tie plate. In case of a lesser gap, adjust HPO to 1 mm wider than the measured gap.</p> <p>That may lead to one of the single rollers to stop rotating. This may be acceptable, provided that at least a 0.5 mm gap is achieved as required in step 14.</p>
End of Table	




9. Switch Point Roller Setup Recommended Practice for Nortrak #16 Turnouts with hollow steel ties.

Table 013-06


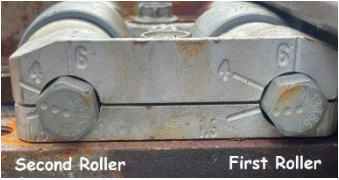

Step	Action
1	<p>Make sure that the Closed switch point is sitting freely (no point clamps, no track jacks, etc. are applied) and that there is a minimum to no gap between the machined portion of the switch point and the stock rail as specified in GO Track Standard 13.4.10, 17.5.1(d).</p> <p>(To achieve proper settlement of the switch point on the stock rail's base, gauge rod setup and stock rail layout may need to be verified. Additional tools like lining bars, prybars, track jacks, etc. may be used to overcome friction to assist the point motion towards the stock rail.)</p>







GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Step	Action
2	<p>Make sure that there are no solid contaminants between the switch point, tie plates and the stock rail all the way to the heel of the switch point.</p> 
3	<p>Make sure there is a vertical clearance of about 1/8" between the top of the gauge rods and static elements of the switch layout on the side of a Closed point.</p> <p>If this tolerance is less than 1/16", the proper vertical lift height might not be achieved without gauge rods noticeably rubbing against static switch layout elements.</p> 
4	<p>Loosen the two fixing bolts holding roller assemblies to the tie plate using a 17mm socket wrench.</p> <p>Remove bolts and roller assembly.</p> <p>Inspect the roller pocket and threaded holes in the tie plate. Clean all solid contaminants (like sand, stone chips, or ice)</p> 

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE


Step	Action
	<p>Severely rusted threads must be re-tapped to reduce thread friction; otherwise, even with proper torque applied during fastening, it may not be enough to secure roller assemblies in place.</p> 
5	<p>On the first roller assembly, set the Vertical Lift Height (VLH) position on the dials to 2.5 for the first roller and 3.5 for the second roller.</p> 
6	<p>Set up initial Horizontal Position Offset (HPO) for 1.5 mm</p> <p>For that, insert a 1.5 mm feeler gauge between the roller assembly and the switch point's base and gently slide the assembly toward the switch point, while maintaining slight pressure to the top plate till there are no gaps on either side of the feeler gauge.</p> <p>Ensure the roller assembly is properly seated in the tie plate's channel.</p> <p>Make sure that roller VLH dials did not rotate. If dials</p> 

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Step	Action
	moved repeat Steps 5 and 6.
7	<p>Tighten holding bolts using a 17 mm socket and a torque wrench, applying 50 ft-lbs of torque.</p> 
8	<p>On the first single roller assembly, set the VLH position on a dial to 3.</p> 
9	<p>Position the first single roller assembly such that the apex of the roller is the same distance from the base of the point as the gap between rollers in the first double roller assembly.</p> <p>Fasten the roller assembly in place as described in Step 7.</p>  



GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Step	Action
10	<p>Set all remaining rollers VLH positions on dials to approximately 4.</p> <p>Perform Step 6 and Step 7</p> 
11	Operate the switch to the opposing position and perform Steps 1 to 10 on rollers for the second switch point.
12	<p>Operate the switch by hand a couple of times and observe that switch points move smoothly, without noticeable jerking and that minimal effort is required to move points in mid-stroke.</p> <p>Jerking may be caused by some rollers VLH being too high, gauge rod rubbing or insufficient lift of the point between the heel and the last roller.</p> <p>If rod rubbing is significant, then all rollers' VLH could be dialled down by approx. 0.5 mm</p>
13	<p>Operate the switch by hand and verify that all rollers are rotating when switch points are moving over them.</p> <p>If one of the rollers did not rotate, measure the gap between that roller and the bottom of the base of the Open point. If the gap is 1 mm or less, adjust the roller gently up, just enough to start rolling when the point moves over it. (It may be easier to do so when the Opening point has just reached the apex of the roller in question).</p> <p>If the gap is more than 1 mm, either one of the neighbouring rollers is set up too high, the switch's track elements may have defects, or the track layout is not exactly flat.</p>

**GO TRANSIT SIGNALS & COMMUNICATIONS
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Step	Action
14	<p>For each switch point, verify a minimum of 0.5 mm gap between the switch point in the Open position and every switch plate between rollers. If some plates have a lesser gap, then gently dial the nearest roller VLH up just to achieve a minimum of 0.5 mm gap mentioned above.</p> <p>It is also recommended to have at least a 0.5 mm gap between the bottom of the Open switch point and tie plates on a portion from the last roller assembly to approximately halfway toward the switch point's heel.</p>
15	<p>Finishing set up. For each roller assembly for each switch point, verify that HPO is at least 0.5 mm wider than the gap between the fully Closed point's base and a tie plate. In case of a lesser gap, adjust HPO to 1 mm wider than the measured gap.</p>
End of Table	

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014 - Signal System Safety Assurance Process

1. Purpose

- 1.1. This document describes the safety assurance process used by Signals & Communications when installing and testing a signaling system.
- 1.2. The purpose is to describe the various forms and the documentation flow involved in the process.

2. SCP-1209 Signal Safety Assurance Installation & Commissioning Process Checklist

- 2.1. This document is an overview of all the processes and critical information required to be kept during the signal system installation process. This form shall be used by the person responsible for collecting the various information or forms and keeping them together in a working file.

3. SCP-1209-1, SCP-1209-2 Testing Certification Form

- 3.1. This form will be completed by the party responsible for performing the inside wiring, either a S&C person, or an outside supplier/contractor.

4. SCP-1209-3 Signal Installation Safety Assurance Checklist

- 4.1. This document lists the minimum checks which must be performed for any signal system, or modification thereto, before placing the system in service. It is designed to provide guidance to the employees responsible by directing them to the applicable tests required and identified in General Instructions. It is to be signed by the designated foreman and the responsible Supervisory Officer, certifying the signal system has been installed and checked in accordance with all applicable rules and instructions.

5. SCP-1209-4 Signal Plan Transmittal Notice

- 5.1. The purpose of this notice is to track the distribution of the signaling design plans to ensure all applicable drawings are distributed with the appropriate revision levels. When issued for construction, the Plan Transmittal Notice must be authorized by signature indicating that all safety critical aspects of the site have been addressed and properly engineered per Metrolinx Standards.
- 5.2. Alternative customized transmittal notices may be used; however, they must contain the same information content.

6. SCP-1202-5, SCP1202-6

- 6.1. The purpose of this form is to record test results for Approach Locking, Time Locking, Route Locking, Indication Locking, Traffic Locking, and Mechanical Locking.

7. Location Plan / Site Detail Drawing

- 7.1. This plan records the basic design criteria of the signal system such as equipment location and other pertinent information.

8. Operating Test Forms

- 8.1. These documents will vary depending on the type and complexity of the signal system. Basically, an Operating Test form records all the operating tests (using simulated or actual train movements) required to ensure the system functions as intended. It is signed by the designated S&C Supervisory Officer responsible for conducting the tests.

9. Final "As Installed" Plans

- 9.1. During the installation process, there may be changes or modifications required to the vital circuit design. These can only be made with the prior approval from Metrolinx authorized Signal Design Office. All changes are recorded on a copy of the engineering plans marked "As Installed", signed by the Supervisory Officer responsible for the installation and testing. Refer to [GI-301\(f\) Condition of Plans](#), and be governed by those instructions.

10. SCP-1208-1 In Service Notification

- 10.1. An "In Service Notice" is issued to all concerned parties when the operating tests of the signal system operating tests are successfully completed and the site is placed in service. The notice is generated by Metrolinx.

11. Rail Corridors Infrastructure Handover Protocols

- 11.1. Metrolinx designated Supervisory Officer shall follow the Rail Corridors Infrastructure Handover Protocols (RC-0503-01) when the location is placed in service.

12. Filing

- 12.1. All copies of these forms and plans must be forwarded to the responsible Metrolinx designated S&C Supervisor for filing in the appropriate file.

Appendix 000A – Guidelines for Testing and Information – Control Office

1. General

- 1.1. This appendix is intended to serve as a reminder or guideline to the employee(s) responsible for Metrolinx investigation of an incident. It contains recommendations on which tests should be performed on what equipment and how certain information should be retrieved.
- 1.2. These guidelines should NOT be considered comprehensive since the configuration of the system and the type of incident will ultimately determine the actual test requirements.

2. Important

- 2.1. All tests should be performed as soon as possible and prior to any train movement through the field locations involved.

3. Processor Based Control Machine

- 3.1. On modern processor based control machines gather the following information:

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Table 000A-01

Category	Details
Log	<p>Extract all log file portions related to the incident. These logs should include logs related to the actions of the RTC, control and indication logs, train activity report, signal activity report, code activity report, and when available code line emulator logs. The logs should extend back at least 12 hours and if possible 24 hours from the time of the incident.</p> <p>Request Silent Witness from Train Operations, and when possible information from the Train Crew.</p> <p>If not already performed in the field and if the functionality is available, download the field code unit buffer (buffer dump).</p>
Graphs	Using the WEB based Graphical OS Train Logging System, generate and print a graph of train movements on the subdivision the day of the incident.
Signal Failures	Gather all information in connection with signal failures at all locations involved during the preceding month.
Voice Recording	Record of any voice tape conversations in connection with the incident.

4. Lever Type Control Machine

- 4.1. On older type control machines using levers and lights for controls and indications, gather the following information:

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Table 000A-02

Category	Details
Control Levers	<p>The position of all control levers or the indicated positions of all control relays at the incident location and adjacent controlled locations.</p> <p>Any information available on the position of the control levers or relays at the time of the incident.</p> <p>The details of the manipulation of the control or push-buttons in connection with the movement of the train(s) involved in the incident together with any subsequent manipulation.</p>
Indications	<p>The indications displayed on the control machines for the incident location and adjacent controlled locations and whether or not any indication lamps for these locations are defective.</p> <p>Any information available regarding the indications displayed for the incident location and adjacent locations at the time of the incident.</p>
Signal Failures	All information in connection with signal failures at all locations involved during the preceding month.
Voice Recording	A record of any taped voice conversation in connection with the incident.

Appendix 000B – Guidelines for Testing and Information – Field Location

1. General

- 1.1. This Appendix is intended to serve as a reminder or guideline to the employee(s) responsible, to test a location where an incident has occurred. It contains recommendations on which tests should be performed on what equipment and how certain information should be retrieved, PRIOR TO MAKING ANY REPAIRS.
- 1.2. These guidelines should NOT be considered comprehensive since the configuration of the location and the extent of the damage will ultimately determine the actual test requirements.

2. Important

- 2.1. All tests should be performed as soon as possible and prior to any train movement though the location. If a train movement does occur, details of that movement should be recorded and if necessary any operating type tests repeated.
- 2.2. Tests which do not require the opening of test straps, disconnection of wires or other type of circuit disconnection shall be performed first.
- 2.3. Tests requiring the disconnection of circuits should be performed last.

3. Signal Aspects

- 3.1. Record the aspects displayed by all signals at or near the incident location and at adjacent locations including at least one controlled location in each direction.
- 3.2. WARNING: To verify the aspect of approach lit signals, do not shunt or de-energize track circuits. When necessary, open the approach lighting relay test strap.

4. Alignment and Visibility

- 4.1. Verify and record the alignment and visibility of the last signal passed by the train(s) involved in the incident.

5. Relays

- 5.1. Record the position and condition of all relays at the incident location or the last controlled location(s) passed by the train(s) involved.
- 5.2. This must include all relays and the contact position of any polar relays.

6. Switches

- 6.1. Record the position and condition of any power switch machine, hand throw switch and switch circuit controlled contacts within the route of the incident block.

7. Circuit Ground Test

- 7.1. Perform and record the results of ground voltages as per [GI-303 Testing for Circuit Grounds and Battery Isolation Faults](#), on each circuit at the incident location.

8. Memory Dumps

- 8.1. Save the outputs from any field recording devices or dumps from DFC-2000 code unit at the location(s) involved.
- 8.2. Perform and save a data dump or request and save a chart recorder paper copy of the train involved from the Wayside Detection System in advance of the incident location.

9. Wire and Cable Insulation Resistance Test

- 9.1. Perform and record the results of wire and cable insulation resistance tests as per [GI-312 Testing Wire and Cable Insulation Resistance](#).

10. Storage Battery Test

- 10.1. Perform and record the results of operating and track battery tests as per [GI-305\(a\) Inspecting and Testing Storage Batteries](#).

11. Track Circuit Tests

- 11.1. Perform and record the results of track circuit tests, as per [GI-333 Testing Track Circuits](#) for each track circuit involved at the incident location.

201 - Procedures for Working on Bungalows Constructed Using Asbestos

1. Purpose

- 1.1. There are a number of Signals & Communications bungalows which have been constructed using asbestos sheeting. Samples taken from selected sites were tested and found to be chrysotile asbestos with a content of up to 70% by volume. Because asbestos may cause health or respiratory problems to employees if not handled properly, the following procedures are to be followed when conducting work which may, in any way, disturb the fabrication materials in a location which is identified as containing asbestos.
- 1.2. At all locations known to contain asbestos sheeting there shall be at least two signs affixed to the interior of the housing. One sign shall be placed at eye level on the interior of the door and another sign shall be placed in a predominant position on the wall immediately opposite the door. Depending on the size and layout of the facility additional signs may be posted as required. The sign(s) shall state:

ATTENTION

**This wall board contains ASBESTOS. Do NOT cut or drill.
Refer to S&C Codes of Practice Manual for instructions.
Contact your Supervisor!**

- 1.2.1. If a sign is found illegible or damaged it shall be replaced immediately.

2. Important

- 2.1. Work associated with the handling or cleanup of asbestos shall only be performed by employees who have completed the Metrolinx approved Respirator Protection Course. To ensure personal safety all employees must comply with these instructions. Contact Metrolinx for additional information or assistance if necessary.

3. Equipment

- 3.1. The following is a list of the equipment required to perform the various activities associated with working in buildings constructed using asbestos. Contact a Health & Safety Officer for additional information regarding the availability of this equipment.

Table 201-01: Personal Protection Equipment

Quantity	Equipment
1	Half Mask Respirator ¹
1	Pair (Clear) Non-Ventilated Goggles
1	Disposable Coveralls - Hooded Type
1	Pair Steel Toed Rubber Boots
1	Pair Rubber Gloves
1	Roll Duct tape 2 inches wide

¹Approved personal fit mask respirator assigned during training.

Table 201-02: Site Preparation and Cleanup Equipment

Quantity	Equipment
1	Aerosol Spray Bomb
As Req'd	Asbestos Plastic Disposal Bag, 6 mil., 44"x 64"
1	Roll Banner Tape
As Req'd	Polyethylene sheeting, 6 mil
1	Roll Masking Tape 2 inches wide
1	HEPA Equipped Vacuum Cleaner

4. Procedures

- 4.1. There are numerous sites which have been worked on over the years that may contain already disturbed asbestos particles. These particles could become airborne when work is performed in the building. It is therefore very important that an initial cleanup of all asbestos sites is performed in accordance with the procedures outlined below.
- 4.2. This section also describes the procedures to be followed when work such as cutting or drilling is to be done in a site constructed using asbestos sheeting.

Table 201-03: Personal Protective Equipment

Step	Action
1	Use only approved personal protective equipment listed.
2	Use Duct tape on wrists and ankles as an extra precaution to ensure asbestos particles do not enter at the cuffs.

Table 201-04: Initial Site Cleanup

Step	Action
1	Confirm with Supervisor whether the site has been identified as containing asbestos.
2	Assemble all necessary equipment and supplies.
3	Don personal protective equipment.
4	Secure area with banner tape. Install " Attention this wallboard... " signs.
5	Vacuum complete area with HEPA equipped vacuum.
6	Place contents of vacuum in specially marked (Asbestos) plastic disposal bag.
7	Follow personal decontamination and asbestos disposal procedures.

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

Table 201-05: Cutting or Drilling – Preparation

Step	Action
1	Confirm with Supervisor initial cleanup has been performed.
2	Assemble all necessary equipment and supplies.
3	Don personal protective equipment.
4	Cover floor or ground area with polyethylene sheet.
5	Use masking tape to hold polyethylene sheet in place.
6	Follow personal decontamination and asbestos disposal procedures.

5. Asbestos Work and Disposal Procedures

5.1. Prior to drilling, cutting or in any way disturbing the asbestos, soak down the area to be worked on with water using the spray bomb. Continue to apply water while working. This will reduce the amount of airborne particles generated and make clean up much easier.

Table 201-06: Site Cleanup

Step	Action
1	Gather up as much asbestos particulate as possible and place in specially marked (Asbestos) plastic disposal bag.
2	Remove polyethylene sheet and place in specially marked plastic disposal bag.
3	Vacuum complete area with HEPA equipped vacuum.

5.2. After removal of all asbestos has been completed, the specially marked disposal bags shall be carefully stored until they are transported to an approved disposal site. Contact your local Environmental Officer for location of approved disposal sites.

5.3. Asbestos waste can be stored on site however they must be kept covered at all times. The storage room or area must be secured and a warning sign posted at its entrance. The warning sign shall state the following:

“Attention - Asbestos Waste. Contact your Supervisor!”

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

- 5.4. Health & Safety Officers are responsible to maintain accurate records of all disposal procedures, including waste quantities, dates, location and method of disposal. The responsible Supervisory Officer shall ensure Health & Safety Officers are provided with this information.
- 5.5. Copies of these procedures and the above records shall be maintained at the site.

6. Personal Contamination Procedures

- 6.1. After all work has been completed it is important the site is properly cleaned and all personal protective equipment is decontaminated.

Table 201-07

Step	Action
1	Remove coveralls, gloves and place in specially marked (Asbestos) plastic disposal bag.
2	Using sponge and water, wash hands, face, respirator and boots.
3	Wipe off (Asbestos) plastic disposal bag with sponge. Place in bag and seal it.
4	Remove respirator, wash off thoroughly and store.
5	Wash off face and hands again.

301 - Application of AAR Hardware for Case Wiring

1. Purpose

- 1.1. This practice describes the correct usage of AAR standard terminal blocks and associated binding post hardware such as clamp nuts, binding nuts, terminal connectors and insulated test links. The correct application of AAR hardware for case wiring is necessary to prevent intermittent circuit connections.

2. Approved Wiring Equipment and Standards

- 2.1. Approved terminals to be employed in wiring applications using case wire and signal cable are identified in [SCP-1003 Standard Terminals & Tools for Case Wiring](#).
- 2.2. Approved wire and cable types are identified in [SCP-1004 Standard Signal Wire and Cable](#).
- 2.3. Wiring standards for Signals & Communications (S&C) equipment housings, terminal junction boxes and apparatus are identified in [SCP-1007 Equipment Housing and Apparatus Wiring Standard](#).
- 2.4. Approved primary surge arrestors and best practices for their usage are identified in [SCP-1101 Surge Arresters for use on Railway Signal Circuits](#).

3. Tightening Nuts

- 3.1. Each clamp or binding nut in the stack must be fully tightened before additional hardware is added to the binding post. Failure to fully tighten nuts or attempting to tighten the nuts after oilier nuts are placed on the binding post will result in intermittent connections.
- 3.2. The preferred tool for tightening clamp and binding nuts is a terminal wrench. The use of power nut drivers is permitted when the clutch is adjusted to 60 inch-pounds.

4. Terminal Connectors & Insulated Test Links

- 4.1. Terminal connectors and insulated test links shall be installed so that they are on top of a flat nut and/or a binding nut but parallel to the surface on which the terminal blocks are mounted. Additional flat washers may be necessary to obtain this result.
- 4.2. Failure to install terminal connectors and insulated test links parallel to the surface on which the terminal blocks are mounted can result in excessive pressure on the edges of nuts or washers, causing scoring of the terminal connectors and/or insulated test links, ultimately resulting in intermittent connections.

5. Damaged Hardware

- 5.1. All damaged hardware including corroded, scorched and scored nuts, washers, terminal connectors and/or insulated test links are to be replaced.

6. Location of Surge Arrestors

- 6.1. Surge arresters are to be installed so that they can be replaced by removing the minimum amount of hardware and not jeopardize the connectivity of the circuit at which it's protecting.

7. Double Nuts

- 7.1. Two nuts are to be installed at the top of each binding post to prevent vibration from causing the hardware to loosen over time.

8. Wires on Binding Post

- 8.1. No more than 2 wires shall be terminated on any binding post. Wires are to be routed away from binding posts not in between or touching adjacent binding posts.

9. Formed Eyes

- 9.1. A formed eye is to be used to install solid wire on the binding post. A flat washer must be placed on each side of the solid wire. Ring terminals are NOT to be installed on solid conductor wire.

10. Ring Terminals

- 10.1. The first ring terminal is to be installed with the barrel facing down. When two ring terminals are to be placed on the binding post, there is to be a washer placed between the terminals and the second terminal is to be installed with the barrel facing up. Wires are to be parallel with each other and routed perpendicular from the AAR terminal block.

11. Approved Hardware

- 11.1. Metrolinx has approved the following items for use.

Table 301-01

DESCRIPTION	OEM	MPN
Block, Terminal 4 Post (AREMA 14.1.8, Figure 1418-4)	Erico	B2700A2C1WH
Block, Terminal 2 X 6 Post	Siemens	023274-501X
Block, Terminal 2-3/8" Center (AREMA 14.1.8, Figure 1418-1)	Siemens	023612-1X
Link, Copper Slide, 1" Center (AREMA 14.1.15-1)	Siemens	23837
Model 614 Bakelite Fuse Block, 2-3/8" center	Siemens	027614-1X
Washer, Flat (AREMA 14.1.11)	Hitachi	J047818
Model 840 Porcelain Fuse Block, 2-3/8" center	Siemens	400044840000X
Block, Terminal 2 X 6 Post with binding nuts, washers, test links, and gold nuts	Siemens	023274-41X
Buss connector for 12 terminals, 1" spacing	Siemens	023839-14

Continued on Next Page

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DESCRIPTION	OEM	MPN
Straight Insulated Link c/w gold nut and clamp nut, 1" center	Siemens	024620-1X
Straight Insulated Link c/w gold nut and clamp nut, 2-3/8" center	Siemens	024620-4X
Block, Terminal 1 X 12 Post (AREMA 14.1.6 Figure 1416-2)	Siemens	023390-11X
Block, Terminal 2 X 6 Post with binding nuts and washers	Siemens	023274-28X
Terminal assembly, equalizer binding post surge panel, c/w offset test link	Siemens	051883-122X
Block, Terminal 3 Post	Siemens	400044485023X
Offset Insulated Link c/w gold nut and clamp nut, 1" center	Siemens	024620-7X
Gold Nut (AREMA 14.1.15 Figure 14115-11)	Siemens	024620-13
Flat Nut, (Clamping) 3/16" thick (AREMA 14.1.11)	L&W Industries	9A2202
Binding Nut, 5/16" thick (AREMA 14.1.11)	L&W Industries	9A2204
Offset Insulated Link c/w gold nut only, 1" center	Siemens	024620-11X
Straight Insulated Link Only, 1" center	Siemens	024620-3X
Connector, copper, standard 1" center	L&W Industries	9A2200
Connector, copper, standard 2-3/8" center	L&W Industries	9A2201
AAR Terminal Insulated Nut	Siemens	023408-1X
Through AAR Terminal 1 X 12 Post	Siemens	023275-12X
ThreePostTestStrap	Siemens	024620-43X
AAR Insulation Block 1x6 used with Through AAR Terminal	Siemens	023275-2

12. Terminal Mounting Diagrams

Figure 301-1: Main Terminal Board Through Terminal (New Installation)

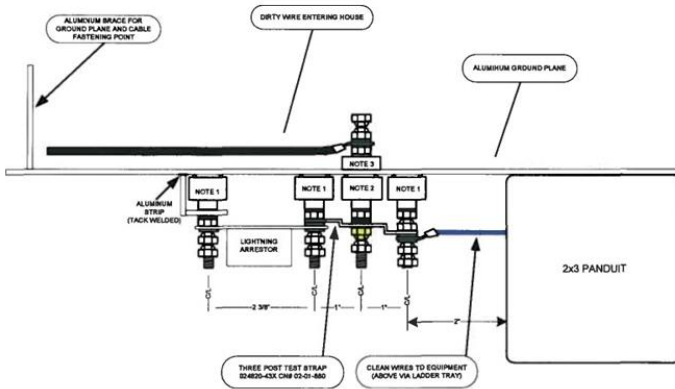
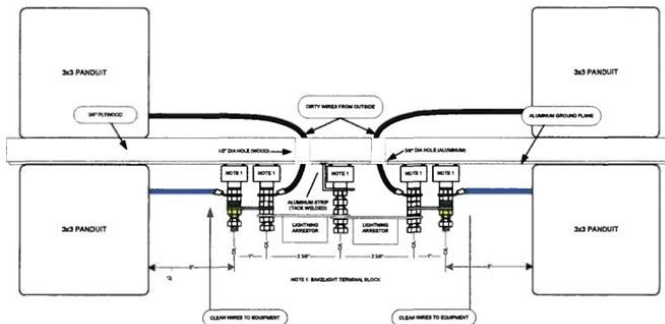
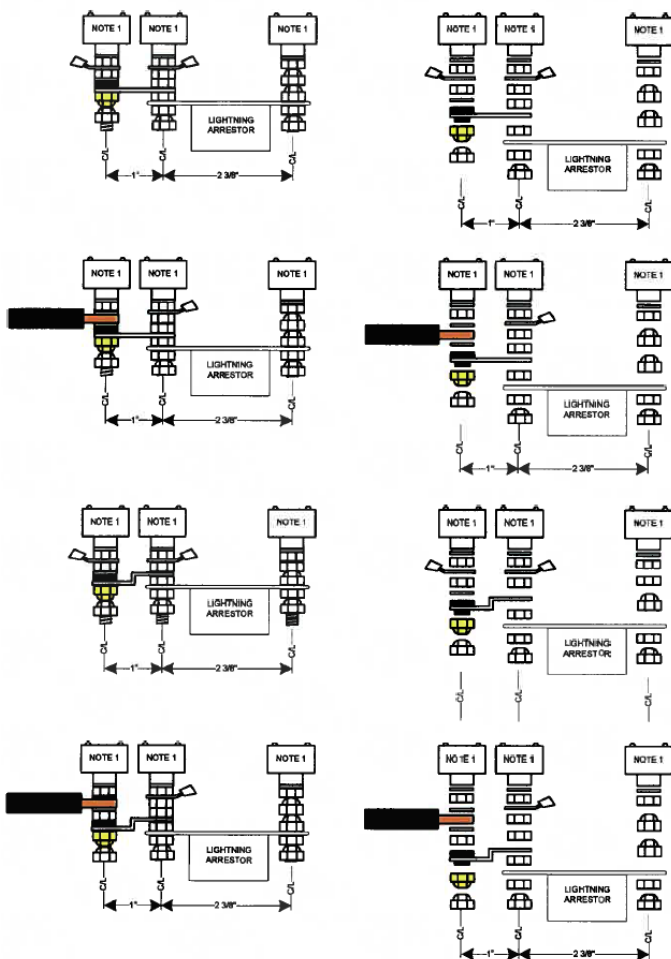


Figure 301-2: Main Terminal Board Through Hole (Not for new installation)



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Figure 301-3: Terminal Stacking Configurations



12.1. NOTE:

1. Bakelite terminal block 023390-11x
2. Bakelite through-hole terminal block 023275-12x
3. Bakelite insulation block 023275-2

302 - Location and Clearance of Wayside Equipment

1. Purpose

- 1.1. This practice describes the location and clearance of wayside signalling equipment. It applies to only new installations or major upgrading work that involves modifying the signal system arrangement.

2. Clearance

- 2.1. Figure 302-1 to Figure 302-5 illustrates the location and clearance of Wayside Equipment and Structures. It is important to install the signal equipment within the limits prescribed, and any deviation to clearance (walkway clearance included) shall be approved by Metrolinx.

3. Horizontal Clearance (From Rail)

- 3.1. The horizontal clearance shall be at least 3 m (10 ft.) from the outside head of the rail to the closest object. Horizontal clearance is measured from the nearest part of the equipment houses, case or other enclosure, signal mast, cantilever/signal bridge, communication tower, and any other free-standing object. Equipment houses and cases shall be placed at the maximum available clearance. Coordinate the location of equipment houses and cases with future electrification and proposed overhead catenary systems (OCS) pole foundations.
- 3.2. Propane tanks shall be at least 6.1 m (20 ft) from the outside head of the rail. Please refer to CSA "CSA B 149.2 Propane Handling Code" and the Ontario Electrical Safety Code (OESC) latest edition for more requirements.

4. Vertical Clearance

- 4.1. When a cantilever/signal bridge is used, the vertical clearance shall be 9.45 m (31ft) above the top of the rail to the lowest point of the signal structure.
- 4.2. Coordinate the cantilever/signal bridge vertical clearance requirements with future electrification and proposed overhead catenary systems (OCS) wires.

5. Electrical Supply Wires

- 5.1. Safe clearance distances shall be provided between signal and electrical supply wires, including messenger and neutral wires or cables. Refer to [SCP-1005 Protection Instructions to Excavators for S&C Infrastructure](#).

6. Hydro wires and conductors

- 6.1. Safe vertical and horizontal clearance distances shall be provided between wayside signal equipment (gantry walkway for access to the signal head) and low/high voltage Hydro lines; the value for the safe clearance distances shall be determined jointly by Metrolinx and the local Hydro authority using the following as a recommended guideline.
- 6.2. The minimum vertical clearances between Hydro wires/conductors and cantilever/overhead signal equipment shall be provided as specified in Ontario Regulation 627/05 Amending O. Reg. 213/91

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No object shall be brought closer to an energized overhead electrical conductor with a nominal phase-to-phase voltage rating set out in Column 1 of the Table below to this subsection than the distance specified opposite to it in Column 2.

Table

COLUMN 1	COLUMN 2
<i>Nominal phase-to-phase voltage rating</i>	<i>Minimum distance</i>
<i>750 or more volts, but no more than 150,000 volts</i>	<i>3 metres</i>
<i>more than 150,000 volts, but no more than 250,000 volts</i>	<i>4.5 metres</i>
<i>more than 250,000 volts</i>	<i>6 metres</i>

For the case where the overhead conductor has a voltage between 0.75 kV and 150 kV, no object shall encroach within a 3m radius, including a person who may be standing on the platform of an overhead structure to perform installation or maintenance activities. The distance from the platform to the wire shall account for a person with outstretched arms, which shall be a minimum of 2.4m. In this situation, the surface of the platform of the overhead structure shall be a minimum of 5.4m (3m + 2.4m) below the overhead conductor. An additional optional safety margin of up to 2m shall be considered when a person is present and may carry elongated tools or equipment, effectively reducing the 3m safety clearance. The additional 2m safety margin is not required for fixed structures.

- 6.3. The minimum horizontal clearances between Hydro wires/conductors and walkways for access to the signal equipment shall be as specified in Clauses 5.4.2 and 5.4.3 (CAN/CSA-C22.3 No.1) and summarized in Table 6. The data presented in Table 6 is for reference only and designs shall be based on the current revision of CAN/CSA-C22.3 No.1). Refer to Figure 302-7.
- 6.4. The minimum horizontal clearances between Utilities structures and railway tracks shall be as specified in Clause 5.5 (CAN/CSA-C22.3 No.1). The distance between Metrolinx right of way and the Utility structure shall be as required for utility maintenance, but not less than 1.1 m.
- 6.5. Suitable additional clearances beyond the minimum specified in the CAN/CSA-C22.3, No.1 might have to be provided as mutually agreed upon between Metrolinx and the local Hydro authority. The minimum vertical and horizontal clearance distances for the platform to the signal head are shown in Figure 302-8.

7. Walkway Clearance (Around Object)

- 7.1. The walkway clearance shall be at least 1.2 m (4 ft.) from the outermost sides of enclosures or structures to the edge of the flat ground (grade) surrounding the object. If a sufficient walkway is not provided, an embankment or a Metrolinx-approved structural platform shall be installed. All walkways shall be free of obstacles and debris which could cause a tripping hazard. In locations where there is more than a 0.61 m (2 ft.) drop-off or grade decline, a railing shall be installed.

8. Embankment

- 8.1. Signal structures and enclosures not installed at the same height as the top of the rail may require an embankment to be installed. Embankments should be constructed of ground material that can be compacted and topped with ballast or small stone to allow for proper drainage. The flat surface areas should be large enough to allow for the placement of the signal enclosure or structure, including its foundation, and a minimum 4 ft. walkway shall be provided. If there is more than a 2 ft drop off, prefabricated walls, such as Dixie Precast, shall be used to prevent the deterioration of the walkway. These walls come with a railing, as seen in Figure 302-5, to prevent falling down the decline.

9. Top of Foundation

- 9.1. The top of the foundation shall be no more than eight (8) inches above the surface of the ground. Proper drainage must be provided for enclosures. Foundations used to support signal structures must be level with the top of the rail and allow for the structure's base plate to be no higher than six (6) inches above the top of the rail.

10. Track Standard Track Clearance Requirements

- 10.1. Metrolinx Track Standards shall be followed for proper track center spacing and clearance from the track.

11. Dimensional Clearance Database

- 11.1. The Clearance Database is a record of all objects which fall within the Dimensional Clearance Envelope. A minimum of 7 ft. horizontal clearance on a straight track and a minimum of 9 ft. on a curved track is required to prevent reporting a dimensional clearance issue to the database. All Dimensional Clearance issues shall be reported in the Metrolinx database.

12. Dimensional Clearance Envelope

- 12.1. Where possible, signal equipment shall be placed outside the dimensional clearance envelope. Whenever conditions require locating signal equipment within the dimensional clearance envelope, an acceptable alternative may need to be applied. If an object must be within this allowed clearance distance, immediate notification shall be made to Metrolinx.

Figure 302-1: Location and Clearance of Signal Bridge

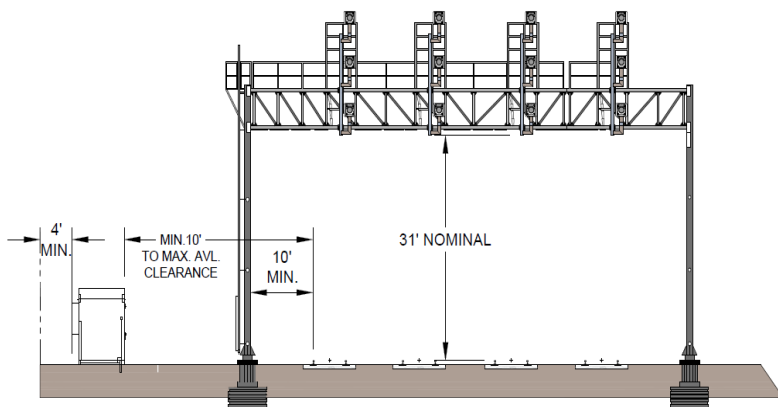


Figure 302-2: Location and Clearance of Signal Cantilever

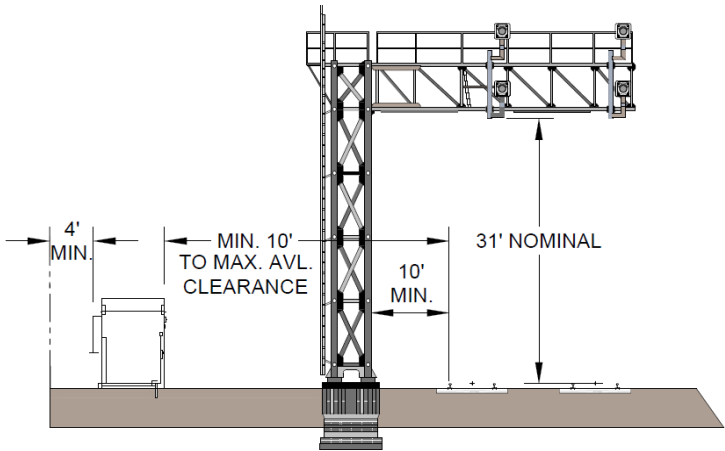


Figure 302-3: Location and Clearance of Signal Mast

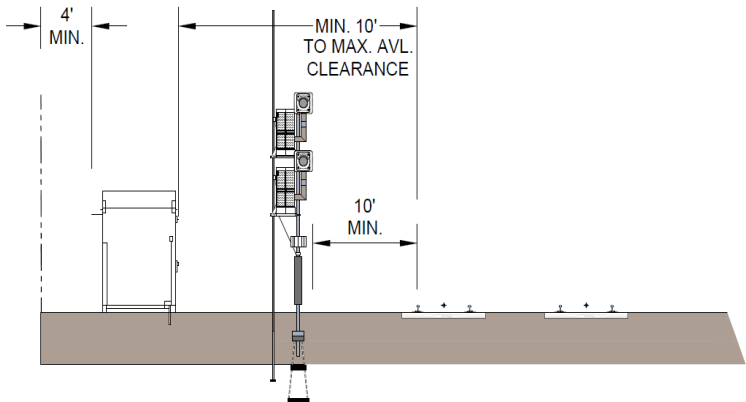


Figure 302-4: Location and Clearance of Wayside Enclosures

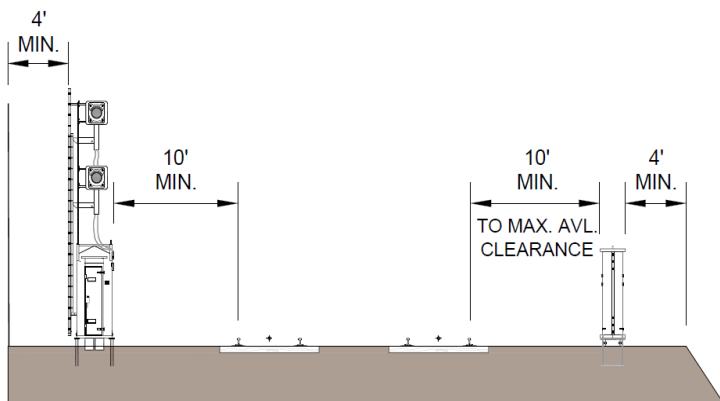


Figure 302-5: Dixie Precast Retaining Wall with Safety Railing

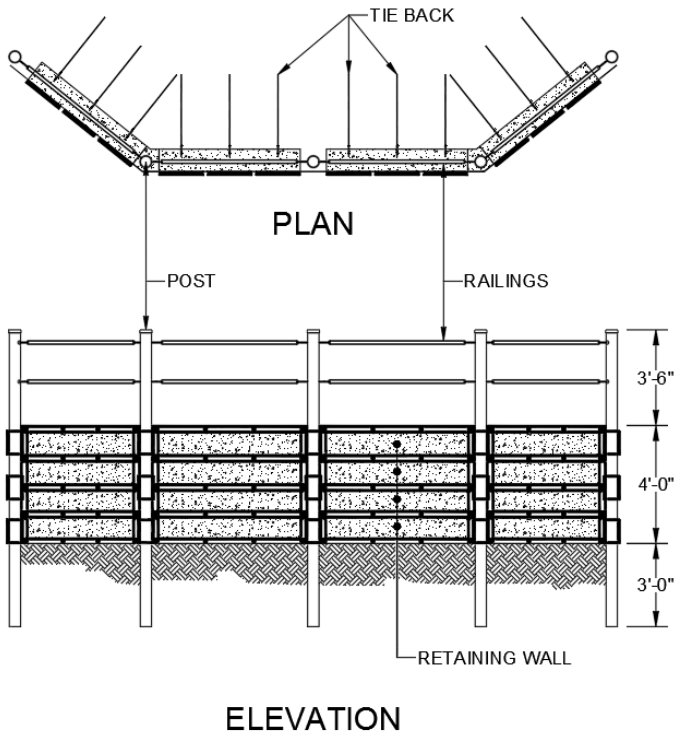


Figure 302-6: Table 6 of CAN/CSA-C22.3 No.1, "Overhead Systems", Canadian Electrical Code, Part 3

Table 6
Minimum horizontal design clearances between wires and railway tracks
(See Clauses 5.4.2 and 5.4.3.)

Wire closest to tracks		Minimum clearance, m	
		Main tracks	Siding
Guys; messengers; communication, span, and lightning protection wires; communication cables		2.5	1.9
Open supply-line conductors and service conductors of 0–750 V and effectively grounded continuous metallic sheathed cables of all voltages		2.5	1.9
AC	Open supply-line conductors and cables other than those having an effectively grounded continuous metallic sheath		
	> 0.75 ≤ 22 kV	2.7	2.1
	> 22 ≤ 50 kV	3.2	2.6
	> 50 ≤ 90 kV	3.5	2.9
	> 90 ≤ 120 kV	3.8	3.2
	> 120 ≤ 150 kV	4.1	3.5
Supply conductors > 150 kV		4.1 + 0.01 m/kV over 150 kV	3.5 + 0.01 m/kV over 150 kV
DC	Open supply conductors		
	0–750 V	2.5	1.9
	> 0.75 ≤ 100 kV	2.8	2.2

(Continued)

September 2020

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CSA C22.3 No. 1:20

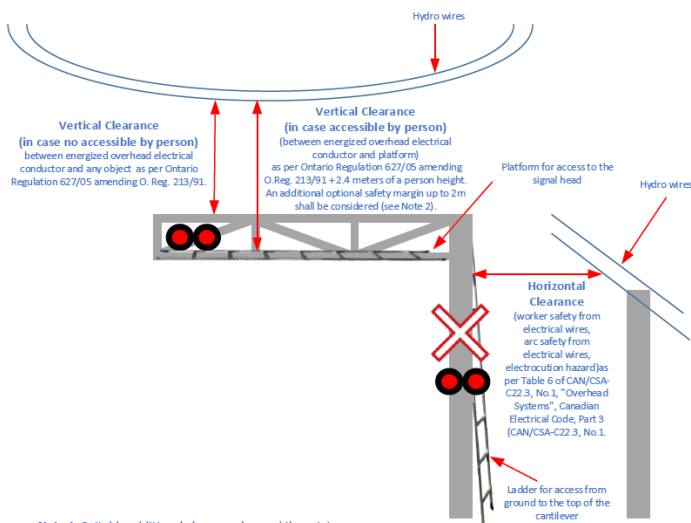
Overhead systems

Table 6 (Concluded)

Wire closest to tracks		Minimum clearance, m	
		Main tracks	Siding
> 100 ≤ 150 kV		3.0	2.5
> 150 ≤ 200 kV		3.3	2.7
> 200 ≤ 250 kV		3.5	2.9
> 250 ≤ 300 kV		3.7	3.1
> 300 ≤ 350 kV		4.0	3.4
> 350 ≤ 400 kV		4.2	3.6
> 400 ≤ 450 kV		4.4	3.8
> 450 kV		4.4 + 0.005 m/kV over 450 kV	3.8 + 0.005 m/kV over 450 kV

Note: Voltages are line-to-ground.

Figure 302-7: The minimum vertical and horizontal clearance distances



Note 1: Suitable additional clearance beyond the minimum specified in the CAN/CSA-C22.3, No.1 might have to be provided as mutually agreed upon between Metrolinx and the local Hydro authority.

Note 2: An additional optional safety margin up to 2m shall be considered in the case where a person is present and may carry elongated tools or equipment, that can effectively reduce the 3m safety clearance. The additional 2m safety margin is not required for fixed structures.

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501 - Safety Instructions for Work on Optical Fibre Telecommunications Systems

1. Purpose

- 1.1. There are numerous optical fiber communication systems (OFCS) installed along Metrolinx's right-of-ways. During normal system operation, an OFCS is completely enclosed and there is no optical energy accessible to personnel. However, during servicing, there is a risk of exposure to radiant energy that could represent a hazard to both the eye and skin. The American National Standard ANSI Z136.2 provides guidance for the safe use, maintenance, and servicing of OFCS utilizing laser diode and/or light emitting diode (LED).
- 1.2. When working with fibre optics in the field, employees must be aware of the hazards a fibre optic system can present. Whether splicing, terminating or testing, employees are exposed to a potentially dangerous environment.
- 1.3. The goal of this document is to provide an overview of the safety hazard to which employees are exposed while maintaining OFCS or restoring a severed fibre optic cable.

2. General

- 2.1. This Practice outlines the instructions governing safe working conditions for the protection of S&C employees engaged in work on optical fibre telecommunications systems utilizing Laser Diode and Light Emitting Diode (LED) sources. The following instructions cover the minimum safety precautions for work on optical fibres used in telecommunications systems and DO NOT replace or supersede any Federal or Provincial Acts or regulations governing this type of work.

- 2.2. Optical fibre telecommunications systems transmit pulses of light along very fine strands of glass or other transparent material. The repair and handling of optical fibers used in telecommunications systems have ocular (eye), mechanical, electrical, and chemical hazards that present several health and safety concerns.

3. Ocular (eye) Hazards - General

- 3.1. There is never any need to stare at the end of a severed cable and, as a practical safety precaution, one should avoid doing so. Nearly all communication systems use infrared light to communicate meaning light will not be seen.

Table 501-01

Type of Work	Procedure
General	<ul style="list-style-type: none"> Where the integrity of an optical fiber system is knowingly breached (repair/maintenance), do not bring the eye closer than 12 inches (30 cm) to the unprotected ends of damaged or severed optical fiber cables. In any situation where this minimum distance requirement cannot be maintained, laser protective eyewear with a minimum optical density of 4 (OD 4) must be worn. Always assume that every fiber is active and is using a LASER diode.
Cable Preparation and Splicing	<ul style="list-style-type: none"> Prior to starting the cleaning, cleaving, or splicing of optical fibers, disconnect any optical test equipment. During an emergency restoration the laser transmission systems may still be activated. Ensure the power sources are de-activated remotely or manually prior to splicing.

Continued on next page

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Type of Work	Procedure
Troubleshooting	<ul style="list-style-type: none"> A fiber optic power meter shall be used to make certain the fiber is not active since a hazard exists when inspecting connectors with a connector microscope. Because the exposed end of the fiber is viewed for an extended period of time through the microscope you must ensure that the fiber connector or patch cord is deactivated before viewing. Any exposed patch cord ends or connectors shall be capped immediately.
Troubleshooting	<ul style="list-style-type: none"> When using an optical tracer, visual fault locator, or continuity checker, which utilize a ruby red laser beam, the light beam should be observed from an angle at least 6 inches away from the eye.

4. Mechanical Hazards - General

- 4.1. Even though the optical fibers are very thin and flexible, it must be remembered that they consist of glass.
- a) The bare glass fibers have sharp ends, which will readily penetrate the skin. A "bare fiber" is a fiber that has had the primary coating removed, exposing the fiber's glass surface.
 - b) Microscopic splinters will result when optical fibers are broken. Hundreds of these scraps will be generated when splicing or terminating fiber during the cleaving process.
 - c) Severe eye damage could result from glass particles entering the eyes.
 - d) Precautions must also be taken to prevent ingestion of optical fiber cuttings and splinters. If fiber particles are ingested they can cause internal hemorrhaging.
 - e) When cleaving and splicing fibers, onlookers must wear safety glasses. Fiber scraps have been known to fly for several feet.

5. Mechanical Hazards – Specific Safety Instructions

- a) Protective gloves and shields should be worn, especially during cleaning, cleaving or splicing optical fiber.
- b) Wear disposable aprons if possible to minimize fiber particles on your clothing.
- c) Keep all cigarettes, food and beverages out of the work area. Always wear safety glasses with side shields. Fiber optic splinters are to be treated in the same manner as glass splinters.
- d) Never touch eyes or handle contact lenses while working with glass fibers until hands have been thoroughly cleaned.
- e) Every bare fiber scrap must be accounted for and disposed of properly. Never leave a fiber lying around with a bare-end exposed; always cut the fiber back to the coated area. When trimming off the bare end with snips, always cut on the coated part of the fiber, never on the bare glass.
- f) If a fiber scrap is spotted in the work area, maintain visual contact, and consider marking it with an ink pen or some other pointing object. Use tweezers to pick up and dispose of the scrap. Never attempt to drag it to the edge of the table.
- g) Work areas are to be well lit and work supplies and tools kept within reach. Include a magnifier in work area and place chair at a comfortable working height.

- h) Armored cables contain a tough metallic shield that is usually made of stainless steel. When preparing a cable for splicing or termination, gloves are to be worn as a protection from serious cuts caused by the cable armor. Leather or Kevlar™ gloves are a must during this operation. Most cables have a "rip cord" to slit the jacket. Use pliers or a glove to grip the cord to prevent injury.
- i) Thoroughly clean the work area once work has been completed.

6. Proper Disposal of Fiber Scraps

- 6.1. Proper disposal of bare fiber scraps is a must when working in the field.
 - a) Specifically designed disposal containers can be purchased. Alternatively, a disposal container can be made by using a small jar or solid container including lid, and marking it as dangerous fiber scraps.
 - b) Before disposal of the scrap container, ensure that the lid is tightly secured. Use two inch (2") wide duct tape or electrical tape to secure the lid by wrapping the tape completely around the container, then add a second layer of tape perpendicular to the first. The tape should completely cover the container, forming an envelope.
- 6.2. Place scrap container in a double layer of trash bags and then discard in a proper trash receptacle.

7. Electrical Hazards – Specific Safety Instructions

- 7.1. The armored sheath of fiber optic cable is usually grounded only at splice points, and these ground points are often miles apart. Should the cable become energized, the technician may become an easy path to ground.
 - a) Test the fiber optic cable for hazardous current before handling, and always apply temporary grounding and bonding harnesses to the cable while working with it.

8. Chemical Hazards – Specific Safety Instructions

- 8.1. Some splicing or terminating procedures may require the use of adhesives, solvents, or other chemical substances. While it may seem simplistic, read all safety precautions before handling any chemical.
- a) Gloves must be worn to protect the skin as instructed on the warning label of the chemical in use.
 - b) When using a volatile chemical, keep the work area well ventilated.

601 - Bar Coding Standards for S&C Equipment

1. Purpose

- 1.1. It is standard practice to apply bar codes to certain types of wayside S&C equipment. Bar coding provides the ability to manage equipment inventory efficiently by permitting easy and quick retrieval of specific location and equipment records. Unique numbers ensure there is no duplication of records or conflicts with equipment manufacturer's bar code systems.
- 1.2. The intent of this SCP is to identify which equipment requires bar coding, where bar coding should be applied, and what type of bar coding to apply.

2. When to Apply Bar Codes

- 2.1. Bar codes shall be applied to wayside equipment when installed, and upon subsequent replacement of equipment.

3. Bar Code Specifications

- 3.1. This table describes the specifications for the bar code labels currently being used.

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Table 601-01

Current Method	Criteria
Label (Face Stock)	<ul style="list-style-type: none"> • Polyester, 0.0036 - 0.0044 inches thick • Colour - White • Finish - Matte
Adhesive	<ul style="list-style-type: none"> • Acrylic • Adhesion - Permanent • Activation - Pressure Sensitive • Nominal application Temperature 50°F.
Size	1.5 inches long x .25 inches wide - (4 UP)
Bar Code	<ul style="list-style-type: none"> • Human readable - MX authorized alpha code and 7 numbers • Bars - Code 128C at 0.015 inches, 7 numbers
Liner	<ul style="list-style-type: none"> • Paper, Cls silicone • Thickness 0.0024 to 0.0026 inches • Release level 10 to 50 grams
Environmental	<ul style="list-style-type: none"> • Service Temperature -40 to +257°F. • Storage Conditions 32 to 77°F • Shelf Life - 12 months maximum

4. General Location of Bar Codes

4.1. Bar codes shall be located on ground equipment identified in the following table.

Table 601-02

Bar Codes shall be applied to...	Where...
Bungalows	On the upper left hand corner of the main entrance terminal board.
Cases	At the top left side of the main entrance terminal board, immediately below the AC load center.
Electric Switch Machine	Site log book and enter switch # ID on sheet.
Switch Circuit Controller	On the top side of the bakelite terminal block or site log book and enter ID box on sheet.
Electric Lock	On the relay slot or site log book and enter ID on sheet.
Gate Mechanism	On the housing frame which separates the gear section from the contactor/motor section.

5. Relays, S.L. Mechanisms and Locations of Bar Codes

5.1. Bar codes shall be located on vital relays and searchlight mechanisms as indicated in the following table.

Table 601-03

Bar Codes shall be applied to...	Where...
Ansaldo (US&S) Plug-in Relays	Centered, on the front, at the extreme bottom of the relay case.
Alstom (GRS) and Siemens (Safetran) Plug-in Relays	On the front of the relay case.
Shelf Type Relays	On the front upper portion of the relay case.
Searchlight Mechanism	Horizontally on the rear side of the mechanism case.

6. Electronic Equipment and Locations of Bar Codes

6.1. All wayside electronic equipment, such as signal control equipment (VPI's, GEO, Electrologixs, Genrakode, Electocode, Line Overlay's, CN2000, etc), crossing control equipment (GCP's, MS's, HXP's, Electrologixs XP4, etc), WIS systems (DHP2000's, STC's, AEI's, etc), and radio systems (BSCE's, MCP's, BCP's, etc) shall be bar coded, as indicated in the following table.

Table 601-04

Bar Codes shall be applied to...	Where...
Chassis	Horizontally, on the front side of the chassis.
Circuit Board	Either horizontally or vertically, on each printed circuit board of the unit.
Power Supply	Horizontally on the visible surface of the power supply, if applicable.

