Inspection and Maintenance of Signaling Systems

Course 205

PARTICIPANT GUIDE

SIGNALS TRAINING CONSORTIUM

Inspection and Maintenance of Cab and Wayside Signaling Systems

Participant Guide

Signals Maintenance Training Consortium

COURSE 205

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How to Use the Participant Guide

Purpose of the Course

The purpose of the *Inspection and Maintenance of Cab and Wayside Signaling Systems* course is to assist the participant in gaining knowledge on how to inspect and maintain cab and wayside signals and their associated components.

Approach of the Book

Each course module begins with an outline, a statement of purpose and objectives, and a list of key terms. The *outline* will discuss the main topics to be addressed in the module. A list of *key terms* identifies important terminology that will be introduced in this module. *Learning objectives* define the basic skills, knowledge, and abilities course participants should be able to demonstrate to show that they have learned the material presented in the module. A list of *key terms* identifies important terminology that will be introduced in each course module. *Review exercises* conclude each module to assist the participants in reviewing key information.

Module 1

OVERVIEW AND SAFETY

Outline

Purpose and Objectives

The purpose of this module is to provide the participant with an overview on how to safely inspect and maintain cab and wayside signaling systems.

Following the completion of this module, the participant should be able to complete the exercises with an accuracy of 70% or greater:

- Identify trip, slip and fall hazards related to inspection and maintenance of signaling systems
- Identify pinch points related to inspection and maintenance of signaling systems
- Describe procedures for working in electrified territory
- Identify proper PPE to be used during inspection and maintenance of signaling systems
- Identify and describe tools specific to inspection and maintenance of signaling systems
- List Tests Mandated by the FRA
- List pertinent timing for each test (monthly, quarterly, etc) as per your authority
- Demonstrate ability to complete proper documentation

Key Terms

- Analog Meter
- Butt Splices
- Capacitor
- Clamp On Amp Meter
- Continuity Test
- Documentation
- Electrified Territory
- Function Generator
- Hot Spot Alignment
- Job Briefing Meeting
- Melter/Splicer
- Multi-Meter
- Oscilloscope
- Personal Protective Equipment (PPE)
- Pinch Points
- Proper Authority
- Relay Test
- Road Worker In Charge (RWIC)
- Securing the Area
- Signal Sniffer
- Speed Code Transmission
- Third Rail
- Track Transformer Functionality Test
- Trip, Slip, and Fall Hazards
- Wayside Signal Tests

1-1 OVERVIEW

In the previous course, Course 105 *Overview and Introduction to Cab and Wayside Signaling*, the participant was introduced to signaling systems and their basic components. The approach to this next level of training, Course 205 *Inspection and Maintenance of Signaling Systems*, is to help the participant hone essential skills for inspecting and maintaining cab and wayside signaling systems. In doing so, this module supplements and enhances on-the-job, classroom, and other training the signal maintainer will receive from their rail agency.

This course was developed by a consortium of Signal Specialists from several rail systems that, on the federal level, are governed by the Federal Railroad Administration (FRA) or the Federal Transit Administration (FTA). Each federal agency provides the baseline for compliance in areas of safety, testing, maintenance, and record keeping pertaining to cab and wayside signaling systems.

One focus of this module is on the practice of safety for signal maintainers working around cab and wayside signaling equipment. As such, this module enhances standard safety policies of the participant's rail system as well as the principles of safety covered in your orientation and in Course 100 of this series of courses, particularly the module on *Signal Maintainer Worker Safety*.

Safety extends to the proper use of tools when inspecting and maintaining signaling systems. This module discusses the safe use of standard tools the signal maintainer can expect to use when working on signaling systems.

This module uses the guidelines outlined in FRA §236 for inspection, testing, maintenance and repair as the minimum standard. Each rail authority may prescribe additional or more stringent guidelines. The FRA guidelines also prescribe standards to ensure that personnel working with, and affected by, safety-critical train control system related products receive appropriate training and testing.

