MCI 3521A

MARINE CORPS INSTITUTE

TROUBLESHOOTING THE M998 ELECTRICAL SYSTEM

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IN REPLY
REFER TO:

3521A
3 Nov

03

From: Director
To: Marine Corps Institute Student

Subj: TROUBLESHOOTING THE M998 ELECTRICAL SYSTEM

1. Purpose: MCI course 3521A, *Troubleshooting the M998 Electrical System*, provides instruction to all Marines performing organizational maintenance duties on the M998.

2. Scope: MCI 3521A is a hands-on, performance-oriented course designed to provide the skills needed to effectively troubleshoot the electrical system of the M998. The course consists of modules containing self-instructional dialogues and performance tests. These modules require the student to troubleshoot simulated faults on an M998 using the technical manual and the appropriate test equipment. It also contains the Student Evaluation Guide Job Aid for Marines
who have been assigned as course administrators.

3. Applicability: This course is for instructional purposes only. It is for use by Marines in the ranks of private through sergeant who have assignments as organizational mechanics in units equipped with the M998.

4. Recommendations: We invite comments and recommendations on the content of the course text. Your remarks will aid in subsequent revisions. To comment on the course, complete the Student Questionnaire located at the end of the course. Return the questionnaire to your proctor to mail with your grade report form.

T. M. FRANUS
By direction

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TROUBLESHOOTING THE M998 ELECTRICAL SYSTEM

CONTENTS

		Page
Contents		i
Student Information		iii
Study Guide		v
Course Preview/Preparation		ix
Module #1	Using the Technical Manual	1-1
Dialogue	Performance Exercise	1-9
Module #2	Troubleshooting the M998 Battery System	2-1
Dialogue	Performance Test	2-21
Module #3	Troubleshooting the M998 Starting System	3-1
Dialogue	Performance Test	3-19
Module #4	Troubleshooting the M998 Generating System	4-1
Dialogue	Performance Test	4-29
Module #5	Troubleshooting the M998 Lighting and Instrument System	5-1
Dialogue	Performance Test	5-29
Module #6	Troubleshooting the M998 Lighting and Instrument System	6-1
Dialogue	Performance Test	6-27

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Student Information

Number and Title	MCI 3521A TROUBLESHOOTING THE M998 ELECTRICAL SYSTEM
Study Hours	18
Course Materials	Text Student Evaluation Guide Job Aid
Review Agency	MCSSSS, Camp Lejeune, NC 28542
Reserve Retirement Credits (RRC)	6
ACE	Not applicable to civilian training/education
Assistance	For administrative assistance, have your training officer or NCO log on to the MCI home page at www.mci.usmc.mil. Marines CONUS may call toll free 1-800-MCI-USMC. Marines worldwide may call commercial (202) 685-7596 or DSN 325-7596. Unlike most MCI courses, you will need additional materials and equipment to the text provided. Each module contains a list of all materials and equipment needed to complete that module. **Be sure to review the list before you begin the module!** For assistance concerning course content, subject matter, or equipment/materials, see your course manager or course administrator.

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Study Guide

Congratulations

Congratulations on your enrollment in a distance education course from the Distance Learning and Technologies Department (DLTD) of the Marine Corps Institute (MCI). Since 1920, the Marine Corps Institute has been helping tens of thousands of hard-charging Marines, like you, improve their technical job performance skills through distance learning. By enrolling in this course, you have shown a desire to improve the skills you have and master new skills to enhance your job performance. The distance learning course you have chosen, MCI 3521A, *Troubleshooting the M998 Electrical System,* has been published to provide instruction to Marines in the ranks of private through sergeant who have assignments as organizational mechanics in units equipped with the M998.

Your Personal Characteristics

- **YOU ARE PROPERLY MOTIVATED.** You have made a positive decision to get training on your own. Self-motivation is perhaps the most important force in learning or achieving anything. Doing whatever is necessary to learn is motivation. You have it!

- **YOU SEEK TO IMPROVE YOURSELF.** You are enrolled to improve those skills you already possess, and to learn new skills. When you improve yourself, you improve the Corps!

- **YOU HAVE THE INITIATIVE TO ACT.** By acting on your own, you have shown you are a self-starter, willing to reach out for opportunities to learn and grow.

- **YOU ACCEPT CHALLENGES.** You have self-confidence and believe in your ability to acquire knowledge and skills. You have the self-confidence to set goals and the ability to achieve them, enabling you to meet every challenge.

- **YOU ARE ABLE TO SET AND ACCOMPLISH PRACTICAL GOALS.** You are willing to commit time, effort, and the resources necessary to set and accomplish your goals. These professional traits will help you successfully complete this distance-learning course.

Continued on next page

Beginning Your Course

This course is different from most other MCI courses in that there is a course manager (assigned officer) and a course administrator (assigned sergeant or above in the motor transport maintenance field) who will be assisting you with your studies and evaluating your performance. If you do not know who your course manager or course administrator is, see your training officer or NCO.

The course consists of modules. Each module contains a list of all materials and equipment needed to complete **that** module. **As stated in the student information page, be sure to review the list before you begin each module**. If you do not have access to the required equipment or materials, see your course manager or course administrator.

Leafing Through the Text

Leaf through the text and look at the course. Read a few module exercise questions to get an idea of the type of material in the course. If the course has additional study aids, such as a handbook or plotting board, familiarize yourself with them.

Reading the Coarse Goal and Performance Objectives

The course you have chosen is designed to provide you with those skills needed to effectively troubleshoot the electrical system of the M998.

You will be troubleshooting simulated faults on the M998 using module dialogues and tests, the technical manual, and appropriate tools and test equipment. Each module contains a performance objective, which describes in concise terms what the successful learner, you, will be able to do as a result of the instruction. Read these objectives carefully.

To familiarize you with the contents of the course, read through the table of contents. Note the subjects covered and the order in which they are presented. Complete the modules in sequences.

Preview/ Preparation

The course preview preparation module is designed to help prepare you for the dialogues. It contains required readings and lists of common terms and definitions and explains the procedures for using the dialogues and for taking the performance exercise and tests. Read it and the required readings carefully.

Continued on next page

Module Dialogues

This course has six self-instructional dialogues: There is one for each course module. Think of the dialogues and the technical manual ™ as being your instructor. Complete each dialogue in sequence and each of the tasks in the dialogues in sequence. You will do this by performing hands-on tasks using the M998, the TM, and test equipment.

Completing the Exercises

To determine your mastery of the performance objectives, complete the exercise or tests that have been developed for each dialogue. After completion of the exercises; use the answers, located at the end of each exercise, to check your work.

Seeking Assistance

If you have problems with the dialogues or tasks that you cannot resolve, ask your course administrator. If your course administrator cannot help you, ask your course manager for assistance.

Preparing for the Final Exam

To prepare for your final exam, you must review what you learned in the course. The following suggestions will help make the review interesting and challenging.

- **CHALLENGE YOURSELF.** Try to recall the entire learning sequence without referring to the text. Can you do it? Now look back at the text to see if you have left anything out. This review should be interesting. Undoubtedly, you'll find you were not able to recall everything. But with a little effort, you'll be able to recall a great deal of the information.

- **USE UNUSED MINUTES.** Use your spare moments to review. Read your notes or a part of a module dialogue, rework performance tasks, exercise items, review again; you can do many of these things during the unused minutes of every day.

Continued on next page

Preparing for the Final Exam, Continued

- **APPLY WHAT YOU HAVE LEARNED.** It is always best to use the skill or knowledge you've learned as soon as possible. If it isn't possible to actually use the skill or knowledge, at least try to imagine a situation in which you would apply this learning. For example make up and solve your own problems. Or, better still, make up and solve problems that use most of the elements of a module.

- **USE THE "SHAKEDOWN CRUISE" TECHNIQUE.** Ask another Marine to lend a hand by asking you questions about the course. Choose a particular module and let your buddy "fire away." This technique can be interesting and challenging for both of you!

- **MAKE REVIEWS FUN AND BENEFICIAL.** Reviews are good habits that enhance learning. They don't have to be long and tedious. In fact, some learners find short reviews, conducted more often prove more beneficial.

Tackling the Final Exam

When you have completed all module dialogues and tests, your course manager will submit a grade report form indicating course completion to MCI. You will be graded on a pass/fail basis using a specific set of standards. Be sure to give your grade report form and the business reply envelope addressed to MCI to your course manager along with the student questionnaire.

Completing Your Course

The sooner you complete your course, the sooner you can better yourself by applying what you've learned! HOWEVER--you do have 2 years from the date of enrollment to complete this course.

Graduating!

As a graduate of this distance education course and as a dedicated Marine, your job performance skills will improve, benefiting you, your unit, and the Marine Corps.

Semper Fidelis!

COURSE PREVIEW/PREPARATION

TARGET AUDIENCE:

All organizational mechanics (MOS 3521)

ORGANIZATIONAL/COURSE GOALS:

A basic organizational goal of any Marine Corps unit that performs organizational maintenance on motor transport equipment is to have **operational vehicles**. One way to achieve this goal is to perform troubleshooting procedures that will **correctly identify faults** when they occur. This course will provide you, the organizational mechanic, with those skills needed to effectively troubleshoot the electrical system of the M998 Series High Mobility Multipurpose Wheeled Vehicle (HMMWV).

COURSE OBJECTIVE:

Given simulated faults on a M998, the TM, and the tools and test equipment, you will use diagnostic troubleshooting procedures to determine the cause of the faults and then state the action required to correct the faults found.

OUTLINE OF MAJOR TASKS THAT YOU WILL PERFORM:

TASK 1: Using the Technical Manual

TASK 2: Troubleshooting the M998 Battery System

TASK 3: Troubleshooting the M998 Starting System

TASK 4: Troubleshooting the M998 Generating System

TASK 5: Troubleshooting the M998 Lighting and Instrument Systems

TASK 6: Troubleshooting the M998 Glowplug System

COURSE PREREQUISITES:

You must be able to OPERATE the M998 and be FAMILIAR with BASIC SET UP PROCEDURES for operating the STE/ICE-R and a MULTIMETER. If you cannot perform these prerequisites, see your course administrator NOW!

REQUIRED READING:

Pages 1-35 through 1-58 (paragraphs 1-16 through 1-34) of TM 9-2320-280-20-1. Pay close attention to the pages that explain how components of the electrical system of the M998 series vehicles operate.

Page 2-39 and 2-40 (paragraph 2-16) and pages 2-41 (paragraph 2-17) of TM 9-2320-280-20-1. These pages contain basic information that is essential to electrical system troubleshooting.

Page 2-71 (paragraph 2-21) and pages 2-86 through 2-94 of TM 9-2320-280-20-1. On these pages you will find electrical circuit diagrams that show various interfaces between systems. You may need to use these diagrams if you are having trouble locating faults within specific systems.

Pages 2-733 through 2-752 of TM 9-2320-280-20-1. You will be using these pages when using the STE/ICE-R to perform tests during the course.

Pages 2-753 through 2-766 of TM 9-2320-280-20-1. These pages describe the basic set-up and operation of the STE/ICE-R.

Look at the functional flow diagrams of the electrical systems located in back of TM 9-2320-280-20-1. Again, you may need to refer to these diagrams while performing various tests in the course.

Did you read the above readings? If not, read them now!

Note: If you have any questions concerning the required reading assignment, see your assigned course administrator.

GETTING STARTED:

For this course you will not be required to memorize any troubleshooting procedures. You will be using self instructional dialogues along with the TM to teach you how to effectively troubleshoot the electrical system of the M998. Think of the dialogues and the TM as being your instructor.

Each module dialogue is sequentially numbered; complete them in sequence.

The first module consists of tasks that relate to troubleshooting in general and to the use of TM 9-2320-280-20-1. All course modules require you to use this TM.

Module dialogues are designed for individual student use; however, you may want to work with another student when performing some of the required actions.

PROCEDURE FOR USING THE MODULE DIALOGUES:

A statement such as the one below will inform you of a required action. It is important that you perform the action(s) stated; normally, this will be a reading assignment in the TM. This is your instructional element.

Example of an instructional element:

> **Study paragraph 2-14 (pages 2-33 through 2-37) of the TM. After you have studied these pages, read the situation below and answer the questions that follow. You will need to use the TM just as you would when troubleshooting a fault.**

After the instructional element, a situation and a series of questions or actions will allow you to apply what you learned in the instructional element. An example of a situation and typical questions are shown below. You should carefully read the situation and then answer the questions/perform the actions.

Example of a situation:

Situation: The description of work block of the equipment repair order (ERO) states the "vehicle won't start." Upon verification, you determine that a problem does exist and further troubleshooting is needed. You selected the startability test, page 2-41, for troubleshooting the symptom. Study Startability Test Question #1, the Diagnostic Logic and the Reference Information, on page 2-42 and answer these questions:

Example of questions/actions:

> **1. What is the known information?**
>
> **2. List the first three possible problems.**

Once you respond to the questions or actions, the text will provide you with feedback for your responses and the location or reference in the TM that addresses the response. If you didn't answer the question correctly, refer back to the reference pages provided. Your course administrator will also be available to provide assistance and feedback/rationale as needed. An example of feedback appears on the next page.

Example of feedback:

Here are the correct answers and the references for them:

1. Nothing

(Refer to the Known Information block.)

2. a. Starter system

b. Batteries

c. Fuel system

(These items are found in the Possible Problems block.)

THE PERFORMANCE TEST:

Once you successfully complete the module dialogue, you will be required to take a hands-on performance test that will give you the opportunity to use the skills you have acquired in the dialogue. You will be asked to respond to various situations and questions that simulate actual troubleshooting procedures. You will be graded on a Pass/Fail basis. Your course administrator will be your evaluator. You will not be allowed to work with another student while performing the tests.

COMMON ELECTRICAL TERMS YOU SHOULD BE FAMILIAR WITH:

Alternator:

An alternating current (AC) generator that uses engine power to produce electricity.

Ammeter:

An instrument that measures current flow, in amperes (amps).

Ampere (amp):

Unit of measurement for the flow of electric current.

Charging rate:

The rate of flow, in amps, of electric current flowing through a battery while it is being charged.

Circuit:

A path or combination of paths through which electric current is possible.

Circuit breaker:

A device for interrupting an electrical circuit. It protects the circuit from excess current damage.

Conductor:

Material through which electric current will readily flow.

Current:

Flow of electricity, measured in amps.

Direct current (dc):

Electric current that flows in one direction only.

Fuse:

A device containing an element (wire) that carries a limited amount of current, then melts and opens the circuit to avoid damage from excessive current flow.

Glowplug:

An electric heating element placed in some diesel engines that aids in cold weather starting.

Ground/negative

A connection of an electrical unit to the engine or frame that allows the return of current to its source.

Multimeter:

A voltmeter, ammeter, and ohmmeter combined in one housing.

Ohm:

A measure of electrical resistance. A conductor of 1-ohm resistance allows a flow of 1 ampere of current when 1 volt is imposed on it.

Ohmmeter:

An instrument that measures the resistance to current flow in ohms.

Resistance:

The opposition to the flow of current in an electrical component or circuit.

Resistor:

A device that has a definite value of resistance that serves a definite purpose by virtue of that resistance.

Sensor:

A device which mechanically, electrically, or thermally senses a state of change and activates a mechanism to compensate for change.

Short circuit:

In an electrical circuit, it is an abnormal connection that permits current to take a short path, thus by-passing important parts of the normal circuit.

Solenoid:

A coil of wire that exhibits magnetic properties when electric current passes through it. Often used to actuate mechanisms by electrical means.

Volt:

A unit of electrical force that causes a current of one ampere to flow through a resistance of one ohm.

Voltage:

The electrical force that causes current to flow through a resistance.

Voltage drop:

Decrease in voltage as current passes through a resistance.

Voltage regulator:

An electrical device used to regulate voltage output.

Voltmeter:

An instrument that measures electrical pressure (voltage).

Wiring diagrams (schematics):

Drawings that show how the wires connect to each component in an electrical or electronic circuit. Symbols represent components and lines represent wires. They serve as electrical roadmaps.

COMMON TERMS THAT RELATE TO THE USE OF THE TECHNICAL MANUAL:

Top level tests:

> These are tests used to troubleshoot general symptoms such as vehicle will not start, engine runs rough, etc.

System level tests:

> These are tests to use if you know what you are doing and have a good idea as to the vehicle system involved.

Diagnostic troubleshooting:

> This refers to the investigation or analysis of a problem for the purpose of identifying symptoms and causes.

Diagnostic logic and flowcharts:

> The diagnostic logic and flowcharts are on the left-hand pages of the troubleshooting guide. The flowchart contains questions to be answered. The diagnostic logic provides test options, reasons for asking the questions, known information, and a list of possible problems.

Reason for question:

> This block box (located on the left-hand page of the troubleshooting guide) provides you with the reason for asking the question. If you know why a question is being asked, it often makes it easier to understand the diagnostic logic and easier to answer the question.

Known info:

> This block box (located on the left-hand page of the troubleshooting guide) indicates what is known about the vehicle's condition. As you follow a test chain, information that is known will be listed here after being checked OK.

Possible problems:

> This block box (located on the left-hand page of the troubleshooting guide) is opposite to the Known Information box. Possible causes are listed in these blocks until they have been tested and shown to be OK.

Test options:

This block box (located on the left-hand page of the troubleshooting guide) lists at least one way of getting the answer to the question. When there is more than one way to get the answer, the different options will be given. Usually the easiest or best (preferred) option is listed first.

Test questions:

This block box (located on the left-hand page of the troubleshooting guide) provides you with the question to be answered. A Yes or No answer is required.

Reference information:

This is the supporting information (located on the right-hand page of the troubleshooting guide) that will help you perform the tests and answer the questions on the left-hand page of the troubleshooting guide. It includes important warning and caution statements that must be observed.

Test procedures:

These are special notes (located on the right-hand page of the troubleshooting guide) about how to make measurements with the test equipment. The procedures presume a basic working knowledge of the equipment to be used, but references are included for the less experienced operator.

Pictures:

The pictures (located on the right-hand page of the troubleshooting guide) help you locate what you're looking for, such as a pin in a connector or a particular wire or component.

COMMON TERMS THAT RELATE TO THE USE OF SIMPLIFIED TEST EQUIPMENT/INTERNAL COMBUSTION ENGINE-REPROGRAMABLE, (STE/ICE-R):

TK (and TK Mode):

Transducer Kit, a collection of transducers, adapters, and fittings which permit the STE/ICE-R to be used as a general purpose measurement system for any application. It allows the STE/ICE-R to be used anywhere that you want to measure voltage, current, resistance, pressure, or speed. The TK mode is what you are doing when you use the kit (as opposed to DCA mode where you are using the vehicle's built-in sensors to make measurements).

Transducer:

A device by which one form of energy may be converted to another form, such as mechanical to electrical.

UEH (VEH):

Prompting signal to enter the vehicle identification number.

VIN:

Vehicle Identification Number. For the M998, it is 21.

VTM:

Vehicle Test Meter, an instrument which performs the measurement and analysis functions of the STE/ICE-R system.

GO:

Signal to crank the engine when performing certain tests.

OFF:

Signal to stop cranking the engine when performing certain tests.

66:

Prompting signal for entering 99 when performing the confidence test.

99 (Confidence test):

A self-test designed to check operation of the STE/ICE-R Vehicle Test Meter.

Interleave test:

A test that alternately measures two parameters at the same time, such as engine speed and alternator voltage output.

Offset test:

This test nulls out characteristic differences in the VTM, test leads, and transducers. It zeros the meter.

Pass/fail:

Indicates the component you are checking either passes or fails the test.

.9.9.9.9:

Indicates the VTM is reading a test value beyond the range of its measurement capability.

.8.8.8.8:

Indicates there is power to the VTM, and all elements of the readout display are operative.

DCA:

Diagnostic Connector Assembly. An electrical connector mounted on the vehicle that allows the STE/ICE-R to be powered and to make measurements from a single connection.

Go chain:

A series of tests to be followed in a particular order or sequence.

SAFETY:

Safety is the last area we'll discuss at length; however, keep in mind that it's hardly the least important. Remember, you will encounter the same hazards when performing hands-on exercises as you would encounter if you were actually working on a vehicle on a daily basis.