7. Other Equipment and Locations of Bar Codes

7.1. Bar codes shall be located on other equipment as indicated in the following table.

Table 601-05

Bar Codes shall be applied to...	Where...
Chargers	Horizontally, on the front side of the charger chassis.
Electronic Stick Timers	Horizontally, on the front side of the case.
AC/DC Track Circuit Equipment	EPC - Horizontally, on the front side of each module; Style C Converters - Horizontally, on the front side of the chassis
Fixed Radios (Not Handhelds or Mobiles)	Horizontally, on the front side of the chassis.
Crossing Monitors	Horizontally, on the front side of the chassis.
Remote Crossing Activators	Horizontally, on the front side of the chassis.

701 - Procedures to be Followed by S&C Personnel in the Event of an Incident Involving a Grade Crossing Warning System

1. Purpose

- 1.1. The purpose of this practice is to provide guidelines for the first employee on scene and to describe investigation criteria in a form that will assist the investigator to comprehensively report an incident's circumstances and more readily recognizing the causal factors associated. It is intended as a source of reference to supplement practical experience.
- 1.2. This practice recommends the procedures to be followed by S&C personnel in the event of any incident involving a Grade Crossing Warning System.
- 1.3. NOTE: For convenience, a shorter term "Warning System" is used herein.
- 1.4. It is designed to aid S&C Personnel on scene and/or responsible for investigating and reporting incidents involving Warning Systems.
- 1.5. No attempt has been made to deal with all the variables associated with incident investigation other than to outline certain guidelines that will provide a point of departure in the total investigative process.

2. Standardized Incident Reporting

- 2.1. In addition to reporting consistency, the ultimate value of a standardized system of incident reporting techniques is to produce a uniform database from which meaningful comparisons of incident information can be made and used to affect preventative and corrective measures.

3. References

- 3.1. The following documents should be referred to in conjunction with this practice:
- a) Grade Crossing Warning Systems Post Incident Checklist

4. Definition of Incident

- 4.1. The term "Incident," in this practice, is defined as "Any accident, damage to equipment, malfunction or failure to operate as intended."

5. Evidence

- 5.1. In the event that equipment is requested as evidence by an outside investigator (Police, Coroner, or other), the request must be referred to Metrolinx BEFORE the equipment is released.
- 5.2. Be sure to record the identification and state of the requested equipment in the presence of Metrolinx before allowing the release of any equipment.

6. Witness Information

- 6.1. Whenever possible, obtain identification, license numbers, etc., of any witness at the scene.

7. Statement to Media

- 7.1. When approached by the media for comments during an incident investigation, it is recommended employees restrict their statements to the following:
- 7.2. "It is company policy for employees not to comment on incidents during an ongoing investigation. Please contact Metrolinx".

8. Initial Employee at Scene

- 8.1. The "Initial Employee at scene" is defined as the first qualified Metrolinx designated S&C employee who arrives at the incident scene. This employee is usually the maintainer in charge of the affected signalling system; it could also be a Metrolinx designated adjacent territory Maintainer, a relief Maintainer, a Coordinator, or an S&C Supervisory Officer.
- 8.2. Prior to the arrival of the responsible Metrolinx authorized S&C Supervisory Officer, the S&C employee must identify themselves to local law enforcement officers or emergency responders when they arrive on the scene. They must advise law enforcement or emergency responders that they are waiting for the arrival of a responsible Metrolinx-authorized S&C Supervisory Officer or a Metrolinx S&C Officer. The initial employee on scene will "NOT" open or enter the equipment housing. The initial employee on the scene will "NOT" discuss the situation with news media or bystanders, only referring them to the officials in charge of the scene.

9. Supervisory Notification

- 9.1. The responsible Metrolinx authorized S&C Supervisory Officer must be notified immediately. The Supervisor should proceed to the location, assess the situation and follow the Metrolinx incident protocol.
- 9.2. If the responsible S&C Supervisory Officer is unavailable, another Metrolinx authorized Supervisory Officer must be notified immediately.

10. Metrolinx Authorized S&C Supervisory Officer Responsibility

- 10.1. The Metrolinx authorized Senior S&C Supervisory Officer is in charge and is held accountable for the overall coordination of the S&C portion of the investigation, having due regard for ongoing investigation of those areas outside the realm of their responsibility.

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- 10.2. After preliminary inspection and when work priorities have been determined and set in motion, other specific staff responsibilities should be established and assigned. This should be coordinated with Metrolinx.

11. Protecting the Grade Crossing and Rail Traffic

- 11.1. Any S&C employee who is made aware of a grade crossing warning system damaged to the extent that proper functioning is impaired must provide protection to vehicular and pedestrian traffic and rail traffic as required by [GI-301\(i\) Protecting Train Operation During Signal System Interruption](#).

Table 701-01

If	Then
Employee is unable to contact the RTC	If the situation presents a danger to other movements, follow CROR. If still unable to contact the RTC, the employee must attempt to enlist the services of a passerby or another Metrolinx employee to advise either the responsible Supervisory Officer or the RTC of the situation.
Employee is able to contact the RTC	The employee shall ensure that the RTC has or will arrange to either post a flagman and/or place a train movement restriction at the crossing.

12. Initial Investigation

12.1. The table recommends the required testing depending on the incident type being investigated.

Table 701-02

If the incident...	Then
Involves an accident between a vehicle and a train, whether or not it has resulted in personal injury or death	<p>The first employee on the scene must, as soon as practicable, in the presence of a witness (preferably a Police Officer):</p> <ol style="list-style-type: none"> 1. If the playback and/or event recorder download is available and after approval by a Senior Manager, Signals Maintenance Delivery, Metrolinx, for GI-310, a test must only be performed for the track(s) involving train movement(s) at the time of the incident. Otherwise, perform ALL tests prescribed by GI-310 Testing Grade Crossing Warning Devices and record the results for further review. 2. Perform additional test(s) as per Appendix 700A- GUIDELINES FOR TESTING AND INFORMATION RETRIEVAL.
Is an alleged malfunction of the warning system	The employee must perform all tests prescribed by GI-310 Testing Grade Crossing Warning Devices and record the results.
Is damage caused by vandalism	The employee should try to preserve evidence, if any, for Metrolinx.

NOTE: Refer to Accident/Incident Reporting and Report Keeping Procedure for added details.

13. Repairs

- 13.1. Repairs may commence only when instructed by the responsible Metrolinx authorized Supervisory Officer. Repairs must be made per [GI-301\(i\) Protecting Train Operation During Signal System Interruption](#).
- 13.2. All temporary repairs must be authorized by a Metrolinx designated S&C officer.
- 13.3. System or equipment repairs shall NOT be made until the following:
- a) It is known that the damage was a result of the incident, or
 - b) Tests are conducted to determine what effect the damage would have had on the normal operation of the system if the damage had occurred prior to the incident.

EXCEPTION: Failing exceptional circumstances or the need to ensure the health and well-being of passengers and employees, S&C personnel shall never remove or move any S&C equipment or material involved in a train incident from the accident site, unless first authorized by a Metrolinx Authorized S&C Supervisory Officer.

14. Defective Equipment

- 14.1. S&C equipment that is suspect or found to be defective must be replaced, and tagged as described in [GI-301\(j\) Replacing and Tagging Defective In-Service Equipment](#). The equipment must also be held in a secure location for possible further tests by Metrolinx or as potential evidence.
- 14.2. If it is not possible to transport the equipment without disturbing a particular state of the equipment, it should be moved as little as possible and only to the extent of placing it in a protected environment.

15. Operating Tests

- 15.1. Whenever an installation has been disarranged, complete operating tests must be performed to ensure safe operation before restoring the system to service.
- 15.2. 15.2.Coordinate with Metrolinx to arrange for operating tests as outlined in [GI-301\(b\) Installation & Commissioning Tests](#).

16. Report Equipment Damage - No Train Involved

- 16.1. If the accident involves equipment damage and no train is involved, the Metrolinx designated S&C Supervisory Officer shall submit a crossing incident report using Metrolinx Protocol for reporting injuries and accidents and forward a copy to Metrolinx.

17. Report Train - Vehicle Accident

- 17.1. If the accident involves a Train and a Vehicle, the Metrolinx designated S&C Supervisory Officer shall submit a report in letter form to Metrolinx. The report must reference the original Metrolinx Protocol for reporting injuries and accidents form and other forms and contain the following.
 - a) Findings and results of inspections and equipment/operating tests made in addition to those addressed above.
 - b) Identification, license numbers, etc., of any witnesses at the scene.
 - c) S&C costs incurred.
 - d) Dates of last check by Maintenance of Way employees, Metrolinx Designated Maintenance Contractors including S&C Maintainers and S&C Safety Assurance Specialists (Testman).
 - e) Original copy of Weekly Performance Logbook.

- f) If the Weekly Performance Logbook does not include the record of tests for at least (2) Months prior to the incident, the preceding Weekly Performance Logbook shall be provided.
- g) In addition, include any information considered pertinent to the incident, i.e. sketches, photographs, etc. All information to be marked and headed:

"FOR THE INFORMATION OF THE COMPANY'S SOLICITORS
AND THEIR ADVICE THEREON"

17.2. The complete report shall be forwarded to Metrolinx.

18. Accident/ Incident Investigation Protocol

- 18.1. All accidents or incidents do not represent the same potential for loss. The "Railway Accident/Incident Response, Procedure No.: RC-0401001", found in Mylinx, provides a means to evaluate the potential loss of an accident or incident and to prevent similar recurrences. Refer to this procedure to obtain the evaluation criteria and investigation requirements.

702 - Preferred Locations for S&C Housings at Grade Crossings

1. Purpose

- 1.1. This practice defines the preferred locations for S&C housings (bungalows, cases, and tool sheds) at grade crossings. It is intended to apply at grade crossings with or without warning devices.

2. Grand-Fathering

- 2.1. This practice is intended for new installations only.

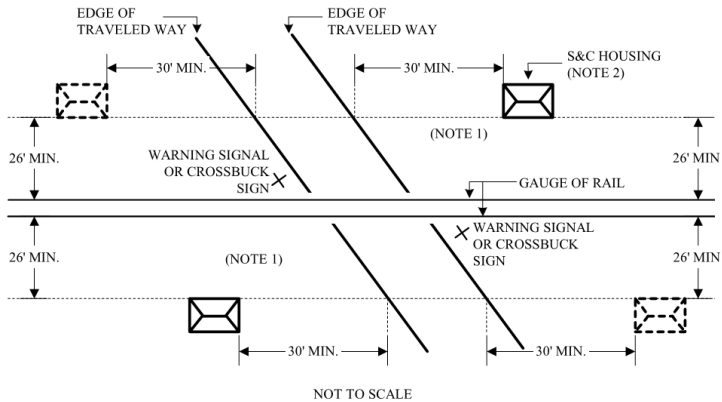
3. Sightlines

- 3.1. The overriding factor that requires consideration in determining the location of housing at a grade crossing is the sightline obstruction presence will cause to road users along the track.

4. Preferred Locations

- 4.1. As illustrated in Figure 702-1, the equipment housing should have a lateral clearance of at least 30 ft from the edge of the traveled way and at least 26 ft from the nearest gauge of rail. The Southwest and Northeast quadrants are preferred although any quadrant is acceptable.

Figure 702-1: Preferred Locations for S&C Housings at Grade Crossings



NOTE:

- Preferred quadrants
- S&C housing may consist of a bungalow, case, or tool shed.

5. Extenuating Conditions

5.1. Consult Metrolinx in the event that it is not practical to locate the house at the preferred locations.

703 - Cantilever Type Signal Structures and Flashing Light Signal Requirements at Grade Crossing Warning Systems

1. Purpose

- 1.1. This practice contains the general requirements for cantilever type signal structures and the allocation of flashing light signal units at grade crossing warning systems on Metrolinx Owned Corridors.
- 1.2. This practice applies to only new grade crossing warning system installations and when major upgrades are required to an existing system.

2. Regulatory Standards

- 2.1. Transport Canada (TC) has standards which define, to a certain extent, when cantilever structures are required. The reason they cannot be specific is that individual grade crossings may have characteristics which may dictate the use of these structures, over and above the criteria set forth in the regulatory standard. The goal of this document is to highlight the general criteria for cantilevers in order that railway personnel involved in the joint road authority and railway regulatory authority crossing safety inspections have a guideline to determine the need for cantilever type signals.

3. Purpose of a Cantilever Structure

- 3.1. The purpose of the cantilever structure is to mount additional flashing light units in a conspicuous location above the roadway to enhance the overall visibility of the warning light system to approaching vehicular traffic.

4. Grade Crossing Safety Inspection

- 4.1. Transport Canada (TC) grade crossing standards should be referred to when conducting a grade crossing safety inspection. Ultimately the final requirements regarding the need and configuration of a cantilever structure will be specified in the joint grade crossing safety inspection report. Refer to [SCP 1210-6 Grade Crossing Inspection Data](#).

5. General Factors to Consider

- 5.1. Some of the factors which should be considered by Railway personnel to determine the need for cantilever structures at grade crossing warning systems are:
- a) When the distance from the centre of the main mast to the centre of the travelled roadway, measured at right angles to the centre line of the road, exceeds 7.6 m (25 feet);
 - b) When the roadway approach has two or more traffic lanes;
 - c) When obstacles such as utility poles, sign posts, trees, parked vehicles (parking zone) will not permit the main signal mast light units to be viewed from the minimum safe stopping distance for the roadway and where the removal of the obstacles is impractical or not considered a permanent solution;
 - d) When the horizontal and vertical curvature of the roadway approach will not permit standard main mast signal lights to be viewed from the minimum safe stopping distance for the roadway; and
 - e) When background conditions such as neon signs impede the ability to determine the operating status of main mast-mounted light units.

6. Cantilever Structural Specifications

- 6.1. All grade crossing cantilever structures shall comply with AREMA, which defines the structural and ergonomic criteria for cantilever structures used at grade crossing warning systems. In most applications, Metrolinx utilizes single mast design structures with cantilever arms of 12 or 20 feet in length. Single main mast structures are usually supplied up to 30 feet in length although double main mast structures can be obtained in lengths up to 40 feet.
- a) In situations where cantilever arm lengths over 9 m (30 feet) are needed alternative methods such as median or island placement of additional mast- mounted signal units should be considered to avoid the use of the larger structures.
 - b) The standard vertical clearance of the cantilever arm is 17 feet, measured from the crown of the road to the lowest portion of the arm. This is essentially the standard height clearance for most roadways however there are known exceptions where 19 feet clearance has been specified by the road authority. The height requirement should always be verified and recorded during the joint crossing safety inspection meeting.
 - c) The length of the cantilever arm is typically measured from the centerline of the main mast to the end of the arm. Although some cantilever signal designs may vary, generally the “far end” flashing light unit assembly is typically installed on a vertical post at the end of the cantilever arm. This is an important consideration when determining the length of cantilever arm required.

7. Location of Light Units Multi-Lane Highways

- 7.1. The location of signal units on cantilever arms at multi-lane highways shall be as follows:
- a) Flashing light unit assemblies shall be provided for each lane;

- b) Flashing light unit assemblies should be located between the right hand edge and the centerline of the traffic lane being covered.

8. Bridge Structures

- 8.1. When circumstances require the use of a bridge structure instead of a cantilever type structure, the location of the signal units described herein shall still apply.

9. Examples

- 9.1. Figures 703-1 to 703-6 illustrate examples of various types of cantilever signal and light unit configurations. Additional flashing light units may be required depending upon the crossing configuration i.e. intersecting roadways.

NOTE:



Denotes centerline of flashing light pair



Denotes centerline of travelled way



Denotes acceptable light location

- ** 6'-0" minimum from the edge of travelled roadway and the clearance point of the warning device - plus 2'-0" to the centerline of the warning device mast.

Figure 703-1: Single Lane Without Curb

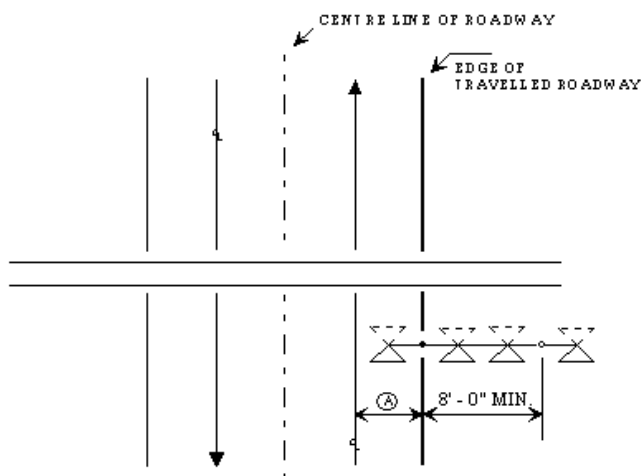


Figure 703-2: Single Lane Highway With Curb

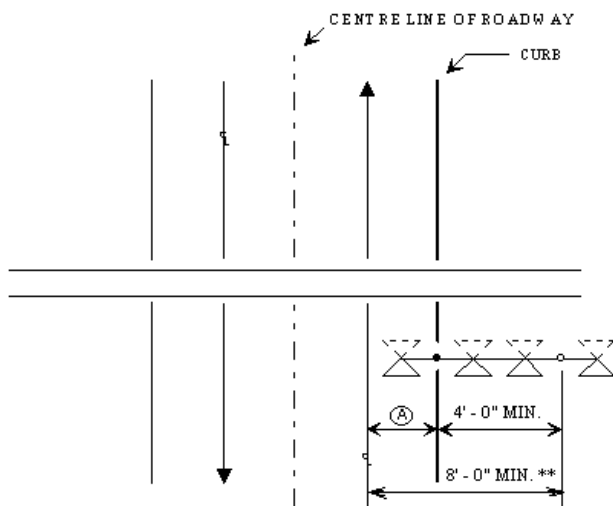


Figure 703-3: Single Lane Highway With Shoulder

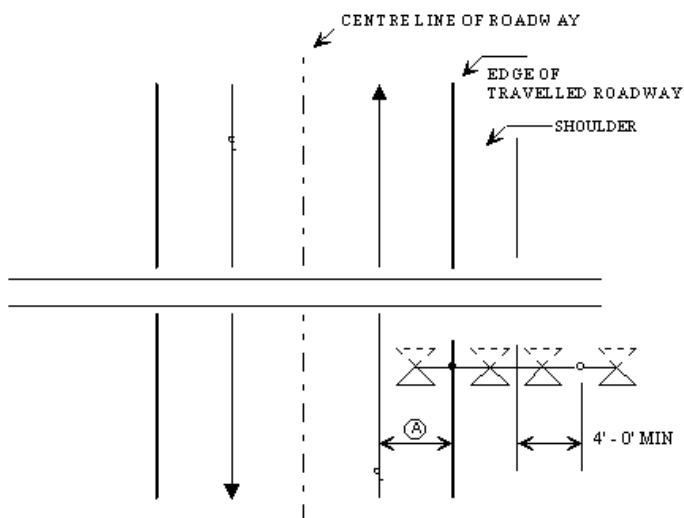
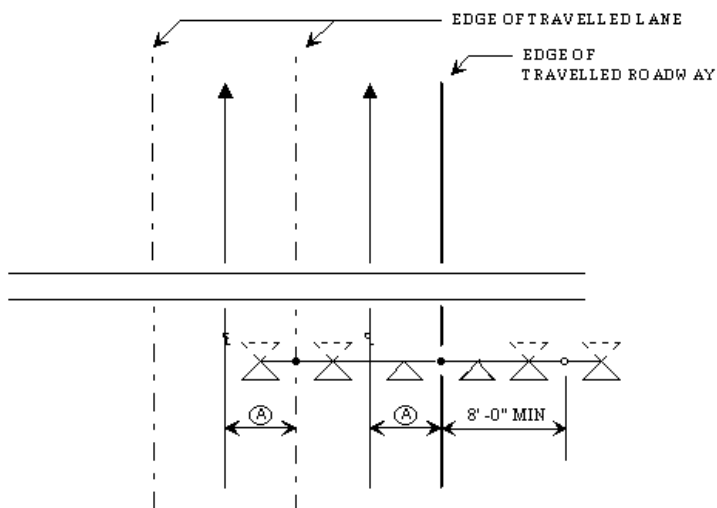


Figure 703-4: Multilane Highway Without Curb



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Figure 703-5: Multilane Highway With Curb

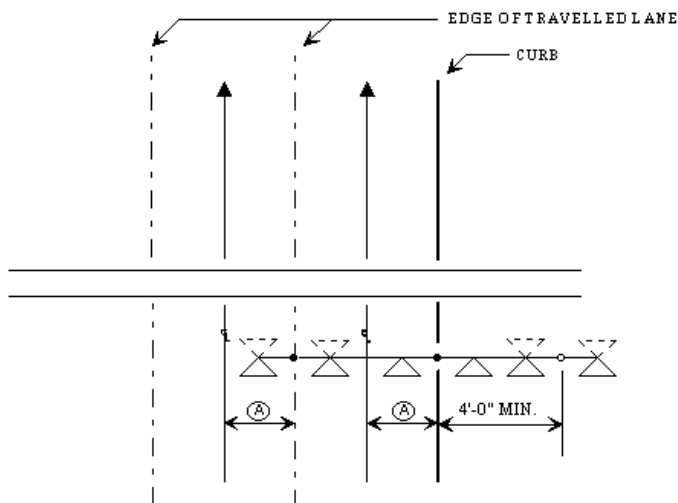
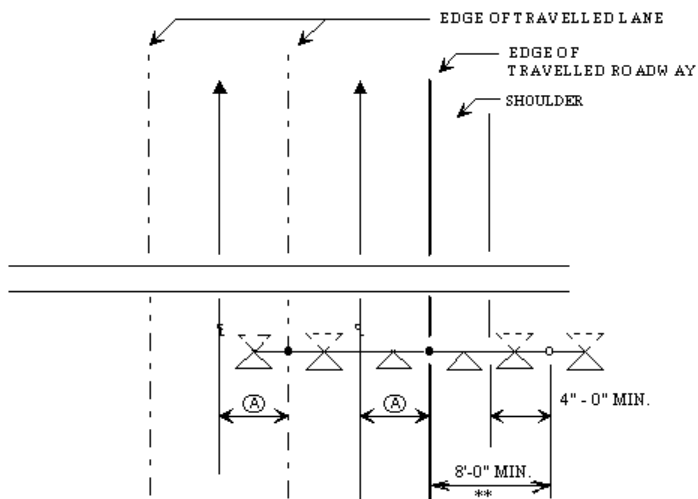


Figure 703-6: Multilane Highway With Shoulder



704 - Location and Clearance of Grade Crossing Warning Systems

1. Purpose

- 1.1. This practice describes the location and clearance of Grade Crossing Warning Devices used at Grade Crossing Warning Systems.
- 1.2. This practice is applicable to only new installations or major upgrading work that involves modifying the warning device arrangement.

2. Clearances

- 2.1. Figure 704-1 illustrates the location and clearance of Grade Crossing Warning Devices. It is important to install the devices within the limits prescribed.

3. Extenuating Conditions

- 3.1. Whenever conditions exist that would prohibit locating the warning devices within the limits prescribe herein, Metrolinx Authorized Signal Designer must be advised prior to commencing installation and an acceptable alternative applied.

4. Horizontal Clearance Offset

- 4.1. Horizontal clearance offset is measured from the closest part of the signal background, wind bracket, or bottom of gate arm in its upright position - up to 5.2 m (17 ft) above the crown of the roadway.
- 4.2. In the case of a gate located in a median, as referenced in Section 14, this also includes the counterweight arm with the gate in the horizontal position.

5. Horizontal Clearance (Curb)

- 5.1. When there is a curb, a minimum horizontal clearance of at least 0.6 m (2 ft) shall be provided from the face of the vertical curb.

6. Horizontal Clearance (Shoulder, No Curb)

- 6.1. Where there is a shoulder, but no curb, a horizontal clearance of at least 0.6 m (2 ft) from the edge of a paved or surfaced shoulder, and a horizontal clearance of at least 1.8 m (6 ft), from the edge of the traveled roadway, shall be provided.

7. Horizontal Clearance (No Shoulder or Curb)

- 7.1. Where there is no curb or shoulder, a horizontal clearance of at least 1.8 m (6 ft), from the edge of the traveled way shall be provided.

8. Vertical Clearance (Cantilever)

- 8.1. When a cantilevered-arm flashing-light signal is used, the vertical clearance shall be at least 5.2 m (17 ft) above the crown of the roadway to the lowest point of the cantilever, which is usually the signal unit. A maximum clearance of up to 6.2 m (20 ft) is allowed.

9. Vertical Clearance (Gate)

- 9.1. When crossing gates are used, the vertical height of the gate in the lowered position shall be between 1.1 m (3.5 ft) and 1.4 m (4.5 ft) above the crown of the roadway, measured from the bottom of the gate.

10. Vertical Clearance (Lights)

- 10.1. The vertical height of the background shall be between 2.3 m (7.5 ft) and 2.8 m (9.5 ft) above the crown of the roadway, measured from the bottom of the background.

11. Top of Foundation

- 11.1. Top of foundation shall be no more than four (4) inches above the surface of the ground. Proper drainage must be provided for the junction box.

12. Foundation Surrounding Ground

- 12.1. The slope away from the ground which surrounds the foundation, towards the traveled part of the road and the road shoulders, shall not exceed the ratio of 1:4 (rise over run). Other local surrounding ground restrictions may apply – consult local road authorities.

13. Electrical Supply Wires

- 13.1. Safe clearance distances shall be provided between the warning devices and electrical supply wires, including messenger and neutral wires or cables. Refer to [SCP - 1005 Protection Instructions to Excavators for S&C Infrastructure](#).

14. Gates Located in Median

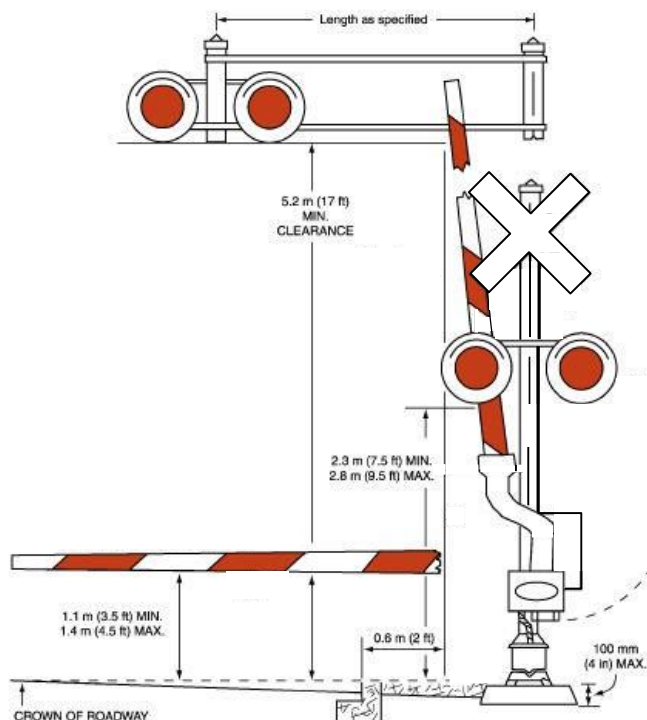
- 14.1. Where gates are located in the median, additional width may be required to provide minimum clearance for the counterweights supports.
- 14.2. Some gate mechanisms have counterweights extending fifty-five (55) inches from the center line of the mast when the gate is horizontal.

15. Cantilever Arms

- 15.1. Refer to [SCP - 703 Cantilever Type Signal Structure and Flashing Light Signal Requirements at Grade Crossing Warning Systems](#) for the location of flashing light signal units on cantilever arms.

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Figure 704-1: Location and Clearance of Grade Crossing Signals



705 - GCWS Safety Assurance Process

1. Purpose

- 1.1. This document describes the safety assurance process used by Signals & Communications when designing, installing and testing a Grade Crossing Warning System (GCWS).
- 1.2. The purpose is to describe the various forms and the documentation flow involved in the process.

2. SCP-1210 GCWS Safety Assurance Installation & Commissioning Process Review Checklist

- 2.1. This document is an overview of all the process critical information required to be kept during the crossing installation process. This form shall be used by the person responsible for collecting the various information or forms and keeping them together in a working file.

3. SCP-1210-1 Testing Certification Form

- 3.1. This form will be completed by the party responsible for performing the inside wiring, either an S&C person, or an outside supplier/contractor.

4. SCP-1210-3 GCWS Installation Safety Assurance Checklist

- 4.1. This document lists the minimum checks which must be performed for any grade crossing warning system or modification thereto, before placing the system in service. It is designed to provide guidance to the employees responsible by directing them to applicable tests required and identified in General Instructions. It is to be signed by the designated tester and the responsible Supervisory Officer, certifying the warning system has been installed and checked in accordance with all applicable rules and instructions.

5. SCP-1210-4 GCWS Plan Transmittal Notice

- 5.1. The purpose of this notification is to track the distribution of all crossing design plans to ensure all applicable drawings are distributed with the appropriate revision levels. When issued for construction, the Plan Transmittal Notice must be authorized by signature indicating that all safety critical aspects of the crossing have been addressed and properly engineered per S&C Standards.
- 5.2. The (a) version SCP-1210-4 is the transmittal notice to be used for internally generated drawings, while the (b) version is to be used by outside design contractors. In all cases, alternative customized transmittal notices may be used, however they must contain the same information content.

6. SCP-1210-5, SCP-1210-6, SCP-1210-7 Grade Crossing Data Form

- 6.1. The purpose of these forms is to record the physical characteristics of the grade crossing as they relate to an existing or proposed warning system, and are filled out prior to approval of the project. The forms are completed in the following sequence:
- a) Form 1210-5 is filled in by the Metrolinx upon request of a crossing installation or upgrade. It contains important train movement data, and is forwarded to the Road Authority upon its completion, along with a blank copy of Form 1210-7.
 - b) Form 1210-7 is filled in by the Road Authority, and contains important vehicular information. Upon its completion, the Form is returned with the 1210-5 to Metrolinx and designated Supervisory Officer, at which time a site meeting will be scheduled.
 - c) Form 1210-6 is filled in by the Metrolinx or designated Supervisory Officer at the site meeting.
- 6.2. The data on these forms is then used to develop the estimate of costs and to engineer the proposed warning system.

7. SCP-1210-9 GCWS – Record of Light Units

- 7.1. The purpose of this form is to record the type and degree of spread deflection of the roundels installed on the front and backs lights of each warning device. The form is signed by the Metrolinx authorized responsible Supervisory Officer, at the time of installation, verifying the correct roundels are installed. The original form shall be left in the facility for reference by Metrolinx authorized S&C Maintenance Contractor and retained as a permanent record of the roundel types installed.

8. Location Plan/ Board Plan/ Site Detail Drawing

- 8.1. This plan records the basic design criteria of the Grade Crossing Warning System such as warning device type, equipment location, and other pertinent information.

9. Operating Test Forms

- 9.1. These documents will vary depending on the type and complexity of the grade crossing warning system. Basically, an Operating Test form records all the operating tests (using simulated or actual train movements) required to ensure the warning system functions as intended. It is signed by Metrolinx authorized S&C Contractor responsible for conducting the tests.

10. Final “As Installed” Plans

- 10.1. During the installation process, there may be changes or modifications required to the vital circuit design. These can only be made with the prior approval from Metrolinx and Metrolinx's designated design contractor. All changes are recorded on a copy of the engineering plans marked "As Installed". They are to be signed by the authorized Metrolinx Contractor's responsible for the installation and testing. A copy shall be returned to Metrolinx and Metrolinx's authorized signal design contractor.

11. In Service Notification

- 11.1. An "In Service Notice" is issued to all concerned parties when the operating tests of the Grade Crossing Warning System operating tests are successfully completed and the Grade Crossing Warning System is placed in service. The notice is generated by Metrolinx.

12. Rail Corridors Infrastructure Handover Protocols

- 12.1. Metrolinx designated Supervisory Officer shall follow the Rail Corridors Infrastructure Handover Protocols (RC-0503-01) when the location is placed in service.

13. Filing

- 13.1. All copies of these forms and plans must be forwarded to the designated Supervisory Officer for filing in the appropriate file.

706 - Grade Crossing Device Light Unit Alignment Procedures

1. Purpose

- 1.1. The purpose of these instructions is to describe the proper method to align grade crossing warning system lights to ensure that maximum visibility is provided to approaching motorists.
- 1.2. This document contains instructions for the alignment of light units at grade crossing warning systems. These instructions apply to both new installations and existing installations requiring modifications or upgrading and apply to both 8 inch and 12 inch diameter light units (incandescent and LED).

2. Safety

- 2.1. Do not begin alignment procedures until all necessary precautions have been taken to ensure the safety of road, pedestrian, and rail traffic. Test the warning devices in accordance with [GI-310\(c\)\(4\) Light Alignment](#) once alignment procedures are completed.

3. Lighting Equipment

- 3.1. The lighting equipment identified in Table 706-01 has been selected based on its ability to provide the best light output to approaching vehicular traffic.

Table 706-01: Typical crossing with no intersecting street(s) located within the first 100 feet of the road approach.

Application	Position	LED	Incandescent Roundel Degree of Spread
Standard Flasher	Front	12"	30-15°
	Back	12"	30-15°
Standard Gate Mast	Front	12"	30-15°
	Back	12"	30-15°
Cantilever Arm	Front	12"	20-32°

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- 3.2. The lighting equipment identified in Table 706-02 has been selected based on its ability to provide the best light output to approaching vehicular traffic.

Table 706-02: Typical crossing with intersecting street(s) located within the first 100 feet of the road approach.

Application	Position	LED	Incandescent Roundel Degree of Spread
Standard Flasher	Front	12"	30-15°
	Back	12"	70°
Standard Gate Mast	Front	12"	30-15°
	Back	12"	70°
Cantilever Arm	Front	12"	20-32°
	Back	12"	20-32°

4. Incandescent Lights – Severe Sighting Situations

- 4.1. In cases where incandescent lights are used and the sighting angles are severe, but the overall road approach distance is relatively short (less than 330 feet), then 70° roundels may be required on the front lights as well as the back lights. Some examples of these situations are as follows:
- a) When all (4) road approaches run parallel to the track and meet at the crossing (thus forming a "H" intersection) all lights would have 70° roundels.
 - b) When (2) road approaches run parallel to the track and meet at the crossing (thus forming a "T" intersection) the light units facing the parallel road would have 70° roundels.

5. New Installations

- 5.1. New installations should be equipped with 12" LEDs. If installing new incandescent lights, the roundel spread types shall comply with these instructions. Installing alternate roundel spread types or 8" LEDs for new installations may only be done in special circumstances and only as authorized by Metrolinx.

6. Replacement and Upgrading

- 6.1. When roundels are changed at existing locations they should be replaced in kind. When upgrading, they should be changed to 12" LEDs, otherwise the roundel spread types should comply with these instructions. Upgrading with alternate roundel spread types or 8" LEDs may only be done in special circumstances and only as authorized by Metrolinx.

7. Alignment Procedures

- 7.1. Before starting, clean each LED module or roundel if necessary, using a mild soap solution (ammonia free), water and a clean, soft cloth.
- 7.2. Primary front light units shall be aligned through the center of the approaching traffic lane, or lanes, for which they are intended at a point in advance of the stop line or vehicle stop position at the crossing determined from the maximum road operating speed and road gradient.
- 7.3. The recommended alignment point distance is shown in Table 706-03 below. Please note that the recommended alignment distances include the maximum downgrade additions for heavy trucks, plus an additional buffer of 5%.

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7.4. If unable to align to the recommended alignment point distance, then use the appropriate base vehicle type and grade compensation factors in Table 706-03, align to that location and advise the responsible Supervisory Officer.

Table 706-03

Maximum Road Operating Speed	kph	40	50	60	70	80	90	100	110
	mph	25	31	37	44	50	56	62	68
Recommended Alignment Point Distance	m	80	130	160	220	250	335	420	480
	ft.	263	427	525	722	820	1099	1378	1575
Minimum Distance for Passenger Cars and Light Trucks	m	45	65	85	110	140	170	210	250
	ft.	148	213	279	361	460	558	689	820
Minimum Distance for Heavy Trucks	m	70	110	130	180	210	265	330	360
	ft.	230	361	427	591	689	869	1083	1181
Add for Percent Downgrade	5%	m	3	5	8	12	17	21	28
		ft.	10	17	27	40	56	69	92
	10%	m	6	11	19	30	42	53	71
		ft.	20	36	63	99	138	174	233
Subtract for Percent Upgrade	5%	m	2	4	6	9	12	15	20
		ft.	7	13	20	30	40	50	66
	10%	m	3	6	10	15	21	27	35
		ft.	10	20	33	50	69	89	115

7.5. Where additional pairs of light units are required for intermediate coverage, they shall be aligned to cover the intermediate areas of the road approaches. Where additional pairs of light units are required for a driver turning onto the road approach to a grade crossing from intersecting roads, lanes, parking lots or a property access, the light units shall be aligned to the point at which the drivers begin their turn.

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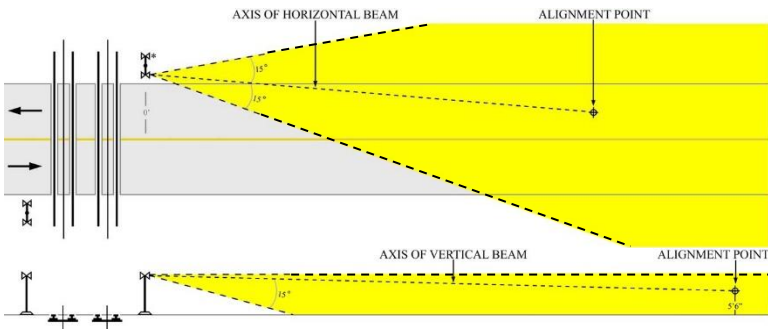
- 7.6. Where front light units are dedicated for sidewalks, recreation trails, pedestrian or bicycle paths, they shall be aligned to a point 1.6 m (5 ft 6 in) above the center of the sidewalk, trail, or path 30 m (100 ft) in advance of the warning signal or the point at which the light units first become visible if less than 30 m (100 ft).
- 7.7. All back lights shall be aligned through the center of the approaching lanes at a point 15 m (50 ft) in advance of the crossing warning signal on the opposite road approach. Refer to the following drawings on Sections 8-13.
- 7.8. Refer to the most applicable profile drawings, from Sections 8-13, to determine each alignment point while performing the following. If practical, continuously light one lamp of each pair during the alignment process.
- 7.9. For incandescent light units:
 - a) Open door wide so clear beam is displayed.
 - b) Adjust light unit vertically to align axis of beam 1.6 m (5 ft 6 in) at the selected alignment point determined from the profile drawing.
 - c) Adjust light horizontally to align axis of beam to the selected alignment point.
 - d) Maintain alignments, tighten clamps, and close door (if applicable).
 - e) Confirm light still aligned with cover closed by standing at alignment point and looking for even light around the center of the roundel.
 - f) Repeat the above steps for all light units.
 - g) Record alignment point distances of all light units on Form [SCP 1210-9 Signal - Safety Assurance Installation & Commissioning Check List](#). NOTE: this information should be used as a reference when conducting tests in compliance with [GI-310\(c\)\(4\) Light Alignment](#).
- 7.10. For LED units, be governed by the alignment point distances in Table 706-03 and Figures 706-1 to 706-11.

7.11. For optimum viewing, the following drawings should be printed in color.

8. Single Lane Light Alignment

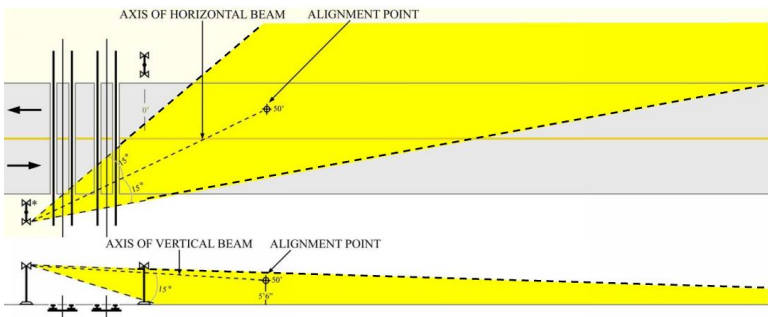
8.1. Front Light Unit Alignment

Figure 706-1: Incandescent Units with 30-15 Spread Lens and All LED Units (1 Lane, Either Direction)



8.2. Back Light Unit Alignment

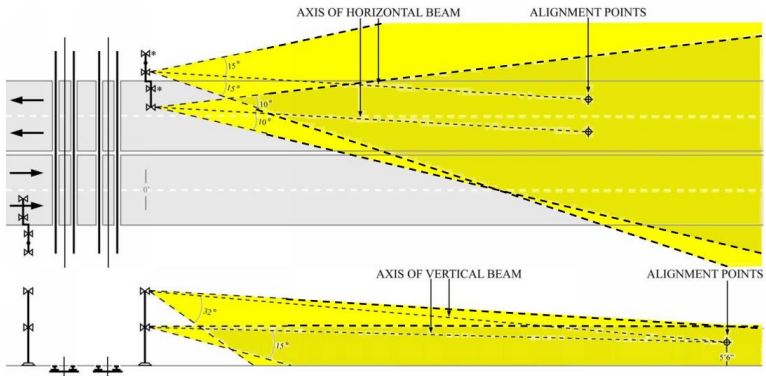
Figure 706-2: Incandescent Units with 30-15 Spread Lens and All LED Units (1 Lane, Either Direction)



9. Multilane Alignment

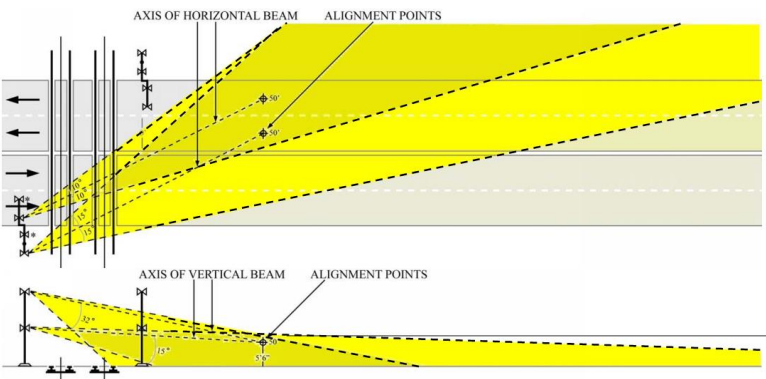
9.1. Front Light Unit Alignment

Figure 706-3: Incandescent Units with 30-15 Spread Lens on Flasher Unit, 20-32 Spread Lens on Cantilever Arm and All LED Units (2 lanes, Either Direction)



9.2. Back Light Unit Alignment

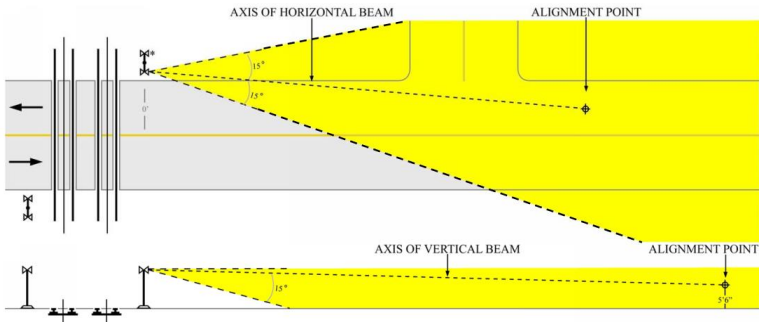
Figure 706-4: Incandescent Units with 30-15 Spread Lens on Flasher Unit, 20-32 Spread Lens on Cantilever Arm and All LED units (2 Lanes, Either Direction)



10. Intersection within 100ft of Crossing Light Alignment

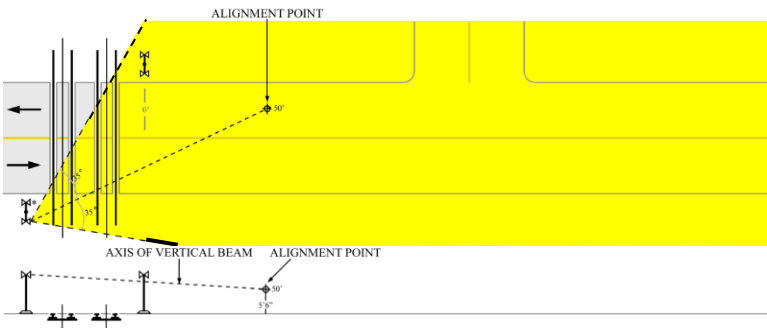
10.1. Front Light Unit Alignment

Figure 706-5: Incandescent units with 30-15 Spread Lens and all LED units (1 lane, either direction, intersecting street(s) within 100ft.)



10.2. Back Light Unit Alignment

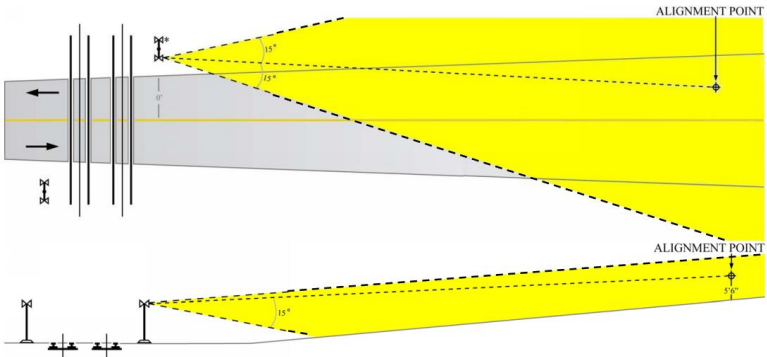
Figure 706-6: Incandescent Units with 70 Spread Lens and All LED Units (1 Lane, Either Direction, Intersecting Street(s) within 100ft.)



11. Single Lane Light Alignment (Downgrade)

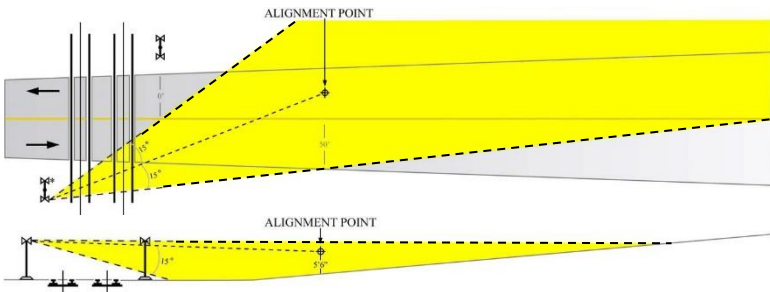
11.1. Front Light Unit Alignment

Figure 706-7: Incandescent Units with 30-15 Spread Lens and All LED Units (1 Lane, Either Direction, Downgrade)



11.2. Back Light Unit Alignment

Figure 706-8: Incandescent Units with 30-15 Spread Lens and All LED Units (1 Lane, Either Direction, Downgrade)



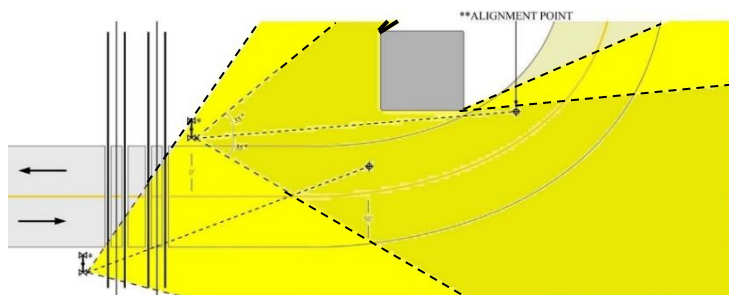
NOTE:

- The same procedure applies for both lights on each flasher unit.
- These drawings are not to scale. Refer to front light alignment distances charts (Table 706-03).

12. Curved Approach with Restricted Visibility Light Alignment

12.1. Front and Back Light Unit Alignment

Figure 706-9: Incandescent Units with 70 Spread Lens and All LED Units (1 Lane, Either Direction, Curved Road with Restricted Visibility)



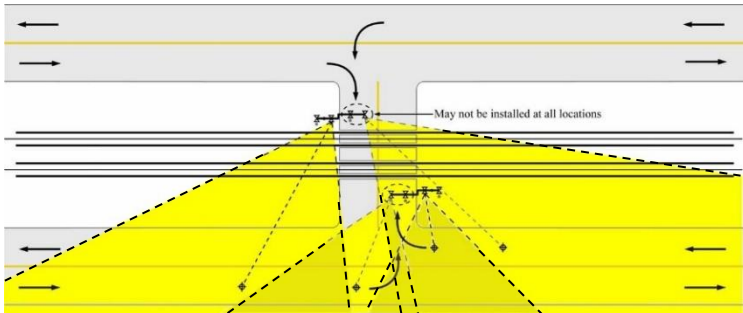
NOTE:

- If at least one set of front light units on a warning signal or cantilever at the grade crossing is not clearly visible to drivers in each lane of the road approach at the minimum distance as specified in the above table, the alignment point will be located at the furthest point in which the front light units are fully visible. An advance warning sign may also be required at a distance from the crossing that takes into account road geometry, vehicle types, and speed limit.
- Vertical alignment for any 70° Spread Lens is always the same (see Back Light Unit Alignment with an intersecting street).

13. H or T Intersection Light Alignment

13.1. Front and Back Light Unit Alignment

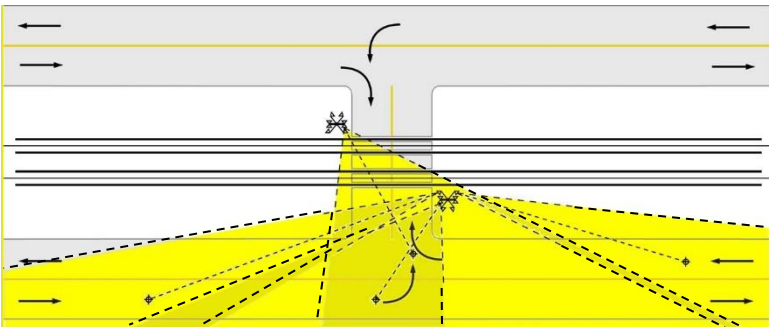
Figure 706-10: Incandescent Units with 70 Spread Lens on Main Flasher Unit, 20-32 Spread Lens Light Units on Cantilever Arm and All LED units (H Intersection or T Intersection)



13.2. Above is the recommended light setup for any intersection with a nearby approach. If more lights are required for certain circumstances, contact Metrolinx.

13.3. Vertical alignment for any 70° Spread Lens is always the same (see Back Light Unit Alignment with an intersecting street).

Figure 706-11: Incandescent 70 Spread Lens on Main Flasher Unit, and All LED Units (H Intersection or T Intersection)



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- 13.4. Above is the recommended light setup for any intersection with a nearby approach. If more lights are required for certain circumstances, contact Metrolinx.
- 13.5. For vertical alignment of lights, see previous examples provided.
- a) The same procedure applies for both lights on each flasher unit.
 - b) These drawings are not to scale. Refer to front light alignment distances charts (Table 706-03).

707 - Excavation & Installation

Guidelines for Sectional Foundations

1. Purpose

- 1.1. This practice describes the method of installing pre-cast sectional foundations for grade crossing cantilever signal structures.

2. Prior to Excavation

- 2.1. Prior to any excavation, locate all underground utilities (electricity, telecommunications, gas, water, etc) and ensure the work will not interrupt these services.

3. Barricades

- 3.1. Install safety barricade around work area with appropriate safety signs and flashing lights to prevent pedestrians from entering the work site.
- 3.2. Barricade the nearest traffic lane of roadway over a 10 m (33 ft) length for the oncoming traffic side of centerline of the proposed mast location, to divert heavy trucks from the curb while excavating and backfilling, see Figure 707-03.

4. Excavations

- 4.1. All un-shored temporary excavations in stable firm ground to be cut according to provincial construction safety guidelines. As a general guideline, cut 1H: 1V with the bottom-most meter vertical, see Figure 707-02.
- 4.2. For conditions where soft ground or high-water table are present, consult the Provincial Safety Standard. A heavy woven geotextile with a weight of 1 km/m² can minimize the problem. Material should be spread over bottom and all sides slopes of excavation before installing pre-assembled liner plates.

- 4.3. Soft ground is ground that is not capable of carrying the weight of an average person, such as peat, wet silt, soft clay and saturated sands.

5. Backfill

- 5.1. Backfill to be hard, clean free draining well graded 20 mm (3/4 inch) crushed stone or clean sand and gravel approved for local highway roadway construction, compacted to 250 mm lifts (10 inches) with 4 passes of tamper. Avoid using stone dust and soft, shale type materials, see Figure 707-01.

6. Retaining Structure

- 6.1. Retaining structure to be made up of galvanized, 4 mm thick, 2.4 meters (7.9 feet) diameter, 2 meters (6.5 feet) high liner plates with overlapping joints in each ring. Structure to be assembled at ground level and lowered into excavation as a complete unit (see Figure 707-1 to Figure 707-7).

7. Excavations Left Overnight

- 7.1. Excavations should not be left open overnight. If it is not possible to complete the backfilling in one day, the bottom portion must be backfilled up to within 1.5 meters of final grade and open excavations must be fenced before leaving the site.

8. Steep Slope

- 8.1. In case of steep slope, add an additional retaining wall and more fill material further down the slope for added structural support.

