



# Troubleshooting and Repair of Signaling Systems

## Course 305

### PARTICIPANT GUIDE



 SIGNALS TRAINING CONSORTIUM



# Troubleshooting & Repair of CAB & Wayside Signaling Equipment

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Participant Guide

Signals Maintenance Training Consortium

COURSE 305

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PREVIEW ONLY

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## How to Use the Participant Guide

### Purpose of the Course

The purpose of the *Cab and Wayside Signaling Troubleshooting and Repair* course is to assist the participant in gaining working knowledge in troubleshooting and repairing cab and wayside signals and their associated components.

### Approach of the Book

Each course module begins with an outline, a statement of purpose and learning objectives, a list of key terms, and review exercises. The *outline* will discuss the main topics to be addressed in the 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 this module. *Review exercises* conclude each module to assist the participants in reviewing key information.

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# Module 1

## PRINCIPLES OF TROUBLESHOOTING

### Outline

- 1-1 Overview
- 1-2 The Process of Troubleshooting
- 1-3 Four Steps in Troubleshooting
- 1-4 Best Practices for Troubleshooting
- 1-5 Charts and Diagrams in Troubleshooting
- 1-6 Summary

### Purpose and Objectives

The purpose of this module is to provide an overview to troubleshooting signal systems equipment and machinery within the context of general troubleshooting and best practices.

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

- Examine the importance of troubleshooting
- Restate the troubleshooting process
- Identify troubleshooting steps
- Identify troubleshooting best practices
- Apply troubleshooting principles to some common signal systems problems and causes

### Key Terms

- Four Ds: Define, Decide, Do, Document
- Symptom Index Table
- Root Cause Analysis (RCA)
- Root Cause
- Troubleshooting Flowchart
- Troubleshooting Matrix



## 1-1 OVERVIEW

Troubleshooting is an integral part of signal systems maintenance. The signal maintainer is guided through a process of troubleshooting in order to get to the heart of the reported signals problem so that solutions can be applied quickly and equipment can be safely returned to service in the most efficient way possible.

As part of the Signals Training Consortium series of courses, this course guides the participant through the troubleshooting process by identifying some general strategies, tips, pitfalls, and application procedures. In later courses the participant will apply this general approach while troubleshooting specific areas of the signals system such as track circuits, switches, interlockings, grade crossings, and power distribution by examining common failures and discussion examples.

## 1-2 THE PROCESS OF TROUBLESHOOTING

Troubleshooting may be defined as a systematic approach to finding the source of a problem in an effort to restore an operation. Troubleshooting is problem-solving in a methodical and organized manner. Sometimes troubleshooting a problem is simple. At other times it may be complex and problems may be difficult to diagnose. Whatever the level of complexity of a signals system, the approach to troubleshooting should be orderly and logical.

The focus of troubleshooting is to find the **root cause** of a problem: that which is initiating a problem. In order to get at the root cause, the troubleshooter would apply **Root Cause Analysis (RCA)** which is the collective term that describes the processes or procedures that help guide signal maintainers not only to discover and understand the initiating causes of a problem, but to determine what is needed to prevent recurrence.

In general, there is a series of steps in troubleshooting. There are many descriptions of these steps in the signals industry, but a simple approach involves four steps which we can refer to as the **Four Ds**. They are:

1. **Define**
2. **Decide**
3. **Do**
4. **Document**



## 1-3 FOUR STEPS IN TROUBLESHOOTING

Figure 1.1 illustrates the four-step method for troubleshooting. Some rail transit authorities may have additional or different steps in approaching troubleshooting but, in general, all the principles are captured in these four steps which can be followed when beginning to troubleshoot a problem within transit signal systems. This list is a basic approach or model that the participant can follow.

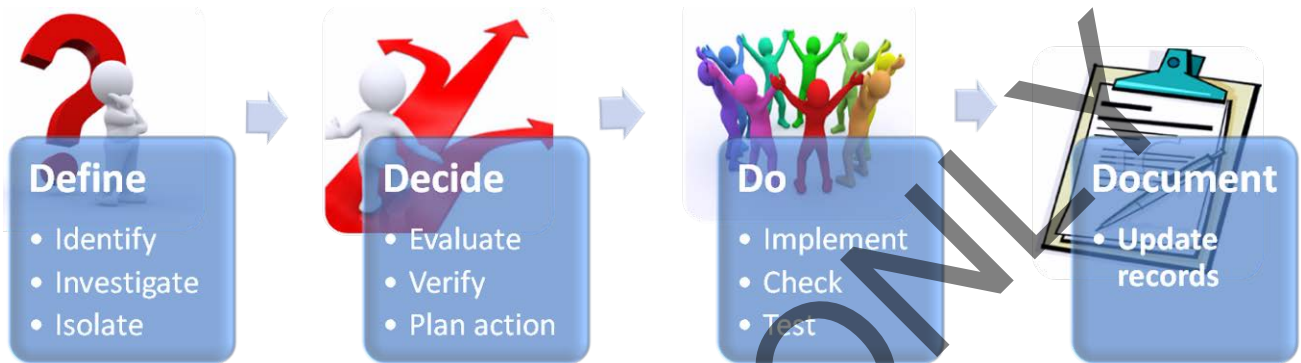


Figure 1.1 The Four Ds: Steps in Troubleshooting Signals Systems

### Step 1 - Define

#### Identify Symptoms, Investigate Situation, Isolate Problem



In order to define the problem, the Signal Maintainer needs to identify the symptoms of the trouble call by collecting as much information as possible on the reported problem. Some questions the Signal Maintainer may ask are:

- Who may have relevant knowledge about the problem?
- What other local equipment is having trouble? Look at broader, larger picture.
- Investigate initial complaints or situation, employ sensory inspection – check the problem out for yourself. Is there an environmental condition that is affecting the equipment performance? Have temperatures dropped too low? Is something overheated? Do you notice any unusual smells or sounds? Do any parts of the system seem unusual to the touch?
- Use your eyes, ears, and nose when possible to get a feel for the problem.
- Check log book for problems with the specific equipment – has the equipment displayed the same symptoms previously? Perhaps the symptoms have been treated but the root cause not identified.

