Troubleshooting and Repair of Highway Grade Crossings

Course 304

PARTICIPANT GUIDE

SIGNALS TRAINING CONSORTIUM

HIGHWAY GRADE CROSSING TROUBLESHOOTING AND REPAIR

Participant Guide

Signals Maintenance Training Consortium

COURSE 304

August 2019 Version

TABLE OF CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

How to Use the Participant Guide

Purpose of the Course

The purpose of the *Highway Grade Crossing Troubleshooting and Repair* course is to assist the participant in gaining knowledge in troubleshooting and repairing highway grade crossings and their associated components.

Approach of the Book

Each course module begins with an outline, a statement of purpose and 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.

Module 1

PRINCIPLES OF TROUBLESHOOTING

Outline

1-1 Overview
1-2 Four Steps in Troubleshooting
1-3 Best Practices for Troubleshooting
1-4 Charts and Diagrams in Troubleshooting
1-5 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
- Root Cause
- Root Cause Analysis (RCA)

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.

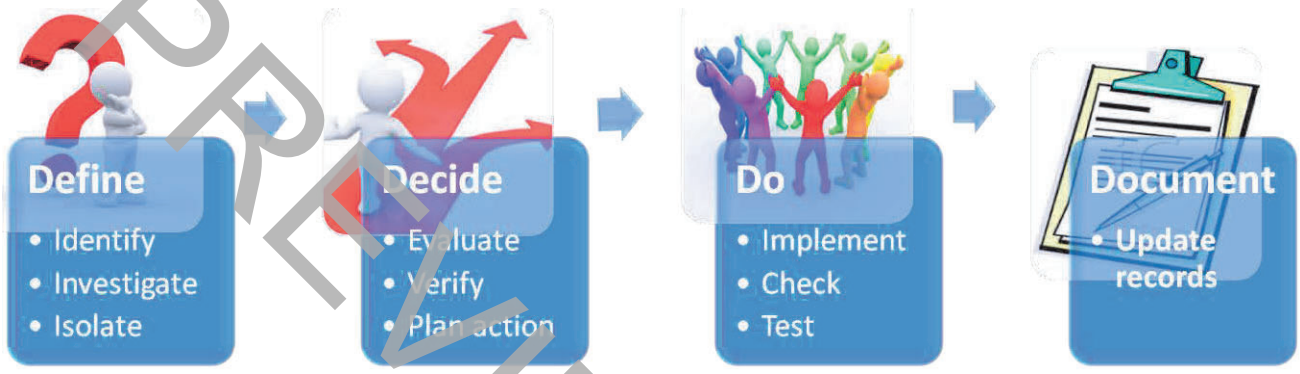


Figure 1.1 The Four Ds: Steps in Troubleshooting Signals Systems

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, 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 problem not solved.

1-5 CHARTS AND DIAGRAMS USED IN TROUBLESHOOTING

In many cases, original equipment manufacturers (OEMs) offer solutions to commonly reported problems with their equipment. Many times their solutions are offered in a chart where questions are posed and, depending on the observation of the signal maintainer, the user is guided through steps to troubleshoot the problem. By posing questions in the troubleshooting process the OEM is offering different solutions to the root cause of the problem. Typically the chart walks the user through first applying the simpler solutions leading to those that are more complex.

Troubleshooting charts use standard shapes as symbols [protocol] which help the user recognize steps and actions to take.

Figure 1.4 shows four common shapes or symbols used in troubleshooting charts. The symbols help quickly guide the user through the steps to troubleshoot a problem.