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Figure 707-1: Backfill Gradation Guidelines

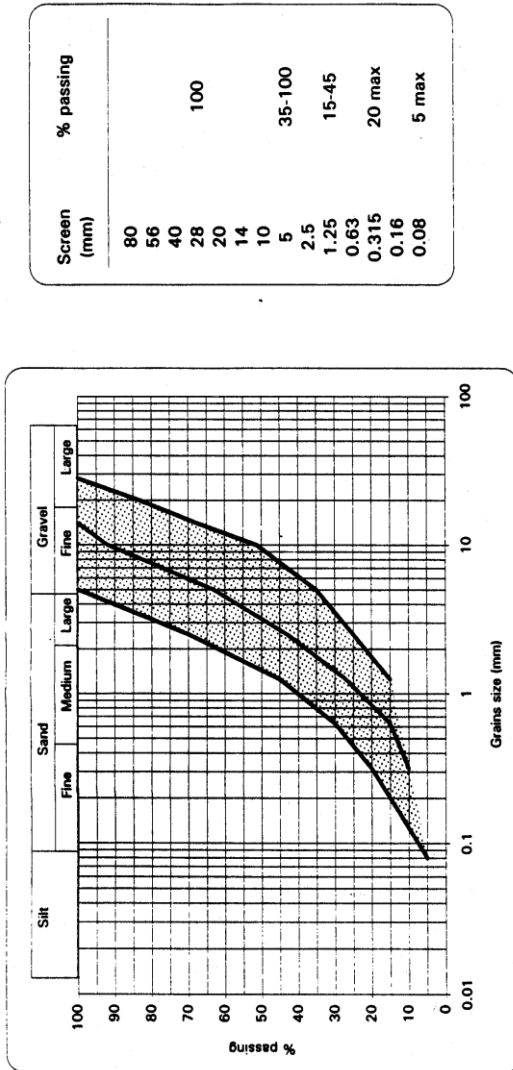


Figure 707-2: Minimum Unshored Excavation Safety Requirements

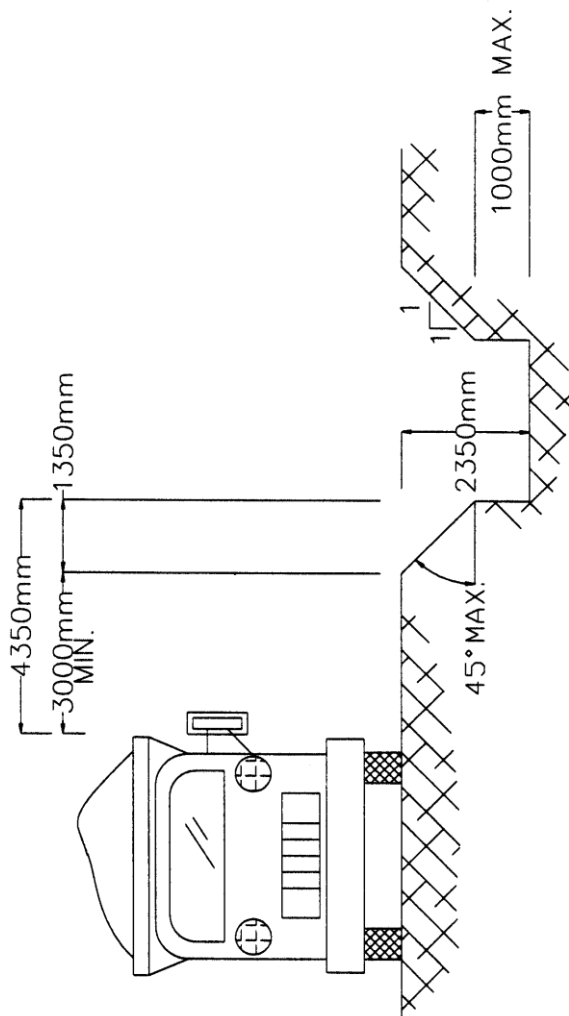


Figure 707- 3: 3-Dimensional Aerial Cut- Away View

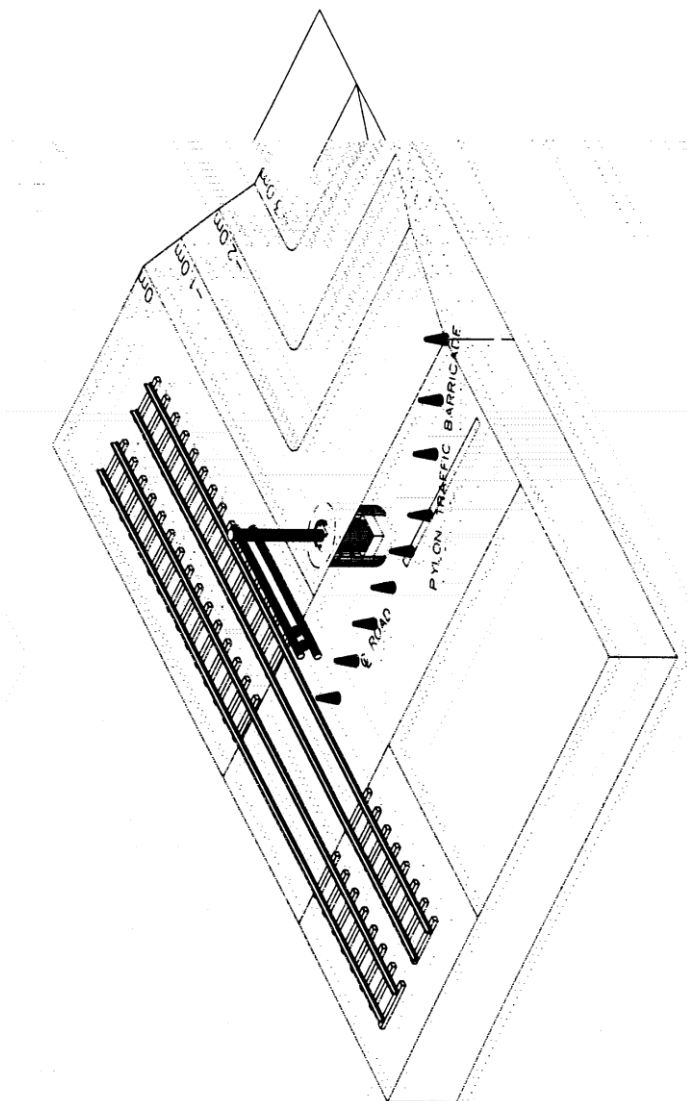
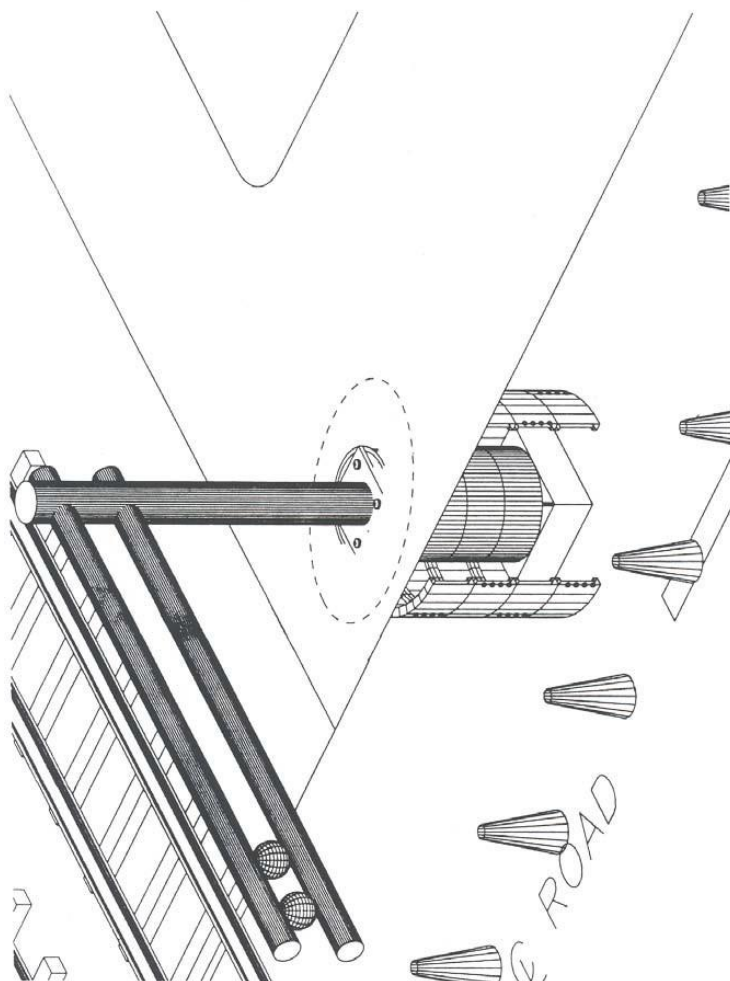


Figure 707-4: Typical Installation Close-up View



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Figure 707-5: Plan View

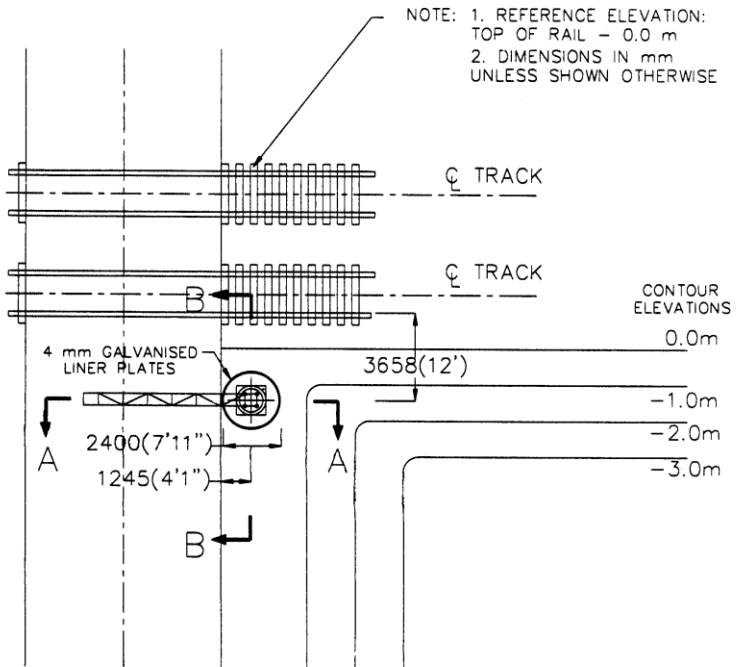
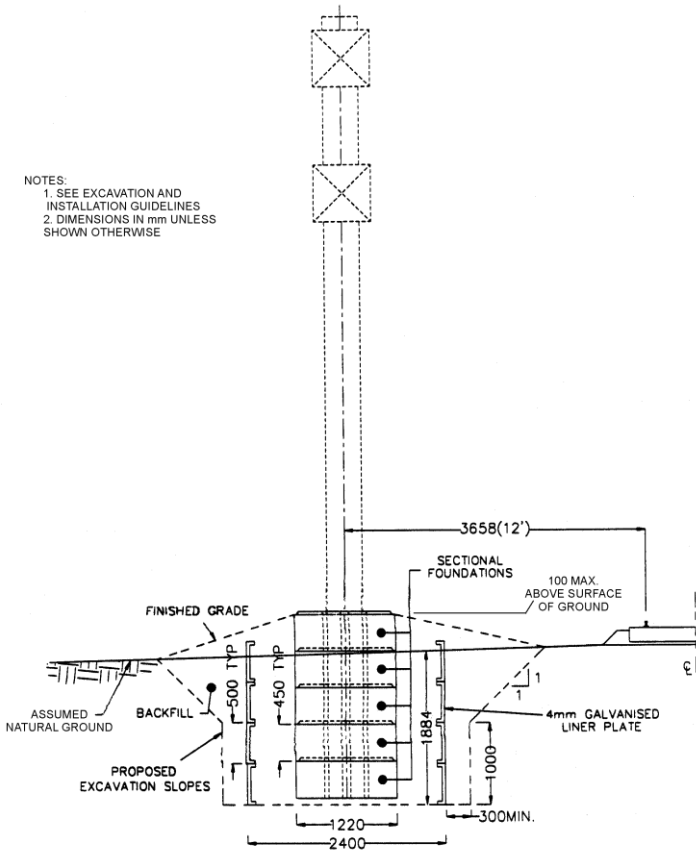


Figure 707-6: Curbside Section A-A



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Figure 707-7: Railside Section B-B



709 - Procedures to be followed by S&C Employees in the Deactivation of Grade Crossing Warning Systems

1. Purpose

- 1.1. These procedures are to be followed by S&C employees during formal deactivation of Grade Crossing Warning Systems (GCWS).

2. When to Deactivate

- 2.1. Deactivation of the crossing warning system is necessary when:
 - a. Track or signal work result in the inadvertent or excessive operation of the warning system, or
 - b. Crossing system troubleshooting or maintenance activities may create excessive operation of the warning system, or
 - c. Train disabled on approach causing the crossing to nuisance ring.
- 2.2. Although the crossing will nuisance ring while performing periodic inspections or tests in accordance with [GI-310 Testing Highway Grade Crossing Warning Devices - General](#), it is generally accepted that SCP-709 deactivation is not required in most of these circumstances.
- 2.3. However, if the inspections or tests will interfere with the safe operations of trains, then positive protection must be in place in accordance with [GI-301\(i\), Protecting Train Operations During Signal System Interruptions](#).
- 2.4. While performing GI-310 inspections and tests, every effort must be made to keep nuisance ringing to a minimum while also maintaining high visibility to the traveling public (such as by use of red traffic cones or rotating beacon).

- 2.5. There may be circumstances where the work being performed may cause the crossing to nuisance ring sufficient to warrant SCP-709 deactivation, such as when relays are being removed for electrical testing.

3. When SCP 709 is Not Used to Deactivate

- 3.1. SCP 709 is not to be used where crossings or portions of crossings are to be removed from service (deactivated) for extended periods of time. In this case an approved circuit revision shall be used in conjunction with a formal handover protocol to Rail Corridor Maintenance. Refer to [GI 301\(d\) Performing Vital Circuit Revisions](#) and adhere to the following instructions.
- 3.2. Protection in the form of a GBO or special instructions must be applied to the crossing or portion of crossing being deactivated. Refer to [GI 301\(i\) Protecting Train Operations During Signal System Interruptions](#).
- 3.3. The number of GBO or special instruction applied must be added to the approved circuit plan pages modified.
- 3.4. Wiring modifications must be tagged and remain tagged until the crossing or portion of the crossing is restored to service.
- 3.5. The circuit plans must be restored to the as-built state and the In-Service Protocol is to be used when the crossing or portion of the crossing is restored.
- 3.6. The GBO or special instruction can be removed once the In-Service protocol has been finalized.

4. Definitions

- 4.1. Deactivation: Inhibiting the normal functioning of the GCWS to prevent excessive nuisance ringing. This includes preventing lights from illuminating, bells from ringing, or gates from dropping.
- 4.2. Reactivation: GCWS is put back in full operation and fully tested as described by the procedures herein.
- 4.3. RTC: The term "RTC" refers to Rail Traffic Controller.

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- 4.4. Constant Warning Time Device (CWTD): A GCWS controller which activates the GCWS at a preset number of seconds regardless of train speed.
- 4.5. Yard Master (or Yard Coordinator): is the person in charge with train movements in a yard.
- 4.6. Full deactivation: To utilize a single point of deactivation to ensure that the public safety warning devices of a GCWS will not operate, even though train detection systems are still fully functional. Test Key may remain operational in this scenario.
- 4.7. Partial Deactivation: Disabling one or more of the components of the train detection system or public safety warning devices of a GCWS while leaving remaining components operational.
- 4.8. Pre-emption: The transfer of normal operation of highway traffic signals to a special control mode. When highway traffic control devices (traffic lights, etc.) are located near a railroad crossing which is equipped with a warning system, the systems can be interconnected so the crossing warning system will provide two contact closures to the traffic control devices when: the crossing warning system starts to operate the lights, or a specified time period before the crossing warning system starts to operate the lights. When highway traffic control devices (traffic lights, etc.) are located near a railroad crossing which is equipped with a warning system, the systems can be interconnected so the crossing warning system will provide one or more contact closures to the traffic control devices when: the crossing warning system starts to operate the lights, or a specified time period before the crossing warning system starts to operate the lights. Thus, on the approach of a train, the normal operation of the traffic control devices is pre-empted in favor of a higher priority or special operation by the contact closure from the crossing warning system.
- 4.9. Simultaneous Interconnection: Notification of an approaching train is forwarded to the IHTSD simultaneously upon activation of the GCWS. This would be considered as Interconnection with No Pre-emption.

- 4.10. Advance Interconnection: Notification of an approaching train is forwarded to the IHTSD for a predetermined period of time prior to activation of the GCWS. This would be considered as Interconnection with Pre-emption.

5. Deactivation Planning

- 5.1. Prior to deactivating a GCWS, the S&C employee responsible for Deactivation must conduct deactivation planning and obtain a clear understanding and agreement upon the method of deactivation & reactivation to be used with Supervisory Officer.
- 5.2. Deactivation planning must include the following:
- a. Reviewing applicable circuit plans;
 - b. Selecting the method of crossing and/or track protection that will be used;
 - c. Determine whether a full or partial deactivation is required. If partial deactivation is required, determine the methods which will be used to test the active portions of the GCWS;
 - d. Determine the method of deactivation and testing: Deactivation techniques may consist of jumpers, dummy loads, master/slave switch positions, shunting, etc. Where available, follow the deactivation instructions provided on the location wiring plans.
- 5.3. When selecting the method of deactivation, the following must be reviewed:
- a. The type of GCWS;
 - b. The effects of the GCWS system on the signal system;
 - c. Whether the deactivation affects any GCWS that are interconnected with foreign railways and what methods of protection with the foreign railway will be utilized;
 - d. Whether the deactivation affects any other adjacent GCWS;

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- e. Whether or not the method of deactivation deactivates the island or leaves it functional. Whenever possible, the island should be left functional;
 - f. Whether or not the method of deactivation disables the test switch. Whenever possible, the test switch should be left functional;
 - g. Whether the method of deactivation also deactivates the traffic pre-emption (if applicable). A GCWS that pre-empt traffic signals can be identified by either a label on the housing door or by examination of the wiring plans. Traffic pre-emption needs to be deactivated separately from the GCWS. It may not be possible to partially deactivate pre-emption, in which case a partial GCWS deactivation is not possible. Methods of deactivation must minimize the impact on traffic pre-emption and may require special flagging. Notify affected local authorities when required.
- 5.4. Review and determine the method of testing all GCWS after deactivation.
- a. Review the method for testing each affected GCWS after reactivation so that it can be confirmed that the GCWS is functioning as intended. GCWS protection must not be cancelled until all affected GCWS are proven to be functioning as intended.

6. Approval

- 6.1. Obtain approval of the S&C Supervisory Officer before initiating or modifying deactivation procedures. Approval granted more than 24 hours before the planned initiation of deactivation procedures shall be in writing.
- 6.2. Approval shall only be granted after the Supervisor has thoroughly reviewed the procedures for the specific deactivation being planned. It is strictly forbidden to issue blanket approvals covering multiple deactivations.

7. Advising RTC

- 7.1. In all cases, formal deactivation will not be initiated until the RTC has been advised. This advice must include:
- a. subdivision name;
 - b. mileage;
 - c. time of deactivation; and
 - d. the method of protection in place to ensure trains are not operated unprotected over the crossing while the GCWS is deactivated.

8. Job Briefing

- 8.1. Before undertaking any work, a job briefing must be carried out. The job briefing must include all employees affected by the crossing deactivation, and shall include:
- a. a review of all affected GCWS;
 - b. the planned deactivation procedures; and
 - c. protection procedures in use.

9. Protection

- 9.1. The S&C employee shall ensure that proper protection is in place for the affected GCWS before deactivation. The type of protection to be used will depend on the circumstances of the deactivation. Typical means of protection include:
- a. Rule 42 and/or 41;
 - b. Positive track protection such as a TOP;
 - c. Manual flagging procedures;
 - d. If there is a nearby crossing start within 500 ft from the deactivated crossing, a protection is needed to protect it from the accelerated trains.

- 9.2. In all cases, the qualified S&C employee deactivating the GCWS, as well as the employee in charge of track work (if applicable), must have a clear understanding of the means of protection utilized to ensure trains do not operate unprotected over the crossing while the GCWS is deactivated.

10. Crossings Interconnected with Other Railroads

- 10.1. Extreme caution must be used when Metrolinx circuits are interconnected with other Railroads. A clear understanding of any interconnected Railroad crossing operation is essential to maintain safety to the motoring public. Crossing operations must remain safe and at no time compromise the other roads.

11. Crossings Used as Remote Start (DAX)

- 11.1. Extreme caution must be used when the GCWS is used as a remote start (DAX) for another GCWS, identify shunts used where crossing approaches overlap. A clear understanding of the operation of any adjacent GCWS is essential to maintain safety to the motoring public. GCWS operations must remain safe for all nearby crossings.
- 11.2. Any other crossing track(s) that are remotely started by the deactivated crossing track(s) must be deactivated accordingly; each crossing will have their own deactivation forms.

12. Road Traffic Pre-emption Deactivation

- 12.1. When determining the work zone and the deactivation requirements, provisions shall be made to address any location that has preemption circuits which require special flagging requirements. Refer to [GI 310\(b\)\(2\) - Pre-emption and Active Advance Warning Signs](#).
- 12.2. Deactivation procedures should always be planned to minimize the impact on traffic preemption.

13. Temporary Circuit Modifications

- 13.1. Only qualified S&C employees shall perform the circuit modifications required to temporarily deactivate a GCWS. Metrolinx or designated Supervisory Officer shall approve the method used for deactivation.
- 13.2. These temporary circuit modifications shall not be performed until the necessary protection has been received from the RTC and Yard Coordinator.

14. Signal Design

- 14.1. The circuitry and the method used for crossing deactivation may vary depending on the complexity and the type of crossing. In all the cases the deactivation method used shall be reviewed and approved by responsible Supervisory Officer and Metrolinx in accordance with location specific GCWS.

15. GCWS Deactivation Form

- 15.1. The GCWS Deactivation Form [SCP-709-Form](#) must be filled out as the deactivation proceeds and must contain the following information:
 - a. Date, full name and contact information of the Authorized deactivation S&C employee;
 - b. The subdivision, mileage and street name of the GCWS;
 - c. The reason for deactivation;
 - d. The name of the Supervisory Officer approving the deactivation procedures and the date/time of approval;
 - e. The time the RTC / Yard Coordinator was advised of the intended deactivation;
 - f. The date, and time that the Interconnecting Railway was advised of the intended deactivation;
 - g. The type of protection in place;

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- h. All circuit modifications including number of jumper kit(s) used, location of jumpers and/or dummy loads and the ID of jumper kit(s);
- i. All tests performed to prove operation of tracks to be kept operational;
- j. The date, time and full name of the employee performing the modifications and tests;
- k. Any sketches or temporary circuit drawings (to be attached to the form with the number recorded in the comments section);
- l. If a transfer of responsibility occurs, the date, time of the transfer, full name of both employees must be recorded. Further details can be found in Section 18 Transfer of Responsibilities;
- m. The tests performed at time of reactivation;
- n. Verification that [GI 310\(a\)\(9\)](#) and [GI310\(b\)\(2\)](#) tests were performed;
- o. The time the RTC / Yard Coordinator was advised that the GCWS was reactivated;
- p. The incoming employees name and time of transfer if the crossing is deactivated for more than 1 shift and it is necessary to transfer the deactivation responsibilities. Refer to section of Transfer of Responsibilities.

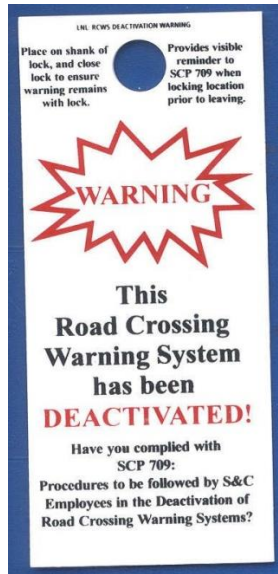
16. Form Retention

- 16.1. The completed form is to be kept in the crossing housing for the duration of the deactivation, and for a minimum of 30 days thereafter. Forms older than 30 days old are to be destroyed.

17. Locking Clasp Tag

- 17.1. Once the RTC / Yard Coordinator has been advised of the intended deactivation of the GCWS, and the necessary protection is in place, a tag must be visibly applied to the locking clasp of the entry door of the Crossing Housing, as shown:

Figure 709-1: Locking Clasp Tag



18. Application of Jumper Kits or Dummy Loads

- 18.1. Once the locking clasp tag has been applied, the crossing may be physically deactivated. When jumper kits or dummy loads are used to deactivate crossing circuitry, each jumper or dummy load location must be individually noted (including date, time and initials) on the GCWS Deactivation Form which is to be kept in the Crossing Housing.
- 18.2. All jumpers must be individually tagged before being applied using the tag shown in Figure 709-2, with pertinent S&C employee information:

Figure 709-2: Jumper Tags



Front

Back

19. Removal of Jumpers or Dummy Loads

- 19.1. Upon commencing reactivation of the GCWS, the S&C employee responsible must note the reactivation date, time and initials on the GCWS Deactivation SCP-709-Form, for each jumper or dummy load as it is removed. Jumper tags can only be removed after the corresponding jumpers are removed.

20. Transfer of Responsibility

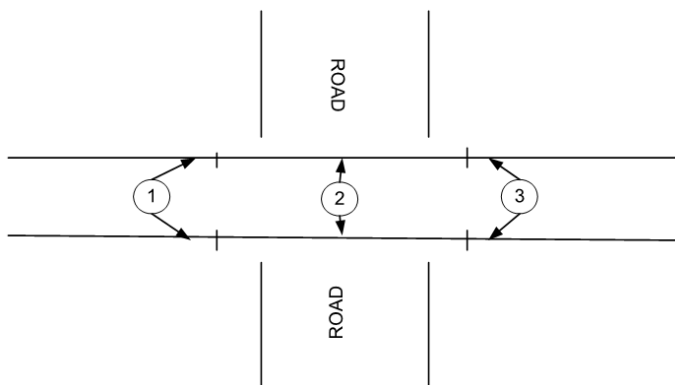
- 20.1. For projects requiring multiple shifts, continuous protection is needed. A formal transfer of this responsibility and notification of the RTC must occur. This transfer must include the following information:
- a. the method of protection used before the shift change;
 - b. the actions taken to deactivate the GCWS;
 - c. the tasks left to complete the work on the GCWS; and
 - d. the actions needed to reactivate the GCWS;

- e. The clear name of the person taking over the responsibility and time when the new shift started;
- f. The Signal Manager/Supervisor must be advised and approve the Transfer of Responsibility.

21. Testing

- 21.1. After removal of the jumpers and/or dummy loads and restoration of other modifications that may have been made, an operational check of the GCWS must be performed on all tracks by sequentially applying a 0.06 ohms shunt to the rail and verifying proper operation. The tests performed and time of testing shall be recorded on the GCWS Deactivation SCP-709-Form.
- 21.2. Figure 709-03 illustrates the test sequence for a simple crossing. More complicated crossings will require more extensive testing.

Figure 709-3: GCWS Restore Test Shunt Sequence



- 21.3. Where there are no insulated joints; the shunts must be applied 100 feet from the roadbed. This distance will ensure that the shunts are not applied on the island circuit.

22. Testing at Constant Warning Locations

- 22.1. In circumstances where the GCWS is a GCP/MS or XP4/HXP/PMD location, and is deactivated on account of track work that may affect the integrity of one or more approaches, then these must be tested with a zero ohm shunt at 90% of the approach track circuit length to ensure the EZ (GCP), ED (MS), or RX (ElectrologIXS XP4/HXP/PMD) levels drop within their normal ranges. In all other cases, before and after EZ/ED/RX readings will be compared to ensure they have not changed. This test is in addition to that described in the previous paragraph. Refer to [GI 310\(c\)\(8\) - Approaches with MS/CW](#).

23. Final Check

- 23.1. Ensure equipment is in normal state, power is on, and the GCWS operates with the test switch (if available). Only then may the locking clasp tag shown in Figure 709-1 be removed. Refer to [GI 310\(a\)\(9\) - Controlling Devices](#).

24. Reactivation

- 24.1. After the final check has been successfully performed, the RTC / Yard Coordinator shall be notified that the GCWS has been tested and may be restored to normal operation. Time of notification shall be recorded on the Deactivation Form.

25. Deactivation Process

- 25.1. This table outlines the steps to be followed to deactivate an GCWS.

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Table 709-01

Step	Action
1	Prepare the method to be used by documenting each action on the GCWS Deactivation Form. Plan to deactivate only those portions of the GCWS required by work being performed.
2	Contact your Supervisor for approval prior to proceeding. Record the time of approval on the Deactivation Form.
3	During the job briefing define the deactivation and flagging processes with all affected parties (including the work foreman if applicable).
4	<p>Inform the RTC / Yard Coordinator of the intent to deactivate the GCWS, and confirm the method of protection to be used, and that it is in force. Methods of protection include:</p> <ul style="list-style-type: none"> • Rule 42; • Positive track protection such as a TOP/OCS; • Manual flagging procedures. <p>Record this information as well as the time of contact with the RTC on the Deactivation Form.</p>
5	A tag must be visibly applied to the locking clasp of the entry door of the crossing housing (Figure 709-1).
6	The GCWS may now be deactivated. Note the date, time and full name on the GCWS Form, for each action as it is being performed (on the left side of the form). If jumper kits are used, they must be individually tagged (Figure 709-2).
7	Test to ensure that the GCWS is deactivated as intended. Test those portions of the GCWS that are not to be deactivated to ensure they remain operational and record on the Deactivation Form, which must remain in the housing.

26. Deactivation on Multiple Track

26.1. When deactivation is required to support construction activities at crossings having multiple tracks, only the affected track shall be modified leaving all other tracks in full automatic operation. All approaches for each of the unmodified tracks shall be tested by sequentially shunting out the rails on "live" track.

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Table 709-02

Step	Action
1	Obtain permission from the RTC / Yard Coordinator to temporarily shunt all tracks included in the GCWS.
2	Proceed with the deactivation of the GCWS.
3	Shunt all track circuits to ensure that the tracks not included in the track protection are fully operational and record on the GCWS Deactivation Form.

27. Revising the Method of Deactivation

27.1. There may be circumstances when the original method of deactivation must be changed on account of unforeseen or unavoidable field changes.

Table 709-03

Step	Action
1	Prepare the method to be used by documenting each new action to be performed on the original GCWS Deactivation Form. Highlight those actions that were originally performed and need to be restored by means of a visible asterisk.
2	Obtain authorization from Metrolinx or responsible Supervisory Officer to proceed with the revised method. Record the time of authorization on the form (use "Comments" field if necessary) and the name of person who approved the new method.
3	Perform a follow-up job briefing and ensure all parties understand the revised deactivation and flagging procedures. Ensure no trains are allowed to operate unprotected over any part of the crossing while the revisions are being performed.
4	Advise the RTC / Yard Coordinator and confirm what additional protection is in place to protect trains over the additional track(s) to be deactivated. Record time on form.
5	Note date, time and full name on the form, when restoring those actions identified with an asterisk (on the right side of the form).
6	Note the date, time and full name on the form, for each new action as it is being performed (on the left side of the form).
7	Shunt all track circuits to ensure that the tracks not included in the track protection are fully operational and record on the form, using the "Comments" field if necessary.

28. Reactivation Process

28.1. This table outlines the steps that shall be performed to reactivate an GCWS.

Table 709-04

Step	Action
1	Using the same GCWS Deactivation Form used for deactivation, identify and restore all modifications that were made to deactivate the GCWS. Note the time, date, and full name for each on the Deactivation Form (on the right side of the form).
2	Remove each jumper or dummy load that had been installed, and note the date, time and initials beside each jumper or dummy load (on the right side of the form).
3	Ensure that each action having a deactivation date/time/initial (on the left side of the form) has a corresponding date/time/name (on the right side of the form).
4	Verify that the crossing is operating as intended (refer to blocks entitled "Testing" and "Testing at Constant Warning Locations"), and record on the Deactivation Form.
5	Ensure equipment is in normal state, power is on, and the GCWS operates with the test switch (if available).
6	The tag applied to the door of the GCWS Housing (Figure 709-1) can be safely removed.
7	Notify the RTC / Yardmaster that the GCWS has been properly tested and is restored to normal operation. Record the time of this contact on the Deactivation Form. If applicable, also advise the Foreman in charge of the protection that the GCWS is back in service.
8	Ensure the GCWS Deactivation Form is retained at the site for a minimum of 30 days. Forms older than 30 days old are to be destroyed.

Appendix 700A – Guidelines for Testing and Information Retrieval

1. General

- 1.1. This Appendix is intended to serve as a reminder or guideline to the employee(s) responsible, to test a location when an incident has occurred. It contains recommendations on which tests should be performed on what equipment, and how certain information should be retrieved, PRIOR TO MAKING ANY REPAIRS.
- 1.2. These guidelines should not be considered comprehensive since the configuration of the location and the extent of the damage will ultimately determine the actual test requirements.

2. Important

- 2.1. Upon arrival of Metrolinx authorized S&C Supervisory Officer or Metrolinx S&C Officer, the S&C Maintainer shall:
 - a) Complete and sign the Grade Crossing Warning System Post Incident Checklist ([Form 701](#)) with all information on the state of the Grade Crossing Warning System and any downloads obtained from the equipment.
 - b) All tests that cannot be performed due to equipment damage shall be recorded as not performed with a short description of the equipment damage.
 - c) The current times of all real time clocks in the Grade Crossing Warning System, as well as an independent device known to be reasonably accurate such as a watch or cellular phone, must be recorded in order to establish the time offsets between all real time clocks.

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- d) Where so equipped, downloads must be obtained from the crossing event recorder; the motion sensor or constant warning time device; the solid state crossing controller; and where possible, downloads should be stored directly to a removable memory device such as a USB memory stick or a CD-ROM. A second copy may be downloaded directly from the recorder or copied from the first copy for internal purposes, but the first download obtained from each device is the official record.
- 2.2. All tests should be performed as soon as possible and prior to any train movement through the location. If a train movement does occur, details of the movement should be recorded and if necessary any operating type tests repeated.
- 2.3. Tests which do not require the opening of test straps, disconnection of wires or other type of circuit disconnection shall be performed first.
- 2.4. Tests requiring the disconnection of circuits should be performed last.

3. Relays

- 3.1. Record the position and condition of all relays at the incident location or the last controlled location(s) passed by the train(s) involved.
- 3.2. This must include all relays and all the contact positions of any polar relays.

4. Switches

- 4.1. Record the position and condition of any power switch machine, hand throw switch and switch circuit controller contacts within the approach of a Grade Crossing Warning System.

5. Grade Crossing Warning Device Test

- 5.1. Perform and record test results as required by [GI-310 Testing Grade Crossing Warning Devices](#).

6. Electronic Equipment Test

- 6.1. In the case of a Grade Crossing Warning System controlled by a Grade Crossing Predictor (GCP) or a Motion Sensor (MS), record all operating parameters as per [GI-335 Inspecting and Testing Vital Electronic Equipment](#).
- 6.2. In the case of a microprocessor controlled Grade Crossing Warning System record all historical events and errors. If the Grade Crossing Warning System is equipped with an event recorder or another type of field recording device perform a data dump and save the result.
- 6.3. Perform and save a data dump or request and save a chart recorder hard copy of the train involved from the Wayside Detection System in advance of the incident location.

7. Circuit Ground Test

- 7.1. Perform and record the results of all circuit grounds as per [GI-303 Testing for Circuit Grounds and Battery Isolation Faults](#) on all circuits at each location involved.

8. Wire and Cable Insulation Resistance Test

- 8.1. Perform and record the results of wire and cable insulation resistance tests as per [GI-312 Testing Wire and Cable Insulation Resistance](#).

9. Track Circuit Tests

- 9.1. Perform and record the results of all track circuit tests, as required by [GI-333 Testing Track Circuits](#) for each track circuit involved at the incident location.

901 - WIS Maintenance and Inspection

1. Purpose

- 1.1. This document outlines the maintenance procedures for Wayside Inspection System (WIS) sites which may include Hot Bearing, Hot Wheel, and Dragging Equipment detectors. The procedures below have been compiled from manufacturer technical manuals and commonly occurring issues seen over the system.
- 1.2. The purpose is to minimize false stops, ensure intended functionality, increase equipment life, and reduce trouble calls by standardizing maintenance and inspection procedures.

2. Track

Table 901-01

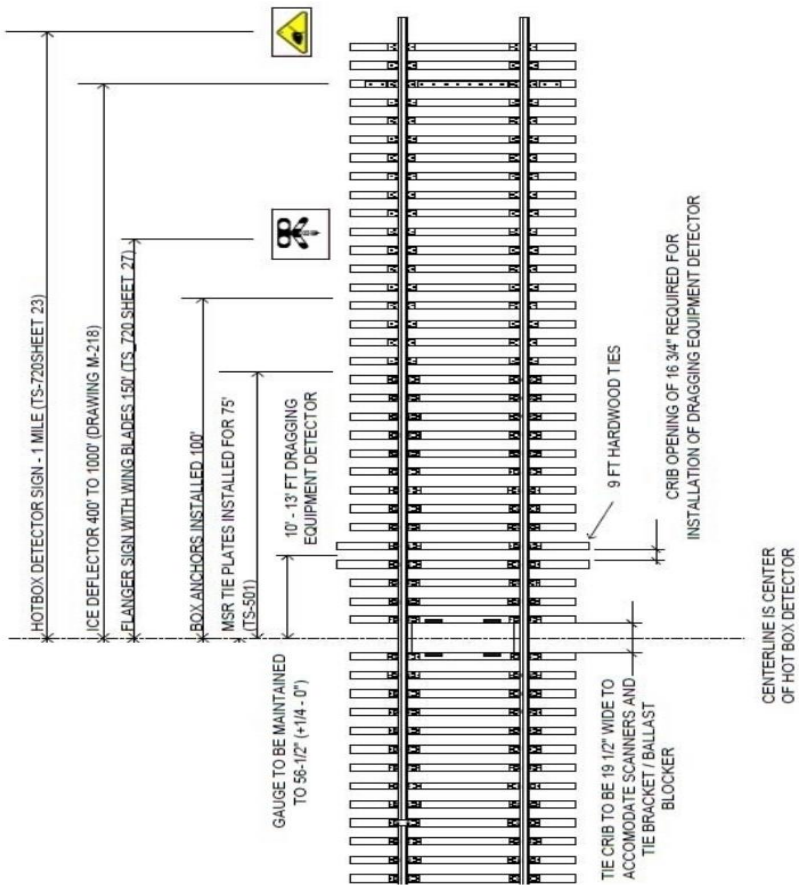
Test/Inspection	Check
Track Condition	Floating rail, loose spikes, and rail pumping of more than 1" are unacceptable track conditions. If these exist, arrangements need to be made with the track department to bring conditions up to the Metrolinx Track Standard.
Adequate Drainage	Improvements should be 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.

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Test/Inspection	Check
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.
Ice Deflectors Installed and Secured	These deflectors are important to remove ice and snow that can build up under trains and cause unnecessary DED stops. Arrange to have deflectors installed if not present at site.
Proper Signage Installed	HBD signs should be installed 1 mile prior to site. Flange signs with wing blades should be installed 150' prior to site. These signs are important indications to track equipment during maintenance.

Figure 901-1 – Wayside Inspection System Details



2.1. NOTES:

- The drawing depicts the required track features at S&C Wayside Inspection Systems.
- Roadbed should be properly maintained to ensure adequate drainage and to minimize vertical deflection. Tie movement or pumping not to exceed 1'.
- Drawing not to scale.

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- d) Same signage and equipment is required on each approach.

3. Bearing Scanners

Table 901-02

Test/Inspection	Check
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.
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 (<i>at applicable sites</i>).
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.
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.
Heaters Functioning Properly	Scanners should always be warm to the touch during cool months. If not, all connections inline with the internal heaters should be checked. If no issues are found, the corresponding scanner should be sent in for repair.
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.
Scanner Deflectors Installed and Secured	Deflectors need to be installed and tightened to rail at no more than 50 ft-lb.

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Test/Inspection	Check												
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.												
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.												
Mouse Screens Installed and in Good Condition (GETS and DHP only)	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.												
Rail to Scanner Impedance	Electrical connections between the rail and scanner cause electrical interference, resulting in false readings. Remove scanner grounding and disconnect scanner cable. Perform an impedance reading between rail and scanner. If the impedance is less than 1MΩ, scanner mounting needs to be replaced and sent in for repair.												
Calibrate Scanners (GETS and STC only)	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.												
	<table><tr><th>Equipment</th><th>Manual Section</th></tr><tr><td>DHP</td><td>Cannot be calibrated onsite</td></tr><tr><td>GETS CPU2</td><td>System Manual - Section 3.16</td></tr><tr><td>GETS CPU3</td><td>Software Manual - Section 3-14</td></tr><tr><td>STC Sentry</td><td>Chapter 12.2.1</td></tr><tr><td>STC NG</td><td>Manual Appendix D.1</td></tr></table>	Equipment	Manual Section	DHP	Cannot be calibrated onsite	GETS CPU2	System Manual - Section 3.16	GETS CPU3	Software Manual - Section 3-14	STC Sentry	Chapter 12.2.1	STC NG	Manual Appendix D.1
	Equipment	Manual Section											
	DHP	Cannot be calibrated onsite											
	GETS CPU2	System Manual - Section 3.16											
	GETS CPU3	Software Manual - Section 3-14											
STC Sentry	Chapter 12.2.1												
STC NG	Manual Appendix D.1												
Tighten Pyro/Bolometer Block (GETS and DHP only)	This internal 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.												

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Test/Inspection	Check		
Scanner Alignment Check	This process is to ensure that the scanners are reading heat from the correct spot on a bearing. Correct alignment also prevents scanners from seeing wheel heat and causing false Hot Box alarms. The instructions for this procedure can be found in the appropriate manuals listed below. The horizontal alignments listed below should be used over the values listed in the manuals.		
	Equipment	Manual Section	Horizontal Alignment
	DHP	Section 4, Pg. 2	@ 7½"
	GETS CPU2	System Manual - Section 3.12	@ 7¼"
	GETS CPU3	Software Manual - Section 3.12	@ 7¼"
	STC Sentry	Chapter 12.2.1	@ 7¾"
	STC NG	Chapter 7.1	@ 7¾"

4. Transducers

Table 901-03

Test/Inspection	Check
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 inline with the mounting bolts. A transducer should then be replaced if missing or odd axle counts still occur.

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Test/Inspection	Check	
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.	
Polarity Check on Gating (A and B) Transducers	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.	
Gating (A and B) Transducer Spacing	The spacing between A and B transducers should be 24". If not exact, this measurement can be fine tuned in the software (by 0.1" increments). Refer to the appropriate manual listed below.	
	Equipment	Manual Section
	DHP	NA
	GETS CPU2	Hardware Manual - Section 3.13
	STC ST2058	Section 2, Pg. 16
	STC Sentry	Section 17.11, Step #5
STC NG	Section 11.7 Step #12	

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5. Dragging Equipment Detector

Table 901-04

Test/Inspection	Check
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.
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.
Replace Damaged Panels	Panels are considered damaged when they are severely deformed and/or cannot be re-secured to detector.
Paint Scarred Panels	Painted panels are useful when distinguishing between false activations and real activations.
Tighten All Terminals Internal to DED	These double nut connections tend to become loose from heavy vibrations on the rail. Many false stops have been reported from these terminals becoming loose.
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.
Check/Adjust Contact Opening	DED should activate when tip of paddles travel $1\frac{3}{4}$ " relative to the rail. If DED activates more than $\frac{1}{4}$ " before or after this mark, contacts need to be re-adjusted

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6. Wheel Scanners

Table 901-05

Test/Inspection	Check												
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.												
Heaters Functioning Properly	During cool months: Rail-mounted scanners should be warm to the touch. Pedestal-mounted scanner should be warm around the hood. If not, all connections inline with the internal heaters should be checked. If no issues are found, the corresponding scanner should be sent in for repair.												
Clean Lens and Debris from Scanners and Sun Filters	This should be done to ensure correct levels are being read by scanner. If a lens looks to be significantly dulled or scratched, arrangements should be made to have it replaced.												
Check/Tighten All Connections Between Scanners and Bungalow	These connections tend to become loose over time and should always be checked.												
Calibrate Scanners (GETS and STC only)	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.												
	<table><tr><th>Equipment</th><th>Manual Section</th></tr><tr><td>DHP</td><td>NA</td></tr><tr><td>GETS CPU2</td><td>Hot Wheel Manual - Section 10-7</td></tr><tr><td>GETS CPU3</td><td>Hot Wheel Manual Section 10-7</td></tr><tr><td>STC Sentry</td><td>Chapter 12.2.2</td></tr><tr><td>STC NG</td><td>Manual Appendix D.2</td></tr></table>	Equipment	Manual Section	DHP	NA	GETS CPU2	Hot Wheel Manual - Section 10-7	GETS CPU3	Hot Wheel Manual Section 10-7	STC Sentry	Chapter 12.2.2	STC NG	Manual Appendix D.2
	Equipment	Manual Section											
	DHP	NA											
	GETS CPU2	Hot Wheel Manual - Section 10-7											
	GETS CPU3	Hot Wheel Manual Section 10-7											
	STC Sentry	Chapter 12.2.2											
STC NG	Manual Appendix D.2												

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Test/Inspection	Check	
Clean Lens and Debris from Scanners	This should be done to ensure correct levels are being read by scanner. If a lens looks to be significantly dulled or scratched, arrangements should be made to have it replaced.	
Scanner Alignment Check	This process is 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 listed below.	
	Equipment	Manual Section
	DHP	Section 4, Page 16
	GETS CPU2	Hot Wheel Manual - Section 4-3
	GETS CPU3	Hot Wheel Manual - Section 4-3
	STC Sentry	Chapter 12.1.2
	STC NG	Chapter 7.2

7. Bungalow

Table 901-06

Test/Inspection	Check
Bungalow Clean and Free of Rodents	Ensure that no evidence of life is present and that all possible entrances into bungalow are sealed.
Confirm DC Voltages	All applicable DC voltages must be within +/-5% of the nominal voltage.
Test Battery as per GI-305(a)	If batteries are insufficient, arrangements to have new batteries installed need to be made.

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Test/Inspection	Check			
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.			
	Equipment	Manual Section		
	DHP	Section 5, Pg. 9		
	GETS CPU2	System Manual - Section 3.7		
	GETS CPU3	Software Manual - Section 3-8		
	STC Sentry	Chapter 13, Step #17		
	STC NG	Section 11.10, Step #4		
Tighten All Connections on Equipment and Terminals in Bungalow	Some of these connections have a tendency to become loose after a period of time. Loose connections cause issues which can be avoided with this simple check.			
Confirm Alarm Threshold Settings	Alarm thresholds should match table below depending on the location of the site.			
		ABS HB	DIFF HB	Hot Wheel
	Mainline	15mm	8mm	558°F
	Branchline	12mm	6mm	558°F
	GO Train	15mm	10mm	558°F
TP105	15mm	8mm	558°F	
Test AC Power	Ensure that the voltage is stable at no less than 110VAC with a 20 Ampere load.			

8. Test Tape

- 8.1. The following procedure is for completing a test tape. Below are the steps that should be followed to ensure that the WIS is working as intended.
- 8.2. 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).

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Table 901-07

Step	Action
1	Setup heat source, let it reach proper temperature: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • STC and DHP systems - turn "Gating" switch on. • GETS - close test nut (do not run through computer: results in a bad test tape).
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 2 wheel scanners, move heat source to South/West WHEEL scanner.
9	End test tape: <ul style="list-style-type: none"> • STC and DHP systems - turn "Gating" switch off. • GETS - wait for test tape to terminate, loosen test nut.

8.3. Following the test tape, contact call desk to confirm that the test tape was received, and the following conditions are satisfied:

- a) 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).
- b) Bearing and Wheel heats must read between conditions in table below.
- c) No more than 1.0mm of heat differential between bearing scanners.
- d) At least 6 DED activations are present.

Table 901-08

	North/East Bearing Avg	South/West Bearing Avg	North/East Wheel Avg	South/West Wheel Avg
GETS	11-13 mm	11-13 mm	60-90° F	60-90° F
STC	9-11 mm	9-11 mm	60-90° F	60-90° F
DHP	10-12 mm	10-12 mm	>60° F	N/A

902 - Policy for WIS Trouble Call Procedures and Taking Sites Out of Service

1. Purpose

- 1.1. This document is to be used as a guideline when dealing with faulty or suspect Wayside Inspection System (WIS) Sites. These instructions are in place to provide optimum system reliability and availability. Use discretion and consider factors such as the amount of rail traffic, mainline, weather conditions, and time of day, prior to dispatching field personnel.
- 1.2. When a site is defective and is affecting train service, the site must be taken Out of Service (OOS). Detailed procedures are contained in this document.

2. Scope

- 2.1. This policy specifies the minimum actions to be taken by S&C personnel across the entire Metrolinx system. Metrolinx may require additional actions to be taken.

3. General Guidelines

- 3.1. **Safety Tip:** While working with field personnel, testing must be stopped to allow the S&C employee to clear and perform the required train inspections (CROR 110) on passing trains. Do not allow the talker to broadcast messages when trains are within radio range. Trains hearing the broadcast could think there is a defect and stop.

3.2. **Immediate Action:** A maintainer/tech must be called 24x7 under the following conditions:

- a. If normal readings were being received, and then the heat suddenly disappeared on one or both rails. This is indicative of a derailment or equipment damage.
- b. If hot bearing and Dragging Equipment Detector (DED) alarms appear on the same train tape.
- c. If equipment malfunctions at the site, that will likely cause a false alarm and stop the next train. The site may need to be removed from service to avoid unnecessary train stops.
- d. If a train had a legitimate NF (nothing found), stop at a site. A legitimate NF stop is where the available information has been examined, and it is determined that an equipment malfunction is likely at the site.
- e. If there are six (6) or more DED alarms on one train.
- f. If many sites in a row are not working (for example, they are all covered by snow), then the key WIS sites, as defined by Metrolinx, must be kept working.
- g. If there is more than 40 miles to the next operational detector.
- h. If the site is a CMA site and a train is due in the CMA-defined direction.

4. Nothing Found Stops - General Instructions

- 4.1. Nothing found stops are reported by the train crews via the RTC.
- 4.2. For all NF stops, dispatch maintainer/tech if not an obvious train defect.

4.3. Procedure:

- a. A trouble ticket must be opened for every NF and updated with investigation results.
- b. Indicate NF and type (HBD, HWD, DED) in the brief description field.
- c. Call the maintainer/tech immediately. The call may be deferred to the next morning if the maintainer/tech can get to the site before the next train.
- d. Advise the maintainer/tech the cause of the stop by reviewing the tape (DED, high deflection on one axle, spiky tape, etc.).
- e. Set Severity Code when closing ticket.

4.4. NOTE: Any time you investigate an NF Stop, use your judgment. If the tape displays random high heat readings and obviously there is a problem that will stop the next train, call the maintainer/tech.

5. Other Trouble Call Instructions

5.1. DED Activation

5.1.1. If a dragging equipment detector is activated, it must be inspected for damage. Nothing Found and Something Found stops both require a DED inspection. If the activation occurs after normal working hours, call-outs will be deferred to the next morning (including Saturday, Sunday & holidays).

5.1.2. However, the maintainer/tech will be called immediately 24x7:

- a. If a second train reports NF DED in less than 24 hours.
- b. If there are Six (6) or more DED alarms on one train.
- c. If the DED is continually activated.

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- d. If the train crew reports the cause of the DED activation and it is significant enough to have possibly damaged the DED paddles. For PEM alarms indicating a "Something Found" stop, evaluate the reported cause of activation. Ice buildup on equipment or low hoses does not require an immediate call-out. Immediate call-out is required if the cause of activation was dragging brake rigging, chains or an object pushed through by the locomotive, because these have a high probability of causing DED damage.

5.2. "No Talker" Report

- 5.2.1. Description: Train crew reports no talker message heard or a garbled message.
- 5.2.2. Investigation: Review VFR, site status data and train tape talker message data.
- 5.2.3. A remote talker replay or site reset may be attempted if a maintainer/tech cannot respond ahead of the next train. IMPORTANT: ensure no trains in the vicinity will overhear the repeat. This is for troubleshooting purposes only to verify the talker is functioning. NEVER replay the talker to relieve a train of the requirements of rule: GOI 5.6(a).
- 5.2.4. Procedure: Open a trouble ticket as an alert, and set the 'Auto close' flag.
 - a. If during normal working hours, dispatch a maintainer/tech immediately. If after normal working hours or weekends, have the RTC monitor the adjacent radio site on the Subdivision end-to-end channel during the next train movement over the site to listen to the talker broadcast.
 - b. If the second train reports "no talker," dispatch maintainer/tech 24x7.

- c. If the second train reports broadcast is okay, do not call the maintainer/tech. Because trains not hearing a talker are instructed to slow down, the RTC may order the site taken Out Of Service (OOS) to protect following trains from delay. The talker equipment should only be removed from service in this case.
- d. If a site is OOS due to a failed talker and a defect alarm is reported into the office by a popup on the RTC's monitor, the defect must be considered genuine. Appropriate action must be taken to notify the RTC so the train can be stopped for inspection of the defect.

5.3. "Not Working" / "Integrity Failure" Message

5.3.1. Description: The train crew reports receiving a "Not Working" or "Integrity Failure" message from the talker. Sometimes, a talker failure is reported as "not working" and incorrectly handled as a "Not Working/Integrity Failure" problem.

5.3.2. Investigation: To confirm the train crew report:

- a. For GETS and STC sites, check the site status. Look for "integrity failure."
- b. For other sites, confirm with the RTC that the site actually broadcasts the "Not Working" or "Integrity Fail" message.
- c. Review VFR site status messages. Examine the related train record for clues such as no heat on one or both rails, low-recorded train speeds, transducer problems or evidence of the train stopping on the site. If the train stopped over the site, this can cause transducer miscounts, resulting in "Not Working/Integrity Fail" messages. Check inter-axle times and transducer counts to determine if the train stopped on the site. If the train stopped over the site, then this explains the cause, and the WIS site is working as intended. In this case, no call-out is required.