Note that for most signaling equipment, inspection and maintenance will be the same - this content will be covered in module 2 of this course. For more advanced radio based signaling systems such as CBTC, there will be additional components/inspections. Inspection and maintenance of CBTC specific components will be covered in module 3.

1-2 SAFELY WORKING IN AN ELECTRIFIED TERRITORY

When inspecting and maintaining signaling systems, the signal maintainer should be aware of both the third rail and catenary, where applicable. Additionally, any tools used should have proper **insulation** - with approved insulating material in sound condition - to protect any worker from making accidental contact with the third rail. When dealing with electrified signaling equipment (impedance bonds, transformers, signal heads, etc): if possible, de-energize. If not possible to de-energize – use proper PPE such as insulated gloves, boots, etc.

More procedures for protective measures can be found in Course 100.

Warning: Safety Precautions!

The third rail and catenary must be considered energized (LIVE) at all times.

Third Rail Safety

Protocols on how to regard the third rail will be different from property to property. Whenever possible, turn off voltage of the third rail, perform proper **lockout-tagout** procedures and discharge any associated **capacitors** before inspection and maintenance. Depending on the property and segment of track, power may be removed by the maintainer themselves or they should contact the **proper authority**. Note that some authorities have a system in place that if a de-energized third rail is re-energized, an alarm will sound as to alert personnel who may be working on the track. When power cannot be removed, one or more of the following keep a pre-determined clearance and/or wrap the third rail.

Authority Specific Third Rail Safety Requirements

Fall Protection

A personal fall arrest system consists of three components: anchorage, body harness, and connector/lanyard and may also include a lanyard, deceleration device or lifeline. The full-body harness distributes the forces throughout the body, and the shock-absorbing lanyard decreases the total fall arresting forces. Workers must be trained in the proper wear and use of the body harness. They are not a one size fits all component. Proper sizing is critical to preventing injuries. The harness must fit snugly across the chest and around the thighs and the D-ring must be positioned in the center of the back between the shoulder blades.

Figure 1.4 Full-body Harness (Source: http://www.1staidsupplies.com/)

Warning: Safety Precautions!

If you need to tie your harness off to something consult with a competent or qualified person. Make sure to tie off to a secure component like a bracket for the guiderail - not to the scaffolding.

Module 2

GENERIC INSPECTION & MAINTENANCE OF SIGNALING SYSTEMS

Outline

Purpose and Objectives

The purpose of this module is to provide an overview of inspection and maintenance of signaling systems.

Following the completion of this module, the participant should be able to complete the exercises with an accuracy of 70% or greater:

- Identify cab and wayside signaling components that need to be inspected and maintained on a regular schedule
- Demonstrate ability to inspect and maintain cab and wayside signaling components
- Demonstrate ability to document inspection and maintenance

Key Terms

- Impedance Bonds
- Track Transformers/Transmitters
- Loops
- Signals
- Relays
- Contacts
- Internal Wiring
- TWC Controller Interrogator
- Masking
- Sweep The Bond
- Function Generator
- Oscilloscope
- Scope Meter
- Peak Frequencies
- Phankill
- Sensory Inspection
- Current Reading Test
- Continuity Test
- Butt Splice
- Hardware
- Signals
- Bulbs
- Lamp Voltage
- Lenses
- Grounding Rod
- Visibility
- Track Elevation
- Track Curvature
- Daily Safety Test
- Visual Inspection
- Wheel Size Agreement
- Voltage Test
- Ground Fault Test
- ATP Functional Test
- Loop Current Test
- AVI/VWC Test
- Aspect Speedometer Test
- Code Rate Detection Test
- One and Only One Check (OOCK)
- Surface Mode Test

2-2 CIL EQUIPMENT

In the CIL, the signal maintainer will be responsible for inspecting and maintaining relays and the interrogator of the TWC controller, if equipped. The communication interfaces (modems and PLC communication interfaces) are only inspected on a failure.

Relays

Relays related to the signaling system should be tested as outlined in Course 100, ensuring they perform according to specifications. Visually inspect for worn, pitted, burnt or dirty contacts. Pay special attention to wire condition and look for any fine metal or debris inside the relay casing which can indicate improper wear.