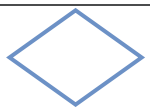
Symbol	Description	Explanation
	Rectangle with rounded corners	Statement of reported problem
	Diamond	Decision point usually “yes” or “no”
	Rectangle	Action to be taken
	Trapezoid	Final steps to be taken

Figure 1.4 Symbols Used in Troubleshooting Charts

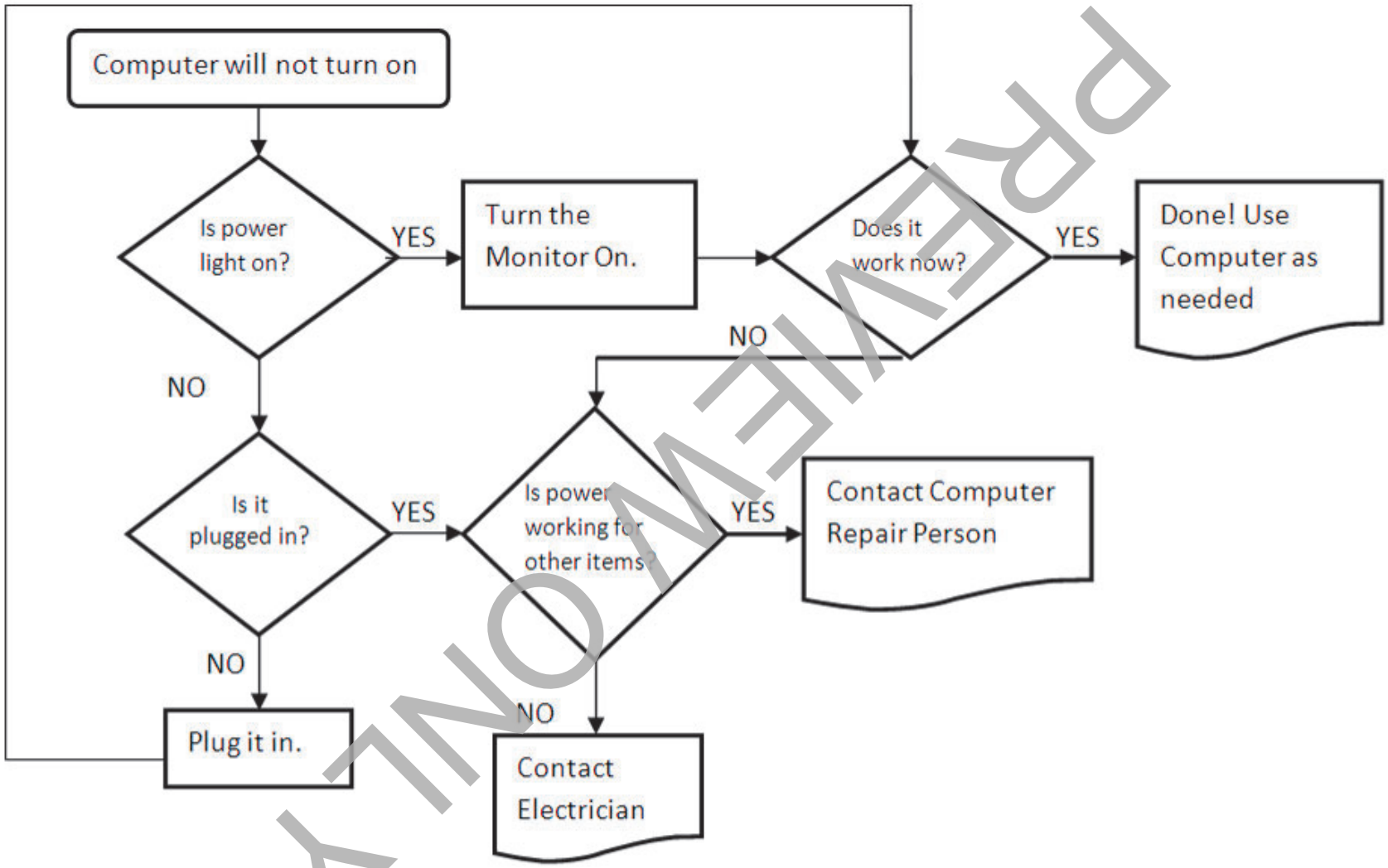


Figure 1.5 Simple Troubleshooting Tree Example

Module 2

OVERVIEW TO HIGHWAY GRADE CROSSING TROUBLESHOOTING & REPAIR

Outline

Purpose and Objectives:

The purpose of this module is to provide the participant with an overview for troubleshooting and repair of highway grade crossings.

