

**ARMY TM 9-2320-280-20-1**  
**AIR FORCE TO 36A12-1A-2092-1-1**  
**MARINE CORPS TM 2320-20/7B**

**Volume No. 1**

(SUPERSEDES TM 9-2320-280-20-1, 19 JANUARY 1990)

## TECHNICAL MANUAL UNIT MAINTENANCE

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4, M998 (2320-01-107-7155) (EIC: BBD); M998A1 (2320-01-371-9577) (EIC: BBN);

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TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, M1037 (2320-01-146-7193) (EIC: BBK);

TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, W/WINCH, M1042 (2320-01-146-7187);

TRUCK, AMBULANCE, 2-LITTER, ARMORED, 4X4, M996 (2310-01-111-2275) (EIC: BBB); M996A1 (2310-01-372-3935) (EIC: BB2);

TRUCK, AMBULANCE, 4-LITTER, ARMORED, 4X4, M997 (2310-01-111-2274) (EIC: BBA); M997A1 (2310-01-372-3934) (EIC: BBZ); M997A2 (2310-01-380-8225) (EIC: BB8);

TRUCK, AMBULANCE, 2-LITTER, SOFT TOP, 4X4, M1035 (2310-01-146-7194); M1035A1 (2310-01-371-9585) (EIC: BBW); M1035A2 (2310-01-380-8290) (EIC: BB9).

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**HEADQUARTERS, DEPARTMENTS OF THE ARMY,  
THE AIR FORCE, AND MARINE CORPS**

**JANUARY 1996**

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**WARNING**

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**EXHAUST GASES CAN KILL**

Brain damage or death can result from heavy exposure. Precautions must be followed to ensure crew safety when the personnel heater, main, or auxiliary engine of any vehicle is operated for any purpose.

1. Do not operate your vehicle engine in enclosed areas.
2. Do not idle vehicle engine with vehicle windows closed.
3. Be alert at all times for exhaust odors.
4. Be alert for exhaust poisoning symptoms. they are:
  - Headache
  - Dizziness
  - Sleepiness
  - Loss of muscular control
5. If you see another person with exhaust poisoning symptoms:
  - Remove person from area
  - Expose to open air
  - Keep person warm
  - Do not permit physical exercise
  - Administer artificial respiration, if necessary\*
  - Notify a medic

\*For artificial respiration, refer to FM 21-11.

6. BE AWARE, the field protective mask for nuclear, biological or chemical (NBC) protection will not protect you from carbon monoxide poisoning.

**THE BEST DEFENSE AGAINST EXHAUST POISONING IS ADEQUATE VENTILATION.**

## **WARNING SUMMARY (Cont'd)**

- Drycleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel and/or damage to equipment.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).
- Diesel fuel is highly flammable. Do not perform any procedure near fire, flames, or sparks. Severe injury or death will result.
- Do not touch hot exhaust system components with bare hands. Severe injury will result.
- Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190°F (88°C). Steam or hot coolant under pressure will cause injury.
- Do not drain oil when engine is hot. Severe injury to personnel will result.
- Always wear eye protection when bleeding brakes. Failure to do this may cause injury if brake fluid comes in contact with eyes.
- Do not perform battery system checks or inspections while smoking or near fire, flames, or sparks. Batteries may explode causing damage to vehicle, injury, or death to personnel.
- Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or disconnected battery ground cable contacts battery terminal, a direct short will result, causing injury to personnel, or damage to equipment.
- Use caution when testing thermostat. Hot water will cause burns.
- Negative battery cable must be disconnected before disconnecting any harness from protective control box, or serious injury to personnel or damage to equipment will result.
- Keep hands and arms away from fan blade and drivebelts while engine is running, or serious injury may result.
- Battery acid (electrolyte) is extremely harmful. Always wear safety goggles and rubber gloves, and do not smoke when performing maintenance on batteries. Injury will result if acid contacts eyes or skin.
- When removing battery cable clamps, disconnect ground cable first. Ensure all switches are in OFF position before disconnecting ground cable. Do not allow tools to come in contact with vehicle when disconnecting cable clamps. A direct short can result, causing instant heating of tools, tool damage, battery damage, or battery explosion.
- Allow transmission/transfer case to cool before performing maintenance. Failure to do this may cause injury.
- Always apply parking brake and chock opposite wheel before removing wheel. Avoid removing wheel when vehicle is on sloping terrain. Injury to personnel or damage to equipment may result.
- Gloves must be worn whenever handling winch cable. Severe injury may result.
- Opening one end of cargo door without ensuring opposite end is securely closed will cause both ends to open simultaneously, resulting in injury to personnel or damage to equipment.
- Direct all personnel to stand clear during engine hoisting operations. Failure to do this may cause injury to personnel.
- Hydraulic jacks are used for raising and lowering, and are not used to support vehicle. Never work under vehicle unless wheels are blocked and it is properly supported. Injury or damage to equipment may result if vehicle suddenly shifts or moves.
- Remove only the inner group of nuts when removing a wheel from the vehicle. Removing the outer nuts which hold the rim together while the assembly is inflated could result in serious injury or death.

**WARNING SUMMARY (Cont'd)**

- In all disassembly of the wheel assembly operations, ensure the tire is totally deflated before removing wheel nuts. Failure to follow proper safety precautions could cause serious injury or death.
- Never inflate a wheel assembly with the wheel locknuts removed in an attempt to separate inner and outer rim halves. The assembly will separate under pressure resulting in serious injury or death.
- Never use wheel assemblies with studs which are damaged, loose, or have damaged threads. Damaged studs can cause improper assembly, which could cause individual fasteners to fail. Any of these situations could cause serious injury or death.
- Never use tubes in wheel assemblies. Use of a tube defeats built-in safety features, and could allow the wheel to come apart under pressure, resulting in serious injury or death.
- Use only replacement parts specified in TM 9-2320-280-24P. Wheels assembled with components which do not meet specifications could cause the assembly to separate under pressure, resulting in serious injury or death.
- Never inflate a wheel assembly without having checked wheel locknut torques to ensure to wheel locknuts are tightened to specifications. An assembly with improperly tightened locknuts could separate under pressure resulting in serious injury or death.
- Always use a tire inflation cage for inflation purposes. Stand on one side of cage, during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate assembly to recommended pressure, using a clip-on air chuck. Do not exceed 30 psi (207 kPa) cold bias tire inflation pressure or 50 psi (344 kPa) cold radial tire inflation pressure. Failure to follow these instructions may result in serious injury or death.
- Never mix radial tires and bias ply tires on the same vehicle. Injury to personnel or damage to equipment may result.
- Rear steps must be raised before disconnecting retractor lever from rear steps. Failure to do this may cause injury to personnel and damage to equipment.
- NBC contaminated filters must be handled and disposed of only by authorized and trained personnel. The unit commander or senior officer in charge of maintenance personnel must ensure that prescribed protective clothing (FM 3-4) is used, and prescribed safety measures and decontamination procedures (FM 3-5) are followed. The local unit SOP is responsible for final disposal of contaminated air filters. Failure to do this may cause severe injury to personnel.
- Seatbelts are to be replaced as a set. Failure to do this may cause injury to personnel or damage to equipment.
- The Department of Transportation requires 105 mm cannon ammunition to be in wooden boxes when transporting ammunition on public highways, by fixed wing aircraft, rail, or ship. Movement of cannon ammunition in fiber containers (inner pack) in the HMMWV ammunition rack is restricted to other than public highways.



CHANGE  
NO. 2

HEADQUARTERS  
DEPARTMENTS OF THE ARMY,  
THE AIR FORCE, AND MARINE CORPS  
Washington, D.C., 15 July 2004

TECHNICAL MANUAL  
VOLUME 1 OF 3  
UNIT MAINTENANCE

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TM 9-2320-280-20-1, 31 January 1996, is changed as follows:

1. Remove old pages and insert new pages as indicated below.
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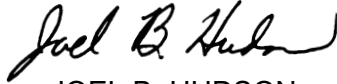
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CHANGE

NO. 1

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DEPARTMENTS OF THE ARMY,  
THE AIR FORCE, AND MARINE CORPS  
Washington, D.C., 30 JUNE 1999

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TM 9-2320-280-20-1, 31 January 1996, is changed as follows:

1. Two new models have been added to the front cover. The new cover, located at the end of the change package, replaces the existing cover.
2. Remove old pages and insert new pages as indicated below.
3. New or changed material is indicated by a vertical bar in the margin of the page.

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cover

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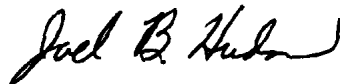
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2-761 and 2-762  
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**LIST OF EFFECTIVE PAGES**

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

Dates of issue for original and  
changed pages of volume 1 are:

Original ... 0 ... 31 January 1996

Change ... 1 ..... 30 June 1999

Change ... 2 ..... 15 July 2004

Volume 1 contains 927 pages

Dates of issue for original and  
changed pages of volume 2 are:

Original ... 0 ... 31 January 1996

Change ... 1 .. 14 September 1998

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Volume 2 contains 947 pages

Dates of issue for original and  
changed pages of volume 3 are:

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Change ... 1 ..... 30 June 1999

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Volume 3 contains 1,170 pages

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 3,044. CONSISTING OF THE FOLLOWING:

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iii .....0  
iv .....1  
v - xi .....0  
xii Blank .....0  
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1-3 .....0  
1-4 - 1-7 .....1  
1-8 - 1-12 .....0  
1-13 - 1-14 .....1  
1-15 - 1-23 .....0  
1-24 .....1  
1-25 - 1-29 .....0  
1-30 - 1-31 .....1  
1-32 .....2  
1-33 - 1-35 .....1  
1-36 - 1-37 .....0  
1-38 .....1  
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2-10 - 2-11 .....1  
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2-14 - 2-17 .....1  
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2-24 - 2-28 .....1  
2-29 - 2-30 .....2  
2-31 - 2-32 .....1  
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2-56 Blank .....0  
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2-64 Blank .....0  
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2-68 - 2-69 .....0  
2-70 Blank .....0  
2-71 - 2-77 .....0  
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2-148 - 2-153 .....0  
2-154 Blank .....0  
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2-159 .....1  
2-160 - 2-169 .....0  
2-170 .....1  
2-171 - 2-173 .....0  
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2-193 .....2  
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2-207 .....1  
2-208 .....0  
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2-211 - 2-212 .....0  
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2-267 .....0	2-444 Blank .....0	FP-12 Blank .....0
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4-52 - 4-57 .....0	4-127 - 4-128 .....3	4-201 .....0
4-58 .....2	4-129 .....0	4-202 - 4-204 .....3
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4-60 - 4-61 .....3	4-131 - 4-135 .....0	4-206 - 4-208 .....3
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7-10 .....3	7-64 .....3	8-62 .....3
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7-12 .....3	7-66 Blank .....0	8-64 .....3
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NO. 9-2320-280-20-1  
NO. 2320-20/7B

HEADQUARTERS  
DEPARTMENTS OF THE ARMY,  
THE AIR FORCE, AND MARINE CORPS  
Washington, D.C., 31 JANUARY 1996

TECHNICAL ORDER  
NO. 36A12-1A-2092-1-1

## TECHNICAL MANUAL

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### UNIT MAINTENANCE

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4, M998 (2320-01-107-7155) (EIC: BBD);  
M998A1 (2320-01-371-9577) (EIC: BBN);

TRUCK, UTILITY: CARGO/TROOP CARRIER, 1-1/4 TON, 4X4, W/WINCH, M1038 (2320-01-107-7156) (EIC: BBE);  
M1038A1 (2320-01-371-9578) (EIC: BBP);

TRUCK, UTILITY: HEAVY VARIANT, 4X4, M1097 (2320-01-346-9317) (EIC: BBM); M1097A1 (2320-01-371-9583) (EIC: BBU);  
M1097A2 (2320-01-380-8604) (EIC: BB6); M1123 (2320-01-455-9593) (EIC: B6G);

TRUCK, UTILITY: TOW CARRIER, ARMORED, 1-1/4 TON, 4X4, M966 (2320-01-107-7153) (EIC: BBC);  
M966A1 (2320-01-372-3932) (EIC: BBX); M1121 (2320-01-456-1282) (EIC: B6H);

TRUCK, UTILITY: TOW CARRIER, ARMORED, 1-1/4 TON, 4X4, W/WINCH, M1036 (2320-01-107-7154) (EIC: BBH);

TRUCK, UTILITY: TOW CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, M1045 (2320-01-146-7191);  
M1045A1 (2320-01-371-9580) (EIC: BBR); M1045A2 (2320-01-380-8229) (EIC: BB5);

TRUCK, UTILITY: TOW CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, W/WINCH, M1046 (2320-01-146-7188);  
M1046A1 (2320-01-371-9582) (EIC: BBT);

TRUCK, UTILITY: ARMAMENT CARRIER, ARMORED, 1-1/4 TON, 4X4, M1025 (2320-01-128-9551) (EIC: BBF);  
M1025A1 (2320-01-371-9584) (EIC: BBV); M1025A2 (2320-01-380-8233) (EIC: BB3);

TRUCK, UTILITY: ARMAMENT CARRIER, ARMORED, 1-1/4 TON, 4X4, W/WINCH, M1026 (2320-01-128-9552) (EIC: BBG);  
M1026A1 (2320-01-371-9579) (EIC: BBQ);

TRUCK, UTILITY: ARMAMENT CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, M1043 (2320-01-146-7190);  
M1043A1 (2320-01-372-3933) (EIC: BBY); M1043A2 (2320-01-380-8213) (EIC: BB4);

TRUCK, UTILITY: ARMAMENT CARRIER, W/SUPPLEMENTAL ARMOR, 1-1/4 TON, 4X4, W/WINCH, M1044 (2320-01-146-7189);  
M1044A1 (2320-01-371-9581) (EIC: BBS);

TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, M1037 (2320-01-146-7193) (EIC: BBK);

TRUCK, UTILITY: S250 SHELTER CARRIER, 4X4, W/WINCH, M1042 (2320-01-146-7187);

TRUCK, AMBULANCE, 2-LITTER, ARMORED, 4X4, M996 (2310-01-111-2275) (EIC: BBB); M996A1 (2310-01-372-3935) (EIC: BB2);

TRUCK, AMBULANCE, 4-LITTER, ARMORED, 4X4, M997 (2310-01-111-2274)  
(EIC: BBA); M997A1 (2310-01-372-3934) (EIC: BBZ); M997A2 (2310-01-380-8225) (EIC: BB8);

TRUCK, AMBULANCE, 2-LITTER, SOFT TOP, 4X4, M1035 (2310-01-146-7194);  
M1035A1 (2310-01-371-9585) (EIC: BBW); M1035A2 (2310-01-380-8290) (EIC: BB9).

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This manual is published in three parts. TM 9-2320-280-20-1 contains chapters 1 and 2, TM 9-2320-280-20-2 contains chapters 3 through 9, and TM 9-2320-280-20-3 contains chapters 10 through 13 and appendices A through G.

This manual contains a table of contents for all three volumes 1, 2, and 3 and alphabetical index for chapters 1 and 2.

\*This publication supersedes TM 9-2320-280-20-1 dated 19 January 1990 and all changes.



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## HOW TO USE THIS MANUAL

### ABOUT YOUR MANUAL

- a. Spend some time looking through this manual. You'll find that it has a new look, different than most of the TMs you've been using. New features added to improve the convenience of this manual and increase your efficiency are:
1. **Accessing Information** - These include physical entry features such as the bleed-to-edge indicators on the cover and edge of the manual. Extensive troubleshooting guides for specific systems lead directly to step by step directions for problem solving and maintenance tasks.
  2. **Illustrations** - A variety of methods are used to make locating and fixing components much easier. Locator illustrations with keyed text, exploded views, and cut-away diagrams make the information in this manual easier to understand.
  3. **Keying Text With Illustrations** - Instructions are located together with figures that illustrate the specific task you are working on. In most cases, the task steps and figures are located side by side making part identification and procedure sequence easier to follow.

The TM is the fundamental means by which the Army communicates to soldiers the requirements and procedures necessary to perform equipment operations and maintenance. This manual describes in detail the Unit Maintenance authorized by the Maintenance Allocation Chart (appendix B) and Source, Maintenance, and Recovery (SMR) codes (TM 9-2320-280-24P).

- b. **General Features.** Your TM is the best source available for providing information and data critical to vehicle operation and maintenance:
- Safety summary (warning page a, b, and c)
  - General information, equipment descriptions, and data (chapter 1)
  - Principles of operation (chapter 1, section III)
  - Preventive Maintenance Checks and Services – PMCS (chapter 2, section III)
  - Electrical/Mechanical Systems Troubleshooting (chapter 2, section IV)
  - Detailed maintenance procedures (chapters 3-12)
  - General maintenance instructions (chapter 2, section II and III)
  - Maintenance Allocation Chart - MAC (appendix B)
  - Expendable/durable supplies and materials list (appendix C)
  - Manufactured items (appendix D)
  - Torque limits (appendix E)
  - Wiring Diagrams and Schematic (appendix F)
  - Mandatory replacement parts (appendix G)

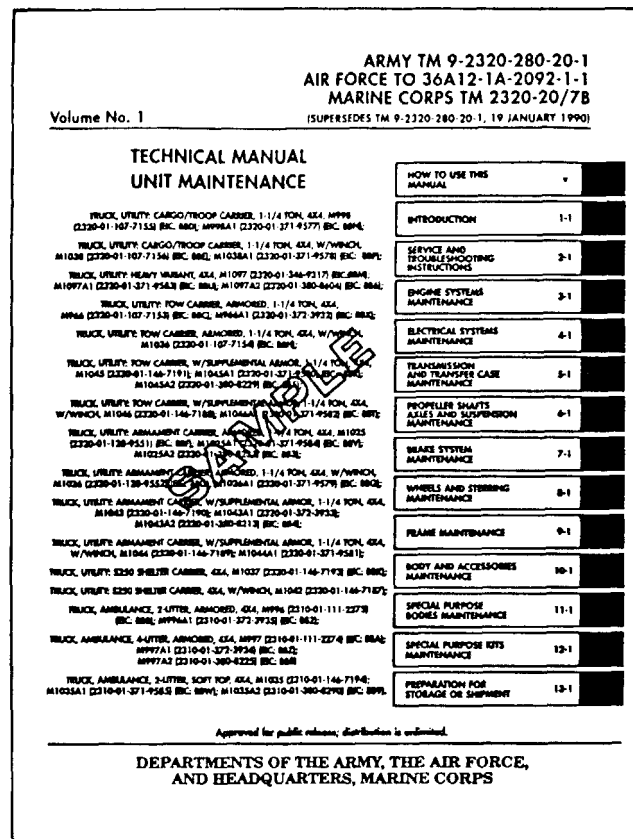
A typical example of how to use this manual is provided on the following pages.

## USING YOUR MANUAL AN EXAMPLE

**a. TASK:** The operator of an M998 series vehicle has complained that his TOW carrier uses too much engine oil. The vehicle has been assigned to you for repair.

### b. TROUBLESHOOTING STEPS:

1. Look at the cover of this manual. You'll see chapter titles listed from top to bottom on the right-hand side.
2. Look at the right edge of the manual. On some of the pages you'll see black bars (bleed-to-edge indicators) that are aligned with the chapter bars on the cover. These are the locations of the chapters in the text.
3. Look for "SERVICE AND TROUBLESHOOTING INSTRUCTIONS" in the chapter list on the cover. This is where the troubleshooting information is located.
4. Turn to those pages with the edge indicator matching the black bar for service and troubleshooting instructions. Page numbers are also listed next to chapter titles.
5. Chapter 2 is divided into four sections:
  - Section I - Repair Parts, Special Tools, TMDE, and Support Equipment
  - Section II - Service Upon Receipt
  - Section III - PMCS
  - Section IV - Electrical/Mechanical Systems Troubleshooting



1 M 9-2320-280-20-1

LUBRICATION TABLE (Cont'd)

USAGE	FLUID/LUBRICANT	CAPACITIES	EXPECTED TEMPERATURE
Transmissions (SL80) (4L80-E)	Delvac® II Delvac® III OEA	Dry 11 qt (10.4 L) Dress & Refill: 6 qt (5.7 L) Dry 13.5 qt (12.6 L) Dress & Refill: 7.7 qt (7.3 L)	All Temperatures Except Arctic Arctic Temperatures
Transfer (R18) Case (R43)	Delvac® II	2.5 qt (2.3 L) 2.50 qt (2.37 L)	All Temperatures
Steering Systems	Delvac® II	1 qt (0.95 L) or Cooler: 1.50 qt (1.38 L)	All Temperatures
Overhaul Wch (4)	Multipurpose Gear OO 80/90	1 pt. ea. (0.47 L)	All Temperatures
Axles (2)	Multipurpose Gear OO 80/90	2 qt. ea. (1.9 L)	All Temperatures
Ball Joints, Tie Rod Ends, Pitman Arms, Pumpkin Shafts, etc.	GAA	As Specified	All Temperatures
Hinges, Cables, and Linkages	OL/HDO	As Specified	All Temperatures

## Section N. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

## 2-12. GENERAL

- a. This section provides information to diagnose and correct malfunctions of the electrical/mechanical system.
- b. Principles of operation showing system operation can be found in chapter 1. It should be used as a reference when performing electrical/mechanical troubleshooting.
- c. Each malfunction symptom given for an individual component or system is followed by step(s) you should take to determine the cause and corrective action you must take to remedy the problem.
- d. Before taking any action to correct a possible malfunction, the following rules should be followed:
- (1) Question operator to obtain any information that might help you determine the cause of the problem.
  - (2) Never ever look the chance that the problem could be of simple origin. The problem would be corrected with minor adjustment.
  - (3) Use all senses to observe and locate trouble.
  - (4) Use test instruments or gauges to help you determine and isolate problem.
  - (5) Always isolate the system where the malfunction occurs and then locate the defective component.
  - (6) Use standard automotive theories and principles when troubleshooting the vehicle covered in this manual.
- e. The STE/KCE-R is an integral part of these troubleshooting procedures. It should be used whenever possible, although other options are given, when available. The Vehicle Identification Number (VIN) assigned to the M299 series vehicle is 21 (14 is the temporary VDI). On page 2-782, you will find information on STE/KCE-R description and operation. Use this information to become familiar with STE/KCE-R operation and the equipment contained in the test set. On page 2-782 you will find STE/KCE-R setup and internal checks. These must be performed prior to performing tests.

2-30

M 9-2320-280-20-1

## 2-13. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

## ELECTRICAL/MECHANICAL TROUBLESHOOTING

PARA NO.	PAGE NO.
2-14. How to use this troubleshooting guide .....	2-32
2-15. Glossary of abbreviations and commonly used terms .....	2-36
2-16. Electrical circuit description .....	2-39
2-17. Startability tests .....	2-41
2-18. Engine running tests .....	2-47
2-19. Cooling system tests .....	2-67
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2-21. Electrical tests .....	2-71
2-22. Fuel system tests .....	2-66
2-23. Air intake/exhaust tests .....	2-137
2-24. Compression/mechanical tests .....	2-143
2-25. Engine cooling tests .....	2-166
2-26. Engine lubrication tests .....	2-167
2-27. Alternator tests .....	2-186
2-28. Protective control lamp tests .....	2-227
2-29. Battery circuit test .....	2-261
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2-31. Overcharge circuit tests .....	2-319
2-32. Instrument tests .....	2-320
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2-42. DCA troubleshooting .....	2-728
2-43. STE/KCE-R test procedures .....	2-729
2-44. Vehicle testing .....	2-761

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## 6. Turn to section IV, "ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING" (page 2-30).

This troubleshooting section is system-oriented and is broken down into five top level tests and twenty-one system level tests.

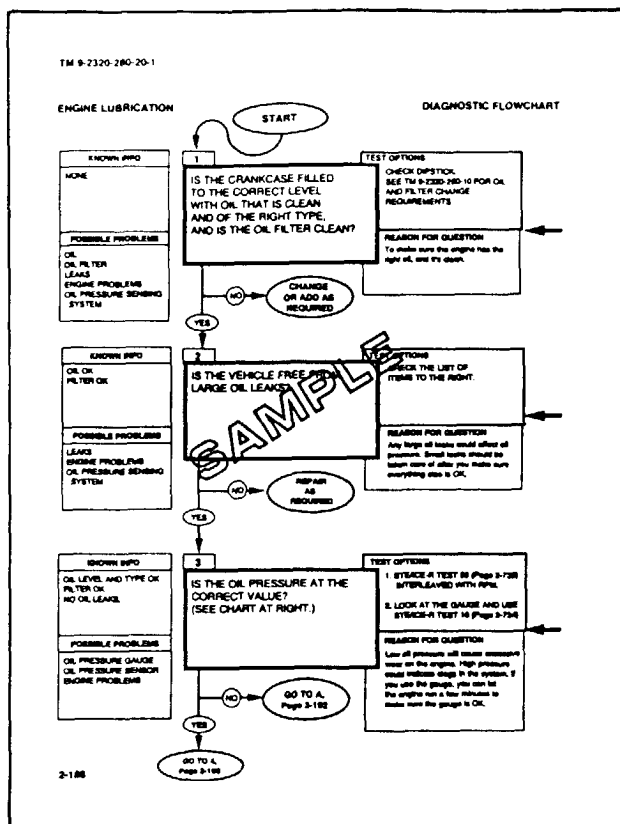
## 7. One of the first pages of this section is the "ELECTRICAL/MECHANICAL SYSTEM TROUBLESHOOTING" (turn to page 2-31)

## 8. Look down the list of symptoms until you find "ENGINE LUBRICATION TESTS". In that paragraph you will find the diagnostic flow chart that the vehicle operator can pick the test as "OIL LEAKS OR ENGINE PROBLEMS".

## 9. Turn to the test indicated.

10. On page 2-188, steps relating to resolving the problem of excessive oil loss are listed. Read the diagnostic flow chart until you find "OIL LEAKS OR ENGINE PROBLEMS". The tests listed are shown in the example page to the right of this text.

11. In accordance with Test 1, you checked the oil level and filter for leaks. The oil level and filter appears normal and you move on to Test 2.



12. In Test 2, you begin a methodical check of the engine lubricating system. You discover a leak in the oil cooler assembly adjacent to one of the mounting brackets. One of the welds has cracked, allowing a class III leak from a small area of the cooling fins. The oil cooler assembly must be repaired or replaced.
13. At this point, the engine lubrication diagnostic flow chart would direct you to a specific detailed procedure to solve the problem. However, the engine lubricating system is complex and you must now refer to the table of contents to locate the proper task paragraph.

**NOTE:** Before attempting to repair or replace the oil cooler assembly, as a Unit mechanic, you must:

- Determine the maintenance responsibility of repair or replacement of the component.
- If the task is at your echelon of maintenance responsibility, you must identify the tools needed and the replacement parts required.

Refer to the Maintenance Allocation Chart – MAC (appendix B) to determine not only the maintenance responsibility of the item, but also to obtain an estimate of the time required to perform the task, tools needed, and any special notes/requirements necessary.

Refer to TM 9-2320-280-24P, Unit Maintenance Repair Parts and Special Tools List for M998 Series Vehicles, for requisition data concerning replacement parts for this task.

1. Turn to the "TABLE OF CONTENTS" and find the chapter dealing with the engine. You find it as "CHAPTER 3, ENGINE SYSTEMS MAINTENANCE". Furthermore, you note that the chapter is divided into five sections; you are interested in "Section I. Lubrication System Maintenance".
2. Turn to chapter 3, section I on page 3-1. Here you find the "Lubrication System Maintenance Task Summary". Read down the list of tasks until you find the one that will correct your maintenance problem. For our example, you find it as task 3-8 "Engine and Transmission Oil Cooler Assembly Maintenance". Turn to page 3-12.

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TM 9-2320-280-20-2

### 3-8. ENGINE AND TRANSMISSION OIL COOLER ASSEMBLY MAINTENANCE

This task covers:

- a. Removal
- b. Installation
- c. Cleaning and Inspection

**INITIAL SETUP**

<p><b>Tools</b></p> <p>General mechanic's tool kit automotive (Appendix B, Item 1)</p> <p><b>Manual References</b></p> <p>TM 9-2320-280-10 TM 9-2320-280-24P</p>	<p><b>Equipment Conditions</b></p> <ul style="list-style-type: none"> <li>• Engine left splash shield removed (para. 10-17)</li> <li>• Power steering cooler removed (para. 8-28)</li> </ul> <p><b>General Safety Instructions</b></p> <p>Do not drain oil when engine is hot.</p>
--	--

**CAUTION**

Do not bend transmission oil cooler hose. Damaged hose reduce cooling efficiency, which may damage engine and/or transmission.

**a. Removal**

**WARNING**

Do not drain oil when engine is hot. Injury to personnel will result.

**Preparation**

Cover or plug all hose ends immediately after disconnection to prevent contamination. Remove all plugs prior to connection.

**NOTE**

Have drainage container ready to catch oil.

- Note position of hoses for installation.

1. Disconnect two engine oil cooler supply and return lines (7) from engine oil cooler parts (9).
2. Loosen two hose clamps (2) and disconnect two transmission oil cooler hose connector hoses (1) from transmission oil cooler parts (3).
3. Remove four socket-head screw and washer assemblies (5), washers (6) and oil cooler (4) from radiator (8).

**b. Installation**

1. Install oil cooler (4) on radiator (8) with four washers (6) and socket-head screw and washer assemblies (5).
2. Connect two transmission oil cooler hose connector hoses (1) to transmission oil cooler parts (3) and tighten two hose clamps (2). Tighten clamps (2) to 10-30 lb-in. (1.1-3.3 N-m).
3. Connect two engine oil cooler supply and return hoses (7) to engine oil cooler parts (9).

**c. Cleaning and Inspection**

1. Remove four socket-head screw and washer assemblies (5) and washers (6) securing oil cooler (4) to radiator (8).
2. Make four two-by-four wood blocks, 3-1/2 inches (91 mm) long. Raise oil cooler (4) 1-1/2 inches (38 mm) and place one block under each corner between oil cooler (4) and radiator (8).

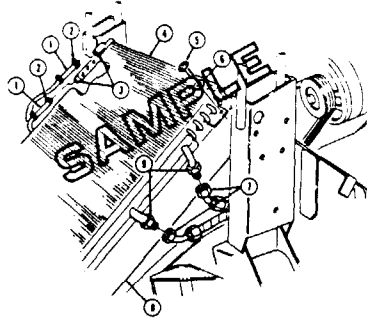
TM 9-2320-280-20-2

### 3-8. ENGINE AND TRANSMISSION OIL COOLER ASSEMBLY MAINTENANCE (Cont'd)

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

3. Using water and compressed air, remove dirt, trash, and insects embedded in oil cooler (4) and radiator fins (6).
4. Inspect oil cooler (4) for breaks, punctures, cracks, and splits. Replace oil cooler (4), if damaged.
5. Remove four wood blocks.
6. Secure oil cooler (4) on radiator (8) with four washers (6) and socket head screw and washer assemblies (5).



**FOLLOW-ON TASKS:**

- Install power steering cooler (para. 8-28).
- Fill transmission oil to proper level (TM 9-2320-280-10).
- Fill engine oil to proper level (TM 9-2320-280-10).
- Install engine left splash shield (para. 10-17).
- Start engine (TM 9-2320-280-10) and check for leaks.

3-12
3-13

3. On page 3-12 you find paragraph 3-8, the detailed procedure for replacing the oil cooler assembly.

d. **DETAILED MAINTENANCE PROCEDURES.** Detailed maintenance procedures include everything you must do to accomplish a basic maintenance task. Unless otherwise stated, general mechanic's automotive tool kit will be used for maintenance of this vehicle.

1. Before beginning the maintenance task, look through the procedure. You must familiarize yourself with the entire maintenance procedure of para. 3-8: "Engine and Transmission Oil Cooler Assembly Maintenance". The task includes "a. Removal" "b. Installation" and "c. Cleaning and Inspection".

2. The ten basic headings listed under "INITIAL SETUP" outline task conditions, materials, special tools, manpower requirements, and special conditions. The headings are:

- **Applicable Models:** Any models that require a particular maintenance task. If a maintenance task covers all models, then this heading will not be used.
- **Test Equipment:** Test equipment needed to complete a task. If test equipment is not required, this heading will not be used.
- **Tools** These are common tools and general mechanic tool sets required to perform maintenance tasks. These common tools should be on hand to properly perform the task. Torque wrenches are required for many tasks; the proper torque wrench should be available to tighten mounting hardware.
- **Special Tools:** Those special tools needed to complete a maintenance task. If no special tools are needed, this heading will not be used.