Warnings and cautions to observe while performing hands-on exercises:

Remove all jewelry such as rings, dog tags, bracelets, etc.

Disconnect the negative battery cable before disconnecting any harness from the protective control box or serious injury to personnel or damage to equipment will result.

Do not perform battery system checks or inspections while smoking or holding an open flame. Always keep batteries away from fire, flames, or sparks. Keep hands and arms away from the fan blade and drive belts while the engine is running.

When removing battery cable clamps, disconnect the ground (negative) cable first. Be sure that all switches are in the OFF position before disconnecting battery cables. Do not allow tools to come in contact with the vehicle when disconnecting cable clamps. A direct short can result, causing instant heating of tools, battery damage, or battery explosion.

If you have any questions concerning the required readings or the procedures for completing the dialogues or performance tests, see your course administrator for assistance or help. If you have no questions, you are now ready to complete the dialogue for module #1.

MODULE #1 DIALOGUE

USING THE TECHNICAL MANUAL

INTRODUCTION:

The technical manual provides the only reliable source for diagnosing electrical problems; you must be able to use the TM effectively! You will find that TM 9-2320-280-20-1 has a new look, different from that of most TMs you've been using. The TM includes extensive troubleshooting guides for specific systems. The guides lead directly to step-by-step directions for problem solving.

Of course, you will use TM 9-2320-280-20-1 to troubleshoot the electrical system of the M998 series HMMWV. This module dialogue will teach you how to use the TM effectively.

PERFORMANCE OBJECTIVE:

Given situations stating that faults exist within the electrical system of the M998 series HMMWV, you will **use TM 9-2320-280-20-1** to identify the most appropriate test to diagnose the fault. Using the diagnostic and logic flowcharts in the TM, you will determine the causes of the faults.

OUTLINE OF TASKS THAT YOU WILL PERFORM:

TASK A: SELECT THE MOST APPROPRIATE TEST

TASK B: USE DIAGNOSTIC LOGIC FLOWCHARTS AND REFERENCE INFORMATION

PREPARING FOR THE MODULE:

To perform the tasks, you will need the following:

1. Module #1 dialogue--Using the Technical Manual
2. TM-9-2320-280-20-1

BACKGROUND:

In most cases, you will be informed of a problem (potential troubleshooting requirement) when your supervisor hands you an Equipment Repair Order (ERO) with an entry in the **Description of Work** column. There are also occasions when a vehicle operator (or the operator's supervisor) may come to you with a problem. Sometimes the information you will be provided will be

vague; your supervisor or the operator may not know exactly what the problem is. This is OK; that's why there are troubleshooting guides in the TMs.

At other times, the information you will be provided may be very specific; you are told exactly what's wrong and how to correct it! But, if this information is incorrect (even though specific), it can be costly. Parts are replaced every day because someone **assumed** they were defective. Don't become a parts replacer. Make sure you know exactly what the fault is before taking any type of corrective action.

When you are given a task that involves specific instructions, you must ask questions. Don't assume that someone before you diagnosed the fault correctly. The following is an example of the type of questions to ask when you are told to do a specific task such as "**Replace the batteries**."

ASK:

Why do the batteries need to be replaced?

How was it determined that the batteries were bad?

Do both batteries need to be replaced?

What's wrong with the batteries?

Who determined that the batteries were bad?

Again, don't become a parts replacer. Follow this rule:

Rule: Always ask questions; don't assume that someone before you has diagnosed the fault correctly.

TASK A: SELECT THE MOST APPROPRIATE TEST

When given an ERO indicating that troubleshooting is necessary, or when asked to troubleshoot a fault, first ask questions; the next step is to select the test from TM 9-2320-280-20-1 to best troubleshoot the fault.

Study pages vi through xi of the TM. After you have studied those pages, read the situation below and answer the questions that follow. You will need to use the actual pages of the TM just as you would when troubleshooting a fault.

Situation: The description of work block of the ERO states the "**vehicle won't start**." Upon questioning your supervisor, you determine that the vehicle definitely won't start. Your supervisor thinks that there is an electrical problem within the starter circuit, but doesn't know exactly what is wrong. Further troubleshooting is needed.

1. What chapter would you select from the cover of the TM to determine why the vehicle will not start?

   _____

2. What section of chapter 2 would you select from the table of contents to determine why the vehicle will not start?

   _____

3. According to section IV, paragraph 2-12 (page 2-30), from who should you obtain information that might help you determine the cause of a problem?

   _____

4. Using paragraph 2-12 (page 2-30), record the VIN number for the M998 series vehicle.

   _____

5. Using paragraph 2-13, (page 2-31), record the paragraph numbers and page numbers for the following tests:

   a. Lights: Page no. _____ Para. no. _____

   b. DC troubleshooting: Page no. _____ Para. no. _____

   c. Starter circuit: Page no. _____ Para. no. _____

6. Using paragraph 2-14 (page 2-32), record the foldout (FO) numbers for the following system level tests:

   a. Battery circuit _____

   b. Starter circuit _____

   c. Alternator circuit _____

7. Using paragraph 2-14 (page 2-33), record the tests and page numbers for the **top level test** and the **system level test** that would most likely be used to determine why the vehicle will not start if you know that the fault is within the starter circuit.

   a. Top level test: _____ Page no: _____

   b. System level test: _____ Page no: _____

Here are the correct answers to the questions:

1. Chapter 2. (You should have selected this chapter from the cover of the TM because this chapter covers troubleshooting.)

2. Section IV. (You should have selected this section from the table of contents, page ii, because this section covers electrical troubleshooting.)

3. The operator. [Refer to paragraph 2-12d(1).]

4. 21. (The VIN is found in paragraph 2-12e, page 2-30.)

5. a. 2-389, 2-33
   b. 2-723, 2-42
   c. 2-261, 2-30

   (The pages and paragraphs were determined from the index on page 2-32, paragraph 2-14.)

6. a. FO-7
   b. FO-8
   c. FO-6

   (These foldouts to include their location are determined from paragraph 2-14, page 2-16.)

7. a. Engine Starting, page 2-41
   b. Starter Circuit, page 2-261

   (These are the most common tests that would be used to troubleshoot the symptom "**vehicle won't start**." They are not necessarily the only tests that you could select. Remember, select top level tests for general symptoms and system level tests for specific symptoms.)

TASK B: USE DIAGNOSTIC LOGIC FLOWCHARTS AND REFERENCE INFORMATION

Once you have selected the appropriate top level or system level test, your next step is to troubleshoot the fault using the DIAGNOSTIC LOGIC FLOWCHART to include the REFERENCE INFORMATION for that system.

Study paragraph 2-14 (pages 2-32 through 2-37) of the TM. After you have studied these pages, read the situation below and answer the questions that follow. You will need to use the TM just as you would when troubleshooting a fault.

Situation: The description of work block of the ERO states the "**vehicle won't start**." Upon questioning your supervisor, you determine that a problem does exist within the starting system and further troubleshooting is needed. Select the startability test, page 2-41, for troubleshooting the symptom. Study the startability test question #1 and all of the reference information. Then answer these questions:

1. What is the known information?
   _____

2. List the first three items in the Possible Problems block.

   a. _____

   b. _____

   c. _____

3. What are your test options?

   a. _____

   b. _____

4. Which test option is recommended or considered the best option?
   _____

5. Test Question #1 asks "Does the engine crank normally?" Why is this question being asked?
   _____

   _____

6. Before performing the listen test, what should be done?

_____

7. What should the normal cranking RPM be?

_____

8. Assume that while you were performing the listen test, the engine cranked over very slowly (below 100 RPM). Based on this result, what should you do?

_____

Here are the correct answers to the questions:

1. Vehicle won't start and nothing else. (You found out that the vehicle would not start from the situation. Nothing came from the Known Info block.)

2. a. Starter system
   b. Batteries
   c. Fuel system

   (These items are found in the Possible Problems block.)

3. a. Listen test
   b. STE/ICE-R Test #10 (for RPM)

   (These items are found in the Test Options block.)

4. Listen test. (Test Options on page 2-36 states that the first test option is usually the best option.)

5. If the engine cranks normally, the battery and starter are good enough to start the engine. (This is found in the Reason For Question block.)

6. Make sure all of the vehicle's fluids are at the proper level. (This is found on the Reference Information page.)

7. Approximately 100 to 200 rpm. (This is found in the STE-ICE/R Test #10 block on the Reference Information page.)

8. Follow the NO path, go to the Starter Circuit Test (engine does not turn over at least 100 RPM's).

If you feel that you have successfully answered all the questions in this dialogue, you should be ready to complete the performance exercise. See your course administrator at this time.

If you feel you are not ready for the performance exercise, review the dialogue and the technical manual until you feel that you can successfully answer all the questions in the dialogue.

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MODULE #1 PERFORMANCE EXERCISE

USING THE TECHNICAL MANUAL

INTRODUCTION: Having successfully completed the instructional portion of the module, you will now put the skills you have gained to use. Complete the performance exercise using the TM in the same manner that you would use it on the job.

PERFORMANCE OBJECTIVE: Given situations stating that faults exist within the electrical system of the M998 series HMMWV, you will use **TM 9-2320-280-20-1** to identify the most appropriate tests to diagnose the faults. Using the diagnostic and logic flowcharts in the TM, you will determine the causes of the faults.

TASKS TO BE PERFORMED:

TASK A: Select the Most Appropriate Test

TASK B: Use Diagnostic Logic Flowcharts and Reference Information

MATERIALS REQUIRED:

MODULE #1 PERFORMANCE EXERCISE

TM 9-2320-280-20-1

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TASK A: SELECT THE MOST APPROPRIATE TEST

INSTRUCTIONS: For this task, you will be using the TM to select the most appropriate test to diagnose a fault.

Read the situation carefully and then answer the questions or complete the statements that follow. Once you have completed this task, perform Task B.

Situation: You are a mechanic working in a motor pool that is responsible for performing organizational maintenance. Your shop chief has just handed you an ERO stating that the "**volt gage is inoperative**" on one of the M998's. After questioning the shop chief, you have concluded that power is available to the volt gage and all other gages are functioning normally. The exact defect is unknown.

1. What chapter would you select from the cover of the TM to troubleshoot the gage?

   _____

2. What section of chapter 2 would you select from the table of contents to determine why the gage is inoperative?

   _____

3. Using section IV, paragraph 2-12, determine the chapter that contains the operating principles for the various vehicle systems and is often used as a reference when performing electrical/mechanical troubleshooting.

   Chapter _____

4. What is the STE/ICE-R VIN number for the M998 series vehicle?

   _____

5. What paragraph and page number would you select from page 2-31 if you wanted to determine how to perform a particular test with the STE/ICE-R?

   Paragraph No. _____ Page No. _____

6. What paragraph and page number would you select from page 2-31 to find out what the term VTM means?

   Paragraph No. _____ Page No. _____

7. Using paragraph 2-14 (page 2-32), record the foldout number for the system level test that should be used to troubleshoot the fault identified in the situation.

   FO-____

8. Based on the situation, would you select a top level or a system level test (paragraph 2-14, page 2-33) to troubleshoot the gage? Circle your answer.

   a. Top level test

   b. System level test

9. What system test listed on page 2-33 would you select to begin testing?

   _____

Here are the correct answers to the questions:

1. Chapter 2, Service and Troubleshooting. (Refer to the TM cover.)

2. Section IV, Electrical and Mechanical Troubleshooting. (Refer to Table of Contents, page ii.)

3. 1. (Refer to paragraph 2-12b.)

4. #21. (Refer to paragraph 2-12e.)

5. 2-43, 2-733. (Refer to STE/ICE-R test procedures, paragraph 2-15, page 2-31.)

6. 2-15, 2-22. (Refer to Glossary of Abbreviations and Commonly Used Terms, paragraph (2-15, page 2-38.)

7. FO-10. (Refer to page 2-32.)

8. b. Based on the situation, the system level test would provide the most direct troubleshooting logic. It is usually best to go straight to the system level test as long as you know what you are doing. (Refer to page 2-34.)

9. Instrument Test. (It would be the best choice based on the situation. Remember, it was stated that power was available to the gage and all other systems were functioning.)

TASK B: USE DIAGNOSTIC LOGIC FLOWCHARTS AND REFERENCE INFORMATION

INSTRUCTIONS: For this task, you will be using the Diagnostic Logic Flowchart and Reference Information pages of the TM to access information that you would normally need to know when troubleshooting an actual fault. Since you have successfully completed Task A, you will not be required to select the most appropriate test for troubleshooting the fault; you should already be proficient at doing that.

Read the situation carefully and then answer the questions that follow.

Situation: You are a mechanic working in a motor pool that is responsible for performing organizational maintenance. The ERO provided by your shop chief states that the "**alternator is not charging**" on one of the M998's. The shop chief assured you that the batteries were serviceable; they were just replaced. Assume that you have just used the TM to locate the most appropriate starting point for troubleshooting the fault. You have selected the Alternator Circuit Tests as the starting point. You have just turned page 2-195 and are ready to answer Alternator Circuit Test Question #1.

1. In Test Question #1 you are asked if the alternator drive belts are tight and in good condition. What is the reason for asking this question?

   _____

   _____

2. What is/are your test option(s) for Test Question #1?

   _____

3. Assume that you are getting ready to check the belt tension using the belt tension gage and you have forgotten how to check it. What paragraph would you refer to for additional information on checking belt tension?

   _____

4. List the possible problems that could exist at this point.

   a. _____

   b. _____

   c. _____

   d. _____

5. Which one of the possible problems are you eliminating by asking Test Question #1?

_____

6. Assume that you have checked the belts and determined that they are tight and in good condition. What should you do?

_____

7. In Test Question #2 you are asked if all wire connections to the alternator are clean, tight, and making good connection. What is the reason for asking this question?

_____

_____

8. What is/are your test option(s) for Test Question #2?

_____

9. Assume that you performed the visual inspection and found an alternator cable connection loose. What should you do?

_____

10. Before disconnecting the protective control box harness to inspect the connector, what cable should you disconnect?

_____

11. Assume that you still have a problem after tightening the cable mentioned in Test Question #2. What should you do?

_____

Here are the correct answers to the questions:

1. If the belts are loose or worn, the engine will not drive the alternator fast enough to recharge the batteries. (Refer to the Reason For Question block.)

2. Visual inspection, belt tension gage. (Refer to the Test Option block.)

3. Paragraph 3-82 (except A2 vehicles). (Refer to the first paragraph on the Reference Information page.)

4. a. Alternator
   b. Control Box
   c. Wiring
   d. Belts

   (Refer to the Possible Problems block.)

5. Belts. (Refer to Test Question #1 and the Known Info block of Test Question #2.)

6. Follow the YES path; go to Test Question #2, page 2-196.

7. Loose or dirty connections can prevent a good alternator from charging the batteries. (Refer to the Reason for Question block.)

8. Visual inspection. (Refer to the Test Options block.)

9. Tighten the connector. (Refer to the statement in the NO path.)

10. Negative battery cable. (Refer to the warning statement on the Reference Information page.)

11. Continue testing, go to Test Question #3. (Refer to the statement in the NO path.)

If you had any problems answering the questions in this exercise, see your course administrator. If you didn't have any problems, continue with the dialogue for module #2.

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MODULE #2 DIALOGUE

TROUBLESHOOTING THE M998 BATTERY SYSTEM

INTRODUCTION:

Up to this point, you have learned the procedures for using TM 9-2320-280-20-1 to identify the appropriate test(s) by using the diagnostic flowcharts to diagnose the cause of the faults. In this module, you will continue learning by performing various actions that relate to troubleshooting the M998 battery system.

As an organizational mechanic, you must be able to effectively troubleshoot the battery system. Of all the electrical components of the M998, the batteries are most often the source of electrical problems. This is true for various reasons including poor preventive maintenance and heavy demand requirements such as cold weather starting, radio operations, etc.

PERFORMANCE OBJECTIVE:

Given situations stating that faults exist within the M998 battery system, **TM 9-2320-280-20-1,** and **selected test equipment,** perform various tests to diagnose the cause of the faults. In addition, state what must be done to correct the faults.

OUTLINE OF THE TASKS THAT YOU WILL PERFORM:

TASK A: PERFORM STARTER CIRCUIT TEST QUESTION #1

TASK B: PERFORM STARTER CIRCUIT TEST QUESTION #1A

TASK C: PERFORM BATTERY CIRCUIT TEST QUESTION #1

TASK D: PERFORM BATTERY CIRCUIT TEST QUESTION #2

TASK E: PERFORM BATTERY CIRCUIT TEST QUESTION #3

TASK F: PERFORM BATTERY CIRCUIT TEST QUESTION #4

TASK G: PERFORM BATTERY CIRCUIT TEST QUESTION #5

TASK H: PERFORM BATTERY CIRCUIT TEST QUESTION #6

PREPARING FOR THE MODULE:

If you have not already done so or if you are not familiar with the M998 battery system component operation, review paragraph 1-24 on page 1-36 of TM 9-2320-280-20-1.

MATERIAL REQUIRED:

To perform the tasks in this module, you will need the following:

1. Dialogue for Module #2
2. TM 9-2320-280-20-1
3. General mechanic's toolbox
4. Droplight/flashlight
5. STE-ICE/R
6. Multimeter
7. M998 HMMWV (operational and clean)
8. Rags or handi-wipes
9. Camouflaged utilities (coveralls optional)

See your course administrator to obtain these items.

CAUTION

In this module, you will be performing hands-on type tasks. All safety rules and regulations must be observed. Before beginning, review the WARNING SUMMARY in the front of the technical manual.

TASK A: PERFORM STARTER CIRCUIT TEST QUESTION #1

Situation: In the dialogue for the previous module, you answered Startability Test Question #1 to diagnose the symptom "**vehicle will not start**." You found that when the engine turned over slowly (less than 100 RPM's), the flowchart directed you to the starter circuit tests. Assume that you have just answered Startability Test Question #1 and are ready to continue testing.

Read the GENERAL DESCRIPTION section for the starter circuit (page 2-261) and then study Starter Circuit Test Question #1, the Diagnostic Flowchart and the Reference Information (pages 2-262 and 2-263). Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the only "**known information**" is that the **engine won't start**. The TM has directed you to Test Question #1. Answer the questions below and then conduct the visual inspection. Use the chart that follows the questions to record your findings from the visual inspection.

1. Which foldout (FO) provides a schematic of the starter circuit and should be used to help determine the location of the cables and connections?

   _____

2. What action should you take if you find cables or connections that are loose or corroded?

   _____

3. What action should you take if you find broken or damaged cables or connections?

   _____

4. What action should you take if all the cables and connections are clean and serviceable and the fault **"engine won't start"** still exists?

   _____

5. Perform a visual inspection of all the cables and connections for each item listed below. Place a check indicating the condition of each of the cables or connections. If you find anything wrong that you are not able to correct, see your course administrator before continuing with this dialogue.

	Good	Clean/ repair	Replace
BATTERY	____	____	____
STARTER	____	____	____
SOLENOID	____	____	____
ROTARY SWITCH	____	____	____
PCB	____	____	____

Here are the correct answers to the questions:

1. FO8. (It is referred to in the General Description section on page 2-261. Remember, in the block above the situation, you were directed to read page 2-261)

2. Disconnect, clean, and reconnect the cable(s) or connection(s). (This is stated on the Reference Information page under the paragraph BAD CONNECTIONS ARE THE MOST COMMON PROBLEM!)

3. Repair or replace the cable(s) or connection(s). (Refer to the statement in the NO path.)

4. Follow the YES path to the next test.

5. (See your course administrator for feedback on your visual inspection.)

TASK B: PERFORM STARTER CIRCUIT TEST QUESTION #1A

Situation: You previously completed Starter Circuit Test Question #1. Let's assume that you determined that the cables and connections appear to be OK. Based on this information, the flowchart directed you to the Starter Circuit Test Question #1A.

Study Starter Circuit Test Question #1A, the Diagnostic Flowchart, and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **cables and connections appear to be in good shape**.

1. What should you do?

   _____

2. What are your test options?

   a. _____

   b. _____

   c. _____

3. Select and perform STE/ICE-R Test 67 while cranking the engine. Record the minimum acceptable voltage and the actual voltage reading below.