# Module 2

## *OVERVIEW TO TROUBLESHOOTING & REPAIR OF CAB & WAYSIDE SIGNALS*

### Outline

- 2-1 Overview
- 2-2 Safety and Procedures when Troubleshooting Signals
- 2-3 Preparation for Troubleshooting Signals
- 2-4 Documentation Procedures
- 2-5 Summary

### Purpose and Objectives

The purpose of this module is to provide the participant with an overview to troubleshooting cab and wayside signals using examples drawn from various types of signaling systems present in rail systems.

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

- Identify safety practices when troubleshooting and repairing signaling systems
- Organize process for troubleshooting when signaling systems are faulty
- Describe FRA guidelines and agency-specific documentation procedures
- Describe specialized test equipment used for troubleshooting signaling systems
- Identify procedures for removing equipment from service
- Identify procedures for placing equipment back into service

### Key Terms

- Best Practices
- Individual Train Activated Warning System (ITAWS)
- Isolating the Fault
- Roadway Worker Protection Rule

The rule is based on five basic principles:

1. A person who is not fouling a track will not be struck by a train.
2. A person who is fouling a track upon which a train will not move will not be struck by a train.
3. No person should foul a track unless that person knows either that:
  - a. No train will arrive, or
  - b. The person on the track will be able to move to a place of safety before a train arrives.
4. Each roadway worker bears the ultimate responsibility for his/her own on-track safety.
5. Each employer is responsible for providing the means for achieving on-track safety to each roadway worker employee.

## Railroad On-track Safety Programs

Each railroad is required to adopt and implement a program that will afford on-track safety to all roadway workers performing duties on that railroad. FRA will review each railroad's on-track safety plan. FRA review and approval is not necessary before the program is implemented, but the railroad is responsible for having a complying plan regardless of FRA review.

Every railroad on-track safety program should include the following components:

1. Documentation
  - a. Operating rules.
  - b. Safety rules.
  - c. Established procedures.
  - d. Required records.
2. Training
3. Communication
4. Action
5. Internal monitoring



**Classroom Activity**

With the assistance of your instructor, describe your authority's Railroad On-track Safety Program and how it complies to the five requirements discussed above.

FRA Requirement	Location Example
Documentation	
Training	
Communication	
Action	
Internal Monitoring	

The regulation calls for each of these provisions. Each railroad has considerable latitude in the implementation of the provisions, within the requirements of the regulation. The intent of the regulation is to have each railroad cover the required points, and adapt them to the operating situation of the railroad. Certain points should be noted when reviewing a railroad's on-track safety program, which are discussed in the following paragraphs.

# Module 3

## RESOLVING PROBLEMS WITH CAB & WAYSIDE SIGNALS

### Outline

- 3-1 Overview
- 3-2 Symptoms of Signaling System Failures and Probable Causes
- 3-3 Repair Procedures
- 3-4 Scenario-Based Sample Problems
- 3-5 Summary

### Purpose and Objectives

The purpose of this module is to provide the participant with an overview to troubleshooting signaling systems using examples drawn from various types of signaling systems present in rail transit systems.

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

- Identify symptoms of signaling failures and possible causes
- Given a signaling problem and cause, describe possible solution and necessary repairs
- Given a real world signaling problem, apply troubleshooting principles to figure out the root cause

### Key Terms

- Corrective Actions
- Probable Causes
- Symptoms

## 3-4 SCENARIO-BASED SAMPLE PROBLEMS

### Cab & Wayside Signaling Troubleshooting Practice and Discussion Problems

Below are examples of problems from the field in troubleshooting signals. These problems are based on real situations.



#### Classroom Activity

Using what you already know about signaling systems, use the **Troubleshooting Note Record Form** (Figure 3.5) to assist in organizing your thoughts and for taking notes to come up with solutions for the following problems. Consider each problem and determine:

- What systems or subsystems are involved?
- What are all possible causes and which is the most likely cause?
- What are possible corrective actions?

It may be useful to organize your thoughts via a troubleshooting tree as presented in module 1. Your instructor will have the findings and solutions to these problems (**Troubleshooting Scenario Discussion Problem - Appendix A**) to verify your ideas when you are finished.

#### Problem 1

A call was just received by a train operator at signal ABC on the red line. The signal ahead of him is dark – showing no aspect. As a safety precaution, he is holding the car stationary until the problem is resolved. According to the dispatcher, it seems that there are no cars ahead of this train, therefore the aspect should be green.



Figure 3.1 Dark Wayside Signal – Courtesy NFTA (modified by consortium)



### Problem 2

A call was just received by a train operator at signal 123 on the green line. The signal ahead of him is restrictive stop signal. According to the dispatcher's display, it appears that there are no cars ahead of this train, therefore the aspect should be a proceed signal. As a safety precaution, she is holding the car stationary until the restrictive situation is resolved.



Figure 3.2 Stop Signal on a Wayside Signal

### Problem 3

A call was just received by a train operator reporting a problem with sporadic cab speed display. According to the operator, there does not seem to be any pattern to when the cab speed is displayed and when it drops quickly and displays a “zero” as a maximum speed.



Figure 3.3 Aspect Display Unit Showing Cab Flip- Courtesy NFTA