If you don't have one of these special tools, requisition it (before starting the task) using the data supplied in TM 9-2320-280-24P, the repair parts and special tools list for this level of maintenance. Special tools are located in section III.

- **Materials/Parts:** This heading lists only mandatory replacement materials or parts (gaskets, O-rings, sealant, etc.). To replace other unserviceable parts, refer to TM 9-2320-280-24P for requisition data. If no mandatory replacement materials/parts are required, this heading will not be used.

- **Personnel Required:** The number of personnel needed to perform a task. If only one mechanic is needed, this heading will not be used.

## NOTE

If you think that you need more help to adequately or safely complete a task, perhaps as the result of unusual conditions, etc., alert your supervisor and ask for help.

- **Manual References:** Those TMs needed to complete the task.
  - **Equipment Condition:** Notes the conditions that must exist before starting the task. If none are required, this heading will not be used. For oil cooler assembly replacement, the left-hand engine splash shield should be removed before we can start the task. If not already done, follow the procedure for splash shield removal in para. 10-17, before proceeding with this task.
  - **General Safety Instructions:** Summarizes all safety warnings for the maintenance task. If none are required, this heading will not be used.
3. A step by step maintenance procedure follows the "INITIAL SETUP" and gives detailed instructions for the procedure. These instructions give the part's general location and name and action performed. In the example, oil cooler assembly replacement -a. Removal, step 1 is "Disconnect engine oil cooler supply and return lines (7) from engine oil cooler ports (9)". Note that the numbers in parenthesis correspond to the part's callout number in the accompanying illustration.

## NOTE

Warnings, cautions, and notes provide supplemental information:

- **Warnings:** Indicate conditions, practices, or procedures which must be observed to avoid personnel injury, loss of life, loss of life, or long-term health hazard.
  - **Cautions:** Indicate condition, practices, or procedures which must be observed to avoid damage to equipment or destruction of equipment.
  - **Notes:** Include essential information of special importance, interest, or aid in job performance which should be remembered and would be otherwise difficult to find or incorporate into the text.
4. At the end of a procedure, "FOLLOW-ON TASKS" will list those additional tasks that must be performed to complete the procedure. The Follow-On Tasks for oil cooler assembly replacement are:
- Ž Fill oil to proper level (TM 9-2320-280-10).
  - Ž Install left-hand splash shield (para. 10-17).
  - Ž Start engine (TM 9-2320-280-10) and check for leaks.
- e. Refer to the example pages for para. 3-8, Engine and Transmission Oil Cooler Assembly Maintenance, as we review the following points:
1. **Modular Text:** Both pages of text and illustrations are to be used together. This manual was designed so that the two pages would be visible at once, making part identification and procedure sequence easy to follow.
  2. **Initial Setup:** Outlines task conditions.
  3. **Illustrations:** An exploded diagram of the component shows part locations, attachments, and spatial relationships. Cutaway views (part of the vehicle is "erased") show the location and orientation of screws and attachments.
- f. Your manual is easy to use once you understand its design. We hope it will encourage you to use your TM more often as an aid to maintenance support for M998 series vehicles.

# CHAPTER 1

## INTRODUCTION

### Section I. GENERAL INFORMATION

#### 1-1. SCOPE

a. This technical manual contains instructions for organizational maintenance of the 1-1/4 ton, 4X4, M998 series vehicles.

b. Models included are:

- (1) M998 and M998A1, Cargo/Troop Carrier
- (2) M1038 and M1038A1, Cargo/Troop Carrier, W/Winch
- (3) M1097, M1097A1, M1097A2, and M1123 Heavy Variant
- (4) M966, M966A1, and M1121 TOW Carrier, Armored
- (5) M1036, TOW Carrier, Armored, W/Winch
- (6) M1045, M1045A1, and M1045A2 TOW Carrier, W/Supplemental Armor
- (7) M1046 and M1046A1, TOW Carrier, W/Supplemental Armor, W/Winch
- (8) M1025, M1025A1, and M1025A2 Armament Carrier, Armored
- (9) M1026 and M1026A1, Armament Carrier, Armored, W/Winch
- (10) M1043, M1043A1, and M1043A2 Armament Carrier, W/Supplemental Armor
- (11) M1044 and M1044A1, Armament Carrier, W/Supplemental Armor, W/Winch
- (12) M1037, S250 Shelter Carrier
- (13) M1042, S250 Shelter Carrier, W/Winch
- (14) M996 and M996A1 2-Litter Ambulance, Armored
- (15) M997, M997A1, and M997A2 4-Litter Ambulance, Armored
- (16) M1035, M1035A1, and M1035A2 2-Litter Ambulance, Soft Top

#### 1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

(Army) Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, The Army Maintenance Management System (TAMMS). (Marine Corps) Refer to TM 4700-15/1-.

#### 1-3. DESTRUCTION OF ARMY EQUIPMENT TO PREVENT ENEMY USE

Refer to TM 750-244-6, Procedures for Destruction of Army Tank-Automotive Equipment to Prevent Enemy Use.

#### 1-4. PREPARATION FOR SHIPMENT

(Army) Refer to TM 746-10, Marking, Packaging and Shipment of Supplies and Equipment: General Packaging Instructions for Field Use. (Marine Corps) Refer to MCO 4450-7.

#### 1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

(Army) If your vehicle needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. The preferred method for submitting QDRs is through the Army Electronic Product Support (AEPS) website under the Electronic Deficiency Reporting System (EDRS). The web address is: <http://aeps.ria.army.mil>. This is a secured site requiring a password that can be applied for on the front page of the website. If the above method is not available to you, put it on an SF 368, Product Quality Deficiency Report (PQDR), and mail it to us at: Department of the Army, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/PQDR MS 267, 6501 E. 11 Mile Road, Warren, MI 48397-500. We'll send you a reply. (Marine Corps) Submit QDR's in accordance with MCO 4855-10.

## **1-6. EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE DIGEST (EIR MD)**

The quarterly Equipment Improvement Report and Maintenance Digest, TB 43-0001-62 series, contains valuable field information on the equipment covered in this manual. The information in the TB 43-0001-62 series is compiled from some of the Equipment Improvement Reports that you prepared on the vehicles covered in this manual. Many of these articles result from comments, suggestions, and improvement recommendations that you submitted to the EIR program. The TB 43-0001-62 series contains information on equipment improvements, minor alterations, proposed Modification Work Orders (MWOs), warranties (if applicable), actions taken on some of your DA Form 2028s (Recommended Changes to Publications and Blank Forms), and advance information on proposed changes that may affect this manual. The information will help you in doing your job better and will help in keeping you advised of the latest changes to this manual. Also refer to DA Pam 25-30, Consolidated Index of Army Publications and Blank Forms, and appendix A, References, of this manual. (Marine Corps) Submit QDR's in accordance with MCO 4855-10. For those with access to the World Wide Web (WWW), the EIR MD can be viewed through the Army Electronic Product Support. The site is <http://aeps.ria.army.mil>.

## **1-7. METRIC SYSTEM**

The equipment described herein contains metric components and requires metric common and special tools; therefore, metric units in addition to standard units will be used throughout this publication. In addition, a metric conversion table is located on the inside back cover of this publication.

## **1-8. MANDATORY REPLACEMENT PARTS**

The maintenance instructions contained herein make reference to removing and discarding piece parts such as: gaskets, lockwashers, cotter pins, O-rings, seals; etc.; these items should be considered mandatory replacement items and replaced with new parts during assembly/installation.

## **1-9. BREAK-IN PROCEDURE**

Upon receipt of vehicles, or after engine replacement, break-in procedures must be observed during the first 500 miles (804 kilometers) of operation. For break-in procedure, refer to TM 9-2320-280-10.

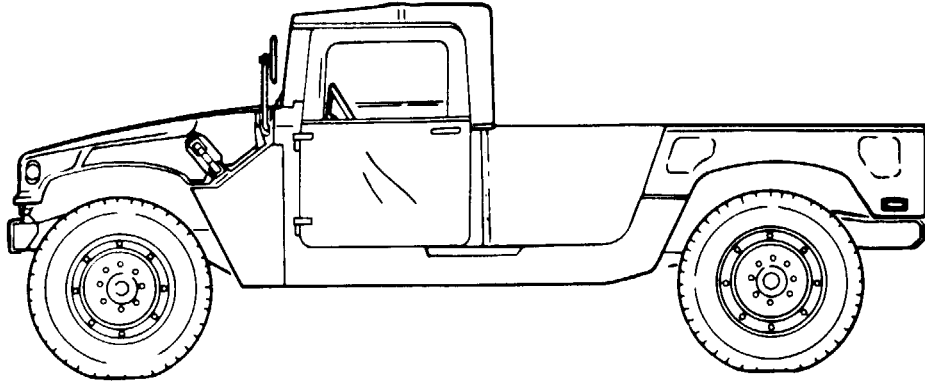
# **Section II. EQUIPMENT DESCRIPTION AND DATA**

## **1-10. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES**

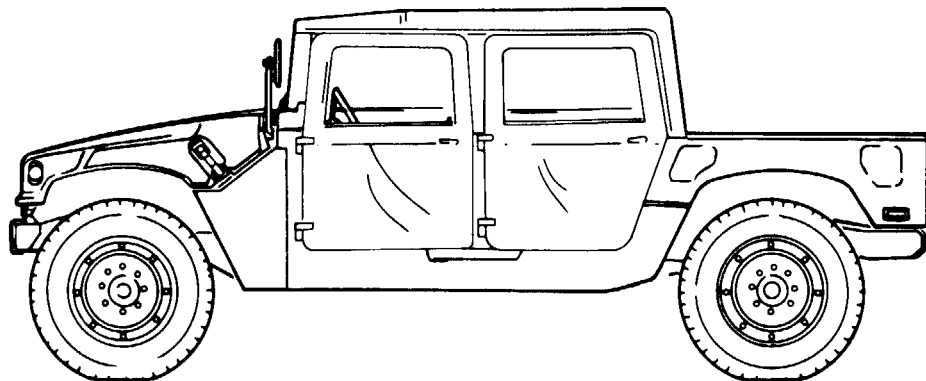
The 1-1/4 ton, 4x4, M998 series of vehicles are tactical vehicles designed for use over all types of roads, as well as cross-country terrain in all weather conditions. The vehicles have four driving wheels powered by a V-8, liquid-cooled, diesel engine. Four-wheel hydraulic service brakes and a mechanical parking brake are common to all models in the M998 series. All vehicles are equipped with a pintle hook for towing. Tiedown and lifting eyes are provided for air, rail, or sea shipment.

**CARGO/TROOP CARRIERS: M998, M998A1, M1038, AND M1038A1**

**PURPOSE:** These models are used to transport cargo and troops. The M1038 and M1038A1 models, which have a winch, can be used for recovery operations. Both models utilize a troop seat kit for troop transport operations.



**M998/M998A1  
(WITH 2-MAN SOFT TOP INSTALLED)**



**M1038/M1038A1 W/WINCH  
(WITH 4-MAN SOFT TOP INSTALLED)**

## HEAVY VARIANT CARGO/TROOP CARRIERS: M1097, M1097A1, M1097A2, AND M1123

**PURPOSE:** This model is used for transporting equipment, materials, and/or personnel (including crew) of 4,400 pounds (1,998 kilograms). The only difference between the M998 and M998A1 cargo/troop carriers and the M1097, M1097A1, M1097A2, and M1123 heavy variant cargo/troop carriers is that the M1097, M1097A1, M1097A2, and M1123 are specifically designed to accommodate a higher payload capacity. This difference affects vehicle length, width, and shipping dimensions, but does not affect the basic purpose and performance of the vehicle. The increased payload capabilities accommodate the following kit configurations:

### A. 105MM TOWED HOWITZER PRIME MOVER (L119 KIT) consists of:

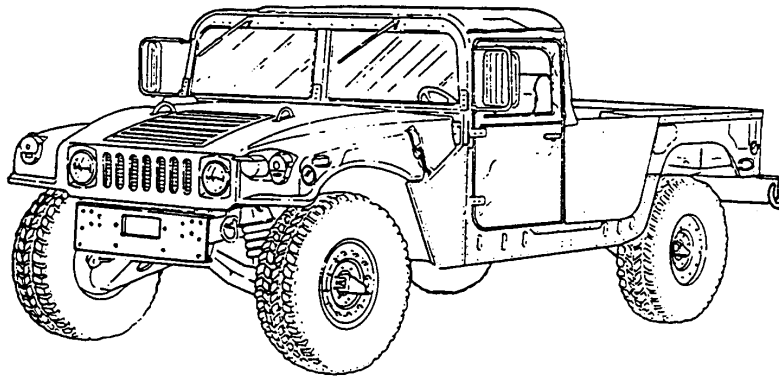
- Larger rear bumper and reinforced mounting
- Body wiring harness trailer receptacle extension
- Ammunition stowage rack and tiedown straps
- Camouflage net stowage rack
- Winch
- Two-man crew area soft top
- Troop area soft top
- Cargo bulkhead

### B. TOWED VULCAN SYSTEMS (TVS) MOVER consists of:

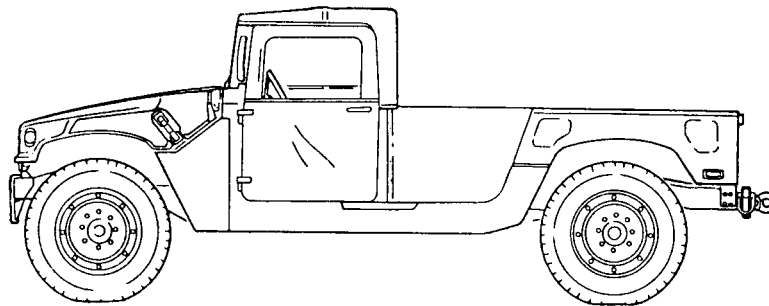
- Two-man crew area soft top
- Troop area soft top
- Camouflage net stowage rack
- Troop seat kit
- Cargo bulkhead

### C. S250 ELECTRICAL EQUIPMENT SHELTER consists of:

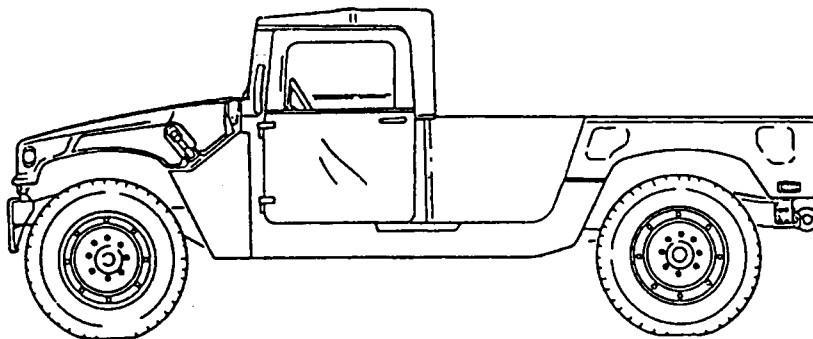
- Shelter support
- Shelter tailgate
- 200 amp umbilical power cable



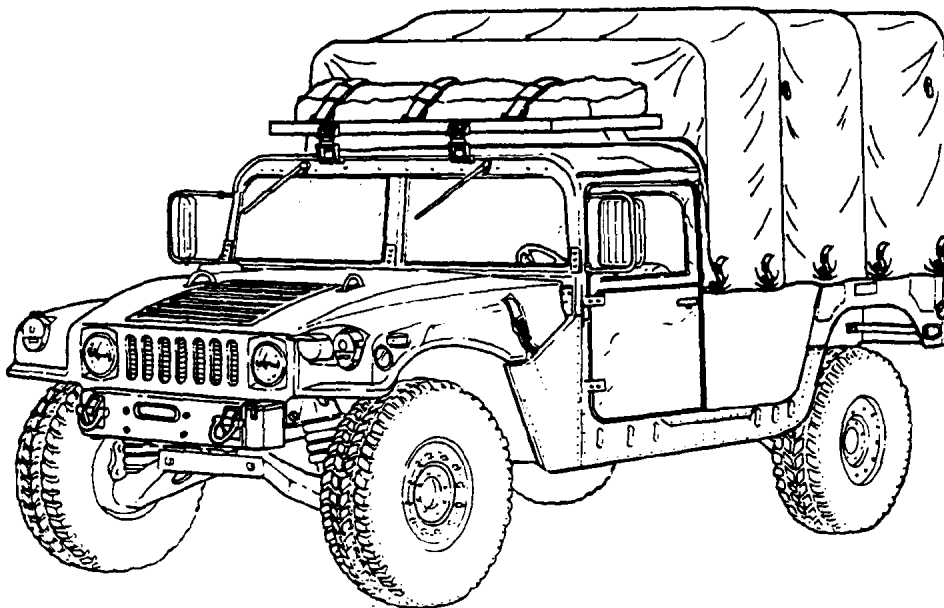
**M1097/M1097A1/M1097A2/M1123  
(WITH 2-MAN SOFT TOP INSTALLED)**



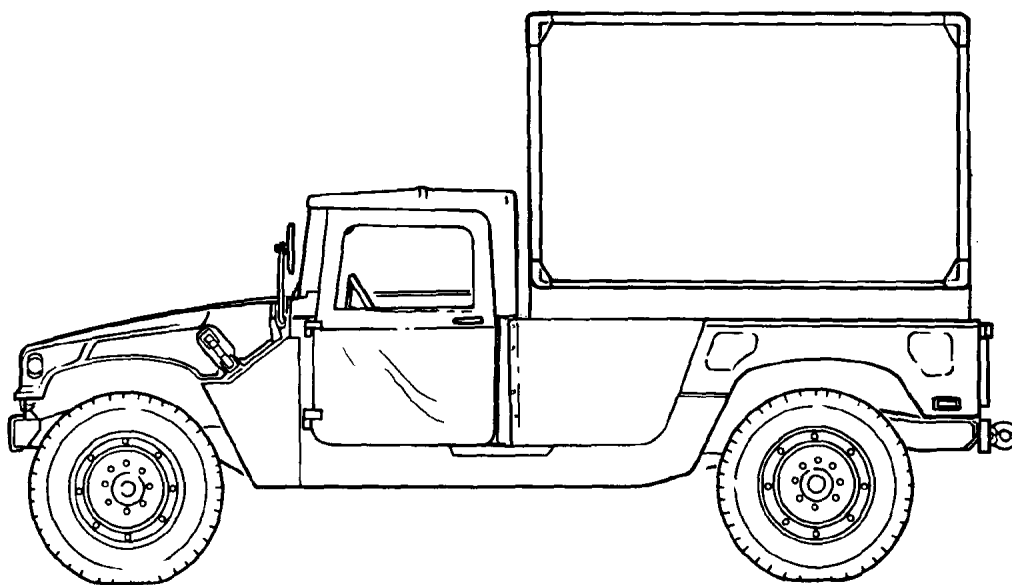
**M1097A2**



**M1123**



**M1097/M1097A1/M1097A2/M1123  
(WITH L119 KIT INSTALLED)  
(WITHOUT WINCH, TOWED VULCAN SYSTEMS (TVS) MOVER)**

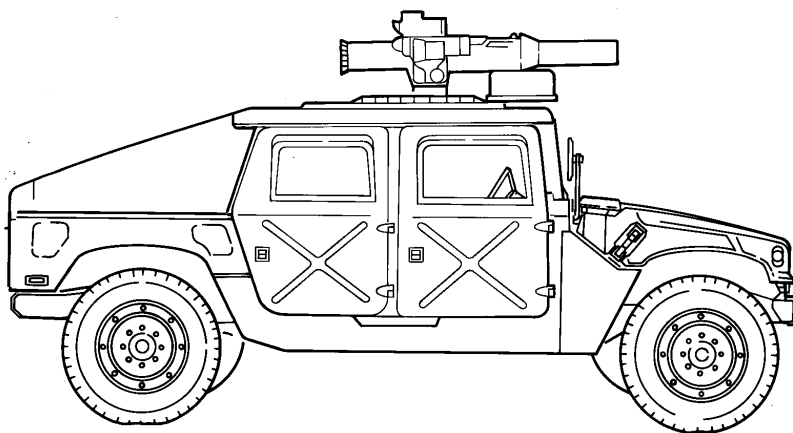
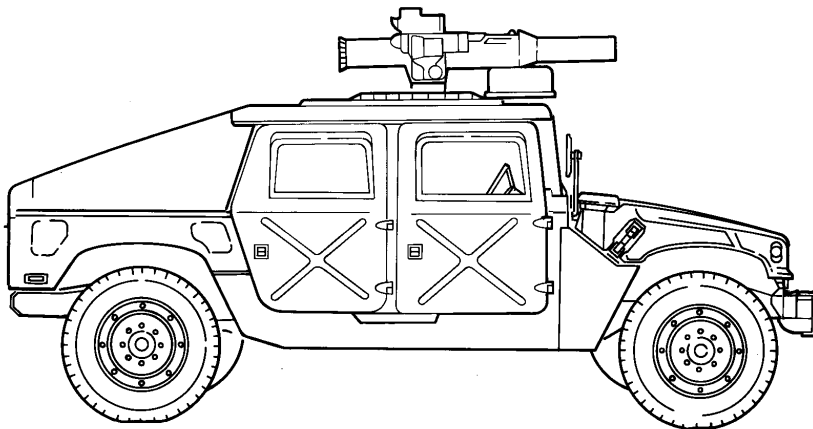


**M1097/M1097A1/M1097A2/M1123  
(WITH S250 SHELTER INSTALLED)**



**TOW CARRIERS: M966, M966A1, M1036, AND M1121**

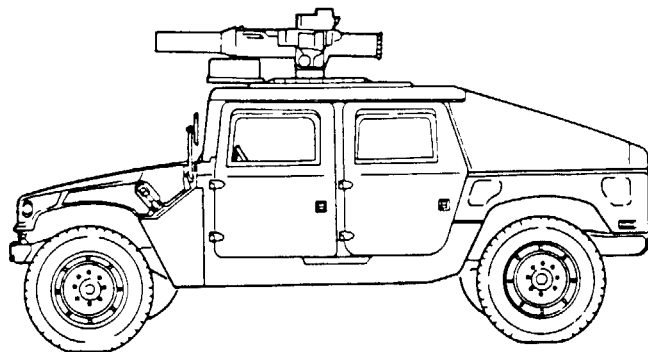
**PURPOSE:** These models are used to transport, mount, and operate the TOW missile launcher system with armor protection for crew, TOW system components, and ammunition. The M1036 model, which has a winch, can be used for recovery operations.

**M966/M966A1/M1121****M1036 W/WINCH**

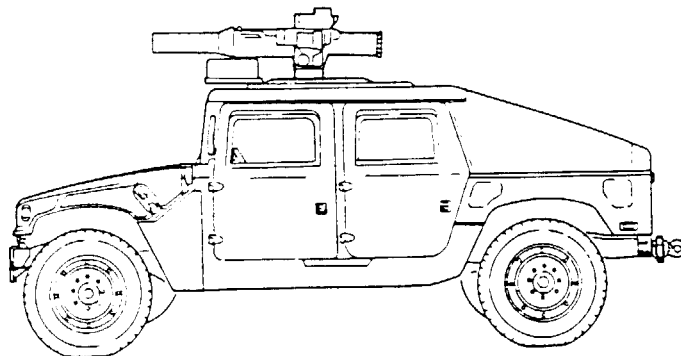
**TOW CARRIERS, W/SUPPLEMENTAL ARMOR M1045, M1045A1, M1045A2, M1046, AND M1046A1**

a. **PURPOSE:** These models are used to transport, mount, and operate the TOW missile launcher system with added ballistic protection for crew, TOW system components, and ammunition. The M1046 and M1046A1 models, which have a winch, can be used for recovery operations.

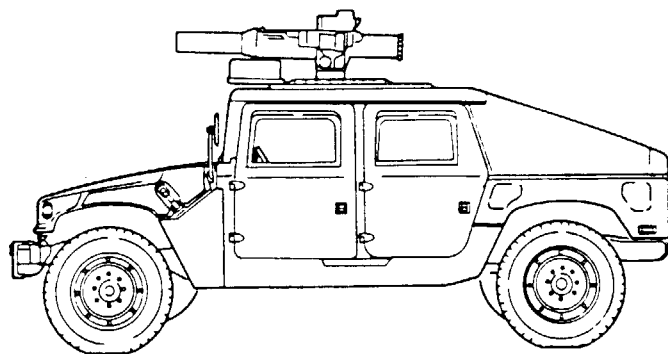
b. **SPECIAL LIMITATIONS:** Weapon station azimuth is limited to 300° left and right of vehicle centerline when Vehicle Power Conditioner (VPC) cables are connected. With launcher installed, elevation is limited to 20° and depression is limited to 10°.



**M1045/M1045A1**



**M1045A2**

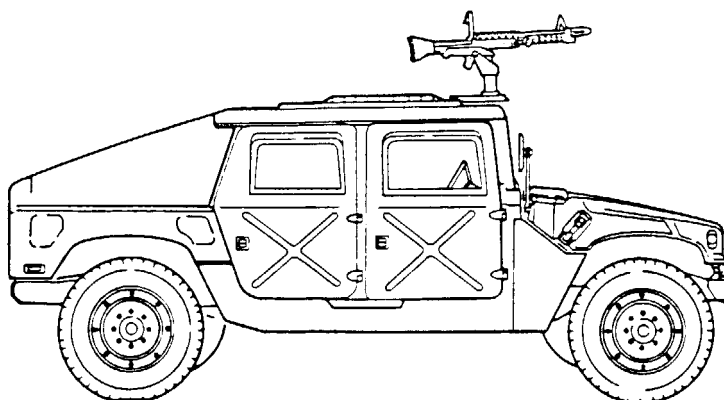


**M1046/M1046A1 W/ WINCH**

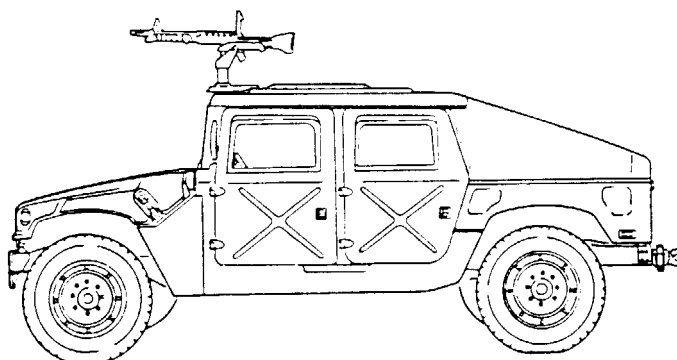
**ARMAMENT CARRIERS, W/SUPPLEMENTAL ARMOR: M1025, M1025A1, M1025A2, M1026, AND M1026A1**

a. **PURPOSE:** These models are used to transport, mount, and operate the M2 and M60 machine guns and MK19 automatic grenade launcher with armor protection for crew, weapons components, and ammunition. The M1026 and M1026A1 models, which have a winch, can be used for recovery operations.

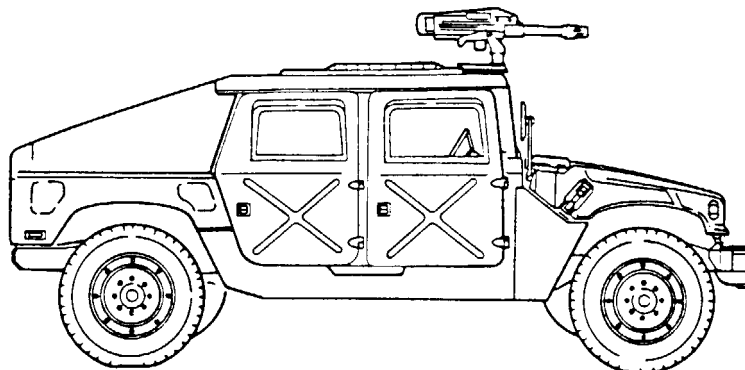
b. **SPECIAL LIMITATIONS:** Weapon station azimuth is limited to 300° left and right of vehicle centerline when Vehicle Power Condition (VPC) cables are connected. With launcher installed, elevation is limited to 20° and depression is limited to 10°.



**M1025/M1025A1  
(WITH M60, 7.62 MM MACHINE GUN MOUNTED)**



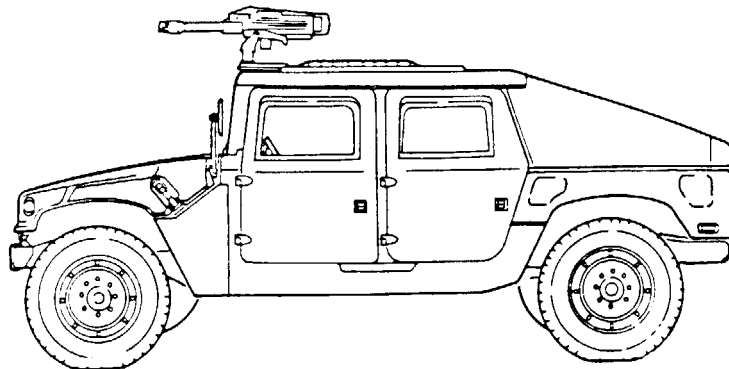
**M1025A2  
(WITH M60, 7.62 MM MACHINE GUN MOUNTED)**



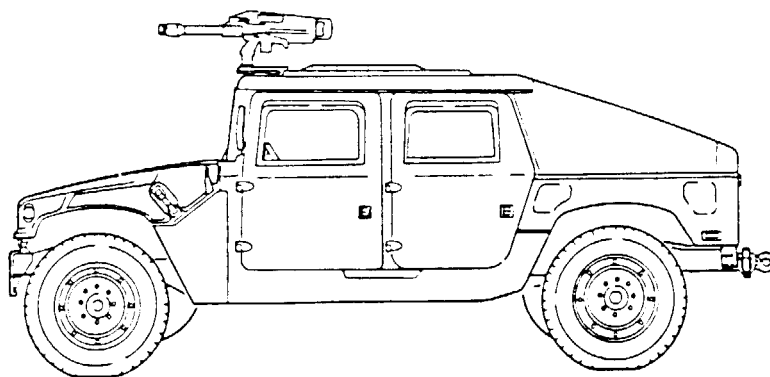
**M1026/M1026A1 W/WINCH  
(WITH MK19 GRENADE LAUNCHER MOUNTED)**

**ARMAMENT CARRIERS, W/SUPPLEMENTAL ARMOR M1043, M1043A1, M1043A2, M1044, AND M1044A1**

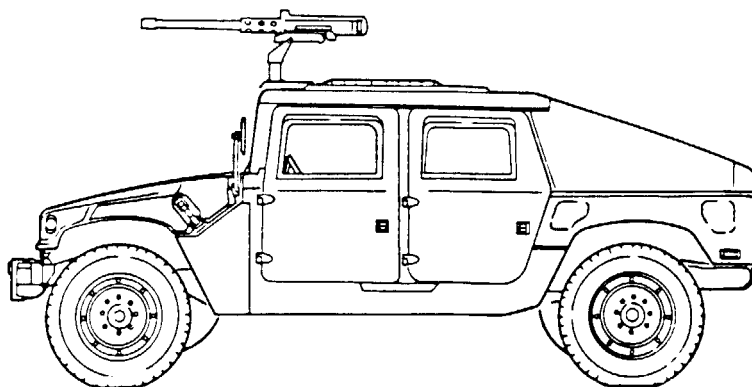
**PURPOSE:** These models are used to transport, mount, and operate the M2 and M60 machine guns and MK19 automatic grenade launcher with added ballistic protection for crew, weapons components, and ammunition. The M1044 and M1044A1 models, which have a winch, can be used for recovery operations.