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5.3.3. Procedure:

- a. For all sites, call the maintainer/tech 24x7.

5.4. Single Site No Status (No Communications)

5.4.1. Description: Site does not respond to polls, does not dial in once per hour. An alarm is displayed on the PEM alarm screen after 1 hour of no status.

5.4.2. Investigation: Upon observing failure or receiving the alarm, confirm and look for possible additional failed locations. Commercial power failure is a common cause.

5.4.3. Procedure:

- a. Open ticket and set the Action field to Attention.
- b. Contact RTC and request information of what exact message the next train receives to ensure talker is working and the site is functioning properly in stand-alone.
- c. After one hour of "no status," contact the maintainer/tech during normal working hours or defer to the next morning's call-out.
- d. Contact the Telecommunication Company to correct circuit failures if required.
- e. Contact Power Company if required.

5.4.4. If a site is not talking to trains AND is not communicating with the office, immediate call-out is required, consult Metrolinx and remove the site from service.

5.5. Multiple Sites No Status (No Communications)

5.5.1. Description: multiple sites in the same geographic area do not respond to polls, dial in once per hour.

5.5.2. An alarm is generated on the PEM alarm screen after 1 hour of no status.

5.5.3. Investigation: Upon receiving an alarm message, evaluate the outage scope.

5.5.4. Procedure:



- a. If the cause is a communication problem, open a ticket on the multipoint circuit.
- b. If the cause is a wide-area power problem that affects multiple sites on different circuits, open the ticket on each multipoint circuit affected.
- c. Power: Observe other systems (i.e. CTC) for power outages in the area. Check with the Power Company. Most sites are battery-backed, but not all communications equipment at the site is protected. Discuss with RTC and request reports from train crews regarding talker messages heard.
- d. Comms: Observe other systems (i.e. CTC) for comm issues in the area. Possible circuit problem: check for noise, loops, opens, etc. If a single site is noisy and affecting the entire circuit, contact Metrolinx and/or the local Telco to isolate the defective site.

5.6. Temperature Probes

5.6.1. Description: WIS sites are being used as valid references for the purposes of both high-temperature and low-temperature TSOs (temporary slow orders). The train crews are instructed to observe the WIS talker temperature announcement and follow the TSO instructions on the TGBO. Therefore, the temperature probes need to be calibrated and maintained. There is no provision for taking temperature probes out of service.

5.6.2. Procedure: For faulty temperature readings, open a ticket for following working day coverage.

5.7. Train Speed Announcements

5.7.1. Description: Train speed is calculated based on the inter-axle times of the first locomotive. Incorrectly recorded speeds are generally caused by transducer errors. Check train records for details.

5.7.2. Train speed must be constant to be accurate. Check train records for irregularities.

5.7.3. Procedure: Contact Metrolinx for next working day coverage.

5.8. CMA Sites

5.8.1. Description: This is a designated site protecting a major urban area. A site is CMA designated only in the direction of trains travelling toward the major population center they are protecting. A train must have both bearings and dragging equipment inspected. When the site is taken out of service, trains carrying special dangerous commodities must stop and be inspected manually. For these reasons extra effort should be used to keep these sites fully operational.

5.8.2. Procedure: Contact Metrolinx for 24x7 mainline coverage

6. Out-of-Service Instructions

6.1. The intent of the Out of Service policy is to prevent unnecessary train delays. If a WIS site has a problem and is likely to stop trains for false alarms, the defective component must be removed from service until repaired.

6.2. Metrolinx must be notified when a site or portion of a site is removed from service and also when returned to service.

6.3. Hot Bearing Out of Service

6.3.1. If two trains are stopped within a 24-hour period for HB alarms, and nothing is found: OR

6.3.2. If a single train has 3 or more HB alarms and nothing is found:

- a. Consult Metrolinx and remove the HB portion of the site from service until repairs can be made.
- i. NOTE: Not applicable for CMA sites, both HB and DED must be working. If DED or HB is faulty, the entire site must be removed from service.

6.4. Hot Wheel Out of Service

- 6.4.1. When determining if an NF HW stop is due to a site problem, examine the wheel tape and look for the sticking brake pattern. A site problem will show heat on random wheels. If the sticking brake pattern is evident, do not consider the stop an NF for the purposes of this instruction.
- 6.4.2. If two trains are stopped within a 24-hour period for HW alarms, and nothing is found, consult Metrolinx and remove the Hot Wheel portion of the site from service until repairs can be made. (It is common for a single train to have multiple hot wheels.)

6.5. DED Out of Service

- 6.5.1. If two trains are stopped within a 24-hour period for DED alarms, and nothing is found: OR
- 6.5.2. If a single train has 6 or more DED alarms, and nothing is found:
 - a. Consult Chief RTC (MCO) and remove the DED portion of the site from service until repairs can be made.
 - ii. NOTE: Not applicable for CMA sites.

6.6. Talker Out of Service

- 6.6.1. If two successive trains report "No Talker": OR
- 6.6.2. If Metrolinx orders the Talker taken out of service
 - a. Consult Metrolinx and remove the Talker from service until repairs can be made.

7. NOTES

7.1. NOTE 1: WIS 40 mile inspection criteria

- 7.1.1. A train may pass one or more Hot Bearing and Dragging Equipment Detectors which are out of service, and the crew **NEED NOT STOP** to perform the required inspection in General Operating Instructions, provided that a distance of 40 miles has not been exceeded since the last inspection by either a working Hot Bearing and Dragging Equipment Detector, wayside employees, crews of standing trains or transfer movements or by a pull by or walking inspection by crew members.

7.2. NOTE 2: WIS Out Of Service (OOS) Instructions

- 7.2.1. Only Metrolinx or a designated S&C Supervisory Officer may remove an entire site or portions of a site from service.
- 7.2.2. To remove a site from service, the RTC must issue instructions in the GBO to affected trains.
- 7.2.3. When the maintainer/tech arrives at the site, the portion of the system removed from service may be disabled until repaired. If the entire site is removed from service, the talker radio may be turned off to prevent false and nuisance alarm broadcasts.
- 7.2.4. Every 12 hr. shift will check all WIS OOS GBO's against Service Centre tickets and ensure there are no discrepancies.
- 7.2.5. If there is a discrepancy, check the last few trains over the site and take appropriate action.
- 7.2.6. If there is not a trouble ticket, one must be opened. Investigate the site history. If the site is malfunctioning, respond accordingly. If the site should be placed back in service, consult your coordinator or Supervisor.
- 7.2.7. GBO Example for entire site removed from service:
**WAYSIDE INSPECTION SYSTEM LOCATED AT MILE 4.9
Bala SUB REMOVED FROM SERVICE**

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- 7.2.8. GBO Example for Hot Bearing portion removed from service: HOT BEARING DETECTOR PORTION ONLY OF WAYSIDE INSPECTION SYSTEM LOCATED AT MILE 4.9 Bala SUB REMOVED FROM SERVICE. ALL OTHER COMPONENTS REMAIN IN SERVICE.
- 7.2.9. GBO Example for Hot Wheel portion removed from service: HOT WHEEL DETECTOR PORTION ONLY OF WAYSIDE INSPECTION SYSTEM LOCATED AT MILE 4.9 Bala SUB REMOVED FROM SERVICE. ALL OTHER COMPONENTS REMAIN IN SERVICE.
- 7.2.10. GBO Example for DED portion removed from service: DRAGGING EQUIPMENT DETECTOR PORTION ONLY OF WAYSIDE INSPECTION SYSTEM LOCATED AT MILE 4.9 Bala SUB REMOVED FROM SERVICE. ALL OTHER COMPONENTS REMAIN IN SERVICE.
- 7.2.11. GBO Example for Talker portion removed from service: TALKER PORTION ONLY OF WAYSIDE INSPECTION SYSTEM LOCATED AT MILE 4.9 Bala SUB REMOVED FROM SERVICE. ALL OTHER COMPONENTS REMAIN IN SERVICE.
- 7.3. NOTE 3: Call Outs NF
 - 7.3.1. When calling the maintainer/tech on an NF stop, provide them with the appropriate information, such as possible causes of malfunction.
 - 7.3.2. If the train stop appears to be a legitimate good stop, it is up to the maintainer/tech and the instructions of their Supervisor if they actually go to the site.
 - 7.3.3. If there is an obvious problem with the site, then instruct the maintainer/tech to proceed to the site. Any concerns they have should be discussed with their Supervisor.

7.4. NOTE 4: PEM Alarms

- 7.4.1. A major (orange) alert will be produced on PEM when there is a Nothing Found stop related to the DED/HBD/HWD at a site or there is a Something Found stop. If the Something Found stop was due to dragging equipment, the DED must be inspected for damage. No action is required for HBD/HWD Something Found stops.

7.5. NOTE 5: System Special Instructions 4.19 - Revision to GOI Item 5.6(a) WIS MALFUNCTIONS

- 7.5.1. The first paragraph of GOI Item 5.6(a) has been revised, with the inclusion of a third provision to allow for a resumption of track speed in the case of a 'NOT WORKING,' garbled, not heard, or unintelligible message at a WIS site. It states that track speed may be resumed if the crew is in receipt of RTC advice, after a check of Office systems, that no defects are present.

7.6. NOTE 6: HWD Disable Instructions

- 7.6.1. *DHP2000 sites* - If the maintainer/tech is unable to repair immediately, open HWD Test Link and jumper HWD signal (terminal B10 on the entrance board) to 24V common (terminal B15 on the entrance board).
- 7.6.2. *STC sites* - disable HWD using the keypad on the Analyzer module.

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7.6.3. *GETS/Progress Rail sites* - The HWD system is disabled by changing the configuration of the uHBD box. Connect a laptop to COM3 and enter the following commands:

```
ms    <ENTER> password is supervisor
equip <ENTER>
ha    <ENTER>
2     <ENTER>
hw    <ENTER>
2     <ENTER>
ws    <ENTER>
3     <ENTER>
e     <ENTER>
```

7.6.4. To enable the HWD after repairs have been made, enter the following commands:

```
ms    <ENTER> password is supervisor
equip <ENTER>
ws    <ENTER>
1     <ENTER>
hw    <ENTER>
1     <ENTER>
ha    <ENTER>
1     <ENTER>
e     <ENTER>
```

7.7. NOTE 7: DED Disable Instructions

7.7.1. CMA sites only:

- a. A train must be inspected for both hot bearings and dragging equipment. The DED alone cannot be removed from service. The entire site must be taken out of service.

7.7.2. Non-CMA sites:

- a. *DHP2000 sites* - Short the DED input test-links with a jumper.
- b. *STC sites* - Short the DED AAR terminals with a jumper.
- c. *GETS sites with Field Interface panel* - install jumper across AAR terminals DED+ and DED-.
- d. *GETS sites with entrance board* - install jumper across AAR terminals DED+ and DED-.
- e. *GETS sites with Faraday cage (does not have AAR terminals)* - Locate the DED+ input P1-1 of the uHBD box. Remove the existing wire and tape back. Insert a temporary wire into P1-1. Connect the other end of the wire to N12. (N12 is available on P1-9 thru P1-16).
- f. *GETS sites all* - The DED can be disabled through the configuration menu. Enter ms (supervisor mode), then go to the EQUIP menu. The DED can be disabled or enabled from this menu. To enter Supervisor Mode, the password is Supervisor.

7.8. NOTE 8: Talker Disable Instructions

- 7.8.1. Disable the talker by removing power from the radio. Some radios can be turned off using the Power/Volume dial. Other radios are hardwired on, and the power connector will need to be disconnected.

7.9. NOTE 9: Key Sites

- 7.9.1. Key WIS sites are those sites which, based on spacing and site access must be protected to meet the 40-mile Transport Canada inspection guidelines. This designation applies when multiple adjacent sites fail or are at risk due to storm conditions or power failures.
- 7.9.2. Trains must stop and be inspected manually if they have travelled 40 miles without an inspection.
- 7.10. NOTE 10: Hot Bearing Disable Instructions

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- 7.10.1.DHP2000 sites *Single intermittent HB alarm* - Presently there exists no simple method to disable a bearing scanner. The GBO issued to trains advising that the Hot Bearing portion is removed from service will allow the train crew to ignore any Hot Bearing Alarms. This method is appropriate for situations where the site is producing a few intermittent HB alarms.
- 7.10.2.DHP2000 sites *Multiple HB alarms* - For situations where the site generates multiple HB alarms, the talker will broadcast a series of tones for the subsequent alarms. The message broadcast at the end of the train will be "MULTIPLE ALARMS," with no indication of axle# to inspect. Any valid DED alarms will be announced by a double tone, the same as the HB defect. Any Hot Wheel defects will be announced by a single tone. Any valid DED or HW alarms will be masked by the non-valid HB alarms. This series of tones produced by the talker will be confusing to the crew. They may assume the GBO allows them to disregard the talker message. If they decide to stop and inspect, they must walk the entire train, resulting in an extended delay. This clearly opposes the intention of issuing the GBO. THEREFORE, WHEN A SITE IS GENERATING MULTIPLE HB ALARMS, THE ENTIRE SITE MUST BE REMOVED FROM SERVICE.
- 7.10.3.STC Sentry sites *Single intermittent HB alarm* - There exists no simple method to disable the HB portion of the Sentry system. This option does not presently exist in the System options. The GBO issued to trains advising that the Hot Bearing portion is removed from service will allow the train crew to ignore any Hot Bearing Alarms. This method is appropriate for situations where the site is producing a few intermittent HB alarms. Any DED or HW alarms have a high probability of being announced and handled correctly.

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7.10.4. *STC Sentry sites Multiple HB alarms* - For situations where the site generates multiple HB alarms, the talker will broadcast a series of tones for the subsequent alarms. The message broadcast at the end of the train will be "MULTIPLE ALARMS," with no indication of axle# to inspect. Any valid DED alarms will be announced by a double tone, the same as the HB defect. Any Hot Wheel defects will be announced by a single tone. Any valid DED or HW alarms will be masked by the non-valid HB alarms. This series of tones produced by the talker will be confusing to the crew. They may assume the GBO allows them to disregard the talker message. If they decide to stop and inspect, they must walk the entire train, resulting in an extended delay. This clearly opposes the intention of issuing the GBO. THEREFORE, WHEN A SITE IS GENERATING MULTIPLE HB ALARMS, THE ENTIRE SITE MUST BE REMOVED FROM SERVICE.

7.10.5. *GETS (Progress Rail) Sites* - the uHBD system configuration provides an Enable/Disable function to turn off the HB portion only. This is used at locations installed for Cold Wheel Detection.

7.10.6. For GETS/Progress Rail sites, the HB system is disabled by changing the configuration of the uHBD box. Connect a laptop to COM3 and enter the following commands:

```
ms    <ENTER> password is supervisor
equip <ENTER>
s      <ENTER> (this toggles the enable/disable status)
e      <ENTER> (this exits the menu)
```

921 - Wayside Inspection System (WIS) Site Selection Guidelines

1. Purpose

- 1.1. Herein are guidelines for the survey and/or selection of Wayside Inspection Systems.
- 1.2. This document is closely based on AREMA C&S Manual Part 5.3.1 entitled "Recommended Instructions for Hot-Bearing Detector Site Selection". Metrolinx consolidates other types of defect detectors such as dragging equipment and hot wheel detectors at the same location.

2. Site Selection Process

- 2.1. Once the need is determined, follow the process below for site selection.

Table 921-01

Step	Action
1	Perform risk assessment demonstrating the location will serve the needs for all type of trains operating through the subdivision or corridor.
2	Using the Site Selection Criteria below in conjunction with the risk assessment results select a site.
3	Record the following information: <ol style="list-style-type: none">a. Location Nameb. Subdivisionc. Mile point nearest 10thd. Track(s) where site will be installede. Corridorf. Site type if more than one choiceg. GPS Coordinatesh. Train Operationsi. Any other pertinent information
3	Metrolinx will provide the sign off on the selection of the location.
4	After sign-off, project continues.

3. Site Selection Criteria

- 3.1. Although there are many criteria to consider when selection WIS sites, generally the criteria falls in descending priority order from the most important to those of lesser importance:
- a) Those that concern public safety and safety of Metrolinx employees.
 - b) Protection of public property and protection of Metrolinx property, including the train being inspected by the site(s) in question.
 - c) Setout location to minimize operating delays.
 - d) Ease of site maintenance.
 - e) Ease of site installation.
- 3.2. Any necessary trade-offs are to be made with these criteria in mind.

4. Detector Location

- 4.1. Wayside Inspection Systems shall be located so the maximum amount of train traffic will be examined. Consideration should be given to areas where freight trains traversing on Metrolinx right of way are inspected.
- a) Sites should not be located close to terminals so that bearings of outbound equipment are permitted to stabilize at their normal operating temperature.
 - b) Sites should not be located where prolonged stops may occur such as an inbound area to a terminal.
 - c) Sites should be readily accessible from nearby roads to facilitate maintenance.
 - d) Where access by rail is the only option, consideration should be given to a take-off point for hi-rail vehicles. If there is no other means, budget for a "portable" take-off and any necessary buildup of the take-off point.

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- e) Sites should provide sufficient space to install wayside equipment conforming to standard practice. Ensure sight lines are maintained.
- f) Choose areas where there is good drainage, avoid low areas where flooding may occur.
- g) Avoid areas of high vandalism.
- h) Avoid placing site in areas that may require braking, stopping, and other train moves that may cause a detector malfunction.
- i) Consideration should be given to the availability of communication facilities required for WIS operation, maintenance, and remote interrogation/diagnostics. This includes Data Radio, and owned and leased DATA Circuits. Radio frequency licensing must be considered for DATA radio communications.
- j) Sites for WIS should be located near or accessible to a commercial power source.
- k) WIS sites are equipped with radios and talkers to alert crews of detector's inspection results. Consideration should be given to terrain, structures and other restrictions to radio transmissions. Radio frequency licensing must be considered for voice radio communications.
- l) Scanners should face a direction that minimizes solar interference. (Sun Interference)
- m) Consideration should be given to placing sites no closer than braking distance from a switch for moves in the facing point direction.
- n) Electrical grounding should be given careful consideration. Avoid soil with a lot of sand or crushed rock, especially where it is not naturally occurring.

5. Track Conditions

- 5.1. The AREMA recommended instructions for track is added here however track structure should be modified including but not limited to tie placement, rail fasteners and spikes after the site has been chosen and before the detection system is installed.
- 5.2. Track should be tangent for a minimum of 1500 ft. from curves, turnouts, and 400 ft. from grade crossing (highway or rail), and/or other structures that could cause excessive lateral displacement or truck skew.
- 5.3. Track gauge at Wayside Detection Systems shall not exceed 56-3/4 in. when measured under moving load. This is the maximum dynamic gauge allowable. Gauge transition requires minimum of 100 ft. of rail for each 1/4 in. of gauge correction.
- 5.4. Track gauge at WIS shall not exceed 56-5/8 in. when measured on the unloaded track. This dimension should be reduced by the extent to which physical evidence indicates that both rails can move toward the field under load. Track gauge tighter than 56-1/2 in. does not adversely affect hot bearing detection. Therefore, the gauge through the detector should be as tight as possible conforming to track standards.
- 5.5. Track should be anchored on both sides of every tie for a minimum distance of 100 ft. on each side of the installation, referred to as box anchoring by some.
- 5.6. In addition:
 - a) Track bed should be tamped, stable, and well maintained.
 - b) Ties, plates, anchors and/or insulation in good condition.
 - c) Jointed/sectioned track requires the installation be placed midway between the adjacent rail joints, place it as best you can, given the normal practice of staggering joints.

- d) In the case of CWR place site well away from insulated joints.

6. Train Operations

6.1. Consultation with Metrolinx, see "Site Selection Process" above.

- a) Sites should be selected where trains generally travel more than 10 mph.
- b) Site should be selected where trains do not stop or switch over location.
- c) Site should be chosen where train braking is minimal.
- d) Site should be chosen to permit normal braking to stop the train for inspection before passing a set out location.
- e) Consideration should be given to the availability of suitable setout locations nearby that are accessible by road for car inspectors.
- f) Sites should be avoided where the terrain and/or structures presents hazards to crews inspecting the trains. The area for several miles in either direction of the detector site should conform to this need. This includes placement of WIS site cables and other equipment that is on the ground.
- g) Sites that are near highway-rail grade crossings should be avoided; trains stopped for inspection may block the crossings.

1001 - Identification of Buried Cable

1. Purpose

- 1.1. Applicable regulations require that buried cable be identified above ground as permanently as possible, using visual means such as a post, pedestal, or label on above ground equipment.
- 1.2. This practice covers the installation of above ground markers for the purpose of indicating the presence of S&C cable on the railway right-of-way.
- 1.3. The term "above ground marker" includes the following in Table 1001-01:

Table 1001-01

Type	Description
Warning Label	Label with pressure sensitive backing for attachment to the surface of above ground fixed plant, such as cable splicing pedestals, equipment housings, etc.
Buried Cable Marker	A warning label applied to a suitable post or channel.

- 1.4. Underground marking tape may be used to supplement the protection afforded by above ground markers and is normally placed 12" above the running line of the cable. Marking tape installation is MANDATORY for underground fiber cables.
- 1.5. This Practice is intended to apply to new installations and for replacement on existing installations where general renewal or replacement is to be made.

2. Application

- 2.1. In general, above ground markers are not required for buried cable within an S&C location, such as cable runs to switch machines, signal units, track circuits, repeaters, etc.

- 2.2. Above ground markers are required for the main underground cable runs between S&C locations.
- 2.3. Warning labels shall be applied to all above ground, fixed, S&C plant associated with the main underground cable runs.

3. Location

- 3.1. Where practicable, buried cable markers shall be located so as to provide a horizontal separation of at least 10' (3m) from gauge side of the nearest rail. Above ground markers should indicate the route of the cable as well as the presence of buried cable in the immediate vicinity.

NOTE: Underground cable may be installed closer to the track than the fixed plant or buried cable markers, particularly when rail-mounted cable plows are utilized. Therefore, labels should be worded so as to caution workers from digging or driving stakes on the right-of-way. (Figure 1001-1 illustrates the recommended warning label).

- 3.2. Although a cable marker is used to indicate the cable route it should never be considered as indicating the exact location of the cables.
- 3.3. Above ground markers should be placed:
 - a) so that each marker is visible from the next adjacent marker, but distance between markers shall not exceed 820 feet (250 m).
 - b) at each splice location.
 - c) at points where cable route changes direction.
 - d) at culverts.
 - e) on both sides of roads, railways, bridges, etc.

4. Special Applications

- 4.1. Additional warning labels may be required in special situations to properly indicate the cable route, such as:
 - a) At points where cable route crosses under the track.
 - b) Where the cable route is between tracks.

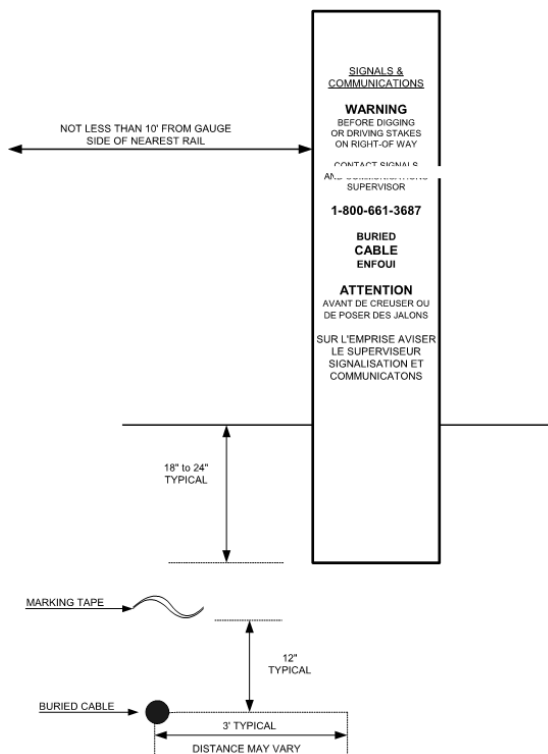
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- c) At points where the cable is shallow and mechanically protected.
- d) On conduit mounted on tunnel walls.
- e) On transition ducts where they enter the ground.

5. Installation of Cable Markers

- 5.1. Installation of above ground markers is depicted in Figure 1001-1 and Figure 1001-2. Note the figures below and messages on the markers are for examples only.
- 5.2. This is intended to indicate the recommended wording only and should not be used for the production of finished marker.

Figure 1001-1: Installation of Buried Cable Markers

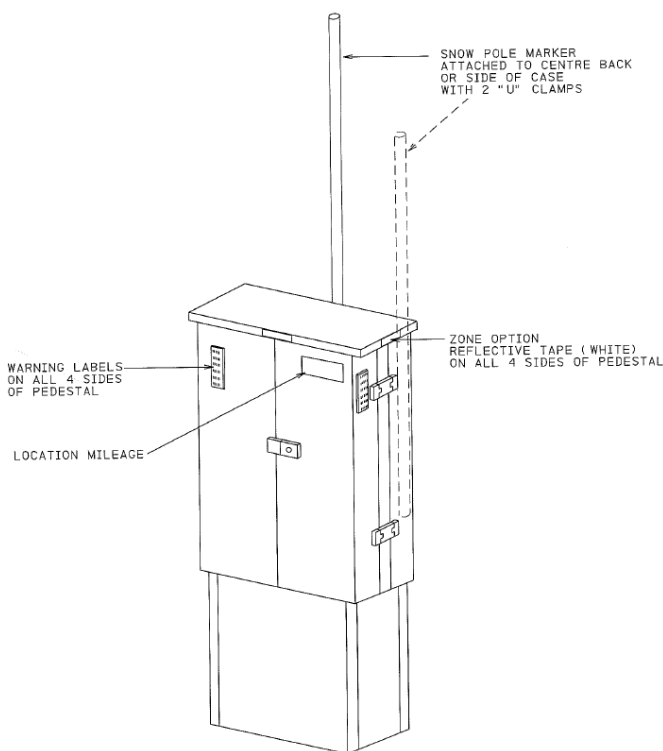


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NOTE: When required because of dense brush or other field condition, cable markers may be mounted on standard signposts.

- 5.3. When installing standard signposts, guidelines in [SCP-1005 Protection Instructions to Excavators for S&C Infrastructure](#) apply.

Figure 1001-2: Installation of Warning Labels



5.4. NOTE:

- Warning labels should be applied to any suitably located smooth, clean surface.
- Use cleaning solvent to remove all grime, oil, grease, etc.
- Remove backing from pressure sensitive adhesive and apply warning label with light even pressure.

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Figure 1001-3: Metrolinx Warning Label (Not Actual Size)



BLACK LETTERS
ON ORANGE
BACKGROUND

NOTE: This is intended to indicate the recommended wording only and should not be used for the production of finished labels.

6. Marker Material Ordering References

Table 1001-02

Type
"I" type cable marker c/w decal
"I" type post driver
"Metrolinx Warning Label" decal
Small cable marker 3 7/8" x 9 3/8" plastic type with 4 slotted mounting holes
Cable marker tape orange tape 6" width
Snow pole
Standard signpost (15')

7. Metrolinx Warning Label with Danger Shock Hazard Decal

- 7.1. Cable Markers used for joint buried power and fibre optic / signal cable installations shall consist of a standard post type cable marker with the standard "Metrolinx Warning" label AND a "Danger Shock Hazard" decal.

8. Combination Danger Warning and Danger Shock Hazard Signs

- 8.1. Where buried power cables are present, a combination "Danger Warning" and "Danger Shock Hazard" sign shall be installed at each access point to the right of way and at all rail bridges to warn the public, railway employees, contractors and/or trespassers of the presence and danger of buried cables.
- 8.2. An access point includes but is not limited to road crossings at grade.
- 8.3. These signs may be mounted either on a standard steel "U" post or on a Metrolinx structure such as a bungalow or a bridge. Signs shall be located on each side of the crossing in accordance with GO Transit Track Standard.

Figure 1001-4



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Table 1001-03

Type
"Danger Warning" sign
"Danger Shock Hazard" decal (7200 V)
"Danger Shock Hazard" sign (7200 V)
"Danger Shock Hazard" sign (25000 V)

9. Danger Buried Cable Sign

- 9.1. Where buried power cables are present and not otherwise identified with joint power/fibre optic markers, then "Danger Buried Cable" signs shall be installed to warn the public, railway employees, contractors and/or trespassers of the presence and danger of buried cables.
- 9.2. These signs shall be installed, parallel to the right of way, facing the property line, on the buried cable side of the track approximately every 1000' (300m). They shall be mounted on a 1 1/2" PVC post roughly 10' (3m) from the buried cable or in tight clearance situations "Ramset" to rock faces.

Figure 1001-5: Danger Buried Cable Sign



1002 - Cable Splicing-Composite Sig-Com Armoured Cable

1. Purpose

- 1.1. This practice covers splicing procedures for composite armoured multi-conductor signal and communication cable utilizing a filled D-Screen ALPETH type cable for the communication section.
- 1.2. NOTE: For convenience, the short term 'sig-com' cable is used herein.
- 1.3. Splices and terminations in a cable are discontinuities in the system and as such are more susceptible to failure than most other components of the cable system. It is therefore essential that splices and terminations be properly designed and installed.
- 1.4. All splices are to be made in approved splice closure pedestals.
- 1.5. While this practice illustrates a 34-conductor cable. The procedures described should be applicable to other composite armoured multi-conductor cables utilizing a filled D-Screen ALPETH type communication section.

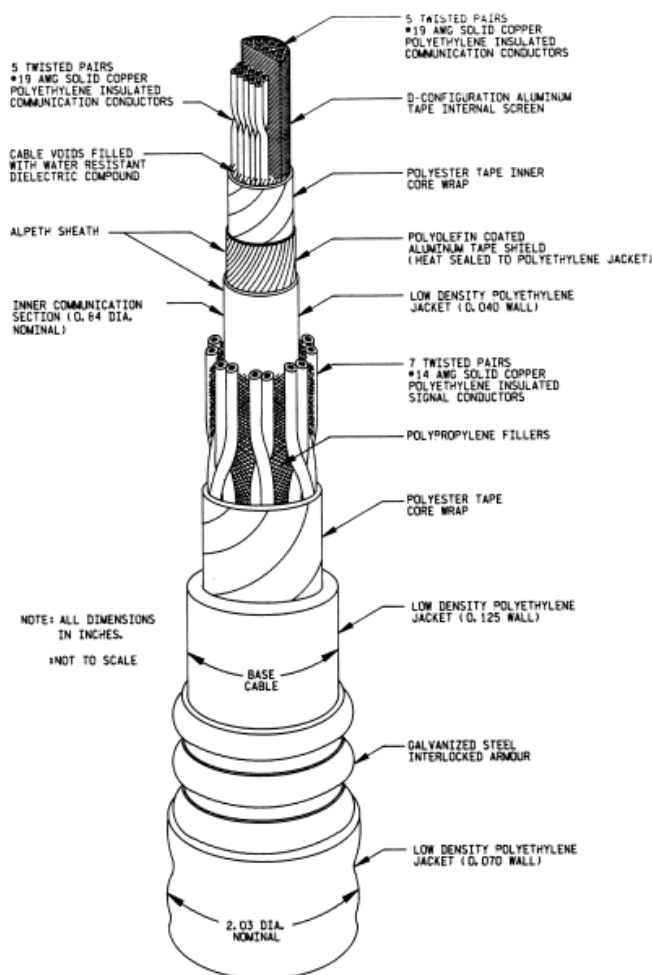
2. Cable Description

- 2.1. **Communication Section:** The communication section consists of a filled twin core sealed ALPETH sheath type cable. The cable voids are filled with a water resistant dielectric compound that prevents moisture travel.

- 2.2. NOTE: Sealed ALPETH sheath consists of an aluminum shield with an outer extruded fused polyethylene jacket. The aluminum shield has a polyolefin coating which seals and bonds the aluminum to the polyethelene jacket. The sealed ALPETH sheath protects against moisture permeation and increases sheath resistance to mechanical damage.
- 2.3. Twin-core is an ALPETH cable with a special D-shaped aluminum screen which separates the cable bundles into two separate compartments, half of the bundles are encapsulated within the D-screen, and the other half of the bundles are outside the D-screen. This arrangement permits simultaneous transmission of high-frequency pulse streams in two different directions without either stream being affected by the other.
- 2.4. **Signal Section:** The signal section consists of a single layer of polyethylene insulated signal conductors plus fillers applied over the communication core. A black polyethylene jacket is applied over the signal conductors forming the base cable.
- 2.5. **Mechanical Protection:** Flexible interlocking steel armour and overall black polyethylene jacket is applied over the base cable completing the sig-com cable construction.

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Figure 1002-1: Typical Composite Multi-Conductor Sig-Com Armoured Cable (34 Cond. Shown for Illustration Purposes)



3. Conductor Identification

- 3.1. Signal conductors are identified using number coding applied to one conductor of each pair.
- 3.2. Communication conductors are identified using the standard even-count telephone colour code. This is as shown below, for pairs 1 to 10 inclusive.

Table 1002-01

Number	Tip	Ring
1	White	Blue
2	White	Orange
3	White	Green
4	White	Brown
5	White	Slate
6	Red	Blue
7	Red	Orange
8	Red	Green
9	Red	Brown
10	Red	Slate

- 3.3. NOTE: Pairs 1 to 5 inclusive are located within the 'D' configuration aluminum tape screen.

4. Materials and Tools Required

- 4.1. The following lists special items and indicates the quantities required for each cable splice location.

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Table 1002-02

Item No.	Material Description	Quantity per Splice
1	Clamp, hose, geartype, all stainless type. Range 1 ¹¹ / ₁₆ " to 2 ²¹ / ₃₂ "	2
2	Compound, NO-OX-ID 'A' Special	As Req'd
3	Compound, sealing & dielectric, AMP	As Req'd
4	Connector, splicing, Scotchlok, type UIR. 3m Telcomm Products Division.	10
5	Connector, shield, Scotchlok, type 4460-S. 3m Telcomm Products Division.	2
6	Connector, Bond Stud Coin, type C-2058 Communications Technology (Canada) Ltd.	1
7	Tape, Electrical, Vinyl	As Req'd
8	Clamp, Cable. 2' Galv. Thomas & Betts •1281 Or Equal	2

4.2. The table below lists the tools that are required.

Table 1002-03

Item No.	Tools
1	Bullet bond punch tool
2	Cable sheath remover
3	Splicer's tool kit (snips & knife)
4	Scotchlok crimping tool, type E-9B
5	Hack saw (24T)
6	T-shears (C-4432)

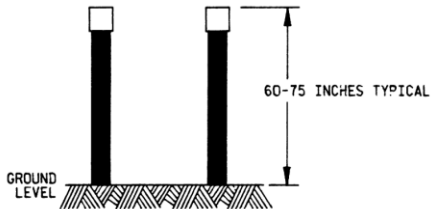
4.3. NOTE: Items 1, 3 & 6 available from Communications Technology (Canada) Limited. Item 4 available from 3M Telecomm Products Division.

5. General Procedures

- 5.1. It is essential that an adequate, yet not excessive amount of cable be placed within the splice closure pedestal.
- 5.2. Under standard installation conditions, the top of the pedestal will be Between 34 and 65 inches above the final grade depending upon the particular pedestal used.

- 5.3. A sufficient amount of cable above ground level should be provided (Figure 1002-2). This length will be governed by the type of pedestal used. Generally, between 60 and 75 inches is adequate.

Figure 1002-2: Cable End Dimension

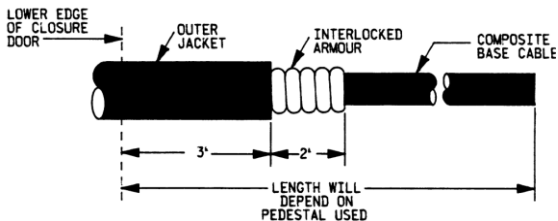


6. Cable Preparation

Table 1002-04

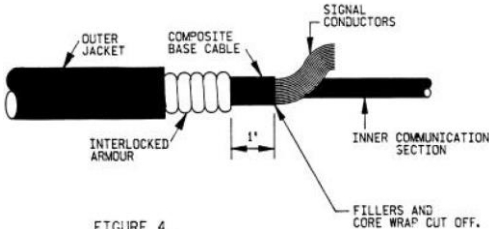
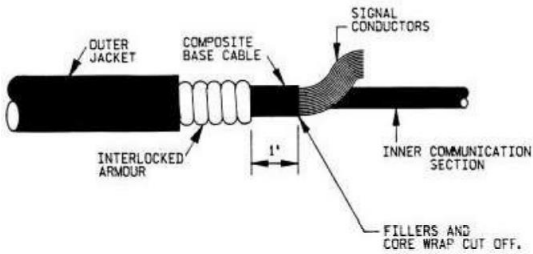
Step	Action
1	Remove the outer polyethylene jacket from each cable end. The length of outer jacket removed will depend on the particular pedestal utilized. The outer jacket should extend approx. 3" above the lower edge of the pedestal access door.
2	Cut through the raised helix of the armour using a fine-tooth Hacksaw (24T). Be careful not to cut into the composite base cable. The use of protective gloves is recommended.
3	Remove the interlocking armour from a point approx. 2" above the outer jacket as illustrated in Figure 1002-3 to provide space to install the required grounding hardware.

Figure 1002-3: Cable Preparation



Continued on next page

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Step	Action
4	<p>Remove the polyethylene jacket of the composite base cable from a point approximately 1" above the interlocked armour as illustrated in Figure 1002-4. This will prevent damage to the signal conductors by the steel armour.</p> <p>Figure 1002-4: Cable Preparation</p>  <p>FIGURE 4</p>
5	<p>Cut off the polypropylene fillers and core wrap close to the end of the composite base cable outer jacket (Figure 1002-4) and separate the signal conductors.</p>
6	<p>Remove the ALPETH sheath of the inner communication section from a point just above the signal conductor terminal block as shown in Figure 1002-5 and Figure 1002-13. Allow approx. ½" of core wrap to extend beyond sheath to prevent damage to the insulation by the aluminum tape shield.</p> <p>NOTE: Extending the ALPETH sheath of the inner communication section will minimize the amount of filling compound to be removed.</p> <p>Figure 1002-5: Cable Preparation</p> 

7. Filling Compound Removal

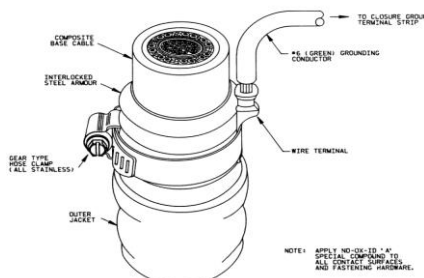
- 7.1. It is not necessary to remove all the filling material from the cable conductors before splicing. It is, in fact, desirable to leave some around the conductors because of the additional protection provided to the insulation and because the filling compound helps hold the conductors together reducing the likelihood of split pairs. If the compound is to be removed prior to splicing, special care must be taken to ensure that pair identity is maintained during and after this operation. Excess compound should be removed after completion of splicing operations to minimize dirt and dust adhering to conductors. Use only a soft cloth or paper towel.
- 7.2. Where splice closure pedestals are provided with ventilation louvers it may be necessary to remove as much filling compound as practicable to minimize dirt and dust adhering to conductors. Use only approved solvents such as trichloroethane in accordance with the manufactures instruction together with a soft cloth or paper towels. Use solvents only with adequate ventilation.

8. Bonding and Grounding

- 8.1. Shield and cable armour of all cables entering a pedestal should be bonded together inside the pedestal and grounded to the "Ground Terminal Strip" as shown in Figure 1002-13.
- 8.2. D-Configuration screens of all cables entering a pedestal should be bonded together inside the pedestal as shown in Figure 1002-13. Screens must not be grounded.

9. Steel Interlocked Armour

Table 1002-05

Step	Action
1	<p>Steel cable armour should be grounded as shown in Figure 1002-6 and Figure 1002-13.</p> <p>Figure 1002-6: Bonding Steel Armour</p> 
2	<p>Position gear type hose clamp around the armour and secure wire terminal under clamp as shown in Figure 1002-6. Use only hose clamps manufactured entirely of stainless steel including the tightening screw.</p>

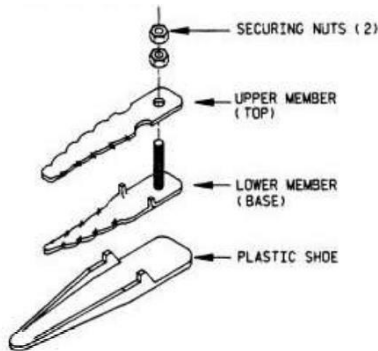
- 9.1. NOTE: A protective antioxidant compound (NO-OX_ID 'A' special) should be applied to all contact surfaces and fastening hardware to prevent corrosion and ensure a positive electrical connection. Compound should be applied with a stubby brush or swab and rubbed onto the metal surfaces thoroughly to absorb any moisture present and to ensure contact over all surface irregularities.

10. Communication Section Shield (ALPETH Sheath)

- 10.1. In order to continue the shield across the splice and to ground the shield at splicing locations, a solid bonding device capable of carrying shield currents to ground is required. With the introduction of polyolefin coated aluminum shields it is necessary to use a bonding device that is able to penetrate the polyolefin coating in order to make a positive electrical contact with aluminum shield.

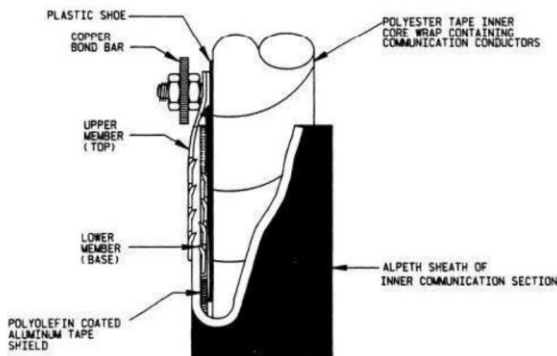
- 10.2. A bonding device suitable for this application is the Scotchlok type 4460-S shield connector illustrated in Figure 1002-7.

Figure 1002-7: Scotchlok Type 4460-S Shield Connector



- 10.3. The 4460-S connector consists of 5 pairs: lower member (base), upper member (top), 2 securing locknuts and a plastic shoe to aid connector insertion and to protect the communication conductors. Rows of teeth on both the top and base members pierce the thin polyolefin film which coats the aluminum shield and bite into the outer polyethylene jacket to provide good-pull-out resistance. Figure 1002-8 illustrates installation of the shield connector.

Figure 1002-8: Installation of Shield Connector



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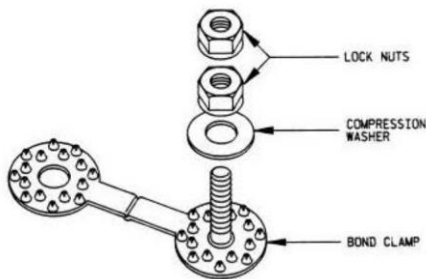
Table 1002-06

Step	Action
1	<p>Insert the base member and plastic shoe between the outer surface of the polyester tape core wrap and the inner surface of the aluminum tape shield.</p> <p>NOTE: It may be necessary to cut a longitudinal relief slit in the end of the ALPETH sheath to ease insertion of the base member and plastic shoe. Using T-Shears (Tabbing shears) make a single cut approximately 1½" long opposite where the shield connector will be placed taking care not to damage the core wrap.</p>
2	Position the top member over the base member and tighten down one of the locknuts.
3	<p>Several turns of 3/4" wide vinyl electrical tape should be wrapped over the filled cable core at this point as shown in Figure 1002-9 to restrain the filling compound. Do not include the shield connector stud and locknut under this wrapping. Ensure that the relief split is completely covered and that no wires are pinched in the split. Whenever applying vinyl electrical tape, continue beyond the required amount with three extra turns applied with care to ensure that the tape is not stretched. With a sharp knife or splicer's scissors, cut tape from the roll. Press the end down smooth and snug. This procedure is to minimize subsequent creeping and flagging of tape end.</p>
	<p>Figure 1002-9: Terminating Communication Sheath</p>
4	<p>As shown in Figure 1002-13. The aluminum tape shield is continued across the splice position by a section of #10 AWG (green) copper grounding conductor which is secured to the shield connector stud by the second locknut.</p>

11. Communication Section D-Screen

- 11.1. D-Screens should be continued across the splice position but unlike interlocked armour and shield. The D-screen must not be grounded, as the aluminum D-Screen is coated with insulating polyolefin film. It is necessary to use a bonding device that can penetrate the film to make a positive electrical contact with the D-Screen. A bonding device suitable for this application is the C-2058 bond stud coin illustrated in Figure 1002-10.

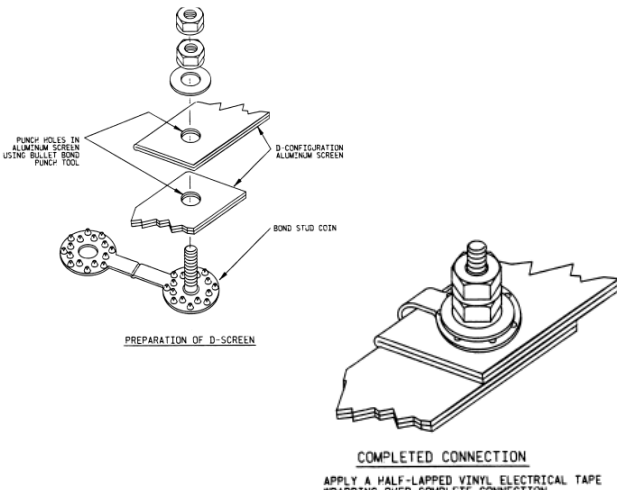
Figure 1002-10: Bond Stud Coin



- 11.2. The C-2085 bond stud coin consists of four parts: a perforated sandwich-type bond clamp with a threaded stud. One compression washer and two securing locknuts. Specially designed tangs pierce the thin polyolefin film which coats the screen.

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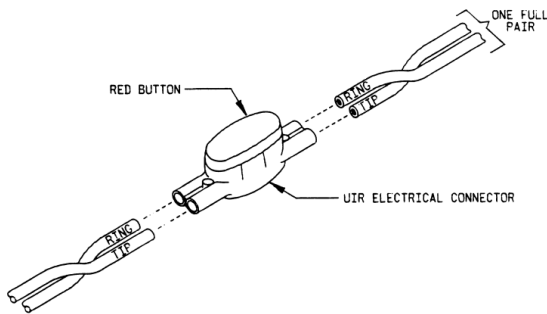
Table 1002-07

Step	Action
1	<p>Prepare the D-screen for bonding by punching a hole in the end of the aluminum tape using a bullet bond punch tool. Overlap the two aluminum tapes and insert the stud of the bond coin into the two holes. Fold over the opposite 'coin' of the bonding clamp as shown in Figure 1002-11 and install the compression washer and locknuts.</p>
2	<p>Figure 1002-11: Installation of Bond Stud Coin</p> <p>Apply a wrapping of 3/4' wide electrical vinyl tape over the completed connection to prevent inadvertent grounding of the D-Screen.</p> 

12. Splicing Communication Conductors

12.1. Scotchlok brand UIR electrical connectors are used to splice the communication conductors. Brand UIR connectors will splice up to four 19-gauge solid copper conductors (1 full pair). Unless the connectors are compressed correctly, unsatisfactory Conductor splice's result. Therefore, it is essential that the correct tool be used and that it is in correct adjustment in all cases. Figure 1002-12 illustrates the Scotchlok brand UIR connector.

Figure 1002-12: Scotchlok Type UIR Splice Connector



12.2. Scotchlok connectors employ u-shaped elements which are forced down causing the elements to pierce and shear through the conductor insulation. The spring loaded metal fingers of the u-element develop a high contact pressure on the conductor. The u-elements are encased in a Transparent plastic sleeve filled with silicone grease sealant which excludes moisture but will not harm polyethylene or other insulations.

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Table 1002-08

Step	Action
1	The Scotchlok crimping tool E-9B is used to compress the u-element button into the sleeve. If the ends of the pairs are untwisted, go over all the wires and retwist the pairs.
2	The brand UIR Scotchlok connector is used to make an inline splice. Do not strip any insulation from the conductors. Insert the insulated conductors fully into the connector, observing through the transparent plastic sleeve that the conductors are in proper position. With the conductors in position, compress the red u-element button into the sleeve using the E-9B tool.
3	In joining paired conductors, splice tip to tip and ring to ring, i.e. straight per color code. Do not reverse or interchange pairs.
4	The two communication conductor groups (pairs 1-5 and 6-10) must be physically and electrically isolated from each other as well as from the D-Screen and signal conductors. Pay particular attention where the conductor groups emerge from the ALPETH sheath.
5	After all communication conductors are spliced together and arranged to provide a uniform layup, the two communication groups should be secured to the pedestal backboard at several locations using cable ties for mechanical support and to maintain separation.

12.3. If it is necessary to rearrange a pair that is spliced, remove the connector by crimping the sides with pliers until the red button is forced out. The connector can then be slipped off the pair. After the connector has been removed, the conductor ends should be cut off at a point where the insulation has been perforated. About 1/4-inch of conductor will be cut off.

13. Terminating Signal Conductors

13.1. A.A.R terminals C/W test straps are used to terminate the signal conductors as shown in Figure 1002-13.

14. Moisture blocks

14.1. Moisture blocks are required to prevent the entrance of water into the cable at the following locations:

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- a) between the overall outer polyethylene jacket and the interlocked armour.
- b) between the composite base cable and the interlocked armour.
- c) between the inner communication section and the composite base cable.

14.2. Figure 1002-13 shows the location of the moisture blocks.

Table 1002-09

Step	Action
1	Wrap the cable section to be sealed with a length of sealant tape (amp sealing and dielectric compound) to form a collar. Mold the collar with the fingers to eliminate all voids and to make a tight seal.
2	Apply a wrapping of ¾" wide vinyl electrical tape smoothly and tightly over the sealant extending the tape ¾" beyond the sealant at each end.

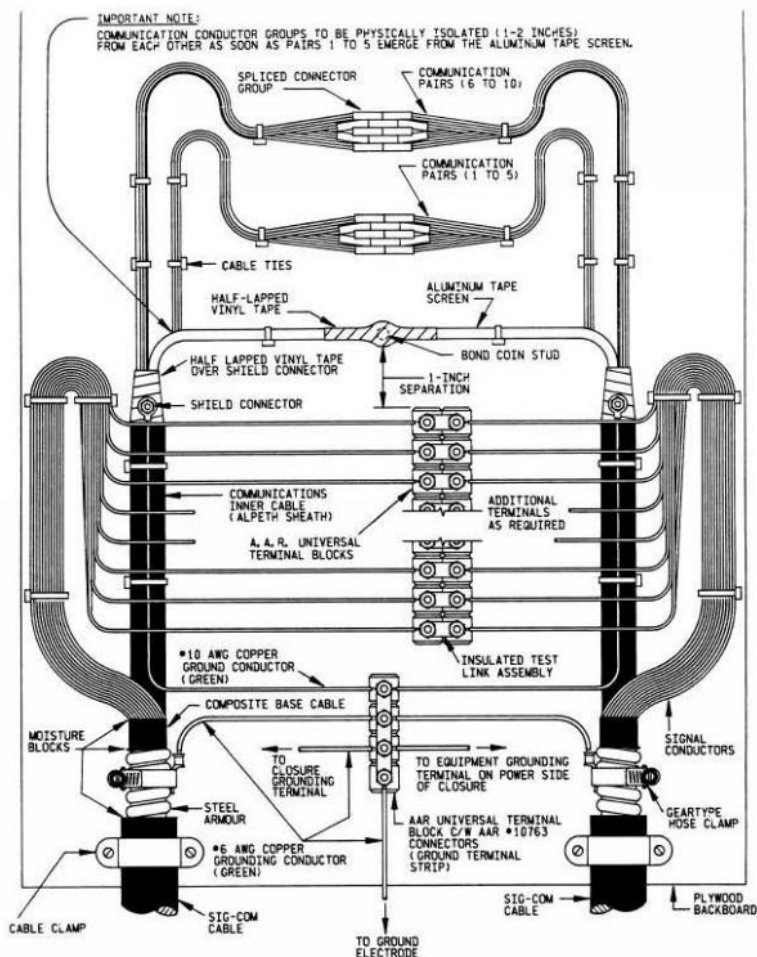
15. Completion of Work

Table 1002-10

Step	Action
1	Inspect closure pedestal to ensure that: <ul style="list-style-type: none"> • All communication pairs are properly spliced. • All signal pairs are properly terminated. • Cable armour and ALPETH sheaths are properly bonded and grounded. • D-Screens are properly bonded and not inadvertently grounded. • Communication conductor bundles are physically and electrically isolated from each other as well as from the D-screen and signal conductors.
2	Inspect closure pedestal to assure that good workmanship has been carried out.
3	Test frequently for defective pairs. Completed cable plant must be 100 percent free from grounds, shorts, crosses and open conductors.

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Figure 1002-13: Layout of Splice Closure pedestals (Typical Signal Conductor Termination Illustrated)



15.1. NOTE: Refer to location circuit plans for actual layout details.

1003 - Standard Terminals & Tools for Case Wiring

1. Purpose

- 1.1. The purpose of this document is to identify the approved tools and associated terminals used in various vital and non-vital wiring applications using insulated stranded case wire (Okonite Blue EPR) and polyethylene insulated solid cable wire (LLDPE).

2. Vital Wiring

- 2.1. This table lists the approved AMP / 3M / ANSALDO (US&S) terminals and the associated AMP crimp tools to be used when wiring vital signal circuits.