MINIMUM ACCEPTABLE VOLTAGE READING _____

ACTUAL VOLTAGE READING _____

4. Assume that the voltage reading was 23 volts. What would you do?

   _____

5. Assume that the voltage reading was 13 volts. What would you do?

   _____

Here are the correct answers:

1. Test for battery voltage while trying to crank the engine. (Refer to the statement in Test Question #1A.)

2. a. STE/ICE-R Test 67
   b. Multimeter
   c. Vehicle's volts gage

   (Refer to the Test Options block for information on all three tests.)

3. The minimum acceptable voltage is 18 volts. (Refer to the statement in the Test Question block. If you had a problem performing the test, ask your course administrator for feedback.

4. Follow the YES path; go to Test Question #2. (The voltage was greater than 18 volts).

5. Follow the NO path; go to the Battery Circuit Test Question #1. (The voltage was less than 18 volts).

TASK C: PERFORM BATTERY CIRCUIT TEST QUESTION #1

Situation: You previously performed Starter Circuit Test Question #1A. Let's assume that the voltage reading was 13 volts. Based on this information, the flowchart directed you to the Battery Circuit Test Question #1.

BATTERY CIRCUIT TEST QUESTION #1

Read the GENERAL DESCRIPTION section for the battery circuit (page 2-251) and then study Battery Circuit Test Question #1, Diagnostic Flowchart, and the Reference Information (pages 2-252 and 2-253). Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **cranking voltage is 13 volts** and the **condition of the batteries is unknown**. The TM has directed you to Test Question #1.

1. What is/are your test option(s)?

   _____

2. The question asks: Are all battery connections clean and tight? Do you need to perform the inspection again to answer the question?

   _____

Here are the correct answers:

1. Perform a visual inspection of the connections.

2. NO, there is no need to repeat the inspection. (Remember, there are Top Level and System Level tests. You started out using a Top Level test with the general symptom of "**engine won't start**." Checking for dirty connections is common to both levels of testing and you've already done that check.)

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TASK D: PERFORM BATTERY CIRCUIT TEST QUESTION #2

Situation: You previously performed Battery Circuit Test Question #1. Assume that the battery connections addressed in Test Question #1 were good. Based on this information, the flowchart directed you to the Battery Circuit Test Question #2.

Study Battery Circuit Test Question #2, the Diagnostic flowchart, and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **connections are OK**.

1. What action should you take?

   _____

2. What should the correct electrolyte/water level be?

   _____

3. Using a visual inspection, check each battery cell. Did you find any of the electrolyte/water levels to be low?

   _____

4. Assume that the batteries are filled to the proper level. What action would you take?

   _____

5. Assume that the batteries are not filled to the proper level. What action would you take?

   _____

Here are the correct answers:

1. Visually inspect the electrolyte/water level. (Refer to the Test Options block.)

2. Each cell should be filled to the ring inside the battery fill plug. (Refer to the statement and diagram on the Reference Information page.)

3. This will either be YES or NO based on your inspection.

4. Follow the YES path; go to Test Question #3.

5. Follow the NO path; add water to the proper level.

TASK E: PERFORM BATTERY CIRCUIT TEST QUESTION #3

Situation: You previously completed Battery Circuit Test Question #2. Assuming that the batteries are filled to the proper level and a fault still exists, the flowchart directed you to the Battery Circuit Test Question #3.

Study Battery Circuit Test Question #3, the Diagnostic flowchart, and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **battery connections and cables are OK and the electrolyte/water levels are correct**.

1. What is Test Question #3 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. Test the battery voltage using the **multimeter**. Record the acceptable voltage range and the actual voltage reading in the box below.

ACCEPTABLE VOLTAGE RANGE _____

ACTUAL VOLTAGE READING _____

4. What should happen to the battery voltage reading when the glow plugs turn on during testing?

   _____

5. Assume that the voltage reading is between 23.5 and 25.5 volts. What should you do?

   _____

6. Assume that the voltage reading was not within the acceptable range. What should you do?

   _____

Here are the correct answers:

1. Test the battery voltage.

2. a. STE/ICE-R Test 67
   b. Multimeter

   (Refer to the Test Options block.)

3. Acceptable range is 23.5 to 25.5 volts. (Refer to the Question block for the acceptable range and ask your course administrator for feedback on the voltage reading you obtained.)

4. The voltage will drop. (This is found in the Battery Voltage STE/ICE-R Test 67 block on the Reference Information page.)

5. Follow the YES path; go to Test Question #4 on page 2-254.

6. Follow the NO path; go to Battery Circuit on page 2-256.

TASK F: PERFORM BATTERY CIRCUIT TEST QUESTION #4

Situation: You previously completed Battery Circuit Test Question #3. Let's assume that the battery voltage was 23.7 volts. Based on this information, the flowchart directed you to the Battery Circuit Test Question #4.

Study Battery Circuit Test Question #4, the Diagnostic Flowchart, and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **battery connections, electrolyte level, battery voltage, and alternator circuit are OK**.

1. What is Test Question #4 asking you to do?

   _____

2. What is/are your test option(s)?

   _____

   _____

3. Before you perform Test 73 and/or Test 75, what wires or components must you disconnect?

   a. _____

   b. _____

   c. _____

4. Where could you go to in the TM to locate components or items such as wire 54A, the glow plug controller, or the fan clutch solenoid? (The fan clutch solenoid is located between the time delay module and the hydraulic control valve. It is actually a part of the control valve.)

   _____

5. Record the maximum allowable readings for Test 73 and Test 75 in the box below. Perform STE/ICE-R Tests 73 and 75; record your test results.

MAXIMUM ALLOWABLE READING FOR TEST 73	_____
MAXIMUM ALLOWABLE READING FOR TEST 75	_____
YOUR RESULTS FROM TEST 73	_____
YOUR RESULTS FORM TEST 75	_____

6. What does a high resistance reading indicate?

   _____

7. Assume that the battery pair resistance is above 25 milliohms and the battery resistance change is above 50 milliohms/seconds. What should you do?

   _____

8. Assume that the battery pair resistance is below 25 milliohms and the battery resistance change is below 50 milliohms/seconds. What should you do?

   _____

Here are the correct answers:

1. Test the battery pair resistance and the battery resistance change. (Refer to the statement in the Question block.)

2. STE/ICE-R Tests 73 and 75. (Refer to the Test Options block.)

3. a. Wire 54A
   b. Glowplug controller
   c. Fan solenoid (The fan clutch solenoid is located between the time delay module and the hydraulic control valve, page 1-39).

   (Refer to the NOTE in the STE/ICE-R Test 73 block on the Reference Information page. The note tells you to disconnect all three components.)

4. System foldouts, electrical circuit drawings, and section iii of chapter 1. (These are good sources for locating components. Don't forget that you must be able to use the whole TM. The foldouts are listed on page 2-32 and the electrical circuit drawings begin on page 2-86 and section III, chapter 1, on page 1-35.)

5. The maximum allowable reading for test 73 is 25 milliohms. The maximum allowable reading for test 75 is 50 milliohms/second. (Ask your course administrator for feedback on your readings for both tests.)

6. The reading indicates that the batteries are weak and may not produce enough power. (See the Reason for Question block.)

7. Follow the NO path; go to Battery Circuit Test Question #B1, page 2-258.

8. Follow the YES path; go to Battery Circuit Test Question #5.

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TASK G: PERFORM BATTERY CIRCUIT TEST QUESTION #5

Situation: You previously performed the Battery Circuit Tests 73 and 75. Let's assume that the readings were 10 milliohms for test 73 and 20 milliohms for test 75. Based on this information, the flowchart directed you to the Battery Circuit Test Question #5.

Study Battery Circuit Test Question #5, the Diagnostic Flowchart and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

The "**known information**" is that the **batteries and the alternator circuit are OK**.

1. What is Test Question #5 asking you to do?

   _____

   _____

2. What are your test options?

   _____

   _____

3. What wire must be disconnected to prevent the engine from starting while performing STE/ICE-R Test 69?

   _____

4. Record the maximum allowable voltage drop reading in the box below. Perform the starter negative voltage drop test and record your test results.

MAXIMUM ALLOWABLE VOLTAGE DROP _____

STARTER NEGATIVE VOLTAGE DROP READING _____

5. Assuming that you had a voltage drop reading of .01 volts, what should you do?

   _____

6. What does a large voltage drop indicate?

   _____

Here are the correct answers:

1. Test the starter negative cable voltage drop. (Refer to the statement in the Test Question block.)

2. a. STE/ICE-R Test 69
   b. Multimeter

   (Refer to the Test Options block.)

3. Wire 54A from the fuel solenoid. (Refer to procedures for performing STE/ICE-R Test 69 on page 2-742.)

4. The maximum voltage drop is 0.25 volts. (Refer to the Test Question block and/or STE/ICE-R Test 69 block on the Reference Information page. Ask your course administrator for feedback on your voltage drop reading.)

5. Follow the YES path; go to Battery Circuit Test Question #6.

6. High resistance. (Refer to the Reason for Question block. Remember, high resistance means less current flow.)

TASK H: PERFORM BATTERY CIRCUIT TEST QUESTION #6

You previously completed STE/ICE-R Test 69 to check the voltage drop for the starter negative cable. Let's assume that the voltage drop was less than 0.25 volts. Based on this reading, the flowchart directed you to the Battery Circuit Test Question #6.

Study Battery Circuit Test Question #6, the Diagnostic Flowchart, and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, read the situation below and follow the directions provided.

At this point the "**known information**" is that the **battery, negative starter cable, and the alternator circuit are OK**.

1. What is Test Question #6 asking you to do?

   _____

2. What are your test options and which option is preferred?

   _____

   _____

3. Where do you connect the red clip of the test lead, when performing Test 89?

   _____

4. Where do you connect the black clip of the test lead when performing Test 89? (Remember, you are checking the voltage drop in the cable that goes from the power stud to the starter.)

   _____

5. Record the maximum allowable voltage drop reading in the box provided below and then, using the STE/ICE-R Test 89, perform the voltage drop test and record your reading.

MAXIMUM ALLOWABLE VOLTAGE DROP	_____
YOUR VOLTAGE DROP READING	_____

6. What should you do if you found the cable had a voltage drop reading of more than 0.25 volts?

_____

Here are the correct answers:

1. Test for voltage drop of the cable that goes from the power stud to the starter. (Refer to the Test Question block.)

2. STE/ICE-R Test 89 and the Multimeter. (Refer to the Test Options block.) Test 89 is preferred; the first test listed is the preferred option.

3. At the power stud. (Refer to the STE/ICE-R Test 89 block on the Reference Information page.)

4. At the positive (+) terminal on the starter. This cable (6A) has a red band on its end. Don't forget that you are checking the voltage drop in the cable that goes from the power stud to the starter.

5. The maximum voltage drop is 0.25 volts. (Refer to the Test Question block and or STE/ICE-R Test 89 block on the Reference Information page. Ask your course administrator for feedback on your voltage drop reading.)

6. Repair or replace the wire 6A. (Refer to the statement in the NO path.)

This completes the dialogue for the Module #2. If you had a difficult time completing any part of it, review it again carefully paying close attention to the feedback sections and/or see your course administrator for assistance.

Once you feel confident in your ability to complete the dialogue, inform your course administrator that you are ready for the performance test.

MODULE #2 PERFORMANCE TEST

TROUBLESHOOTING THE M998 BATTERY SYSTEM

INTRODUCTION: Having successfully completed the instructional portion of the module, you will now be tested on your ability to troubleshoot the M998 battery system. You will be performing some of the same tasks that you performed in the dialogue.

PERFORMANCE OBJECTIVE: Given the technical manual, tools, TMDE, and verbal scenarios indicating various faults within the battery system, you will troubleshoot the system according to TM 9-2320-280-20-1. In addition, you will state what must be done to correct identified faults.

TASKS TO PERFORM:

TASK A: PERFORM STARTER CIRCUIT TEST QUESTION #1

TASK B: PERFORM STARTER CIRCUIT TEST QUESTION #1A

TASK C: PERFORM BATTERY CIRCUIT TEST QUESTION #1

TASK D: PERFORM BATTERY CIRCUIT TEST QUESTION #2

TASK E: PERFORM BATTERY CIRCUIT TEST QUESTION #3

TASK F: PERFORM BATTERY CIRCUIT TEST QUESTION #4

TASK G: PERFORM BATTERY CIRCUIT TEST QUESTION #5

TASK H: PERFORM BATTERY CIRCUIT TEST QUESTION #6

INSTRUCTIONS: You are expected to perform each task just as you would on the job; however, since the faults are simulated, test readings, actions, or other information needed to perform each task will be provided. If you do not understand something or have questions, **ask your course administrator.**

Your course administrator will be using a written script to guide you. Feedback will be provided as needed.

Although this is not a timed event, you will be stopped if it is determined that you are not able to successfully complete the test.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

MATERIALS REQUIRED:

1. Performance Test
2. TM 9-2320-280-20-1
3. General mechanic's toolbox
4. Droplight/flashlight
5. STE-ICE/R
6. Multimeter
7. M998 HMMWV (operational and clean)
8. Rags or handi-wipes
9. Camouflaged utilities (coveralls optional)

PERFORMANCE STANDARDS:

You will be graded on a PASS/FAIL basis. To pass this performance test, you must successfully complete all tasks on the evaluation sheet. Your ability to perform each of the tasks will be based on the professional judgment of the course administrator using the criteria listed in items 1 through 3.

Note: Your course administrator may provide a very limited amount of assistance; however, remember that your course administrator is judging your ability to perform. If he/she determines that you cannot successfully complete a task, you will not receive a passing grade for that task. Although testing is not timed, you will be stopped if the course administrator finds that you are not able to complete the test in a reasonable amount of time.

1. Demonstrate competency in the use of the tools and test equipment.

a. Select appropriate tools and test equipment for performing the task.

b. Prepare equipment for testing.

(1) Correct set-up.

(2) Perform operational check (if required).

c. Complete all necessary equipment operational steps in the correct or an acceptable sequence.

d. Read and correctly interpret the test results displayed.

2. Demonstrate competency in the use of the technical manual.

a. Locate the appropriate test in the TM for troubleshooting the simulated fault.

b. Complete all necessary test procedural steps in the correct or an acceptable sequence.

c. State the appropriate or corrective action for simulated or identified faults.

d. Locate additional reference information such as schematics, STE/ICE-R test procedures, system operation instructions, etc.

e. Locate and identify components and circuits on schematics.

3. Observe safety rules.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

When you are ready to begin testing, enter your name, rank, and social security number on the student evaluation sheet. Remove the sheet and hand it to your course administrator.

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STUDENT EVALUATION SHEET FOR MODULE #2

NAME: _____

RANK: _____

SSN: _____

GRADE: PASS FAIL

DID THE STUDENT SUCCESSFULLY COMPLETE:	**YES**	**NO**
TASK A: Perform Starter Circuit Test Question #1?		
TASK B: Perform Starter Circuit Test Question #1A?		
TASK C: Perform Starter Circuit Test Question #1?		
TASK D: Perform Starter Circuit Test Question #2?		
TASK E: Perform Starter Circuit Test Question #3?		
TASK F: Perform Starter Circuit Test Question #4?		
TASK G: Perform Starter Circuit Test Question #5?		
TASK H: Perform Starter Circuit Test Question #6?		

REMARKS:

CRS ADMINISTRATOR'S SIGNATURE: _____

CRS MANAGER'S SIGNATURE: _____

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MODULE #3 DIALOGUE

TROUBLESHOOTING THE M998 STARTING SYSTEM

INTRODUCTION:

In the previous module, you learned the procedures for using the TM and the test equipment to diagnose faults within the battery system. In this module, you will continue with your learning by performing various actions that relate to diagnosing faults within the starting system of the M998.

As an organizational mechanic, you must be able to effectively troubleshoot the starting system. Remember, the time spent in identifying and isolating the problem before replacing parts is always less costly than having to do the job over.

PERFORMANCE OBJECTIVE:

Given situations stating that faults exist within the M998 starting system, **TM 9-2320-280-20-1,** and **selected test equipment,** diagnose the cause of each fault. In addition, state the appropriate action needed to correct the faults.

OUTLINE OF TASKS THAT YOU WILL PERFORM:

TASK A: PERFORM STARTER CIRCUIT TEST QUESTION #E1

TASK B: PERFORM STARTER CIRCUIT TEST QUESTION #E2

TASK C: PERFORM STARTER CIRCUIT TEST QUESTION #E3

TASK D: PERFORM STARTER CIRCUIT TEST QUESTION #E4

TASK E: PERFORM STARTER CIRCUIT TEST QUESTION #G1

TASK F: PERFORM STARTER CIRCUIT TEST QUESTION #G2

TASK G: PERFORM STARTER CIRCUIT TEST QUESTION #I1

TASK H: PERFORM STARTER CIRCUIT TEST QUESTION #I2

PREPARING FOR THE MODULE:

If you have not already done so, or if you are not familiar with the M998 starter system component operation, review paragraph 1-21 on page 1-40 of TM 9-2320-280-20-1.

MATERIAL REQUIRED:

To perform the tasks in this module, you will need the following:

1. Dialogue for Module #3
2. TM 9-2320-280-20-1
3. General mechanic's toolbox
4. Droplight/flashlight
5. STE/ICE-R
6. Multimeter
7. M998 HMMWV (operational and clean)
8. Rags or handi-wipes
9. Camouflaged utilities (coveralls optional)
10. Creeper

See your course administrator to obtain these items.

CAUTION

In this module, you will be performing hands-on type tasks. All safety rules and regulations must be observed. Before beginning, review the WARNING SUMMARY in the front of the technical manual.

TASK A: PERFORM STARTER CIRCUIT TEST QUESTION #E1

Situation: In the previous module, you were troubleshooting the battery system to diagnose the reason that the "**vehicle would not start**." The dialogue led you through a series of tests for isolating defective components. Now, you will be troubleshooting the starter circuit. The starter circuit flowchart contains some of the same tests that you performed in the battery module. Since you successfully completed the battery module, we skipped the tests that you previously performed. There is no need to duplicate a test at which you are already proficient.

Read the GENERAL DESCRIPTION section for the starter circuit (page 2-261) and then study Starter Circuit Test Question #E1, the Diagnostic Flowchart, and the Reference Information associated with the question (pages 2-262 and 2-263). Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

You have just read pages 2-262 and 2-263 in your TM and are now ready to determine the answer to Test Question #E1; the only "**known information**" is that the **engine won't crank**.

1. What is Test Question #E1 asking you to do and why is it asking you to do it?

   _____

   _____

2. What are your test options?

   a. _____

   b. _____

3. Select and perform STE/ICE-R Test 67. Record the minimum acceptable voltage and the actual voltage in the box below.

MINIMUM ACCEPTABLE VOLTAGE READING _____

ACTUAL VOLTAGE READING _____

4. Assume that the voltage reading was 23 volts. What should you do?

_____

5. Assume that the voltage reading was below 20 volts. What should you do?

_____

Here are the correct answers:

1. To test for battery voltage because low battery voltage can prevent cranking.

   (Refer to the statements in Test Question #E1 and the Reason For Question blocks.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. The minimum acceptable voltage is 20 volts. (Refer to the statement in Test Question #E1. If you had a problem performing Test 67, see your course administrator for feedback.)

4. Follow the YES path; go to Test Question #E2. (The voltage was more than 20 volts.)

5. Follow the NO path; replace the batteries. (The voltage was less than 20 volts.) Before replacing the batteries, you should try charging them.

TASK B: PERFORM STARTER CIRCUIT TEST QUESTION #E2

Situation: You previously completed Starter Circuit Test Question #E1. Let's assume that you determined that the battery voltage was more than 20 volts. Based on this information, the flowchart directed you to the Starter Circuit Test Question #E2.

Study Starter Circuit Test Question #E2 and the Reference Information associated with the question. Once you completely understand the QUESTION, FLOWCHART and the REFERENCE INFORMATION, answer the questions and follow the directions below.

At this point, the "**known information**" is that the **batteries should at least crank the engine slowly**.