**M1043/M1043A1  
(WITH MK19 GRENADE LAUNCHER MOUNTED)**



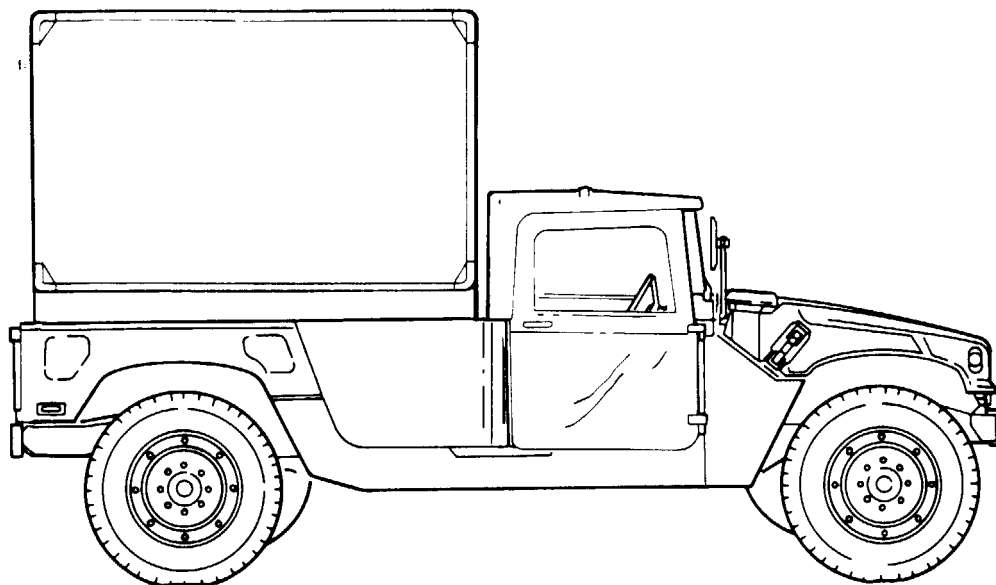
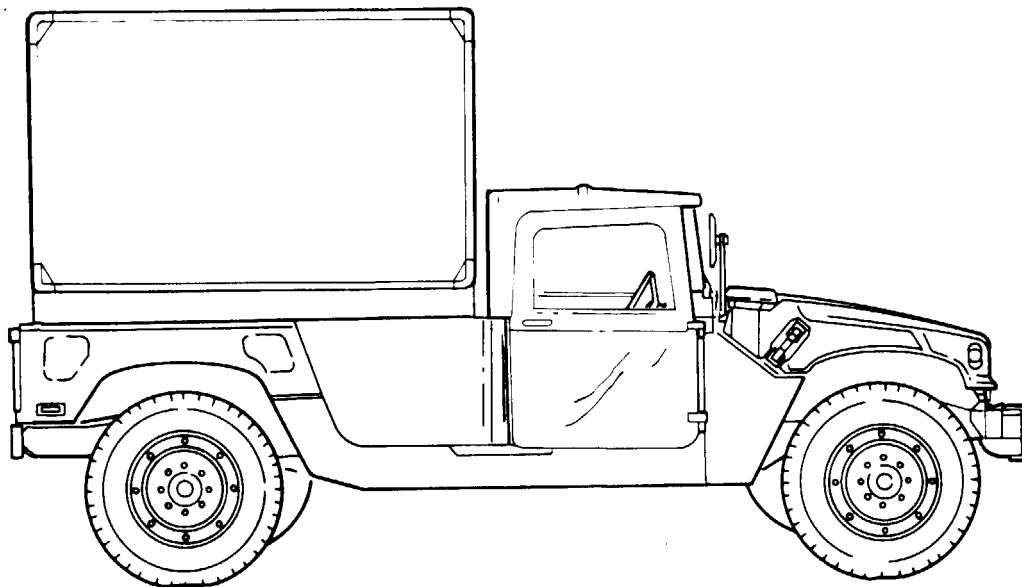
**M1043A2  
(WITH MK19 GRENADE LAUNCHER MOUNTED)**



**M1044/M1044A1 W/ WINCH  
(WITH M2, CALIBER .50 MACHINE GUN MOUNTED)**

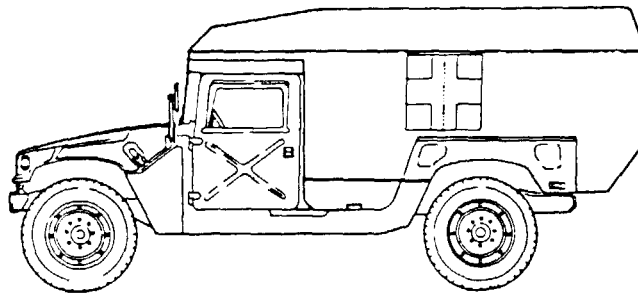
**S250 SHELTER CARRIERS M1037 AND M1042**

**PURPOSE:** These models are used for securing and transporting the S250 electrical equipment shelter. The M1042 model, which has a winch, can be used for recovery operations.

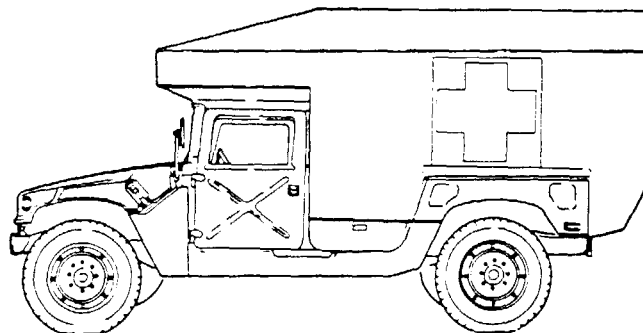
**M1037****M1042  
W/WINCH**

**ARMORED AMBULANCES: M996, M996A1, M997, M997A1, AND M997A2**

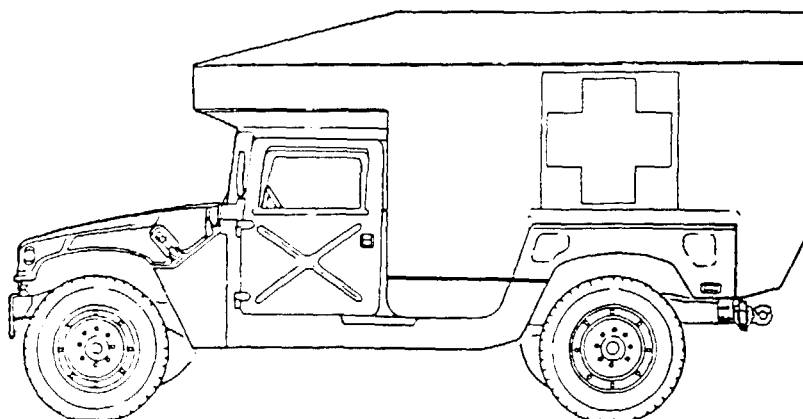
**PURPOSE:** These models are used to transport patients with armor protection for crew and patients. The M996 and M996A1 are reducible in height for CH47 helicopter transport. The M997, M997A1, and M997A2 have air conditioning for patient comfort. For operation in an NBC environment, the M997, M997A1, and M997A2 is equipped with a Gas-Particulate Filter Unit (GPFU) with heaters capable of supporting up to seven personnel equipped with either M25 series protective masks or M13 series patient protective masks.



**M996/M996A1**



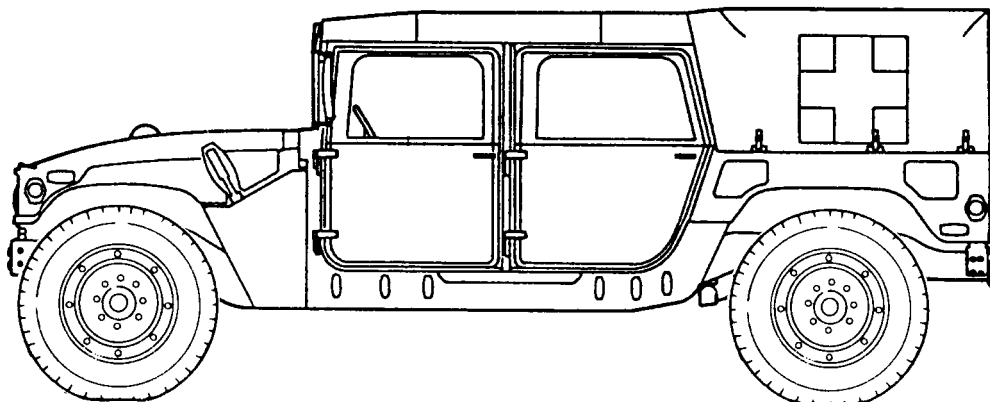
**M997/M997A1**



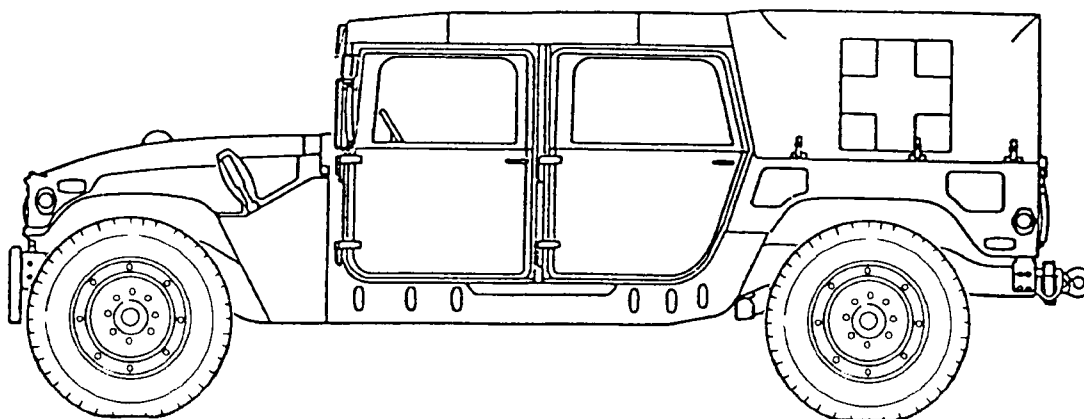
**M997A2**

# **SOFT TOP AMBULANCES: M1035, M1035A1, AND M1035A2**

**PURPOSE:** These models are used to transport a maximum of 2 litter and 2 ambulatory patients and are transportable by a CH47 helicopter.



**M1035/M1035A1**



**M1035A2**

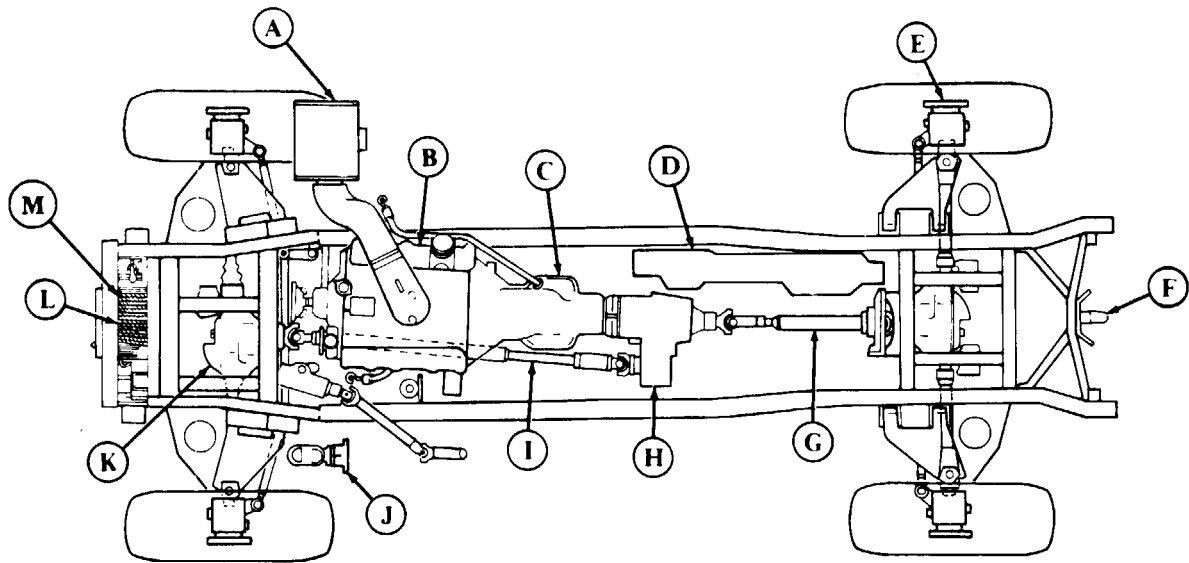
## 1-11. LOCATION AND DESCRIPTION OF MAJOR EXTERIOR COMPONENTS

The exterior components described below are common to all vehicles covered in this manual. Special differences are found in TM 9-2320-280-10 or table 1-1, differences between models, of this manual.

- (A) AIR CLEANER** – Filters air before it enters intake manifold.
- (B) ENGINE** – Provides power for the vehicle.
- (C) TRANSMISSION** – Transmits engine power to transfer case at varying speeds.
- (D) FUEL TANK** – Stores fuel.
- (E) GEARED HUB** – Transfers turning action of half shafts to wheels for vehicle motion.
- (F) PINTLE HOOK** – Permits towing of vehicles or equipment.
- (G) REAR PROPELLER SHAFT** – Transmits power from the transfer case to the rear differential.
- (H) TRANSFER CASE** – Provides full-time four-wheel drive with three drive ranges.
- (I) FRONT PROPELLER SHAFT** – Transmits power from the transfer case to the front differential.
- (J) MASTER CYLINDER AND HYDRO-BOOST** – Provides hydraulic pressure and power assist for vehicle stopping power.
- (K) DIFFERENTIAL** – Transfers turning action of the propeller shaft to the geared hubs through the half shafts.
- (L) WINCH** – 6000 lb (M1026, M1026A1, M1036, M1038, M1038A1, M1042, M1044, M1044A1, M1046, and M1046A1 only), electrically powered to provide recovery capability.
- (M) WINCH** – 9000 lb, can be used on “A2” models M1025A2, M1043A2, M1045A2, and M1097A2 and M1123.



**1-11. LOCATION AND DESCRIPTION OF MAJOR EXTERIOR COMPONENTS (Cont'd)**



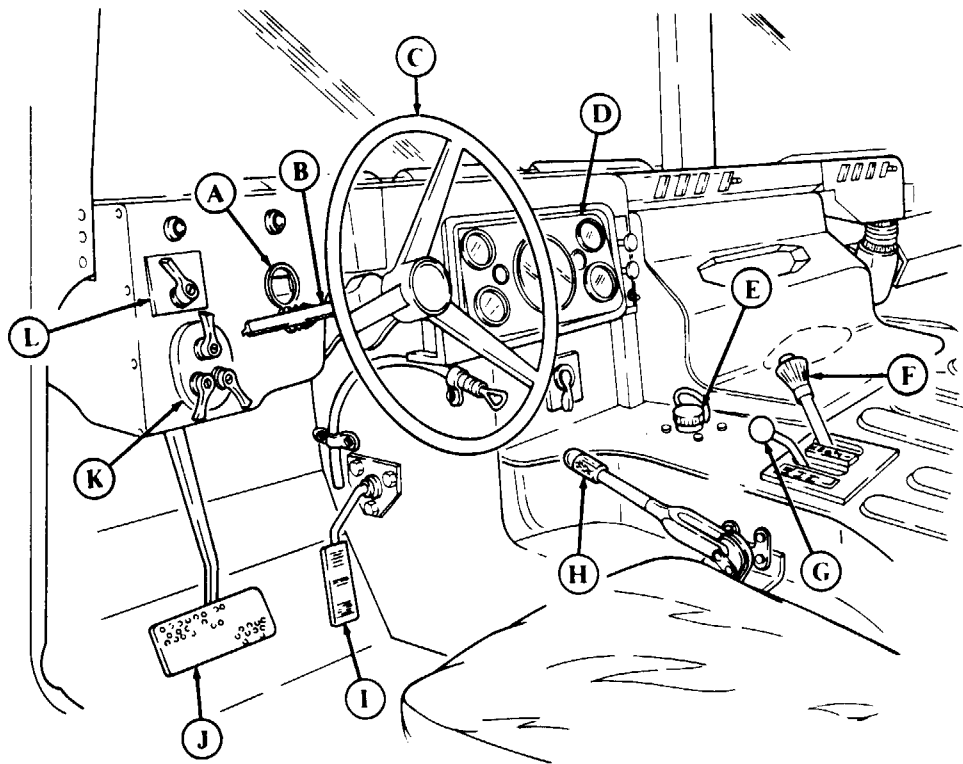
- |                         |  |
|-------------------------|--|
| <b>(A) AIR CLEANER</b>  | <b>(G) REAR PROPELLER SHAFT</b>            |
| <b>(B) ENGINE</b>       | <b>(H) TRANSFER CASE</b>                   |
| <b>(C) TRANSMISSION</b> | <b>(I) FRONT PROPELLER SHAFT</b>           |
| <b>(D) FUEL TANK</b>    | <b>(J) MASTER CYLINDER AND HYDRO-BOOST</b> |
| <b>(E) GEARED HUB</b>   | <b>(K) DIFFERENTIAL</b>                    |
| <b>(F) PINTLE HOOK</b>  | <b>(L) WINCH (6000 lb)</b>                 |
|                         | <b>(M) WINCH (9000 lb)</b>                 |

## 1-12. LOCATION AND DESCRIPTION OF MAJOR INTERIOR COMPONENTS

The major interior components shown below are common to all vehicles covered in this manual. Components not covered here can be found in TM 9-2320-280-10 or the applicable maintenance chapters of this manual.

- (A) AIR RESTRICTION GAUGE** – Indicates restrictions in the air cleaner.
- (B) DIRECTIONAL SIGNAL CONTROL** - Activates turn signal lights.
- (C) STEERING WHEEL** – Manual control for turning vehicle.
- (D) INSTRUMENT CLUSTER** – Houses controls and indicators.
- (E) DIAGNOSTIC CONNECTOR** – Connection point for STE/ICE-R test set.
- (F) TRANSMISSION SHIFT LEVER** – Manual control for shifting transmission.
- (G) TRANSFER CASE SHIFT LEVER** – Manual control for shifting transfer case.
- (H) PARKING BRAKE LEVER** - Manual control for applying parking brake.
- (I) ACCELERATOR PEDAL** – Foot control for determining engine speed.
- (J) BRAKE PEDAL** – Foot control for stopping vehicle.
- (K) MAIN LIGHT SWITCH** - Controls operation of vehicle lights.
- (L) ROTARY SWITCH** – When positioned to START, the starter is engaged to crank the engine.

# 1-12. LOCATION AND DESCRIPTION OF MAJOR INTERIOR COMPONENTS (Cont'd)



① "R" (Reverse)

② "N" (Neutral)

③ "D" (Manual Third)

④ "2" (Manual Second)

⑤ "1" (Manual First)

⑥ "P" (Park)

⑦ "R" (Reverse)

⑧ "N" (Neutral)

⑨ "D" (Overdrive)

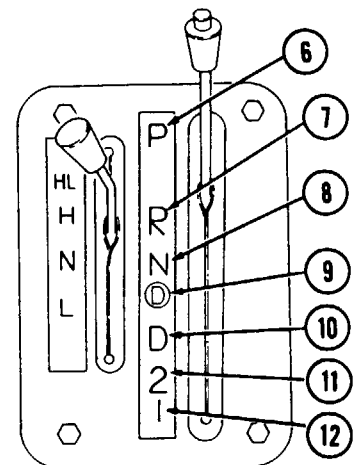
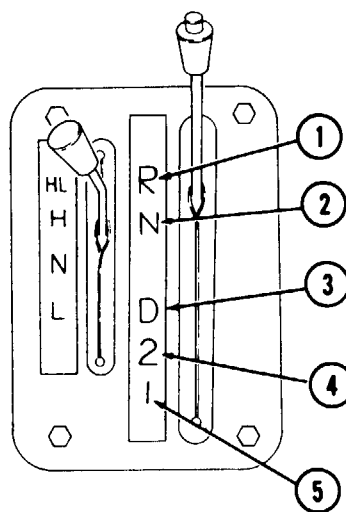
⑩ "D" (Manual Third)

⑪ "2" (Manual Second)

⑫ "1" (Manual First)

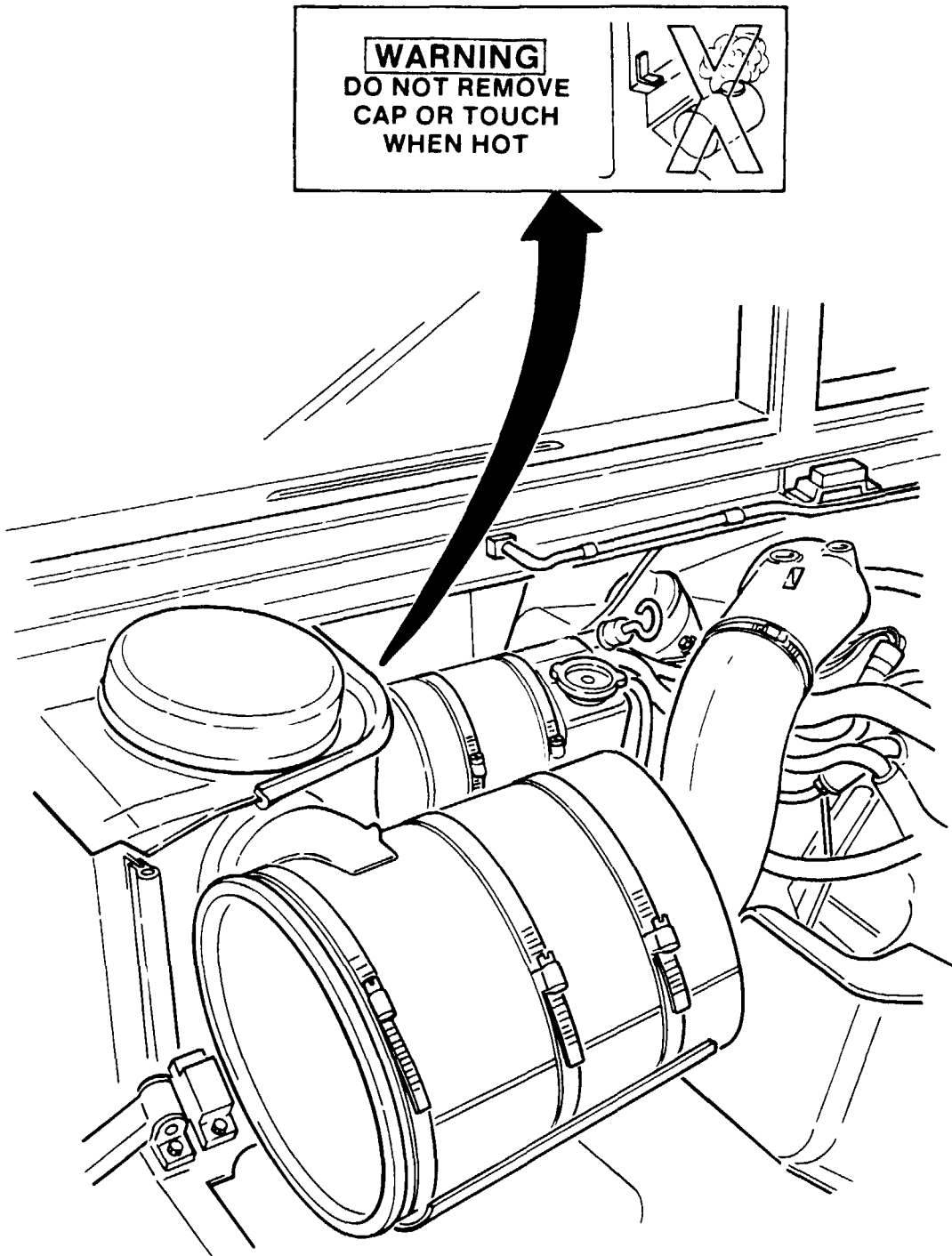
3L80 TRANSMISSION

4L80-E TRANSMISSION

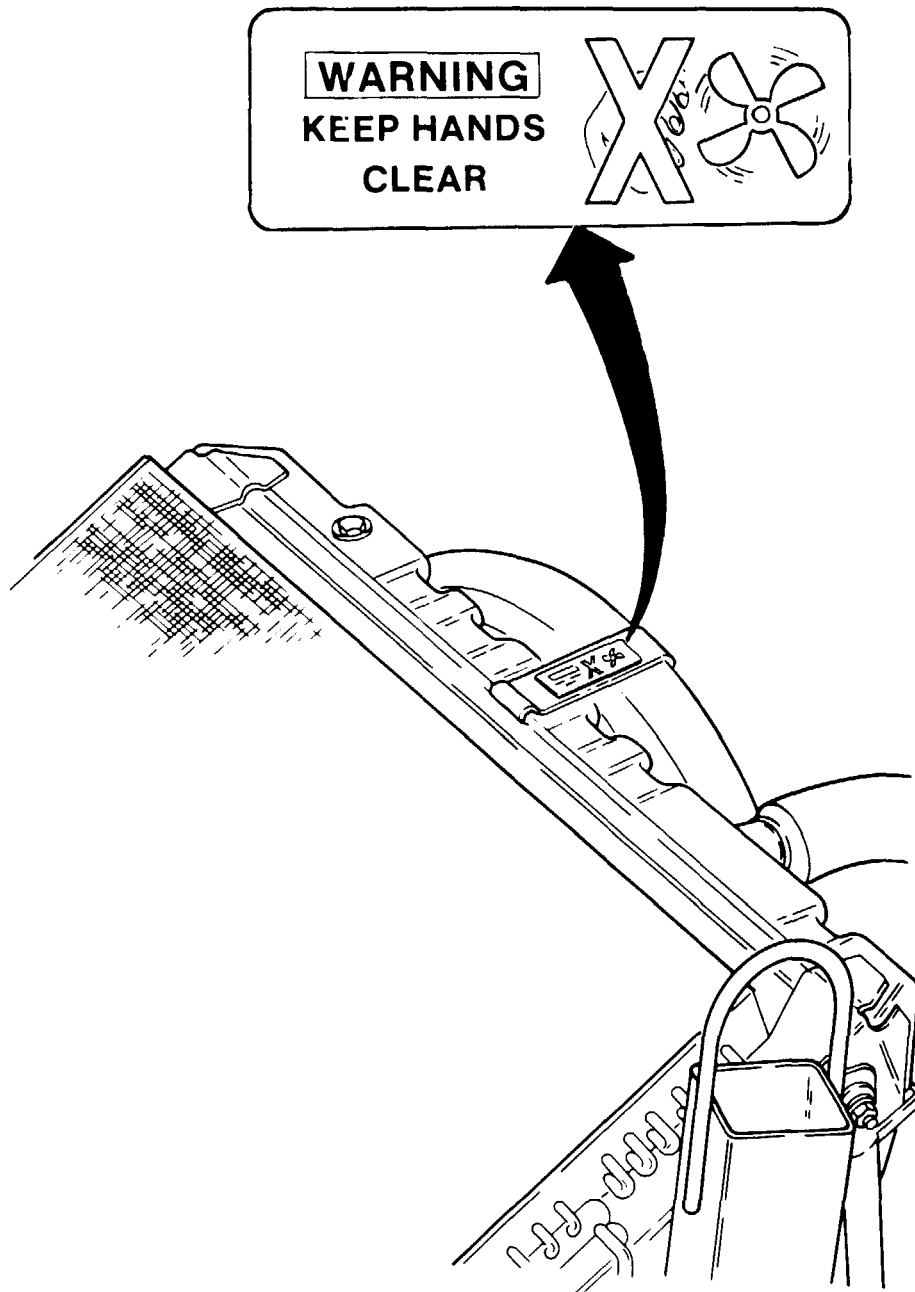


### 1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES

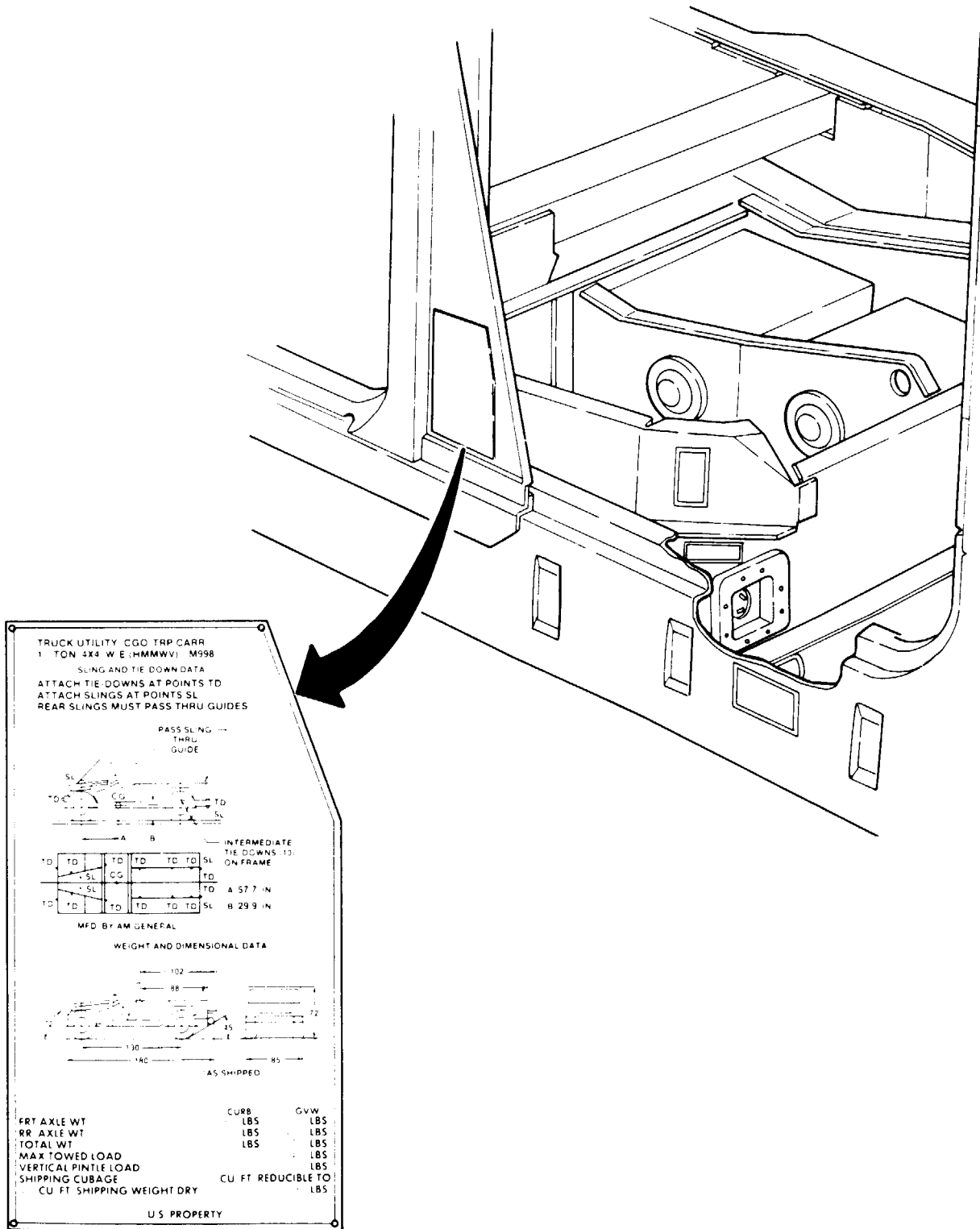
The location and contents of caution, data, and warning plates are provided in this paragraph. If any of these plates are worn, broken, painted over, missing, or unreadable, they must be replaced. Information on data plate may vary per model.