Table 1003-01

	TOOL	TERMINAL		
Wiring Application	AMP Number	Type / Colour	Wire Size/Type	AMP Number
Vital Shelf Type Relay and Terminal Board Wiring to AAR Terminals (1/4" Stud)	169400	PIDG/Blue	#16-14 EPR, LLDPE	321045
	Die #169404			
	47387	PIDG/Blue	#16-14 EPR, LLDPE	321045
	169400	PIDG/ Yellow	#12-10 EPR, LLDPE	320569
	Die #169404			
	59239-4			
Ground Wire Connections to AAR Terminals (1/4" Stud)	601075-1	Solistrand	#6 EPR	33465
	Die #601092			
	169400	Solistrand	#12-10 EPR	33458
	Die #169409		#16-14 EPR	34124

Continued on next page

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	TOOL	TERMINAL		
Wiring Application	AMP Number	Type / Colour	Wire Size/Type	AMP Number
Battery Lug and Ground Stud Connections (3/8" Stud)	601075-1	Solistrand	#6 EPR	1-331471-1
	Die 601092			
	59239-4	PIDG/ Yellow	#10 EPR	320577
Battery Lug and Ground Stud Connections (5/16" Stud)	59239-4	PIDG/ Yellow	#12-10 EPR, LLDPE	35111
	47387	PIDG/Blue	#16-14 EPR, LLDPE	328998
Track Wire, Battery Bus and Lighting Circuit Connections to AAR Terminals (1/4" Stud)	601075-1	Solistrand ¹	#6 EPR, LLDPE	33465
	Die #601092			
Siemens (Safetran) and ALSTOM (GRS) Plug-in Relays	68262-1	Solistrand	#14-10 EPR	53889-1
	68074-1	Solistrand	#22-16 EPR	53112-1

¹The exposed barrel portion of the terminal shall be protected with heat shrink tubing or boot. Use Sigmaform SST-9-11 or equivalent.

Table 1003-02

	TOOL	TERMINAL		
Wiring Application	AMP Number	Type / Colour	Wire Size/Type	3M Number
Track Wire, Battery Bus and Lighting Circuit Connections to AAR Terminals (1/4" Stud)	59974-1	Nylon / Blue	#6 EPR, LLDPE	MN6-14R/SK
	Die #48753-1 Mod. W			
	601075-1			
	Die #601092			

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Table 1003-03

	TOOL	TERMINAL		
Wiring Application	AMP Number	Type / Colour	Wire Size/Type	ANSALDO (US&S) Number
ANSALDO (US&S) Plug-in Relays "Long Clip"	68378-1	Solistrand	#12-10 EPR	J680181
	45499	Solistrand	#16-14 EPR	J680165
ANSALDO (US&S) Plug-in Relays "Short Clip"	68378-1	Solistrand	#12-10 EPR	M451142-2703
	45499	Solistrand	#16-14 EPR	M451142-2702

3. Non-Vital Wiring

3.1. This table lists the approved AMP terminals and the associated AMP crimp tools to be used when wiring non-vital signal circuits.

Table 1003-04

	TOOL	TERMINAL		
Wiring Application	AMP Number	Type / Colour	Wire Size/Type	AMP Number
Code Interface Boards, Local Control Panels, Transfer Units, Data Loggers, etc. (#8 Stud)	169400	Spade Fork / Red	#22-16	52410
		Spade Fork / Blue	#16 EPR	52421-1
	Die #169404	Spade Fork / Yellow	#12-10 EPR	326859
	47386	Spade Fork / Red	#16-22	52410
	47387	Spade Fork / Blue	#16 EPR	52421-1
	59239-4	Spade Fork / Yellow	#12-10 EPR	326859

4. Test Eye

- a) Siemens (Safetran) system part # 024628-3X (16-14),
- b) Siemens (Safetran) system part # 024628-4X (12-10).

5. GI-301(g)

- 5.1. Refer to [GI-301\(g\) Maintenance of Vital Tools and Test Instruments](#), for instructions regarding the inspection and calibration testing of tools used for wiring vital circuits.

6. Crimpers

- 6.1. For purchase of a Pro-Crimper III with dies included use AMP # 58433-3. Pro-Crimper III AMP # 354940-1 is equal to AMP # 169400.

1004 - Standard Signal Wire and Cable

1. Purpose

1.1. The purpose of this document is to identify the approved wire and cable used in various vital and non-vital wiring applications.

2. Vital Wiring

2.1. These tables list the approved Okonite, Nexans, Erico, and Anixter wire that should be used.

Table 1004-01

	CASE WIRE		
WIRING APPLICATION	Type / Colour	Wire Size/Type	Okonite Number
Equipment in the Case	TC / Blue	#10 EPR	152-11-3038
	TC / Blue	2C#10 EPR Twisted	152-11-3039
	TC / Blue	#16 EPR	152-11-3002
	TS-CPE / Black	#6 EPR	151-12-1201

Table 1004-02

	GROUNDING WIRE		
WIRING APPLICATION	Type / Colour	Wire Size/Type	Anixter Number
Case Wire & Ground Loop	Stranded / Bare	1C / #6	1B-0607
	Stranded / Green	1C / #6	6CN-0607-04
	Stranded / Green	1C / #10	6CN-1007-04

Table 1004-03

	TRACK WIRE		
WIRING APPLICATION	Type / Colour	Wire Size/Type	Nexans Number
Track Circuits	Stranded / Black	1C / #6	641993
	Stranded / Black	2C / #6 Twisted	652926

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Table 1004-04

	UNDERGROUND POWER CABLE		
WIRING APPLICATION	Type / Colour	Wire Size/Type	Anixter Number
Heavy Armored Power Runs	TECK 90 / Black	2C / #8	7TJ-0802AJ
	TECK 90 / Black	3C / #8	7TK-0803AJ
	TECK 90 / Black	3C / #6	7TK-0603AJ
	TECK 90 / Black	3C / #4	7TK-0403AJ
	TECK 90 / Black	3C / #2	7TK-0203AJ

Table 1004-05

	UNDERGROUND POWER CABLE		
WIRING APPLICATION	Type / Colour	Wire Size/Type	Nexans Number
Power Runs	Stranded / Black	2C / #8	643502
	Stranded / Black	2C / #6	660172
	Stranded / Black	3C / #6	660096

Table 1004-06

	BONDSTRAND WIRE		
WIRING APPLICATION	Type / Colour	Wire Size/Type	L&W Number
Bootleg to Track for Track Circuits	Bondstrand / Black	4/64 / Tinned	DA6625

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Table 1004-07

WIRING APPLICATION	SIGNAL CABLE		
	Type / Colour	Wire Size/Type	Nexans Number
Gate Mechanism & Switch Machine	Stranded Composite / Black	7C / #6 & 9C / #14	660171
Searchlight Signal, Snow Clearing Device, Line Drop, & Switch Circuit Controller	Stranded Composite / Black	2C / #10 & 6C / #14	660092
Color Light Signal	Stranded / Black	5C / #6	660083
Color Light Signal (Long Run)	Stranded / Black	7C / #6	660170
Switch Circuit Controller	Solid / Black	6C / #14	395376
Maintenance	Stranded / Black	3C / #6	660095
	Stranded / Black	2C / #10	660167
	Solid / Black	5C / #14	660169
	Solid / Black	8C / #14	660685
	Solid / Black	12C / #14	660308
Line Circuits	Solid / Black	19C / #14	651778
	Solid / Black	28C / #14	651786
	Solid / Black	37C / #14	651794

1005 - Protection Instructions to Excavators for S&C Infrastructure

1. Purpose

- 1.1. The purpose of this standard is to define the minimum requirements for safe, effective excavating practices in the vicinity of underground Signals and Communications (S&C) infrastructure such as cable, foundation, bungalow, crossing gates and warning signals on the Metrolinx Right-of-Way.

2. Importance of Buried Cables

- 2.1. S&C cables are installed to provide power, signal control, wayside communications, and in the case of fibre optic cables, telecommunications which are important to safe and reliable Railway operation.
- 2.2. Metrolinx has several external customers who have fibre optic cables along Metrolinx's Right-of-Way. The economic importance of fibre optic facilities continues to increase, as these fibre networks expand in both scope and capacity.

3. Excavation Definition

- 3.1. Excavating includes any activity that results in an opening being made in the ground, including, but not exclusive to, digging, trenching, plowing, auguring, pile driving, blasting, directional boring, installing sign posts and pipe pushing. This may include surfacing activities where machinery or equipment can damage, or break cable and support structures which have been installed at or near ground level i.e. bridges, culverts, underground passageways, station platforms.

4. Fibre Territories Definition

- 4.1. Fibre territories are those segments of the Right-of-Way where fibre optic cables are found. Fibre optic cables are now installed on all of Metrolinx's main corridors and may be located anywhere along the Right-of-Way. The limits of the Right-of-Way should be considered from the center of track(s) to the Metrolinx property line.

5. Contractors

- 5.1. Before a contractor, or its employees, are allowed to excavate on Metrolinx Right-of-Way, they must be familiar with this Code of Practice. The contractor or his designated representative shall sign the document "Important Memo to Contractors" confirming they have read and that they will abide by the associated terms and conditions.

6. Potential Impact of Disruptions to Metrolinx and Its Fibre Customers

- 6.1. Damage to underground cables can have a severe impact on the operations of both Metrolinx and its external customers. Metrolinx Centralized Traffic Control, Engineering and Train to Wayside Radio Communications and Metrolinx's WAN/LAN backbone can be disrupted resulting in service and operational problems.
- 6.2. In addition, the fibre optic network installed on Metrolinx is utilized by clients that offer important services such as, cable, banking, national defense, air-traffic control and emergency communication services (i.e. 911). Damage or cuts to cable thereby affects a much wider range of operations and services.

7. Metrolinx Signals & Communications

- 7.1. Metrolinx S&C is responsible for the day-to-day operation of the fibre optic, signal, power cables, and S&C infrastructure that runs the Metrolinx signal system and is the primary contact for Metrolinx's fibre optic customers. Prior to the commencement of any work that could jeopardize Metrolinx's S&C plant, the responsible S&C representative or foreman-in-charge shall be notified of the of the situation.
- 7.2. If such work poses a threat to the integrity of the fibre optic plant Metrolinx S&C will advise its fibre optic customers, who may in turn set up alternate routes for their priority traffic.
- 7.3. Metrolinx S&C will notify the Operations Centre of each customer potentially affected by the excavation work. The list of possibilities includes, but is not limited to: threat of washout, landslides, derailments, major track work such as undercutting, rail-pick-up and tie replacements, and relocation of the fibre cable, drilling or digging near the fibre cable. The Metrolinx S&C representative will provide: their name and location, a description of the work to be performed and instructions on how they can be reached during the course of these activities. S&C will open a trouble ticket to record all instances of fibre work being performed on the Right-of-Way.

8. At Bridges, Pedestals & Bungalows

- 8.1. Cable slack is usually coiled near cable ends, such as at splice pedestals, tunnels, bridges, bungalows, road and track crossings and some culverts. Cable slack coils can be of unequal size, unequal depth, and are nearly impossible to locate accurately with cable locating equipment.
- 8.2. Where excavating or digging near cable slack coils, the entire coil shall be located and exposed by hand digging or using Metrolinx approved vacuum equipment. Locating a portion of the cable coil and assuming the location of the remainder of the coil is not acceptable.

9. Direct Buried Cables

- 9.1. Signal, power, fibre optic and other high capacity communication cables are typically buried directly in the sub grade, and generally, but not always, parallel to the railway tracks, typically at a distance of 1.2 to 2.1 meters (4 to 7 feet) from the edge of ties. The preferred depth of burial is typically 1.2 meters (4 feet), however depths of only 45 centimeters (18 inches) or less may be encountered near underground obstructions such as culverts, station platforms, passageways or approaches to bridges and tunnels. Cables may be located on either side of the track or between tracks. In addition, cables may pass under the tracks as the cable is routed from one side of the track to the other.

10. Common Trench

- 10.1. Wherever possible, a common trench is used when installing power, fibre optic and other S&C cables. Voltages used in underground power systems range from 120-volts to 7200-volts AC or more. Special precautions outlined in Section 19 - Work Near Buried Power Cables - must be followed when excavating near power cables.

11. Cable Markers

- 11.1. Permanent cable markers are installed only to indicate the presence of buried cable and are not meant to indicate the precise location of the cable. Permanent cable markers are not necessarily placed directly above buried cables.

12. Clearance of Overhead Utility Cables and Structures

- 12.1. The excavator shall determine the clearance between the maximum extended height of the mechanical excavation equipment and the lowest point of overhead cables and structures. If the equipment is transported by flatbed truck, the total height shall be considered. Temporary warning signs shall be placed on each side of the work area, specifying the permitted equipment height.
- 12.2. The *Occupational Health and Safety Act Ontario Regulation 213/91 Construction Projects Section 188* requires that equipment be kept at least 3m (10 feet) away from power lines with voltages up to 150 kV. Cranes, similar hoisting devices, backhoes, power shovels or other vehicle or equipment are required to take additional steps before beginning work.
- 12.3. In the case of bare overhead power distribution conductors up to 150KV, the permissible clearance (conductor to top of rail) is 7.3m (24 ft). Therefore, the maximum height of the excavation equipment must not exceed about 4.3m (14.2ft).
- 12.4. Transmission conductors (wires) are dynamic in nature. They can sag lower to the ground depending on parameters such as ambient temperature and operating conditions. Minimum vertical clearances must be maintained from the maximum design sag levels of the conductors (worst-case scenario). These clearances are case-specific, not immediately apparent by observation alone and shall be reviewed with the Utility.

13. Preparation for Excavation Work

- 13.1. Excavators must contact Metrolinx before any excavating along the railway Right-of-Way. Metrolinx will arrange for S&C employees to locate, and mark the location of fibre optic, power, and other S&C cables prior to excavation.

- 13.2. Contractors perform various excavation services on Metrolinx Right-of-Way shall be familiar with the instructions contained in this document.

14. Precautions Prior to Excavation

- 14.1. Prior to commencement of any type of excavation along the Right-of-Way, the S&C employee (Foreman-in-charge) must notify Metrolinx. The S&C employee shall provide their name, location where work will be performed, a description of the work and instructions on how they can be contacted. Excavation work shall not proceed unless authority has been granted by Metrolinx.
- 14.2. When excavation activities are being conducted by outside contractors or Track forces, within 2 meters of an underground cable, the designated S&C Employee or other qualified S&C employee shall remain at the excavation site until all excavation work is completed.

15. Cable Locates

- 15.1. Cable locates shall be requested a minimum of 72 hours in advance of the scheduled excavation work. Outside contractors responsible for the excavation work shall be present when the cable locate is being performed.

16. Cable Location Marking

- 16.1. Table 1005-01 shows the cable location marking guidelines, which is representative of industry standards, and is a good practice to follow when identifying the location of underground cables and utilities prior to excavation.

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Table 1005-01

Mark the location of the underground...	With...	Using...
Fibre optic or communications cable	A series of 4 foot long lines directly over the cable	Fluorescent orange paint
Power or signal cables	A series of 4 foot long lines directly over the cable	Fluorescent red paint
Gas, chemical or petroleum utility distribution pipe	A series of 4 foot long lines directly over the pipe	Fluorescent yellow paint
Water or sewer pipe	A series of 4 foot long lines directly over the pipe	Blue paint
Hand Excavation only zone	A series of 8 foot straight lines, 1 meter parallel to and on each side of the cable or utility line	White spray paint

17. Precautions When Excavating

17.1. Railway excavation experience has proven there are certain situations where the risk to damaging in service S&C cables is increased and special precautions are necessary. The following describes various situations and the method to use to avoid damaging any buried cables:

- a) Whenever excavating is performed within 1 meter (3.3 feet) of a buried cable the ground shall only be excavated by hand digging, or by using Metrolinx approved equipment especially designed for exposing cables utilizing a vacuum system to remove the surrounding soil. Under no circumstances are mechanical excavating machines of any kind to be used unless the cable is fully exposed and pulled clear of the work area.

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- b) Whenever parallel trenching or excavating is performed with a back hoe or cable plow unit, beyond the 1m (3.3 feet) hand excavation zone, but within 2m (6.6 feet) of the existing cable, the preferred method of protecting the fibre cable is to install a temporary bypass communication cable with "protection" circuits connected prior to excavating.
 - i. The intent is to eliminate the possibility of unexpected service disruptions or failures due to the excavating equipment snagging and forcing sharp rocks or foreign objects through the cable(s) while plowing or trenching.
- c) If the precautions described in items a or b are impractical, a Method of Procedure (MOP) shall be developed by the responsible Supervisory Officer. Refer to Section 18 Method of Procedures in this document.
- d) When exposing cables, use extreme care to avoid damage to cable or wire insulation. Dig down 15 cm to 30 cm (6 to 12 inches) to one side of the established cable route. When at a depth below the established burial depth, carefully dig toward cables to expose them.
- e) The use of mechanical excavating equipment shall be restricted to situations where it is known that there is no danger of contacting or damaging buried cables. Mechanical excavating equipment may be used **ONLY AFTER ALL BURIED FACILITIES INVOLVED HAVE BEEN EXPOSED** and are clear of the excavation area.
- f) If buried cable is encountered while excavating, **STOP OPERATIONS IMMEDIATELY**. Expose it and investigate with extreme caution. The buried cable shall not be cut, chopped through, or broken off without first determining if it serves a useful purpose. Under no circumstances is a buried cable to be disturbed unless authorized by the responsible S&C employee.

- g) If any underground obstruction is encountered while excavating, **STOP OPERATIONS IMMEDIATELY**. Expose and investigate the obstruction with extreme caution. Do not attempt to remove the obstruction until you are satisfied that removing it will not disturb or damage the buried cable. Under no circumstances is the buried cable to be disturbed unless authorized by the responsible S&C employee.
- h) To prevent breaking or fracturing internal conductors or fibres, excavators shall avoid moving or bending fibre optic, power, or signal cables at any time. The responsible S&C employee shall provide extra mechanical protection using split steel ducts and/or other protective materials, as required.
- i) In the event that damage to a cable still occurs, **STOP OPERATIONS IMMEDIATELY** and report the location of damaged cable to the appropriate S&C employee. At no time shall unauthorized persons attempt to move, splice or repair damaged cables.

18. Method of Procedures

18.1. A Method of Procedure (MOP) shall be developed for situations where it is impractical to comply with items 17.1 a. or b. of Section 17 – Precautions When Excavating. The MOP shall be developed by the Metrolinx designated Supervisory Officer responsible to protect the cable, in conjunction with either outside contractors or other personnel involved in the excavation work. The MOP shall contain the following information:

- a) Limits of proposed work (Subdivision - mile points)
- b) Date and time duration i.e. yy/mm/dd 13:00 to 18:00
- c) Identity of S&C employee (Foreman in charge) and Supervisor including their emergency contact information i.e. phone number(s)

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- d) Detailed explanation of alternative excavation methods, excavation supervision and/or special excavation equipment to be used.
 - e) Risk Assessment.
 - f) Contingency Plan (Description; location and availability of temporary by-pass cable; splicing kits; and additional personnel).
- 18.2. The completed MOP shall be submitted to Metrolinx S&C for authorization at least 14 days in advance of the planned work. Metrolinx S&C will in turn submit a copy of the proposed MOP to Metrolinx's Fibre customers involved for approval of the MOP. The excavation work shall not proceed until the S&C employee and responsible Supervisory Officer have received final authorization.
- 18.3. IMPORTANT: The employee responsible for the excavation work shall inform all individuals, including outside contractors, involved in the excavation work and ensure that they fully understand the work procedures described in the MOP.

19. Work Near Buried Power Cables

- 19.1. Use extreme care when excavating near buried power cables to avoid damaging cable insulation and armor protection.
- 19.2. Wear properly rated protective clothing i.e. gloves.
- 19.3. Use properly rated non-conductive tools.
- 19.4. When necessary, to protect persons excavating in proximity to hazardous equipment and cables, power circuits in the affected area may be isolated or de-energized for work safety. The decision to isolate or de-energize circuits for work safety will be based on a site-specific inspection and guidance of SCP 1501 Work on or Near Underground AC Power Distribution System.

- 19.5. Regardless of the alternate work method selected, all employees required to work in close proximity of the cable should consider it as possibly energized and use the same level of caution, gloves and tools as described in the above items a, b, and c.
- 19.6. **WARNING:** Accidental contact with a live power cable, or piece of equipment that is in contact with a live power cable, can result in loss of life.

20. Safety During Work With Fibre Optic Cables

- 20.1. In a typical fibre optic system the transmitting light source emits a concentrated beam of light that may not be visible to the naked eye. The level of radiation may be sufficient to cause eye injury and caution must be exercised to avoid exposure. This precaution applies to any point in the system where the laser signal can be addressed (for example in inside shelters at the optical connectors or on the optical interface circuit packs). As there is no requirement to stare directly at the end of a severed fibre optic cable, as a practical safety precaution, one should avoid doing so.
- 20.2. A fibre optic cable is comprised of strands of glass that guide the light pulses down the cable. These glass strands have sharp ends that will readily penetrate the skin. Therefore, unnecessary manipulation of bare fibres should be avoided to ensure that the fibre does not damage skin or eyes. Safety glasses are mandatory when working with fibre optic cables.

21. Safety During Trenching or Excavating

- 21.1. Supervisors and the employees in charge of excavating operations shall be familiar with all applicable safety regulations. These regulations are designed to ensure the safety of workers involved in the excavation operations and may be enforced by safety inspectors on behalf of Metrolinx, provincial or federal regulators.

- 21.2. Protect all openings, construction material, excavated material, or equipment with approved warning devices and/or barricades. Observe any other precautions that may be required by local conditions.

22. Completion of Work

- 22.1. After all work has been completed, backfill carefully, ensuring it does not contain materials that may cause damage to the cables. Restore the surface, as near as practicable, to its original condition, ensuring that any cable markers removed or damaged during work are replaced.

23. Metrolinx Track Standards

- 23.1. Standards for work on Metrolinx's Right-of-Way are covered in Metrolinx Track Standards RC-0506-02TRK and explains precautions to be Taken During Maintenance of Track to Avoid Interference with Signal & Communications Systems. This document covers the general practices and precautionary measures to be taken when work is to be performed on Metrolinx's right of way near Signal and Communication facilities.

24. Risk and Track & Structures Work Activities

- 24.1. There are many Metrolinx Track and Structures work activities that could pose considerable risk to above ground and buried S&C cables. Table 1005-02 is provided as a guideline only, to assist in assessing the associated risk with these and equivalent types of activities.

Table 1005-02

Work Activity	Risk
Ditching	High
Ballast Regulation	Medium
Undercutting	High
Culvert Replacement	High
Brooming	Low
Tie Replacement	Medium
Bridge deck replacement	High

24.2. IMPORTANT: Work activities shall not start without prior consultations with the responsible Metrolinx designate S&C Supervisory Officer, and if necessary with the development and approval of a MOP. When in doubt, review the proposed work with the Metrolinx designated S&C Supervisory Officer.

25. Clearance Distance to be Maintained from S&C Infrastructure

25.1. Zone of influence is described as the edge of the foundation then 1:1 slope outward.

25.2. In proximity of critical railway S&C infrastructure, such as S&C bungalow, crossing gates and warning signals, the underground utility power lines shall not be installed within 5 meters of S&C infrastructure, or within 1 meter (3.3 feet) of the zone of influence for the foundations of S&C infrastructure. Any deviations to distance must be highlighted in the proposed design, accepted, and approved by Metrolinx before construction.

25.3. No drilling is permitted within 5 meters of S&C infrastructure or within 1 meter of the zone of influence for the foundations of S&C Infrastructure.

25.4. In all cases of drilling or boring next to S&C infrastructure, daylight holes are required to visually verify the drill head's location relative to the S&C infrastructure.

26. Excavation in Proximity to S&C Underground Cables

- 26.1. In all cases of drilling, boring or trenching under or next to the Metrolinx S&C underground cables, a minimum separation of 1 meter (3.3 feet) must be maintained. Daylight holes are required to visually confirm the separation relative to the underground cables.
- 26.2. S&C infrastructure shall not be disturbed or impacted and shall always be supported with temporary support during the work and until the backfilling is completed to restore the ground support.

1007 - Equipment Housing and Apparatus Wiring Standard

1. Purpose

- 1.1. This document describes the wiring and tagging standards for Signals & Communications (S&C) equipment housings, terminal junction boxes and apparatus for various wayside S&C system applications.
- 1.2. This standard applies to all new vital S&C equipment facilities and whenever major new modifications are made to any existing vital S&C equipment facility.

2. General Wiring Practices

- 2.1. The following are some of the general practices which apply when wiring vital S&C equipment:
 - a) Wiring between equipment located on different bungalow walls shall be run either in overhead ladder-type cable trays, where provided, or in surface wire way.
 - b) Special precautions shall be taken to ensure that the surface wire way is suitably arranged at wall corners to provide complete mechanical protection to the wiring. Corners should be checked for sharp edges or metal burrs which could damage the wire insulation.
 - c) All conductors within surface wire way or cable trays shall be run straight and parallel unless otherwise specified as twisted wires on the approved circuit plans.
 - d) Wire shall be laid in surface wire way or cable trays loosely without stretching or crowding and shall not be doubled back.
 - e) Splices or any type of repair to wires are prohibited.

- f) Wires must be visually inspected as they are being pulled from spool to assure there are no splices or defects. Spool length markings that reveal more than 1 length could be indicative of splices in the coil.
- g) Wire leaving surface wire ways or cable trays shall be harnessed together and tied using tie wraps or other approved material. The length of "exposed" vital circuit wiring shall be kept as short as practicable.
- h) Wire routing shall be accomplished in a manner to present a reasonably neat and orderly appearance, and to protect wires from chafing, damage from moving or heat dissipating parts, interference with other assemblies or elements, and damage from vibration.
- i) Surface wire way and cable trays may contain any number of conductors. For new locations, the aggregate cross-sectional area of the conductors and their insulation should not exceed 70% of the interior cross-sectional area of the surface wire way or cable tray, after allowing for future expansion.
- j) A maximum of 2 wires can be connected on any single AAR terminal.
- k) Ferrules are not to be used on case wire being installed into Wago termination blocks.

3. Vital Equipment Wire Specifications & Applications

- 3.1. All case wire types approved for use on new Metrolinx S&C equipment housing and signal apparatus must be EPR type insulation with PVC jacket. Wires must be constructed of 19 strands ASTM B-8 Class C tinned copper with ethylene- propylene rubber insulation (EPR), colour black, with polyvinyl chloride jacket, colour blue, in accordance with AREMA Signal Manual Part 10.3.15.

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- 3.2. All signal cable wire approved for use on new Metrolinx S&C installations must be high performance linear low density polyethylene (LLDPE) type insulation.
- 3.3. The 3 standard wire types, known as A, B, and C, which refer to the 3 approved gauge sizes, are used in the typical applications as shown in these tables. Wire sizes shown in these tables are the minimum sizes allowed; use of any other type of wire for vital wiring applications is not permitted without prior approval by Metrolinx.

Table 1007-01

Typical Application	Type	AWG
Vital Relay and Electronic Wiring	A	16
Battery Loops	B	10
Track Circuits	B	10
Lamp Lighting Circuits	B	10
Gate Mechanism Control Circuits	B	10
Switch Machine Control Circuits	B	10
Searchlight Mechanism Control Circuits	B	10
Battery Charging/Feed Circuits	C	6

Table 1007-02

Typical Application (from equipment junction box to apparatus)	Type	AWG
Switch Circuit Controller	B	10
Switch Machine	B	10
Wayside Signal	B	10
Crossing Signal	B	10
Gate Mechanism	B	10

4. Standard Terminals & Tools

- 4.1. The reliability and safety of S&C systems depend on the terminals and tools utilized being compatible with the wire/insulation type used. Refer to [SCP-1003 Standard Terminals & Tools for Case Wiring](#) for details on the approved AMP crimping tools and associated terminals to be used.
- 4.2. Wiring tools used for safety critical wiring shall be inspected and tested periodically (at least once per year) for proper calibration. A date tag should be applied to the tool verifying when it was last tested/calibrated.

5. Equipment Identification

- 5.1. In order to facilitate the proper identification and wiring of the equipment (devices) used in a signal bungalow or housing, each device shall be tagged in accordance with the nomenclature identified on the Metrolinx authorized Signal Design drawings.
- 5.2. The design and mounting criteria for internal equipment tags is as follows:
 - a) Some equipment tags will vary depending on the type of equipment and manufacturer. Where provided, the Manufacturer's equipment identification method and tagging system shall be used. For example, use Wago Terminal Tags on Wago Terminal Blocks;
 - b) Surface mount equipment tags shall be white or light grey, high humidity/heat and fade resistant, non-metallic material (plastic) with self-adhesive backing to permit applying to wood, Bakelite, plastic and/or metal surfaces (painted and non-painted);
 - c) Equipment tags designed for insertion into an equipment specific tag receptacle shall be white, high heat/humidity, fade resistant, non-metallic material (plastic);
 - d) Equipment tags shall be located in a conspicuous location on the equipment itself;

- e) Equipment tags shall be white, with black lettering;
- f) Hand written tags/labels are acceptable on a temporary basis, so long as they are clearly legible;
- g) The tag size, location and font size will vary depending on the application, with larger tags appropriate for racks and entrance boards. A simple font such as Arial, should be chosen, for easy readability.

6. AREMA Wire Tagging Methods

- 6.1. There are two wiring methods recommended in AREMA Signal Manual Part 16.1.1, Recommended Circuit Nomenclature. These describe processes which require individual wire tagging, the intent of which is to ensure correct component connectivity and aid in the eventual wire tracing and troubleshooting of the installed signal system. The two methods are:
- 6.2. **The Termination Nomenclature Method:** This method requires the "termination" point to be marked on the tag on each end of the wire. This is the preferred Metrolinx method.
- 6.3. **The Circuit Nomenclature Method:** This method requires the "from and to" information in addition to the wire nomenclature to be marked on a wire tag on each end of the wire.

NOTE: AREMA Part 16.1.1 states "Combinations of the two methods may be used."

7. Metrolinx Standard Wire Tagging Method (Internal Equipment)

7.1. The Metrolinx standard wire tagging method is based on the above Termination Nomenclature Method with additional nomenclature applied that identifies the circuit. Refer to the following table to see how wire tags should be applied and what information is to be applied in different situations.

Table 1007-03

In this Situation	The wire tag reads...	Because...
Typical MS/GCP Chassis Terminal.	NGCP, TB1-2	The device is uniquely identified on the circuit plan i.e. NGCP, and the MS/GCP terminal numbers are permanently marked on face plate (TB1-2).
Main Terminal Board ITR (+) track feed connection.	1TB, A36	The wire nomenclature shown on the circuit plan should read "1TB" and the termination point as row A, terminal 36.
Plug-in or shelf type relay "1TR" (+ coil).	1TR, (+)	The rear of the plug-board (or yoke for a shelf type relay) should be tagged ITR and the circuit plan shows the wire termination on the (+) coil of the 1TR relay.
Plug-in or shelf type relay "ITR" number 1 front contact.	ITR, 1F	The rear of the plug-board should be tagged ITR and the circuit plan shows the wire termination on the number 1 Front contact of the 1TR relay.

8. Wire Tags on Equipment Jumpers

- 8.1. Certain circuit designs require the use of jumper wires. Jumpers that are long enough to be tied should be tagged so that each termination of the jumper and the nomenclature of apparatus are indicated on the wire tag. For example, the jumper on the coils of a plug in track relay should indicate "1TR 3E to 3B".

9. Faraday Cage Type Entrance Panel

- 9.1. In bungalows or housings with Faraday Cage terminal boards, both terminal and row designation equipment identification tags shall be provided on each side of the entrance panel. A separate wire tag is required for each wire terminating on the internal and external sides of the panel.

10. Metrolinx Standard Wire Tagging Method (External Equipment)

- 10.1. External equipment/housing terminal and associated equipment junction box wiring shall be tagged in accordance with the terminal board number and nomenclature as shown on the circuit plans.
- 10.2. This shall include searchlight mechanisms, color-light signals, base of signal mast junction boxes, cantilever signal junction boxes, gate mechanism signal junction boxes, light arm signal junction boxes, switch machines, switch machine junction boxes, switch circuit controllers etc.

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10.3. Refer to the examples shown in this table.

Table 1007-04

In this situation...	The wire tag reads...	Because...
Switch Machine terminals (normal position indication circuit) in the contactor compartment	5ANWC, A6	The circuit plan shows the number "5A" switch machine normal indication wire, terminating on Row A, terminal 6 of the switch machine.
Searchlight Mechanisms (negative coil) at the base of mast junction box	N20NAG, L2	The circuit plan shows the negative wire of the 20N signal, "A" head, terminating on terminal "L2" of the junction box.

11. Internal & External Wire Tag Specifications

11.1. Wire tags for internal equipment wiring and external apparatus wiring shall be "Brady" type, white, plastic, humidity and heat resistant, sleeve type wire tags, sized to permit (2) rows of (12) characters of nomenclature. The type must be clearly legible.

12. PVC Wiring Duct Systems

12.1. Approved PVC Wiring Duct Systems (herein called surface wire way) shall be used for mechanical protection of signal equipment case wire. These shall be mounted directly to plywood walls, backboards, or to equipment racks. The surface wire way shall be of the slotted-wall type, light gray in colour, complete with PVC cover.

13. AC Wiring – Metal Conduit

13.1. AC power equipment mounted directly to plywood walls, backboards, or equipment racks shall be wired with Type RW90 flexible wire in certified electrical metallic tubing (EMT) or Armoured Cable type AC 90.

14. AC Wiring – Typical Applications

14.1. The following table depicts the colour code for approved AC power circuit applications.

Table 1007-05

AC Voltage	Use these conductors...
115 Volts	One black conductor and one white conductor
230 Volts	One black conductor and one red conductor

14.2. The following table depicts the types of cables and wire sizes for approved AC power circuit applications. All cables must meet or be approved equal with CSA or NEC specifications. Cable shall be cross-linked polyethylene insulated.

Table 1007-06

Branch Circuit	When using armoured cable type AC 90...	When using EMT...
15 Amps	AWG-14 Type AC90 XLPE	AWG-14 Type RW90
20 Amps	AWG-12 Type AC90 XLPE	AWG-12 Type RW90
30 Amps	AWG-10 Type AC90 XLPE	AWG-10 Type RW90

15. Circuits Over 50 Volts AC or DC

15.1. Terminals used in circuits operating at a nominal 50 volts or more shall be protected using insulated nuts or insulated cap and shield assemblies. Where practicable, such terminals shall be grouped together and away from lower voltage terminals and equipment. These terminals shall be clearly tagged with the voltage level.

15.2. Equipment, such as fuses and lightning arresters, which operate in circuits of nominal 50 volts or more and which have exposed, live metal parts, shall be equipped with protective covers or shall be installed in protective enclosures.

16. Over Current Protection

- 16.1. Over current protection in the form of approved circuit breakers or fuses shall be used in all power circuits and busses operating at a nominal 50 volts or higher. The over current values shall be determined by the weakest thermal link of the circuit. For example; a #10 wire feeds a transformer rated at 15 amps, the #10 wire is rated for 30 amps and is used to reduce the voltage drop. In this case the fuse or breaker must be rated for 15 amps.

17. Bonding and Grounding

- 17.1. Refer to signal design schematics for specific grounding arrangements.

18. Bonding and Grounding Wiring Practice

- 18.1. Bonding and grounding conductors shall not be run parallel and in close proximity to S&C circuit wiring. Wherever practicable, a minimum of 6" of separation shall be provided. Bonding and grounding conductors may cross S&C circuit wiring (at approximately right angles) without any specified minimum separation.
- 18.2. All exposed, non-current carrying metal parts of fixed equipment and equipment racks shall be bonded directly to the frame of the bungalow.

19. Inspections, Tests and Wiring Certificate

- 19.1. All signal circuit wiring and apparatus shall be subjected to the following inspections and tests, in the order shown below:
- a) Component check;
 - b) Wire continuity test;
 - c) Circuit breakdown test;
 - d) Terminal, connection and contact check;
 - e) Final wire check; and
 - f) Operational test.

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- 19.2. A completed Wiring Certificate form shall be left in each wired bungalow or case. This form is designed to record the names of the individuals responsible for wiring and performing the above tests of vital wiring (refer to [SCP 1209 Signal – Safety Assurance Installation & Commissioning Process Check List](#)). A copy of this form shall be left in the bungalow (preferably it should be inserted in the site log book; otherwise it can be placed in a plastic envelope and attached to the bungalow wall in a conspicuous location).
- 19.3. For additional information on the required inspections and tests refer to [GI-301\(b\) Installation and Commissioning Tests](#).

20. Qualified Wire Person

- 20.1. Vital S&C circuit wiring must be performed by a qualified wiring person or under the direction of a qualified wiring person. The associated inspections and tests shall be performed by qualified wiring people only.
- 20.2. A qualified wire person (either in Metrolinx or external company) shall be considered to be an employee specifically trained and knowledgeable in the wiring techniques and processes required to properly wire vital S&C systems and AC power systems.

1101 - Surge Arresters for Use on Railway Signal Circuits

1. General

- 1.1. Good practice requires protection for all equipment exposed to the effects of lightning and induced voltage surges.
- 1.2. Surge arresters are used to limit to a safe value the magnitude of voltages impressed across equipment. Surge protection for railway signal and communication systems requires that the withstand-voltage characteristics of the equipment be coordinated with the protective characteristics of the surge arrester.
- 1.3. Surge arresters may be connected between line and ground or rail and ground, as well as line to line or rail to rail in shunt.

2. Purpose

- 2.1. The purpose of this practice is to indicate the types of "primary" surge arresters to be used on exposed railway signal circuits. It is designed to cover application to traditional type equipment.
- 2.2. NOTE: A "primary" surge arrester is an arrester used to protect equipment designed and constructed to A.A.R. signal section 3000-volt insulation breakdown ratings.
- 2.3. IMPORTANT: Additional or multi-level protection may be required in areas of heavy lightning activity, or to protect sensitive semiconductor equipment.
- 2.4. As the development of new arresters progress, other satisfactory arresters will, from time to time, be devised. The fact that particular surge arresters are specified herein does not preclude the use of other mutually satisfactory protective equipment.
- 2.5. This practice is intended to apply to new installations, and for replacement on existing installations where general renewal or replacement is to be made.

3. Arresters for Use Under Normal Conditions

Table 1101-01

Type of Signal Circuit	Protection Configuratio	Surge Arrester
Vital signal control See Note 5.1(a)	Line-to-Ground	Siemens (Safetran) Clearview Air Gap 485 Series Lightning Arrester No. 4000-44585-001X
	Line-to-Ground	Erico Blue Varistor LightningArrester No. ETSP23050
Standard track circuits DC, coded DC, and AC types	Rail-to-Ground	Siemens (Safetran) Clearview Heavy Duty Air Gap 615 Series Lightning Arrester No. 4000-44615-001X
	Rail-to-Ground	Erico Blue Varistor Lightning Arrester No. ETSP23050
	Rail-to-Rail	Siemens (Safetran) Heavy Duty Equalizer 700 Series No. 4000-44700-001X
110 Volt switch machine circuits	Rail-to-Ground	Erico Blue Varistor Lightning Arrester No. ETSP230170
Exterior AC power distribution (550V, 240V, &120V line circuits)	Line-to-Line	See Note 5.1(b)
Interior AC power distribution (120/240V circuits)	Line-to-Ground	Erico Surge Suppressor No. EPD 120/240TDFL
DAX line between locations	DAX	Erico Blue Varistor Lightning Arrester No. ETSP23050

4. Arresters for Signal Circuits Exposed to High Voltage Power Systems

- 4.1. Fault with stand capabilities of a number of signal surge arresters were determined in laboratory tests which simulated induction of 60 Hz currents into signal circuits by fault currents occurring in parallel high voltage power systems. The arresters listed are those judged most likely to satisfactorily cope with induced 60 Hz momentary fault currents.

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- 4.2. It should be recognized that the actual protection design is dependent upon the conditions present in a specific exposure. Since the power influence, coupling and susceptible factors vary from case to case, it is normally not possible to afford adequate protection on the basis of a "primary" lightning arrester only.

Table 1100-02

Type of Signal Circuit	Protection Configuration	Surge Arrester
Vital signal control (5.1.a)	Line-to-Line	Erico Blue Varistor Lightning Arrester No. ETSP230170 (5.1.b)
Exterior AC power distribution (550V, 240V, & 120V line circuits)	Line-to-Line	See Note 5.1(b)
Interior AC power distribution (120/240V circuits)	Line-to-Line	Erico Surge Suppressor No. EPD 120/240 TDFL See Note 5.1(b)

5. General Notes

5.1. NOTES:

- It is important that vital signals, control circuits remain ungrounded, vital-type signal surge arresters are designed so that they will not short-circuit under overload or failure conditions and must always be used in vital signal circuits.
- Line-to-line arresters (or equalizers) are not normally used as line-to-ground arresters usually provide satisfactory protection. Furthermore, leakage current associated with line-to-line arresters may cause excessive circuit loading.

1102 - Made Ground Systems

1. Purpose

- 1.1. The primary function of a made ground system is to increase safety, to both personnel and property; its secondary function is to aid in system operation. In general, these two functions are compatible and complementary.
- 1.2. This SCP covers the minimum requirements for proper installation, maintenance, and testing of made ground systems.
- 1.3. The made ground system is from the prime ground terminal in a bungalow, signal device, signal case, or pole mounted equipment to the made ground equipment.

2. Definitions

- 2.1. **Bonding Conductor:** A conductor which is used to join two or more made ground electrodes.
- 2.2. **Grounding Conductor:** A conductor which is used to connect the prime ground terminal in a bungalow, signal device, signal case, or pole mounted equipment, to the made ground electrodes.
- 2.3. **Made Ground:** An electrode of any form buried in the ground for the purpose of attaching a grounding conductor to it. Driven ground rods are the most generally used and are the recommended type of made ground electrodes for all signal and communications installations.
- 2.4. **Made Ground Systems:** Made ground systems consist of a prime ground terminal, grounding conductors, driven ground rods, bonding conductors, ring counterpoise, buried plates, buried strips of metal.
- 2.5. **Prime Ground Location:** This is considered to be the made ground system with the prime ground terminal at an S&C housing or case.

- 2.6. **Prime Ground Terminal:** The prime ground terminal is the connection point in a bungalow, signal device, signal case, or pole mounted equipment, that the grounding conductor connects to.
- 2.7. **Ring Counterpoise:** The bonding conductor run around the exterior perimeter of a bungalow or WCP radio tower interconnecting all the ground rods is known as a ring counterpoise. In addition to serving as an additional made ground electrode, it affords protection to personnel by equalizing surge voltages between the housing and earth beside it.

3. Application

- 3.1. This Code of Practice applies to all new, and existing installations. Additional grounding may be required where the methods outlined in this practice can be improved.
- 3.2. Made ground systems near high voltage power systems or made ground systems for base radio and microwave stations may be installed and maintained to more stringent requirements than are covered here. Separate instructions will be issued for the locations where this is required. Refer to R56 Motorola Standards and Guidelines for Communications Sites 2005.
- 3.3. The preferred test instrument used to test a made ground system is the AEMC Clamp-on Ground Resistance Tester, Model 6416. With this meter you do not need to disconnect wires to make tests of the made ground system.
- 3.4. The made ground system must be completely buried, except for the grounding conductor to the prime ground terminal, signal device, case, mast, or base.

4. Safety

- 4.1. The made ground system at a location where there is an AC power service must be considered as electrically "live" unless the system is positively known to be dead.
- 4.2. Work must not be done on a made ground system during an electrical storm.
- 4.3. IMPORTANT: You must always exercise care when connecting or disconnecting any part of a made ground system. Leakage through lightning arresters or transformers connected to the AC supply lines could cause the voltage on the disconnected made ground system to reach dangerous levels. In addition to required PPE, electrical rubber gloves suitably rated to the power source voltage, with leather covers must be worn when taking voltage or current tests on made ground systems.
- 4.4. In the absence of an AEMC Clamp-on Ground Resistance Tester Model 6416, and before disconnecting, or opening a made ground system at any location having an AC power service, the following precautions must be taken as shown in Table 1102-01 using a TS111B Signal Meter. This meter has a specified sensitivity of 300 ohms/volt on the AC scale. Use of meters with sensitivity levels other than that specified above may lead to invalid results.

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Table 1102-01

Step	Action
1	Check all lightning arresters connected to AC supply circuits for visible shorts and replace defective arresters.
2	If the location to be tested is at an AC power service, shut off the AC power before making the test.
3	Place a temporary jumper across the points to be opened (normally at the prime ground terminal).
4	Disconnect the wires at the point to be opened. Keeping the jumper in place and making sure that you don't put yourself across the open point
5	Connect a TS111B voltmeter set initially to its highest AC voltage range across the open point and remove the jumper.
6	Turn the AC power back on.
7	If the meter reading is higher than 100 VAC on the 150 VAC range a dangerous situation may exist. To determine the seriousness of the problem, further investigation is required as described in 4.5 to 4.11.
8	If a low voltage or no voltage is measured, the earth resistance measurement or other work can proceed. If test shows any significant reading, take care while the ground circuit is open.

- 4.5. Where the tests outlined in Table 1102-01 Step 7 reveal a voltage of 100 volts AC or greater, the leakage current to ground can be determined as described below. This test will show whether the leakage current is greater than 5 mA which is considered by the electrical industry to be a maximum allowable leakage.
- 4.6. If the location to be tested is at an AC power service, shut off the AC power before making the test.
- 4.7. Place an AC ammeter having AC current ranges down to about 200 mA across the point in the grounding system to be opened.
- 4.8. Turn the AC power back on.
- 4.9. Initially, the highest AC current range must be selected, and then switched down to get a significant reading.

- 4.10. A measurement of 5 mA or greater indicates that a potentially dangerous situation exists, the source of which must be identified, and the fault corrected.
- 4.11. Most likely areas of leakage are shorted lightning arresters, or damaged insulation on AC power circuits. It may be necessary to isolate the device.

5. Equipment to Be Grounded

- 5.1. The following must be connected to the made ground system, however, depending on the distance, they may require an independent made ground system:
 - a) Metal skin of signal bungalows, cases, or other instrument housings.
 - b) Cantilever signals, bridge signals, high or low mast signals.
 - c) Crossing gate mechanisms, cantilevers, and flashing light unit masts.
 - d) Switch Clearing devices.
 - e) WCP radio tower at CTC location.
 - f) AEI antenna masts.
 - g) Hot Wheel Detector masts.
 - h) AC power transformers, and pole mounted lightning arresters.
 - i) Permanently mounted AC power generators.
 - j) AC power service equipment installed outside of equipment housings. They must be connected to the equipment housing made ground system.
- 5.2. The following equipment must be connected to the prime ground terminal inside equipment housings, cases, and terminal boxes:
 - a) AC power load center.
 - b) Low Impedance Ground Plane (LIGP).
 - c) Battery chargers.

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- d) Cable trays.
 - e) Equipment racks.
 - f) Polyphasers if not mounted directly on a metal grounded surface.
 - g) Power, heater, or lighting transformers located inside equipment housings.
 - h) All wall mounted electronic units with a metal casing, such as GEO, Electrologix, GCP's, HXP's, SSCIII, SEAR II recorders, EMS.
- 5.3. The following equipment is generally NOT grounded to a made ground system, unless specifically called for on circuit drawings or instructions:
- a) Power switch machines.
 - b) Electric switch locks.
 - c) Switch circuit controllers.

6. Material References

Table 1102-02

Material Description
Ground rod, $\frac{3}{4}$ " diameter x 10' long, copper covered steel.
Wire, S.C. #6 AWG, copper, stranded, green CSA type TWU (-40),
Wire, S.C. #6 AWG, copper, stranded, bare
Ground wire molding, plastic, $\frac{1}{2}$ " x 8'. McGraw-Edison no. 9805P or equal.
Staple, galv. steel, 2" long (for $\frac{1}{2}$ " plastic molding) McGraw-Edison No.9809.
Ground electrode box. McGraw-Edison no. DN6MC1 or equal.
NO-OX-ID "A" special sealing compound.
Chemical ground rod, XIT K2-10 (straight) or XIT K2-H (L-shaped), available from Leblanc & Royle Communications Inc.
Ground rod driving sleeve
Ground rod driving sleeve extension

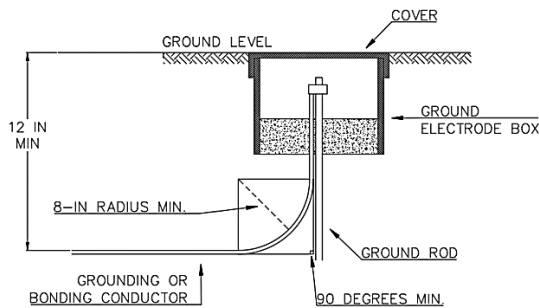
7. Installation – Ground Rods

- 7.1. Ground rods must be copper clad construction, 10 feet long, and a minimum cross-sectional dimension of 3/4-inch.
- 7.2. Ground rods must be located as close as practicable to the prime ground terminal or pole equipment, but not less than 24-inches from posts, poles, or foundations. Where space is not available to drive ground rods vertically, the rods may be driven at an angle so that the lower end is more than 24-inches from posts, poles, or foundations.
- 7.3. Ground rods must be driven to a depth of at least 10 feet, except that where:
 - a) Rock bottom is encountered at 4 feet or more, the rods may be driven at an angle, or
 - b) Where rock bottom is encountered at less than 4 feet, the rods should be buried in a horizontal trench as deeply as possible.
- 7.4. Where practicable, the lower end of ground rods should penetrate into permanent moisture level and below the frost line.
- 7.5. Ground rods must be installed not less than 10 feet apart.

NOTE: This will minimize the effect of overlapping of the spheres of influence of the rods.
- 7.6. The preferable location for a ground rod is where the surrounding earth will be moist throughout most of the year. Abundant vegetation usually indicates underlying moisture and favorable conditions. However, if the soil is such that surface water readily seeps away, the natural salts in the earth are dissolved and carried off, leaving the earth a relatively poor conducting medium. For this reason, filled-in ground, gravelly or sandy soil and in some cases, freshwater streams are not desirable locations for made grounds.

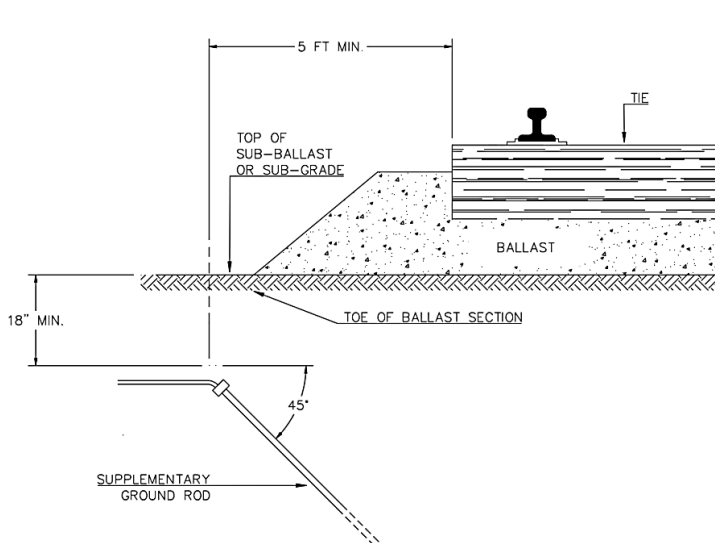
- 7.7. As ground rods are installed in locations where they may present a tripping hazard, or where the grounding and bonding conductor attachment may be exposed to mechanical damage, the upper end of each ground rod must be driven below ground level. Ground electrode boxes must be used to provide access to the point of attachment. See Figure 1102-1 for installation of ground electrode box.

Figure 1102-1: Ground Electrode Box



- 7.8. If a ground rod is to be installed under a track it must be installed on a 45-degree angle at last 18-inches below top of sub-ballast or sub-grade. See Figure 1102-2.

Figure 1102-2: Installation of Ground Rod Under Track

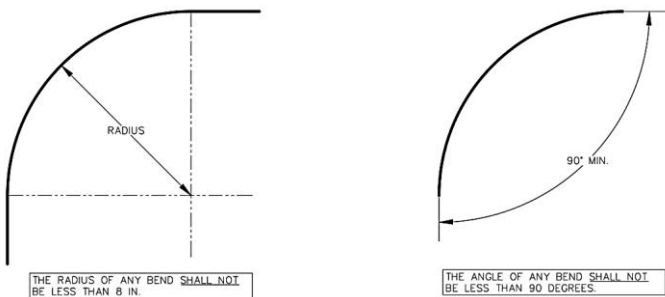


- 7.9. Ground rods must be free from nonconductive coatings, such as paint or enamel. Attention should be paid to the grounding and bonding conductor attachment point.
- 7.10. Ground rods should be separated by 10 feet or more from pipelines used for transmission of flammable liquids or gases operating at a high-pressure (150 pounds per square inch or greater) unless they are electrically interconnected and cathodically protected as a single unit. Grounds within 10 feet of such pipelines should be avoided or shall be coordinated so that hazardous alternating current conditions will not exist, and cathodic protection of the pipeline will not be nullified.
- 7.11. Ground rods should be installed using a ground rod driving sleeve or other tool which will prevent damage to the top of the ground rod.

8. Installation - Grounding and Bonding Conductors

- 8.1. Grounding conductors must be green insulated No.6 AWG stranded copper, or larger when so specified.
- 8.2. Bonding conductors must be bare No.6 AWG stranded copper, or larger when so specified.
- 8.3. Grounding and bonding conductors must be installed in one continuous length without splice or joint except their connection at ground rods.
- 8.4. Grounding and bonding conductors must be run as short, straight, and smoothly as possible, avoiding loops or sharp bends.
- 8.5. The grounding ring at a WCP radio tower is to be run in a smooth and circular pattern and is an exception to being run straight.
- 8.6. Grounding and bonding conductors must have sufficient slack to avoid breakage from the effects of frost or vibration. Excess slack must be avoided, and the slack must never be coiled.
- 8.7. When a bend is required in a conductor such as to connect to a ground rod or enter a housing, a minimum bending radius of 8 inches must be maintained, and the angle of any bend shall not be less than 90 degrees. See Figure 1102-3.