1. What is Test Question #E2 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What is the advantage of using the STE/ICE-R instead of the multimeter to perform this test?

   _____

4. Select and perform STE/ICE-R Test 68. Record the actual voltage reading in the box below.

ACTUAL VOLTAGE READING WHILE CRANKING _____

5. Assume that the voltage reading was 23 volts while cranking the engine. What should you do?

   _____

6. Assume that the voltage reading was 15 volts. What should you do?

   _____

Here are the correct answers:

1. Test for battery voltage at the starter motor (wire 6A). (Refer to the statement in Test Question #E2.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. It is easier to use because STE/ICE-R Test 68 requires DCA hookup only so the test can be performed from the inside of the vehicle. (Refer to the description of the test procedure for Test 68 on page 2-741.)

4. The voltage reading should be at least 18 volts while cranking. (Refer to the statement in STE/ICE-R Test 68 block on page 2-227. If you had a problem performing the test, ask your course administrator for feedback.)

5. Follow the YES path; go to Test Question #E3. (The voltage was at least 18 volts.)

6. Follow the NO path; go to Test Question #F1, page 2-288. (The voltage was less than 18 volts.)

TASK C: PERFORM STARTER CIRCUIT TEST QUESTION #E3

You previously completed Starter Circuit Test Question #E2. Let's assume that the voltage reading was 24 volts. Based on this information, the flowchart directed you to the Starter Circuit Test Question #E3.

Study Starter Circuit Test Question #E3, the Diagnostic Flowchart, and the Reference Information associated with the question (pages 2-284 and 2-285). Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, read the situation below and follow the directions provided.

Situation: At this point, the "**known information**" is that the **battery voltage is available at the starter**.

1. What is Test Question #E3 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. Select and perform STE/ICE-R Test 70. Record the actual voltage reading in the box below.

ACTUAL VOLTAGE READING WHILE CRANKING _____

4. Assume that the voltage reading was 19 volts while cranking the engine. What should you do?

   _____

5. Assume that the voltage reading was below 17 volts while cranking the engine. What should you do?

   _____

Here are the correct answers:

1. Test for battery voltage at solenoid switch terminal (wire 74A). (Refer to the statement in Test Question #E3.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. The voltage reading should be at least 18 volts while cranking. (Refer to the statement in STE/ICE-R Test 70 block on page 2-743. If you had a problem performing the test, ask your course administrator for feedback.)

4. Follow the YES path; go to Test Question #E4, page 2-286. (The voltage was at least 18 volts.)

5. Follow the NO path; go to Test Question #G1, page 2-290. (The voltage was less than 18 volts.)

TASK D: PERFORM STARTER CIRCUIT TEST QUESTION #E4

You previously completed Starter Circuit Test Question #E3. Let's assume that the voltage reading was 24 volts. Based on this information, the flowchart directed you to the Starter Circuit Test Question #E4.

Study Starter Circuit Test Question #E4, the Diagnostic Logic, and the Reference Information associated with the question. Once you completely understand the QUESTION, the LOGIC, and the REFERENCE INFORMATION, read the situation below and follow the directions provided.

Situation: At this point, the "**known information**" is that **battery voltage is available at the starter**, so the **PCB, rotary switch, neutral safety switch, and wiring are all OK**. You also know that the engine is not locked up.

1. What is Test Question #E4 asking you to do?

   _____

Here is the correct answer:

1. Replace the starter. (Refer to the statement in Test Question #E4.)

(This page intentionally left blank.)

Situation: You previously completed Starter Circuit Test Question #E4. By following the YES path through the series of questions, you determined that the starter was defective.

Let's now go back to Test Question #E3, page 2-284. Assume that **with the rotary switch in the start position** you **DO NOT** have battery voltage at the solenoid switch terminal, 74A. Based on this information, follow the flowchart down the NO path to Test Question #G1, page 2-290.

Study Starter Circuit Test Question #G1, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point, the "**known information**" is that **there is no solenoid control voltage**.

1. What is Test Question #G1 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What is the purpose of testing wire 14A?

   _____

4. What should the voltage be at wire 14A (neutral safety switch end) with the rotary switch turned to the start position?

   _____

5. Select and perform this voltage test with the multimeter. Record the actual voltage reading in the box below.

ACTUAL VOLTAGE READING _____

6. Assume that the voltage reading was 24.5 volts. What should you do?

_____

7. Assume that the voltage reading was 16 volts. What should you do?

_____

Here are the correct answers:

1. Disconnect wire 14A at the neutral safety switch, turn the rotary switch on, and then check for battery voltage at the end of wire 14A. (Refer to the statement in the Test Question #E5 block.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. Current flows to the neutral safety switch before reaching the starter solenoid. (Refer to the Reason For Question block.)

4. Battery voltage, 23-25.5 volts. (Refer to Test Question #G1 block.)

5. To perform this test, refer to Voltage Multimeter block on the Reference Information page. (If you had a problem performing the test, ask your course administrator for feedback.)

6. Follow the YES path; go to Test Question #G2. (The voltage reading is the same as battery voltage.)

7. Follow the NO path; go to Test Question #I1, page 2-298. (The voltage reading is below the required voltage.)

TASK F: PERFORM STARTER CIRCUIT TEST QUESTION #G2

Situation: You previously completed Starter Circuit Test Question #G1. Let's assume that the voltage reading was 24 volts. Based on this information, the flowchart directed you to the Starter Circuit Test Question #G2.

Study Starter Circuit Test Question #G2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point, the "**known information**" is that **voltage is available at the neutral safety switch** and that the **rotary switch is OK.**

1. What is Test Question #G2 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What is the reason for asking the test question?

   _____

4. Select and perform this continuity test using the multimeter. Record the value that indicates there is continuity and your actual reading in the box below.

A READING OF LESS THAN _____ OHMS INDICATES CONTINUITY.

YOUR ACTUAL READING IS _____ OHMS.

5. Assume that the resistance reading was less than 2 ohms. What should you do?

_____

6. Assume that the resistance reading was more than 200 ohms. What should you do?

_____

Here are the correct answers:

1. Disconnect wire 14B at the neutral safety switch and then test for continuity across the neutral safety switch. (Refer to the statement in Test Question #G2.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. If there isn't continuity, current will not flow through the switch. (Refer to the Reason For Question block.)

4. 5 ohms. Refer to the Continuity (Resistance) Multimeter block on the Reference Information page (page 2-291). For feedback on your reading, see your course administrator.

5. Follow the YES path; go to Test Question #G3. (There is continuity across the neutral safety switch.)

6. Follow the NO path; replace the neutral safety switch. (Current will not flow through the neutral safety switch.)

TASK G: PERFORM STARTER CIRCUIT TEST QUESTION #I1

Situation: You previously completed Starter Circuit Test Question #G2. Assuming that you follow the NO path for Test Question #G2, you would be told to replace the neutral safety switch.

Let's now go back to Test Question #G1, page 2-290, and assume that **with the rotary switch in the START position you DO NOT have battery voltage at the neutral safety switch, wire 14A.** Based on this information, you would follow the NO path for Test Question #G1 to Test Question #I1 on page 2-298.

Study Starter Circuit Test Question #I1, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point, the "**known information**" is that there is **no voltage available at the neutral safety switch.**

1. What is Test Question #I1 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What is the purpose of testing wire 11A?

   _____

4. What should the voltage be at wire 11A?

   _____

5. Select and perform voltage test using the multimeter. Record the minimum acceptable voltages and the actual voltage reading in the box below.

MINIMUM ACCEPTABLE VOLTAGE READING _____
ACTUAL VOLTAGE READING _____

6. Assume that the voltage reading was 24 volts. What should you do?

   _____

7. Assume that the voltage reading was 18 volts. What should you do?

   _____

Here are the correct answers:

1. Disconnect wire 11A at the rotary switch and then test for battery voltage at wire 11A. (Refer to the statement in Test Question #I1 block.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. Power must be available to the rotary switch before power can reach the neutral safety switch. (Refer to the Reason For Question block.)

4. Battery voltage 23-25.5 volts. (Refer to the statement in the Test Question #I1 block.)

5. The minimum acceptable voltage is battery voltage. (Refer to the statement in the Test Question block. If you had a problem performing the test, ask your course administrator for feedback.)

6. Follow the YES path; go to Test Question #I2. (Battery voltage is available at wire 11A.)

7. Follow the NO path; go to Test Question #J1, page 2-300. (Battery voltage isn't available at wire 11A.)

TASK H: PERFORM STARTER CIRCUIT TEST QUESTION #I2

Situation: You previously completed Starter Circuit Test Question #I1. Let's assume that the voltage reading was 24 volts. Based on this information, the flowchart directed you to the Battery Circuit Test Question #I2.

Study Starter Circuit Test Question #I2, the Diagnostic Flowchart, and the Reference Information. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point, the "**known information**" is that **voltage is available at the rotary switch.**

1. What is Test Question #I2 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What does it indicate if you don't have continuity across the switch?

   _____

4. Select and perform the continuity test using the multimeter. Remove the rotary switch for this test. Record the value that indicates continuity and your actual reading in the spaces provided below.

A READING OF _____ OHMS INDICATES CONTINUITY.

ACTUAL READING _____

5. Assume that the resistance reading was 2 ohms. What should you do?

   _____

6. Assume that the resistance reading 8 ohms. What should you do?

   _____

Here are the correct answers:

1. Test for continuity between the "B" stud and the "S" stud of the rotary switch with the switch turned to the start position. (Refer to the statement in Test Question #I2 block.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. That there is excessive resistance or an open circuit within the rotary switch. (Refer to the Reason For Question block.)

4. 5 ohms. (Refer to the Continuity (Resistance) Multimeter block.)

5. Follow the YES path; go to Test Question #I3. (There is continuity between the "B" and "S" studs that the rotary switch is OK.)

6. Follow the NO path; replace the rotary switch. (There isn't continuity between the "B" and "S" studs that indicates that the rotary switch is defective.)

This completes the dialogue for Module #3. If you had a difficult time completing any part of it, review that part again carefully, paying close attention to the feedback sections and/or see your course administrator for assistance.

Once you feel confident in your ability to complete the dialogue, inform your course administrator that you are ready for the performance test.

Remember, this dialogue allowed you to troubleshoot the major components that make up the starting circuit. You were given various situations that had you check the starter motor, neutral safety switch, rotary switch, and some of the wiring. Most of the testing you performed was done with the STE/ICE-R rather than the multimeter. This was done to help illustrate the testing ability of the STE/ICE-R. As you can see, the STE/ICE-R is very effective for testing most items.

MODULE #3 PERFORMANCE TEST

TROUBLESHOOTING THE M998 STARTING SYSTEM

INTRODUCTION: Having successfully completed the instructional portion of the module, you will now be tested on your ability to troubleshoot the M998 starting system. You will be performing the same tasks that you performed in the dialogue.

PERFORMANCE OBJECTIVE: Given the TM, tools, TMDE, and verbal scenarios indicating various faults within the starting system, you will troubleshoot the system according to TM 9-2320-280-20-1. In addition, you must state what must be done to correct identified faults.

TASKS TO PERFORM:

TASK A: PERFORM STARTER CIRCUIT TEST QUESTION #E1

TASK B: PERFORM STARTER CIRCUIT TEST QUESTION #E2

TASK C: PERFORM STARTER CIRCUIT TEST QUESTION #E3

TASK D: PERFORM STARTER CIRCUIT TEST QUESTION #E4

TASK E: PERFORM STARTER CIRCUIT TEST QUESTION #G1

TASK F: PERFORM STARTER CIRCUIT TEST QUESTION #G2

TASK G: PERFORM STARTER CIRCUIT TEST QUESTION #I1

TASK H: PERFORM STARTER CIRCUIT TEST QUESTION #I2

INSTRUCTIONS: You are expected to perform each task just as you would on the job; however, since the faults are simulated, test readings, actions, or other information needed to perform each task will be provided. If you do not understand something or have questions, **ask your course administrator.**

Your course administrator will be using a written script to guide you. Feedback will be provided as needed.

Although this is not a timed event, you will be stopped if it is determined that you are not able to successfully complete the test.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

MATERIALS REQUIRED:

1. Performance Test
2. TM 9-2320-280-20-1
3. General mechanic's toolbox
4. Droplight/flashlight
5. STE/ICE-R
6. Multimeter
7. M998 HMMWV (operational and clean)
8. Rags or handi-wipes
9. Camouflaged utilities (coveralls optional)
10. Creeper

PERFORMANCE STANDARDS:

You will be graded on a PASS/FAIL basis. To pass this performance test, you must successfully complete all tasks on the evaluation sheet. Your ability to perform each of the tasks will be based on the professional judgment of the course administrator using the criteria listed in items 1 through 3.

Note: Your course administrator may provide a very limited amount of assistance; however, remember that your course administrator is judging your ability to perform. If he/she determines that you cannot successfully complete a task, you will not receive a passing grade for that task. Although testing is not timed, you will be stopped if the course administrator determines that you are not able to complete the test in a reasonable amount of time.

1. Demonstrate competency in the use of the tools and test equipment.

a. Select the appropriate tools and test equipment for performing the task.

b. Prepare equipment for testing.

(1) Correct set-up.

(2) Perform operational check (if required).

c. Complete all necessary equipment operational steps in the correct or an acceptable sequence.

d. Read and correctly interpret the test results displayed.

2. Demonstrate competency in the use of the technical manual.

a. Locate the appropriate test in the TM for troubleshooting the simulated fault.

b. Complete all necessary test procedural steps in the correct or an acceptable sequence.

c. State the appropriate or corrective action for simulated or identified faults.

d. Locate additional reference information such as schematics, STE/ICE-R test procedures, system operation instructions, etc.

e. Locate and identify components and circuits on schematics.

3. Observe safety rules.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

When you are ready to begin testing, enter your name, rank, and social security number on the student evaluation sheet. Remove the sheet and hand it to your course administrator.

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STUDENT EVALUATION SHEET FOR MODULE #3

NAME: _____

RANK: _____

SSN: _____

GRADE: PASS FAIL

DID THE STUDENT SUCCESSFULLY COMPLETE:	**YES**	**NO**
TASK A: Perform Starter Circuit Test Question #E1?		
TASK B: Perform Starter Circuit Test Question #E2?		
TASK C: Perform Starter Circuit Test Question #E3?		
TASK D: Perform Starter Circuit Test Question #E4?		
TASK E: Perform Starter Circuit Test Question #G1?		
TASK F: Perform Starter Circuit Test Question #G2?		
TASK G: Perform Starter Circuit Test Question #I1?		
TASK H: Perform Starter Circuit Test Question #I2?		

REMARKS:

CRS ADMINISTRATOR'S SIGNATURE: _____

CRS MANAGER'S SIGNATURE: _____

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MODULE #4 DIALOGUE

TROUBLESHOOTING THE M998 GENERATING SYSTEM

INTRODUCTION:

In the previous module, you learned the procedures for using the TM and the test equipment to diagnose faults within the starting system. In this module, you will continue with your learning by performing various actions that relate to diagnosing faults within the M998 generating system.

The tests you will be performing are **NOT** designed to test the batteries. They are designed to test the alternator and its associated components and wiring.

PERFORMANCE OBJECTIVE:

Given situations stating that faults exist within the M998 charging system, **TM 9-2320-280-20-1**, and **selected test equipment**, diagnose the cause of each fault. In addition, state what must be done to correct the faults.

OUTLINE OF TASKS THAT YOU WILL PERFORM:

TASK A: PERFORM ALTERNATOR TEST QUESTION #1

TASK B: PERFORM ALTERNATOR TEST QUESTION #2

TASK C: PERFORM ALTERNATOR TEST QUESTION #3

TASK D: PERFORM ALTERNATOR TEST QUESTION #4

TASK E: PERFORM ALTERNATOR TEST QUESTION #5

TASK F: PERFORM ALTERNATOR TEST QUESTION #6

TASK G: PERFORM ALTERNATOR TEST QUESTION #7

TASK H: PERFORM ALTERNATOR TEST QUESTION #B2

TASK I: PERFORM ALTERNATOR TEST QUESTION #B3

TASK J: PERFORM ALTERNATOR TEST QUESTION #B4

PREPARING FOR THE MODULE:

If you have not already done so, or if you are not familiar with the operation of the M998 generating system, read paragraphs 1-22 and 1-23 on pages 1-41 and 1-42 of TM 9-2320-280-20-1.

MATERIAL REQUIRED:

To perform the tasks in this module, you will need the following:

1. Dialogue for Module #4
2. TM 9-2320-280-20-1
3. TM 9-2320-280-20-2
4. General mechanic's toolbox
5. Droplight/flashlight
6. STE/ICE-R
7. Drive belt tension gage
8. Multimeter
9. M998 HMMWV (operational and clean)
10. Rags or handi-wipes
11. Camouflaged utilities (coveralls optional)
12. Creeper

See your course administrator to obtain the above items.

CAUTION

In this module, you will be performing hands-on type tasks. All safety rules and regulations must be observed. Before beginning, review the WARNING SUMMARY in the front of the technical manual.

TASK A: PERFORM ALTERNATOR TEST QUESTION #1

Situation: As stated earlier, the tests you will be performing are designed strictly to troubleshoot the alternator and its associated generating system components. All tests covered in this module are performed under the assumption that the batteries are fully charged and in good condition. Let's now assume that an operator has just told you that he thinks his "**vehicle has a generating system problem**." You have gathered all of your equipment and the TM and are now on the vehicle ready to begin testing.

Read the GENERAL DESCRIPTION section for the alternator circuit (page 2-195) and then study Alternator Circuit Test Question #1, the Diagnostic Flowchart, and the Reference Information associated with the question (pages 2-196 and 2-197). Once you completely understand the TEST QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

The only "**known information**" at this time is that the **volt gage needle remains in the yellow area while the engine is running**.

1. What is Test Question #1 asking you to do?

   _____

2. What is/are your test option(s)?

   a. _____

   b. _____

3. What publication is used as a reference for checking the belt tension using the belt tension gage?

   _____

4. Perform the visual inspection of the alternator drive belts and then test the belt tension using the belt tension gage. (Refer to the first note on page 3-197, paragraph 3-81, 3-82, and 3-83 of TM 9-2320-280-20-2.) Record your results in the box on the next page.

RESULTS OF VISUAL INSPECTION:

_____

_____

FRONT BELT TENSION: _____ PSI

REAR BELT TENSION: _____ PSI
(A2s will have a serpentine belt)

5. Assume that the alternator drive belts are in good condition and the tension is within specification. How would you answer Test Question #1?

   _____

6. Assume that the alternator drive belts were worn out. What would you do?

   _____

Here are the correct answers to the questions:

1. Inspect the drive belts and test the belt tension. (Refer to the first note of the Reference Information on page 2-197 for the procedure.)

2. Visual inspection, belt tension gage. (Refer to the Test Options block.)

3. TM 9-2320-280-20-**2**. (The first note of the Reference Information (page 2-197) refers you to para 3-81, 3-82, and 3-83, which are in TM 9-2320-280-20-**2**.)

4. Actual results. (Refer to the first paragraph of Reference Information, page 2-197. Ask for feedback on your actual readings.)

5. Follow the YES path; go to Test Question #2. (The belts and tension are OK.)

6. Follow the NO path; replace the drive belts as required. If you still have the problem, continue testing. (The belts are unserviceable.)

TASK B: PERFORM ALTERNATOR TEST QUESTION #2

Situation: You previously completed Alternator Test Question #1. Let's assume that you determined that the drive belts were tight and in good condition. Based on this information, the flowchart directed you to Alternator Test Question #2.

Study Alternator Circuit Test Question #2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **drive belts are OK**.

1. What is Test Question #2 asking you to do?

   _____

2. What is your test option?

   _____

3. What is the reason for the question?

   _____

4. What cable must be disconnected before disconnecting or reconnecting the PCB cable?

   _____

5. Perform the visual inspection of all wire connections and record the results in the box below.

   _____

Place a check in the spaces provided once you have inspected the following:

BATTERY CONNECTIONS _____

STARTER CONNECTIONS _____

PCB CONNECTIONS _____

ALTERNATOR CONNECTIONS _____

6. Assume that all connections are clean and tight and appear to be making good electrical contact. What should you do?

_____

7. Assume that you found loose or dirty connections. What should you do?

_____

Here are the correct answers:

1. Inspect all wiring for loose or dirty connections. (Refer to the statement in the Test Question #2 block.)

2. Visual inspection. (Refer to the Test Options block.)

3. Loose or dirty connections can prevent a good alternator from charging the batteries. (Refer to the statement in the Reason for Question block.)