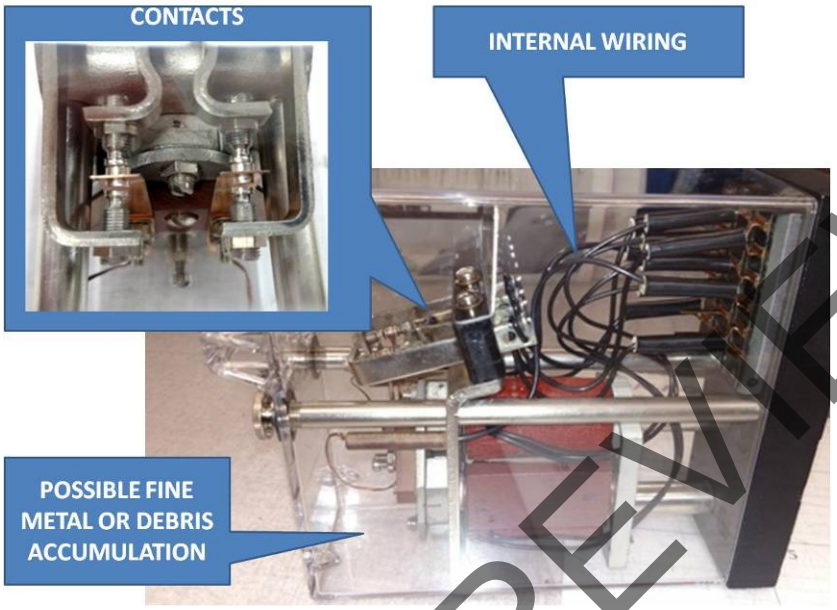

Figure 2.1 A62-600 DC track relay (TR) on the receive section of a coded track circuit - Courtesy NFTA

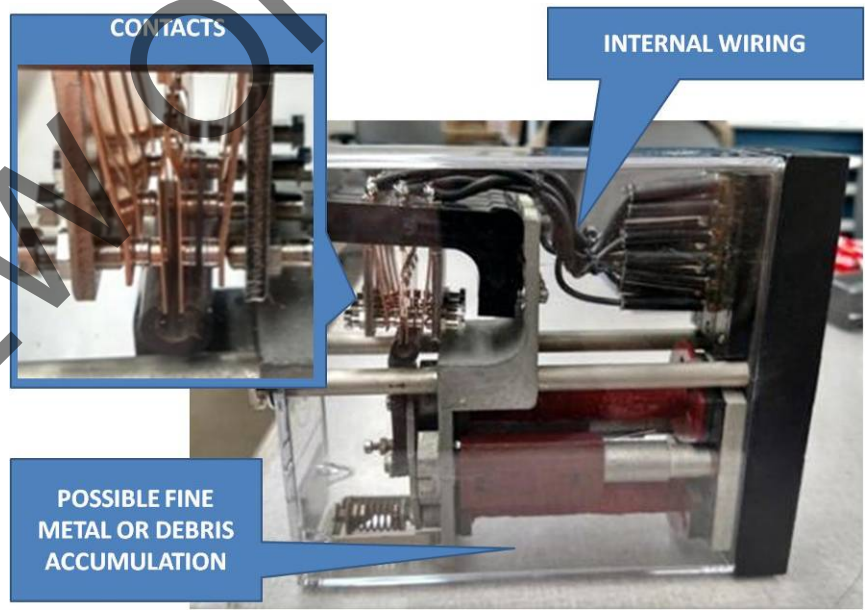

Figure 2.2 A62-622 DC Code Transmit Repeater relay (CTPR) on the transmit side of a coded track circuit - Courtesy NFTA

2-3 WAYSIDE EQUIPMENT

Transmitter Module

Ensure proper voltage/current, frequency and coding as per OEM specifications. This information is outlined in **Course 201: Inspection and Maintenance of Track Circuits**.