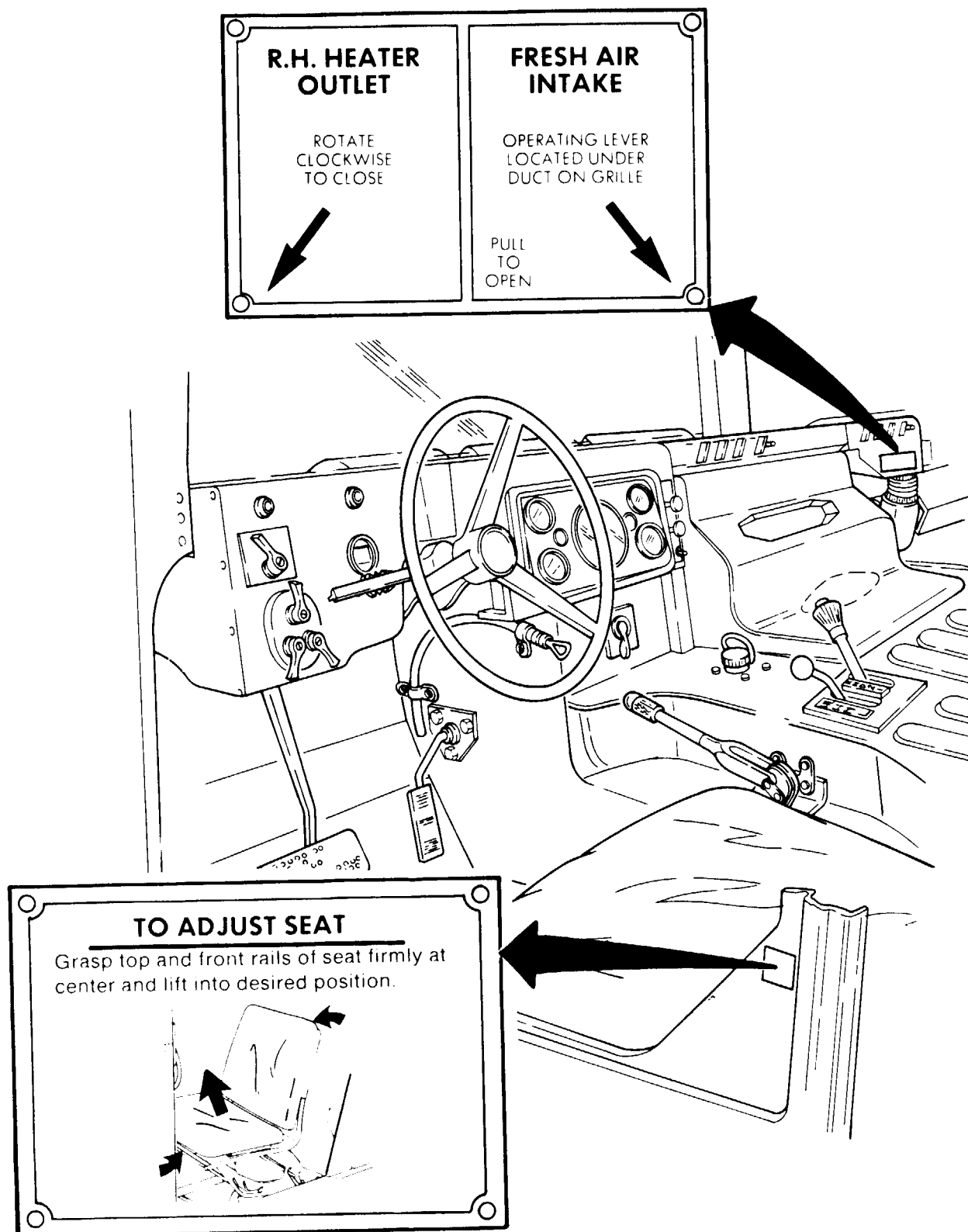


1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES  
(Cont'd)



# 1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



**1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES**  
(Cont'd)

**1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES  
(Cont'd)**

**MAX. VEHICLE OPERATING SPEEDS**

**TRANSFER CASE RANGE SELECTION**

TRANSMISSION RANGE SELECTION	"L" Low Lock	"H" High	"H/L" High Lock
"R" Reverse	11 MPH	29 MPH	11 MPH
"D" Drive	27 MPH	55 MPH	55 MPH
"2" Second	19 MPH	48 MPH	48 MPH
"1" First	11 MPH	29 MPH	29 MPH

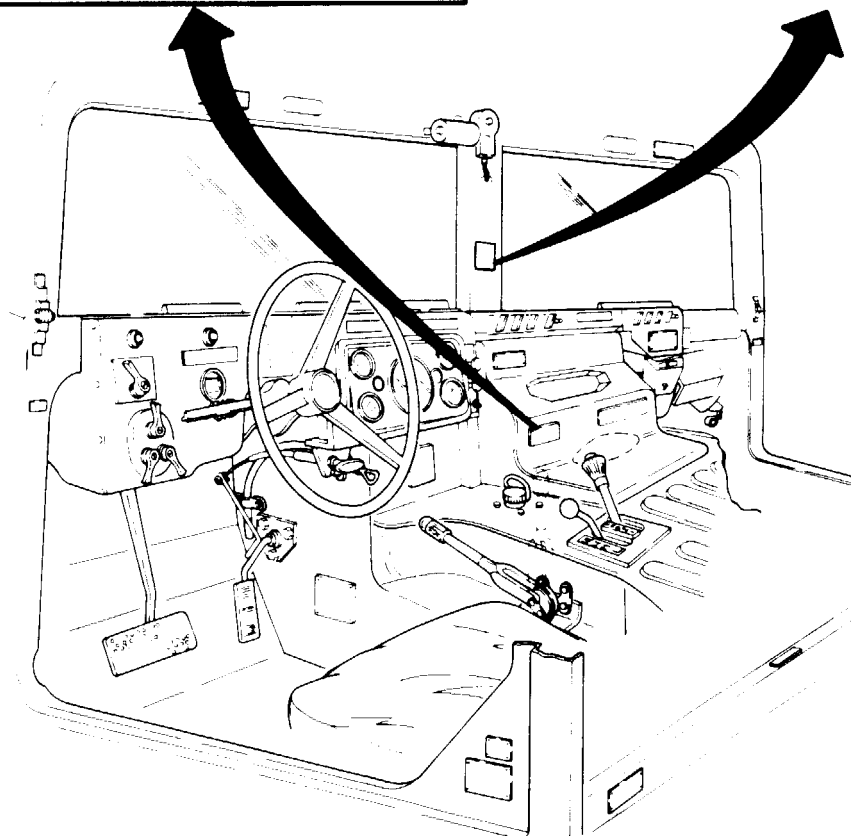
**TRANSFER CASE IN HIGH "H" WHEN  
OPERATING ON HARD SURFACE**

**FORDING  
SHALLOW FORDING DEPTH 30 INCHES**

**VEHICLE BREAK-IN  
SERVICE**

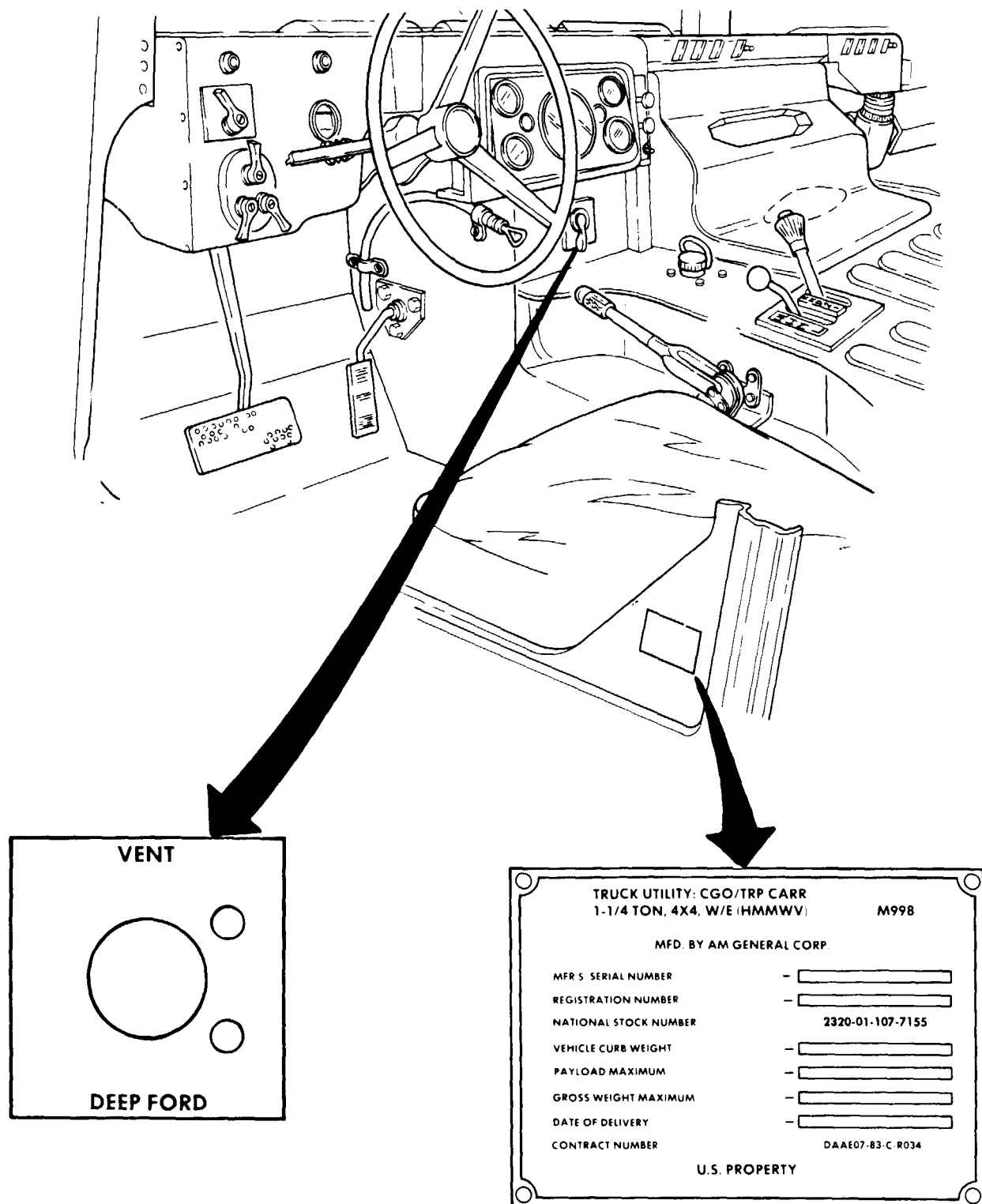
**DURING THE FIRST 500 MI.  
(804 KM) OF OPERATION:**

- DO NOT EXCEED A SPEED OF 55 MPH (88 KPH)
- DO NOT DRIVE FOR LONG PERIODS OF TIME AT CONSTANT SPEED
- AVOID RAPID ACCELERATION OR DECELERATION
- DRIVE AT MODERATE SPEED UNTIL THE ENGINE IS FULLY WARMED UP
- NO TRAILER TOWING

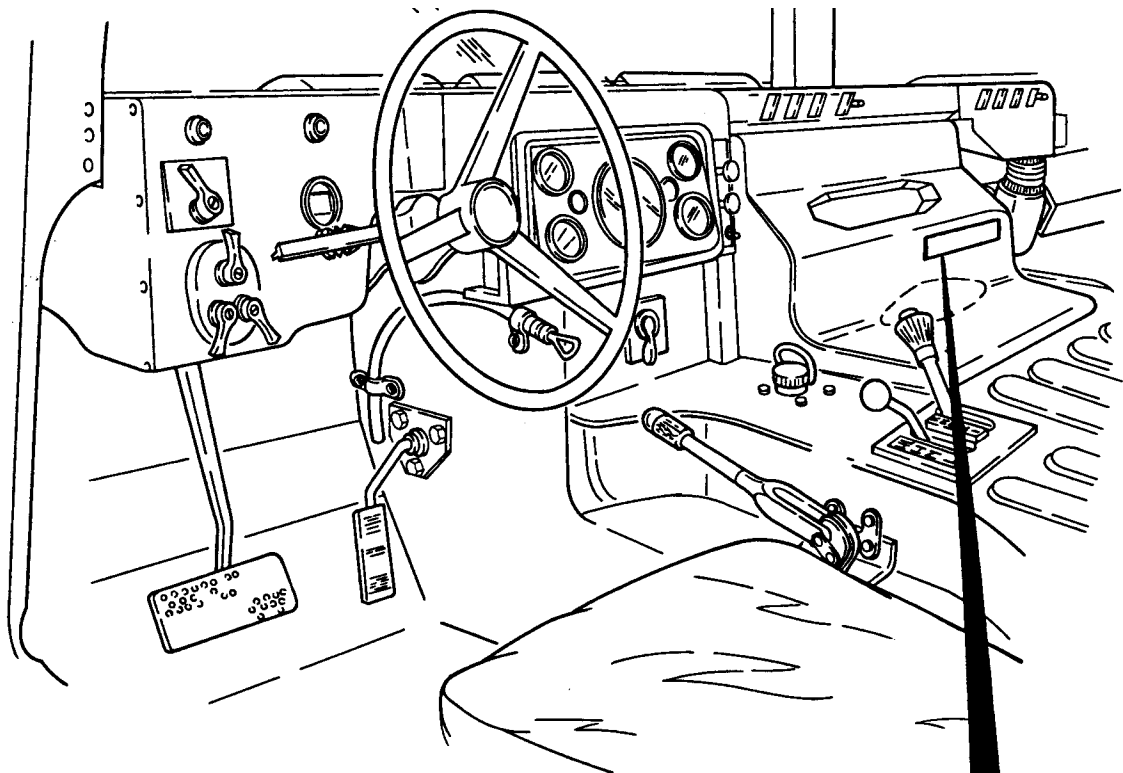




**1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES**  
(Cont'd)

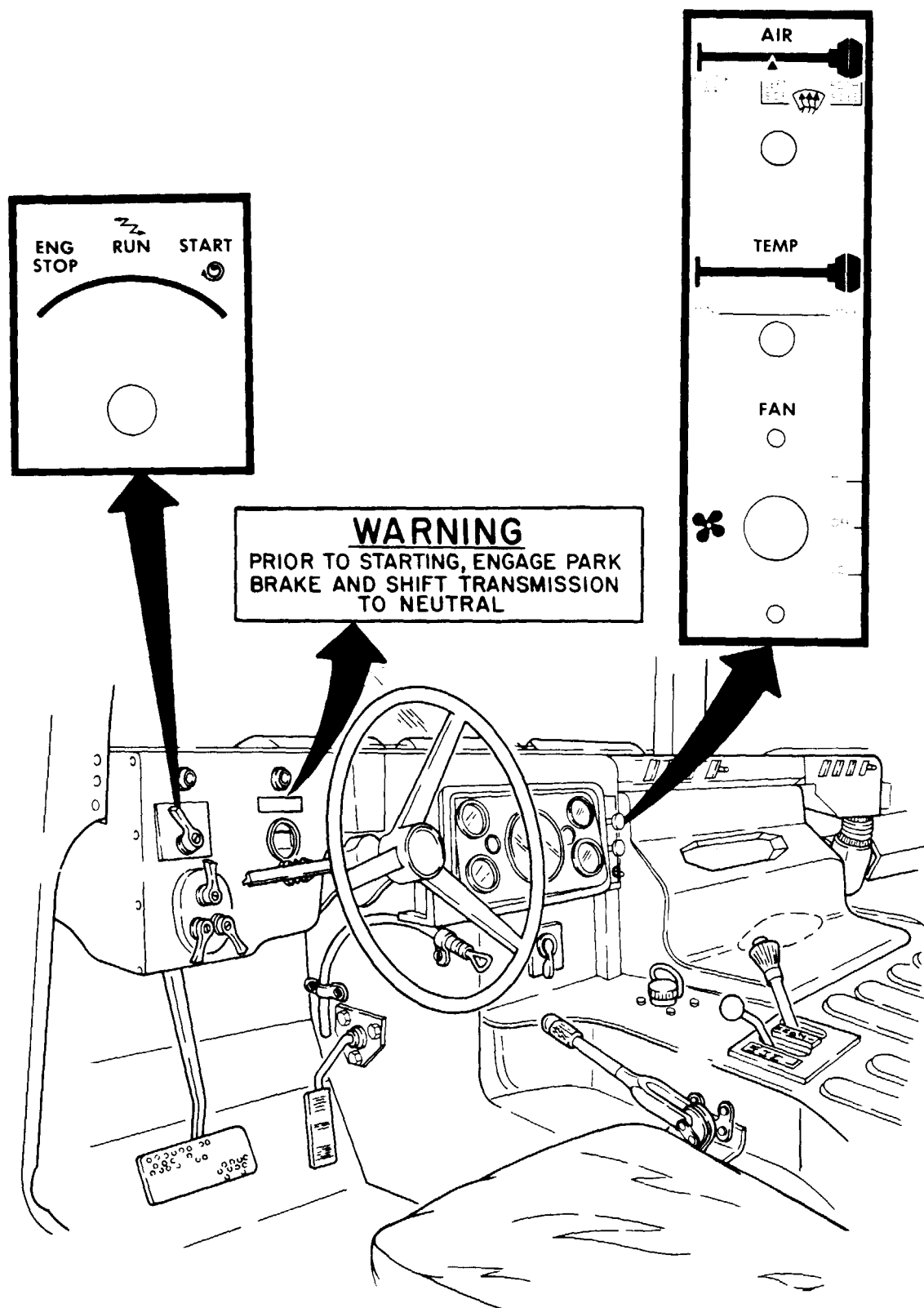


1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES  
(Cont'd)

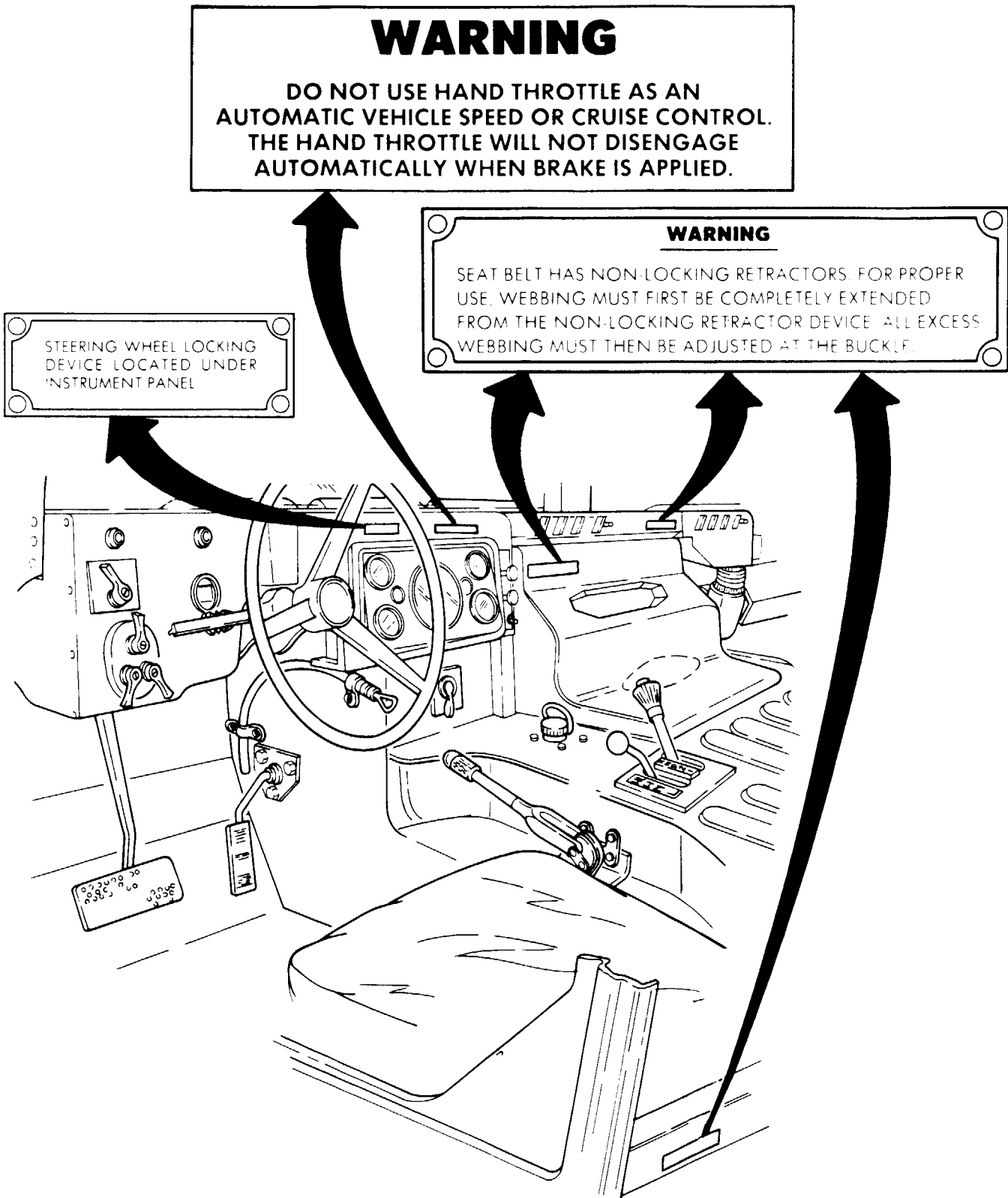


SERVICING DATA				TIRE INFLATION PRESSURE		MANUALS	
FUEL	DIESEL NO. 1, NO. 2, DFA			ALL MODELS EXCEPT	FRONT P.S.I.	REAR P.S.I.	
FUEL TANK CAPACITY	25 GALS			M1996, M1997, M1037, AND M1042	20	22	
COOLING SYSTEM CAPACITY	25 QTS						
CRANKCASE CAPACITY	7 QTS + 1 QT FOR FILTER			M1996, M1997, M1037, M1042	22	30	
TEMPERATURE	ABOVE +15°F	+40° TO -15°F	+40° TO -65°F	TO DRAIN COOLING SYSTEM OPEN DRAINCOCK LOCATED AT LOWER RADIATOR TUBE			
ENGINE OIL	OE-30	OE-10	OEA				MAINTENANCE MANUAL TM 9-2320-280-20 TM 9-2320-280-34
GEAR OIL	GO 80/90	GO 80/90	GO 75				OPERATOR'S MANUAL TM 9-2320-280-10
GREASE	GAA	GAA	GAA				PARTS LIST TM 9-2320-280-20P TM 9-2320-280-34P

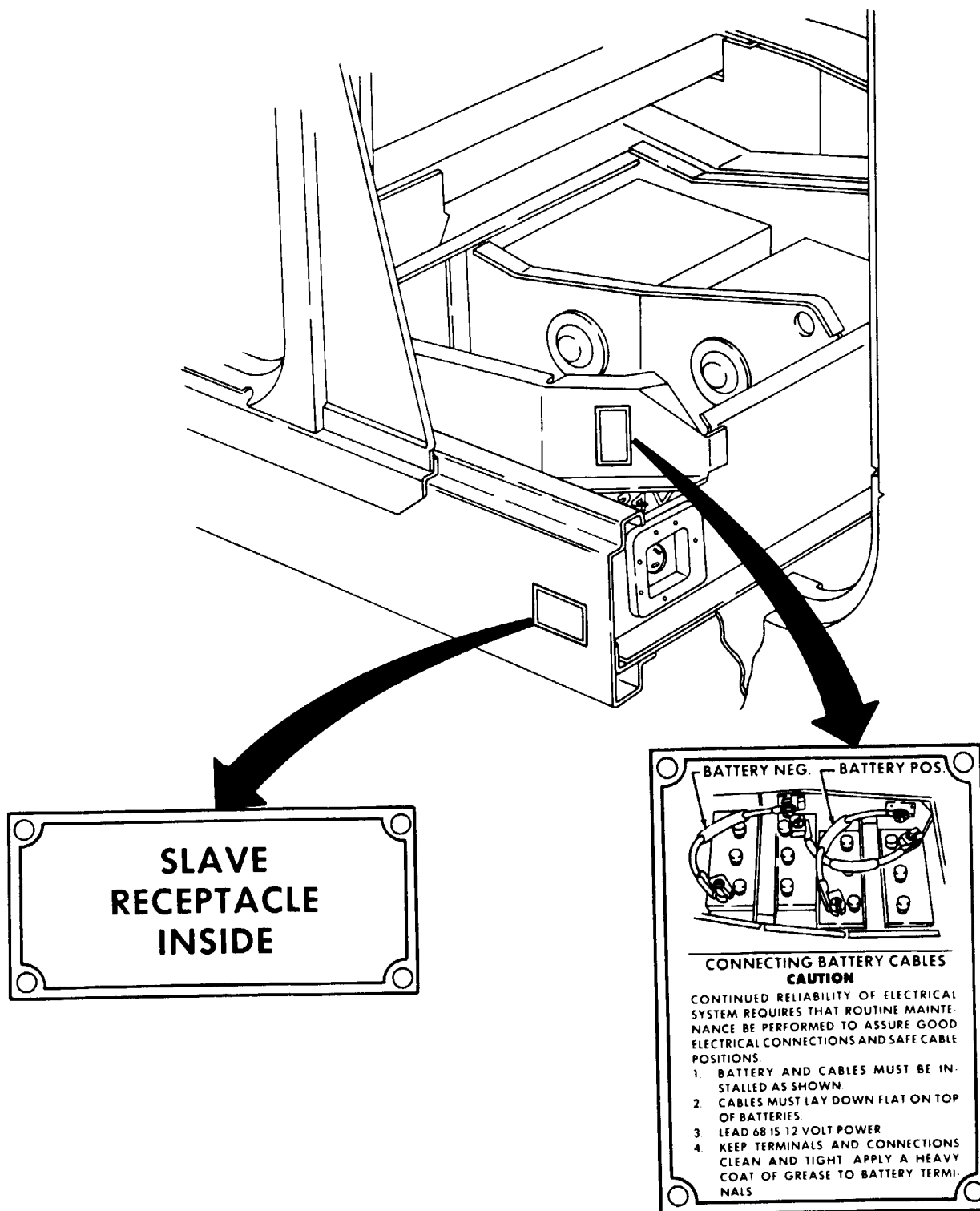
1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES  
(Cont'd)



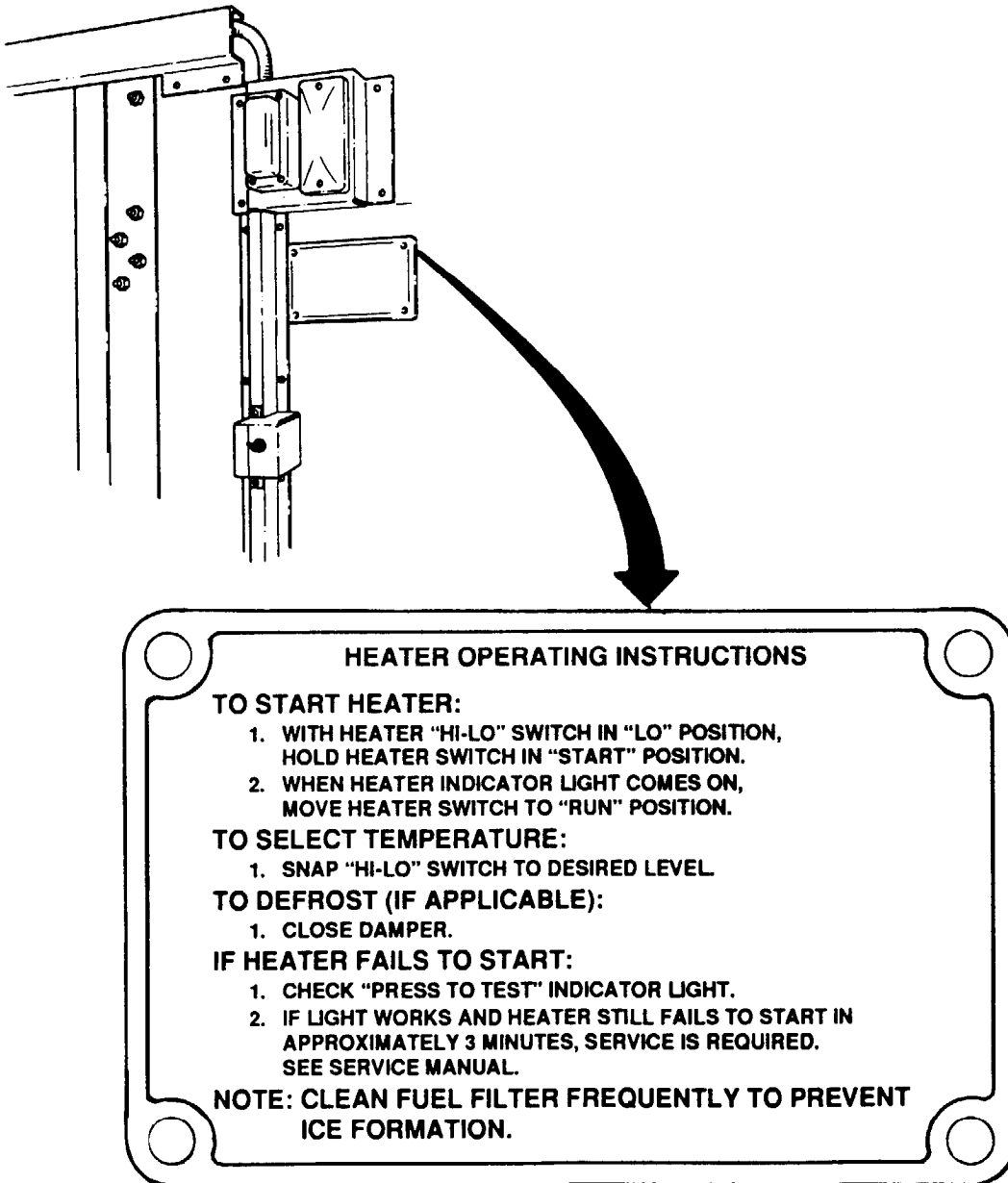
1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES  
(Cont'd)



## 1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)



1-13. LOCATION AND CONTENTS OF WARNING, CAUTION, AND DATA PLATES (Cont'd)

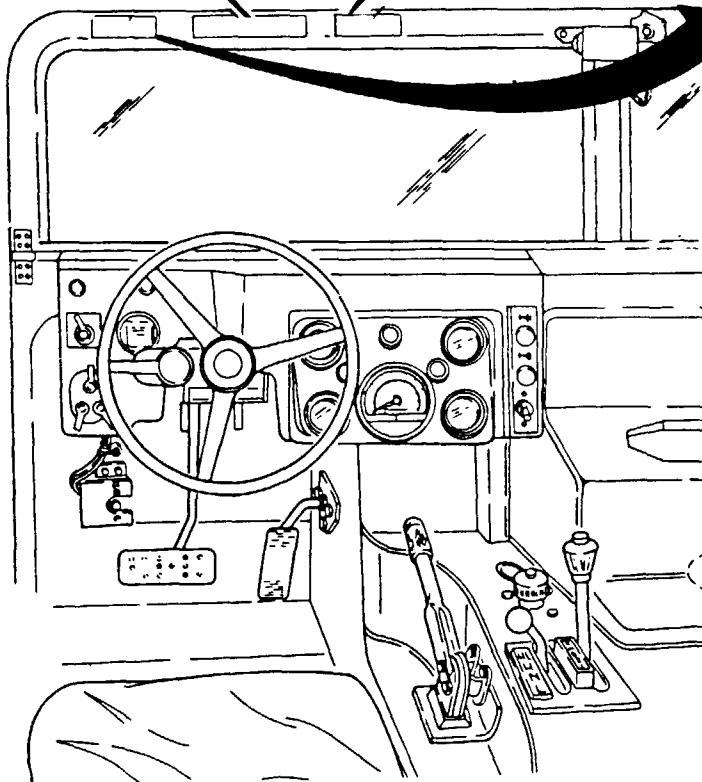
## WARNING

THE DEPARTMENT OF TRANSPORTATION REQUIRES 105 MM CANNON AMMUNITION TO BE IN WOODEN BOXES WHEN TRANSPORTING AMMUNITION ON PUBLIC HIGHWAYS, BY FIXED WING AIRCRAFT, RAIL, OR SHIP.

RESTRICT MOVEMENT OF CANNON AMMUNITION IN FIBER CONTAINERS (INNER PACK) IN THE AMMUNITION RACK OF THE HMMWV TO OTHER THAN PUBLIC HIGHWAYS.

## CAUTION

HIGH INTENSITY NOISE  
HEARING PROTECTION  
REQUIRED



# 1-14. DIFFERENCES BETWEEN MODELS

Table 1-1. Differences Between Models

Equipment/ Function	M966, M966A1, M1121	M996, M996A1	M997, M997A1, M997A2	M998, M998A1	M1025, M1025A1, M1025A2	M1026, M1026A1	M1035, M1035A1, M1035A2	M1036	M1037	M1038, M1038A1	M1042	M1043, M1043A1, M1043A2	M1044, M1044A1	M1045, M1045A1, M1045A2	M1046, M1046A1	M1097, M1097A1, M1097A2, M1123
Personnel/Cargo Operations				x						x						x
TOW Launcher Mounting	x							x						x	x	
Armament Mounting					x	x						x	x			
S250 Shelter Configuration									x		x					x
Ambulance:																
Two Litter Patients		x					x									
Four Litter Patients			x													
Eight Ambulatory Patients			x													
Six Ambulatory Patients		x														
Two Litter and Four Ambulatory Patients			x													
One Litter and Three Ambulatory Patients		x														
Vehicle Winch						x		x		x	x		x		x	
Communications:																
AN/GRC-160	x	x	x	x	x	x	x	x		x		x	x	x	x	
AN/VRC-12 Series				x					x							
Collective NBC Protection		x	x													
Basic Armor	x	x	x		x	x		x				x	x	x	x	
Supplemental Armor												x	x	x	x	
Howitzer Prime Mover																x



## 1-15. TABULATED DATA

Vehicle performance data for the M998 series vehicles is listed in table 1-2. This information includes only that data applicable to unit maintenance. Information not covered can be found in TM-9-2320-280-10.