4. Negative battery cable. (Refer to the Warning Statement on Reference Information, page 2-197.)

5. Actual Results. (Ask for feedback from your course administrator if you had a problem performing the inspection. Remember, cable connections can cause problems.)

6. Follow the YES path; go to Test Question #3.

7. Follow the NO path; clean and tighten all connections as required. If you still have the problem, return to this point and continue testing.

TASK C: PERFORM ALTERNATOR TEST QUESTION #3

Situation: You previously completed Alternator Test Question #2. Let's assume that all wire connections were clean and tight. Based on this information, the flowchart directed you to the Alternator Test Question #3.

Study Alternator Test Question #3, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **belts, wiring, and connections are OK**.

1. What is Test Question #3 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. What control function is used during this test to tell STE/ICE-R to display more than one reading?

   _____

5. Select and perform STE/ICE-R Test 67 and 89 (Interleave). Record your test results in the box below. To run the test, use the procedure on the next page.

BATTERY VOLTAGE (STE/ICE-R TEST 67)	**_____**
ALTERNATOR OUTPUT TERMINAL VOLTAGE WIRE 5A (STE/ICE-R TEST 89)	**_____**

********** **SPECIAL INSTRUCTIONS** **********

The procedure for performing the Interleave test is shown on page 2-197 of the TM. The hook-up procedures for STE/ICE-R Tests 67 and 89 are located on pages 2-740 and 2-750 of the TM.

Since the TM doesn't tell you when to perform the calibration (CAL) of the TVM and cables, the complete procedure for performing the interleave test is shown below. It's important to remember that the CAL must be performed before entering the 06 for the Interleave test.

Make sure the vehicle power is off.

Remove alternator cover and potting.

Connect DCA cable.

Power up the VTM.

Run the confidence test.

Enter the VIN.

Attach the P1 end of W2 cable to J4 connector on the VTM.

Set the test select switch to 89.

Short the test leads together.

Press and hold the TEST button until CAL appears on the display.

The offset value should read between -6.8 and +6.8.

Press and release the TEST button.

Attach the red lead to wire 5A at the alternator connector.

Attach the black lead to a good ground.

Set rotary switch to RUN position.

Dial 06 and press the TEST button.

When prompted by the VTM, (CON) dial 67 and press the TEST button.

When prompted by the VTM, (CON) dial 89 and press the TEST button.

VTM will display the test results for Test 67, then Test 89, then 6789 and then repeat.

6. Assume that the alternator output terminal voltage (wire 5A) was the same as the battery voltage. How would you answer Test Question #3?

   _____

7. Assume that the alternator output terminal voltage (wire 5A) was below battery voltage. How would you answer Test Question #3?

   _____

Here are the correct answers:

1. Test for battery voltage at the alternator output terminal (wire 5A). (Refer to the statement in the Test Question block.)

2. a. STE/ICE-R, Test 67 and 89 Interleave.
   b. Multimeter

   (Refer to the statement in the Test Options block.)

3. Alternator, Control Box, or Wiring. (Refer to the statements in the Possible Problems block.)

4. Control function (06). (Refer the Interleave Test block on Reference Information page 2-197.)

5. Actual Results. (Refer to Reference Information on pages 2-197, 2-740, 2-750, and the instructions in the dialogue for performing these tests. If you had a problem with this test question, ask for additional feedback from your course administrator.)

6. Follow the YES path; go to Test Question #4, page 2-198.

7. Follow the NO path; go to Test Question #A, page 2-202.

(This page intentionally left blank.)

TASK D: PERFORM ALTERNATOR TEST QUESTION #4

Situation: You previously completed Alternator Test Question #3. Let's assume that you had battery voltage at the alternator output terminal wire 5A. Based on this information, the flowchart directed you to the Alternator Test Question #4.

Study Alternator Test Question #4, the Diagnostic flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the DIAGNOSTIC FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **batteries, belts, alternator connections, and control box** are all OK.

1. What is Question #4 asking you to do?

   _____

2. What is your test option?

   _____

3. What does the idle RPM have to do with the alternator charging?

   _____

4. Select and perform STE/ICE-R Test 10. Record the correct idle speed (RPM) and the actual idle RPM reading in the box below.

CORRECT IDLE RPM: _____ TO _____

ACTUAL IDLE RPM: _____

5. Assume that the idle RPM is at 650 RPM. What should you do?

   _____

6. Assume that the idle RPM is at 450 RPM. What should you do?

   _____

Here are the correct answers:

1. Determine if the engines idle is at the correct RPM. (Refer to the Test Question block.)

2. STE/ICE-R (Refer to the Test Options block.)

3. If the engines idle is too low, the alternator will not be driven fast enough to charge the batteries. (Refer to the statement in the Reason for Question block.)

4. The correct idle RPM is 625 to 675 RPM. (Refer to Test Question #4 block and ask for feedback on your actual reading.)

5. Follow the YES path; go to Test Question #5. (The RPM reading is below 625-50 RPM.)

6. Follow the NO path; adjust the idle RPM and then go to Test Question #5. (If the idle cannot be adjusted, you may have a problem with the fuel system. See note on idle adjustment Reference Information page 2-199.)

TASK E: PERFORM ALTERNATOR TEST QUESTION #5

Situation: You previously completed Alternator Test Question #4. Let's assume that the alternator idle RPM was between 625-650 RPM. Based on this reading, the flowchart directed you to the Alternator Test Question #5.

Study Alternator Test Question #5, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the DIAGNOSTIC FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **batteries, belts, alternator connections, control box, and alternator drive are all OK**.

1. What is Test Question #5 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. Select and perform STE/ICE-R Test 10 to measure the engine RPM. When the RPM reaches between 1200 and 1500 RPM, perform STE/ICE-R Test 89 and record the test results in the space provided below.

ALTERNATOR OUTPUT TERMINAL VOLTAGE: _____ VOLTS
(STE/ICE TEST 89 at wire 5A)

5. Assume that the alternator output voltage was within specification. How would you answer Test Question #5?

   _____

6. Assume that the alternator output voltage was not within specification. How would you answer Test Question #5?

   _____

Here are the correct answers:

1. Increase the engine speed to 1200-1500 RPM and test the alternator output voltage at wire 5A. (Refer to the Statement in the Test Question block.)

2. a. STE/ICE-R Tests 10 and 89
   b. Multimeter

   (Refer to the Test Options block.)

3. Alternator or wiring. (Refer to statement in the Possible Problems block.)

4. Actual reading. (If you had a problem performing this test, ask your course administrator for feedback.)

5. Follow the YES path; go to Test Question #6.

6. Follow the NO path; go to Test Question #B1, page 2-204

TASK F: PERFORM ALTERNATOR TEST QUESTION #6

Situation: You previously completed Alternator Test Question #5. Let's assume that the alternator output voltage was between 27-29 volts. Based on this reading, the flowchart directed you to the Alternator Test Question #6.

Study Alternator Test Question #6, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **batteries, belts, alternator connections, control box, alternator drive, and alternator are all OK**.

1. What is Test Question #6 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. Why would you want to measure alternator output at the battery terminals?

   _____

4. Select and perform STE/ICE-R Test 67. Record your test results in the space provided. (Note: The engine must be running with the RPM between 1200-1500.)

RESULTS FROM TEST QUESTION #5:	**_____ VOLTS**
VOLTAGE AT BATTERY TERMINALS:	**_____ VOLTS**

5. Assume that the battery voltage reading was the same as the alternator output voltage; how would you answer Test Question #6?

   _____

6. Assume that the battery voltage reading was 26 volts and the alternator output voltage was 27 volts; how would you answer Test Question #6?

   _____

Here are the correct answers:

1. Test battery voltage and compare it to the alternator output voltage. (Refer to the statement in the Test Question block.)

2. a. STE/ICE-R
   b. Multimeter

   (Refer to the Test Options block.)

3. If the voltage at the battery terminals is a lot lower than alternator voltage output at wire 5A, the wiring resistance is too high. (Refer to the Reason for Question block. Remember, excessive resistance will keep the alternator from charging the batteries properly.)

4. Actual readings. (If you had a problem with the test or the test results, see your course administrator for feedback.)

5. Follow the YES path; go to Test Question #7.

6. Follow the NO path; repair or replace wiring as required. (See Notes on page 2-199 for possible problem areas.)

TASK G: PERFORM ALTERNATOR TEST QUESTION #7

Situation: You previously completed Alternator Test Question #6. Let's assume that the voltage reading was the same as the alternator output voltage (27-29 volts). Based on this assumption, the flowchart directed you to the Alternator Test Question #7.

Study Alternator Test Question #7, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the instructions provided below.

At this point the "**known information**" is that the **batteries, belts, alternator connections, control box, alternator drive, and alternator output are all OK**.

1. What is Test Question #7 asking you to do?

   _____

2. What is your test option?

   _____

3. Select and perform STE/ICE-R Test 90. Read the note and instructions provided before performing the test. Record your results in the box below the Special Instructions on the next page.

   Note: The Test Options block for Test Question #7 shows STE/ICE-R Test 80 as the option. **Do not use this option; perform STE/ICE-R Test 90 instead**. Test 90 will provide you with a more accurate measurement than Test 80. Instructions for performing Test 90 are as follows:

********** **SPECIAL INSTRUCTIONS** **********

STE/ICE-R Test 90

Step 1. **Connect STE/ICE-R W1 cable to the DCA connector. Connect test probe cable W4. (P1 connector to J2 connector on the VTM.)**

Step 2. **Connect the current probe to P2 connector of cable W4.**

Step 3. **Set test select switch to 90.**

Step 4. **Clamp the current probe around the de-energized wire (wire 5A at the alternator). Make sure that the arrow on the probe is pointing AWAY from the alternator and the probe clamp is AROUND the wire.**

Step 5. **Press and hold the test button until CAL appears on the display.**

Step 6. **Release the test button and wait for offset value to appear on the display. If offset is within 225 to -225 proceed. If not, go to DCA Troubleshooting procedures.**

Step 7. **Start the engine and observe the STE/ICE-R reading with no accessories on. You should have a reading of more that 30 amps.**

Step 8. **Observe the readings as you turn on each of the following: headlights, heater, wipers, and turn signals. On a good alternator, the reading will increase as accessories are placed in operation.**

<u>Note</u>: Use the initial reading (no accessories on) to answer Test Questions 4 and 5 of the dialogue.

INITIAL AMP READING (ACCESSORIES OFF):	**_____ AMPS**
READING WITH HEADLIGHTS ON	**_____ AMPS**
READING WITH HEATER ON	**_____ AMPS**
READING WITH WIPERS ON	**_____ AMPS**
READINGS WITH TURN SIGNALS ON	**_____ AMPS**
DID THE AMPS GO UP AS THE ACCESSORIES WERE TURNED ON?	**_____ YES/NO**

4. Assume that the current reading was 38 amps. How would you answer Test Question #7?

_____

5. Assume that the current reading was 22 amps. How would you answer Test Question #7?

_____

Here are the correct answers:

1. Measure the amount of current the alternator is producing. (Refer to Test Question block #7. Remember, you are seeing if the alternator is supplying enough current to power the electrical components and still keep the batteries charged.)

2. STE/ICE-R test 80. (Refer to the Test Options block.)

3. Actual readings. (See your course administrator for feedback on Test 90. The amp readings should have increased when each accessory was turned on. Increasing the demand causes an increase in current flow.)

4. Follow the YES path; go to Question #8.

5. Follow the NO path; replace the alternator and rerun the tests.

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TASK H: PERFORM ALTERNATOR TEST QUESTION #B2

Situation: You previously completed Alternator Circuit Test Question #7. By following the YES path, you would replace the PCB and by following the NO path, you would replace the wiring harness.

Let's now go back to Test Question #5, page 2-198. Assume that you **DO NOT** have 27-29 volts at the alternator output terminal wire 5A. Based on this information, follow the flowchart to Test Question #B1, page 2-204. Test Question #B1 directs you to identify the alternator model. Since you are using the M998 as the test vehicle, continue on to Test Question #B2.

Study Alternator Test Question #B2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **batteries, belts, alternator connections, control box, and alternator drive are all OK; however, the alternator output is not correct.**

1. What is Test Question #B2 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. Select and perform STE/ICE-R test 89. Unplug wire 568 from the alternator and test for battery voltage at wire 568A, make sure the rotary switch is in the **RUN** position. Record your reading in the space provided.

WIRE 568A READING IS _____ VOLTS.

5. Assume that voltage reading was 24 volts. How would you answer Question #B2?

_____

6. Assume that the reading was 16 volts. How would you answer Question #B2?

_____

Here are the correct answers:

1. Test for voltage at wire 568A with the rotary switch turned to the **RUN** position. (Refer to the Test Question block. Remember that wire 568A carries field current to the alternator.)

2. a. STE/ICE-R tests 89.
   b. Multimeter

   (Refer to the Test Options block.)

3. Alternator or wiring. (Refer to the Possible Problems block.)

4. Actual voltage reading. (The reading should be very close if not exactly the same as battery voltage. If you had a problem performing the test, see your course administrator for feedback.)

5. Follow the YES path; go to Question #B3. (The voltage reading at wire 568A would have been the same as battery voltage.)

6. Follow the NO path; replace the wiring harness. (The voltage reading would have been less than battery voltage.)

TASK I: PERFORM ALTERNATOR TEST QUESTION #B3

Situation: You previously completed Alternator Circuit Test Question #B2. Let's assume that the voltage reading was 24 volts at wire 568A. Based on this assumption, the flowchart directed you to Alternator Test Question #B3.

Study Alternator Test Question #B3, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **alternator output voltage is not correct.**

1. What is Question #B3 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. Select and perform STE/ICE-R test 89. Unplug wire 568 from the alternator and test for battery voltage at the end of wire 568A. Make sure the rotary switch is in the **RUN** position. Record your reading in the space provided.

WIRE 568 READING IS _____ VOLTS.

5. Assume that voltage reading was 24 volts. How would you answer Question #B3?

   _____

6. Assume the reading was 16 volts. How would you answer Question #B3?

   _____

Here are the correct answers:

1. Test for voltage at wire 568 with the rotary switch turned to the RUN position. (Refer to the Test Question block. Remember that wires 568A and 568 carry ignition current to turn on the regulator.)

2. a. STE/ICE-R tests 89.
   b. Multimeter

   (Refer to the Test Options block.)

3. Alternator or wiring. (Refer to the Possible Problems block.)

4. Actual voltage reading. (The reading should be very close if not exactly the same as battery voltage. If you had a problem performing the test, see your course administrator for feedback.)

5. Follow the YES path; go to Test Question #B4. (The voltage reading at wire 568 would have been the same as battery voltage.)

6. Follow the NO path; replace wire 568. (The voltage reading would have been less than battery voltage.)

TASK J: PERFORM ALTERNATOR TEST QUESTION #B4

Situation: You previously completed Alternator Test Question #B3. Let's assume that the voltage reading was 24 volts at wire 568. Based on this assumption, the flowchart directed you to the Alternator Test Question #B4.

Study Alternator Test Question #B4, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the LOGIC, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **alternator output is not correct.**

1. What is Test Question #B4 asking you to do?

   _____

2. What is/are your test option(s)?

   _____

   _____

3. What is the reason for asking the question?

   _____

4. Perform the tests specified in the box below. When performing the tests, if the output voltage is within range, change the setting and observe the STE/ICE-R reading. Reset the adjuster to the recommended setting. Record your readings in the spaces provided.

RECOMMENDED VOLTAGE READING _____

INITIAL VOLTAGE READING _____

ADJUSTED VOLTAGE READING _____

5. Assume that the alternator could be adjusted within the specified range. How would you answer Test Question #B4?

   _____

6. Assume that the alternator could not be adjusted within the specified range. How would you answer Test Question #B4?

   _____

Here are the correct answers:

1. Attempt to adjust the alternator output to correct the problem. (Refer to the Test Question block.)

2. Adjust the output using the adjustment procedure for the STE/ICE-R. (Refer to the Test Options block.)

3. The alternator might just need to be adjusted. (Refer to Reason For Question block.)

4. Recommended voltage reading is 27-29 volts; however, when making adjustments, adjust to 28±0.5 volts. (Refer to the Test Option block and the Reference Information page 2-207.)

   Actual voltage readings. (If you had a problem with the test or the results see your course administrator for feedback.)

5. Follow the YES path; go to Test Question #B5. Your next step would be to verify the current output.

6. Follow the NO path; replace the alternator.

In this module, you tested the major components that make up the generating circuit. The situations purposely took you through the process that would lead to the replacement of the alternator, the PCB, and the wiring. Additionally, you were required to adjust alternator output.

Notice that the testing you performed was done with the STE/ICE-R rather than the multimeter. This was done intentionally to help illustrate the testing ability of the STE/ICE-R.

This completes the dialogue for Module #4. If you had a difficult time completing any part of it, review that part again carefully, paying close attention to the feedback sections. Also, see your course administrator for assistance.

Once you feel confident in your ability to complete the dialogue, inform your course administrator that you are ready for the performance test.

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MODULE #4 PERFORMANCE TEST

TROUBLESHOOTING THE M998 GENERATING SYSTEM

INTRODUCTION: Having successfully completed the instructional portion of the module, you will now be tested on your ability to troubleshoot the M998 generating system. You will be performing the same tasks that you performed in the dialogue.

PERFORMANCE OBJECTIVE: Given the TM, tools, TMDE, and verbal scenarios indicating various faults within the generating system, you will troubleshoot the system according to TM 9-2320-280-20-1. In addition, you must state what must be done to correct identified faults.

TASKS TO PERFORM:

TASK A: PERFORM ALTERNATOR TEST QUESTION #1

TASK B: PERFORM ALTERNATOR TEST QUESTION #2

TASK C: PERFORM ALTERNATOR TEST QUESTION #3

TASK D: PERFORM ALTERNATOR TEST QUESTION #4

TASK E: PERFORM ALTERNATOR TEST QUESTION #5

TASK F: PERFORM ALTERNATOR TEST QUESTION #6

TASK G: PERFORM ALTERNATOR TEST QUESTION #B2

TASK H: PERFORM ALTERNATOR TEST QUESTION #B3

TASK I: PERFORM ALTERNATOR TEST QUESTION #B4

INSTRUCTIONS: You are expected to perform each task just as you would on the job; however, since the faults are simulated, test readings, actions, or other information needed to perform each task will be provided. If you do not understand something or have questions, **ask your course administrator.**

Your course administrator will be using a written script to guide you. Feedback will be provided as needed.

Although this is not a timed event, you will be stopped if it determined that you are not able to successfully complete the test.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

MATERIALS REQUIRED:

1. Performance Test
2. TM 9-2320-280-20-1
3. TM 9-2320-280-20-2
4. General mechanic's toolbox
5. Droplight/flashlight
6. STE/ICE-R
7. Drive belt tension gage
8. Multimeter
9. M998 HMMWV (operational and clean)
10. Rags or handi-wipes
11. Camouflaged utilities (coveralls optional)
12. Creeper

PERFORMANCE STANDARDS:

You will be graded on a PASS/FAIL basis. To pass this performance test, you must successfully complete all tasks on the evaluation sheet. Your ability to perform each of the tasks will be based on the professional judgment of the course administrator using the criteria listed in items 1 through 3.

Note: Your course administrator may provide a very limited amount of assistance; however, remember that your course administrator is judging your ability to perform. If he/she determines that you cannot successfully complete a task, you will not receive a passing grade for that task. Although testing is not timed, you will be stopped if the course administrator determines that you are not able to complete the test in a reasonable amount of time.

1. Demonstrate competency in the use of the tools and test equipment.

a. Select the appropriate tools and test equipment for performing the task.

b. Prepare equipment for testing.

(1) Correct set-up.