When inspecting and maintaining the transmitter module, start by performing a sensory inspection. Ensure proper engagement of circuit boards. Ensure board is free of burn marks, dust, dirt or damage. Make sure all hardware and wires are in place and in good condition. Beware of any moisture build up. Perform any corrective maintenance on these items as needed.

Tuned Impedance Bonds

Inspection/maintenance of tuned impedance bonds focuses on:

- Sensory inspection
- Functional Test
- Lubrication

Inspect impedance bond for loose connections, physical damage or unsatisfactory track conditions around the impedance bond(s).

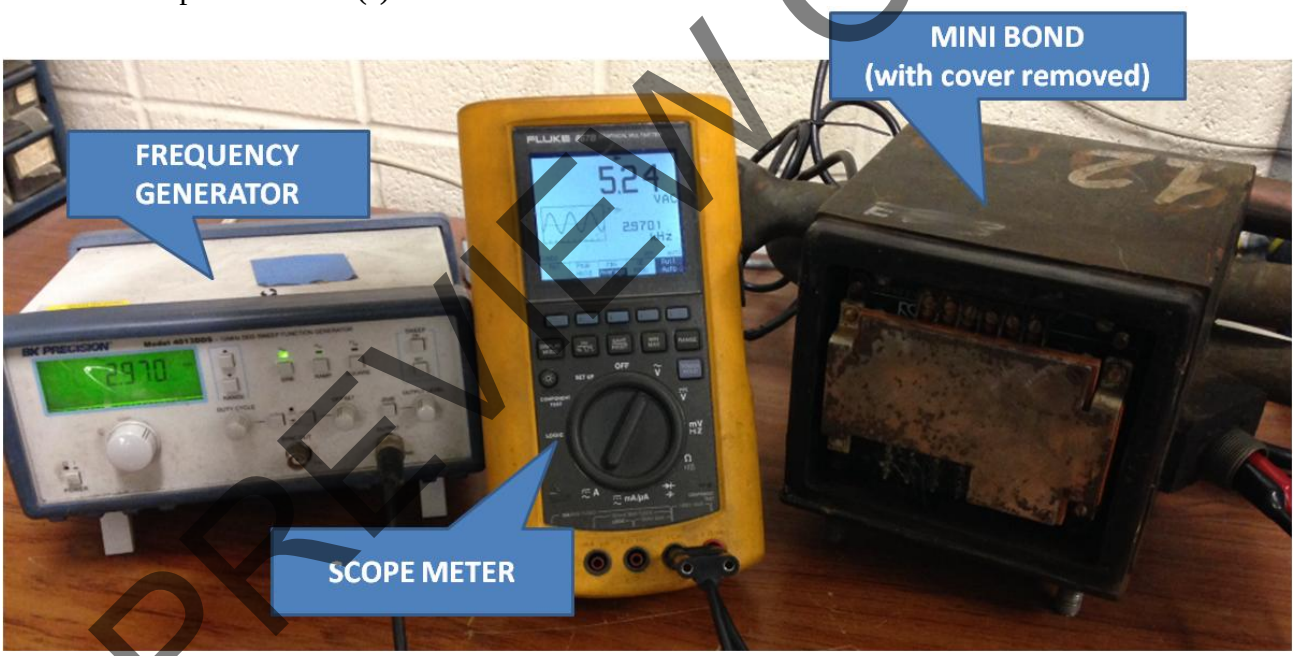

Figure 2.4 Sweeping a Bond - Courtesy GCRTA

For a functional test, check the track circuit by performing a shunt test (as covered in Course 201) and **sweep the bond** using a **function generator** and **oscilloscope** or **scope meter**. To sweep the bond, the frequency generator is ran in parallel with the oscilloscope to the input of the mini bond to find the **peak frequencies**.

Module 3

COMMUNICATION BASED TRAIN CONTROL

Outline

3-1 Overview
3-2 CBTC Specific Components
3-3 Summary

Purpose and Objectives

The purpose of this module is to provide an overview of inspection and maintenance of Communication Based Train Control specific components.