Figure 1102-3: Bending Conductors



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- 8.8. Grounding and bonding conductors should be buried at least 12-inches below ground level.
- 8.9. Grounding and bonding conductors must not be run with other cables and wires and should, if possible, exit the housing through a separate conduit assembly. As an alternative, grounding and bonding conductors may exit the housing through a separate bushed hole. If it is necessary to run grounding and bonding conductors in the same conduit assembly, a 1/2-inch separation or greater must be maintained. See .
- 8.10. Grounding and bonding conductors must be connected to ground rods by approved connectors. One of the methods indicated in a, b or c below should be used:
- a) Bolted clamps such as Burndy catalog No. GAR 644C. Bolted clamps (mechanical fittings) are readily available, simple to install, disconnect for measurements of resistance to earth, and have a long history of satisfactory usage. Although corrosion has sometimes presented a problem, treatment of the joint as an ordinary electrical connection in a corrosive element eliminates most of the problems in this respect. To minimize corrosion problems all underground connections associated with bolted clamps must be given a liberal application of "NO-OX-ID 'A' Special" sealing compound.
 - b) Compression connectors such as Ampact Tap System, Thomas & Betts "Grid" Grounding System or Burndy "Hyground" Grounding System. Compression connectors involves the use of a copper or copper-alloy fitting which is squeezed onto both ground rod and cable simultaneously by a hydraulic press, or in the case of the Ampact Tap System, by a powder activated tool.

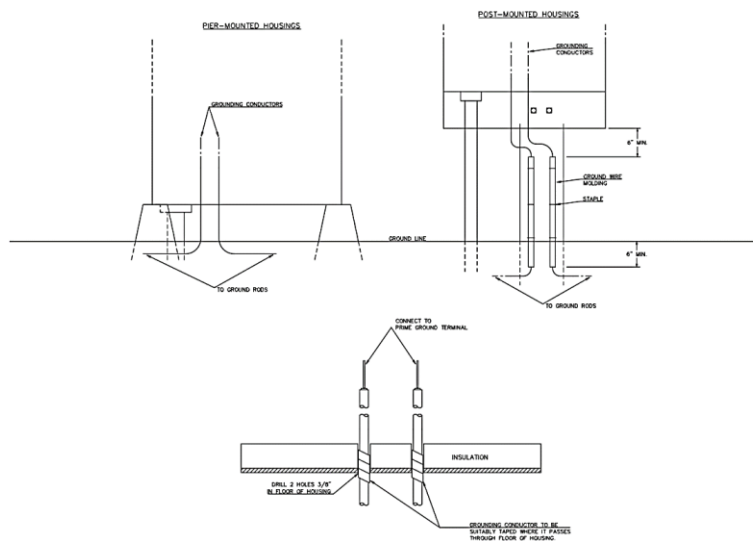
- c) Exothermic (welding) connections such as Cadweld one-shot grounding connections. Exothermic welding is a process in which a permanent electrical connection of copper to copper or copper to steel is made. An exothermic chemical reaction is utilized to produce molten copper which welds the desired metal components together. The process requires the use of a certain amount of training, and it cannot be used in the presence of volatile or explosive mixtures, or where the gaseous products of the procedure would interfere with nearby operations. Safety precautions as outlined in the manufacturer's instructions must be strictly adhered to. It is important that the exothermic mold and all connections be clean and thoroughly dry since moisture can cause hazardous splattering of molten metal. This is best accomplished with a few slow passes of hot flame, such as from a propane torch.

8.11. Compression-type and exothermic connectors offer a superior and longer-lasting joint than bolted connectors. There are applications where the effects of loosening and corrosion, which may occur with bolted connectors, are not acceptable. An example is the low impedance grounding or special inductively shielded cables installed to mitigate electromagnetic induction from nearby power line disturbances. Locations where frequent lightning is experienced is another example where compression-type or exothermic connectors offer superior safety and performance characteristics and are the preferred method.

8.12. Grounding conductors on poles and other exposed surfaces must be guarded from physical damage with plastic or wood moldings. Molding must extend at least 8 feet above ground on poles.

EXCEPTION: Moldings used for post-mounted housings must extend from a point 6-inches below ground level to a point approximately 6-inches below the floor or support bracket of the housing. See Figure 1102-4.

Figure 1102-4: Routing and Installation of Grounding Conductors

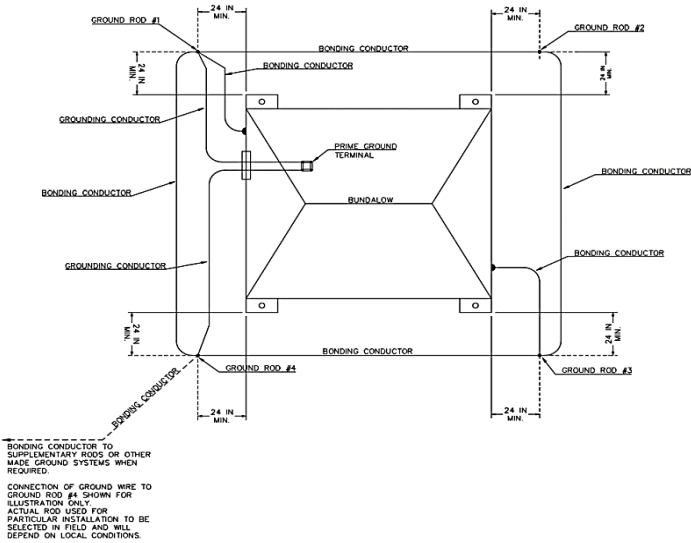


9. Installation-General

- 9.1. Metal cribbing must be bonded to one of the ground rods at the prime ground location. The attachment point or the bonding conductor to metal cribbing is not critical. However, the point selected should be consistent with the requirement to keep all grounding and bonding conductors as short as practicable.
- 9.2. Made ground systems at bungalows must consist of at least four ground rods placed at the corners of the housing. The ground rods must be bonded together and have two grounding conductors connected to the housing prime ground terminal as per Figure 1102-5.

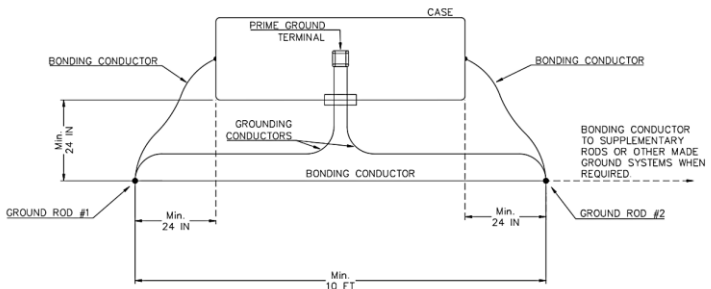
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Figure 1102-5: Typical Grounding Arrangement at Bungalows



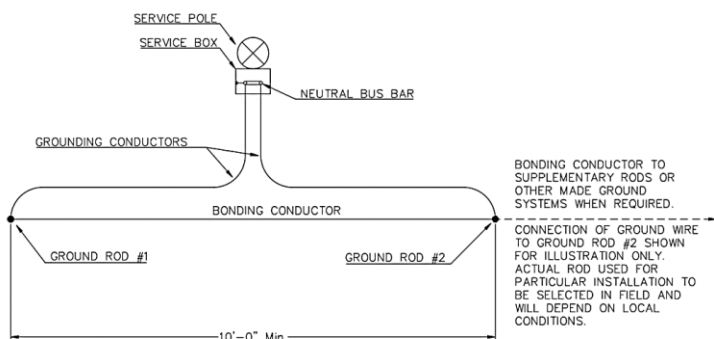
- 9.3. Made ground systems at cases must consist of at least two ground rods. The ground rods must be bonded together and have two grounding conductors connected to the housing prime ground terminal as shown in Figure 1102-6.

Figure 1102-6: Typical Grounding Arrangement at Cases



- 9.4. Made ground systems at service poles must consist of at least two ground rods. The ground rods must be bonded together and have two grounding conductors connected to the service equipment grounding terminal and neutral bus bar as shown in Figure 1102-7.

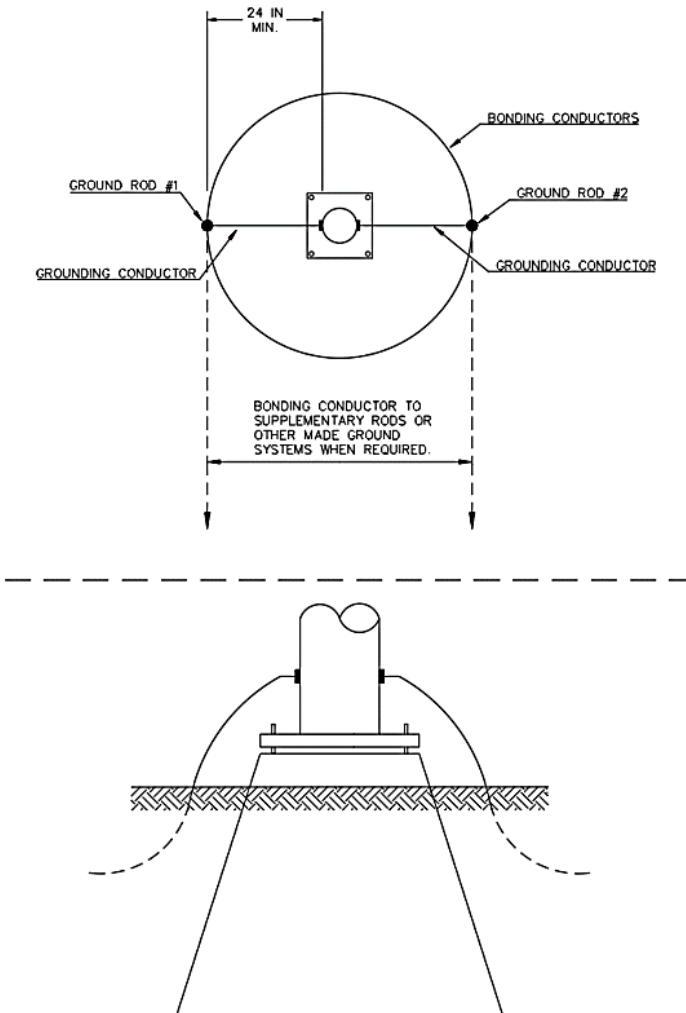
Figure 1102-7: Typical Grounding Arrangement at Service Poles



- 9.5. Made ground systems at WCP radio towers must consist of at least two ground rods placed across from each other with the tower in the middle. The ground rods must be bonded together and have two grounding conductors connected to the tower as shown in Figure 1102-8. The bonding conductor ring must be in a circular pattern.

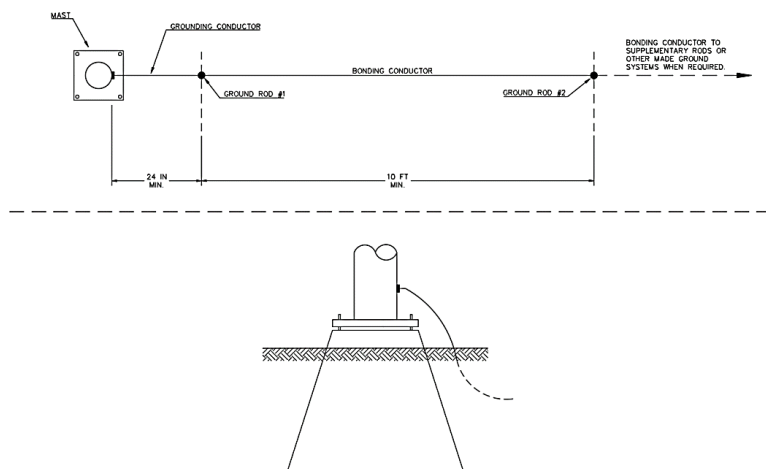
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Figure 1102-8: Typical Grounding Arrangement at WCP
Radio Towers



- 9.6. Made ground systems at signal, gate mechanism, flasher or cantilever masts must consist of at least two ground rods. The ground rods must be bonded together and have a single grounding conductor connected to the mast as shown in Figure 1102-9.

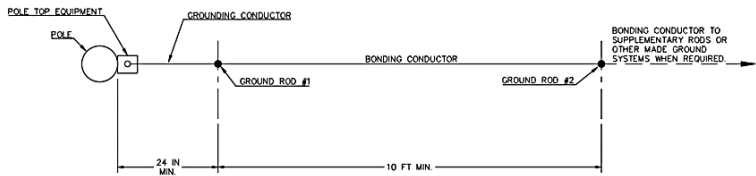
Figure 1102-9: Typical Grounding Arrangement at Signal, Gate, Flasher or Cantilever Masts



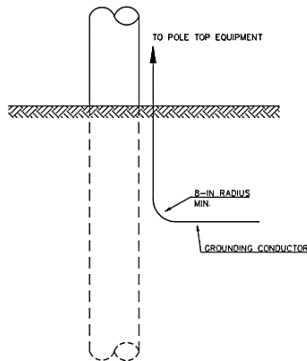
- 9.7. Made ground systems at transformer and arrester poles must consist of at least two ground rods. The ground rods must be bonded together and have a single grounding conductor connected to the pole top equipment as shown in Figure 1102-10.

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Figure 1102-10: Typical Grounding Arrangement at Transformer and Arrester Poles



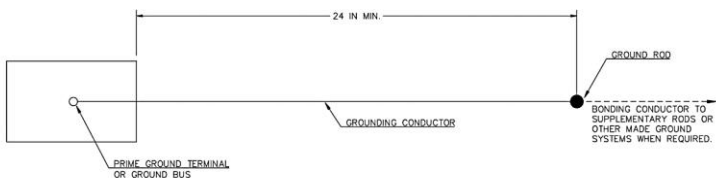
TOP VIEW



SITE VIEW
AT POLE

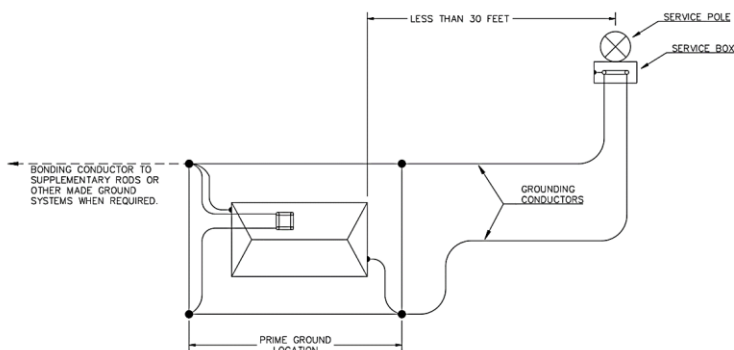
- 9.8. Made ground systems at junction boxes and cable terminals must consist of at least one ground rod and have a single grounding conductor connected to the housing prime ground terminal or ground bus as shown in Figure 1102-11.

Figure 1102-11: Grounding Arrangement at Junction Boxes and Cable Terminals



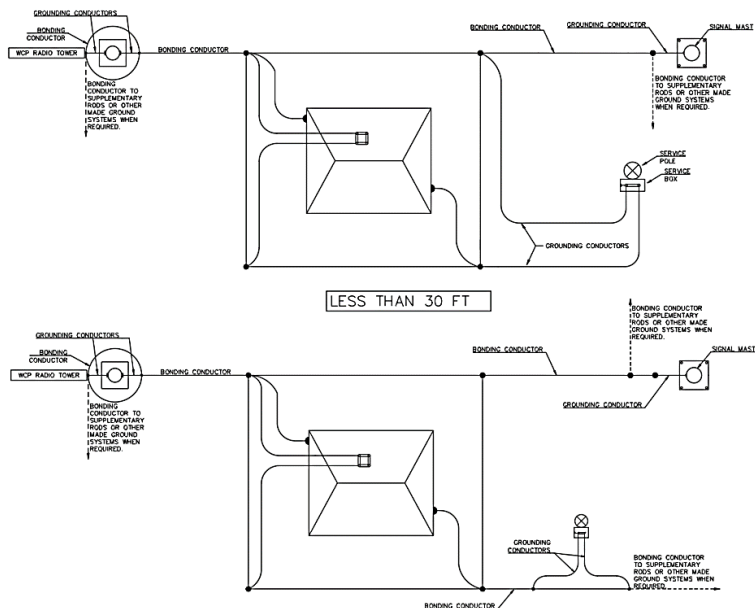
- 9.9. Where multiple made ground systems are required, such as an S&C housing, an AC service pole, signal mast, or signal tower etc, and they are less than 30 feet apart, the prime ground location at the S&C housing may be used for all systems as shown in Figure 1102- 12.

Figure 1102-12: Interconnection of Made Ground Systems Less Than 30 Feet Apart



- 9.10. Where multiple made ground systems are required, and they are between 30 feet and 200 feet apart, each must be treated as an independent made ground system, and where practicable, the two systems should be interconnected with a single buried No. 6 AWG bonding conductor. Where it is impractical to bury a bonding conductor between the two systems, it may be omitted.
- 9.11. Examples of these multiple made ground systems are shown in Figure 1102-13.

**Figure 1102-13: Interconnection of Made Ground Systems
30 to 200 Feet Apart**



10. Earth Resistance

10.1. Earth as a conductor generally has variable characteristics which are unpredictable, and it is difficult to determine resistivity with any degree of accuracy. The resistance of an earth connection varies with earth composition. Moisture, temperature, season, etc. Regardless of absolute resistance, the connection to earth has the desired effect of establishing a common potential for all grounded equipment and this removes the hazard or difference of potentials at various points within the structure. Low resistance grounds also afford electrical paths of sufficient capacity to permit protective devices, such as fuses or circuit breakers to operate should a fault occur. The earth resistance of a made ground netblock at the time of installation should not exceed the values given in the Table 1102-03.

Table 1102-03: Earth Resistance

Plant for which ground is provided...	Recommended Allowable earth resistance
S&C Housings	15 ohms *
Power Services (Main Services)	10 ohms *
Transformer and Arrester Poles	25 ohms
Junction and Termination Boxes	25 ohms
Signal high or low mast, Bridge, Cantilever	25 ohms
All other plant	25 ohms

*Note that these values are lower than the maintenance value.

10.2. Every reasonable effort should be made to obtain a resistance of not more than those stated above in Table 1102-03 for the various types of plant for which made grounds are provided. If the earth resistance is found to be greater than those stated, improvement work should be undertaken in an effort to reduce the resistance. Suggested improvement methods are:

- a) One or two supplementary ground rods may be installed at least 10 feet from all other ground rods. Supplementary rods must be bonded together and interconnected to one of the rods at the prime ground location. Where the location is on top of fill, the supplementary rods may be driven at the foot of the slope where good soil exists, or the supplementary rods may be driven under the track as shown in Section 7.9.
- b) A chemical ground rod may be installed at least 10 feet from all other ground rods. The chemical ground rod must be bonded to one of the rods at the prime ground location.
- c) Increase the length of the ground rods at the prime ground location with additional sections. A longer ground may be installed by thermite welding two or more ground rods together.

- 10.3. At many railway locations, the surrounding ground is covered with a fill of cinders, gravel or sandy soil or other material of doubtful conductivity. Therefore, it may be necessary to drive ground rods to a greater depth than 10 feet to obtain the resistance specified in Table 1102-03.
- 10.4. Rechecking the resistance of a deep-driven ground a month or two after the installation will often show a marked decrease in resistance. The reason for this is that the couplings are larger than the rods which makes the hole in the ground larger, resulting in poorer contact between earth and rod until the soil has settled firmly around the entire rod. Allowances may generally be made for this lowering of resistance.
- 10.5. Salt or other corrosive chemicals must not be used to attempt to reduce the earth resistance.
- 10.6. The Supervisory Officer must be informed of all instances where the earth resistance cannot be reduced to those specified in Table 1102-03.

11. Testing

- 11.1. Made grounds should be tested for earth resistance during dry weather.
- 11.2. Tests made to determine the resistance of a made ground must use a direct reading instrument specifically designed for this purpose. Earth resistance may be tested with a three-point Vibroground 263 instrument or equivalent. Multimeters or other meters not designed to measure earth resistance will not provide an adequate reading and must not be used for this test.
- 11.3. Tests must be made from the prime ground terminal in the housing and not from any of the installed ground rods. All conductors except the grounding conductors to the ground rods must be removed from the prime ground terminal.

- 11.4. Where the test is required at a pole. It may be made from the ground wire on the side of the pole. The ground wire from the point of test to the connection to pole-top equipment must be visually checked for damage and proper connection.
- 11.5. Ensure that all disconnected grounding and bonding conductors are restored and securely attached.

12. Maintenance

- 12.1. The earth resistance should preferably be maintained to 25 ohms or less. This requirement may be lowered at specified locations or types of installations. Refer to [GI 309 Testing Ground Resistance](#).
- 12.2. The visible parts of a made ground system must be inspected at least once every 6 months. Refer to [GI 301\(h\) Inspection and Test Intervals](#).
- 12.3. Damaged or corroded parts of made ground systems must be repaired immediately and replaced without undue delay to avoid possible injury to personnel or damage to equipment.
- 12.4. NOTE: A green film called a Patina may form on copper grounding and bonding conductors and copper clad ground rods. This Patina should not be cleaned off because it slows down the process of corrosion, even though it was originally caused by corrosion.
- 12.5. Connections within the made ground system must be kept mechanically and electrically secure.

1201 - Service Testing of S&C Equipment and Materials

1. Purpose

- 1.1. This Practice describes the procedures to be followed by S&C employees in initiating, gaining approval, and conducting Service Tests of new equipment, or materials.
- 1.2. New or modified materials or equipment shall not be considered for use on Metrolinx corridors as a standard without first being subjected to a service test, unless prior analysis and evaluation by Metrolinx determines a service test is not necessary.

2. Definition

- 2.1. A Service Test is the testing of material or equipment under actual service conditions to verify quality, reliability, functionality and overall performance.

3. Purpose of Service Test Process

- 3.1. The purpose of the Service Test process is to track the various on-going equipment service tests, inform of the parts of equipment being tested, and what the test results are.

4. Initiation of Service Test

- 4.1. Service Tests may be initiated by any Signals & Communications employee with concurrence from Metrolinx.

5. Authorization of Service Tests

- 5.1. Metrolinx will evaluate and authorize all Service Tests.

6. Safety Critical Applications

- 6.1. Vital signal apparatus or equipment which will be utilized in a safety critical application shall NOT be service tested without first being subject to a safety audit and prior approval from Metrolinx.

7. Test Site Selection

- 7.1. The selection of the test site should consider the equipment application and to expose it to extreme operating and environmental conditions, and it shall also consider the potential disruption to train operations.

8. Service Test Authorization Form

- 8.1. Service Test Form SCP-1201-F shall be completed by the initiator, and be approved by Metrolinx, prior to starting the test.
- 8.2. The Service Test Form contains data fields to record the following information:
- a) Responsible Metrolinx Designate.
 - b) Subdivision and Mileage of the Service Test.
 - c) Equipment to be tested.
 - d) Manufacturer.
 - e) Type or model.
 - f) Duration of service test.
 - g) Purpose and description of the service test.
 - h) Definition of positive outcome.
 - i) Signature and date of Supervisor directing the test.
 - j) Confirmation of a safety audit if it is for safety critical equipment.
 - k) Evaluation results.
 - l) Approval signature and date of the Metrolinx Manager, Signals and Communications.

9. Authorization Form Completion Process

9.1. Table 1201-01 describes the steps and responsibilities to initiate, authorize and complete the required service test form.

Table 1201-01

Step	Action
1	The employee initiating the Service Test shall complete the Service Test Form 1201-F. In addition, the employee must forward copies of all related manufacturer's specifications and documents to the responsible Supervisory Officer and Metrolinx.
2	Metrolinx will review the request ensuring: <ul style="list-style-type: none"> • the responsible Supervisory Officer concurs with the proposed Service Test. • the equipment meets all applicable AREMA, CSA, NEC, ANSI, or other applicable industry standards. • that a similar Service Test is not already ongoing. • there is an operational or cost benefit. • that a safety audit has been successfully performed for safety critical equipment. • the functional and operational test plan and recommended monitoring instructions are properly documented.
3	Providing the requirements of Step 2 are satisfied, Metrolinx will authorize the Service Test and: <ul style="list-style-type: none"> • Distribute an electronic copy of the completed Service Test form to the responsible Supervisory Officer.
4	If the Service Test is NOT authorized, the responsible Supervisory Officer and initiating employee will be advised, with an appropriate explanation.

10. Service Test Implementation

10.1. When the service test has been authorized the responsible employees shall follow the instructions in Table 1201-02.

Table 1201-02

Step	Action						
1	Proceed with service test as directed by the responsible Supervisory Officer and Metrolinx.						
2	Ensure all applicable periodic inspections and tests including functional and operational tests shall be performed as instructed in the service test plan.						
3	Monitor and record all pertinent data recorded during the test period to evaluate the equipment performance.						
4	<p>When the test period is completed, follow these instructions.</p> <table> <tr> <th>If</th><th>Then</th></tr> <tr> <td>The apparatus on test proves to be of no value and there is no point in further testing.</td><td>The responsible Supervisory Officer shall arrange to remove the equipment under test and submit a report to Metrolinx and the service test will be terminated.</td></tr> <tr> <td>The apparatus on test proves to be sufficiently beneficial to warrant its continued use within the system.</td><td>The responsible Supervisory Officer shall submit a report to Metrolinx recommending the apparatus or material be approved and adopted as a standard.</td></tr> </table>	If	Then	The apparatus on test proves to be of no value and there is no point in further testing.	The responsible Supervisory Officer shall arrange to remove the equipment under test and submit a report to Metrolinx and the service test will be terminated.	The apparatus on test proves to be sufficiently beneficial to warrant its continued use within the system.	The responsible Supervisory Officer shall submit a report to Metrolinx recommending the apparatus or material be approved and adopted as a standard.
If	Then						
The apparatus on test proves to be of no value and there is no point in further testing.	The responsible Supervisory Officer shall arrange to remove the equipment under test and submit a report to Metrolinx and the service test will be terminated.						
The apparatus on test proves to be sufficiently beneficial to warrant its continued use within the system.	The responsible Supervisory Officer shall submit a report to Metrolinx recommending the apparatus or material be approved and adopted as a standard.						

11. Disruption of Service Test

- 11.1. Service Tests shall not be disrupted, except in emergency, unless authorized by Metrolinx.
- 11.2. The responsible Supervisory Officer shall advise Metrolinx of any circumstances which could adversely affect the results of the test.

12. Termination of Service Test

- 12.1. The Service Test form will remain active until completion of the service test period, subsequent analysis, and recommended action by the responsible Supervisor and Metrolinx.
- 12.2. The test results referred to in Table 1201-03 of the Service Test will be then recorded by Metrolinx in the appropriate evaluation field of the Service Test form.

Table 1201-03

If the test results are...	Rail Corridors Infrastructure will....
Positive	Notify Metrolinx of its approval.
Negative	Notify Metrolinx accordingly.

- 12.3. Metrolinx will then terminate the Service Test, archiving the completed Service Test form.

1201(a) - Job Aid Service Testing of S&C Equipment and Materials

1. Purpose

- 1.1. This job aid provides clarifies the procedures to be followed by S&C employee in conducting Service Tests of new equipment of material.
- 1.2. New or modified materials or equipment shall not be considered for use at Metrolinx as a standard without first being subjected to a service test, unless prior analysis and evaluation by Metrolinx determines a service test is not necessary.

2. Definition

- 2.1. A Service Test is the testing of material or equipment under actual service conditions to verify quality, reliability, functionality and overall performance.

3. Job Aid

- 3.1. The purpose of the job aid is to assist with the startup of service testing. This document will elaborate on the steps of SCP-1201 and add supplementary information on all of the information and documentation that needs to be submitted. Details of the supplementary information and documentation that is to be provided is listed in each section.

4. Authorization Form Completion Process

- 4.1. The following table provides additional information on what needs to be addressed at this point before a service test can be initiated.

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Table 1201(a)-01

Step	Action
1	<p>Background information to be supplied at time of interest to having product put on test:</p> <ul style="list-style-type: none"> • Related documentation to be supplied can be included but is not limited to, data sheets, schematics, pictures, performance graphs on the equipment and any promotional information provided. • Obtain a sample, if possible, for review before installation and testing. • List of the locations where the product is to be installed and tested. • Information on where the equipment is already installed with other railways. • Information on how equipment is performing for other railways. • How long it has been installed with other railways. • Minimum information needing to be provided to Metrolinx for the SCP-1201 Service Test form: <ul style="list-style-type: none"> ○ Subdivision and Mileage, ○ Apparatus or type of equipment, Manufacturer, ○ Brief description of the test purpose, including information on what equipment, if any, that the item under test is to replace, ○ Supervisory Officer of the planner group that the equipment will be installed.
2	<p>Standards and Safety reviewing the request by Metrolinx:</p> <ul style="list-style-type: none"> • Operational or cost benefit, including the comparison to currently approved equipment and materials that perform the same task as the one to be tested. • Performing a safety audit that verifies the equipment that will provide protection for the safe movement of trains and safety of employees. • Verification that the equipment is compatible with equipment currently installed.
3	<p>Creation of a test plan:</p> <ul style="list-style-type: none"> • Test to be performed. • Length of testing after installation. • Monitoring and frequency of viewing testing.
4	<p>SCP-1201 form is to be filled out prior to testing.</p>

5. Service Test Implementation

5.1. After the authorization of the service test and the equipment is installed follow the SCP and supplementary table for proceeding.

Table 1201(a)-02

Step	Action
1	Follow test plan that was created: <ul style="list-style-type: none"> Record detailed information on the product both positives and negatives. Perform testing that was proposed. Monitor testing at proposed rate. Record all data taken. Record inspection findings each time visiting.
2	Completion of testing: <ul style="list-style-type: none"> Submit all data, findings and any additional feedback to Metrolinx. Provide any additional feedback on the performance of the equipment that would be helpful in the determination of the acceptance of the equipment.

6. Completion of Testing

6.1. When the testing of the product has been completed, and product is approved, the following table shall be followed:

Table 1201(a)-03

Step	Action
1	Metrolinx S&C employee will supplement the following product data in the Metrolinx designated system if the product is approved: <ul style="list-style-type: none"> Short description of the material. Long description of the material. Manufacturer Part Number. Vendor. Price.
2	Metrolinx will update the Signals and Communications Material List.
3	Requestor to be notified when completed.

1205-E - Guidelines for Preparing for Locking Tests

1. Purpose

- 1.1. To describe the general concepts for the preparation and execution of signal operating tests in accordance with [GI-301\(e\) Signal Installation and Testing Documentation](#).

2. Electric Locking

- 2.1. Electric locking is the combination of one or more electric locks and controlling circuits so that switches, signals, or other units operated in connection with the signal system are secured against operation under certain conditions.
- 2.2. Types of electric locking to cover herein include: time locking, approach locking, route locking, traffic locking, detector locking, and indication locking.

3. ASR Functionality

- 3.1. The ASR, "Approach Stick Relay", or slang term "At Stop Relay", associated with each home signal plays a central role in the initiation and enforcement of time, approach, route, and traffic locking. When energized, the ASR confirms that the associated signal is not requested or running time.
- 3.2. Each of the types of electric locking is initially enforced by:
 - a) the ASR assuming a de-energized state in response to a home signal request to clear or the home signal indicating clear (not displaying stop); and
 - b) in turn, the open front contacts of the ASR, or relays controlled by such contacts, preventing opposing or conflicting signals from being requested or clearing and also preventing power switches in the governed route from moving.

3.3. Enforcement of such locking by the ASR is then maintained until it becomes restored to an energized state, which normally occurs once the home signal has returned to stop position, and either:

- a) upon system detection of a train movement accepting the home signal and typically occupying two successive track circuits in the selected route, or
- b) in the absence of such movement, upon expiration of a preset "ASR" timer.

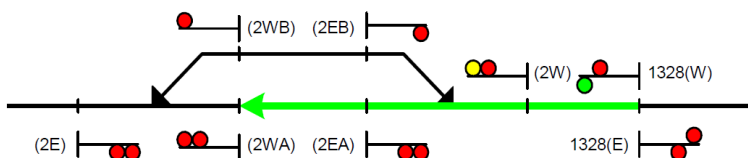
4. Time Locking

4.1. Time locking is a type of electric locking that is in effect when a home signal, previously requested to clear or already clear, is cancelled. This cancellation initiates a timing cycle that maintains electric locking until a predetermined time interval has elapsed.

5. Illustrations of Time Locking

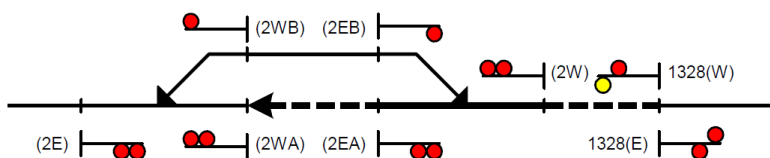
5.1. If this was the original route requested;

Figure 1205-E-1



And the route was subsequently cancelled;

Figure 1205-E-2



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- 5.2. 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.
- 5.3. NOTE: The electric locking that remains in effect as shown by the heavy dotted lines is called traffic locking, to be explained later.

6. Guidelines for Testing Time Locking

- 6.1. There are typically 2 progressive stages of the verification process required to confirm that time locking is effective. Detailed verification is required in the second stage of testing.

Table 1205-E-1

Stage	Verification Process
1	<p>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:</p> <ul style="list-style-type: none"> • 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	<p>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:</p> <ul style="list-style-type: none"> • 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. <p>NOTE: <i>Request conditioned</i> means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.</p>

7. Approach Locking

- 7.1. Approach locking is a type of electric locking that is in effect when a home signal, previously requested to clear or already clear, is cancelled while a train is occupying a pre-defined section of track approaching the signal. This cancellation initiates a timing cycle that maintains electric locking until a predetermined time interval has elapsed.
- 7.2. The ability to change routes without having to run time after canceling a signal with no train on the approach section, as would be the case with time locking, provides operational flexibility to aid in the handling of traffic

8. Approach vs. Time Locking

- 8.1. The difference between approach locking and time locking is that enforcement of electric locking in systems where approach locking is provided depends upon the detection of a movement approaching a home signal, whereas for systems without approach locking, i.e. time locking, it does not.
- 8.2. Such detection is provided by a number of consecutive track circuits in approach of the home signal, often referred to as the "approach section".

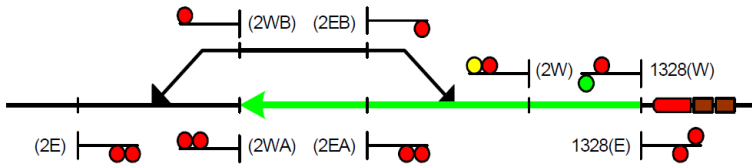
9. Detection of Approach Section Occupancy

- 9.1. Approach section occupancy is detected by the de-energized response of an approach relay (AR) to the occupancy of track circuits and trap circuit protected dead sections within its limits.
- 9.2. If track circuits within the approach section employ loss of shunt protection, such protection must be included in the control circuit of the AR relay in order to maintain locking in the event of momentary loss of shunt.
- 9.3. Where loss of shunt protection is not provided, equivalent protection must be provided by means of a holding circuit that takes effect once the approach section has been detected as occupied.

10. Illustrations of Approach Locking

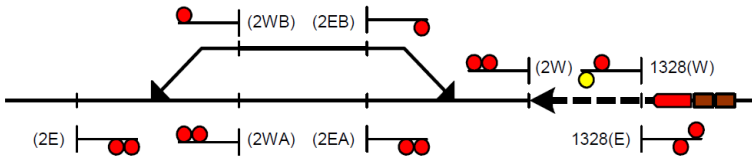
10.1. If this was the original route requested;

Figure 1205-E-3



And the route was cancelled while the train was in this position;

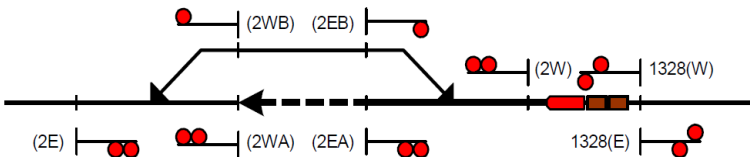
Figure 1205-E-4



Then no electric locking remains in effect against the original route, other than the traffic locking shown by the heavy dotted lines (to be explained later).

10.2. However, instead if the route was cancelled while the train was in this position;

Figure 1205-E-5



10.3. Then the electric locking that remains in effect as shown by the heavy solid black line is called approach locking. This remains in effect for a specified period of time.

10.4. NOTE: The electric locking that remains in effect as shown by the heavy dotted lines is called traffic locking, to be explained later.

11. Guidelines for Testing Approach Locking

11.1. There are typically 3 progressive stages of the verification process required to confirm that approach locking is effective. Detailed verification is required in the second and third stages of testing.

Table 1205-E-02

Stage	Verification Process
1	<p>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:</p> <ul style="list-style-type: none"> • 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	<p>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:</p> <ul style="list-style-type: none"> • 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.
3	<p>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:</p> <ul style="list-style-type: none"> • Request conditioned electric switch machines controlling a switch, movable point frog or derail, movable bridge cannot be operated. • Request conditioned home signals governing conflicting routes cannot display aspects to proceed. <p>NOTE <i>Request conditioned</i> means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.</p>

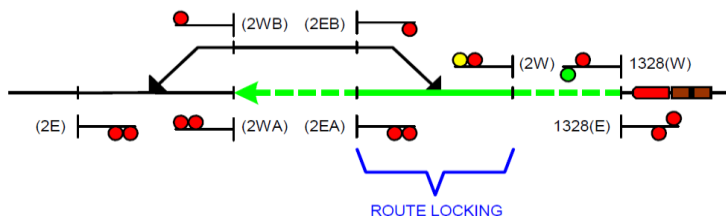
12. Route Locking

12.1. Route locking is a type of electric locking that is in effect when a home signal is caused to display a permissive aspect, and remains in effect for the established route governed by that signal until a train passes the signal, occupies and progresses through the selected route.

13. Illustrations of Route Locking

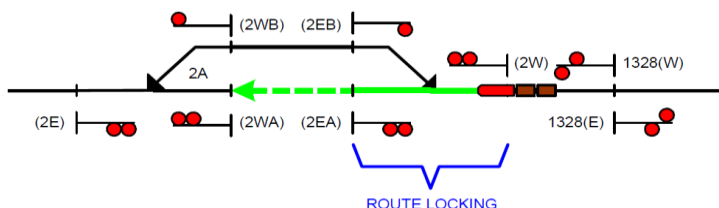
13.1. Referring back to the previous examples, note that route locking is in effect as shown once the route is established:

Figure 1205-E-6



13.2. And the route locking remains in effect as shown until the train has passed the control point.

Figure 1205-E-7



13.3. NOTE: The electric locking that remains in effect as shown by the heavy dotted lines is called traffic locking, to be explained later.

14. Guidelines for Testing Route Locking

14.1. Verification of route locking is performed by means of simulated movements which are to be performed as follows:

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- 14.2. Following occupancy of each track circuit, the track circuit previously occupied is to be vacated. The movement will therefore never occupy more than two, or less than one, track circuit as it progresses through a route.
- 14.3. EXCEPTION: When a simulated movement occupies or crosses a track circuit divided by a trap circuit protected dead section, then each energized section, as well as the dead section, is to be regarded as an individual track circuit with respect to the movement previously described.

Table 1205-E-03

Step	Verification Process
1	<p>Verify that as a simulated movement passes each home signal displaying an aspect to proceed for each route, that:</p> <ul style="list-style-type: none"> • Electric switch machines, controlling switches, movable-point frogs or derails at the controlled location, movable bridge located within the occupied track circuit or within a track circuit in advance of the movement cannot be operated.
2	<p>Verify loss of shunt protection on track circuits so protected.</p> <p>Where sectional release locking is provided, determine that the position of each switch, movable-point frog, derail, and facing point lock levers, to the rear of the simulated movement, will release and operate as the movement progresses 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.</p>

15. Traffic Locking

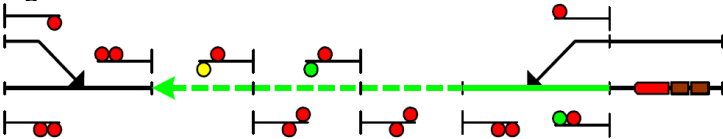
15.1. Traffic locking is a type of electric locking that is commonly misunderstood. In a strictly Regulatory sense, it is a type of electric locking that prevents the manipulation of levers or other devices for changing the direction of traffic on a section of track while that section is occupied or while a signal displays an aspect for a movement to proceed into that section, and is applicable only to interlockings with traffic levers.

15.2. Because the incidence of actual traffic locking as it is formally defined is very rare, the term is often used to apply to traffic verification logic used in most CTC systems. This interpretation of traffic locking, which is associated more with the functionality of the system, will be used herein.

16. Illustrations of Traffic Locking

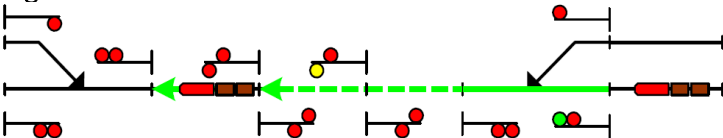
16.1. With a route selected between adjacent control points, traffic locking, shown in heavy dotted lines, will prevent opposing routes from being established into the block;

Figure 1205-E-8



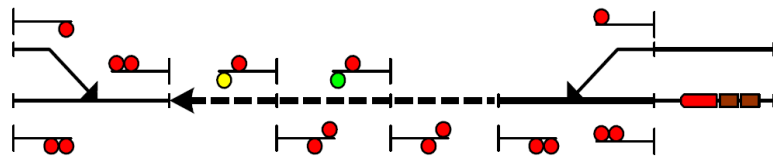
16.2. While it may allow following moves to be made into the occupied block:

Figure 1205-E-9



16.3. 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 in Figure 1205-E-9 is cancelled:

Figure 1205-E-10



17. Guidelines for Testing Traffic Locking

17.1. There are typically 5 progressive stages of the verification process required to confirm that traffic locking is effective. Detailed verification is required in the fourth and fifth stages of testing.

Table 1205-E-04

Stage	Verification Process
1	Verify that the approach stick relay (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 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	<p>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 two track circuits immediately adjacent to each approach/intermediate location, followed by simulation of the movement approaching the next approach/intermediate location, 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:</p> <ul style="list-style-type: none"> • Directional stick relays 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.

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Stage	Verification Process
4	<p>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 location, with an appropriate directional stick relay at the same location energized:</p> <ul style="list-style-type: none"> • A request conditioned home signal opposing the movement cannot display an aspect to proceed. • Approach/intermediate signals opposing the movement cannot display aspects other than most restrictive. <p>NOTE: <i>Request conditioned</i> means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.</p>
5	<p>With each home signal displaying an aspect to proceed for each available route providing entry to each signaled block adjacent to the home signal location under test, verify that as a simulated movement passes each such signal and is progressively confined to each track circuit or trap circuit protected dead section between the home signal passed and the opposing home signal at the same location:</p> <ul style="list-style-type: none"> • A request conditioned 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. <p>NOTE: <i>Request conditioned</i> means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.</p>

18. Other Traffic Locking Functionalities

18.1. 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.

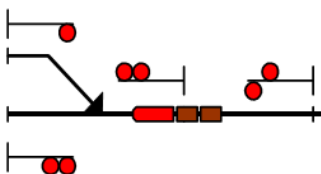
19. Detector Locking

19.1. Detector locking is a type of electric locking that prevents the movement of any interlocked or electrically locked switch, movable point frog, movable bridge or derail within a specific portion of track and maintains other previously established forms of electrical locking (i.e. route locking, traffic locking, etc.) while that track is occupied.

20. Illustration of Detector Locking

20.1. Consider a train passing a home signal and over a switch while not under signal indication:

Figure 1205-E-11



20.2. Detector locking will prevent the switch from throwing while the train is on the OS track.

21. Guidelines for Testing Detector Locking

21.1. The following will verify that detector locking is enforced as intended.

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Table 1205-E-05

Stage	Verification Process
1	<p>With all governing home signals indicating stop and electric locking not in effect:</p> <ul style="list-style-type: none"> • Open motor control circuit of an electric switch machine controlling a switch, movable- point frog or derail. • Confirm switch machine does not respond to request conditioning (account open control circuit). • Close switch machine motor control circuit. Confirm switch machine does respond to request conditioning. • Shunt the track circuit within which the switch, movable- point frog or derail is located. • Confirm switch machine does not respond to request conditioning (account shunted track circuit). • Remove shunt and confirm switch machine does respond to request conditioning. • Shunt 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.
2	<p>If the track circuit under test is not divided by a trap circuit protected dead section, then go to Stage 4, otherwise:</p> <ul style="list-style-type: none"> • Shunt the track circuit. • Confirm trap stick relay(s)* (TSR) down. • Remove shunt to simulate the occupancy vacating the track circuit and occupying the dead section. • Confirm TSR remains down. <p>Verify switch machine will not respond to request conditioning, when by simulation the track circuit is vacated and the dead section is occupied.</p> <p>* There may be two stick relays employed in the trap circuit configuration. When such is the case, the term "TSR" refers to both.</p>

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Stage	Verification Process
3	<p>Reset TSR to simulate removal of occupancy from dead section, using manual reset feature or by momentarily applying energy to coil circuit if manual reset is not provided.</p> <p>Verify the switch machine will respond to request conditioning when TSR is reset to simulate removal of occupancy from dead section.</p> <p>Verify the response of switch machine is sufficiently delayed to indicate that loss of shunt protection is incorporated in trap circuit protection.</p>
4	<p>Repeat tests for switch machine in the opposite direction.</p> <p>NOTE: <i>Request conditioned</i> means to have the control requested in the field while overriding any non-vital cross checks normally performed by code units or application relays.</p>

22. Indication Locking

22.1. Indication locking is a type of electric locking that prevents the establishment of a route when the operation of a signal, switch or other operative unit fails to make the required movement.

23. History of Indication Locking

23.1. Originally, indication locking was built into electromechanical interlockings, whereby the full motion of a signal or switch lever would be impeded until a positive feedback was received from the affected signal or switch that it was in its intended position. Only then could the lever complete its full motion, thereby allowing the interlocking logic affected by the lever to be enforced.

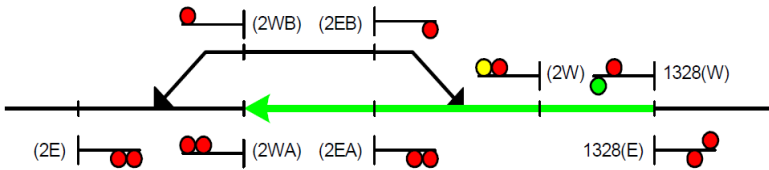
23.2. A parallel functionality exists with any device which is capable of indicating its state or position, such as switch machines (having switch circuit controllers) and signal mechanisms (having repeater contacts). For this reason, the intent of indication locking as it originally applied to electromechanical interlocking has been expanded to include these devices.

23.3. NOTE: Colour light signals have no repeater contacts therefore indication locking does not apply to them.

24. Illustrations of Indication Locking

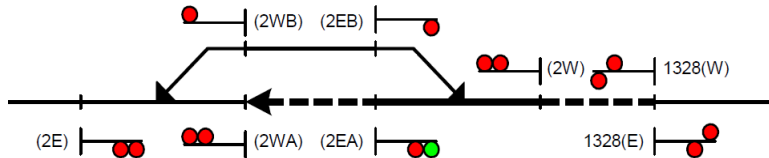
24.1. If this was the original route requested:

Figure 1205-E-12



24.2. And if an opposing red repeater opens;

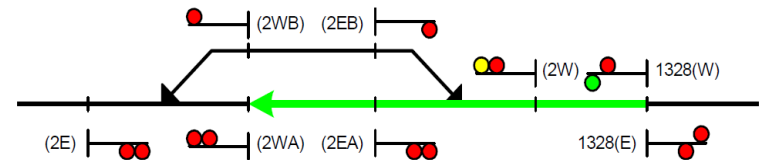
Figure 1205-E-13



24.3. Then indication locking causes the original route to cancel and run time.

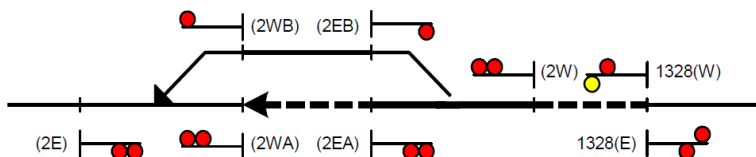
24.4. If this was the original route requested:

Figure 1205-E-14



24.5. And if a switch within the route loses correspondence;

Figure 1205-E-15



24.6. Then indication locking causes the original route to cancel and run time.

24.7. NOTE: The electric locking that remains in effect as shown by the heavy dotted lines is called traffic locking, as previously explained.

25. Guidelines for Testing Indication Locking

25.1. The following will verify that indication locking is enforced as intended for a power operated switch.

Table 1205-E-06

Device	Verification Process
Switch Machine	<ul style="list-style-type: none"> For each switch, in each route, and in each position (normal and reverse), verify that switch correspondence is open with a ¼-inch obstruction between the switch point and the stock rail 6-inches from the end of the point. For each possible route, attempt to clear a signal over the route, and then 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 runs time.

25.2. The verification of indication locking for searchlight signals is normally performed during the validation that the ASR is correctly responding to detected aspects displayed by the home signal under test (usually performed in Stage 1 of time locking and approach locking tests). A detailed example of these procedures is provided below:

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Table 1205-E-07

Step	Action	Check...	Verify that...
1	If approach locking is employed, de-energize approach relay.	Approach relay down.	
2	Request home signal under test to display an aspect to proceed.	Home signal clear.	Home red repeater relay and ASR drop in response.
3	Reverse home signal request and manually reset ASR.	<ul style="list-style-type: none"> • Home signal at stop. • Home red repeater up. • Home ASR up. 	
4	Open home signaled repeater circuit.	<ul style="list-style-type: none"> • Home red repeater relay down. • Timing device not operating. 	Home ASR drops in response.
5	Close home signal red repeater circuit.	<ul style="list-style-type: none"> • Home red repeater relay up. • Timing device operating. 	Home ASR does not pick up in response.
6	Re-request home signal.	<ul style="list-style-type: none"> • Home signal clear. • Home ASR down. • Timing device not operating. 	
7	Open opposing signal red repeater circuit.	<ul style="list-style-type: none"> • Opposing red repeater relay down. • Opposing ASR down. • Home red repeater relay up. • Home ASR down. • Timing device operating. 	

Continued on next page

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Step	Action	Check...	Verify that...
8	Close opposing signal red repeater circuit.	<ul style="list-style-type: none"> • Opposing red repeater relay up. • Opposing ASR up. • Home red repeater relay up. • Home ASR down. • Timing device operating. 	Home ASR does not pick up in response.
9	Repeat steps 6-8 for each opposing signal.		
10	Allow approach relay to energize, if applicable.		

1208 - Installation and Commissioning Procedure

1. Purpose

- 1.1. Installation and commissioning procedures must be followed when installing new equipment, changing an existing installation, or putting replacement equipment in service. This will ensure that the signaling system or road crossing warning system is installed properly and functioning as intended.

2. Supervisory Officer

- 2.1. For new installations, Metrolinx will designate the Supervisory Officer who will:
 - a) Ensure that there is a commissioning Test Plan developed before project begins.
 - b) Ensure that appropriate track and crossing protection is provided before project begins. This protection will provide all necessary safety to trains, employees, railroad, and general public at crossings, as applicable.
 - c) Ensure that tests are executed according to the plan
 - d) Ensure that tests are documented, as required.
 - e) Ensure that approved signal plans are being used. Any required design changes must be authorized by Metrolinx and documented, including the time and name of the individual authorizing changes.
 - f) Ensure that the commissioning tests are successfully completed, and documentation reviewed before placing location in service.
 - g) Declare the location in-service.
 - h) Direct the removal of any protection placed to provide safety.

3. Establishing Protection

- 3.1. The Metrolinx designated Supervisory Officer is responsible for establishing protection of the site being commissioned.
- 3.2. When establishing protection, the responsible Supervisory Officer must notify the RTC that the only person authorized to remove the protection is the current Supervisory Officer and a designated alternate, if necessary.

4. Removing Protection

- 4.1. The Supervisory Officer, or designate, is the only person allowed to remove protection from the location.
- 4.2. The protection must only be removed after Supervisory Officer is sure that the testing is complete and sure that all automatic crossing warning or CTC devices are tested and functioning properly. This includes watching train movements as applicable.

5. Installations Lasting More Than One Shift

- 5.1. For projects requiring multiple shifts, a Supervisory Officer will always be designated on each shift. A formal transfer of this responsibility must occur. This transfer must include the following information:
 - a) current protection / authority in effect
 - b) status of signal and / or crossing tests
 - c) documentation of testing to that point
 - d) any issues affecting the normal progression of the commissioning.