(2) Perform operational check (if required).

c. Complete all necessary equipment operational steps in the correct or an acceptable sequence.

d. Read and correctly interpret the test results displayed.

2. Demonstrate competency in the use of the technical manual.

a. Locate the appropriate test in the TM for troubleshooting the simulated fault.

b. Complete all necessary test procedural steps in the correct or an acceptable sequence.

c. State the appropriate or corrective action for simulated or identified faults.

d. Locate additional reference information such as schematics, STE/ICE-R test procedures, system operation instructions, etc.

e. Locate and identify components and circuits on schematics.

3. Observe safety rules.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

When you are ready to begin testing, enter your name, rank, and social security number on the student evaluation sheet. Remove the sheet and hand it to your course administrator.

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STUDENT EVALUATION SHEET FOR MODULE #4

NAME: _____

RANK: _____

SSN: _____

GRADE: PASS FAIL

DID THE STUDENT SUCCESSFULLY COMPLETE:	**YES**	**NO**
TASK A: Perform Alternator Test Question #1?		
TASK B: Perform Alternator Test Question #2?		
TASK C: Perform Alternator Test Question #3?		
TASK D: Perform Alternator Test Question #4?		
TASK E: Perform Alternator Test Question #5?		
TASK F: Perform Alternator Test Question #6?		
TASK G: Perform Alternator Test Question #B2?		
TASK H: Perform Alternator Test Question #B3?		
TASK I: Perform Alternator Test Question #B4?		

REMARKS:

CRS ADMINISTRATOR'S SIGNATURE: _____

CRS MANAGER'S SIGNATURE: _____

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MODULE #5 DIALOGUE

TROUBLESHOOTING THE M998 LIGHTING AND INSTRUMENT SYSTEMS

INTRODUCTION:

In the previous module, you learned the procedures for using the TM and the test equipment to diagnose faults within the charging system. In this module, you will continue performing various actions that relate to troubleshooting the M998 lighting and instrument systems.

As an organizational mechanic, you must be able to troubleshoot the lighting and instrument systems. Because of hard and extensive use, components of these two systems take a beating. Vibration and weather are two factors that contribute to problems. While many problems can easily be identified by simply checking for loose or corroded connectors and burned out bulbs, some problems will require more in-depth troubleshooting.

PERFORMANCE OBJECTIVE:

Given situations stating that faults exist within the M998 lighting and instrument systems, **TM 9-2320-280-20-1**, and **selected test equipment,** diagnose the cause of each fault. In addition, state what must be done to correct the faults.

OUTLINE OF TASKS THAT YOU WILL PERFORM:

PART 1: LIGHTS

TASK A: PERFORM LIGHT CIRCUIT TEST QUESTION #1

TASK B: PERFORM LIGHT CIRCUIT TEST QUESTION #2

TASK C: PERFORM LIGHT CIRCUIT TEST QUESTION #3

TASK D: PERFORM VOLTAGE TEST AT WIRE 75 ON BRAKE LIGHT SWITCH

TASK E: PERFORM VOLTAGE TEST AT WIRE 75A ON BRAKE LIGHT SWITCH

TASK F: PERFORM INSPECTION AND TEST OF THE LEFT BRAKE LIGHT ASSEMBLY

TASK G: PERFORM VOLTAGE TEST AT WIRE 22-461B

TASK H: PERFORM VOLTAGE TEST AT SOCKETS "D" AND "G" OF THE TURN SIGNAL SWITCH HARNESS CONNECTOR.

PART 2: INSTRUMENT CIRCUIT

TASK I: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I1

TASK J: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I2

TASK K: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I3

TASK L: PERFORM INSTRUMENT CIRCUIT TEST QUESTIONS #I4 and #I5

PREPARING FOR THE MODULE:

If you have not already done so, or if you are not familiar with the M998 lighting and instrument systems, read paragraph 2-16 on pages 2-40 of TM 9-2320-280-20-1. Another good reference tool to review is the Electrical System Wiring Diagrams located on pages 2-392 through 2-397 of TM 9-2320-280-20-1.

To effectively troubleshoot the lights, you will most likely be required to use a wiring diagram (schematic). A wiring diagram is an electrical road map that will help you identify components so that you can isolate a problem without wasting too much time. FO-6 through FO-11, located in the back of TM 9-2320-280-20-1 and FO-1 located in the back of TM 9-2320-280-20-1 contains diagrams that will help you locate components and isolate problems.

VOLTAGE and **CONTINUITY** are the two main types of tests performed when troubleshooting the lighting system.

MATERIAL REQUIRED:

To perform the tasks in this module, you will need the following:

1. Dialogue for Module #5
2. TM 9-2320-280-20-1
3. TM 9-2320-280-20-3 (FO-1)
4. General mechanic's toolbox
5. Droplight/flashlight
6. STE/ICE-R
7. Multimeter
8. M998 HMMWV (operational and clean)
9. Rags or handi-wipes

10. Camouflaged utilities (coveralls optional)

11. Creeper

See your course administrator to obtain these items.

CAUTION

In this module, you will be performing hands-on type tasks. All safety rules and regulations must be observed. Before beginning, review the WARNING SUMMARY in the front of the technical manual.

PART 1: LIGHTS

The following tests are designed strictly for the testing of the lighting circuits. All tests covered in Part 1 are performed under the assumption that all system components of the vehicle that you are testing are serviceable and the batteries are fully charged.

TASK A: PERFORM LIGHT CIRCUIT TEST QUESTION #1

Read the GENERAL DESCRIPTION section for the lights, paragraph 2-33, page 2-389 and then study Light Circuit Test Question #1, the Diagnostic Flowchart, and the Reference Information associated with the question (pages 2-390 and 2-391). Once you completely understand the TEST QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, read the situation below and follow the directions provided.

Situation: Assume that an operator has just determined that **all the lights on his M998 are inoperative**. The shop chief has assigned you the job of identifying the fault by troubleshooting the system. At this point, there is no "**known information**."

1. What is Test Question #1 asking you to do?

   _____

2. Perform an operational check (visual inspection) of all the lights. Record the results in the box below.

Headlights:	_____
Stoplights:	_____
Tail lights:	_____
Turn signals:	_____
B.O. Drive:	_____
B.O. Markers:	_____

3. Assuming that no lights are working, how would you answer Test Question #1?

   _____

4. Assuming that the left headlight is not working, how would you answer Test Question #1?

   _____

Here are the correct answers:

1. Perform an operational or visual check of the lights. (Refer to the Test Question block.)

2. Actual findings. (The lights should all work. If they don't, make sure the light switch levers are in the correct positions for the lights you are checking.)

3. Follow the NO path; go to test 2.

4. Follow the YES path to the box with the checks that should be performed before changing any components.

TASK B: PERFORM LIGHT CIRCUIT TEST QUESTION #2

Situation: You previously completed Light Circuit Test Question #1. Assume that all the lights are inoperative. Based on this assumption, the flowchart directed you to the Light Circuit Test Question #2.

Study Light Circuit Test Question #2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the only "**known information**" is that **none of the lights are working**.

1. What is Test Question #2 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. Using FO-11, determine the wire that goes from Socket "F" of the light switch to the Pin "F" of the PCB. Place your answer in the space provided.

   Wire _____

4. Why would you want to test for battery voltage at Socket "F" of the wiring harness connector that connects to the light switch?

   _____

   _____

5. To answer Test Question #2, use the multimeter as your test option. Record the voltage that you should have at Socket "F" and then perform the voltage test and record your actual test results in the box below.

VOLTAGE AT SOCKET F SHOULD BE	**_____ VOLTS.**
VOLTAGE AT SOCKET F IS	**_____ VOLTS.**

6. Assume that there is 24 volts at Socket "F" of the light switch connector harness. How would you answer Test Question #2?

   _____

7. Assume that there is 0 volts at Socket "F" of the light switch connector harness. How would you answer Test Question #2?

   _____

Here are the correct answers:

1. Test for battery voltage at Socket "F" of the wiring harness connector that attaches to the light switch. (Refer to the Test Question block.)

2. a. STE/ICE-R Test 89
   b. Multimeter

   (Refer to the Test Options block.)

3. 15A. (Refer to FO-11.)

4. Because the wire that goes to Socket "F" is the one that powers the light switch. (It is the hot wire that comes from the PCB.)

5. Actual reading. (Any reading other than battery voltage would indicate a problem. If you had a problem performing the test, ask for feedback from your course administrator.)

6. Follow the YES path; replace the faulty light switch. (Since all lights are inoperative, the fault would be within the switch itself.)

7. Follow the NO path; go to Test Question #3. (Since you don't have power to the light switch, you know that the fault is not in the switch.)

TASK C: PERFORM LIGHT CIRCUIT TEST QUESTION #3

Situation: You previously completed Light Circuit Test Question #2. Let's assume that you did not have battery voltage at Socket "F" of the light switch connector harness. Based on this assumption, the flowchart directed you to the Lights Circuit Test Question #3.

Study Light Circuit Test Question #3, the Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is there is **no power to the light switch**.

1. What is Test Question #3 asking you to do?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What components are you checking when performing Test Question #3?

   a. _____

   b. _____

4. Why must the negative battery cable be removed before disconnecting or reconnecting the PCB harness connector?

   _____

5. Record your expected result in the top space of the box below. Then perform the voltage test with the multimeter and record your test result in the bottom space of the box.

VOLTAGE AT PIN F SHOULD BE _____ VOLTS.

VOLTAGE AT PIN F IS _____ VOLTS.

6. Assume that you had 24 volts at Pin "F" of the PCB connector. How would you answer Test Question #3?

_____

7. Assume that you had 0 volts at Pin "F" of the PCB connector. How would you answer Test Question #3?

_____

Here are the correct answers:

1. Test for battery voltage at Pin "F" of the PCB body connector (on the PCB). (Refer to the Test Question block.)

2. a. STE/ICE-R Test 89
   b. Multimeter

   (Refer to the Test Options block.)

3. a. PCB
   b. Wire 15A

   (Refer to the statements in the YES and NO paths.)

4. There is battery voltage at the PCB at all times. Failure to disconnect the battery cable will result in damage to equipment or injury to personnel. (Refer to the Warning Statement on Reference Information page 2-391.)

5. Expected reading: 23-25.5 volts.
   Actual reading: (Ask your course administrator for feedback on your actual reading.)

6. Follow the YES path; repair or replace wire 15A. (If you have battery voltage at Socket "F," this would indicate that the PCB is good and that wire 15A is faulty.)

7. Follow the NO path; replace the PCB. (Either no voltage or voltage of less than battery voltage would indicate that the PCB is faulty.)

TASK D: PERFORM VOLTAGE TEST AT WIRE 75 ON THE BRAKE LIGHT SWITCH

Situation: You previously completed Light Circuit Test Question #3. Test Question #3 was designed to isolate a problem for a situation in which all lights are inoperative.

Now, let's go back to Test Question #1, page 2-390. This time, assume that only the brake lights are inoperative. Based on this assumption, the flowchart directs you to a box that provides you with checks that you should perform before changing any components. The items in the box may or may not pertain to the symptom that you are diagnosing; use the information in the box if it pertains.

Study the checks in the box at the end of the YES path from Test Question #1. Then, answer the questions and follow the directions provided below.

Using FO-11 and the schematic on page 2-392, perform the following actions and answer the questions while troubleshooting the fault, "**brake lights (STOP LAMPS) inoperative**." Assume that both brake lights are inoperative. Remember that the components that control the brake lights are the brake light switch and the light switch. Use the multimeter to perform the test.

Steps to follow:

a. Disconnect wire 75B at the brake light switch.
b. Set the light switch to the STOP LIGHT position.
c. Depress the brake.
d. Check for battery voltage at wire 75.

1. How much voltage should you have at wire 75? Record your answer in the box below.

2. How much voltage do you have at wire 75? Record your answer in the box below.

VOLTAGE AT WIRE 75 SHOULD BE _____ VOLTS.

VOLTAGE AT WIRE 75 IS _____ VOLTS.

3. By checking for voltage at wire 75, what components are you checking?

_____

4. Assume that there is 24 volts at wire 75. What does that indicate?

_____

5. Assume that there is no voltage (0 volts) at wire 75. What does that indicate?

_____

Here are the correct answers:

1. 23-25.5 volts. (You should have battery voltage available at this checkpoint.)

2. Actual reading. (If your reading is abnormal, see your course administrator for feedback.)

3. Brake light switch, light switch, and related wiring. (Refer to FO-11 in TM 9-2320-280-20-1 and FO-1 in TM 9-2320-280-20-3.)

4. It indicates that the light switch, the brake light switch, and wire 75A are all OK.

5. It indicates that the brake light switch, wire 75A, or the light switch is defective.

TASK E: PERFORM VOLTAGE TEST AT WIRE 75A ON THE BRAKE LIGHT SWITCH

Situation: You previously completed a voltage test at wire 75 on the brake light switch. Let's assume that you had a reading of 0 volts at this location. Based on this assumption, your next step is to determine if voltage is available at the other side of the switch.

Study the checks in the box at the end of the YES path from Test Question #1. Then, answer the questions and follow the directions provided below.

At this point, you know that current isn't passing through the switch when the brake switch is depressed. Use the multimeter to perform the voltage test on wire 75A.

Steps to follow:

a. Disconnect wire 75A at the brake light switch.
b. Set the light switch to the STOP LIGHT position.
c. Check for voltage at wire 75A.

1. How much voltage should there be at wire 75A? Record your answer in the box below.

2. How much voltage do you have at wire 75A? Record your answer in the box below.

VOLTAGE AT WIRE 75A SHOULD BE _____ VOLTS.

VOLTAGE AT WIRE 75A IS _____ VOLTS.

3. Assume that there is 24 volts at wire 75A. What does that indicate?

_____

4. Assume that there is no voltage (0 volts) at wire 75A. What does that indicate?

_____

Here are the correct answers:

1. 23-25.5 volts. (Battery voltage should be available at this check point.)

2. Actual reading. (If your reading is abnormal, see your course administrator for feedback.)

3. That the brake light switch is defective and must be replaced. (If voltage is available at wire 75A, you know that the light switch and wire 75A are OK.)

4. That the light switch or wire 75A is defective. (If voltage is not available at wire 75A, voltage is not going to be available at the brake light switch.)

For the next three tasks, assume that only the left rear brake light is inoperative. All other lights are working.

Note: As you troubleshoot the left brake light, remember that the fault would not be within the brake light switch or the light switch. If these components were defective, both brake lights would be inoperative. The components that you will be testing are the turn signal switch, light assembly, and associated wiring. These components are a part of the brake light circuit.

TASK F: PERFORM INSPECTION AND TEST OF THE LEFT BRAKE LIGHT ASSEMBLY

Study the checks in the box at the end of the YES path coming from Test Question #1. Then, read the situation below, perform the actions, and answer the questions that follow.

Situation: Using the instructions in the chart on page 2-390, the schematic on page 2-392, and the multimeter, troubleshoot the fault "**left rear brake light inoperative**." Assume that the right rear brake light is working properly.

1. Remove the lens cover from the light. Perform a visual inspection of the socket, bulb, and connections. What are you checking for?

   _____

2. What effect will corrosion have on the light socket?

   _____

3. Test for battery voltage at the light socket. Record the expected voltage reading and your actual reading in the box below.

Steps to follow:

a. Place the light switch in the SERVICE DRIVE position.
b. Remove the brake light bulb.
c. Connect the red test lead to the brake light contact.
d. Connect the black test lead to a good ground.
e. Ask someone to apply the brakes.
f. Observe the voltage reading.

VOLTAGE AT THE BRAKE LIGHT SHOULD BE _____ VOLTS.

VOLTAGE AT BRAKE LIGHT IS _____ VOLTS.

4. Assume that there is 24 volts at the light socket. What does that indicate?

   _____

5. Assume that there is no voltage (0 volts) at the light socket. What does that indicate?

   _____

Here are the correct answers:

1. Corrosion, cracked wires, loose connections, and burned out bulbs. (Refer to item 2 in the box on page 2-390.)

2. Corrosion will create excessive resistance and/or interrupt the path for current flow.

3. Voltage at the brake light should be 23-25.5 volts.

   Actual reading. (If your reading is abnormal, see your course administrator for feedback.)

4. It indicates that voltage is available at the light. (The problem is more than likely a bad ground. Check all ground wires for continuity.)

5. It indicates that voltage is not available to power the light. (A short or open circuit must exist.)

TASK G: PERFORM VOLTAGE TEST AT WIRE 22-461B

Situation: You previously completed an inspection and test of the brake light assembly. Let's assume that the light socket and connections are OK but you still have a "0" voltage reading at the light socket.

Study the checks in the box at the end of the YES path coming from Test Question #1. Then, answer the questions and follow the directions provided below.

Using the instructions in the chart on page 2-390, the schematic on page 2-392, and the multimeter, troubleshoot the fault "**left rear brake light is inoperative**."

Steps to follow:

a. Place the light switch in the SERVICE DRIVE position.
b. Disconnect wire 22-461 from wire 22-461B at the left rear brake light assembly.
c. Connect the red test lead to wire 22-461B.
d. Connect the black test lead to a good ground.
e. Ask someone to apply the brakes.
f. Observe the voltage reading.

1. How much voltage should there be at wire 22-461B? Record your answer in the box below.

2. How much voltage do you have at wire 22-461B? Record your answer in the box below.

VOLTAGE AT WIRE #22-461B SHOULD BE _____ VOLTS.

VOLTAGE AT WIRE #22-461B IS _____ VOLTS.

3. Assume that there is 24 volts available at wire 22-461B. What does that indicate?

_____

4. Assume that there is no voltage (0 volts) available at wire 22-461B. What does that indicate?

_____

Here are the correct answers:

1. 23-25.5 volts (battery voltage).

2. Actual reading. (If your reading is abnormal, see your course administrator for feedback.)

3. That the fault is within the light assembly. (Remove the negative cable from the batteries and test for continuity from wire 22-461 to the center contact of the light socket.)

4. That the turn signal arm (switch) or the wiring from the arm to the light assembly is defective.

TASK H: PERFORM VOLTAGE TEST AT SOCKETS "D" AND "G" OF THE TURN SIGNAL SWITCH HARNESS CONNECTOR

Situation: You previously completed a voltage test at wire 22-461B. Let's assume that you had a reading of 0 volts. Based on this assumption, the next step is to perform a continuity check of wire 22-461B. For this task, let's assume that you tested for continuity and that the wire is serviceable. Under this assumption, you would now see if there is power to the turn signal switch.

Study the checks in the box at the end of the "YES" path coming from Test Question #1. Then, answer the questions and follow the directions provided below.

Using the instructions in the chart on page 2-390 the schematic on page 2-392, and the multimeter, troubleshoot the fault "**left rear brake light is inoperative**."

Steps to follow:

a. Place the light switch in the SERVICE DRIVE position.
b. Disconnect the wiring harness at the turn signal switch.
c. Connect the red test lead to Socket "G" of the wiring harness connector.
d. Connect the black test lead to a good ground.
e. Observe the voltage reading.
f. Connect the red test lead to Socket "D" of the wiring harness connector.
g. Leave the black lead connected to a good ground.
h. Depress the brake pedal.
i. Observe the voltage reading.

1. How much voltage do you have at Socket "G" of the connector at the turn signal switch? Record your answer in the box below.

2. How much voltage do you have at Socket "D"? Record your answer in the box below.

VOLTAGE AT SOCKET G IS _____ VOLTS.

VOLTAGE AT SOCKET D IS _____ VOLTS.

3. Assume that there is 24 volts at Socket "G". What does that indicate?

_____

4. Assume that there is 24 voltage at Socket "D". What does that indicate?

_____

5. Now that you know that there **is** voltage available at the turn signal switch but **not** at the left turn signal assembly (tail light assembly) and you know that wire 22-461B is OK, what component should you check next to determine the cause of the fault?

_____

Here are the correct answers:

1. Actual reading. (You should have from 23-25.5 volts or battery voltage.)

2. Actual reading. (You should have from 23-25.5 volts or battery voltage.)

3. That there is voltage to the turn signal switch. (By checking voltage at this socket, you are verifying that power is available at the turn signal switch.)