*Table 1-2. Tabulated Data*

### NOTE

Standard and metric measurements will be used in this table.

A list of their abbreviations is provided below.

### TABULATED DATA ABBREVIATIONS

MEASUREMENT	ABBREVIATION	MEASUREMENT	ABBREVIATION
Pint . . . . .	pt	Fahrenheit . . . . .	F
Quart . . . . .	qt	Celsius . . . . .	C
Gallon . . . . .	gal.	Liters . . . . .	L
Inch . . . . .	in.	Centimeter . . . . .	cm
Miles Per Hour . . . . .	mph	Kilometers Per Hour . . . . .	kph
Miles Per Gallon . . . . .	mpg	KiloPascal . . . . .	kPa
Pounds Per Square Inch . . . . .	psi	Maximum . . . . .	max
Revolutions Per Minute . . . . .	rpm	Minimum . . . . .	min
Kilometers Per Liter . . . . .	km/L	Kilogram . . . . .	kg
Pound-Feet . . . . .	lb-ft	Newton-Meter . . . . .	N•m
Gallon Per Minute . . . . .	gpm	Millimeter . . . . .	mm
Volt . . . . .	V	Ampere . . . . .	A
Horsepower . . . . .	hp	KiloWatt . . . . .	kW
Liters Per Minute . . . . .	l/m		

	STANDARD	METRIC
<b>1. PAYLOAD</b>		
M998, M998A1, M1038, and M1038A1 . . . . .	2,500 lb	1,135 kg
M1097, M1123, "A1" and "A2" Series . . . . .	4,400 lb	1,998 kg
<b>2. CAPACITIES*</b>		
Cooling System . . . . .	26 qt	24.6 L
Engine		
Crankcase Only . . . . .	7 qt	6.6 L
Crankcase and Filter . . . . .	8 qt	7.6 L
Fuel Tank . . . . .	25 gal.	94.6 L
Differential (each) . . . . .	2 qt	1.9 L
Transmission (3L80):		
Drain and Refill . . . . .	6 qt	5.7 L
W/Dry Converter . . . . .	11 qt	13.2 L
Transmission (4L80-E):		
Drain and Refill . . . . .	7.7 qt	7.3 L
W/Dry Converter . . . . .	13.5 qt	12.8 L
Transfer Case (model 218) . . . . .	3.5 qt	3.3 L
Transfer Case (model 242) . . . . .	3.35 qt	3.17 L
Geared Hub . . . . .	1 pt	0.47 L
Steering Hydraulic System . . . . .	1 qt	0.95 L
Steering Hydraulic System with Steering Cooler . . . . .	1.25 qt	1.18 L
Brake Hydraulic System (All except M1097, M1123, "A1" and "A2" series) . . . . .	1.2 pt	0.57 L
Brake Hydraulic System (M1097, M1123, "A1" and "A2" series) . . . . .	1.63 pt	0.77 L
Brake Master Cylinder (All except M1097, M1123, "A1" and "A2" series) . . . . .	0.69 pt	0.33 L
Brake Master Cylinder (M1097, M1123, "A1" and "A2" series) . . . . .	1.12 pt	0.53 L
Windshield Washer Reservoir . . . . .	1 qt	0.95 L

\*ALL HYDRAULIC SYSTEMS AND ALL FUEL CAPACITIES  
ARE CALCULATED APPROXIMATIONS

Table 1-2. Tabulated Data (Cont'd)

	STANDARD	METRIC
3. ENGINE		
Model . . . . .	DDA 6.2 L	
Type. . . . .	Diesel, Naturally Aspirated Liquid-Cooled, V8	
Brake Horsepower . . . . .	150 hp @ 3,600 rpm	111.9 kW @ 3,600 rpm
Idle Speed . . . . .	650 ± 25 rpm	
Operating Speed. . . . .	1,500-2,300 rpm	
Oil Pressure:		
@ Idle . . . . .	10 psi	69 kPa
@ Operating Speed . . . . .	40-50 psi	276-345 kPa
4. ENGINE		
Model . . . . .	DDA 6.5 L and 6.5 L Detuned	
Type. . . . .	Diesel, Naturally Aspirated, Liquid-Cooled, V8	
Brake Horsepower . . . . .	160 hp @ 3,400 rpm	119.4 kW @ 3,400 rpm
Idle Speed . . . . .	700 ± 25 rpm	
Operating Speed . . . . .	1,500-2,300 rpm	
Oil Pressure		
@ Idle . . . . .	10 psi	69 kPa
@ Operating Speed . . . . .	40-50 psi	276-345 kPa
5. FUEL SYSTEM		
Fuel Pump (Mechanical):		
Type . . . . .	Cam-Driven Diaphragm	
Fuel Filter		
Type. . . . .	Fuel/Water Separator	
Air Cleaner:		
Type. . . . .	Dry Element	
Glowplug:		
Type. . . . .	Fast Start	
6. COOLING SYSTEM		
Surge Tank Cap Pressure . . . . .	15 psi	103 kPa
Thermostat:		
Starts to Open . . . . .	190°F	88°C
Fully Open . . . . .	212°F	100°C
Radiator:		
Type. . . . .	Downflow	
Fan:		
Type . . . . .	Ten Blade	
Diameter . . . . .	19 in.	48.26 cm
7. ELECTRICAL SYSTEM		
Alternator:		
60 Ampere . . . . .	60 A @ 28 V	
100 Ampere . . . . .	100 A @ 28 V	
200 Ampere . . . . .	200 A @ 28 V	
400 Ampere . . . . .	400 A @ 28 V	
Starter:		
Voltage . . . . .	14 V	
Batteries (2):		
Voltage . . . . .	12 V	

Table 1-2. Tabulated Data (Cont'd)

	STANDARD	METRIC	
8. TRANSMISSION			
Model . . . . .	3L80		
Type . . . . .	3-Speed, Automatic		
Oil Type . . . . .	Dexron® II		
Oil Pressure . . . . .	55-160 psi	379-1,103 kPa	
9. TRANSMISSION			
Model . . . . .	4L80-E		
Type . . . . .	4-speed, Automatic Torque Converter Stall Ratio and Direct Drive w/Lock Up Clutch		
Gear Ratios			
First . . . . .	2.48:1		
Second . . . . .	1.45:1		
Third . . . . .	1.00:1		
Fourth . . . . .	0.75:1		
Reverse . . . . .	2.08:1		
Oil Type . . . . .	Dexron® III		
Oil Pressure . . . . .	35-324 psi	241-2,234 kPa	
10. TRANSFER CASE			
Model . . . . .	NPG 218 w/Cooler NPG 242 w/Cooler		
Type . . . . .	2-speed		
Oil Type . . . . .	Dexron® II		
11. SERVICE BRAKE CALIPER (FRONT)			
Manufacturer . . . . .	Kelsey-Hayes		
Piston Diameter . . . . .	2.6 in.	66 mm	
12. SERVICE/PARKING BRAKE CALIPER (REAR)			
Manufacturer . . . . .	Kelsey-Hayes		
Piston diameter . . . . .	2.6 in.	66 mm	
13. SERVICE BRAKE ROTOR (FRONT)			
Manufacturer . . . . .	Kelsey-Hayes		
A2 Manufacturer . . . . .	Kelsey-Hayes		■
Diameter . . . . .	10.5 in.	267 mm	
A2 Diameter . . . . .	12 in.	305 mm	■
Thickness . . . . .	0.87 in.	22.1 mm	
A2 Thickness . . . . .	1.02 in.	26 mm	■
14. SERVICE/PARKING BRAKE ROTOR (REAR)			
Manufacturer . . . . .	Kelsey-Hayes		
A2 Manufacturer . . . . .	Kelsey-Hayes		■
Diameter . . . . .	10.5 in.	267 mm	
A2 Diameter . . . . .	12 in.	305 mm	■
Thickness . . . . .	0.87 in.	22.1 mm	
A2 Thickness . . . . .	1.02 in.	26 mm	■

Table 1-2. Tabulated Data (Cont'd)

15. PARKING BRAKE (VEHICLES SERIAL NUMBERS 1 THROUGH 44824)			
Type . . . . .	Rod and Cable Actuated, Caliper		
Rotor Diameter . . . . .	8 in.	203 mm	
Brake Pad:			
Type . . . . .	Bonded		
Minimum thickness . . . . .	0.125 in.	3.2 mm	
Lever Type . . . . .	Over-Center		
16. WHEELS AND TIRES			
Tire size (Bias ply) . . . . .	36 in. x 12.5 in. x 16.5 in.	91.4 cm x 31.75 cm x 41.9 cm	
Tire size (Radial) . . . . .	37 in. x 12.5 in. x 16.5 in.	93.98 cm x 31.75 cm x 41.9 cm	
Wheels:			
Type . . . . .	Offset Disc		
Runflat Insert:			
Type . . . . .	2-Piece Magnesium		
17. STEERING SYSTEM			
Steering Gear:			
Manufacturer . . . . .	Saginaw		
Type . . . . .	Variable Ratio		
Ratio . . . . .	13/16:1		
Power Steering Pump:			
Model . . . . .	Saginaw 125		
Output Pressure (max) . . . . .	1,450 psi	9,998 kPa	
Flow Rate (max) . . . . .	3.5 gpm	13.2 l/m	
Tow-In (Front/Rear @ curb weight):			
M998, M998A1, M1025, M1025A1, M1025A2, M1026, M1026A1, M1035, M1035A1, M1035A2, M1038, M1038A1, M1043, M1043A1, M1043A2, M1044, M1044A1, M1097, M1097A1, M1097A2, and M1123 . . . . .			
	0.438 in. ± 0.125 in.	11 mm ± 3.2 mm	
M966, M966A1, M996, M996A1, M997, M997A1, M997A2, M1036, M1037, M1042, M1045, M1045A1, M1045A2, M1046, M1121, and M1046A1 . . . . .			
	0.312 in. ± 0.125 in.	8 mm ± 3.2 mm	
18. WINCH			
Model . . . . .	W6000D25		
Type . . . . .	Electric Drive, Thermal Cutoff Switch		
Capacity . . . . .	6,000 lb	2,724 kg	
19. WINCH			
Model . . . . .	MIL-9000		
Type . . . . .	Electric Drive, Thermal Cutoff Switch		
Capacity . . . . .	9,000 lb	4,086 kg	
19.1. WINCH			
Model . . . . .	983-75-50050		
Type . . . . .	Hydraulic		
Capacity . . . . .	10,500 lb	4,767 kg	
20. AIR-CONDITIONING COMPRESSOR			
Manufacturer . . . . .	Sanden		
Model . . . . .	510		
Field Coil . . . . .	24V		

### Section III. PRINCIPLES OF OPERATION

#### 1-16. GENERAL

This section explains how components of the M998 series vehicles work together. The systems (functional groups) covered are listed in the Principles of Operation Reference Index, paragraph 1-17.

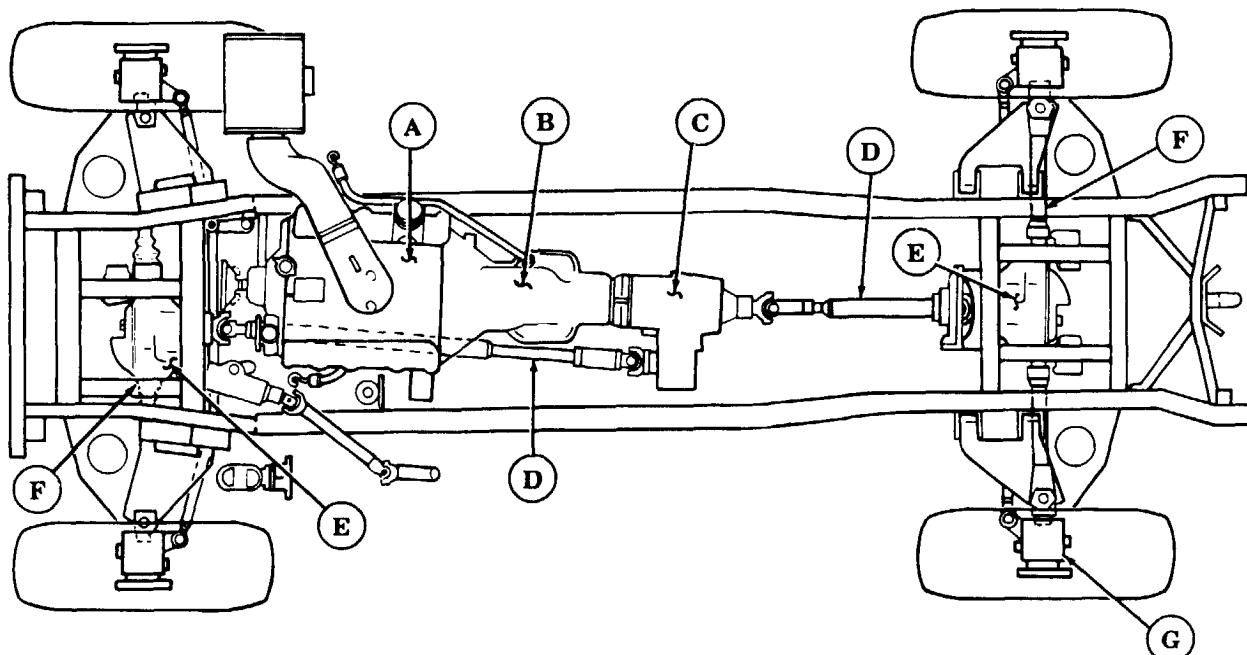
#### 1-17. PRINCIPLES OF OPERATION REFERENCE INDEX

REF. PARA.	SYSTEM	PAGE NO.
1-18.	Drivetrain Operation	1-36
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1-22.	Generating System Operation	1-41
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## 1-18. DRIVETRAIN OPERATION

The drivetrain is identical for all models covered in this manual. It converts horsepower into mechanical force to move the vehicle. Major components of the drivetrain are:

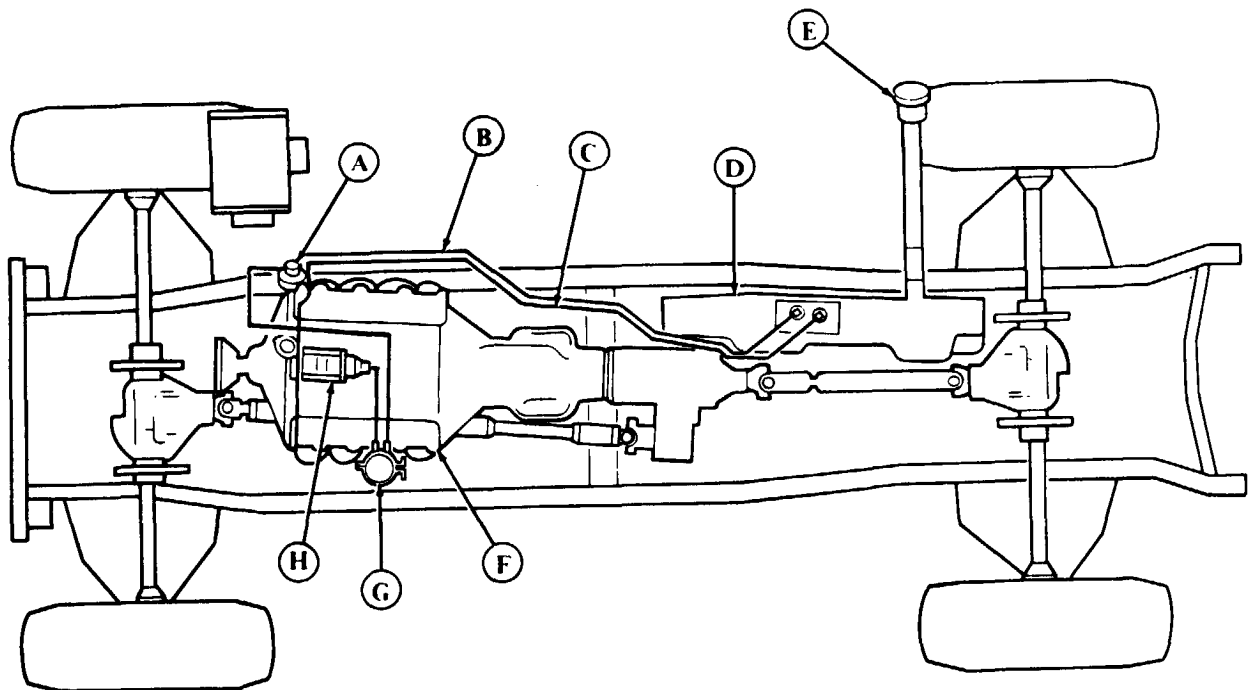
- (A) ENGINE** - The water-cooled 6.2 liter, V-8, Diesel engine provides up to 150 horsepower at 3600 rpm to power the vehicle. The 6.5 liter V-8 engine develops approximately 160 horsepower at 3400 rpm to power the vehicle. The engines are essentially the same on all models except those equipped with deep water fording kit installed, which adds a specially sealed dipstick, dipstick tube, and vented CDR valve. These differences do not affect engine performance.
- (B) TRANSMISSION (3L80)** - Adapts engine power to meet different driving conditions. The automatic transmission has three forward speeds, a reverse and a neutral. A neutral safety switch prevents the vehicle from being started with the transmission in any selector lever position except neutral.  
**TRANSMISSION (4L80E)** - Adapts engine power to meet different driving conditions. The automatic transmission has four forward speeds, a reverse, a neutral and a park. A neutral safety switch prevents the vehicle from being started with the transmission in any selector lever position except park and neutral.
- (C) TRANSFER CASE** - Directs engine-to-transmission power to front and rear differentials simultaneously. This condition means the vehicle is always in four-wheel drive. The transfer case allows for selection of three drive ranges and a neutral position. A complete description of these driving ranges and the recommended driving conditions during which they are used can be found in TM 9-2320-280-10.
- (D) PROPELLER SHAFTS** - Link transfer case to differentials. Universal joints, located at either end of the front and rear propeller shafts, permit inline driving power between the transfer case and differentials even though they are mounted at different angles.
- (E) DIFFERENTIALS** - Transmit driving power, via halfshafts and geared hubs, to left and right wheels. The differential ensures power is applied to the wheel having traction, regardless of which wheel is slipping. This feature is called torque biasing.
- (F) HALFSHAFTS** - Transmits power from differentials to geared hubs.
- (G) GEARED HUBS** - Serve as the front wheel steering spindle and act as the final drive components to front and rear wheels.



## 1-19. FUEL SYSTEM OPERATION

The HMMWV diesel fuel system operation is identical for all models covered in this manual. It stores, cleans, and supplies fuel for the engine. Major components of the fuel system are:

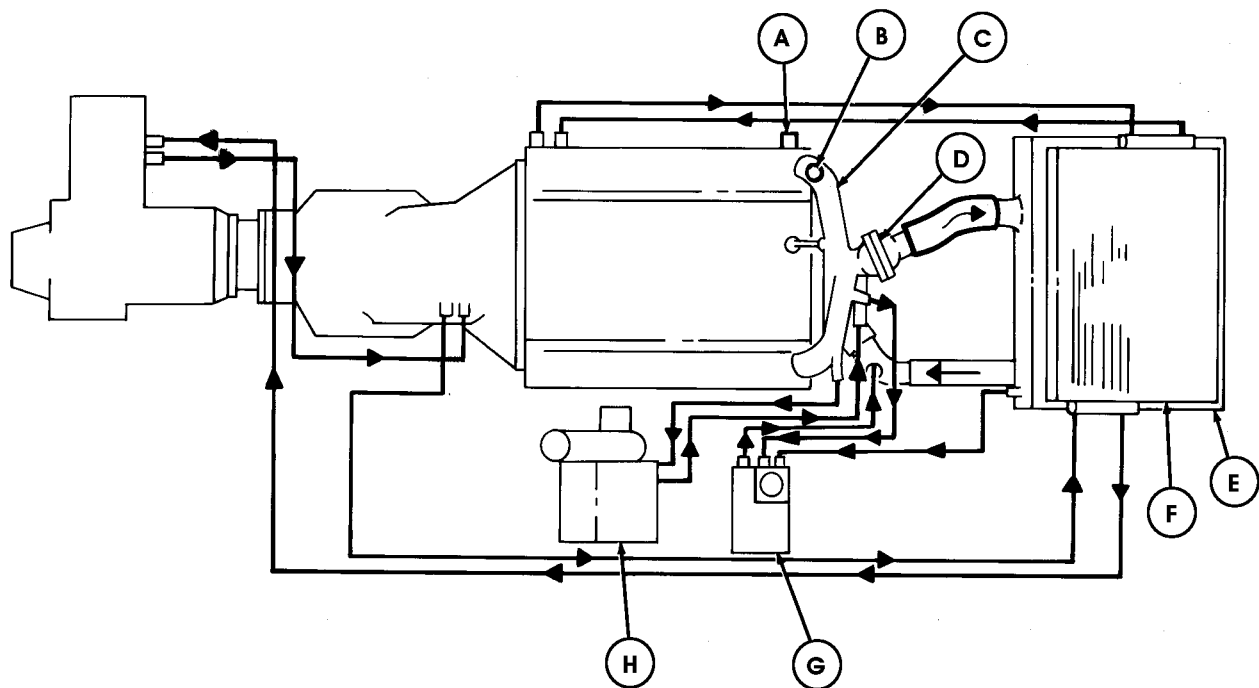
- (A) FUEL PUMP** - Draws fuel from fuel tank through the supply line and pumps it to the fuel filter.
- (B) FUEL RETURN LINE** - Directs unused fuel from the injection pump back to the fuel tank.
- (C) FUEL SUPPLY LINE** - Directs fuel from fuel tank to the system.
- (D) FUEL TANK** - Stores 25 gallons of diesel fuel.
- (E) FUEL FILLER CAP** - Located at right rear side of vehicle, the cap is removed to permit fuel tank servicing.
- (F) FUEL INJECTORS** - Receive metered fuel from the injection pump and sprays fuel into the combustion chamber.
- (G) FUEL FILTER/WATER SEPARATOR** - Filters water and sediment from fuel before fuel enters the injection pump.
- (H) INJECTION PUMP** - Directs metered and pressurized fuel to the eight injector nozzles. It is mounted on top of the engine under the intake manifold.



## 1-20. COOLING SYSTEM OPERATION

The cooling system removes excess heat from the engine, engine oil, transfer oil, and transmission oil. This system is identical on all models covered in this manual. Major components of the cooling system are:

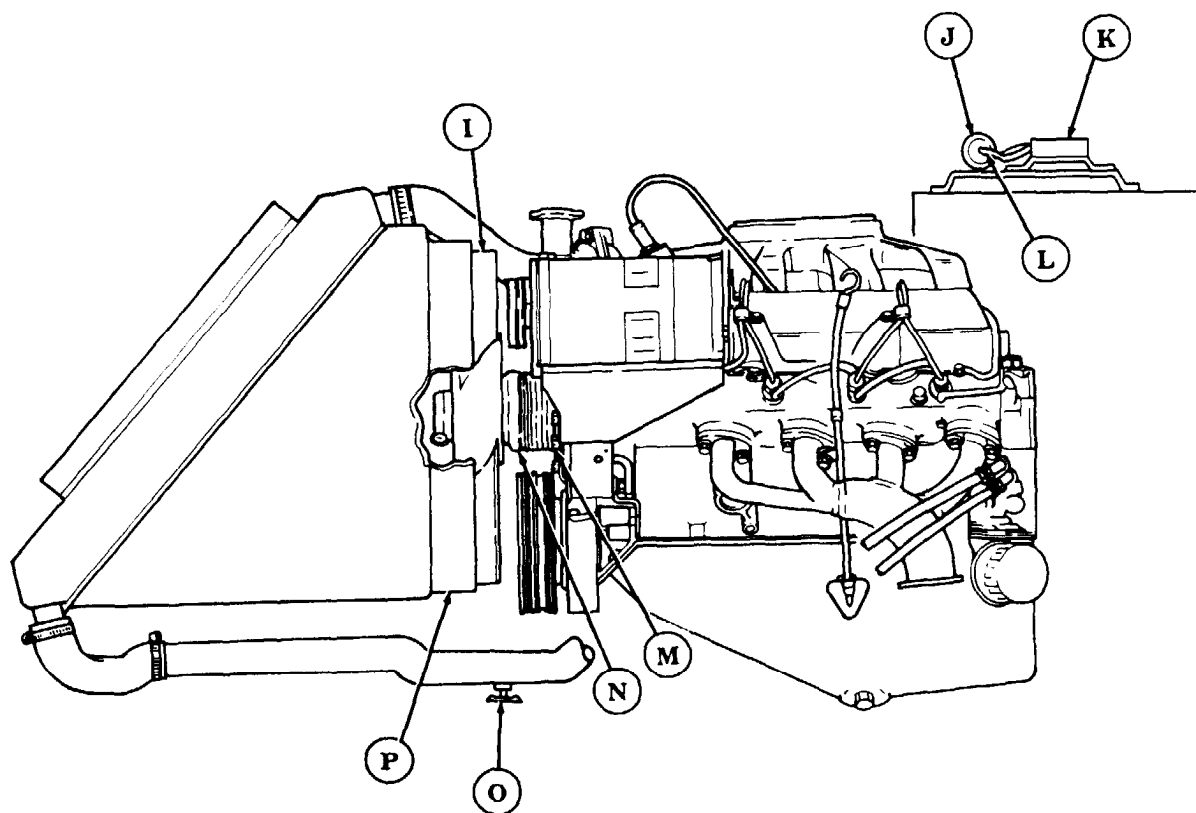
- (A) **ENGINE TEMPERATURE SENDING UNIT** – Sends signal indicating coolant temperature to gauge on instrument cluster.
- (B) **ENGINE TEMPERATURE SWITCH** – Sends signal to activate control valve system to operate fan when engine temperature exceeds 215°F (102°C) and deactivate when engine temperature drops below 190°F (88°C).
- (C) **WATER CROSSOVER** – Collects coolant from cylinder heads and channels it to the thermostat housing where it is redirected through the cooling system.
- (D) **THERMOSTAT** – Shuts off coolant return flow to radiator until temperature reaches 190°F (88°C). Coolant is then directed to the radiator through the radiator inlet hose.
- (E) **RADIATOR** – Directs coolant through a series of fins and baffles so outside air can dissipate excess engine heat before the coolant is recirculated through the engine.
- (F) **OIL COOLER** – Directs engine oil (lower half of cooler) and transmission oil (upper half of cooler) through a series of fins or baffles so outside air can remove heat from oil.
- (G) **SURGE TANK** – Filling and expansion point for cooling system.
- (H) **PERSONNEL HEATER** – Provides heat for personnel and interior of vehicle.





## 1-20. COOLING SYSTEM OPERATION (Cont'd)

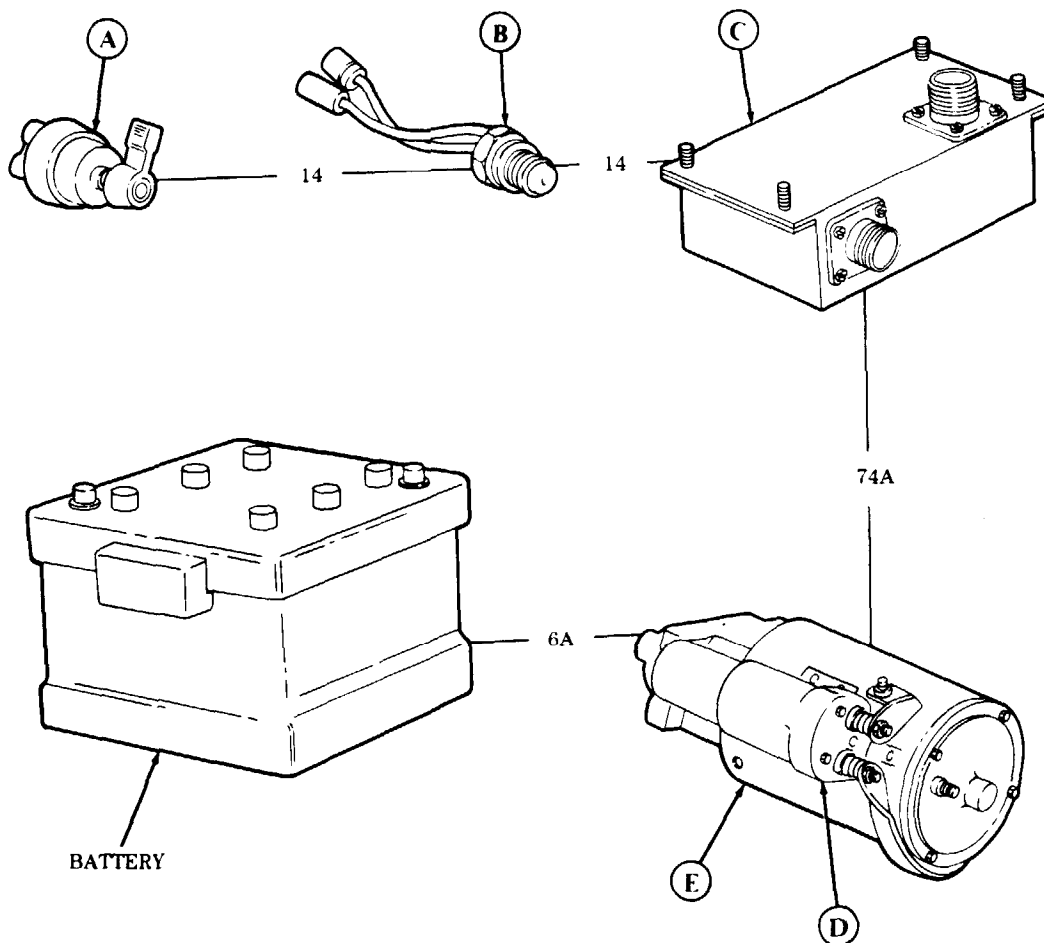
- (I) FAN** - Pulls outside air through radiator to remove heat from coolant.
- (J) HYDRAULIC CONTROL VALVE** - Directs hydraulic fluid to provide required pressure to actuate fan clutch as required by engine temperature. Hydraulic pressure supplied by power steering pump.
- (K) TIME DELAY MODULE** - Sends delayed signal to fan clutch solenoid for delay of fan actuation to provide needed horsepower for engine acceleration.
- (L) FAN CLUTCH SOLENOID** - Actuates hydraulic control valve as required by coolant temperature.
- (M) WATER PUMP** - Driven by V-belts provides circulation of coolant through cooling system.
- (N) FAN CLUTCH** - Hydraulically actuated by pressure from hydraulic control valve to control operation of fan. Hydraulic pressure supplied by power steering pump.
- (O) DRAINCOCK** - Draining point for radiator and cooling system.
- (P) RADIATOR SHROUD** - Permits a greater concentration of air to be pulled through the radiator.



## 1-21. STARTING SYSTEM OPERATION

The starting system is identical for all vehicles covered in this manual, and consists of the following components and circuits.