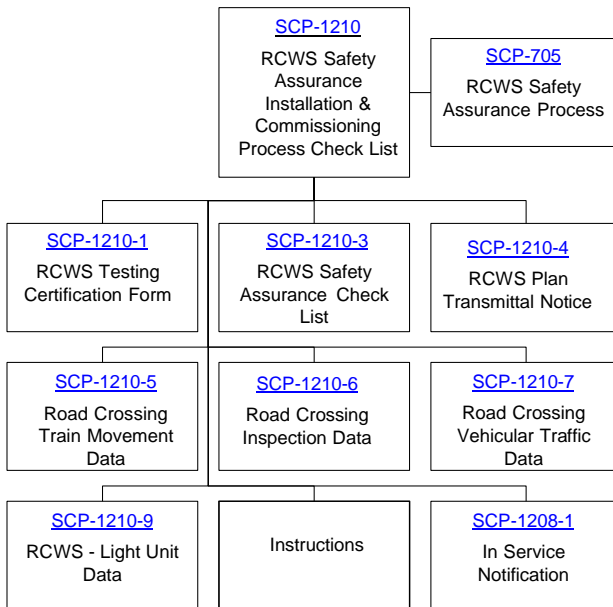
6. General Instructions

- 6.1. The Supervisory Officer is responsible to ensure that all appropriate instructions, directives, or tests are completed as necessary.

7. Road Crossing Installations

- 7.1. [SCP-1210 RCWS Installation & Commissioning Process Check List](#) must be completed before a road crossing warning system is placed in service.
- 7.2. SCP-1210 provides a check list of tasks, forms, SCPs, and GIs that must be completed in order to commission a RCWS.

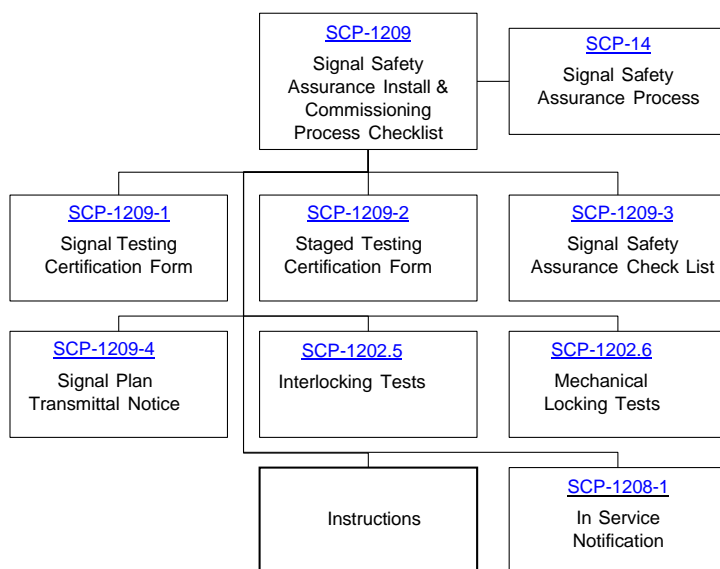
Figure 1208-1



8. Signalling Installations

- 8.1. [SCP-1209 Signal Installation & Commissioning Process Check List](#) must be completed before a signal site is placed in service.
- 8.2. SCP-1209 provides a check list of tasks, forms, SCPs, and GIs that must be completed in order to commission an interlocking, intermediate, or other signaling related location.

Figure 1208-2



9. After a Location is put In Service

- 9.1. When the location is placed in service, the responsible Supervisory Officer shall follow the [Rail Corridors Infrastructure Handover Protocols \(RC-0503-01\)](#).
- 9.2. The most current version of the rail Corridors Infrastructure Handover Protocols is located in Mylinx.

1301 - Prevention of Electric Sparks at Flammable Liquid and Gas Transfer Facilities

1. General

- 1.1. This practice covers procedures for the prevention of electric sparks that may cause fire during the transfer of flammable liquids or compressed flammable gases to or from rail equipment and stationary bulk storage facilities.
- 1.2. Static electricity is generated when liquids move in contact with other materials. If the accumulation of static is sufficient, a spark may occur. If the spark occurs in the presence of a flammable vapor-air mixture, an ignition may result. Where a static spark and flammable mixture may occur simultaneously, suitable preventive measures are required to avoid ignition.
- 1.3. The accumulation of static charges may be prevented by bonding and grounding.

2. Definitions

- 2.1. **Bonding:** is the process of connecting two or more conductive objects together by means of a conductor. Bonding is done to minimize potential differences between metallic objects
- 2.2. **Grounding:** is the process of connecting one or more conductive objects to earth, and is specific form of bonding. Grounding is done to minimize potential differences between objects and the ground.

- 2.3. **Compressed flammable gas:** means any product, material or mixture that has a critical temperature less than 50°C, an absolute vapour pressure greater than 295kPa at 50°C or an absolute pressure in a pressure vessel greater than 275kPa at 21.1°C or 716kPa at 54.4°C. and is flammable when in a mixture of 13% or less by volume with air at normal atmospheric temperature and pressure or has a flammable range with air wider than 12% regardless of the lower limit
- a) NOTE: Typical compressed flammable gases include liquefied petroleum gases (propane, butane) and methyl chloride.
- 2.4. **Flammable range:** means the difference between the minimum and maximum volume percentage of product, material or mixture in air that, with air, forms a flammable mixture.
- 2.5. **Flammable liquid:** means any liquid having a flash point below 23°C in a closed cup test.
- a) NOTE: Typical liquids include naphtha, gasoline, petroleum solvents, certain paints and common alcohols.
- 2.6. **Combustible liquids:** means any liquid having a flash point at or above 23°C in a closed cup test. Typical combustible liquids include kerosene, stove oil, diesel fuel oil, and heavy fuel oils. Bonding and grounding **is not required** for combustible liquids.

3. Application

- 3.1. This practice is intended to apply to all stationary bulk storage facilities on railway property or other property adjacent to private trackage serviced by the railway where **flammable liquids** or **compressed flammable gases** are loaded or unloaded.
- 3.2. This practice applies to all new installations and for replacement on existing installations where general renewal or replacement is to be made.

- 3.3. This practice is intended to be complementary to "Railway Prevention of Electric Sparks Regulations, SOR/82-1015" should there be any conflict between this practice and Railway Prevention of Electric Sparks Regulations, the regulation shall govern.
- 3.4. This practice does not apply to loading and unloading tracks equipped for electric train operation. This application requires special considerations.

4. Permanent Bonding and Grounding Connections

- 4.1. This section is intended to cover the permanent bonding and grounding connections required for the prevention of electric sparks at transfer facilities. Portable or temporary connections which may be required such as between the piping system and railway rolling stock are not covered as this protection is not installed, operated or maintained by railway forces.
- 4.2. Each section of track on which any part of rail equipment stands while a flammable liquid or compressed flammable gas is being loaded or unloaded shall be protected in accordance with the following requirements:
- a) The sections of track shall be bonded at each rail joint.
 - b) Two rail bond cross-connections shall be installed between two rails of each bonded track section, one near each end of the section.

- c) The bonded track sections shall be grounded with two ground rods. Each 10 ft. (3m) long and at least $\frac{5}{8}$ " (15.875mm) in diameter. Ground rods shall be separated at least 10 ft. (3m) from each other and from any ground rod used for any other purpose. Ground rods shall be driven to a depth of at least 10ft. (3m) except where rock bottom is encountered. Where rock bottom is at a depth of 4 ft. (1.2 m) or more, ground rods shall be driven to rock bottom. Where rock bottom is encountered at a depth of less than 4 ft. (1.2m) they shall be buried in a horizontal trench.
- d) Two No. 6 AWG stranded copper conductors shall be installed between the bonded track sections and piping system that is to be used for the transfer, conductors to be continuous from rail connection to the piping system.
- e) Insulated rail joints shall be installed to electrically separate each bonded track section from all other track rails.

4.3. Bonding and grounding conductors to be installed so as not be subject to mechanical damage.

4.4. Other precautions such as insulated joints in the permanent piping system. Additional grounding, temporary bonds between the piping system and the rail equipment tank and other special measures as may be required under specific local conditions, shall be taken to provide adequate protection.

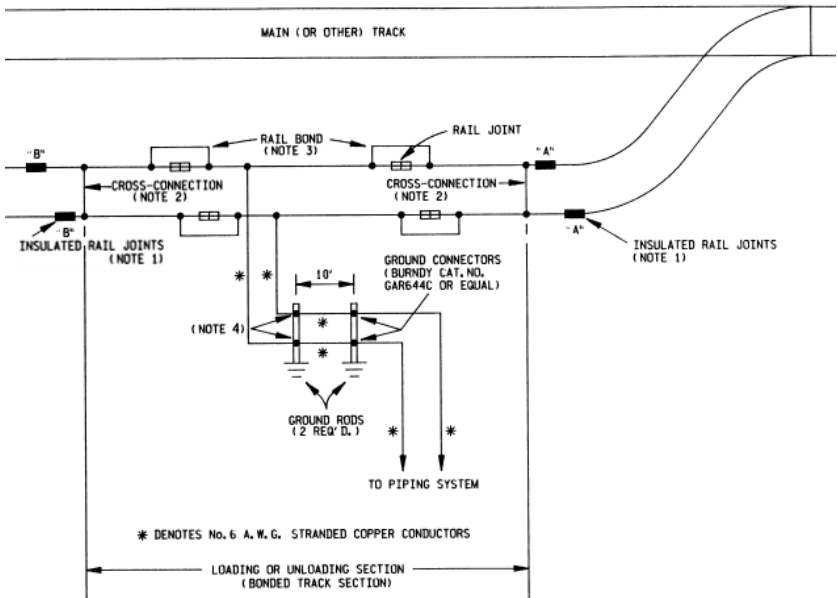
5. Inspection and Maintenance

5.1. Permanent bonding and grounding shall be inspected in accordance with GI 332 and repairs made where necessary.

5.2. Such facilities off railway right-of-way shall only be maintained in accordance with the above, under condition of agreement between Railway and Private Party concerned.

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Figure 1301-1: Typical Bonding and Ground Connections
Single Transfer Track

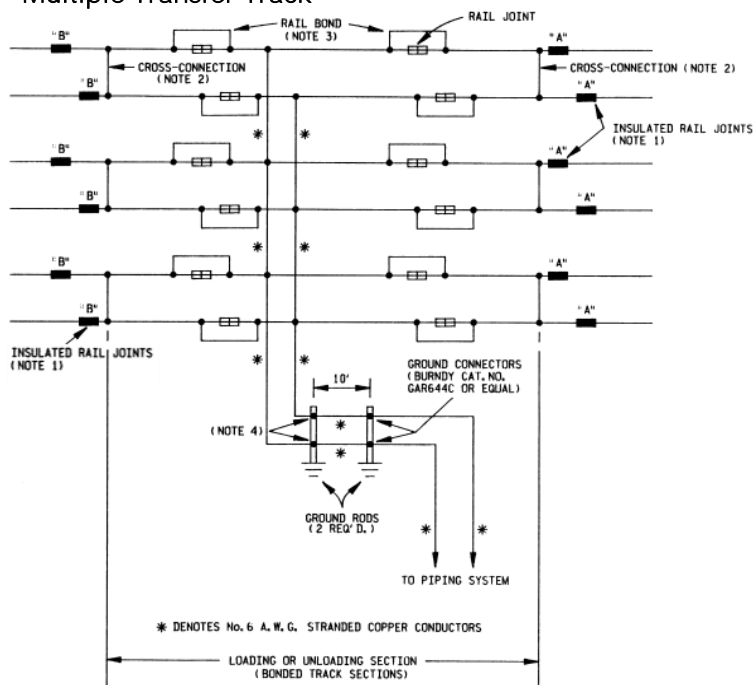


NOTES:

- a) Insulated rail joints marked "A" may be the insulated rail joints at end of fouling circuit in signalled territories. Insulated rail joints marked "B" are not required if loading or unloading station is located at end of spur track.
- b) "Cross-connection" to consist of a 6' length of rail bond strand wire complete with rail connection plugs at each end.
- c) Rail bonds may be web-to-web; web-to-bar; or head types.
- d) Grounding conductors to be continuous' from rail connection to piping system conductors shall not be cut but shall "feed-through" connector at ground rod.

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Figure 1301-2: Typical Bonding and Ground Connections
Multiple Transfer Track



NOTES:

- a) Insulated rail joints marked "A" may be the insulated rail joints at end of fouling circuit in signalled territories. Insulated rail joints marked "B" are not required if loading or unloading station is located at end of spur track.
- b) "Cross-connection" to consist of a 6' length of rail bond strand wire complete with rail connection plugs at each end.
- c) Rail bonds may be web-to-web; web-to-bar; or head types.
- d) Grounding conductors to be continuous' from rail connection to piping system conductors shall not be cut but shall "feed-through" connector at ground rod.

1302 - Isolation and Grounding of Railway Tracks Servicing Electrical Supply Stations

1. Purpose

- 1.1. This practice covers recommended procedures for the prevention of hazardous potentials on railway tracks which service electrical supply stations.
- 1.2. A serious hazard may result to personnel and railway signalling and communication systems during a power system ground fault, from the transfer of potentials between the supply station ground-grid area and points outside the station by railway tracks. The seriousness of the problem results from the very high potential differences that may occur.
- 1.3. The potential rise of the station grounding system above remote earth is usually limited to a value of 3000-volts. In particular difficult grounding conditions, station designers may limit this value to a maximum rise of 5000-volts. This potential rise is due to the flow of ground current through the station ground resistance. Ground current results from ground faults, and is limited by the impedances of lines, transformers, grounding systems and other electrical components from the source up to the point of fault.
- 1.4. The transfer of hazardous potentials to remote points by railway tracks may be prevented by isolating the rails outside of the station ground-grid area, and by grounding the rails inside the station to the main ground bus. Grounding of the rails within the station fence also ensures proper operation of the station's protective devices in the event of unintentional rail contact with high voltage station conductors.

2. Scope and Application

- 2.1. The practices outlined are intended to be representative and are therefore indicative of the type of protection which may be required to reduce the effects of hazardous potentials. Before application to new installations a site-specific inspection and evaluation should be made and the protection approved by Metrolinx. The fact that certain methods are specified herein does not preclude the use of other methods mutually satisfactory to both the railway and electric power utility.

3. Prevention of Hazardous Potentials

- 3.1. Track rails located inside the fenced area of an electrical supply station shall be connected to the station main ground bus with No. 2/0 AWG (minimum) stranded copper conductors. The spacing between taps to the station main ground bus shall not exceed the spacing established for the station ground grid.
- 3.2. A No. 2/0 AWG minimum copper ground grid shall be buried under the track rails where the track rails pass through the station gate(s). This ground grid shall consist of 2m by 2m (6.5 ft. X 6.5 ft.) squares and cover the area of the gate swing. This ground grid shall be connected to the station main ground bus with a No. 2/0 AWG (minimum) copper conductor.
- 3.3. The sections of track within the fenced area of an electrical supply station shall be bonded at each rail joint with a No. 2/0 AWG stranded copper conductor.
- 3.4. Track rails located outside the station ground-grid area shall be electrically isolated from the station-grounding electrode with a minimum of three (3) insulated rail joints in each rail. The number of insulated rail joints depends on the expected station ground potential rise and the dielectric strength of an insulated rail joint.

- 3.5. **IMPORTANT:** The removal of a complete section of rail is a preferred permanent solution and should be implemented where operations permit, as high voltages may appear across some of the insulated rail joints during power system ground faults. There shall be a minimum of 1.5m (5'-0") clearance between the station gate grid and the nearest rail outside of the station fence. The removed lengths of rail should be left out and only replaced when the station spur track is required for immediate use. The removal of a complete section of rail does not eliminate the insulated rail joints required unless the insulated rail joints are installed each time the railway track is made operational.
- 3.6. Grounding conductors shall be installed in such a way as to minimize mechanical damage.

4. Inspection and Maintenance

- 4.1. Rail grounding connections, insulated joints, etc. shall be inspected in accordance with GI 332 and repairs made where necessary.
- 4.2. Such facilities off railway right-of-way shall only be maintained in accordance with the above, under condition of agreement between Railway and Private Party concerned.

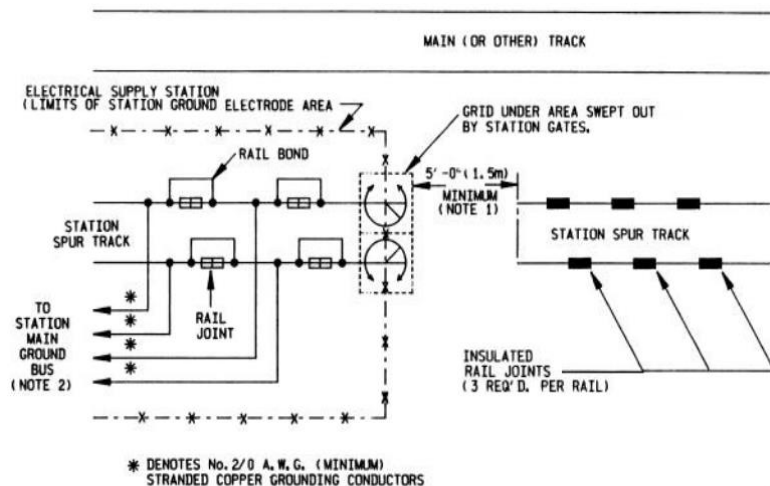
5. Safety

- 5.1. Hazardous voltages can occur if the grounding conductors are disconnected, or if insulated rail joints are removed, while the power station is energized. If modifications to the railway track protective system are necessary, all work shall be done in accordance with the electric power utility's safety rules and approved work practices, and with the full knowledge of the supply station operators. Modifications to the railway track protective system, should preferably be made with the station de-energized.

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- 5.2. To prevent transfer of hazardous potentials, the insulated rail joints must not be bridged by stationary rail equipment or by other means. This is specifically important when the removable rail sections have been installed to permit rail access to the supply station.

Figure 1302-1: Typical Rail Way Track Protective System



5.3. NOTES:

- (Note 1 in Figure 1302-1) - Rail sections should be removed where operations permit, rail sections should be temporarily replaced when track is to be used by rail equipment (See section 3.5).
- Rail grounding conductors to station main grounding grid to be installed by electric power utility.
- Rail joints within station to be bonded by electric power utility.

1304 – S&C Fault Reporting Criteria

1. Purpose

- 1.1. The priority and goal of S&C Fault Reporting is to produce consistently accurate information pertaining to failures, to track and identify systematic failures, failed or failing components, repeat failures, procedures, and to identify trends.
- 1.2. The intent of providing concise information on historical failures is to learn from these failures and improve the reliability of Metrolinx Signals & Communications Systems and improve on time train performance.
- 1.3. To provide background and guidelines to maintenance providers and S&C Fault Reporting providers so they can create, initiate and complete the S&C Fault reports to ensure consistently accurate reporting.

2. Recorder Downloads and DATA Collection

- 2.1. All S&C Fault reports for incidents such as wrong side, alleged wrong side failures, CROR or other rule violations, train accidents, and GCWS accidents must include all software versions, Field and Office recorder downloads, and applicable Field Test Reports.
- 2.2. All incidents where software versions, recorder downloads, RTC/GTCS Computer playback history are used for analysis and to identify failures, these records must be added to the S&C Fault report.

3. Incident Reporting

- 3.1. Incidents are reported or generated from numerous sources. In order to facilitate an accurate investigation of the incident the identity of the person initially reporting the incident, including the person's name, and contact information must be added to the S&C Fault report.

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- 3.2. The maintenance provider shall thoroughly investigate the incident and determine the root cause of the failure. They must provide details on their testing, or actions used to determine the fault, and the corrective actions taken to resolve it.
- 3.3. Please note that the initial reported fault or symptom may not end up being the final determined cause of the failure. A review of the S&C Fault report must take place while the failure is being investigated, and when a resolution is finally determined in order to accurately code the root cause of the failure. An example would be a "False Clear" was reported and upon investigation it was found that the progression of signals followed the route and aspect chart, the S&C Fault report should be upgraded to an "Alleged False Clear".
- 3.4. Where an S&C Fault report is found to be incorrectly coded please contact the appropriate Call Desk to have the report changed.

4. S&C Fault Report Criteria

- 4.1. S&C Fault report shall reflect the true nature of the reported incident.

1401 - Safety Instructions for Vented Storage Batteries

1. Purpose

- 1.1. This Practice outlines the instructions covering safe working conditions for the protection of S&C personnel engaged in work on or near vented storage batteries, such as flooded lead acid, VRLA's, and NiCad's.

2. Static Electricity

- 2.1. Electrostatic discharge is suspected in a number of incidents where nickel-cadmium storage batteries have exploded.
- 2.2. Under certain circumstances, vented storage cells produce a flammable (and explosive) mixture of hydrogen and oxygen gasses. Electrostatic discharge can cause the explosive mixture to ignite.
- 2.3. Clothing made from synthetic materials, such as the nylon used in some safety vests, can generate large electrostatic voltage as the result of normal movements by its wearer. Substantial electrostatic charges can also be generated between two objects of the same material if they are in intimate contact and suddenly separated. Electrostatic voltages can also be generated when liquids move in contact with other materials.
- 2.4. The simple act of pouring water into a plastic water container can generate and retain an electrostatic voltage. An electrostatic discharge may result when the charged water is later introduced into the cell during routine battery maintenance operations.
- 2.5. Always remember to discharge yourself of accumulated static charge by touching a nearby permanent ground before touching any battery cell.

3. Danger- Excessive Gassing

- 3.1. Be especially wary of dehydrated cells, where the electrolyte has dropped below the minimum level indicator. Cells in this condition may experience excessive gassing for up to 3 hours after charge current has been removed. Excessive gassing can present a serious risk of explosion. Always treat dehydrated battery cells with extreme caution.

4. Safety Precautions

- 4.1. Before commencing any work in battery rooms or equipment housings containing storage batteries the following general safety precautions shall be taken:
- a) The room or area shall be adequately ventilated; vents should be kept clear at all times.
 - b) Open flames or smoking shall be prohibited in the immediate vicinity of a battery. Extreme care shall be exercised to avoid spark or flash when changing connections or working near a battery.
- 4.2. Before commencing any battery service work, including the measurement of specific gravity, or the removal of any cells, the following safety precautions shall be taken:
- a) A face shield which attaches to a hard hat shall be worn.
 - b) Hearing protection shall be worn.
 - c) Personnel shall be familiar with the practices and precautions for working with acids and alkalis as covered in section "Electrolyte Precautions" of this Practice.
 - d) Avoid wearing metallic objects, such as jewelry.
 - e) Personnel shall discharge themselves of accumulated static charge by touching a nearby permanent ground.
 - f) Care shall be exercised to avoid external short circuiting.

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- g) Steel cell containers are “live”. DO NOT allow objects to rest across or fall between containers.
- h) Use tools with insulated handles.
- i) When the battery load is disconnected or connected, it should be done at a point remote from the battery. (i.e. not at the battery terminal post).
- j) Ensure that battery vent caps are clear and well maintained. DO NOT remove caps unless water must be added or caps inspected.
- k) Water shall be added to storage batteries in accordance with the special safety procedures outlined in the following section.

5. Adding Water

- 5.1. Special conductive battery filling containers have been developed incorporating a metal pouring spout and grounding conductor as illustrated in Figure 1401-1: **Conductive Battery Filler**.
- 5.2. Water shall be added in accordance with the following special safety procedures in Table 1401-01.

Table 1401-01

Step	Action
1	Using bare hands, touch the spring clip (at the end of the ground lead) to a nearby permanent ground such as the housing prime ground terminal or to any grounded chassis or rack. This action is intended to neutralize any accumulated charge on either the water or filling container. It is also intended to neutralize any accumulated charge on the body.
2	Connect the ground lead to the negative side of the storage battery. This action is intended to equalize any accumulated charge between electrolyte and water.
3	Water may now be added to the cells. Ensure the ground lead is connected to the negative side of the battery at all times during the filling process. CAUTION: Use extreme care to avoid contact between the metal pouring spout and the positive side of the battery.

6. Electrolyte Precautions

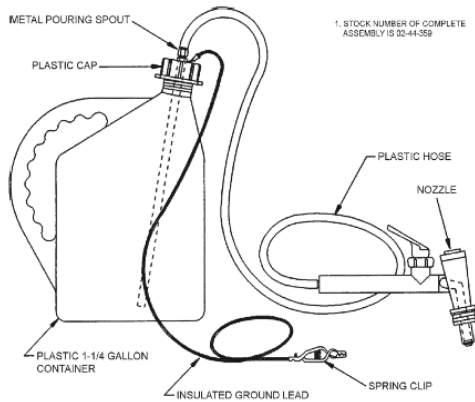
- 6.1. Electrolyte used in nickel-cadmium cells is an alkaline solution, a mixture of potassium hydroxide and water. Electrolyte used in lead-acid cells is a mixture of a sulphuric acid and water.
- 6.2. Before commencing any work involving the use of acids or alkalis, personnel shall familiarize themselves with the location of the nearest water supply. Always have a minimum of 25 liters of clean bottled water on hand if a ready supply of water is not otherwise available.
- 6.3. Protective clothing in the form of rubber gloves and a rubber apron shall be worn to protect the hands and clothes from acids and alkalis.
- 6.4. Electrolyte is highly corrosive and must be handled carefully to avoid injury to person or damage to clothing or equipment.
- 6.5. Acid and alkaline solutions shall be used only in well ventilated locations.
- 6.6. When mixing electrolyte, the alkaline or acid solution must be added to the water, NOT the water to the alkaline or acid solution.
- 6.7. Open flames or smoking shall be prohibited in the immediate vicinity.
- 6.8. Always wash immediately, with water, all skin areas and clothing wetted by acids or alkalis.

7. In Case of Burns

- 7.1. In the event of accidental contact with electrolyte, rinse the affected area thoroughly for a minimum of 15 minutes with clean water. Seek medical attention if burning persists.

8. Conductive Battery Filler

Figure 1401-1: Conductive Battery Filler



- 8.1. Use a non-metallic filling container that will not produce a static charge when using.

9. Flame Arrestor Caps

- 9.1. Some older style NiCad batteries may have had the battery cap threads filed down to expedite watering. These caps present an explosion hazard and must be replaced with approved flame arrestor caps.

1402 - Storage Batteries and Chargers

1. Purpose

- 1.1. The purpose of this document is to describe the various battery and charger technologies used in signal applications, the criteria on how to choose the appropriate battery and charger technologies, as well as the prescribed methods of maintaining, charging, and testing batteries.
- 1.2. Signal designs and applications of the batteries and chargers shall also comply to AREMA S&C Manual, Section 9.

2. Standby Requirements

- 2.1. Table 1402-01 below summarizes the currently implemented standby requirements for various systems across Metrolinx.
- 2.2. Determining the capacity of the standby DC power source shall meet the hours listed in the Table 1402-01 as the minimum. These hours can be exceeded under the direction given by Metrolinx based on site specific operation conditions and power calculations.
- 2.3. Grade Crossings shall comply with Grade Crossing Standards, section 12.6, which requires: "Warning system battery back-up of 8 hours of continuous activation and 24 hours of normal railway operations must be provided."

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Table 1402-01

Type of System	Minimum Standby Power Requirements at -20°F (-29°C) (hours)
CTC Signal System Controlled Locations	8
CTC Signal System Intermediates / Cut Sections (Track Circuit Repeater) / Electric Lock Locations	16
Defect Detection System Locations	16
Fiber Optic & Data Communications	24
Radio Base Stations	24
Crossing Warning Systems - Continuous Activation	8
Crossing Warning Systems - Normal Railway Operations	24
USRC	4

3. Battery Technologies

3.1. There are 5 major battery technologies currently in use on Metrolinx S&C systems as listed in Table 1402-02.

Table 1402-02

Battery	Description
Flooded NiCad	<p>The recommended battery of choice for most signal applications. NiCad's, such as SAFT SPL and SCM batteries, offer excellent cold weather operation, long operating life, high rate charge and discharge capability, and are quite impervious to abuse.</p> <p>The disadvantages of NiCad's are high initial costs, and the requirement for occasional watering.</p>

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Battery	Description
Sealed Lead Acid	Gas recombinant sealed lead acid batteries, such as the "Gates" cells, when used with temperature compensated constant voltage chargers, are the preferred battery for 110V switch machine applications.
VRLA	<p>Valve Regulated Lead Acid batteries, such as the GNB Absolutes and Marathons, provide an economical choice for CTC standby applications, particularly in moderate climates. VRLAs require no watering, can be mounted in any position, and can survive very deep discharges.</p> <p>The major disadvantages to VRLAs are the substantial lifespan degradation that occurs with temperature variations above 25°C, and the severe derating that must be applied at very low temperatures. Also, the inability to predict when VRLAs have reached end of life makes them a poor choice for crossing locations. VRLA batteries shall only be used with temperature compensated, constant voltage chargers.</p>
Sealed	Limited usage, low capacity batteries used in some data applications.
Flooded Lead Acid (Lead Calcium or Selenium)	Due to poor low temperature performance, and high maintenance requirements, flooded lead acid batteries are no longer viewed as a good economical choice for most S&C applications. They do continue to serve a role as track circuit batteries where a higher cell voltage is required on account of track circuit length or ballast conditions.

4. Temperature Derating

- 4.1. When selecting a battery technology, it is important to derate the amp-hour capacity to account for low temperature operation. Typical derating is applied at -20°F, or approximately -30°C.

- 4.2. The following table summarizes the typical low temperature derating values for the battery technologies accepted for use in Metrolinx. The amount of rated capacity must be reduced by the derating value to obtain the actual available capacity. For example, in Canada, an 80 AH Nicad cell must be reduced by 26%, or 21 AH, which provides an actual capacity of 59 AH.

Table 1402-03

Battery Type	Derating at Temp
	-20°F/-30°C
Flooded NiCad	26%
Sealed NiCad	35%
SLA (Gates Cells)	45%
VRLA	73%
Flooded Lead Acid	65%

5. Mixing Battery Technologies

- 5.1. There is no restriction on mixing various battery technologies in the same housing, so long as different types are not used in the same string. The only provision is that the same thermometers, syringes, and hydrometers are not used with the different types of batteries, otherwise the electrolytes will be neutralized when cross-contaminated between battery types.
- 5.2. CAUTION: Do not mix battery technologies when transporting batteries as they can spontaneously combust.

6. Memory Effect

- 6.1. None of the batteries approved for use on Metrolinx S&C systems are prone to any type of memory effect. Therefore, it is not necessary to perform any type of deep discharging which is often the case with other battery technologies used in the consumer market (such as with cell phones and portable computers). In fact, deep discharge cycles are detrimental to the health of the batteries and should only be done when necessary to test for capacity.

7. Equalizing Charge

- 7.1. Also referred to as a fast charge, an equalize charge is applied to batteries at the time of installation, when the state of charge has been depleted, or when the state of one or more cells in a string is degraded.
- 7.2. The circumstances and methods of applying an equalize charge differ for NiCad batteries than for lead acids (VRLA, FLA, SLA). These are described below.

Table 1402-04

Battery Type	Procedure
NiCad	<p>An equalize charge is applied to NiCads at the time of installation, whenever state of charge has been depleted due to an extended power failure, or when the discharge voltage of one or more cells in a string are more than .03V below the average cell discharge voltage.</p> <p>For constant current chargers, the equalize charge current should be set at 2A for every 10 AH of battery capacity, up to the maximum capacity of the charger. Thus a 320 AH string could be fast charged at 64A, however the charger current limit would normally be reached before that amount of current could be supplied.</p> <p>For constant voltage chargers, the equalize charge can be applied by setting the charger output to the next highest cell quantity.</p> <p>The time, in hours, that an equalize charge should be applied is calculated by:</p> $\text{Equalize Charge Time} = \frac{1.4 \times \text{Capacity}}{\text{Charge Current}}$ <p>The capacity is the rated capacity of the batteries in AH. The charge current (in Amps) is the applied charger current minus the normal load current.</p> <p>Battery electrolyte levels should always be checked before and immediately after performing an equalize charge cycle.</p> <p>It is always recommended that the manufacturer's manual be consulted when deciding on charge rates.</p>

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Battery Type	Procedure
Lead Acid (VRLA, FLA, SLA)	<p>An equalize charge is applied to the batteries at the time of installation, when stored for longer than 6 months, when the float voltage difference between any 2 cells in a string is greater than 0.10V, or when the discharge voltage on one or more cells in a string are more than .05V below the average cell discharge voltage.</p> <p>For constant voltage chargers, the equalize charge can be applied by setting the charger output to 2.30V per cell for 24 hours, or 2.35V per cell for 12 hours. For Flooded Lead Acid batteries, the electrolyte levels should always be checked before and immediately after performing an equalize charge cycle.</p>

8. Float Charge

- 8.1. After an equalize charge has been performed, the charger output should be reduced to maintain the battery at its rated charge voltage. This is known as a float charge. Constant current chargers should be set to charge at 2 mA per AH of battery capacity, so for example, a 320 AH string would require 0.64A of float charge (the charger must supply float charge plus load current). Constant voltage chargers are set to float by selecting the rated battery charge voltage, adjusted for temperature, which is normally done via a knob that selects the correct number of cells to charge.

9. Trickle Charge

- 9.1. A trickle charge is generally applied to batteries that are disconnected from any load and are being kept fully charged and ready for immediate use. The amount of charge applied is only enough to compensate for the battery's internal losses.

10. Battery Rated Voltages

- 10.1. This table summarizes the typical rated voltages, at 25°C (20°C for NiCads), for the various battery technologies in use on Metrolinx corridors.

- 10.2. There are many different brands of batteries in use by Metrolinx today. Consult manufacturer's service manuals for more detailed information.

Table 1402-05

Rated Voltages	NiCad	VRLA	SLA ¹	FLA ²
Charge Voltage	1.47 V	2.25 V	2.35 V	2.23 V
Start Discharge Voltage ¹	1.30 V	2.10 V	2.20 V	2.10 V
Final Discharge Voltage	1.00 V	1.75 V	1.75 V	1.70 V

¹SLA represents Sealed Lead Acid, such as Gates J-cells.

²FLA represents Flooded Lead Acid, such as Alcads.

- 10.3. Start Discharge voltage readings may vary and are measured with the charger off-line and the battery allowed to discharge with the load applied for 15 minutes.

11. Temperature Adjustment

- 11.1. Actual measured voltages will vary with temperature. The following table provides a guide for adjusting expected cell values.

Table 1402-06

Temperature Adjustment from Nominal °C	NiCad	VRLA	SLA	FLA
	-3.0 mV/°C from 20°C	-4.8 mV/°C from 25°C	-2.5 mV/°C from 25°C	-3.0 mV/°C from 25°C

- 11.2. For example, the expected cell charge voltage for a NiCad cell at block temperature 0°C (-20°C from nominal ambient) would be:

$$1.47V + (-3 \text{ mV} \times [0^\circ\text{C} - 20^\circ\text{C}]) = 1.47V + 60\text{mV} = 1.47V + .06V = 1.53V$$

- 11.3. As another example, the expected cell charge voltage for a VRLA cell at block temperature +30°C would be:

$$2.25V + (-4.8 \text{ mV} \times [30^\circ\text{C} - 25^\circ\text{C}]) = 2.25V - 24\text{mV} = 2.25V - .02V = 2.23V$$

- 11.4. It is important to remember that a battery has a high thermal mass, which means the block temperature will not vary much with daily variations in ambient temperature. Always try to measure the temperature of the battery itself when making temperature adjustments.

12. Specific Gravity

12.1. It is no longer recommended that Specific Gravity (S.G.) measurements be made, other than at time of installation. S.G. readings cannot be made for sealed batteries such as VRLA and SLA's. Readings should be adjusted for electrolyte temperature variances as described in this table.

Table 1402-07

Specific Gravity	NiCad	Flooded Lead Acid
S.G. @ nominal °C	1.245 @ 20°C	1.250 @ 25°C
± S.G. above/below ±°C	±0.001 / ±2.2°C	±0.001 / ±1.7°C

13. Specific Gravity Test

13.1. Follow the instructions in this table when testing the specific gravity of a battery.

Table 1402-08

Step	Action	
1	Check that electrolyte level is up to the maximum level.	
	If	Then
	Water is added to the electrolyte.	Specific gravity readings must not be taken for at least 24 hours to allow the water to properly mix into the solution.
	Electrolyte level is acceptable but not up to maximum level and tests are performed without the addition of water.	Subtract 0.010 from the temperature corrected specific gravity figure, for each 1/4 inch the electrolyte level is below the maximum level marker.
2	Measure the temperature of the electrolyte in the battery.	
3	Measure the specific gravity with a hydrometer.	
4	Calculate temperature and electrolyte level corrections.	
5	Contact the appropriate supervisory officer if the specific gravity is not within specified values.	

14. Battery Design Life

14.1. Design life varies for different battery technologies. For safety critical service involving crossing warning systems, batteries should be monitored more closely as they approach their design lives. The following table lists the design life for various battery/charger combinations used in Metrolinx.

Table 1402-09

Design Life for Batteries Used with Crossing Warning Systems				
Battery Type	Charger Type			
	CV-F	CV-E	CV-ET	CV-M
NiCad	25 years	25 years	25 years ¹	25 years ¹
VRLA ²	5 years ¹	7 years ¹	10 years	10 years
Flooded Lead Acid ²	10 years ¹	12 years ¹	15 years	15 years

¹This combination of battery/charger is no longer prescribed for new installations.

²It is recommended that the house be environmentally controlled in extreme climates.

14.2. Where charger type is (refer to charger section for more information):

- a) CV-F Constant Voltage - Ferroresonant
- b) CV-E Constant Voltage - Electronic
- c) CV-ET Constant Voltage - Electronic c/w temperature compensation
- d) CV-M Constant Voltage - Microprocessor c/w temperature compensation.

15. Load Capacity Test

15.1. For those batteries used with crossing warning systems that have reached their specified design life, an annual load capacity test is suggested to verify actual capacity. Instructions for performing and documenting this test are contained in [Form SCP-1205-B](#).

16.Chargers

- 16.1. Reliable chargers are critical to the longevity of batteries. In fact, the primary motivation for a regular battery inspection is to verify the charging state of the chargers.
- 16.2. There are many variations of chargers approved for use on Metrolinx corridors, which are explained in the following sections.

17. Temperature Compensation

- 17.1. Temperature compensation is used to enhance lead acid battery life in areas of continuous extreme temperatures, where the average daily temperature varies by more than $\pm 10^{\circ}\text{C}$ from 25°C for long periods of time. Temperature compensation must measure the battery's temperature and not ambient air temperature (the two can differ substantially). Temperature compensation is not recommended for Flooded NiCad batteries.

18. Constant Current Chargers

- 18.1. The constant current (CC) charger is no longer recommended, except where exceptional power circumstances, such as very long power runs over line wire, preclude the adoption of constant voltage chargers.
- 18.2. CC chargers have unregulated output voltages, which fluctuate with variations in input voltage as well as with output impedance. These conditions subject batteries to fluctuating float voltages, which can be detrimental to the longevity of the batteries, particularly lead acid types.
- 18.3. CC chargers should not be used with lead acid batteries (VRLA, FLA, SLA). Although the natural current limiting feature of CC chargers will prevent thermal runaway effect with these batteries, this benefit is more than offset by the life cycle degradation that will occur during those periods that the lead acid batteries are receiving too much charge current.

19.Constant Voltage Chargers

- 19.1. The three major categories of constant voltage (CV) chargers in use by Metrolinx are Ferroresonant, Electronic, and Microprocessor.
- 19.2. **Ferroresonant** chargers are effectively similar to constant current chargers, with the exception that an inductive capacitive circuit is added as a second winding on the power transformer. This provides reasonable load regulation, allowing a very robust charger at an economical price. However, these chargers suffer from poor load regulation with frequency variations, so they should be avoided at locations powered by Metrolinx generators. A Ferroresonant charger cannot be supplied with temperature compensation and are no longer designed into new crossing warning systems.
- 19.3. **Electronic** chargers usually refer to those that are equipped with SCRs and integrated circuits to provide additional regulation. These are higher priced than Ferroresonant chargers; however, they provide excellent output regulation and can be equipped with temperature compensation for lead acid type batteries. However, these can generate harmonics which can affect the quality of the power supply to the chargers, so they should use sparingly on long power distribution systems. Electronic chargers are a good middle of the road solution for most Metrolinx applications.
- 19.4. **Microprocessor** chargers are similar to electronic chargers, except they utilize microprocessors to perform some of the electronic functions, and they provide many intelligent features such as health monitoring, automatic equalizing, and enhanced temperature compensation. These units suffer the same harmonic generation problem as electronic chargers and can also be quite expensive.

20. Sizing Chargers

20.1. When sizing chargers, use the applicable formula:

$$C = (AH \div 62) + L \text{ (for Constant Current Chargers)}$$

$$C = (0.1 \times AH) + L \text{ (for Constant Voltage Chargers)}$$

Where: C is the current limit rating, in Amps, for the charger

AH is the ampere hour rating of the battery.

L is the continuous connected load, in Amps, on the battery.

21. Procedures for Deep Cycle Load Testing Batteries

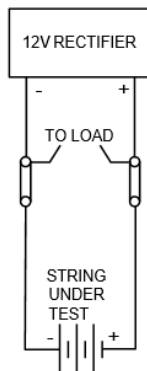
21.1. **Purpose:** To verify the State of Health of a battery.

21.2. **Duration:** Approximately 10 Hours at a typical location.

21.3. **Materials:** Temporary Monoblock battery, 4 x #6 AWG battery cables c/w suitable bolt on battery terminals & AREMA terminal eyes, load resistor, thermometer, multimeter c/w clamp-on current probe.

21.4. The following table outlines the steps to develop the battery test plan while the battery bank is connected to the load and charger as shown in Figure 1402-1.

Figure 1402-1



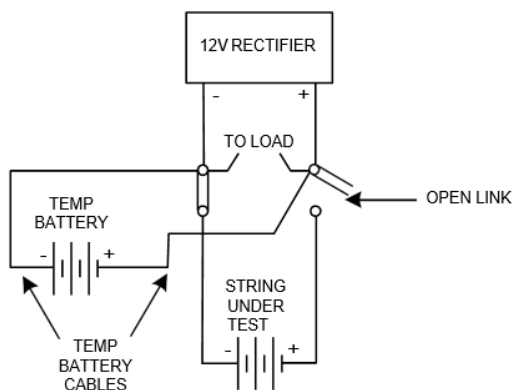
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Table 1402-10

Step	Action
1	Verify Voltage and A-Hr rating of battery to be tested. Calculate the battery end voltage as: the number of cells x 1.65 (VLRA); or the number of cells x 1.00 (NiCad).
2	Divide A-Hr rating by 8. This is the target discharge current to test the battery at.
3	Using Ohm's law, calculate the test load resistance as $R=V/I$, where V is the battery voltage and I is the target discharge current calculated in Step 2. Derate this resistance value by 80% to account for heating which will tend to increase the actual resistance.
4	Obtain a load resistor close to the derated value calculated in Step 3. Ensure it is rated to handle the power to be generated, where $P=V*I$, with V being the battery voltage, and I being the target discharge current.
5	Obtain a fully charged portable monoblock battery, rated at the same voltage as the battery to be tested, and proceed to site along with load resistor, battery cables, and multimeter.

21.5. The following table outlines the steps to prepare the site for test with the battery bank disconnected from the charger and load as shown in Figure 1402-2.

Figure 1402-2



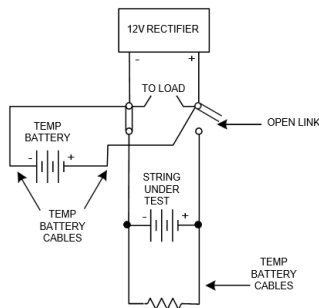
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Table 1402-11

Step	Action
1	Before beginning the test, ensure the battery under test is fully charged. Refer to GI-305(a) Inspecting and Testing Storage Batteries on procedures to verify the battery.
2	Ensure the crossing is deactivated per SCP-709 .
3	Open link connecting positive post of battery to load and charger.
4	Using battery cables, jumper the positive and negative electrodes of the temporary monoblock battery to the load and charger.
5	Ensure the temporary monoblock battery is being charged by the charger by measuring the charge voltage across its electrodes and verifying it is identical to the charger voltage.
6	Crossing can be re-activated per SCP-709 .

21.6. The following table outlines the steps to perform the test with the temporary battery cables connected to the battery bank as shown in Figure 1402-3.

Figure 1402-3



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Table 1402-12

Step	Action
1	Using the 2nd set of battery cables, connect the load resistor across the battery under test. Exercise caution as the load resistor will become very hot.
2	Record the battery temperature, voltage, individual cell voltages, current (using clamp-on probe), and start time of test on Form SCP-1205-B .
3	Continue to record the battery voltage, individual cell voltages, current and test time at 15 minute intervals.
4	Once the recorded battery voltage has reached the end voltage as calculated in development of the test plan, record the time as the test completion time.
5	Ensure the crossing is deactivated per SCP-709 .
6	Remove the load resistor from the battery under test, remove the temporary battery, and close the link between the battery under test and the load & charger. Remain at the location for at least 1 hour to allow the battery to recharge. In the event of a subsequent power outage, be prepared to re-insert the temporary battery, inject generator power, or flag the crossing.

1501 - Work on or Near Underground AC Power Distribution System

1. Purpose

- 1.1. Underground power distribution systems for S&C purposes consist of power cables directly buried in the earth on Metrolinx right-of-way and usually share a common trench with other S&C cables. Voltages in use for underground AC power systems range from low voltage (31-600 volts) systems to medium voltage (7.2-12.5 kV) systems.
- 1.2. These procedures cover work performed by qualified personnel on or near Metrolinx low voltage (600V), and near the medium voltage (7.2kV single phase, 12.5 kV three phase) underground AC circuits located on the Weston Subdivision. Higher voltage systems are not covered in these procedures.

2. Definitions

- 2.1. **AC Power Circuit:** A circuit used to transmit a supply of electrical energy for railway signaling and communication purposes. AC power circuits operate at voltages not exceeding 600 volts between conductors in most installations.
- 2.2. **Common Trench:** The burying of AC power and signal control or communication wires and cables in the same trench.
- 2.3. **Control Device:** A circuit breaker, switch, or other suitable device that will safely disconnect an electrical facility from its source of supply. The safe position of a circuit breaker or switch is with the operating handle secured in the "OFF" position. Padlock attachment devices are required to lock circuit breakers in the "OFF" position.
- 2.4. **De-activate:** The act of separating or disconnecting AC power circuits and apparatus from their source of supply.

- 2.5. **De-energize:** The act of isolating and grounding AC power circuits and apparatus. For protection purposes, a de-energized circuit shall always be properly isolated, grounded, tested, tagged and secured. De-energized circuits are safe to work around or directly on.
- 2.6. **Excavation:** Any opening made in the ground such as holes, trenches, ditches or tunnels.
- 2.7. **Exposed:** Not insulated or guarded.
- 2.8. **Grounded:** Connected effectually with the general mass of the earth through a grounding path of sufficiently low impedance and having an ampacity sufficient at all times, under the most severe conditions which are liable to arise in practice, to prevent any current in the grounding conductor from causing a harmful voltage to exist:
- a) Between the grounding conductors and neighbouring exposed conducting surfaces which are in good contact with the earth; or
 - b) Between the grounding conductors and neighbouring surfaces of the earth itself.
- 2.9. **Isolate:** The act of separating or disconnecting AC power circuits and apparatus from their source of supply, by approved devices or procedures.
- 2.10. **Live:** Electrically connected to a source of potential difference, or electrically charged so as to have a potential difference from that of the ground.
- 2.11. **Low Voltage:** Any voltage from 31 to 600 V inclusive.
- 2.12. **Medium Voltage:** Any voltage from 601 V to 15 kV inclusive.
- 2.13. **OTO:** "Order to Operate" - A prescribed form for describing, in a step-by-step fashion, the exact sequence of operations required to isolate, de-energize, or re-energize a cable. The OTO form shall be used in connection with the performance of all operations requiring the opening or closing of such apparatus as circuit breakers, isolating devices, grounding devices, and valves.

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- 2.14. **Qualified Person:** A person who, because of his knowledge, training and experience, is qualified to perform a specified job safely and properly.
- 2.15. **Shall, Must:** When the words "shall" or "must" appear in the wording of a rule, the rule is to be obeyed as written.
- 2.16. **Should:** When the word "should" appear in the wording of a rule, the rule is to be obeyed as written when it is reasonable or practical to do so.
- 2.17. **Job Briefing/Tailboard Talk:** To be held with all qualified persons involved in isolating, de-energizing, or re-energizing procedures. The tailboard must include all procedures required to isolate, de-energize, or re-energize the cable, which must be formalized on the Order to Operate (OTO) forms.
- 2.18. **Working "Around" Cable:** Performing work in the vicinity¹ of cable or apparatus whereby no direct contact with exposed elements is expected. Examples include working on bridge troughing, replacing culverts, and during the operation of a ballast spreader. In these cases the cable must be de-energized.
- 2.19. **Working "On" Cable:** Performing work in the vicinity¹ of cable or apparatus whereby direct contact with exposed elements may be anticipated. Examples include exposing cut cable, splicing cable, and during the cleanup of derailments. In these cases the cable must be de-energized.
- a) ¹"In the vicinity" is taken to mean working near un-insulated cable or apparatus within the limits of approach, or when excavating within 3 feet of insulated cable or apparatus.

3. Underground Power Systems

- 3.1. Underground power systems have a number of disadvantages over overhead systems; these are:
 - a) Confined working spaces.
 - b) Closer clearances between live parts.
 - c) Greater exposure to grounded surfaces.
- 3.2. If protective equipment is not used, direct contact with the ground, or grounded equipment could complete the loop of an electrical circuit and serious injury or death could result.

4. Qualified Persons

- 4.1. Personnel required to work on underground power distribution systems shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards, and all work shall be authorized by the Metrolinx designated Supervisor. The necessary qualifications are identified in [SCP-1507 Qualifications and Certification for Maintenance of Underground Power Systems](#).

5. Applicability to Contractors

- 5.1. All requirements identified herein are applicable to outside contractors performing work on behalf of Metrolinx; on Metrolinx low voltage and near medium voltage underground AC power circuits.

6. Apparatus To Be Treated As Live

- 6.1. All wires and cables shall be considered live at all times, unless personnel have positive knowledge to the contrary.
- 6.2. Before commencing work, personnel shall ascertain the operating voltage in cables and other nearby conductors and equipment.

7. Signal Control and Communication Circuits

- 7.1. Signal control and communication circuits and apparatus are normally not considered live. They may, however, be a source of danger when near live power circuits due to the effects of electromagnetic or electrostatic induction. They may also be a source of danger when energized by accidental contact with live power conductors. Exercise caution when working around these circuits and apparatus when in proximity to underground power circuits.

8. When to Isolate or De-energize

- 8.1. The decision to isolate or de-energize underground power circuits for work safety should be based on criteria defined in [SCP-1508 Protection Requirements for MOW Activities](#).
- a) Refer to [SCP-1502 Isolating, De-Energizing and Re-Energizing Low Voltage Underground Power Distribution System](#) when isolating, de-energizing and re-energizing Low Voltage Underground Power Distribution Systems (600V).
 - b) Refer to [SCP-1503 Isolating, De-Energizing and Re-Energizing Medium Voltage Underground Power Distribution System](#) when isolating, de-energizing and re-energizing Medium Voltage Underground Power Distribution Systems (7.2 kV) is required.

9. Power Method of Procedures (PMOP)

- 9.1. A Power Method of Procedure (PMOP) shall be developed for certain situations as prescribed in [SCP-1508 Protection Requirements for MOW Activities](#). The PMOP shall be developed by the Supervisory Officer responsible for the work, in conjunction with the Supervisory Officer responsible for the corridor. Prior to execution, the PMOP shall be reviewed by Metrolinx. The PMOP shall contain, as a minimum, the following information:
- a) Limits of proposed work (subdivision and mileage points).

- b) Date, time, and duration.
 - c) Identity of S&C person (Foreman in charge) and Supervisor including emergency contact information, i.e. phone number(s).
 - d) Risk assessment.
 - e) Detailed explanation of protective measures to ensure safe operations.
 - f) Detailed explanation of emergency restoration procedures.
 - g) Contingency plan (description, location, and availability of temporary by-pass cable, splicing kits, additional personnel and standby contractors).
- 9.2. A copy of the PMOP should also be provided to Metrolinx S&C for informational purposes. The completed PMOP should be submitted to all parties at least 14 days in advance of the planned work.
- 9.3. IMPORTANT: The qualified person responsible for the protection shall inform all affected personnel and outside contractors involved in the planned work and ensure that they fully understand the work procedures described in the PMOP.

10. Safe Working Distances – Exposed Conductors & Apparatus

- 10.1. The safe working distances from exposed live conductors and apparatus are known as the safe limits of approach. These will vary, depending on personnel qualifications, and type of equipment near the exposed conductors and apparatus. These distances are valid for low and medium voltage systems.
- 10.2. Personnel shall not approach, work, or allow any conductive material or equipment to within the safe working distances of exposed live conductors and apparatus unless the work is being done in accordance with these Codes of Practice.

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- a) Careful consideration shall be given to the work location, weather conditions, job to be done, job method, materials and tools to be used, and the length of time required to work within the safe working distance.
- b) Any conductive objects brought closer than the safe working distance shall be treated as energized at the same voltage as the circuit and apparatus to which it is exposed.

10.3. The following table defines the safe limits of approach when working around exposed live conductors and apparatus. Note that a qualified person must be appointed to act as a dedicated observer whenever equipment approaches these distances.

Table 1501-01

Application	Safe Limits of Approach (Minimum Distance from Exposed)
Qualified Personnel	0.3 m (1 ft)
General Personnel	3.0 m (10 ft)
Heavy Equipment	3.0 m (10 ft)

11. Safe Working Distances – Insulated Conductors

- 11.1. In no cases shall mechanical excavating equipment be allowed to approach to within 0.9 m (3 ft) of live insulated conductors¹. Use the following table when deciding whether to isolate and expose the cable.
- 11.2. NOTE: This is not referencing the Limits of Approach, since in this case the conductors are insulated.