Following the completion of this module, the participant should be able to complete the exercises with an accuracy of 70% or greater:

- Demonstrate ability to perform and document Radio-Frequency Based Signaling Systems specific tests

Key Terms

- Active/Standby Local Selection Panel
- Doppler Radar
- Maximum Position Error
- Norming Point De-Programming
- Norming Point Misalignment
- Norming Point Number
- Norming Point Programmer
- Norming Point Reader
- Norming Point Re-Ordering
- Norming Points
- Optical Speed Measurement Device
- Power Supply
- Radio Frequency (RF) Interference.
- Restricted Speed Condition
- Slip/Slide
- System Mismatch
- Tachometer
- Visual Alarms

3-1 OVERVIEW

This module will cover the inspection and maintenance of major components of Signaling that are specific to CBTC equipment. Note that all items that are specific to CBTC and need to be inspected and maintained are **wayside** items – either directly next to the track or in a nearby signals closet.

Generally, it is the responsibility of signal maintainers to inspect and maintain the following on CBTC systems:

- Norming Points
- Tachometers
- Optical System Measurement Device
- Doppler Radar
- Power Supply

Preparing for Inspection/Maintenance

In CBTC systems there are two systems which are up and ready to run at all times, in case one fails. In Figure 3.21, you can see the "active/standby local selection panel" that is in the CBTC room. Both systems A and B are in a "healthy" state, but only one system (in this case A) is "active" at a time. In case of failure of one system, the other system will take over automatically. The system being used can also be changed manually as to prepare one of the systems for inspection and maintenance.

Figure 3.21 Active/Standby Local Selection Panel - Courtesy SEPTA

3-2 CBTC SPECIFIC COMPONENTS

Norming Points

Figure 3.1 Norming Point with New Mount as to Minimize Space Between Reader and Norming Point - Courtesy SEPTA

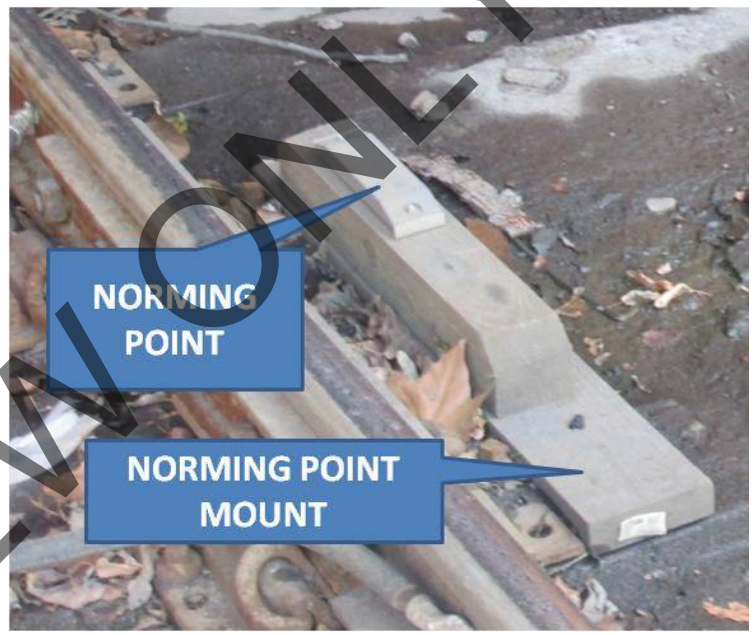

Figure 3.2 Norming Point - Courtesy SEPTA

Three common problems:

1. Misalignment of Norming point - causing there to be too much space between carborne reader and wayside norming point
2. De-programming of Norming Points
3. Re-ordering of Norming Points during track work

Signal maintainers are generally not responsible for maintaining carborne equipment. They will however maintain norming points themselves but only when there is a trouble call such as the system relaying that a norming point is missing or out of order. In either case (or whenever communication is down), the CBTC system will put the car in a **restricted speed condition**, disrupting normal service. Therefore it is important for a signal maintainer to fix the problem in a timely matter.