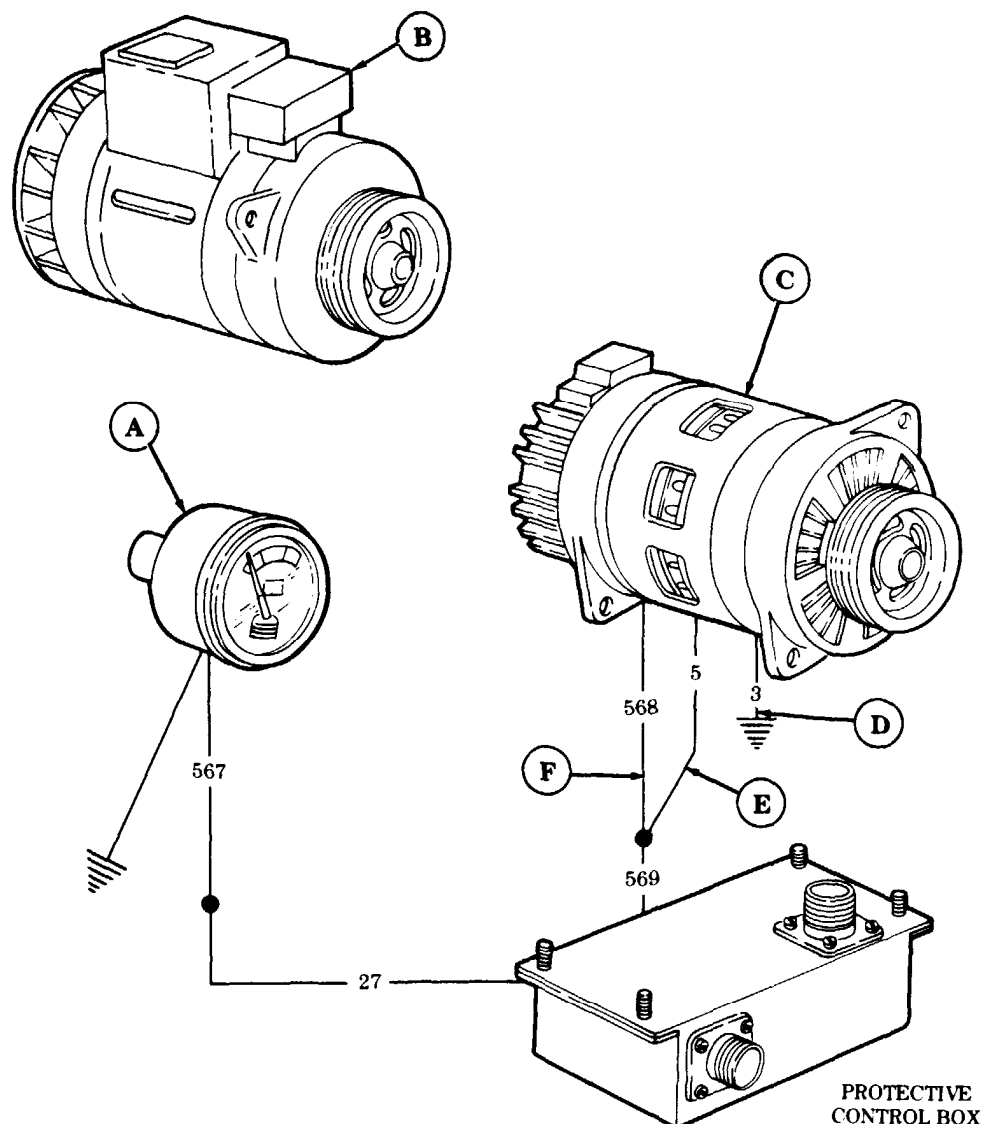
- (A) ROTARY SWITCH** - When in "START" position, provides battery power to the starter solenoid and to the neutral start switch through circuit 14.
- (B) NEUTRAL STARTER SWITCH** - When transmission shift lever is in "N" (neutral) position, this switch closes a relay in the protective control box through circuit 14 allowing battery power to reach the starter solenoid.
- (C) PROTECTIVE CONTROL BOX** - Locks out the starter circuit, which prevents starter from reengaging while engine is running.
- (D) STARTER SOLENOID** - A magnetic relay that transmits 24-volt battery power to the starter motor.
- (E) STARTER MOTOR** - Cranks the engine for starting, and is supplied 24-volt battery power through circuit 6A.



## 1-22. GENERATING SYSTEM OPERATION (60/100 AMPERE ALTERNATOR)

The 60 ampere generating system is identical for all vehicles except the M997, M997A1, M997A2 4-litter and M996, M996A1 2-litter ambulances.

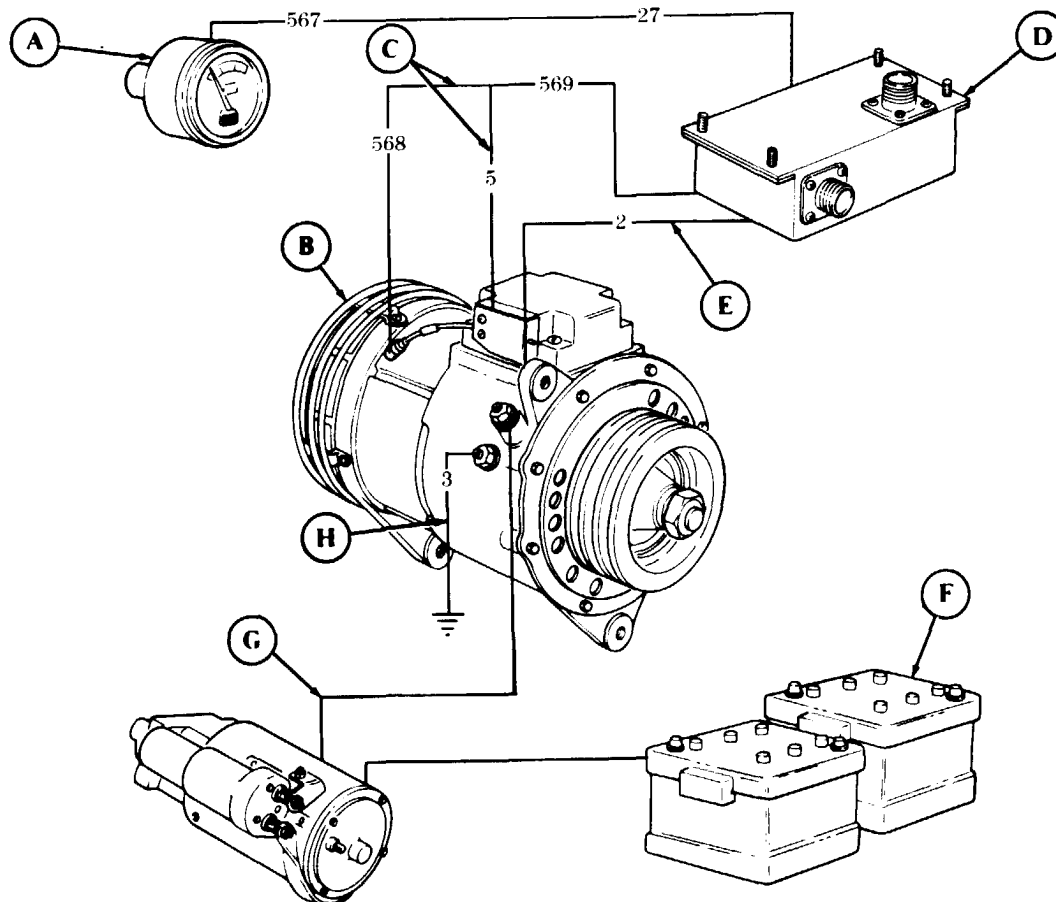
- (A) **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.
- (B) **ALTERNATOR (100 ampere)** – Rated at 28 volts, 100 amperes, with external regulator. The alternator assists and recharges the batteries during operation.
- (C) **ALTERNATOR (60 ampere)** – Rated at 28 volts, 60 amperes, with internal regulator. The alternator assists and recharges the batteries during operation.
- (D) **CIRCUIT 3** – Provides a ground circuit to alternator.
- (E) **CIRCUIT 5** – Conducts alternator output to charge the batteries and maintain vehicle voltage.
- (F) **CIRCUIT 568** – Senses vehicle voltage activating the field current in the alternator to generate current.



## 1-23. GENERATING SYSTEM OPERATION (200 AMPERE ALTERNATOR)

The 200 ampere generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

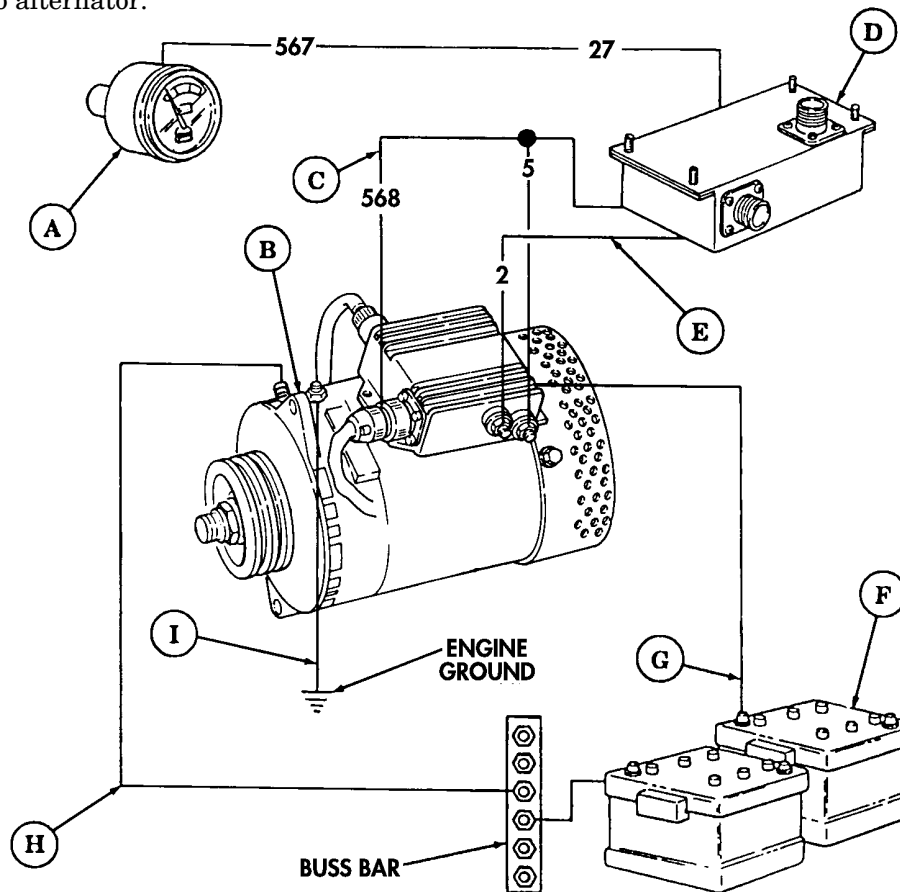
- (A) **BATTERY GAUGE** - Indicates electrical system voltage. It is connected to the electrical system through circuit 567.
- (B) **ALTERNATOR (200 AMPERE)** - Is rated at 28 volts, 200 amperes, with external regulator. The alternator assists and recharges the vehicle batteries during operation.
- (C) **CIRCUIT 568/CIRCUIT 5 (ALTERNATOR A0013036AA ONLY)** - Senses vehicle voltage, and activates the field current in the alternator to generate current.
- (D) **PROTECTIVE CONTROL BOX** - Protects the vehicle electrical system in the event battery polarity is reversed.
- (E) **CIRCUIT 2** - Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.
- (F) **BATTERIES** - Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.
- (G) **POSITIVE CABLE** - Transmits alternator output to maintain battery charge. A fuse at the alternator power stud will prevent damage to alternator if battery polarity is reversed.
- (H) **CIRCUIT 3** - Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.



### 1-23.1. GENERATING SYSTEM OPERATION (100 AMPERE DUAL VOLTAGE ALTERNATOR)

The 100-ampere dual voltage generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

- (A) **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.
- (B) **ALTERNATOR (100 AMPERE)** – Is rated at 28 volts at 100 amperes and 14 volts at 50 amperes with external regulator. The alternator assists and recharges the vehicle batteries during operation.
- (C) **CIRCUIT 568** – Senses vehicle voltage, and activates the field current in the alternator circuit to alternator.
- (D) **PROTECTIVE CONTROL BOX / DISTRIBUTION BOX\*** – Protects the vehicle electric system in the event battery polarity is reversed. Provides load dump, glow plug operation, and interfacing of engine and body harnesses.
- (E) **CIRCUIT 2** – Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.
- (F) **BATTERIES** – Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.
- (G) **POSITIVE CABLE 6** – Provides 28-volt alternator output to maintain charge across two batteries.
- (H) **POSITIVE CABLE 68A** – Provides 16-volt alternator output to maintain charge across the lower battery.
- (I) **CIRCUIT 3** – Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.

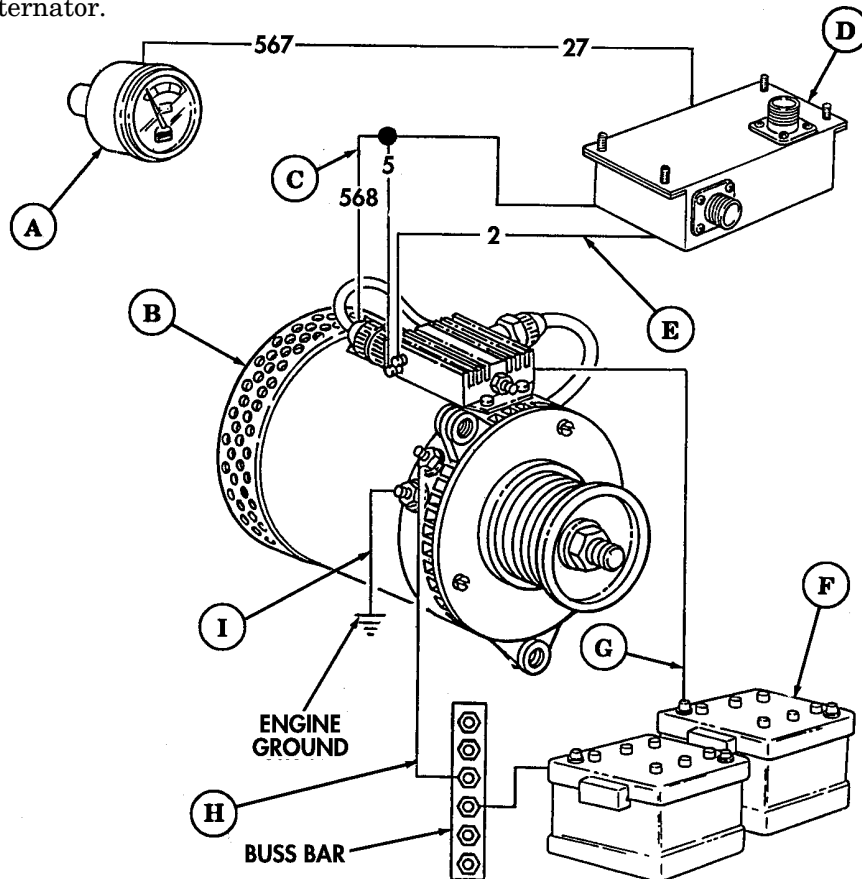


\* Distribution box provides same function as protective control box except distribution box does not protect against reversal of battery polarity.

### 1-23.2. GENERATING SYSTEM OPERATION (200 AMPERE DUAL VOLTAGE ALTERNATOR)

The 200-ampere dual voltage generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

- (A) **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.
- (B) **ALTERNATOR (200 AMPERE)** – Is rated at 28 volts at 200 amperes and 14 volts at 50 amperes with external regulator. The alternator assists and recharges the vehicle batteries during operation.
- (C) **CIRCUIT 568** – Senses vehicle voltage, and activates the field current in the alternator circuit to alternator.
- (D) **PROTECTIVE CONTROL BOX / DISTRIBUTION BOX\*** – Protects the vehicle electric system in the event battery polarity is reversed. Provides load dump, glow plug operation, and interfacing of engine and body harnesses.
- (E) **CIRCUIT 2** – Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.
- (F) **BATTERIES** – Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.
- (G) **POSITIVE CABLE 6** – Provides 28-volt alternator output to maintain charge across two batteries.
- (H) **POSITIVE CABLE 68A** – Provides 16-volt alternator output to maintain charge across the lower battery.
- (I) **CIRCUIT 3** – Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.

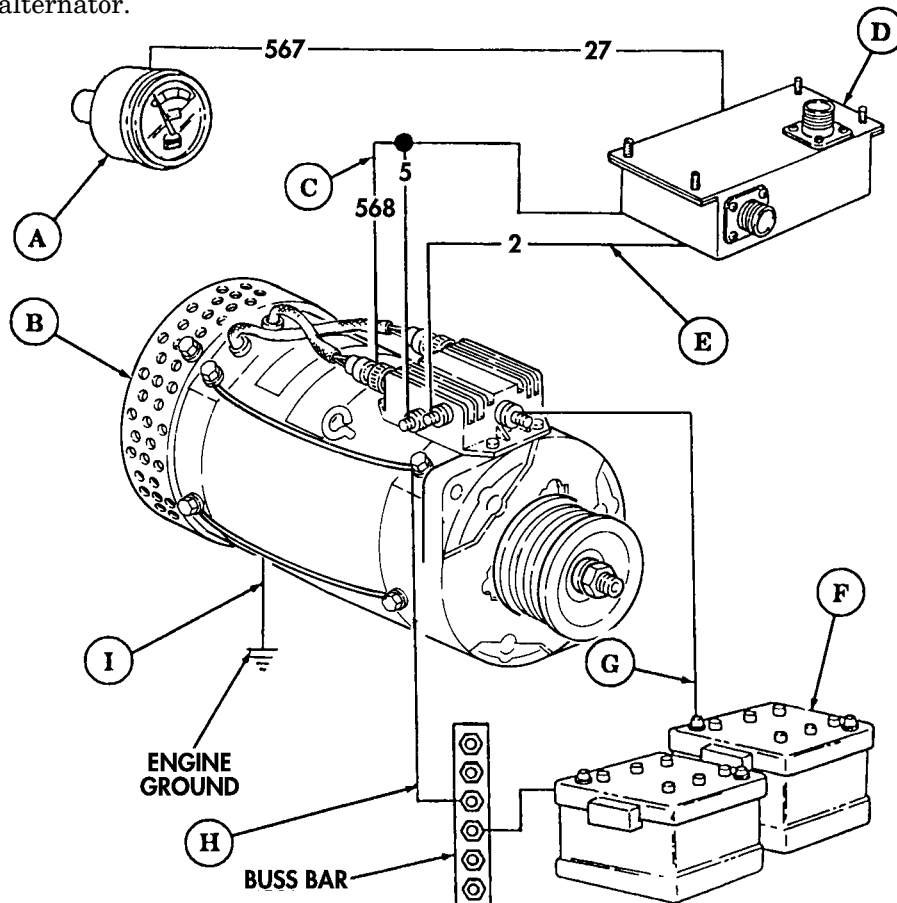


\* Distribution box provides same function as protective control box except distribution box does not protect against reversal of battery polarity.

### 1-23.3. GENERATING SYSTEM OPERATION (400 AMPERE DUAL VOLTAGE ALTERNATOR)

The 400-ampere dual voltage generating system maintains battery charge and provides electrical power to operate vehicle circuits. Major components of the generating system are:

- (A) **BATTERY GAUGE** – Indicates electrical system voltage. It is connected to the electrical system through circuit 567.
- (B) **ALTERNATOR (400 AMPERE)** – Is rated at 28 volts at 400 amperes and 14 volts at 50 amperes with external regulator. The alternator assists and recharges the vehicle batteries during operation.
- (C) **CIRCUIT 568** – Senses vehicle voltage, and activates the field current in the alternator circuit to alternator.
- (D) **PROTECTIVE CONTROL BOX / DISTRIBUTION BOX\*** – Protects the vehicle electric system in the event battery polarity is reversed. Provides load dump, glow plug operation, and interfacing of engine body harnesses.
- (E) **CIRCUIT 2** – Sends AC signal, indicating alternator shaft rpm, to frequency switch in protective control box to prevent operation of starter solenoid when engine is running.
- (F) **BATTERIES** – Two 12-volt batteries are connected in a series to provide 24 volts to start vehicle and assist alternator during operation.
- (G) **POSITIVE CABLE 6** – Provides 28-volt alternator output to maintain charge across two batteries.
- (H) **POSITIVE CABLE 68A** – Provides 16-volt alternator output to maintain charge across the lower battery.
- (I) **CIRCUIT 3** – Connects to negative stud on alternator with engine ground strap to provide a ground circuit to alternator.

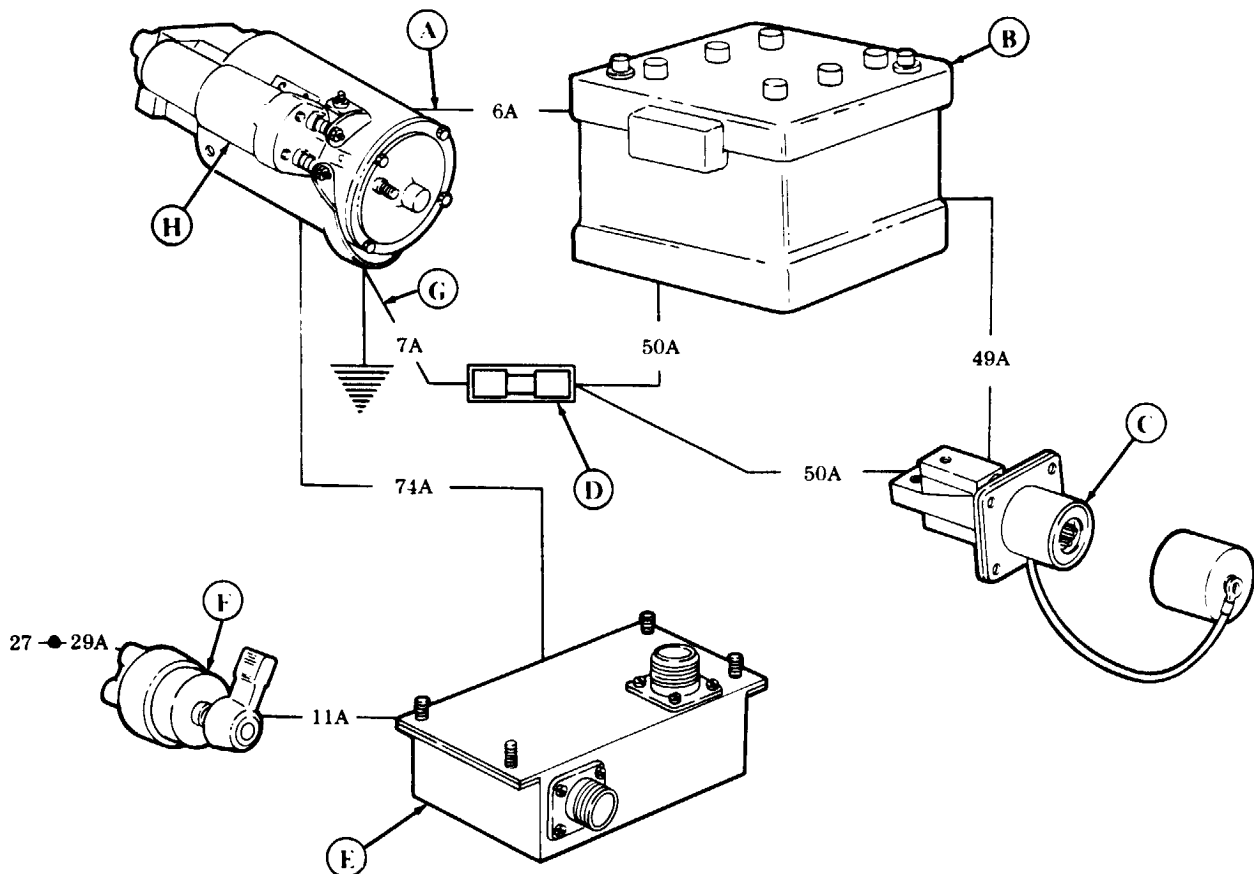


\* Distribution box provides same function as protective control box except distribution box does not protect against reversal of battery polarity.

## 1-24. BATTERY SYSTEM OPERATION

The battery system is identical for all vehicles covered in this manual and consists of the following circuits and components.

- (A) CIRCUIT 6A** - Connects the batteries to the starter and to the protective control box through circuit 74A.
- (B) BATTERIES** - Two 6TN batteries are connected to provide 24 volts D.C. for the electrical starting system.
- (C) SLAVE RECEPTACLE** - Links an external power source directly to the slaved vehicle's batteries to assist in cranking the engine when the vehicle's batteries are not sufficiently charged.
- (D) SHUNT** - Used when measuring current draw from batteries utilizing STE/ICE-R.
- (E) PROTECTIVE CONTROL BOX** - Protects the vehicle electrical system in the event the battery system polarity is reversed.
- (F) ROTARY SWITCH** - When in "START" position actuates starter solenoid through circuit 11A and 74A. When in "RUN" position closes circuit 29A to activate instrument cluster gages through circuit 27.
- (G) CIRCUIT 7A** - Connects the battery system to the starter negative terminal and chassis ground.
- (H) STARTER SOLENOID** - Actuates starter motor gear to crank vehicle engine.

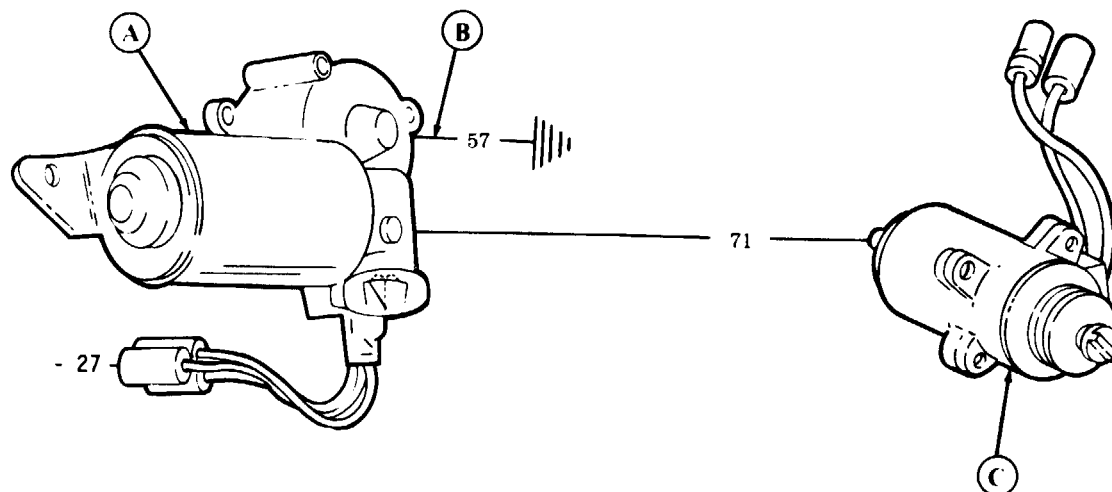




## 1-25. WINDSHIELD WIPER/WASHER SYSTEM OPERATION

The following miscellaneous components and circuits are not covered in any of the other electrical systems:

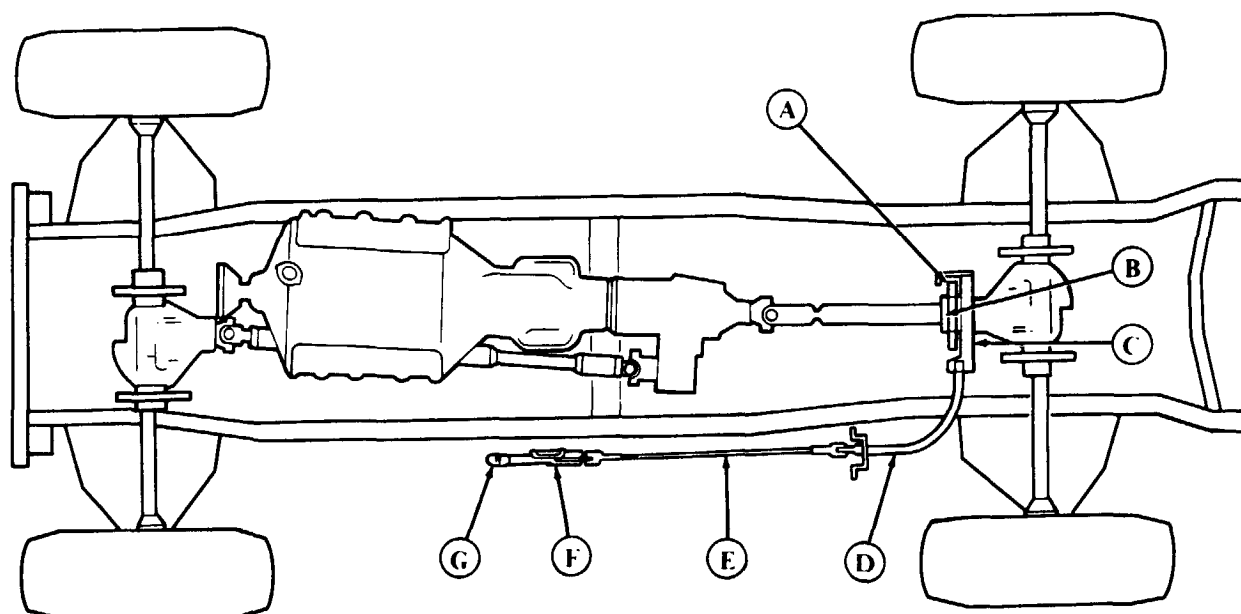
- (A) WINDSHIELD WIPER MOTOR** - When knob is turned to "LOW" or "HIGH" position, circuit 27 carries battery power to wiper motor to activate windshield wipers.
- (B) CIRCUIT 57**- Provides a ground circuit for wiper motor.
- (C) WINDSHIELD WASHER MOTOR** - When knob on wiper motor is pushed, the washer motor is activated through circuit 71 to spray water onto windshield.



## 1-26. PARKING BRAKE SYSTEM OPERATION

The parking brake system for vehicles with serial numbers 1 through 44824 is a mechanically-actuated system that provides a means of keeping the vehicle still once it stops. It also assists in emergency stopping if there is a service brake system failure. Major components of the parking brake system are:

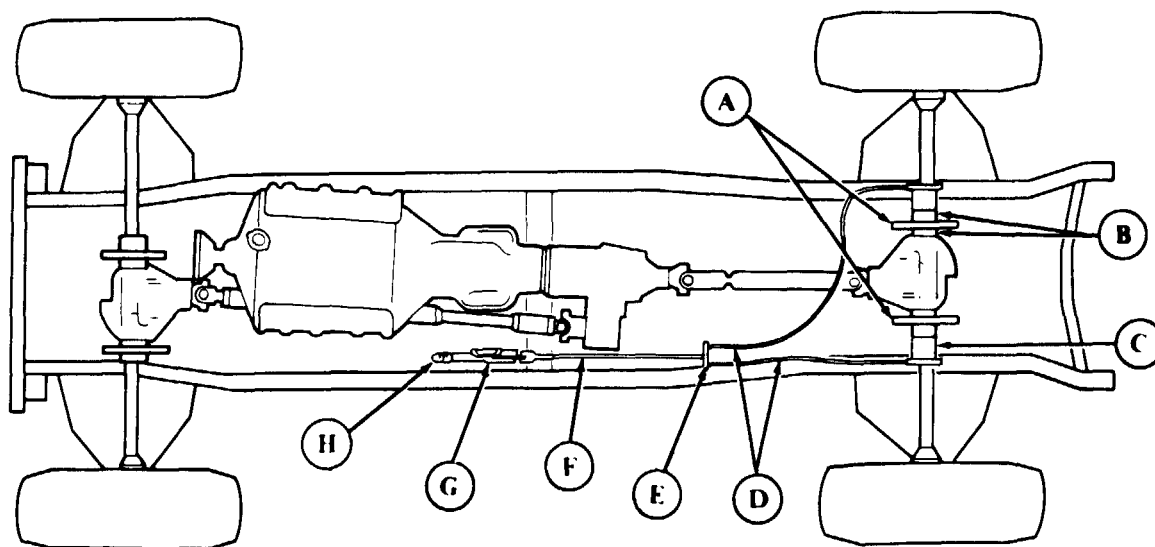
- (A) **PARKING BRAKE ROTOR** - Attached to pinion flange on rear differential, rotor prevents pinion flange from turning when parking brake is applied.
- (B) **BRAKE PADS** - Apply friction to rotor when hand lever is applied.
- (C) **PARKING BRAKE CALIPER** - Forces brake pads against rotor when hand lever is applied.
- (D) **PARKING BRAKE CABLE** - Connects brake caliper to parking brake rod at bracket on left frame rail.
- (E) **PARKING BRAKE ROD** - Connects parking brake hand lever to parking brake cable by means of a adjustable clevis.
- (F) **PARKING BRAKE HAND LEVER** - Permits operator to engage the parking brake.
- (G) **PARKING BRAKE HAND LEVER ADJUSTING CAP** - Permits operator to make minor tension adjustment of parking brake.