Table 1501-02

If the mechanical excavation...	Then...
Can be guaranteed to stay outside 0.9 m (3 ft) of live insulated conductors.	Proceed with caution.
Will approach to within 0.9 m (3 ft) of live insulated conductors ¹ .	De-energize the cable ¹ . Use a vac truck or hand dig to expose the cable at the point of excavation.
May or may not stay outside 0.9 m (3 ft) of live insulated conductors due to uncertainty of cable depth or quality of cable locate.	Use a vac truck or hand dig ² to expose the cable. De-energize if deemed necessary, depending on the nature and proximity of the excavation.

¹ There may be exceptional situations when this requirement may be relaxed, however this requires that a PMOP be developed, approved by Metrolinx or Designate clearly outlining how the risks are to be mitigated. If in doubt, the safe course must be taken.

² Use of hand digging tools on medium voltage cable will require the system to be de-energized by qualified contractor.

12. Lightning in the Work Vicinity

12.1. Work on underground AC power circuits and apparatus shall not be performed while an electrical storm is within the vicinity of the cable system. Take precautions if thunder can be heard.

13. Work in Tunnels

13.1. Special care shall be taken as a result of insulation being less effective due to dampness, and extra precautions shall be taken to avoid contact with exposed live AC power circuits/apparatus where illumination may be poor and space may be restricted.

14. Working Positions

14.1. Personnel shall avoid working from any position in which inadvertent movement will tend to bring the body or material being handled towards exposed live AC power circuits and apparatus.

15. Trouble Work Sequencing

- 15.1. No other work should be conducted at a trouble location until the power circuits have been properly protected.

16. Protective Equipment

- 16.1. Personnel shall use the personal protective equipment, and the protective devices provided for their work.
- 16.2. In addition to the protective equipment required by Metrolinx's PPE policy, the following is essential when working with underground low power AC circuits:
- a) Insulating rubber gloves and covers.
 - b) Do No Operate tags.
- 16.3. On the Weston Subdivision where medium power AC circuits are present, the Qualified contractor must direct their employees to follow appropriate use of Gloves and all hot-line tools as appropriate.
- 16.4. Gloves must be carefully inspected, clean and in good order before being used and must be cared for as outlined in [SCP-1505 In-service Use, Care, Inspection, and Testing of Safety Equipment](#).

17. Working with Rubber Insulating Gloves

- 17.1. When rubber insulating gloves (rated at the appropriate voltage class) are used for work protection, under no circumstances shall parts of the body, other than those parts which are protected by rubber gloves, encroach nearer than the safe working distance from exposed live AC power circuits and apparatus. Never perform direct hands-on work with exposed medium voltage apparatus.

18. Clothing

- 18.1. Clothing (preferably of flame resistant material such as Nomex®) with full length sleeves rolled down and fastened at the wrists shall be worn when working on or near exposed live AC power circuits and apparatus.

- 18.2. Metal articles such as keys, watch chains, rings, wrist watches, or bands, shall not be worn while working near exposed AC power circuits and apparatus.

19. Warning Tags (Do Not Operate Tags)

- 19.1. Removing warning tags from control devices such as breakers and switches, without proper authority, is *strictly prohibited*.
- 19.2. Operating any control devices such as breakers and switches bearing a warning tag is *strictly prohibited*.

20. Opening Enclosures

- 20.1. When any compartment, enclosure or pedestal containing exposed live AC power circuits and apparatus is opened, it shall be directly attended by an employee, otherwise it shall be kept closed and locked at all times.

21. Voltage Tests

- a) Rubber gloves shall be worn while attaching/detaching meter leads when taking voltage tests greater than 250V RMS on AC power circuits/apparatus.
- b) All equipment used for voltage tests shall be rated at the proper voltage level.

22. Operating Control Devices

- a) Operating handles of control devices shall be either opened or closed with a firm deliberate motion.
- b) Stand clear of the device when switching control devices.
- c) When operating control devices, ensure that all protective covers are in place and all doors are securely closed.
- d) Control devices shall be visually checked to ensure that all contacts have been safely separated.

23. Handling Cable Reels

- a) Cable reels shall be securely blocked so they cannot roll accidentally.
- b) Care should be exercised when loading/unloading cable reels to avoid possible injury in case unexpected movement of the reel occurs.
- c) Cable reels should not be left on grades if it can be avoided.
- d) Care should be exercised when turning reels with bars so as not to press against the cable or wire.
- e) Cable reels shall not be rolled over rocks or other projecting objects that are likely to damage the cable.

24. Excavations

- 24.1. Refer to [SCP-1005 Protection Instructions to Excavators for S&C Infrastructure](#) when it is necessary to excavate around underground AC power cables.

25. Derailments or Other Accidents

- 25.1. In cases of derailments or other accidents, AC power circuits and apparatus in the affected area shall be de-energized on both sides of the derailment as soon as possible by qualified personnel.
- 25.2. When AC power circuits and apparatus have been de-energized, the route of the circuit in the affected area shall be patrolled for detection of obvious hazards before the circuit is re-energized.
- 25.3. All conductors shall have safety grounds removed, and then they shall be meggered, prior to re-energizing.
- 25.4. AC power circuits and apparatus shall only be re-energized by qualified personnel.

26. Proceeding with Work

26.1. When working with isolated or de-energized circuits and apparatus, care must be taken to guard against adjacent exposed live AC power circuits and apparatus.

27. Cable Repairs

- a) Where multiple cables exist in an excavation, cables other than the target cable shall be mechanically protected.
- b) If the target cable cannot be determined by visual inspection, it shall be identified by electrical means. Rubber gloves shall be worn while examining the markings and outside structure of the cables during the visual inspection.
- c) Before cutting a medium voltage cable, a spiking operation shall be performed to positively identify the cable. Before opening the metallic cable sheath, place a temporary bond across the area to be opened to minimize potential differences.

28. Completion of Work

28.1. Upon completion of the work on isolated or de-energized circuits/apparatus, personnel shall withdraw from the circuits/apparatus and report clear to employee responsible for and in charge of the work.

1502 - Isolating, De-energizing and Re-energizing Low Voltage Underground Power Distribution System

1. Purpose

- 1.1. These Codes of Practice describe the procedures to be followed when it is necessary to isolate, de-energize, or re-energize any portion or section of low voltage (600 V) underground AC power circuits. All procedures described in [SCP-1501 Work on or Near Underground AC Power Distribution System](#) must always be adhered to when performing any work on underground power systems.
- 1.2. NOTE: The procedures for isolating, de-energizing, and re-energizing the medium voltage systems, shall be more restrictive than those outlined in this document and are addressed in [SCP-1503 Isolating, De-Energizing and Re-Energizing Medium Voltage Underground Power Distribution System](#).

2. Qualified Person

- 2.1. Personnel required working on underground power distribution systems shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards, and all work shall be authorized by the immediate supervisor. The necessary qualifications are identified in [SCP- 1507 Qualifications and Certification for Maintenance of Underground Power Systems](#).

3. Clearance Procedures/ Order to Operate

- 3.1. If there is any risk that the qualified person performing protecting duties on any buried 600V system may become physically separated from any personnel working on or around the system, then the formal clearance procedures identified in [SCP-1506 Procedures for Power Clearance](#) should be followed.
- 3.2. Instances where this may arise include:
 - a) When a major MOW work program requires that excavating procedures be performed over a wide area by large work gangs, such as with an under cutter operation;
 - b) When the duration of the outage is likely to require a shift change of the qualified person performing protecting duties, such as with a derailment;
 - c) When outside contractors are brought in to complete repairs of the system, and the qualified person performing protecting duties is subject to carry out other S&C work.
- 3.3. It is not necessary to follow the Clearance and OTO procedures described in [SCP-1506 Procedures for Power Clearance](#) when maintenance work is to be performed on the system by a lone qualified person, or work team working in close proximity, so long as no other separated maintenance personnel are advised that the system is being isolated or de-energized.
- 3.4. Whether or not the clearance procedures in [SCP-1506 Procedures for Power Clearance](#) are required, it is mandatory that DO NOT OPERATE tags be used on all control devices that are operated during the isolating or de-energizing procedures.

4. Work on Live Underground AC Power

- 4.1. Work on exposed LIVE underground AC power circuits/apparatus is prohibited.

- 4.2. EXCEPTION: This shall not preclude a qualified person from opening any compartment, enclosure or pedestal where exposed live AC power circuits/apparatus are in service, for the purpose of inspection, housekeeping, taking readings, or similar work, if such work can be performed safely.

5. Mobile/ Standby Generators

- 5.1. The use of mobile or standby generators is not permitted on isolated or de-energized AC power circuits. Only circuits designated as de-activated can be injected with generator power.

6. Job Briefing/ Tailboard Talk

- 6.1. If applicable, conduct a main job briefing with all parties engaged in the isolation/de-energization, including MOW personnel requiring protection to ensure there is a thorough understanding of the clearance procedures and limits of protection.
- 6.2. Conduct a secondary job briefing, referred to as a "tailboard" talk with all qualified personnel involved in the isolating, de-energizing, or re-energizing procedures.
- a) Verify all crew members have appropriate training and certification.
 - b) Inspect all equipment.
 - c) Confirm that all drawings and manuals are available and up to date.
 - d) Confirm the system is low voltage (600V).
 - e) Review the portion of the cable to be isolated/de-energized.
 - f) If applicable, generate and review the "Order to Operate" (OTO) detailing the sequence of operations to physically isolate or de-energizes the line.
 - g) Ensure there is a thorough understanding of the responsibilities each party has in the performance of work.

7. Isolating Circuits and Apparatus

- 7.1. AC power circuits/apparatus shall be isolated by either of the following means:
- a) At its source of supply by opening a provided disconnecting device, or;
 - b) At any location where the conductor can be removed from the source of power.
- 7.2. AC power circuits/apparatus shall be isolated at the closest possible isolation point from the work location.
- 7.3. Isolation shall be in accordance with the following procedures:
- a) Contact the affected RTC control office and advise that power will be disrupted over the length of the section to be isolated, and obtain a Service Center ticket.
 - b) If applicable, ensure all personnel performing the isolation are in possession of a copy of the OTO.
 - c) Control devices shall be placed in the appropriate position to afford protection and, unless within sight of the apparatus to be isolated, shall be locked or rendered inoperable.
 - d) Control devices shall be tagged with a DO NOT OPERATE tag, unless only these devices will be worked directly on. The tag shall show the date, time and the name of the person operating the control device.
 - e) If applicable, generate a power clearance form.
 - f) Notify affected parties that the cable has been isolated and tagged.

8. De-energizing Circuits and Apparatus

- 8.1. AC power circuits/apparatus shall be de-energized by either of the following means:

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- a) At its source of supply by opening a provided disconnecting device, and bonding the conductors to an approved ground point and then voltage tested to ensure that there remains no residual charge, or;
 - b) At any location where the conductor can be removed from the source of power and bonded to an approved ground point and then voltage tested to ensure that there remains no residual charge.
- 8.2. AC power circuits/apparatus shall be de-energized at the closest possible isolation point from the work location.
- 8.3. De-energizing shall be in accordance with the following procedures:
- a) Contact the affected RTC control office and advise that power will be disrupted over the length of the section to be de-energized, and obtain a Service Center ticket.
 - b) If applicable, ensure all personnel performing the de-energizing are in possession of a copy of the OTO.
 - c) Control devices shall be placed in the appropriate position to afford protection and, unless within sight of the apparatus to be de-energized, shall be locked or rendered inoperable.
 - d) Control devices shall be tagged with a DO NOT OPERATE tag, unless only these devices will be worked directly on. The tag shall show the date, time and the name of the person operating the control device.
 - e) All conductors, including the neutral, shall be short circuited together and grounded to an approved ground point.
 - f) Voltages test the conductors to ensure there is no residual charge.
 - g) If applicable, generate a power clearance form.
 - h) Notify affected parties that the cable has been de-energized and tagged.

9. Approved Ground Point

- 9.1. An approved ground point, also known as a “Point of Safety Ground” consists of a grounding bus, a grounding network, a multi-grounded neutral, a metal pole structure, or an aerial ground or static wire.
- 9.2. A ground rod at the base of a pole, which is not part of the common grounding system, is not an approved ground point, since the integrity of ground rod could be suspect on account of the age of the installation.
- 9.3. Where an approved ground point is not readily available, either of the following can be used:
 - a) a driven ground rod consisting of an approved metal rod (not screw type) driven normally 6 feet (but not less than 3 feet) into compact earth (not backfill), or;
 - b) a ground plate buried at least 3 feet below grade.
- 9.4. The location of the rod/plate shall be chosen so that it will provide the best ground possible at a minimum distance of 15 feet (preferably 30 feet) from the base of the structure or area where the ground workers must work and in a direction away from the main work area. Precautions shall be taken to prevent unauthorized touching of the driven ground rod.

10. Ground Point Construction

- 10.1. All connections to the approved ground point shall be constructed of mechanical clamps and conductors equivalent to #2 AWG flexible copper cables. All connections shall be clamped, welded, or compressed.

11. Re-energizing Circuits and Apparatus

- 11.1. Before proceeding, communicate to all affected personnel that the system will be re-energized. Verify that all personnel and equipment are free and clear.
- 11.2. If applicable, return (cancel) the appropriate clearance.

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- 11.3. Conduct another "Tailboard" talk to review procedures and if applicable, generate an "Order to Operate" (OTO) detailing the sequence of operations to physically re-energize the line.
- 11.4. All personnel shall stand clear from the vicinity of the re-energized circuit and apparatus for protection purposes.
- 11.5. DO NOT OPERATE tags shall be removed from all points of isolation. Only remove DO NOT OPERATE tags that are:
 - a) Clearly identified to be removed on the OTO, if applicable, or
 - b) Labeled with the name of the person removing the tag.
- 11.6. IMPORTANT: It is prohibited to remove a DO NOT OPERATE tag that bears someone else's name, unless that tag has been identified on the OTO as having to be removed.
 - a) Once all DO NOT OPERATE tags have been removed, the safety ground shall be removed (if applicable) and the control devices shall be closed to re-energize circuits and apparatus.
 - b) Contact the affected RTC, close the Service Center ticket, and verify power has been restored at all sites.

1503 - Isolating, De-energizing and Re-energizing Medium Voltage Underground Power Distribution System

1. Purpose

- 1.1. This practice describes the requirements for coordinating of isolating, de-energizing, and re-energizing a medium voltage underground power distribution system. All procedures described in [SCP-1501 Work on or Near Underground AC Power Distribution System](#) must also be adhered to when performing any work prescribed herein.

2. Definitions

- 2.1. **Isolate:** The act of separating or disconnecting AC power circuits and Apparatus from their source of supply, by approved devices or procedures.
- 2.2. **De-energize:** The act of isolating and rounding AC power circuits and apparatus. For protection purposes, a de-energized circuit shall always be properly isolated, tested, grounded, tagged and secured. De-energized circuits are safe to work around or directly on.
- 2.3. **Re-energize:** The act of reconnecting AC power circuits and apparatus to their source of supply.

3. Qualified Persons

- 3.1. Personnel required to work on an electric apparatus or equipment shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards, and then, only when authorized by the responsible Supervisory Officer. The necessary qualifications are identified in [SCP-1507 Qualifications and Certification for Maintenance of Underground Power Systems](#).
- 3.2. If any fault conditions are noted during any of these procedures, immediately cease procedures and escalate to a qualified Powerline Maintainer.

4. Clearance Procedures/ Order to Operate (OTO)

- 4.1. When isolating or de-energizing underground AC power circuits for work safety, the power clearance procedures identified in [SCP-1506 Procedures for Power Clearance](#) shall be followed. These procedures include generating applicable power Clearance and Order to Operate (OTO) form(s).

5. Applicability of Procedures

- 5.1. These procedures are applicable for work on the medium voltage (7.2 kV single phase, 12.5 kV three phase) underground signal power circuits, and are not intended to cover work on or near any other underground power systems.

6. Section I: Isolating Power Systems

6.1. Purpose

- 6.1.1. A section of the power system should be isolated when:
- a) It is deemed necessary for work safety based on criteria defined in [SCP-1508 Protection Requirements for MOW Activities](#).
- 6.1.2. NOTE: Medium voltage systems are to be de-energized for any work on or around the power system. Refer to Section II.

6.2. Methods

- 6.2.1. Isolation can be performed by means of:
- a) Opening the load break switch at the feed end of the system, or;
 - b) Removing and parking the load break elbow of a drop transformer at the point where the system is to be isolated.

- 6.2.2. NOTE: Single phase systems may be isolated under load, by personnel qualified with Level II training. The methods described herein are for general guidelines only – the actual sequence of operations to be followed must be defined in the “Order to Operate” (OTO).

6.3. Equipment

- 6.3.1. In addition to the standard PPE safety equipment required by Metrolinx this operation requires the qualified contractor to use the appropriate safety equipment to perform these tasks.

6.4. Job Briefing

- 6.4.1. Conduct a main job briefing with all parties engaged in the isolation, including MOW personnel requiring protection (if applicable), to ensure there is a thorough understanding of the clearance procedures and limits of protection. If applicable, review the PMOP.
- 6.4.2. It's required that the contractor shall conduct a secondary job briefing, referred to as a “tailboard” talk with all qualified personnel involved in the isolating procedures.
- a) Verify all crew members have appropriate training and certification.
 - b) Inspect all equipment.
 - c) Confirm that all drawings and manuals are available and up to date.
 - d) Review the portion of the cable to be isolated.
 - e) Confirm the system is single phase.
 - f) Identify the mileage of the transformer to be used as the isolation point, if applicable.
 - g) Generate and review the “Order to Operate” (OTO) detailing the sequence of operations to physically isolate the line.

- h) Ensure there is a thorough understanding of the responsibilities each party has in the performance of work.

6.5. Generate Service Center Ticket

- 6.5.1. Contact Metrolinx and advise that the specific section of cable will be isolated, and obtain a Service Center ticket.

6.6. Generate Power Clearance

- 6.6.1. Generate a power clearance form and notify affected parties that the cable has been isolated and tagged. It is now safe to go to work around the isolated section within the limits of the clearance.

7. Section II: De-Energizing Power System

7.1. Purpose

- 7.1.1. A section of the power system should be de-energized when:
 - a) Work is required on or around the power system, or;
 - b) It is deemed necessary for work safety based on criteria defined in SCP-1508 Protection Requirements for MOW Activities.

7.2. Methods

- 7.2.1. De-energization can be performed by means of:
 - a) Opening the load break switch and grounding at the feed end of the system, or;
 - b) Removing and grounding the load break elbow of a drop transformer at the point where the system is to be de-energized.

- 7.2.2. NOTE: Single phase systems may be de-energized under load, by personnel qualified with Level II training. The methods described herein are for general guidelines only - the actual sequence of operations to be followed must be defined in the "Order to Operate" (OTO).

7.3. Equipment

- 7.3.1. In addition to the standard PPE safety equipment required by Metrolinx this operation requires the qualified contractor to use the appropriate safety equipment to perform these tasks.

7.4. Job Briefing

- 7.4.1. Conduct a main job briefing with all parties engaged in the de-energizing, including MOW personnel requiring protection (if applicable), to ensure there is a thorough understanding of the clearance procedures and limits of protection. If applicable, review the PMOP.
- 7.4.2. It is required that the contractor conduct a secondary job briefing, referred to as a "tailboard" talk with all qualified personnel involved in the de-energizing procedures.
- a) Verify all crew members have appropriate training and certification.
 - b) Inspect all equipment.
 - c) Confirm that all drawings and manuals are available and up to date.
 - d) Review the portion of the cable to be de-energized.
 - e) Confirm the system is single phase.
 - f) Identify the mileage of the transformer to be used as the de-energizing point, if applicable.
 - g) Generate and review the "Order to Operate" (OTO) detailing the sequence of operations to physically de-energize the line.

- h) Ensure there is a thorough understanding of the responsibilities each party has in the performance of work.

7.5. Generate Service Center Ticket

- 7.5.1. Contact Metrolinx and advise that the specific section of cable will be de-energized, and obtain a Service Center ticket.

7.6. Generate Power Clearance

- 7.6.1. Generate a power clearance form and notify affected parties that the cable has been de-energized and tagged. It is now safe to go to work on the de-energized section within the limits of the clearance.

8. Section III: Re-Energizing Power Systems

8.1. Purpose

- 8.1.1. The system must be re-energized upon completion of the work which necessitated isolation or de-energization as described in Sections I & II.

8.2. Methods

- 8.2.1. The method of re-energization will depend on how the system was isolated/de-energized:
 - a) Closing the load break switch at the feed end of the system, or;
 - b) Restoring the drop transformer at the point where the system was isolated/de-energized.
- 8.2.2. NOTE: Single phase systems may be re-energized under load, by personnel qualified with Level II training. The methods described herein are for general guidelines only – the actual sequence of operations to be followed must be defined in the “Order to Operate” (OTO).

8.3. Equipment

- 8.3.1. In addition to the standard PPE safety equipment required by Metrolinx this operation requires the qualified contractor to use the appropriate safety equipment to perform these tasks:

8.4. Prepare OTO

- 8.4.1. Conduct another “Tailboard” talk to review procedures and generate the “Order to Operate” (OTO) detailing the sequence of operations to physically re-energize the line.

8.5. Return Clearance

- 8.5.1. Communicate to all affected personnel that the system will be re-energized. Verify that all personnel and equipment are free and clear, then return (cancel) the appropriate clearance.

8.6. Notification

- 8.6.1. Notify Metrolinx that the section of cable has been re-energized, close the Service Center ticket, and verify power has been restored at all sites.

1504 - Injecting Generator Power – Low Voltage Underground Power Distribution System

1. Purpose

- 1.1. This Codes of Practice describes the approved methods of injecting generator power to provide emergency standby power on low voltage underground power distribution systems (120 -600V).

2. Qualified Person

- 2.1. Personnel required working on underground power distribution systems shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards, and all work shall be authorized by the responsible Supervisory Officer and Metrolinx. The necessary qualifications are identified in [SCP-1507 Qualifications and Certification for Maintenance of Underground Power Systems](#).

3. Communication

- 3.1. It is critical that all parties working on a section of cable are in constant communication, to ensure that no active power clearances exist on any portion of a cable to be injected with generator power.

4. Order to Operate (OTO)

- 4.1. When performing work as required injecting generator power, an Order to Operate (OTO) form must be generated for each location where work is being performed, as described [SCP-1506 Procedures for Power Clearance](#).

5. De-Activating Power System

- 5.1. Generator power shall never be injected into a live section of cable. The section of cable must be deactivated before generator power can be injected into it, which requires that the circuits and apparatus be physically separated or disconnected from their source of supply.

6. Back feeding

- 6.1. Feeding generator power in the direction opposite that of normal feed direction is prohibited..

7. Generator Sizing

- 7.1. Generator sizing is not necessarily proportional to the size of the territory being protected, and may appear counter-intuitive.
- 7.2. IMPORTANT: Generators that are insufficiently sized in relation to the cable reactance will tend to become self-excited and may generate higher than rated voltages which can severely damage equipment fed by the system.

8. Equipment

- 8.1. In addition to the standard PPE safety equipment required by Metrolinx these operations may require the qualified contractor to use the appropriate safety equipment to perform these tasks.

9. Job Briefing

- 9.1. Conduct a main job briefing with all parties engaged in the injection, to ensure there is a thorough understanding of the injection procedures.
 - a) Verify all crew members have appropriate training and certification.
 - b) Inspect all equipment.
 - c) Confirm that all drawings and manuals are available and up to date.
 - d) Review the portion of the cable to be injected.

- e) Confirm there are no active power clearances on any portion of the cable to be injected.
- f) Confirm if the system is single phase or three phases.
- g) Identify the mileage of the location to be used as the injection point.
- h) Generate and review the "Order to Operate" (OTO) detailing the sequence of operations to physically de-activate the line and connect the generator.
- i) Ensure there is a thorough understanding of the responsibilities each party has in the performance of work.

10. Injection Methods

10.1. There are too many methods of injection to document them all within the scope of this document, due to the many scenarios which may arise for which injection is required. However, in all cases, the following general guidelines shall be adhered to:

- a) *Never* use a single phase generator to inject into a 3 phase system.
- b) *Never* use a 3 phase generator to inject into a single phase system.
- c) Always verify the generator is appropriately sized, is of the correct voltage and phase ratings, and is equipped with the necessary connecting cables.
- d) Always ground the generator to the cable system ground.
- e) Document all procedures on an OTO prior to commencing.
- f) Always apply "DO NOT OPERATE" tags on any equipment which must be operated during the injection procedures. These can only be removed when the OTO to remove the injected power is executed.

- g) Do not allow any power clearances to be issued over any section of cable being injected.

11. Scenario 1A - Connection to Bungalow Generator Plug

- a) Verify the generator is properly sized.
- b) Ensure there are no lock-out tags on any equipment to be operated.
- c) Open utility feed breaker and apply "DO NOT OPERATE" tag, include qualified person's name on tag, apply lock in case there are no mechanical interlocked breaker installed between generator breaker and the utility breaker at the load center.
- d) In case of the interlocked breaker installed at load center, slide the mechanical lock bar that trips the utility breaker and allow generator breaker to be set ON.
- e) Install grounding jumper from generator to bungalow ground.
- f) Connect generator cable male connector to the bungalow female plug.
- g) Start generator.
- h) Measure the generator output and verify the voltage is within 10% of 120/240V.
- i) Turn on the Generator breaker on the load center.

12. Scenario 1B - Disconnection from Bungalow Generator Plug

- a) Open the generator breaker at the load center and remove lock and "DO NOT OPERATE" tag from the utility feed breaker, in the case where there are no mechanical interlock is installed between the generator and utility main breaker.

- b) In case of the interlocked breaker installed at load center, slide the mechanical lock bar that trips the generator breaker and allow Utility main breaker to be set ON.
- c) Shutdown the generator set.
- d) Disconnect the generator cable plug from the bungalow.
- e) Remove grounding jumper from generator to step-up transformer ground.
- f) Close the utility breaker.
- g) Measure the utility incoming voltage verify the voltage is within 10% of 120/240V.

13. Scenario 2A - Connection Single Phase 120/240V Utility Service

- a) Verify the generator is properly sized.
- b) Ensure there are no lock-out tags on any equipment to be operated.
- c) Open utility feed breaker and apply "DO NOT OPERATE" tag, include qualified person's name on tag, apply lock.
- d) Install grounding jumper from generator to step-up transformer ground.
- e) Disconnect down rail feeder from step-up transformer.
- f) Install feed-thru junction between down rail feeder and generator cable.
- g) Connect generator cable to high voltage connection of the generator step-up transformer.
- h) Start generator.
- i) Measure the generator output and verify the voltage is within 10% of 120/240V.

14. Scenario 2B - Disconnection Single Phase 120/240V Utility Service

- a) Shutdown the generator set.
- b) Disconnect the generator cable at the high voltage connection of the generator step-up transformer.
- c) Remove feed-thru junction between down rail feeder and generator cable.
- d) Reconnect down rail feeder to utility step-up transformer.
- e) Remove grounding jumper from generator to step-up transformer ground.
- f) Check grounds are intact on each line of the 120/240 volt service.
- g) Remove lock and "DO NOT OPERATE" tag from the utility feed breaker, and close breaker.
- h) Measure the utility incoming voltage to primary of the transformer and verify the voltage is within 10% of 120/240V.

1505 - In-Service Use, Care, Inspection, and Testing of Safety Equipment

1. Introduction

- 1.1. This practice describes the recommended methods of using, caring, storing, testing, and inspecting safety equipment required in the performance of underground AC power circuit maintenance.

2. Rubber Insulating Gloves

- 2.1. Rubber insulating gloves are provided to protect employees from electric shock while they are working on or in the vicinity of live power conductors and apparatus. They may only be used with approved leather covers.
- 2.2. Two types of gloves are available, designated as:
 - a) Type I - non-resistant to ozone;
 - b) Type II - resistant to ozone.
- 2.3. Five classes of Type I and Type II gloves, differing in electrical characteristics, are available and are designated as Class 0, Class 1, Class 2, Class 3 and Class 4.
- 2.4. IMPORTANT: Always use Class 2 gloves when working on 7200 Volt systems.

Table 1505-01

Color Coded Label	Class of Gloves	Recommended Maximum Use of Voltage (Phase-Phase)
Red	0	1,000
White ¹	1	7,500
Yellow ²	2	17,000
Green	3	26,500
Orange	4	36,000

¹ Type I, Class 1 gloves recommended³ for use when working on, or adjacent to, live low voltage AC power circuits and apparatus. These shall be tested at least once every 6 months.

² Type I, Class 2 gloves recommended³ for use when working on, or adjacent to, live medium voltage AC power circuits and apparatus.

³ This does not preclude the use of a superior type or class of glove.

3. Leather Covers

- a) Rubber insulating gloves may only be used with approved leather covers. These covers must never be used on their own as work gloves.
- b) The distance between the cover cuff and the rubber glove bead must be 1 inch (Class 1), or 2 inches (Class 2).
- c) Leather covers must be examined for rips and wood or metal splinters prior to each use. Never use covers that will not provide protection for the rubber insulating gloves.
- d) Leather covers must be sized and shaped so that the rubber insulating glove is not deformed from its natural shape.
- e) Care should be exercised to keep the leather covers as free as possible from oils, greases, chemicals, and other materials that may puncture the rubber insulating glove.

4. When to Wear Rubber Insulating Gloves

4.1. Gloves must be used when:

- a) Working on exposed live AC power circuits and apparatus.
- b) Working closer than the safe working distance from exposed live AC power circuits and apparatus.
- c) Live AC power conductors or cables are moved, handled or protected.
- d) An employee is liable to come into contact with another employee who is working on, or within the safe working distance of exposed live AC power circuits and apparatus.
- e) Any other time an employee considers it desirable or necessary, such as when taking voltage tests or to confirm isolation.

5. Testing of Rubber Insulating Gloves

- a) Always check the last test date stamped on the cuff.
- b) Unused Class 2 gloves must be sent to a certified electrical test facility at 5-month intervals for regular period checks.
- c) Used Class 2 gloves must be sent to a certified electrical test facility at 2-month intervals for regular period checks. A glove is considered "used" once its bag seal is broken - it is important to always record this date.
- d) Class 1 gloves must be sent to a certified electrical test facility at 6-month intervals for regular period checks.

6. Care and Inspection of Rubber Insulating Gloves

6.1. The field care and inspection of rubber insulating gloves is an important requirement in providing protection from electric shock.

- a) Gloves must be visually tested by the wearer for defects prior to each use. They must be inspected over the entire surface by rolling gently between the hands to expose defects and imbedded materials.
- b) Gloves must be given an air test daily, by rolling the cuff tightly toward the palm in such a manner that air is entrapped inside the glove and listening for escaping air. Tag suspected gloves as defective.
- c) Gloves with any of the following defects must not be used and should be returned to a certified electrical test facility for inspection and retest:
 - i. Holes, tears, punctures, or cuts.
 - ii. Ozone cutting or ozone checking.
 - iii. Imbedded foreign objects.
 - iv. Texture changes: Swelling, softening, hardening, becoming sticky or inelastic.
 - v. Other defects that damage the insulating properties.
- d) Never field repair gloves.
- e) Wipe gloves clean of any oil, grease, or other damaging substances as soon as practicable. Rinse gloves in clean distilled or filtered water as necessary to remove perspiration. Shake excess water out of the glove and allow it to air dry completely before use.
- f) Cloth gloves may be worn inside of rubber insulating gloves for warmth in cold weather and to absorb perspiration in hot weather.

- g) The inside surfaces of gloves may be dusted with a powder to prevent sticking, binding and skin irritation during warm weather.
- h) Never wear rings while using gloves.
- i) Always carry gloves in approved containers. Never fold gloves or allow them to come into contact with sharp objects.

7. Storage of Rubber Insulating Gloves

- a) Always store gloves in a cool, dark, and dry location, which must be kept as free as practicable from ozone, chemicals, oils, solvents, and away from electrical equipment, electrical discharges and sunlight.
- b) Gloves should be stored inside leather covers or in a bag, box, or container that is designed and used exclusively for this purpose.
- c) Gloves must be stored in their natural shape and must not be stored folded, creased, inside out, compressed, or in any manner which may cause stretching or compression.

1506 - Procedures for Power Clearance

1. Purpose

- 1.1. These Codes of Practice describe the procedures to be followed when issuing, extending, or returning a power clearance, and are necessary when working on or around isolated/de-energized underground AC power lines, cable and/or electrical apparatus, which for simplicity sake may be referred to in this document as “protected cable”.
- 1.2. Also described are the procedures for generating and performing the requisite Order to Operate (OTO).

2. What is a Power Clearance?

- 2.1. A power clearance is a stated assurance that it is safe to go to work on a section of protected cable. The protection provided by this clearance may be extended to other qualified persons by the use of “Protection Extension”. The use of overlapping power clearances over the same protected cable is not recommended.

3. Who Issues a Power Clearance?

- 3.1. A power clearance shall be issued by the qualified person in charge of the protected cable, either for maintenance or work protection purposes, and is referred to as the Clearance Holder. Only the Clearance Holder has the authority to extend the protection to other qualified persons by means of “Protection Extension”.

4. Qualified Persons

- 4.1. Personnel required to work on underground power distribution systems shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards, and all work shall be authorized by the immediate supervisor. The necessary qualifications are identified in [SCP-1507 Qualifications and Certification for Maintenance of Underground Power Systems](#).

5. Work by Qualified Contractors

- 5.1. Qualified electrical contractors performing any work on any Metrolinx underground AC power distribution system covered by [SCP-1501 Work on or Near Underground AC Power Distribution System](#), shall be deemed to be qualified persons, and must comply with the clearance procedures described herein.

6. Isolating/De-Energizing

- a) Refer to [SCP-1502 Isolating, De-Energizing and Re-Energizing Low Voltage Underground Power Distribution System](#) when isolating, de-energizing and re-energizing Low Voltage Underground Power Distribution Systems (600V).
- b) Refer to [SCP-1503 Isolating, De-Energizing and Re-Energizing Medium Voltage Underground Power Distribution System](#) when isolating, de-energizing and re-energizing Medium Voltage Underground Power Distribution Systems (7.2 kV) is required to perform the task.

7. Who Needs a Power Clearance?

- 7.1. A valid power clearance form "[SCP-1506\(A\)](#)" must be in the possession of:
- a) Any qualified person performing work on or around isolated or de-energized underground AC power lines, cable and/or electrical apparatus¹, or;
 - b) Any qualified person protecting MOW personnel working around isolated or de-energized underground AC power lines, cable and/or electrical apparatus¹.

¹ Not required for work on low voltage (600V) systems where the qualified person will not likely be separated from the work requiring protection.

8. Who Needs an Order to Operate (OTO)

- 8.1. A valid OTO form “[SCP-1506\(B\)](#)” must be in the possession of any qualified person performing isolating, de-energizing, or re-energizing duties¹.

¹ Not required for work on low voltage (600V) systems where the qualified person will not likely be separated from the work requiring protection.

9. Job Briefing (Main Job Briefing & Tailboard Talk)

- 9.1. A job briefing is required whenever protection is required as prescribed in [SCP-1508 Protection Requirements for MOW Activities](#).
- 9.2. During the main job briefing, to be held with all parties including affected MOW personnel, the power clearance procedures must be reviewed. At this time a qualified person must be designated to be in charge of protecting the cable and issuing the clearance. The limits of the clearance, sufficient to provide appropriate protection, must be determined and understood by all parties. These limits, along with the name of the qualified person in charge, date, and subdivision, can be filled as preliminary information on a blank power clearance form.
- 9.3. Once the main job briefing has been conducted, a secondary job briefing, known as a “tailboard” talk, must be held with all qualified persons involved in the isolating, de-energizing, or re-energizing procedures. The tailboard must include all procedures required to isolate, de-energize, or re-energize the cable, which must be formalized on the Order to Operate (OTO) forms.
- 9.4. A separate OTO form is required for each site where isolating, de-energizing, or re-energizing procedures will be performed. It is imperative that all qualified persons have a thorough understanding of the proper sequencing of OTO’s required to safely discharge their duties.
- 9.5. Failure to properly sequence OTO’s may result in serious injury or loss of life.

10. Order to Operate (OTO)

- 10.1. The "Order to Operate" form "SCP-1506(B)" will describe, in a step-by-step fashion, the exact sequence of operations required to isolate, de-energize, or re-energize the system.
- 10.2. The Order to Operate (OTO) form shall be used in connection with the performance of all operations requiring the opening or closing of such apparatus as circuit breakers, isolating devices, grounding devices, and valves.
- 10.3. The OTO process is critical to the safe discharge of duties. Always adhere to the following:
 - a) Only prepare the OTO for the work you intend on performing personally or otherwise directing.
 - b) Prepare the OTO from scratch, do not copy from previous copies, "canned copies", templates, etc.
 - c) Refer to the latest "As-Built" power drawings when preparing the OTO.
 - d) Do not attempt to prepare an OTO if you are not fully confident in doing so.
 - e) Separate OTO's are required for isolating/de-energizing and for re-energizing.
 - f) Each sequence of the OTO shall describe a single operation that changes the state or position of an apparatus. When performing the work, the apparatus must be left in the state or position indicated on the OTO.
 - g) Each OTO must be checked and approved by another qualified person.

11. Performing OTOs

- 11.1. When actually performing the OTO, always adhere to the following:
- a) Perform only one sequence at a time, starting from the top of the form and working down.
 - b) If the sequence requires that a "DO NOT OPERATE" tag be applied, check off the "Place Tag" check box after the tag is applied, adjacent to the one that you checked when the OTO was prepared. Remove the tag after the operation is performed.
 - c) If the sequence results in a "DO NOT OPERATE" tag being removed, check off the "Rem Tag" check box before the tag is removed, adjacent to the one that you checked when the OTO was prepared. Remove the tag before the operation is performed.
 - d) Initial each sequence when it is completed.
 - e) When the OTO is completed, enter the time of completion in the Performed By "Time:" field at the bottom of the [SCP-1506\(B\)](#) form. If applicable, notify the qualified person in charge that the OTO is complete.
 - f) Completed OTO's should be sent to the Metrolinx Designate for filing for a minimum of 1 year.

12. Issue Clearance

- 12.1. Once all applicable OTO's have been completed, the qualified person in charge may complete the power clearance form, indicating the time and date that the limits are isolated or de-energized, and allow work on the protected cable to proceed.

13. Protecting Extension

- 13.1. The qualified person in charge may extend protection for up to ten other qualified persons, by copying the clearance form, one at a time, to each additional qualified person. This must be performed verbally, either directly or remotely via radio or telephone.
- 13.2. Each time a clearance is extended, the qualified person in charge will record the name of whom the extension is being issued, time, date and location of that person, on the "Protection Extension" portion of the power clearance form. The information in the gray section of the form is then copied verbatim and repeated and okayed.
- 13.3. Once the okay is received, the qualified person receiving the protection extension may proceed to work on or around the protected cable, or may protect other MOW personnel working around the protected cable.

14. Loss of Radio During Protection Extension

- 14.1. A qualified person will not act on a protection extension until all information has been copied and repeated, including the okay. The qualified person issuing protection extension (the Clearance Holder) will assume the extension is in effect once the qualified person's name is recorded on his/her form.

15. Legibility

- 15.1. All clearance and protection extension forms must be clean, legible, and free of scribbles, erasures, corrections, or other notations.

16. Protecting MOW Activities

- 16.1. When a clearance or protection extension is issued to protect any MOW activities around the cable, such as bridge work, that does not pose a realistic threat to the cable, it is not a requirement that the qualified person protecting the cable be on-site during the actual work. However, this qualified person must ensure that all affected MOW personnel are free and clear prior to returning the clearance or protection extension.

17. Shift Change

- 17.1. Any qualified person relieving another will assume the name of that person for purposes of holding the Clearance or Protection Extension. The relieving person must have a thorough understanding of the limits of the power clearance, and be aware of all other workers and equipment in the immediate vicinity being protected by the Clearance or Protection Extension.

18. Returning a Protection Extension

- 18.1. All Protection Extension clearances must be returned (cancelled) before the power clearance itself can be returned. Each qualified person to whom an extension was issued must follow these steps when returning the extension:
- a) Ensure all workers and equipment being protected is free and clear. Advise these workers that the line, cable, and/or electrical apparatus are now to be considered live and potentially dangerous.
 - b) Once all workers have been so advised, check off the "Clearance Returned" box located at the bottom of the clearance form. Record the clearing time and date in the designated fields on the bottom of the form. The Protection Extension is now effectively cancelled.

- c) Contact the qualified person in charge (the clearance Holder) and advise that the Protection Extension is being returned, by stating one's name, limits, and the recorded clearing time and date, and confirm that all workers and equipment being protected are "Free and Clear".
- d) Wait for the repeat from the clearance Holder, and then initial the bottom of the clearance form. Acknowledge receipt of the repeat.
- e) Forward the clearance form to the Metrolinx Designate for filing for a minimum of 1 year.

19. Accepting Return of a Protection Extension

- 19.1. Each time a qualified person returns an extension, the qualified person in charge (the Clearance Holder) shall:
- a) Verify that the name and limits are correct.
 - b) Record the stated clearing time and date on the appropriate line on the Protection Extension section of the form, in the designated field (to the right of the "Reported Clear" check boxes).
 - c) Repeat the person's name, limits, the clearing time and date to the qualified person.
 - d) Wait for acknowledgement of the repeat and then check the "Reported Clear" check box on the appropriate line.

20. Returning a Clearance

- 20.1. The qualified person in charge will initiate another tailboard talk (job briefing) to review procedures and generate the OTO(s) detailing the sequence of operations to physically re-energize the line. The clearance must be returned (cancelled) before allowing any OTO that re-energizes the line to be acted on.

GO TRANSIT SIGNALS & COMMUNICATIONS CODES OF PRACTICE

- 20.2. Follow these steps when returning a clearance:
- a) Ensure all names shown in the Protection Extension section of the form have the corresponding “Reported Clear” check boxes checked, with clear times and dates recorded.
 - b) Ensure all other workers and equipment being protected are free and clear. Advise these workers that the line, cable, and/or electrical apparatus are now to be considered live and potentially dangerous.
 - c) Check off the “Clearance Returned” box located at the bottom of the clearance form. Record initials, the clearing time and date in the designated fields on the bottom of the clearance form. The clearance is now effectively cancelled, and the OTO(s) may be performed.
 - d) Forward the clearance form to Metrolinx and Metrolinx designated Supervisory Officer for filing for a minimum of 1 year.

1507 - Qualifications and Certification for Maintenance of Underground Power Distribution Systems

1. Purpose

- 1.1. This document describes the minimum qualifications and certification requirements of S&C personnel necessary to ensure safe and reliable operation of underground AC power systems.
- 1.2. This document provides guidance to ensure personnel have knowledge of the procedures to:
 - a) Safely work on and around underground power systems.
 - b) Afford protection for persons entering within the defined areas around power systems.
 - c) Provide safe grounding of S&C power systems.
 - d) Maximize the availability of power for S&C systems.

2. Qualified Persons

- 2.1. Personnel required to work on S&C electric apparatus or equipment shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards.
- 2.2. Qualified personnel are categorized as either Level 1 or Level 2, based on the degree of knowledge and experience. Some tasks have a level of difficulty sufficient to restrict them to Level 2 personnel only. Other tasks are beyond the expertise of Level 2 personnel, and should only be performed by Journeymen Electricians or Powerline Maintainers.
- 2.3. It is the responsibility of the Metrolinx designated responsible Supervisory Officer to certify personnel as Level 1 or 2, and to ensure re-certification as required.

3. Tasks Not Qualified to Perform

- 3.1. There are many tasks, particularly with the medium voltage systems (7.2 kV), for which neither Level 1 nor Level 2 personnel are qualified to perform, and which should be deferred to a Powerline Maintainer. These include, but are not limited to:
- a) Repair or replacement of equipment, such as reactors, pad mounts transformers, etc.
 - b) Line work (pole mounted regulators, transformers, etc).
 - c) Fault Isolation.
 - d) Concentric neutral cable splicing.
 - e) Hi-pot testing.

4. Level 1 Tasks

- 4.1. There are 2 levels of electrical qualification that allow an S&C person to perform tasks of varying degree of difficulty.
- 4.2. On low voltage (600V) systems, Level 1 personnel can:
- a) Inject generator power to local bungalow.
 - b) Operate Control Devices.
 - c) Issue and extend Power Clearance and protect MOW personnel working within the limits of the Clearance.
 - d) Locate and expose underground cables.
 - e) Perform routine equipment maintenance as defined in system O&M documentation.
 - f) Splice/repair/megger cables.

5. Level 2 Tasks

- 5.1. On all systems up to and including medium voltage, Level 2 personnel can:
- a) Perform any Level 1 task.
 - b) Inject generator power to de-activated medium voltage (7.2 kV) cable system.
 - c) Prepare and perform an OTO, including any tasks described therein.
 - d) Perform work requiring insulating Class 2 rubber gloves and hot-line tools, and maintain this safety equipment as required.
 - e) Perform routine 7.2 kV equipment maintenance as defined in system O&M documentation.

6. Qualification Level 1

- 6.1. All Level 1 personnel must be First Aid qualified, and have a thorough knowledge of:
- a) Grounding and bonding of applicable S&C equipment and housings.
 - b) Ohm's law, so as to understand electrical flow in various forms of conductive materials.
 - c) Current and conductor capacity according to gauge of wire and proper dissipation of heat.
 - d) Transformers and their theory of operation.
 - e) How to accurately read plans applicable to power systems.
 - f) How to generate, extend, and return a power clearance.
 - g) The use of lockouts and warning (DO NOT OPERATE) tags.
 - h) All applicable Codes of Practice (SCPs), General Instructions (GI's), and Service Bulletins.

7. Certification Level 1

7.1. A person can be certified as being Level 1 qualified if he/she:

- a) Holds a valid First Aid certificate.
- b) Has successfully passed an S&C Apprenticeship Training Program or appropriate equivalent.
- c) i) Has a minimum 3 months practical experience working on or around S&C power systems, or qualified Electrician, or
- d) ii) For low voltage (600V) systems only, has successfully completed the S&C Electrical Systems training course or appropriate equivalent.
- e) Is thoroughly familiarized with, and is in possession of, Codes of Practice SCP-1501, 1502, 1506, and 1508.

8. Re-Certification Level 1

8.1. For medium voltage (7.2 kV) systems, a Level 1 person must be re-certified if he/she has allowed a 12-month period to lapse with no exposure to buried power systems. The person then requires a minimum 1 month practical experience working on or around S&C power systems, under the supervision of a Level 2 person, or qualified Electrician, in order to be re-certified.

9. Qualification Level 2

9.1. All Level 2 personnel must be Level 1 qualified, and have a thorough knowledge of:

- a) The use and care of personal safety equipment.
- b) The purpose and use of the Order to Operate (OTO).
- c) The purpose and use of the Power Method of Procedure (PMOP).
- d) Safe limits of approach.
- e) Safe working distances.

- f) Generator power injection and the risks of back-feeding.
- g) The principles of operation of the medium voltage U/G power system.

10. Certification Level 2

- 10.1. A person can be certified as being Level 2 qualified if he/she:
 - a) Has completed a course in Electrical Systems and Electrical Safety as provided by an Industry-certified training agency.
 - b) Has a minimum 6 months practical experience working on or around relevant underground power systems, under the supervision of a Level 2 person, or qualified Electrician.
 - c) Is familiarized with, and is in possession of, Codes of Practice [SCP- 1501](#) to [SCP-1508](#) inclusive.

11. Re-Certification Level 2

- 11.1. A Level 2 person must be re-certified annually, by completing a refresher course in Electrical Systems and Electrical Safety as provided by an Industry-certified training agency.

1508 - Protection Requirements for MOW Activities

1. Introduction

- 1.1. This Codes of Practice prescribe the minimum protection requirements which must be followed while working near underground AC power circuits. It is important that these practices are adhered to at all times on account of the extreme hazards associated with working around live power cables.

2. Background

- 2.1. Underground power distribution systems for railway S&C purposes consist of power cables directly buried in the earth on railway right-of-way and usually share a common trench with signal and communication wires and cables. Voltages in use for underground AC power systems range from low voltage (31-600 volts) systems to medium voltage (above 600 volts) systems.
- 2.2. These instructions apply to all personnel working on or near the Metrolinx low voltage (600V) and medium voltage (7.2 kV) underground AC power circuits and are not intended to cover work on or near any other underground AC power systems.

3. Qualified Persons

- 3.1. Personnel required to work on an electric apparatus or equipment shall be qualified and have a thorough knowledge of its operating voltage and service as well as its potential hazards, and then, only when authorized by the immediate supervisor. The necessary qualifications are identified in [SCP-1507 Qualifications and Certification for Maintenance of Underground Power Systems](#).

4. Qualified Person On Site

- 4.1. For certain MOW activities as indicated in the following Tables, it is necessary that a qualified person, as defined above, remain at the work site and be in a position to closely monitor the work, for the entire duration of the activity.
- 4.2. It is not a requirement that a qualified person remain at the work site for the remaining activities. However, if a clearance is in effect to protect this work, the qualified person must ensure all affected MOW personnel at that site are free and clear prior to returning the clearance.

5. Typical Activities - Medium Voltage

5.1. Table 1508-01 identifies the minimum protection requirements for typical MOW activities on medium voltage (7.2 kV) systems:

Table 1508-01

Protection Requirement	Locate Cable	SCP-1005						
	Test Hole to Confirm Depth	SCP-1005						
	Isolate Cable	SCP-1503						
	De-energize Cable	SCP-1503						
	PMOP	SCP-1501						
	Power Clearance	SCP-1506						
	Power Gloves Required	SCP-1505						
	Qualified Person on Site	SCP-1508						
ACTIVITY								
Digging test hole to confirm depth					✓ ²		✓	✓
Changing ties by hand								✓
Changing ties using excavator							✓	✓
Under cutter program	✓		✓	✓	✓		✓	✓
Leveling ground directly above cable							✓	✓
Adding fill above cable								
Boring under railway tracks	✓							✓
Removing troughing from bridge			✓		✓			
Repairing/replacing/disturbing bridge troughing	✓ ¹		✓		✓			
Culvert replacement (single)	✓		✓		✓		✓	✓
Culvert replacement program	✓		✓	✓	✓		✓	✓
Culvert extension near cable	✓						✓	✓
Derailment	✓		✓		✓		✓	✓
Drop transformer replacement	✓	✓	✓		✓			
Check transformer oil	✓	✓						
Splice power cable	✓	✓	✓		✓			

¹ A qualified person may be required on site if there is any potential to damage the cable by virtue of the type of bridge work being performed.

² De-energize cable when using hand tools to mitigate the risk of puncturing cable jacket.

6. Typical Activities - Low Voltage

6.1. Table 1508-02 identifies the minimum protection requirements for typical MOW activities on low voltage (600V) systems:

Table 1508-02

Protection Requirement	Locate Cable	SCP-1005						
	Test Hole to Confirm Depth	SCP-1005						
	Isolate Cable	SCP-1502						
	De-energize Cable	SCP-1502						
	PMOP	SCP-1501						
	Power Clearance	SCP-1506						
	Power Gloves Required	SCP-1505						
	Qualified Person on Site	SCP-1508						
	ACTIVITY							
	Digging test hole to confirm depth						✓	✓
	Changing ties by hand							✓
	Changing ties using excavator						✓	✓
	Under cutter program	✓		✓			✓	✓
	Leveling ground directly above cable						✓	✓
	Adding fill above cable	✓						
	Boring under railway tracks						✓	✓
	Removing troughing from bridge			2✓			✓	
	Repairing/replacing/disturbing bridge troughing	1✓		✓			✓	
	Culvert replacement (single)	✓		2✓			✓	✓
	Culvert replacement program	✓		2✓			✓	✓
	Culvert extension near cable	✓					✓	✓
	Derailment	✓		✓			✓	✓
	Drop transformer replacement	✓						
	Splice power cable	✓	3✓					✓

¹ A qualified person may be required on site if there is any potential to damage the cable by virtue of the type of bridge work being performed.

² A power clearance form is not necessary if the qualified person in charge of protecting the power system intends to stay close to the work for the duration of the work.

³ Power gloves are required when identifying power conductor when multiple conductors exist in an excavation.

7. Results of Locates/Test Holes

- 7.1. For those activities in Tables 1508-01 & 1508-02 which require cable locating and/or test holes to be dug as described in [SCP-1005 Protection Instructions to Excavators for S&C Infrastructure](#), then additional action may be required depending on the outcome of the locate or test hole.
- 7.2. In no cases shall mechanical excavating equipment be allowed to approach to within 0.9 m (3 ft) of live insulated conductors¹. Use the following table when deciding whether to isolate the cable:

Table 1508-03

If the mechanical excavation..	Then..
Can be guaranteed to stay outside 0.9 m (3 ft) of live insulated conductors.	Proceed with caution.
Will approach to within 0.9 m (3 ft) of live insulated conductors ¹ .	De-energize the cable in accordance with SCP-1502 Isolating, De-Energizing and Re-Energizing Low Voltage Underground Power Distribution System or SCP 1503 Isolating, De-Energizing and Re-Energizing Medium Voltage Underground Power Distribution System . Use a vac truck or hand dig to expose the cable at the point of excavation.
May or may not stay outside 0.9 m (3 ft) of live insulated conductors due to uncertainty of cable depth or quality of cable locate.	Use a vac truck or hand dig to expose the cable. De-energize the cable in accordance with SCP-1502 Isolating, De-Energizing and Re-Energizing Low Voltage Underground Power Distribution System or SCP 1503 Isolating, De-Energizing and Re-Energizing Medium Voltage Underground Power Distribution System if deemed necessary, depending on the nature and proximity of the excavation.

¹There may be exceptional situations when this requirement may be relaxed, however this requires that a PMOP be developed, approved by the Metrolinx designated Engineer, clearly outlining how the risks are to be mitigated. If in doubt, the safe course must be taken.