4. That there is voltage to the turn signal switch when the brake pedal is depressed. (By checking for voltage at this socket, you are verifying that there is voltage to the turn signal when the brakes are applied.)

5. Turn signal switch. (For our situation, we can assume that the fault is in the turn signal switch. Before replacing the switch, perform the continuity checks on page 2-391.)

This concludes the testing of the lights. To troubleshoot other components of the lighting circuit, use the same type of testing procedures (voltage and continuity tests) that you used in this part of the module. Remember to follow the basic rules below:

Identify the components of the faulty circuit.

Using a logical sequence; eliminate the components one at a time until you identify the fault.

Use your schematics and instructions to guide you.

Use the test equipment appropriately.

Take your time, use common sense, and be careful.

PART 2: INSTRUMENT CIRCUIT

The following tests are designed strictly for testing the instruments. All tests covered in Part 2 are performed under the assumption that all system components of the vehicle that you are testing are serviceable and that the batteries are fully charged.

During this part of the module you will be troubleshooting problems that relate only to the operation of one gage. You would test other gages using the same basic procedures.

Let's now assume that an operator has just told you that the temperature gage on his M998 is inoperative. You have gathered your equipment and the TM and are now on the vehicle and ready to begin testing.

TASK I: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I1

Read the GENERAL DESCRIPTION part of paragraph 2-32 (page 2-319) and review FO-10. Leave the foldout open for reference during testing.

Now, study Instrument Circuit Test Question #I1, the Diagnostic Flowchart, and the Reference Information associated with the question (pages 2-320 and 2-321). Once you completely understand the TEST QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, read the situation below and then answer the questions and perform the actions that follow.

Situation: The complaint is that **the temperature gage is inoperative; the vehicle starts and runs normally; all other gages are working correctly**.

1. What is Test Question #I1 asking you to do?

   _____

2. What is the reason for asking the question?

   _____

3. What are your test options?

   a. _____

   b. _____

4. What are the possible problems?

   _____

5. Using the multimeter, perform the voltage test at wire 27G. Record the reading that you should expect and your actual voltage reading in the box below. (Don't forget to set the rotary switch to the RUN position before testing.)

VOLTAGE AT WIRE 27G SHOULD BE	**_____ VOLTS.**
VOLTAGE AT WIRE 27G IS	**_____ VOLTS.**

6. Assume that the voltage reading at wire 27G is 24 volts. How would you answer question #I1?

   _____

7. Assume that voltage reading at wire 27G is 0 volts. How would you answer question #I1?

   _____

Here are the correct answers:

1. Disconnect wire 27G and then test for battery voltage at wire 27G. (Refer to the statement in the Test Question block.)

2. Because this is the wire that provides power to the temperature gage. (Refer to the Reason For Question block.)

3. a. STE/ICE-R Test 89
   b. Multimeter

   (Refer to the Test Options block.)

4. The gage, sending unit, or the wiring. (Refer to the Possible Problems block.)

5. 23-25.5 volts (battery voltage).

   Actual reading. (If your reading is abnormal, see your course administrator for feedback.)

6. Follow the YES path; go to Test Question #I2.

7. Follow the NO path; repair or replace wire 27G or replace the wiring harness.

TASK J: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I2

Situation: You previously completed Instrument Circuit Test Question #I1. Let's assume that the voltage reading was 24 volts at wire 27G. Based on this assumption, the flowchart directs you to the Instrument Circuit Test Question #I2.

Study Instrument Circuit Test Question #I2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point, you know that the temperature gage has power.

1. What is Test Question #I2 asking you to do?

   _____

2. What is the reason for asking this question?

   _____

3. What are your test options?

   a. _____

   b. _____

4. What position must the rotary switch be in when performing a continuity test? Why must the switch be in that position?

   _____

5. What is the approximate ohms scale that you should use when conducting the continuity test with the multimeter?

   _____

6. Using the multimeter, perform a continuity test between wire 58E and ground. Record the value that indicates continuity and your actual resistance reading in the box on the next page.

A READING OF LESS THAN CONTINUITY.	**_____ OHMS INDICATES**
ACTUAL READING IS	**_____ OHMS.**

7. Assuming that the resistance reading was less than 3 ohms, how would you answer the test question?

   _____

8. Assuming that the resistance reading was more than 500 ohms, how would you answer the test question?

   _____

Here are the correct answers:

1. Test for continuity between wire 58E and ground. (Refer to the statement in Test Question block.)

2. Because it is the ground wire for the gage. (Refer to the Reason For Question block.)

3. a. STE/ICE-R Test 91
   b. Multimeter

   (Refer to the Test Options block.)

4. The rotary switch must be in the OFF position. All power must be off while performing continuity tests. (Refer to the statement in the Test Question block.)

5. The 1000 ohms scale. (Refer to the block that contains the procedure for performing the continuity checks with the multimeter on Reference Information page 2-361.)

6. A reading of less than 5 ohms indicates continuity. (Refer the block for performing the continuity checks with the multimeter on Reference Information page 2-361.)

   Actual reading. (If your reading is abnormal, see the course administrator for feedback.)

7. Follow the YES path; go to Test Question #I3.

8. Follow the NO path; repair wire 58E or replace the wiring harness.

TASK K: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I3

Situation: You previously completed Instrument Circuit Test Question #I2. Let's assume that you had continuity between wire 58E and ground. Based on this assumption, the flowchart directs you to the Instrument Circuit Test Question #I3.

Study Instrument Test Question #I3, the Diagnostic flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, read the situation below and then answer the questions or perform the actions follow.

At this point you know that the temperature gage has power and the ground for the gage is OK.

1. What is the reason for asking Test Question #I3?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   a. _____

   b. _____

   c. _____

4. Using the multimeter, perform a continuity test between wire 33A and wire 33B. Record the value that indicates continuity and your actual resistance reading in the box below.

A READING OF LESS THAN _____ OHMS INDICATES CONTINUITY.

ACTUAL READING IS _____ OHMS.

5. Assuming that the resistance reading was 2 ohms, how would you answer the test question?

_____

6. Assuming that the resistance reading was 650 ohms, how would you answer the test question?

_____

Here are the correct answers:

1. If either of the wires are open, then the temperature gage will always read off scale to the left. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 91
   b. Multimeter

   (Refer to the Test Options block.)

3. a. Temperature gage
   b. Sending unit
   c. Wiring

   (Refer to the Possible Problems block.)

4. A reading of less than 5 ohms indicates continuity. (Refer the block for performing the continuity checks with the multimeter on Reference Information page 2-361.)

   Actual reading. (If your reading is abnormal, see your course administrator for feedback.)

5. Follow the YES path; go to Test Question #I4.

6. Follow the NO path; repair wires 33A, 33B, or the wiring harness.

TASK L: PERFORM INSTRUMENT CIRCUIT TEST QUESTIONS #I4 and #I5

Situation: You previously completed Instrument Circuit Test Question #I3. Let's assume that you had continuity between wire 33A and 33B. Based on this assumption, the flowchart directs you to the Instrument Circuit Test Question #I4.

Note: This last task that you will be performing in this dialogue requires you to answer both Test Questions #I4 and #I5.

Study Instrument Test Question #I4 & #I5, the Diagnostic Flowchart, and the Reference Information associated with the questions. Once you completely understand the QUESTIONS, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point you know that the temperature gage has power and the wiring is OK.

1. What are the reasons for asking Test Questions #I4 and #I5?

   _____

2. What are the possible problems?

   a. _____

   b. _____

3. What should you do with wire 33B when performing Test Question #I4?

   _____

4. Perform both Test Questions #I4 and #I5. Record your results in the box below.

TEST QUESTION #I4 - DOES THE GAGE READ OFF SCALE BELOW 120 DEGREES?

YES _____ NO _____

TEST QUESTION #I5 - DOES THE GAGE READ OFF SCALE ABOVE 240 DEGREES?

YES _____ NO _____

5. If you answered "YES" to either Test Question #I4 and #I5, what should you do?

_____

6. If you answered "NO" to either Test Question #I4 or #I5, what should you do?

_____

Here are the correct answers:

1. This will determine if the gage can respond to an input signal. (Refer to the Reason For Questions block.)

2. a. Temperature gage
   b. Sending unit

   (Refer to the Possible Problems block.)

3. Disconnect wire 33B from the sending unit and position it so it doesn't ground out. (Refer to the first statement on reference information page 2-363.)

4. Actual readings. (If your reading is abnormal, see your course administrator for feedback.)

5. Follow the YES path; replace the sending unit.

6. Follow the NO path; replace the gage.

This dialogue led you through the procedure for testing many of the components that make up the lighting and instrument circuits. The situations purposely took you to points where you had to make decisions concerning the replacement of various components such as the brake light switch, turn signal switch, and wiring harnesses.

Even though you were not required to use STE/ICE-R to perform the tests, remember that it could have been used.

This completes the dialogue for Module #5. If you had a difficult time completing any part of it, review that part again carefully, paying close attention to the feedback sections. Also, see your course administrator for assistance.

Once you feel confident in your ability to complete the dialogue, inform your course administrator that you are ready to complete the performance test for Module #5.

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MODULE #5 PERFORMANCE TEST

TROUBLESHOOTING THE M998 LIGHTING AND INSTRUMENT SYSTEMS

INTRODUCTION: Having successfully completed the instructional portion of the module, you will now be tested on your ability to troubleshoot the M998 lighting and instrument systems. You will be performing the same tasks that you performed in the dialogue.

PERFORMANCE OBJECTIVE: Given the TM, tools, TMDE, and verbal scenarios indicating various faults within the lighting and instrument systems, you will troubleshoot those systems according to TM 9-2320-280-20-1. In addition, you will state what must be done to correct identified faults.

TASKS TO PERFORM:

TASK A: PERFORM LIGHT CIRCUIT TEST QUESTION #1

TASK B: PERFORM LIGHT CIRCUIT TEST QUESTION #2

TASK C: PERFORM LIGHT CIRCUIT TEST QUESTION #3

TASK D: PERFORM VOLTAGE TEST AT WIRE 75 ON BRAKE LIGHT SWITCH

TASK E: PERFORM VOLTAGE TEST AT WIRE 75A ON BRAKE LIGHT SWITCH

TASK F: PERFORM INSPECTION AND TEST OF THE LEFT BRAKE LIGHT ASSEMBLY

TASK G: PERFORM VOLTAGE TEST AT WIRE 22-461B

TASK H: PERFORM VOLTAGE TEST AT SOCKETS "D" AND "G" OF THE TURN SIGNAL SWITCH HARNESS CONNECTOR

TASK I: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I1

TASK J: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I2

TASK K: PERFORM INSTRUMENT CIRCUIT TEST QUESTION #I3

TASK L: PERFORM INSTRUMENT CIRCUIT TEST QUESTIONS #I4 and #I5

INSTRUCTIONS: You are expected to perform each task just as you would on the job; however, since the faults are simulated, test readings, actions, or other information needed to perform each task will be provided. If you do not understand something or have questions, **ask your course administrator.** Your course administrator will be using a written script to guide you. Feedback will be provided.

Although this is not a timed event, you will be stopped if it is determined that you are not able to successfully complete the test.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

MATERIAL REQUIRED:

1. Performance Test
2. TM 9-2320-280-20-1
3. TM 9-2320-280-20-3 (FO-1)
4. General mechanic's toolbox
5. Droplight/flashlight
6. STE/ICE-R
7. Multimeter
8. M998 HMMWV (operational and clean)
9. Rags or handi-wipes
10. Camouflaged utilities (coveralls optional)
11. Creeper

PERFORMANCE STANDARDS:

You will be graded on a PASS/FAIL basis. To pass this performance test, you must successfully complete all tasks on the evaluation sheet. Your ability to perform each of the tasks will be based on the professional judgment of the course administrator using the criteria listed in items 1 through 3 below.

Note: Your course administrator may provide a very limited amount of assistance; however, remember that your course administrator is judging your ability to perform. If he/she determines that you cannot successfully complete a task, you will not receive a passing grade for that task. Although testing is not timed, you will be stopped if the course administrator determines that you cannot complete the test in a reasonable amount of time.

1. Demonstrate competency in the use of the tools and test equipment.

a. Select the appropriate tools and test equipment for performing the task.

b. Prepare equipment for testing.

(1)Correct set-up.

(2)Perform operational check (if required).

c. Complete all necessary equipment operational steps in the correct or an acceptable sequence.

d. Read and correctly interpret the test results displayed.

2. Demonstrate competency in the use of the technical manual.

a. Locate the appropriate test in the TM for troubleshooting the simulated fault.

b. Complete all necessary test procedural steps in the correct or an acceptable sequence.

c. State the appropriate or corrective action for simulated or identified faults.

d. Locate additional reference information such as schematics, STE/ICE-R test procedures, system operation instructions, etc.

e. Locate and identify components and circuits on schematics.

3. **Observe safety rules**.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

When you are ready to begin testing, enter your name, rank, and social security number on the student evaluation sheet. Remove the sheet and hand it to your course administrator.

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STUDENT EVALUATION SHEET FOR MODULE #5

NAME: _____

RANK: _____

SSN: _____

GRADE: PASS FAIL

DID THE STUDENT SUCCESSFULLY COMPLETE:	**YES**	**NO**
TASK A: Perform Light Circuit Test Question #1?		
TASK B: Perform Light Circuit Test Question #2?		
TASK C: Perform Light Circuit Test Question #3?		
TASK D: Perform Voltage Test at Wire 75 on Brake Light Switch?		
TASK E: Perform Voltage Test at Wire 75A on Brake Light Swith?		
TASK F: Perform Inspection and Test of the Lieft Brake Light Assembly?		
TASK G: Perform Voltage Test at Wire 22-416B?		
TASK H: Perform Voltage Test at Sockets “D” and “G” of the Turn Signal Switch Harness Connector?		
TASK I: Perform Instrument Circuit Test Question #I1?		
TASK J: Perform Instrument Circuit Test Question #I2?		
TASK K: Perform Instrument Circuit Test Question #I3?		
TASK J: Perform Instrument Circuit Test Questions #I4 & #I5?		

REMARKS:

CRS ADMINISTRATOR'S SIGNATURE: _____

CRS MANAGER'S SIGNATURE: _____

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MODULE #6 DIALOGUE

TROUBLESHOOTING THE M998 GLOWPLUG SYSTEM

INTRODUCTION:

In the previous module, you diagnosed faults within the lighting and instrument systems. In this module, you will continue with your learning by performing various actions that relate to diagnosing faults within the M998 glowplug system. The tests that you will be performing are strictly for the glowplugs, their operating components, and associated wiring. All tests should be performed under the assumption that the batteries are fully charged and in good condition and that the fuel system is fully operational.

As an organizational mechanic, you must be able to troubleshoot the glowplug system. For the M998, the glowplugs provide the means for increasing the air temperature within the engine combustion chambers for initial starting. Improper starting procedures and hard use are often the cause of glowplug failure.

PERFORMANCE OBJECTIVE:

Given situations stating that faults exist within the M998 glowplug system,
TM 9-2320-280-20-1, and **selected test equipment,** diagnose the cause of each fault. In addition, state the corrective action for the faults.

OUTLINE OF TASKS THAT YOU WILL PERFORM:

TASK A: PERFORM GLOWPLUG TEST QUESTION #1

TASK B: PERFORM GLOWPLUG TEST QUESTION #2

TASK C: PERFORM GLOWPLUG TEST QUESTION #3

TASK D: PERFORM GLOWPLUG TEST QUESTION #A1

TASK E: PERFORM GLOWPLUG TEST QUESTION #A2

TASK F: PERFORM GLOWPLUG TEST QUESTION #A3

TASK G: PERFORM GLOWPLUG TEST QUESTION #B1

TASK H: PERFORM GLOWPLUG TEST QUESTION #B2

TASK I: PERFORM GLOWPLUG TEST QUESTION #E1

TASK J: PERFORM GLOWPLUG TEST QUESTION #E2

PREPARING FOR THE MODULE:

If you have not already done so, or if you are not familiar with the M998 glowplug system and component operation, read paragraph 2-31 page 2-303 and study FO-9.

MATERIAL REQUIRED:

To perform the tasks in this module, you will need the following:

1. Dialogue for Module #6
2. TM 9-2320-280-20-1.
3. General mechanics toolbox
4. Droplight/flashlight
5. STE/ICE-R
6. Multimeter
7. M998 HMMWV (operational and clean)
8. Rags or handi-wipes
9. Camouflaged utilities (coveralls optional)
10. Creeper

See your course administrator to obtain these items.

CAUTION

In this module, you will be performing hands-on type tasks. All safety rules and regulations must be observed. Before beginning, review the WARNING SUMMARY in the front of the technical manual.

TASK A: PERFORM GLOWPLUG TEST QUESTION #1

Situation: Let's assume that an operator has just told you that his vehicle will not start. It is the middle of December and the temperature is down to 15 degrees Fahrenheit. You have gathered all of your equipment and the TM and are now on the vehicle ready to begin testing. At this point the only "**known information**" is **that the batteries are OK**.

Study Glowplug Test Question #1, the Diagnostic Flowchart, and the Reference Information associated with the question (pages 2-262 and 2-263). Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the following question.

1. Since we previously stated that the batteries are fully charged and our complaint had nothing to do with the "wait-to-start" lamp, what should you do now?

   _____

Here is the correct answer:

1. Go to Test Question #2.

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TASK B: PERFORM GLOWPLUG TEST QUESTION #2

Situation: You previously completed Glowplug Test Question #1. Assuming that the batteries are OK, the flowchart directed you to Glowplug Test Question #2.

Study Glowplug Test Question #2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the, FLOWCHART and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the only **"known information"** is that the **batteries are OK**.

1. What is the reason for asking Test Question #2?

   _____

   _____

2. What is your test option?

   _____

3. What are the possible problems?

   a. _____

   b. _____

   c. _____

   d. _____

4. Perform a visual inspection of the glowplug circuit connections and then make the following entries in the box below. If a connection is OK, place a check next to the item; if a connection needs cleaning or tightening, state the action needed.

Glowplug Connection Inspection Check List

1. **Protective control box** _____
2. **Glowplug controller** _____
3. **Glowplugs** _____
4. **Cables** _____

5. Assuming that all connections are clean and tight, how would you answer Test Question #2?

_____

Here are the correct answers:

1. Loose or dirty connections can hinder current flow or cause mixups in the control signals. (Refer to the Reason For Question block.)

2. Visual inspection consisting of an inspection of the glowplug circuit connections. (Refer to the Test Options block.)

3. Glowplugs, glowplug controller, PCB and cables. (Refer to the Possible Problems block.)

4. Actual responses. (If your reading is abnormal, see course administrator for feedback.)

5. Follow the YES path; go to Test Question #3.

TASK C: PERFORM GLOWPLUG TEST QUESTION #3

Situation: You previously completed Glowplug Test Question #2. Let's assume that you determined that the glowplug circuit connections were tight and in good condition. Based on this assumption, the flowchart directed you to the Glowplug Test Question #3.

Study Glowplug Test Question #3, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **batteries and cables/connections seem OK**.

Note: Test results will vary depending on the outside temperature.

1. What is Test Question #3 asking you to do?

   _____

2. What is the preferred test option?

   _____

3. What is the reason for the question?

   _____

4. How long do the glowplugs stay ON when you initially turn the rotary switch to the RUN position?

   _____

5. At what engine temperature do the glowplugs first come on?

   _____

6. Select and perform STE/ICE-R Test 80. Record your test results in the box on the next page.

   Note: Pay close attention to the note for Test Question #3 at the bottom of page 2-304.

Glowplug current draw is _____ amps.

7. Assume that the current draw was 80 amps; how would you answer Test Question #3?

   _____

8. Assume that the current draw was 35 amps; how would you answer Test Question #3?

   _____

Here are the correct answers:

1. To determine the current draw of the glowplugs with the rotary switch in the run position. (Refer to the Test Question block.)

2. STE/ICE-R Test 80. (Refer to the Test Options block.)

3. If the current is OK, the glowplugs and the protective control box are OK. (Refer to the Reason For Question block.)

4. For up to 9 seconds. (Refer to the Reference Information on page 2-305.)

5. When the temperature is below 120 degrees. (Refer to the Reference Information for Test Question #3 on page 2-305.)

6. 75-125 AMPS. (Your reading may vary because of the temperature. Ask your course administrator for additional feedback if required.)