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

- Describe safety practices and processes as related to grade crossing troubleshooting & repair
- Describe FRA guidelines and agency specific documentation procedures
- Describe types of highway grade crossing malfunctions
- Describe specialized test equipment used for troubleshooting highway grade crossings

Key Terms

- Additional Personnel
- Effectively Protected
- Initial Notice of Problem
- Job Hazard Analysis
- Potential Hazards
- Preliminary Observations
- Proper Communication
- Quickest Route to Site

Until the type of malfunction is determined, ensure the most restrictive crossing protection is used in accordance with your agency procedure.

Classroom Activity

With the assistance of your instructor, describe policies and procedures for highway grade crossing protection given a malfunction at your agency

Typical Malfunctions

In rare cases, a problem at a highway grade crossing may be unique. However, and in most cases, there are general problems that when a malfunction does occur it tends to be something that is typically seen by many signal maintainers. The following list illustrates some of those typical problems. Module 3 will explore these problems in greater detail.

Typical Highway Grade Crossing Problems

Typical highway grade crossing problems may include but are not limited to:

- All flasher lamps dark and gates down without recovering after train passes
- Gates partially recover and flashers dim
- Gates and lights operating normally, as if a train is present when none is there
- Only one gate does not recover and all other gates recover after train passes
- Only half of the lights illuminate and they stay steadily on or only half are on with intermittent all dark lights
- Sulfur smell or electrical smell in instrument enclosure or house
- Relays not operating normally or detection trouble lights illuminated
- Event recorder download indicates an active problem or history of a problem
- Battery charger not indicating a charge or power off indication
- Damage or vandalism to equipment
- Gates ascend normally, and then slowly fall
- Flashers momentarily illuminate in high wind
- Gate descent speed is too slow or too fast
- No bell or bell not operating normally

Additional Malfunction Guidelines

Accidents at highway grade crossings covered under the FRA involving collisions between a train and an automobile, bus, truck, motorcycle, bicycle, farm vehicle, or pedestrian must be reported to the Federal Railroad Administration within 24 hours of occurrence. The report must include the name of the railroad, name/title/telephone number of the individual making the report, time/date/location of the accident, U.S. DOT-AAR Grade Crossing Identification Number, circumstances of the accident including operating details of the grade crossing warning devices, number of persons killed or injured, maximum authorized speed of train, and posted highway speed limit. This initial telephone report must be followed by a formal written report (ex: FRA Form F6180.83).

Any highway grade crossing malfunction report must be investigated immediately to determine the nature of the malfunction. Until the malfunction is diagnosed and repairs, if needed, are made, every effort to warn highway users, pedestrians, and rail employees must be made. If a malfunction is reported and no cause is found to support the report, warning system operation must be verified and logged. Again, crossing system warning times must be maintained to provide a minimum of 20 seconds at the maximum authorized track speed.

During any type of highway grade crossing malfunction or failure, a data recorder may be useful in determining what happened. Various styles of data recorders exist including some which connect to the gate mechanism and others which may stand alone.

For more information on highway grade crossing malfunctions, defect classifications, and proper rail agency response, see NCRY's *Signal and Train Control Compliance* at http://www.ncrysignal.com/content/documentation/regulations/cfr49-234a.pdf

2-6 SUMMARY

Troubleshooting a highway grade crossing can present issues not typical to troubleshooting other areas of the signaling system. A signal maintainer must be aware of this and conduct troubleshooting accordingly for the safest and most effective grade crossing repair and restoration. Course 304 Module 1 provides processes, tips, and general definitions to supplement agency specific guidelines and regulation for troubleshooting a highway grade crossing warning system.