## 1-27. SERVICE/PARKING BRAKE SYSTEM OPERATION

The parking brake system is a mechanically-actuated system that provides a means of keeping the vehicle still once it stops. It also assists in emergency stopping if there is a complete service brake system failure. Major components of the parking brake system are:

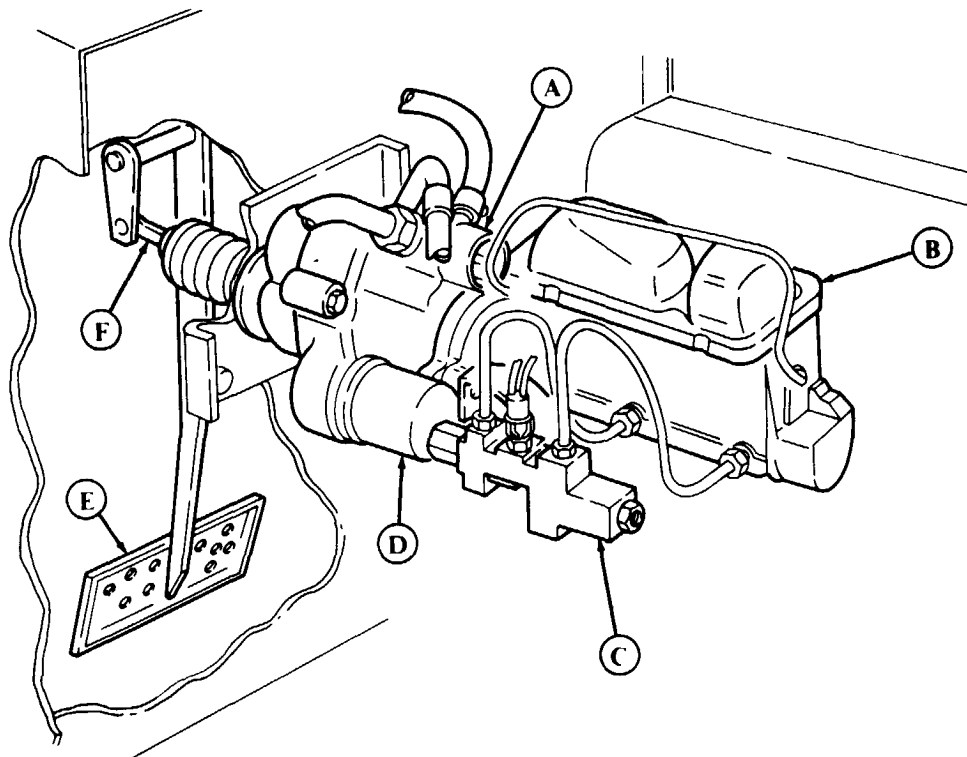
- (A) PARKING BRAKE ROTORS** - Attached to output flanges on rear differential, rotors prevents output flanges from turning when parking brake is applied.
- (B) BRAKE PADS** - Apply friction to rotors when hand lever is applied.
- (C) PARKING BRAKE CALIPERS** - Forces brake pads against rotors when hand lever is applied.
- (D) PARKING BRAKE CABLES** - Connects parking brake hand lever to equalizer bar.
- (E) EQUALIZER BAR** - Evenly distributes braking pressure to the rear brake rotors.
- (F) PARKING BRAKE ROD** - Connects parking brake hand lever to equalizer bar.
- (G) PARKING BRAKE HAND LEVER** - Permits operator to engage the parking brake.
- (H) PARKING BRAKE HAND LEVER ADJUSTING CAP** - Permits operator to make minor tension adjustment of parking brake.



## 1-28. SERVICE BRAKE SYSTEM OPERATION

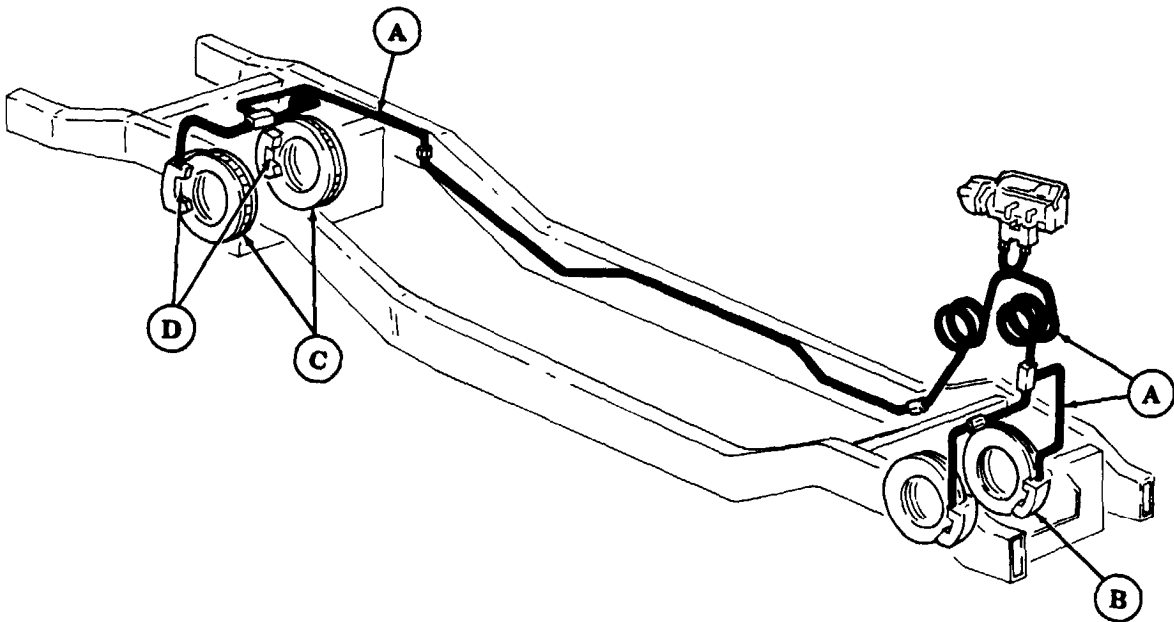
The service brake system is identical for all models covered in this manual. It is an inboard-mounted, four-wheel, disc brake, hydraulically-assisted system. Major components of the braking system are:

- (A) HYDRO-BOOST** - Converts hydraulic power from the steering pump to mechanical power to the master cylinder, providing power assist during braking.
- (B) MASTER CYLINDER/RESERVOIR** - Stores brake fluid, and converts mechanical pedal pressure to hydraulic pressure.
- (C) PROPORTIONING VALVE** - Provides balanced front-to-rear braking and activates brake warning lamp in case of brake system malfunction.
- (D) ACCUMULATOR** - Stores hydraulic pressure for additional power-assisted braking in case of loss of pressure in steering system.
- (E) BRAKE PEDAL** - Provides operator control for stopping vehicle.
- (F) BRAKE LINKAGE** - Directs brake pedal pressure to hydro-boost.



## 1-28. SERVICE BRAKE SYSTEM OPERATION (Cont'd)

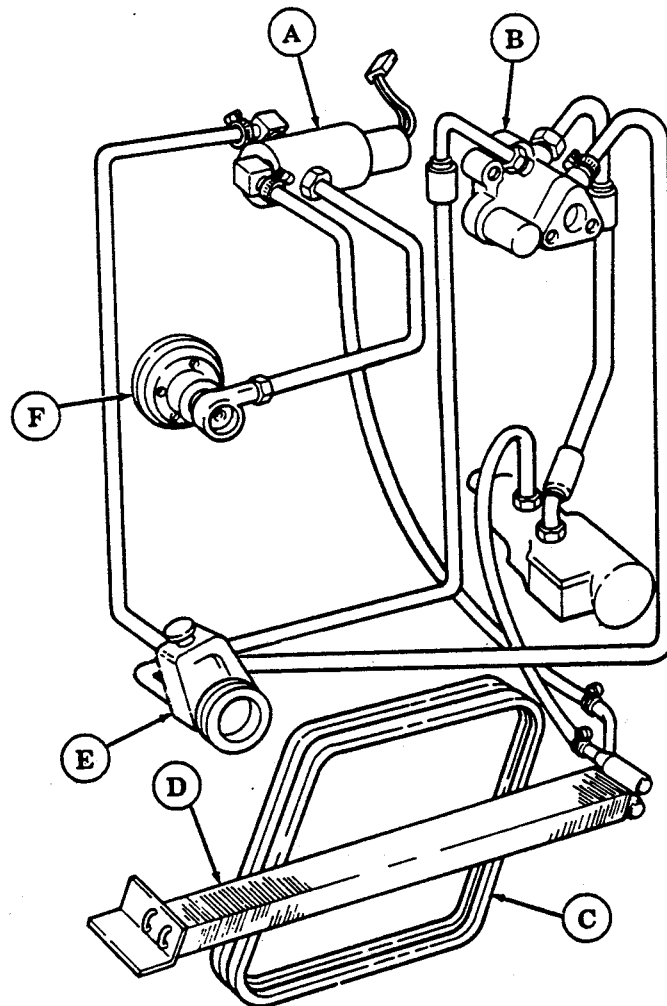
- (A) HYDRAULIC BRAKE LINES** - Directs brakes fluid under pressure to all four brake calipers from master cylinder.
- (B) BRAKE CALIPER** - Converts hydraulic pressure to mechanical force to compress brake pads against brake rotors.
- (C) BRAKE ROTOR** - Attached to output flange on front and rear differentials, rotor prevents output flange from turning when brakes are applied.
- (D) BRAKE PADS** - Apply friction to brake rotor when brake pedal is depressed.



## 1-29. STEERING CONTROL SYSTEM OPERATION

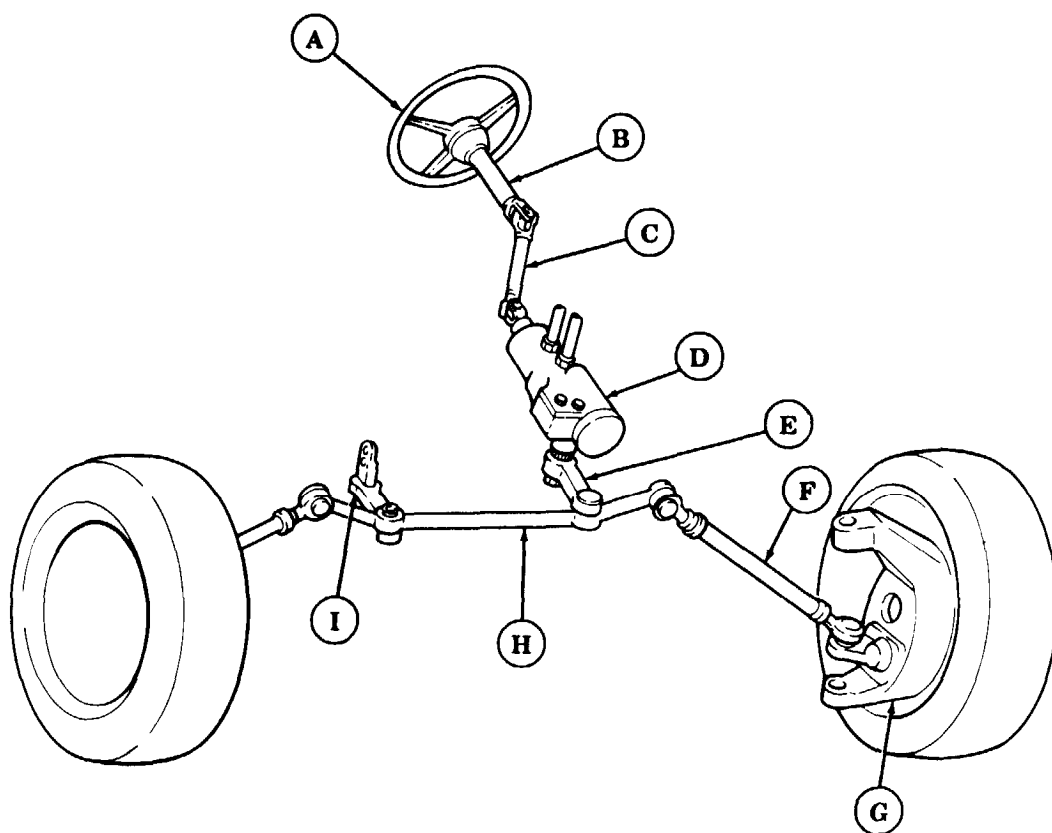
The steering system is identical for all models covered in this manual. Major components of the steering system are:

- (A) **HYDRAULIC CONTROL VALVE** – Directs hydraulic fluid to provide required pressure to actuate and deactuate fan clutch as required by engine temperature. Hydraulic pressure supplied by power steering pump.
- (B) **HYDRO-BOOST** – Converts hydraulic power from the steering pump to mechanical power to the master cylinder, providing power assist during braking.
- (C) **ACCESSORY DRIVE PULLEY BELTS** – Transmits mechanical driving power from crankshaft drive pulley to steering pump pulley which drives the steering pump.
- (D) **POWER STEERING COOLER** – Directs power steering fluid through a series of fins or baffles so outside air can dissipate excess heat before the fluid is recirculated through the steering system.
- (E) **OIL RESERVOIR AND STEERING PUMP** – Combined in one unit, the reservoir serves as an oil filling point and the pump supplies the oil under pressure throughout the steering system.
- (F) **FAN CLUTCH** – Hydraulically actuated and deactuated by the hydraulic control valve. The fan is actuated when hydraulic pressure is released, and deactuated when hydraulic pressure is applied. Hydraulic pressure is supplied by the power steering pump.



## 1-29. STEERING CONTROL SYSTEM OPERATION (Cont'd)

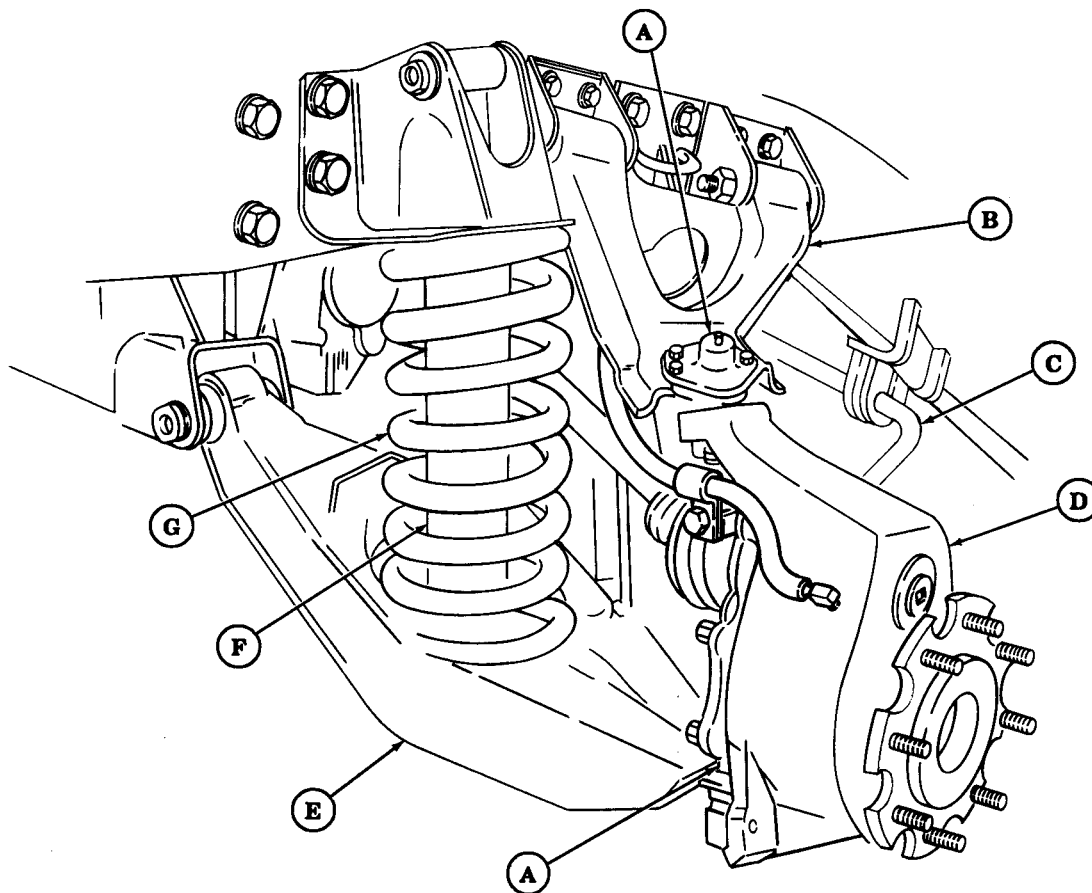
- (A) STEERING WHEEL** - Serves as manual steering control for the operator.
- (B) STEERING COLUMN** - Transmits turning effort from steering wheel to intermediate steering shaft.
- (C) INTERMEDIATE STEERING SHAFT** - Permits angle of torque from steering column to input shaft of power steering gear.
- (D) STEERING GEAR** - Converts hydraulic power from steering pump to mechanical power at pitman arm.
- (E) PITMAN ARM** - Transfers steering torque from power steering gear to center link.
- (F) TIE ROD ASSEMBLY** - Transmits movement from center link to geared hub.
- (G) GEARED HUB** - Serves as the pivot point and link for the front wheels via the tie rod assembly.
- (H) CENTER LINK** - Transmits movement from pitman arm to tie rods.
- (I) IDLER ARM** - Supports right side of center link.



## 1-30. SUSPENSION SYSTEM OPERATION

The suspension system is identical for all models covered in this manual. It is an independent coil spring type system. Major components of the suspension system are:

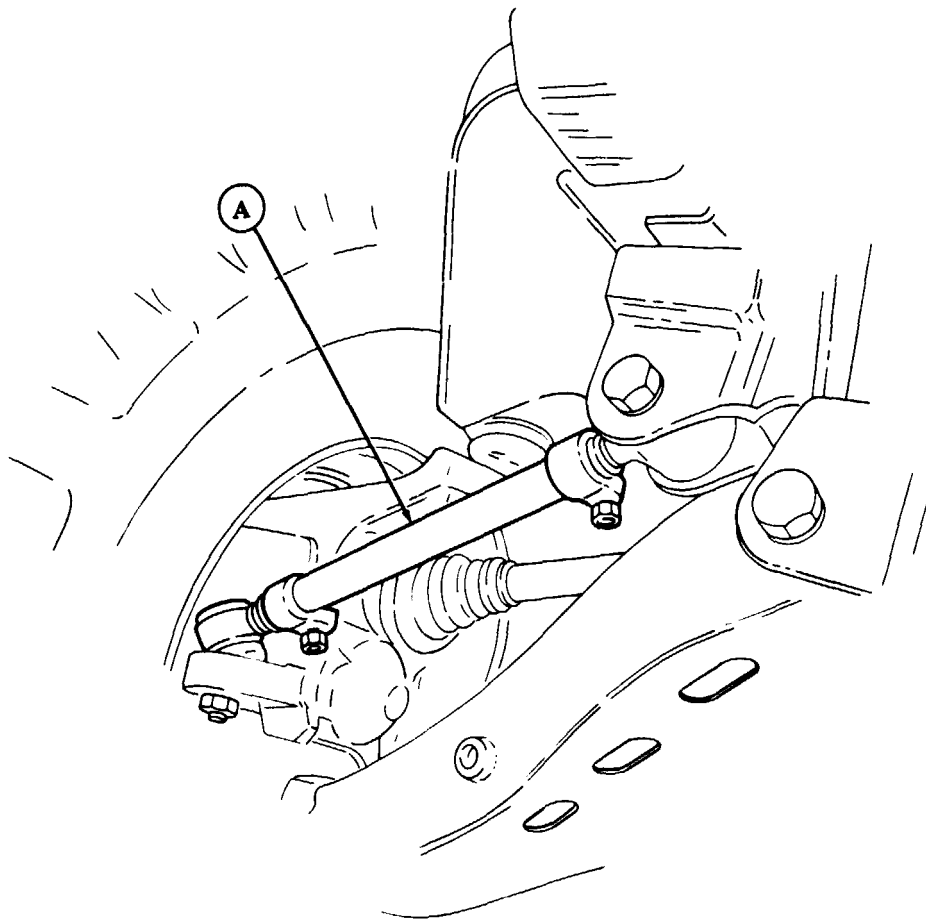
- (A) **BALL JOINTS** – Connects geared hub to control arms, and allows change of angle between geared hub and control arms during suspension movement.
- (B) **UPPER CONTROL ARM** – Connects geared hub to frame rail.
- (C) **STABILIZER BAR (FRONT ONLY)** – Prevents vehicle sway when cornering.
- (D) **GEARED HUB** – Serves as a mounting point for wheel and tire assembly and provides 1.92:1 gear reduction to increase torque to wheel and tire assembly.
- (E) **LOWER CONTROL ARM** – Connects geared hub to frame rail.
- (F) **SHOCK ABSORBER** – Dampens suspension movement and limits amount of suspension travel.
- (G) **COIL SPRING** – Supports weight of vehicle and allows suspension travel to vary depending on terrain and vehicle loading.





### 1-30. SUSPENSION SYSTEM OPERATION (Cont'd)

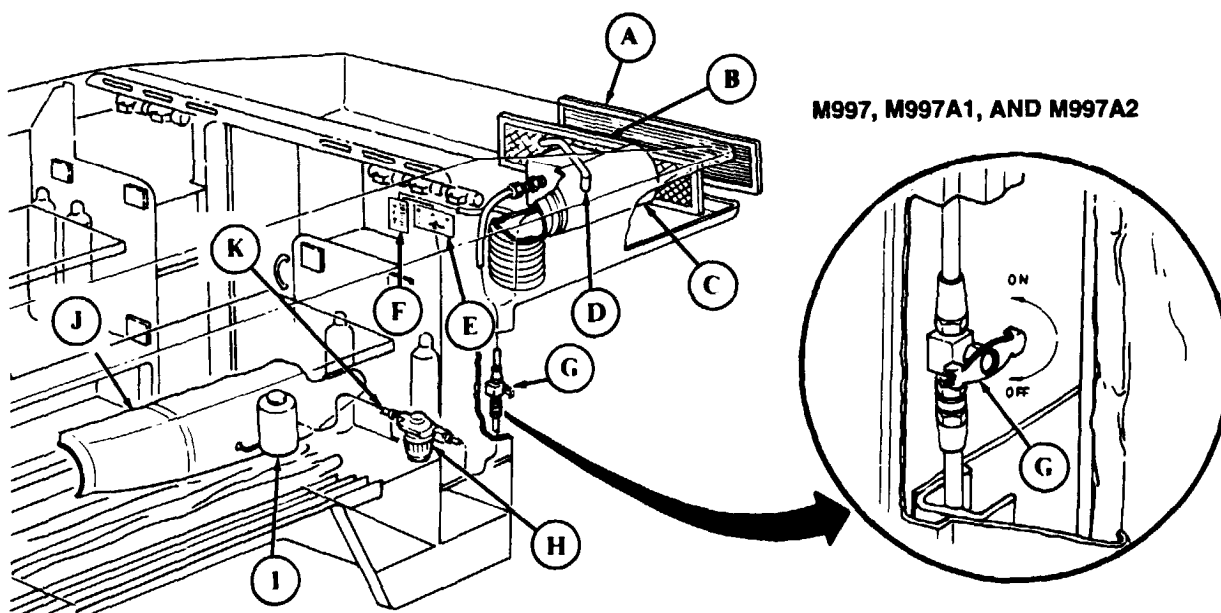
- (A) RADIUS ROD (REAR ONLY)** - Connects geared hub to frame, to maintain rear end alinement.



## 1-31. AMBULANCE PATIENT COMPARTMENT FUEL BURNING HEATER SYSTEM OPERATION

The ambulance patient compartment fuel burning heater in the M996, M996A1, M997, M997A1, and M997A2 vehicles are similar in that they are multi-fuel burning and heat filtered fresh air. Major components of the fuel burning heater system are:

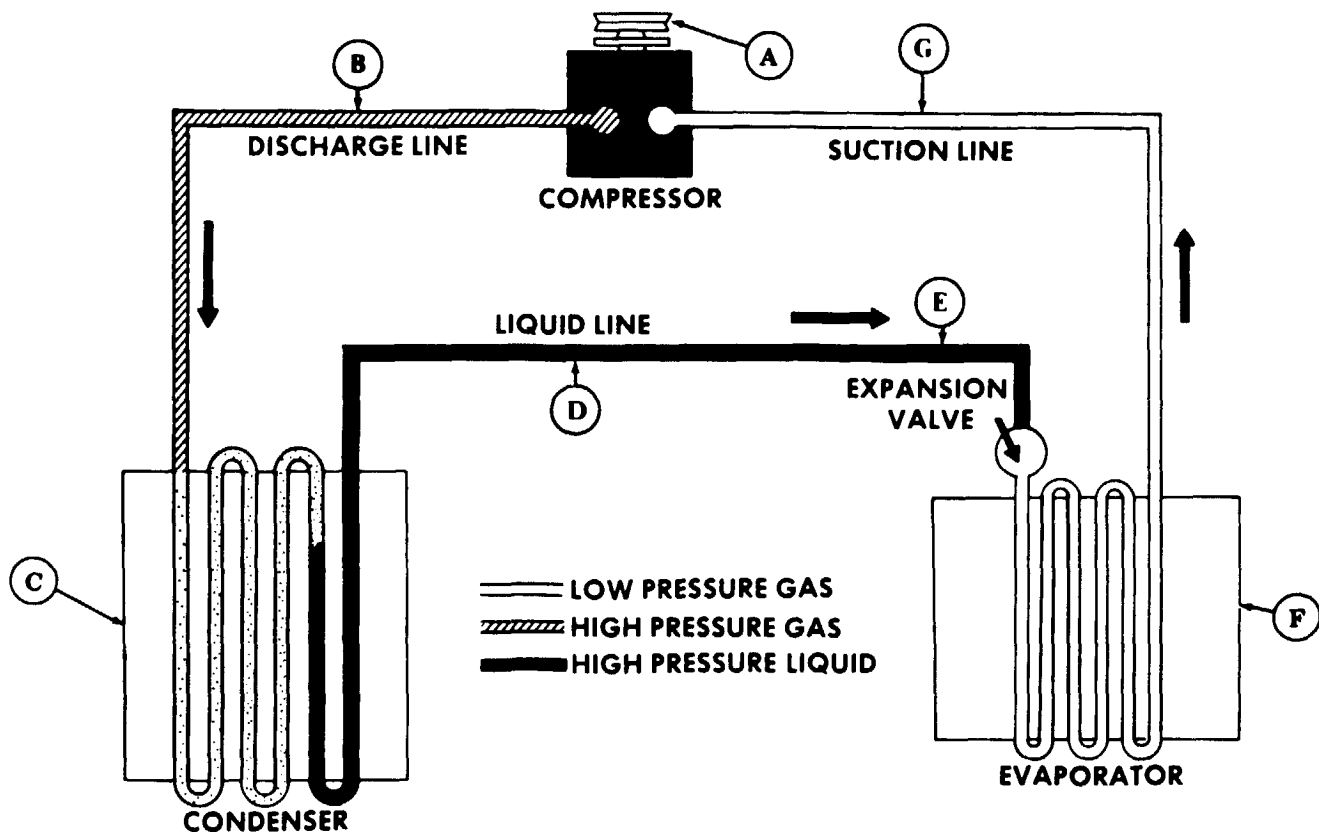
- (A) FRESH AIR INTAKE GRILLE** — The entry point of fresh air for the heater and ventilation system. The grille stops large debris from entering the system.
- (B) FRESH AIR FILTER** — Filters out dust and dirt which could foul the system.
- (C) FUEL BURNING HEATER** — A self-contained heater/blower unit which heats filtered fresh air with a heat exchanger and forces it out to heat vents in the patient compartment.
- (D) HEATER EXHAUST PIPE** — Outlet for exhaust gases from fuel burning heater.
- (E) HEATING/VENTILATION AND AIR-CONDITIONING SYSTEM (HVAC) CONTROL BOX** — The central point of operation for fuel burning heater.
- (F) ELECTRICAL SYSTEM FUSE BOX** — Provides electrical overload protection for the HVAC system.
- (G) MANUAL SHUTOFF VALVE** — Stops fuel flow to heater in an emergency or when performing maintenance on the heater.
- (H) FUEL FILTER** — Filters contaminants out of the fuel for efficient burning.
- (I) FUEL PUMP** — Pumps fuel out of the fuel tank and provides fuel pressure to the rest of the system. Pump will not draw fuel if tank is below 1/4 tank.
- (J) FUEL TANK** — The supply point of fuel for fuel burning heater.
- (K) FUEL LINES** — Supply fuel to the fuel burning heater.



## 1-32. M997, M997A1, AND M997A2 AMBULANCE AIR-CONDITIONING SYSTEM OPERATION

The air-conditioning system covered in this manual applies only to the M997, M997A1, and M997A2 vehicles and consists of the following major components:

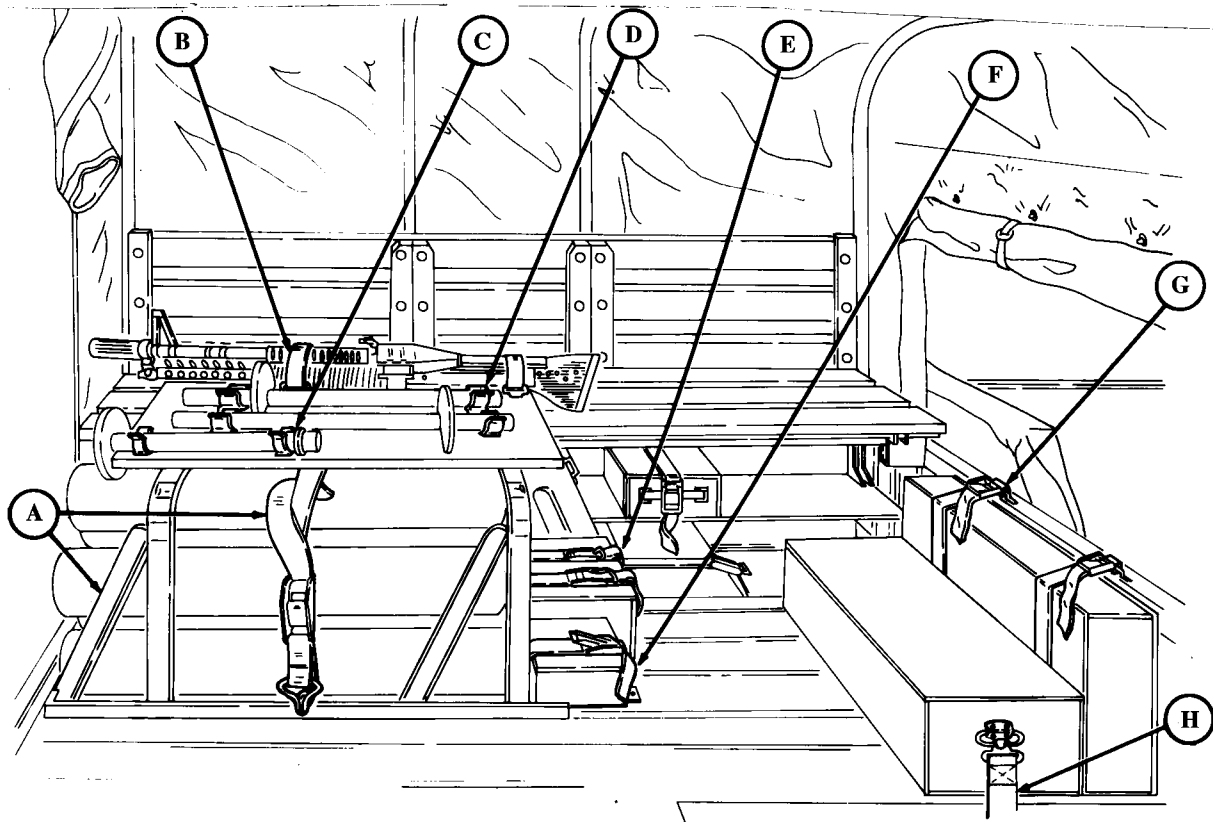
- (A) **COMPRESSOR** - Inside the compressor, low pressure gas refrigerant is compressed into a high pressure gas that is pushed into the condenser by the compressor.
- (B) **DISCHARGE LINE** - High pressure gas is carried through the discharge line from the compressor to the condenser.
- (C) **CONDENSER** - Refrigerant enters the condenser as a high pressure gas. When condensed, it gives up its heat to the outside air and becomes a high pressure liquid.
- (D) **LIQUID LINE** - High pressure liquid refrigerant is carried back to the evaporator by the liquid line to repeat the evaporation/condensation cycle.
- (E) **EXPANSION VALVE** - High pressure liquid refrigerant enters a non-adjustable expansion valve where the refrigerant is formed into a liquid spray.
- (F) **EVAPORATOR** - Refrigerant enters evaporator as a liquid spray. It absorbs heat from the air in the patient compartment and vaporizes into a low pressure gas.
- (G) **SUCTION LINE** - Refrigerant in low pressure gas form is drawn from the evaporator by the suction action of the compressor.