7. Follow the YES path; go to Test Question #4 on page 2-306.

8. Follow the NO path; go to Test Question #A1 on page 2-308.

TASK D: PERFORM GLOWPLUG TEST QUESTION #A1

Situation: You previously completed Glowplug Test Question #3. Let's assume that the glowplug current draw was 68 amps. Based on this assumption, the flowchart directed you to the Glowplugs Test Question #A1.

Study Glowplug Test Question #A1, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, theFLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplugs do not draw enough current**.

1. What is the reason for the question?

   _____

   _____

2. What are your test options?

   a. _____

   b. _____

3. How much current does a dead glowplug draw?

   _____

4. What is the normal amount of current that other parts of the vehicle will draw when the rotary switch is in the run position?

   _____

5. Select and perform STE/ICE-R Test 80. Record your test result in the following box.

Glowplug current draw is _____ amps.

6. Assume that the reading was above 30 amps. How would you answer Test Question #A1?

_____

7. Assume that the reading was 8 amps. How would you answer Test Question #A1?

_____

Here are the correct answers:

1. To determine if you have at least 15 amps. A working glowplug draws between 12-15 amps; if at least one glowplug is working, the PCB is OK. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 80
   b. Multimeter

   (Refer to the Test Options block.)

3. A dead glowplug draws virtually no current. (Refer to the Reference Information for Test Question #A1 on page 2-309.)

4. Up to 8 amps is normal. (Refer to the Reference Information for Test Question #A1 on page 2-309.)

5. Actual reading should be above 15 amps. (If you had a problem performing this test, see your course administrator.)

6. Follow the YES path; go to Test Question #A2.

7. Follow the NO path; go to Test Question #C1, page 2-312.

TASK E: PERFORM GLOWPLUG TEST QUESTION #A2

Situation: You previously completed Glowplug Test Question #A1. Let's assume that the glowplug current draw was more than 15 amps. Based on this assumption, the flowchart directed you to the Glowplug Test Question #A2.

Study Glowplug Test Question #A2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplugs draw some but not enough current and that the PCB is OK**.

1. What is the reason for Test Question #A2?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. After the initial nine-second ON cycle of the glowplugs, they will turn off and stay off for how long?

   _____

5. What is the normal glowplug current draw range when the glowplugs are working properly?

   _____

6. Select and perform STE/ICE-R Test 80. In the box below, record your test results and the readings that you should measure under normal circumstances.

   Note: Before performing this test, read the Reference Information under the NORMAL GLOWPLUG OPERATION section on page 2-307 carefully. Note the engine temperature requirement and the rotary switch position.

When glowplugs come on reading is _____ amps.
When glowplugs turn off reading is _____ amps.
Reading should be _____ amps when glowplugs come on.
Reading should be _____ amps when glowplugs turn off.

7. Assume the glowplugs cycled normally; how would you answer Test Question #A2?

   _____

8. Assume that the glowplugs did not cycle at all; how would you answer Test Question #A2?

   _____

Here are the correct answers:

1. If the glowplugs cycle properly, the glowplug controller is OK. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 80
   b. Multimeter

   (Refer to the Test Options block.)

3. Glowplugs, glowplug controller, or cables. (Refer to the Possible Problems block.)

4. 7 - 15 seconds. (Refer to the Reference Information on page 2-307.)

5. 74 - 125 amps; however, a 74 amp reading would indicate weak batteries. (Refer to the Reference Information on page 2-307.)

6. Actual test results.

   (Reading should be **74-125 amps** when the glowplugs come on. Reading should be **3-8 amps** when the glowplugs turn off. Refer to the Reference Information on page 2-307. If you had a difficult time performing this test or in interpreting your test results, ask for feedback from your course administrator.)

7. Follow the YES path; go to Test Question #A3.

8. Follow the NO path; go to Test Question #B1 on page 2-310.

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TASK F: PERFORM GLOWPLUG TEST QUESTION #A3

Situation: You previously completed Glowplug Test Question #A2. Assuming that the glowplugs were cycling normally but the current draw was below normal, the flowchart directed you to the Glowplug Test Question #A3.

Study Glowplug Test Question #A3, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplugs draw some but not enough current** and that the **PCB and glowplug controller are OK**.

1. What is the reason for the Test Question #A3?

   _____

   _____

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. What is a typical glowplug resistance reading?

   _____

5. When testing for resistance, if the reading goes off the scale, what does that indicate?

   _____

6. Select the MULTIMETER and perform Test Question #A3 (resistance test on the PCB, the #1 glowplug, and its wire).

Note: Even though the test question says to check all glowplugs, check only one glowplug and its wiring. Record your test results in the spaces provided in the box below.

Pay special attention to the reference information on page 2-309 titled Checking Glowplugs and their Wires. Disregard the statement under step 2 that refers to reconnecting the negative battery cable. It must remain disconnected when checking resistances with the multimeter. It would be reconnected if you were using the STE/ICE-R for this test. YOU MUST DISCONNECT ALL GLOWPLUG WIRES WHEN PERFORMING THIS TEST.

If you have forgotten how to set the multimeter for testing resistance, see the testing procedure Continuity (Resistance) Multimeter on page 2-313.

With all the glowplug wires disconnected, do you have continuity between Pin "D" of the engine connector harness of the protective control box (PCB) and ground?

Yes ____ No ____

With the number 1 glowplug wire connected to the glowplug, do you have a resistance reading from 1 and 2 ohms measured between Pin "D" of the PCB engine connector harness and ground?

Yes ____ No ____

With the number 1 glowplug wire disconnected from the glowplug, do you have a resistance reading from 1 and 2 ohms measured between the glowplug and the engine block?

Yes ____ No ____

Note: Under normal conditions, you would check each glowplug using the same procedure that you used to check the number one glowplug.

7. With all the glowplug wires disconnected, assume there is continuity between Pin "D" of the PCB engine connector harness and ground. What does that indicate?

_____

8. What normally causes all or most of the glowplugs to burn out?

_____

9. After replacing the defective glowplugs what should you do before returning the vehicle to service?

_____

Here are the correct answers:

1. Since the glowplugs draw some current and cycle properly, there are only two reasons they wouldn't draw enough current. The glowplugs themselves are bad or the wires are no good. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 91
   b. Multimeter

   (Refer to the Test Options block.)

3. Glowplugs or cables. (Refer to the Possible Problems block.)

4. 1.6 ohms. (Refer to the Reference Information on page 2-309.)

5. Excessive resistance. (Refer to the Reference Information on page 2-307 and page 309.)

6. Actual test results.

   No. (You should not have continuity between Pin "D" and ground with the PCB connector harness disconnected from the PCB.)

   Yes. (You should have a reading of between 1 to 2 ohms with the glowplug wire connected.)

   Yes. (You should have a reading of between 1 to 2 ohms with the glowplug wire disconnected.)

   (If you had problems performing the tests or interpreting your readings, ask for feedback from your course administrator.)

7. The harness is defective. (Refer to Step 2 on page 2-309. You should not get a continuity reading when performing this test. Remember, continuity is less than 5 ohms.)

8. A defective PCB or a glowplug controller. (Refer to Reference Information on page 2-309. Glowplugs normally burn out from cycling on too long or not turning off at all.)

9. Re-run the main glowplug test chain. (Refer to the Statement in the Test Question block.)

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TASK G: PERFORM GLOWPLUG TEST QUESTION #B1

Situation: You previously completed Glowplug Test Question #A3. Based on the last situation in which we stated that the glowplug current was below normal, you would have solved the problem at the completion of Test Question #A3.

Let's now go back to Test Question #A2. The last time you answered this question, you said that the glowplugs were cycling properly. This time let's assume that they are **NOT** cycling properly. Based on this assumption the flowchart directs you to Test Question #B1 on page 2-310. Turn to page 2-310.

Study Glowplug Test Question #B1, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplug current is OK**; however, the **glowplugs are not cycling properly**.

1. What is the reason for the Test Question #B1?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What is/are the possible problem(s)?

   _____

4. Select and perform STE/ICE-R Test 80. Record your test results in the space provided in the box below.

With the rotary switch in the RUN position, the glowplugs draw _____ amps.

5. Assuming that the glowplugs did not draw current, how would you answer Test Question #B1?

   _____

6. Assuming that the glowplugs did draw current, how would you answer Test Question #B1?

   _____

Here are the correct answers:

1. If the glowplug controller is shorted, the glowplug power relay in the protective control box will always be closed. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 80
   b. Multimeter

   (Refer to the Test Options block.)

3. PCB. (Refer to the Possible Problems block.)

4. Actual current reading. (Refer to the STE/ICE-R Test 80 box on page 2-311. If the glowplugs are drawing current, your reading should be above 30 amps, depending on how many accessories are on.)

5. Follow the NO path; go to Test Question #E1 page 2-316.

6. Follow the YES path; go to Test Question #B2.

TASK H: PERFORM GLOWPLUG TEST QUESTION #B2

Situation: You previously completed Glowplug Test Question #B1. Let's assume that the glowplugs were drawing current with the controller disconnected. Based on this assumption, the flowchart directed you to the Glowplug Test Question #B2.

Study Glowplug Test Question #B2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplug current is OK**, the **glowplugs are not cycling**, and the **glowplugs draw current with the controller disconnected**.

1. What is the reason for the Test Question #B2?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. Select and perform STE/ICE-R Test 89. Record your test results in the space provided.

Voltage at Socket "6" is _____ volts.

5. Assume battery voltage was present at Socket "6". How would you answer Test Question #B2?

   _____

6. Assume that battery voltage was **not** present at Socket "6". How would you answer Test Question #B2?

_____

Here are the correct answers:

1. If there is a short in the harness, this wire will have battery voltage. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 89
   b. Multimeter

   (Refer to the Test Options block.)

3. Wiring short or PCB glowplug relay. (Refer to the Possible Problems block.)

4. Actual reading. (See your course administrator for feedback if you have problems performing this test.)

5. Follow the YES path; repair or replace the wiring harness.

6. Follow the NO path; replace the PCB.

TASK I: PERFORM GLOWPLUG TEST QUESTION #E1

Situation: You previously completed Glowplug Test Question #B2. Let's assume that the voltage reading was 0 volts. Based on this assumption, you would replace the PCB. Since you have narrowed the fault down to a defective PCB, that ends this test chain. Now, go back to Test Question #B1. Assuming that you didn't have any current draw with the glowplug controller disconnected, the flowchart directs you to the glowplug Test Question #E1.

Study Glowplug Test Question #E1, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplug current is OK**, and the **PCB is OK, but the glowplugs are not cycling.**

1. What is the reason for Test Question #E1?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. Select and perform STE/ICE-R Test 91. Record your test results in the space provided.

The resistance reading between the PCB engine connector harness Socket "C" and the glowplug controller harness Socket "4" is _____ ohms.

5. Assume that you had continuity (less than 5 ohms) between Socket "C" and Socket "4". How would you answer Test Question #E1?

   _____

6. Assume that you did **not** have continuity between Socket "C" and Socket "4". How would you answer Test Question #E1?

_____

Here are the correct answers:

1. Wire 570A controls the glowplug cycling. If this wire is an open circuit, the glowplugs can't cycle. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 91
   b. Multimeter

   (Refer to the Test Options block.)

3. Wiring or glowplugs controller. (Refer to the Possible Problems block.)

4. Actual reading. (See your course administrator for feedback if you had a problem performing this test.)

5. Follow the YES path; go to Test Question #E2.

6. Follow the NO path; repair or replace wire 570A or replace the wiring harness.

TASK J: PERFORM GLOWPLUG TEST QUESTION #E2

Situation: You previously completed Glowplug Test Question #E2. Let's assume that you had continuity between Socket "C" of the engine connector and Socket "4" of the glowplug controller harness. Based on this assumption, the flowchart directed you to the Glowplug Test Question #E2.

Study Glowplug Test Question #E2, the Diagnostic Flowchart, and the Reference Information associated with the question. Once you completely understand the QUESTION, the FLOWCHART, and the REFERENCE INFORMATION, answer the questions and follow the directions provided below.

At this point the "**known information**" is that the **glowplug current** and the **PCB are OK** and that the **glowplugs are not cycling**.

1. What is the reason for Test Question #E2?

   _____

2. What are your test options?

   a. _____

   b. _____

3. What are the possible problems?

   _____

4. Select and perform STE/ICE-R Test 91. Record your test results in the space provided.

The resistance reading between glowplug controller harness Socket "5" and the engine ground is _____ ohms.

5. Assume you had continuity between Socket "5" and the engine ground. How would you answer Test Question #E2?

   _____

6. Assume you did not have continuity between Socket "5" and the engine ground. How would you answer Test Question #E2?

   _____

Here are the correct answers:

1. The controller can't work properly without a proper ground. (Refer to the Reason For Question block.)

2. a. STE/ICE-R Test 91
   b. Multimeter

   (Refer to the Test Options block.)

3. Wiring or glowplugs controller. (Refer to the Possible Problems block.)

4. Actual reading. (See your course administrator for feedback if you had problems conducting this test.)

5. Follow the YES path; replace the glowplug controller.

6. Follow the NO path; repair or replace wire 93A or replace the wiring harness.

In this module, you tested the major components that make up the glowplug system. The situations purposely took you through the process that would lead to the replacement of glowplugs, PCB, and glowplug controller.

Notice that you used both the STE/ICE-R and the multimeter. You should have found that in some cases, the multimeter may be just as easy to use as the STE/ICE-R. A great advantage for using the STE/ICE-R, however, is that in most cases you can conduct your testing right from the driver's seat.

This completes the dialogue for Module #6. If you had a difficult time completing any part of it, review that part again carefully, paying close attention to the feedback section and/or see your course administrator for assistance.

Once you feel confident in your ability to complete the dialogue, inform your course administrator that you are ready for the performance test.

MODULE #6 PERFORMANCE TEST

TROUBLESHOOTING THE M998 GLOWPLUG SYSTEM

INTRODUCTION: Having successfully completed the instructional portion of the module, you will now be tested on your ability to troubleshoot the M998 glowplug system. You will be performing some of the same tasks that you performed in the dialogue. In addition, you will state what must be done to correct identified faults.

PERFORMANCE OBJECTIVE: Given the TM, tools, TMDE, and verbal scenarios indicating various faults within the M998 glowplug system, you will troubleshoot the system according to **TM 9-2320-280-20-1.** In addition, you will state the corrective action for the faults.

OUTLINE OF TASKS THAT YOU WILL PERFORM:

TASK A: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #1

TASK B: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #2

TASK C: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #3

TASK D: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #A1

TASK E: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #A2

TASK F: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #A3

TASK G: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #B1

TASK H: PERFORM GLOWPLUG CIRCUIT TEST QUESTION #B2

INSTRUCTIONS: You are expected to perform each task just as you would on the job; however, since the faults are simulated, test readings, actions, or other information needed to perform each task will be provided. If you do not understand something or have questions, **ask your course administrator.**

Your course administrator will be using a written script to guide you. Feedback will be provided as needed.

Although this is not a timed event, you will be stopped if it is determined that you are not able to successfully complete the test.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

MATERIALS REQUIRED:

1. Performance Test
2. TM 9-2320-280-20-1
3. General mechanics toolbox
4. Droplight/flashlight
5. STE/ICE-R
6. Multimeter
7. M998 HMMWV (operational and clean)
8. Rags or handi-wipes
9. Camouflaged utilities (coveralls optional)
10. Creeper. Camouflaged Utilities (Coveralls optional)

PERFORMANCE STANDARDS:

You will be graded on a PASS/FAIL basis. To pass this performance test, you must successfully complete all tasks on the evaluation sheet. Your ability to perform each of the tasks will be based on the professional judgment of the course administrator using the criteria listed in items 1 through 3 below.

Note: Your course administrator may provide a very limited amount of assistance; however, remember that your course administrator is judging your ability to perform. If he/she determines that you cannot successfully complete a task, you will not receive a passing grade for that task. Although testing is not timed, you will be stopped if the course administrator determines that you are not able to complete the test in a reasonable amount of time.

1. Demonstrate competency in the use of the tools and test equipment.

a. Select the appropriate tools and test equipment for performing the task.

b. Prepare equipment for testing.

(1) Correct set-up.

(2) Perform operational check (if required).

c. Complete all necessary equipment operational steps in the correct or an acceptable sequence.

d. Read and correctly interpret the test results displayed.

2. Demonstrate competency in the use of the technical manual.

a. Locate the appropriate test in the TM for troubleshooting the simulated fault.

b. Complete all necessary test procedural steps in the correct or an acceptable sequence.

c. State the appropriate or corrective action for simulated or identified faults.

d. Locate additional reference information such as schematics, STE/ICE-R test procedures, system operation instructions, etc.

e. Locate and identify components and circuits on schematics.

3. Observe safety rules.

All safety rules and regulations must be observed. You will be stopped immediately for any safety violations that could result in injury to personnel or damage to equipment.

When you are ready to begin testing, enter your name, rank, and social security number on the student evaluation sheet. Remove the sheet and hand it to your course administrator.

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STUDENT EVALUATION SHEET FOR MODULE #6

NAME: _____

RANK: _____

SSN: _____

GRADE: PASS FAIL

DID THE STUDENT SUCCESSFULLY COMPLETE:	**YES**	**NO**
TASK A: Perform Glowplug Circuit Test Question #1?		
TASK B: Perform Glowplug Circuit Test Question #2?		
TASK C: Perform Glowplug Circuit Test Question #3?		
TASK D: Perform Glowplug Circuit Test Question #A1?		
TASK E: Perform Glowplug Circuit Test Question #A2?		
TASK F: Perform Glowplug Circuit Test Question #A3?		
TASK G: Perform Glowplug Circuit Test Question #B1?		
TASK H: Perform Glowplug Circuit Test Question #B2?		

REMARKS:

CRS ADMINISTRATOR'S SIGNATURE: _____

CRS MANAGER'S SIGNATURE: _____

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GRADE REPORT FORM

STUDENT INFORMATION

NAME: _____
RANK: _____
SSN: _____
RESULTS:

MODULE #	TITLE	PASS/FAIL
2	Troubleshooting the M998 Battery System	
3	Troubleshooting the M998 Starting System	
4	Troubleshooting the M998 Charging System	
5	Troubleshooting the M998 Lighting and Instrument Systems	
6	Troubleshooting the M998 Glowplug System	

COURSE ADMINISTRATOR INFORMATION

NAME: _____
RANK: _____
SSN: _____
UNIT: _____
UNIT PHONE NUMBER: DSN_____**COMM** _____

SIGNATURE:_____

COURSE MANAGER INFORMATION

NAME: _____
RANK: _____
SSN: _____
UNIT: _____
UNIT PHONE NUMBER: DSN_____**COMM**_____

SIGNATURE:_____

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STUDENT QUESTIONNAIRE
MCI 3512A, *Troubleshooting The M998 Electrical System*

Please help us better serve your learning needs by completing the following questionnaire, selecting only one response per statement. **For all comments that you are in disagreement with, please utilize space provided to give specific details**. Mark your responses directly on this form and return it, along with your examination booklet, to your proctor. Thank you.	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Applicable
1. The course objectives were clear to me.					
2. The course content was organized in a way that allowed me to meet the learning objectives.					
3. The course activities gave me sufficient practice and feedback.					
4. The course exam accurately tested me on the learning objectives.					
5. The course delivery was an effective way for me to learn (e.g., paper-based book, CD, web-based format).					
6. For the most part, I could get help when I had content-related problem, questions or comments.					
7. The course length was appropriate to cover the content.					
8. The way the material was presented on a page or screen made it more effective to learn large amounts of information more quickly.					
9. The course held my attention.					
10. Overall, this course met my learning needs.					
11. The knowledge and/or skills gained from the course materials will help me to perform my job better.					
12. I would recommend the course to other Marines in my organization.					

ADDITIONAL COMMENTS:

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If you have questions, comments, or suggestions for improving this course and would like a representative from the Marine Corps Institute to contact you, please include the following information:

Name:_____

Work Phone:_____ E-mail Address: _____