### 1-33. STOWAGE RACKS AND TIEDOWN STRAPS

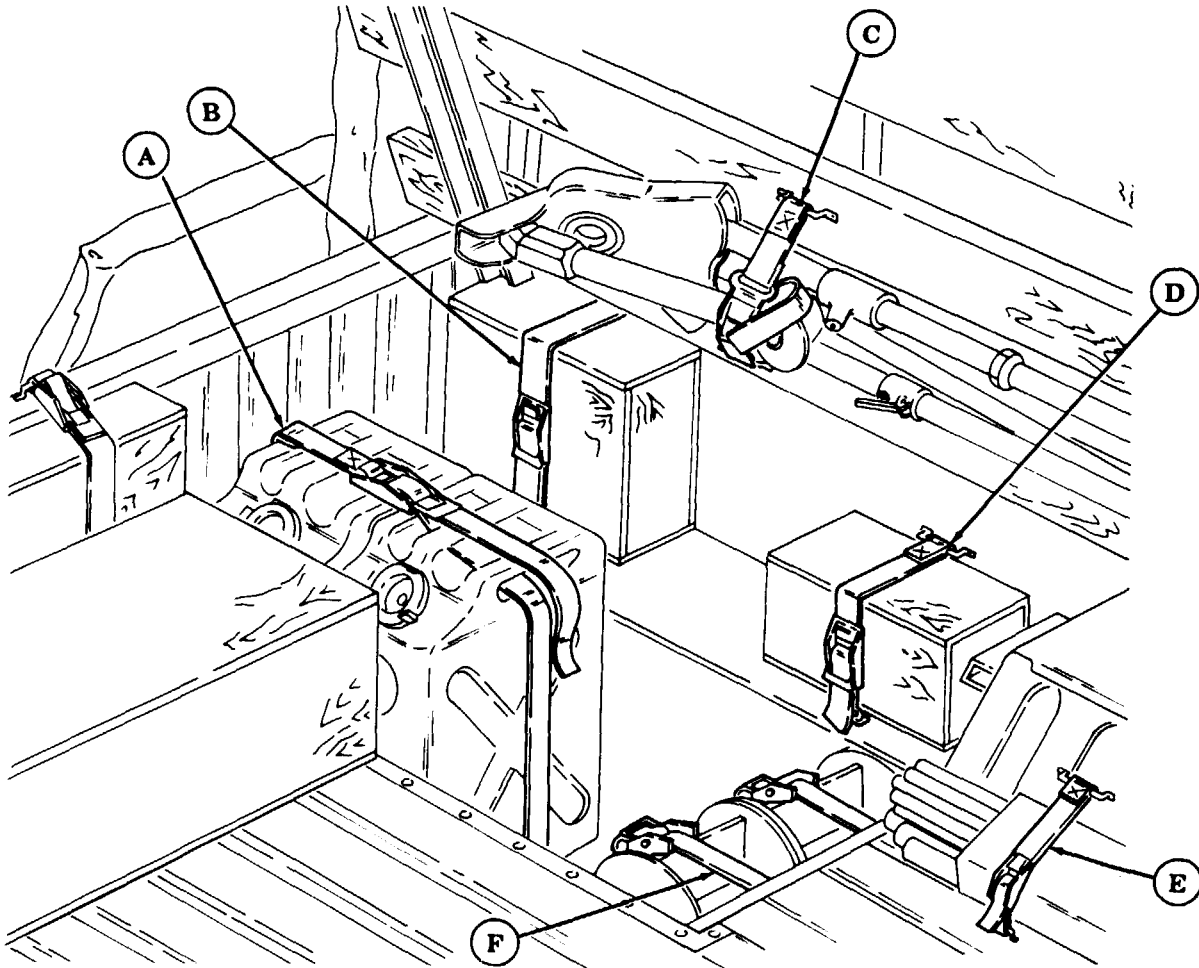
The stowage racks and tiedown straps covered in this manual apply to the M1097, M1097A1, M1097A2, and M1123 vehicles and consist of the following major components:

- (A) **AMMO STOWAGE RACK AND AMMO STRAP ASSEMBLY** — Provides stowage for twenty-two ammunition rounds during transportation and allows quick access to rounds during reload operations.
- (B) **M60 MACHINE GUN STRAPS** (two each) — Secure M60 machine gun on top of ammo rack.
- (C) **JACK STRUT SPRING CLIPS** (two each) — Secure jack strut on top of ammo rack.
- (D) **PARALLELOSCOPE SPIKE CLIPS** (four each) — Secure two aiming stacks on top of ammo rack.
- (E) **SIGHT BOX #1 STRAPS** (two each) — Secure sight box #1 to cargo floor in front of ammo rack.
- (F) **SIGHT BOX #2 STRAP** — Secure sight box #2 to cargo floor in front of ammo rack.
- (G) **SPADE STRAPS** (two each) — Secure spade on cargo floor and against cargo bulkhead.
- (H) **SECTION CHEST STRAPS** (two each) — Secure section box on cargo floor.



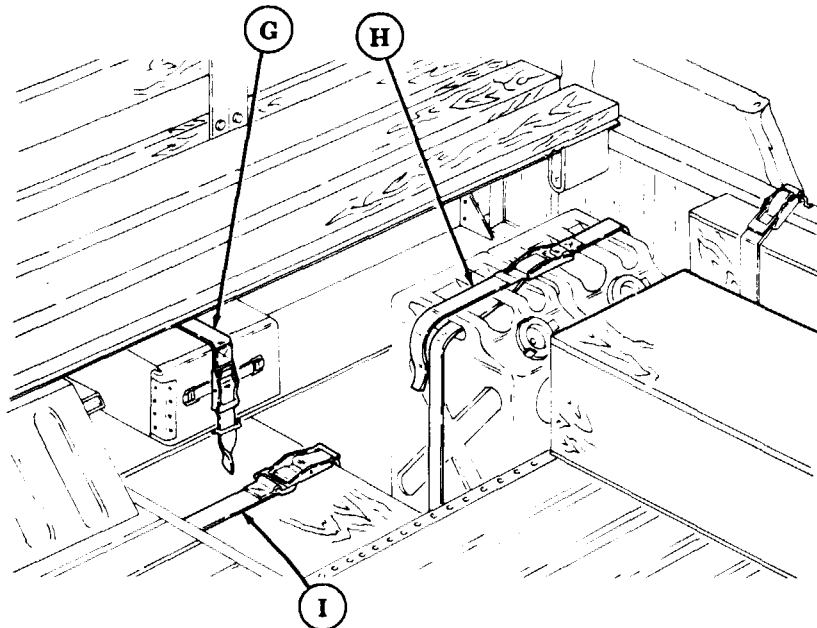
### 1-33. STOWAGE RACKS AND TIEDOWN STRAPS (Cont'd)

- (A) FUEL CAN STRAP** - Secures fuel cans to cargo bulkhead in front of right footwell.
- (B) REMOTE STRAP** - Secures remote to right fixed door behind companion seat.
- (C) TRIPOD STRAPS (two each)** - Secure tripod to bottom of troop seat.
- (D) TELEPHONE STRAP** - Secures telephone to right fixed door in front of wheelhouse.
- (E) PARALLELOSCOPE AIMING POST STRAPS (three each)** - Secure paralleloscope and aiming posts to cargo floor and right wheelhouse.
- (F) CABLE REEL STRAPS (two each)** - Secure cable reels to right footwell in front of wheelhouse.

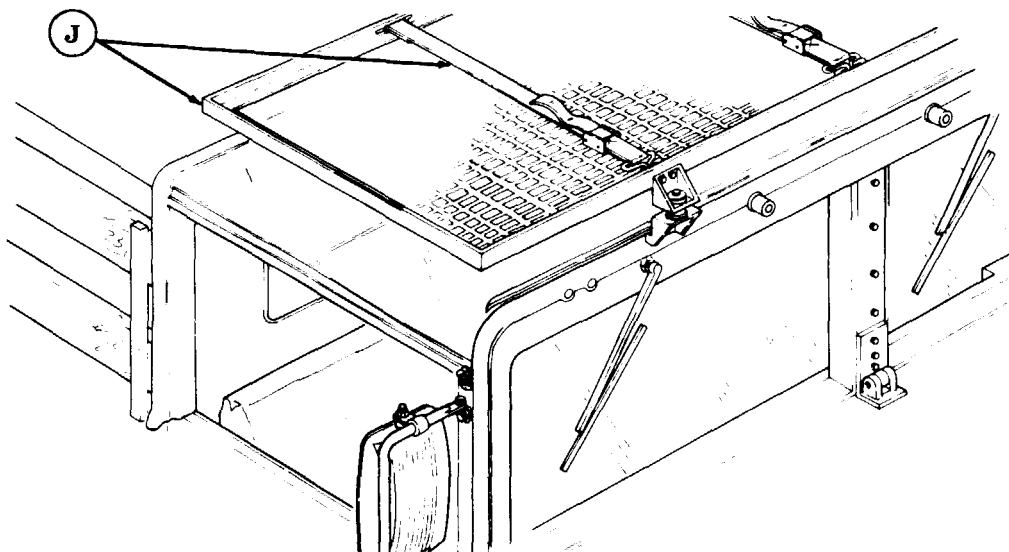


**1-33. STOWAGE RACKS AND TIEDOWN STRAPS (Cont'd)**

- (G) G.D.U. BATTERY STRAP** - Secures G.D.U. battery to left fixed door in front of wheelhouse.
- (H) WATER CAN STRAP** - Secures water cans to cargo bulkhead in front of left footwell.
- (I) G.D.U. BOX STRAP** - Secures G.D.U. to left footwell in front of wheelhouse.



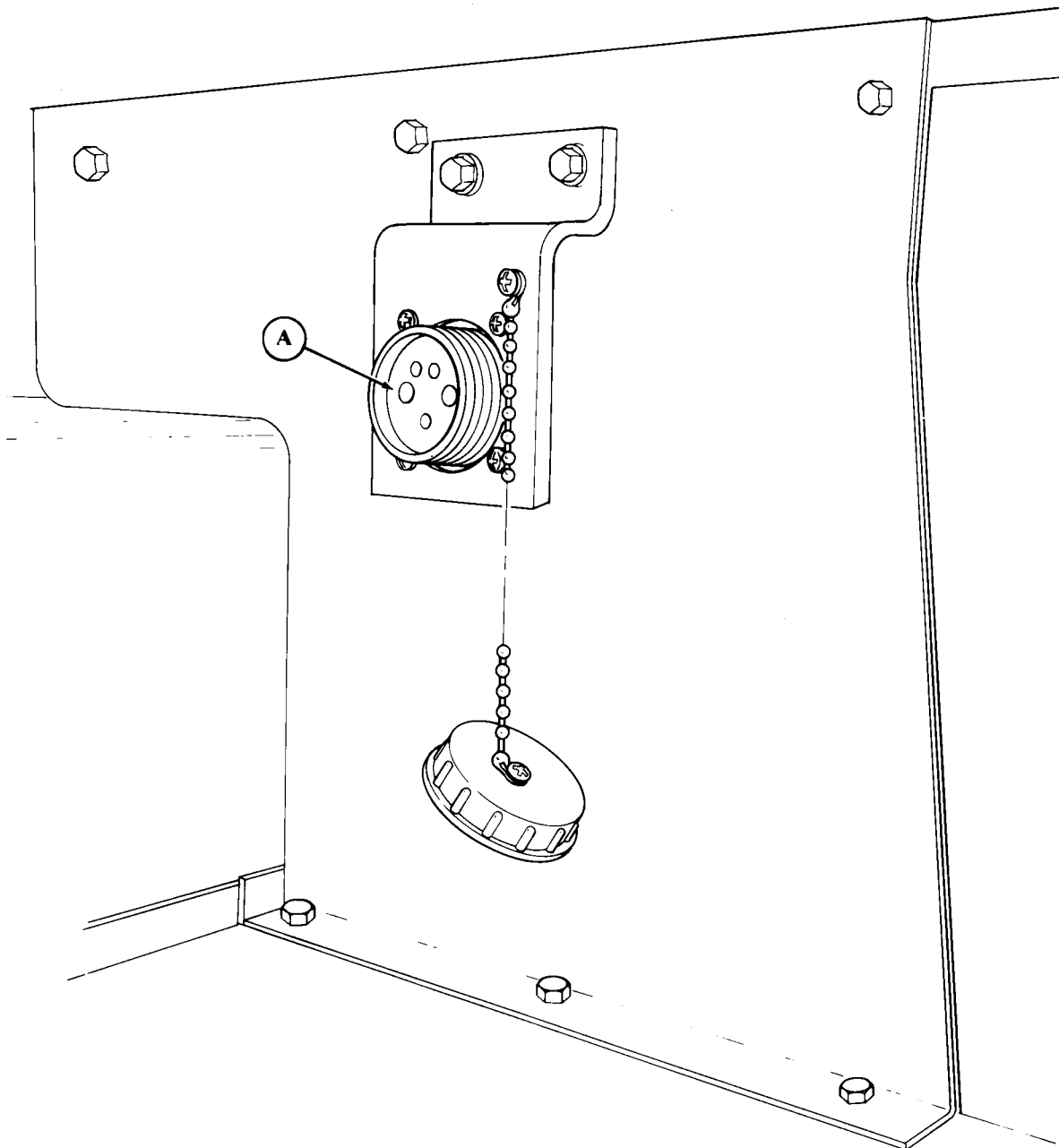
- (J) CAMOUFLAGE STOWAGE RACK AND STRAPS (three)** - Provide stowage for camouflage screen and support system during transportation.



## 1-34. 200 AMPERE UMBILICAL POWER CABLE

The 200 ampere umbilical power cable covered in this manual applies to the M1097A2 and M1123 vehicles and consists of the following major component.

- Ⓐ **POWER CABLE** - Located behind the companion seat provides power for shelter equipment.



## CHAPTER 2

### SERVICE AND TROUBLESHOOTING INSTRUCTIONS

#### Section I. REPAIR PARTS, SPECIAL TOOLS, TEST, MEASUREMENT DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT

##### 2-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

##### 2-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Special Tools, Test, Measurement, Diagnostic Equipment (TMDE), and Support Equipment used to maintain the vehicles covered in this manual can be found in TM 9-2320-280-24P.

##### 2-3. REPAIR PARTS

Repair parts are listed and illustrated in TM 9-2320-280-24P.

#### Section II. SERVICE UPON RECEIPT

##### 2-4. GENERAL

**a.** Upon receipt of a new, used, or reconditioned vehicle, you must determine if the vehicle has been properly prepared for service. The following steps should be followed:

- (1)** Inspect all assemblies, subassemblies, and accessories to be sure they are in proper working order.
  - (2)** Secure, clean, lubricate, or adjust as needed.
  - (3)** Check all Basic Issue Items (TM 9-2320-280-10) to be sure every item is present, in good condition, and properly mounted, or stowed.
  - (4)** Follow general procedures for all services and inspections given in TM 9-2320-280-10.
- b.** The operator will assist when performing service upon receipt inspections.
- c.** See TM 9-2320-280-10 when checking equipment for proper operation.
- d.** Refer to TM 9-2320-280-10 for information concerning brake-in procedures.

##### 2-5. GENERAL INSPECTION AND SERVICING INSTRUCTIONS

The following steps should be taken while performing general inspection and services:

##### NOTE

Cooler fin and engine protective covers can be used to prevent damage to the vehicle components during maintenance. Refer to Appendix D for fabrication instructions.

- (1)** Use TM 9-2320-280-10 as well as other sections of this manual, when servicing and inspecting equipment.

##### WARNING

Drycleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel and/or damage to equipment.

- (2)** Clean all exterior surfaces coated with rust-preventive compounds. Use drycleaning solvent (Appendix C, Item 18).



(3) Clean fittings before lubrication. Clean parts with drycleaning solvent (SD), type II, or equivalent. Dry before lubricating. Relubricate all items found contaminated after fording.

### **WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment such as goggles or shield, gloves, etc.

### **NOTE**

Use compressed air to dry electrical components. Use sealing compound (Appendix C, Item 40) before reconnecting plugs.

(4) Inspect electrical connectors for corrosion and/or damage (i.e., bent pins). Clean and repair damage. Clean electrical components with clean cloth dampened with drycleaning solvent. Care must be taken not to damage protective insulation.

(5) Read "Processing and Deprocessing Record of Shipping, Storage, and Issue of Vehicles and Spare Engines," tag (DD Form 1397) and follow all precautions listed. This tag should be attached to steering wheel, steering column, or rotary switch.

## **2-6. SPECIFIC INSPECTION AND SERVICING INSTRUCTIONS**

The following steps should be taken while performing specific inspections and services:

- (1) Do the Semiannual (S) preventive maintenance checks and services listed in Section III in this chapter.
- (2) Lubricate the vehicle. Do not lubricate gear cases and engine unless processing tag states that the oil is unsuitable for 500 mi (805 km) operation. If oil is suitable, just check level.
- (3) Schedule semiannual service on DD Form 314 (Preventive Maintenance Schedule and Record Card).
- (4) If vehicle is delivered with a dry charged battery, activate it according to TM 9-6140-200-14.
- (5) Check vehicle coolant level and determine if solution is proper for climate (refer to TB 750-651 for preparation of antifreeze solutions).
- (6) Remove towing brackets from their stowed position behind the bumper and install them in their proper location (para. 9-2, 9-3, or 9-4).
- (7) Remove front lifting shackles from stowed position under passenger seat and install on towing brackets (para. 9-13).

## **Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES**

### **2-7. GENERAL**

The best way to maintain vehicles covered by this manual is to inspect them on a regular basis so minor faults can be discovered and corrected before they result in serious damage, failure, or injury. All intervals are based on normal operation. Hard time intervals may be shortened if your lubricants are contaminated or if you are operating the equipment under adverse conditions, including longer-than-usual operating hours. Hard time intervals may be extended during periods of low activity, though adequate preservation precautions must be taken. This section contains systematic instructions of inspection, adjustment, lubrication, and correction of vehicle components to avoid costly repairs or major breakdowns. This is Preventive Maintenance Checks and Services (PMCS).

### **2-8. INTERVALS**

a. Unit maintenance, assisted by operator/crew, will perform checks and services contained in Table 2-1 at the following intervals:

- (1) **Semiannually (S).** Every 6 months or 3,000 miles (4,800 km), whichever comes first.
- (2) **Annually (A).** Every 12 months or 6,000 miles (9,654 km), whichever comes first.
- (3) **Biennially (B).** Every 24 months or 12,000 miles (19,308 km), whichever comes first.

b. Refer to following steps when performing lubrication checks and services:

(1) **Intervals.** Lubrication services coincide with the vehicle's Semiannual (S) Preventive Maintenance Service. For this propose, a 10% tolerance (variation) in specified lubrication point mileage is permissible. Those vehicles not accumulating 1,000 mi (1,609 km) in a 6-month period will be lubricated at the time of (S) Preventive Maintenance Service.

(2) **Army Oil Analysis Program (AOAP).** HMMWV engines and transmissions are enrolled in the Army Oil Analysis Program (AOAP). The sampling interval for the engine is every six months or 3,000 miles, or 100 hours (if hour meter is installed) of operation. For the transmission, the sampling interval is every 12 months or 6,000 miles, or 300 hours (if hour meter is installed) of operation.

(3) **For Operation of Equipment in Protracted Cold Temperatures Below -15°F (-26°C).** Remove lubricants prescribed in lubrication table for temperatures above -15°F (-26°C). Relubricate with lubricants specified in lubrication table for temperatures below -15°F (-26°C). If OEA lubricant is required, see the temperature ranges prescribed in the lubrication table. OEA lubricant is to be used in place of OE/HDO 10 lubricant for all temperature ranges where OE/HDO 10 is specified in the lubrication table.

c. Perform all (S) inspections in addition to (A) inspections at the time of the annual inspection. Perform all (A) and (S) inspections in addition to (B) inspections at the time of the biennial inspection.

## 2-9. REPORTING REPAIRS

All vehicle shortcomings will be reported on DA Form 2404 Equipment Inspection and Maintenance Worksheet or DA Form 5988-E (automated) (DA Pam 738-750) immediately after the PMCS, and before taking corrective action. All vehicle deficiencies will be reported in the equipment record.

## 2-10. GENERAL SERVICE AND INSPECTION PROCEDURES

a. While performing specific PMCS procedures, make sure items are correctly assembled, secure, not worn, serviceable, not leaking, and adequately lubricated as defined below.

(1) An item is **CORRECTLY ASSEMBLED** when it is in proper position and all parts are present.

(2) When wires, nuts, washers, hoses, or attaching hardware cannot be moved by hand, or wrench, they are **SECURE**.

(3) An item is **WORN** if there is too much play between joining parts or when marking data, warning, and caution plates are not readable.

(4) An item is **UNSERVICEABLE** if it is worn beyond repair and is likely to fail before the next scheduled inspection.

(5) **LEAKS.** TM 9-2320-280-10 contains definitions of Class I, II, and III leaks and their effect on vehicle operation.

(6) If an item meets the specified lubrication requirements, then it is **ADEQUATELY LUBRICATED**.

b. Where the instruction "tighten" appears in a procedure, you must tighten with a wrench to the given torque value even when the item appears to be secure.

### **WARNING**

Drycleaning solvent is flammable and will not be used near an open flame. A fire extinguisher will be kept nearby when the solvent is used. Use only in well-ventilated places. Failure to do this may result in injury to personnel, and/or damage to equipment.

c. Where the instruction "clean" appears in a procedure, you must use drycleaning solvent (Appendix C, Item 18) to clean grease or oil from metal parts. After the item is cleaned, rinsed, and dried, apply a light grade of oil to unprotected surfaces to prevent rusting.

d. Clean rubber and plastic materials with soap and water. Refer to TM 9-2320-280-10 for general vehicle cleaning instructions.

## 2-11. SPECIFIC PMCS PROCEDURES

a. The preventive maintenance for which you are responsible is provided in Table 2-1. The checks and services listed are arranged in logical order requiring minimal time and effort on your part.

b. The following columns read across on the PMCS schedule:

(1) **Item Number.** Provides logical order of PMCS performance and is used as a source number for DA Form 2404, on which your PMCS results will be recorded.

(2) **Intervals.** Shows the interval next to each item number to indicate when that check is to be performed. The interval will be repeated when consecutive item numbers are to be inspected during the same interval. Interval columns include:

(a) Semiannual (six month) checks;

(b) Annual (yearly) checks; and

(c) Biennial (every two years) checks.

(3) **Item To Be Inspected.** Lists the system, common name, or location of the item to be inspected.

(4) **Procedures.** Provides instructions for servicing, inspection, lubrication, replacement, or adjustment, and in some cases, having item repaired at a higher level.

### NOTE

Always do your preventive maintenance checks and services in the order prepared. Once it gets to be a habit, you will be able to spot anything wrong in a hurry.

(5) **Not Fully Mission Capable.** If vehicle meets criteria in this column, vehicle is not mission capable (NMC).

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
1	Semi-Annual	Pre-Service Checks	<p><u>PRIOR TO ROAD TEST</u></p> <p>Ensure Operator/Crew has performed PMCS listed in TM 9-2320-280-10.</p> <p><u>ROAD TEST</u></p> <p>Maintenance personnel will be with vehicle operator to assist in performing PMCS checks and verify pre-service checks.</p> <p><b>a.</b> Notice if starter engages smoothly and turns the engine at normal cranking speed.</p> <p><b>b.</b> Listen for unusual noise at idle, at operating speed, and under acceleration. Be alert for excessive vibration and the smell of oil, fuel, and exhaust.</p> <p><b>c.</b> Check for transmission response to shifting and for smoothness of operation in all gear ranges. Be alert for unusual noises and difficulty in shifting in any speed range.</p> <p><b>NOTE</b></p> <p>If desired range cannot be selected, turn engine off, select range, and re-start engine.</p> <p><b>d.</b> Check for transfer response to shifting and for smoothness of operation in all gear ranges. Be alert for unusual noises and difficulty in shifting in any gear range.</p> <p><b>e.</b> Test for response to accelerator feed. Observe for sticking pedal.</p> <p><b>f.</b> With vehicle speed approximately 5 mph (8 kph) turn steering wheel to left, then right, to detect hard steering, steering backlash, or shimmy. Vehicle should respond instantly. With vehicle moving on straight, level terrain, lightly hold steering wheel to check for pull and wandering.</p> <p><b>g.</b> Apply brake pedal with steady force. Vehicle should slow and stop without pulling to one side or jerking. Release brake pedal. The brakes should release immediately and without difficulty.</p>	<p><b>a.</b> Starter inoperative or makes excessive grinding sound.</p> <p><b>b.</b> Engine knocks, rattles, or smokes excessively.</p> <p><b>c.</b> Transmission shifts improperly, does not shift, or makes excessive noises.</p> <p><b>d.</b> Lever inoperable or does not engage in all ranges with engine not running.</p> <p><b>e.</b> Pedal sticking or binding.</p> <p><b>f.</b> Steering binds, grabs, wanders, or has excessive freeplay.</p> <p><b>g.</b> Brakes chatter, pull to one side, or inoperative. Brakes will not release.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Semites HMMWV (Cont'd)

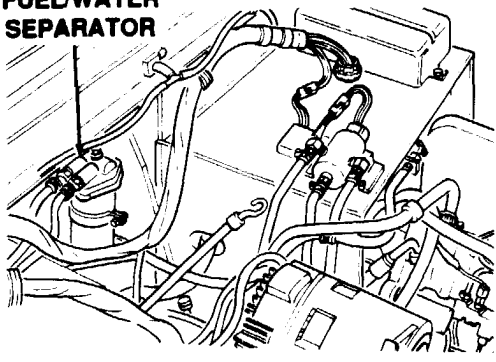
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
1	Semi-Annual	Pre-Service Checks (Cont'd)	<p><b>h.</b> Bring vehicle to full stop. Engage parking brake while transmission is still in "D" (drive) or "D" (overdrive) for A2 series vehicles. Vehicle should remain stationary.</p> <p><b>i.</b> Observe vehicle response to road shock. Side sway or continuous bouncing indicates a malfunction.</p>	<b>h.</b> Parking brake doesn't hold vehicle stationary.
2	Semi-Annual	Body	<p><b>AFTER ROAD TEST</b></p> <p><b>a.</b> Make sure the vehicle has been cleaned of mud, gravel, etc., from the underbody, outside, and crew compartment area.</p> <p><b>b.</b> Thoroughly wash all underbody sheet metal panels and corners.</p> <p><b>NOTE</b> Lubricate vehicle in accordance with Lubrication Table.</p> <p><b>c.</b> Inspect for loose rivets, cracks, loose or missing bolts and general body damage.</p>	<b>c.</b> Any body damage that would hinder vehicle operation.
3	Semi-Annual	Fuel System	<p><b>a.</b> Inspect fuel filter/water separator assembly for dents and cracks that could cause leaks.</p> <p><b>b.</b> Inspect fuel injection pump, nozzle lines, and fittings for leaks and damage.</p> <p><b>c.</b> Inspect rear fuel injector nozzle rubber cap for presence and condition.</p> <p><b>FUEL/WATER SEPARATOR</b></p> 	<p><b>a.</b> Any class III fuel leak.</p> <p><b>b.</b> Any class III leak. Any nozzle loose or damaged.</p> <p><b>c.</b> Rubber cap missing or damaged.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

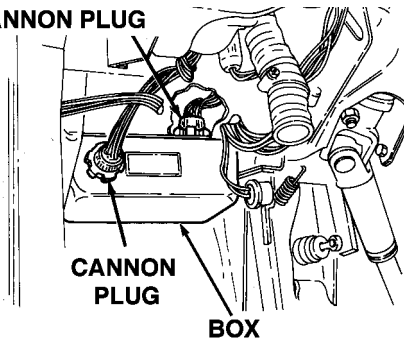
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
3	Semi-Annual	Fuel System (Cont'd)	<p><b>d.</b> Inspect all fuel lines for loose connections, splits, cracks, and bends that could leak.</p> <p><b>e.</b> Disconnect leads from each glow plug (paragraph 3-38) and check for resistance between glow plug terminal and ground. Continuity should be present.</p> <p><b>f.</b> Check each glow plug for looseness and damage. Tighten each plug to 8-12 lb-ft (11-16 N·m).</p> <p><b>g.</b> Check locknut on body mounts. Proper torque 90 lb-ft (122 N·m).</p> <p><b>h.</b> Check the fuel tank for propeller shaft rub marks and damage. Ensure straps are properly installed in fuel tank slots. Tighten strap locknuts to 23-27 lb-in. (2.6 - 3 N·m).</p>	<p><b>d.</b> Any class III leak.</p> <p><b>e.</b> Continuity is not present.</p> <p><b>f.</b> Glow plugs are loose or damaged.</p> <p><b>g.</b> Body mounts loose.</p> <p><b>h.</b> Any class III fuel leak or tank strap improperly installed or loose.</p>
4	Semi-Annual  Belt	Engine Accessory Drive and Serpentine	<p><b>a.</b> Check for missing, broken, cracked, and frayed drivebelts. Ensure serpentine drivebelt has not moved out of place on pulley.</p> <p><b>b.</b> (All models except M1123 and "A2" vehicles). Check all drivebelts tension using belt tension gauge. Belt tension should be 70 lbs (311 N) minimum. If belt tension is not at least 70 lbs (311 N), adjust drivebelts (paragraph 3-82). Tension should not be greater than 110 lbs (489 N) for new belts; old belts 95 lbs (422 N).</p>	<p><b>a.</b> Any drivebelt is missing, broken, frayed, or dry-rotted. Belt fiber has more than one crack 1/8 in. (3.2 mm) in depth or 50% of belt thickness) or has frays more than 2 in. (51 mm) long. Serpentine belt has moved out of place on pulleys.</p> <p><b>b.</b> Tension below 70 lbs (311 N), or greater than 110 lbs (489 N) new belt and 95 lbs (422 N) old belts.</p>
5	Semi-Annual	Protective Control Box	<p><b>a.</b> Inspect four nuts for security of mounting.</p> <p><b>b.</b> Ensure cannon plugs are securely connected to box.</p> <p><b>CANNON PLUG</b></p>  <p><b>CANNON PLUG</b></p> <p><b>BOX</b></p>	<p><b>a.</b> Mounting not secure, four nuts loose.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
6	Semi-Annual	Cooling System	<p><u><b>WARNING</b></u></p> <p>If vehicle has been operating, use extreme care to avoid being burned when removing cooling system radiator cap. Use heavy rags or gloves to protect hands. Turn radiator cap only one-half turn counterclockwise and allow pressure to be released before fully removing cap.</p> <p><u><b>NOTE</b></u></p> <p>Ž Coolant level is correct when coolant recovery tank is full TM 9-2320-280-10).</p> <p>Ž Use MIL-A-46153 in temperatures above 0°F (-18°C) and MIL-A-11755 in temperature below 0°F (-18°C).</p> <p><b>a.</b> Check coolant condition. Test coolant to see if draining is necessary (TB 750-651).</p> <p><b>b.</b> Inspect surge tank, radiator shroud, power steering cooler, oil cooler, all hoses, quick disconnects and fittings for security of mounting, leaks, and deterioration. Inspect and clean as necessary the radiator and oil cooler cores.</p>	<p><b>a.</b> Coolant condition/testing shows draining is required.</p> <p><b>b.</b> Any class III water leak. Hoses cracked or dry rotted.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

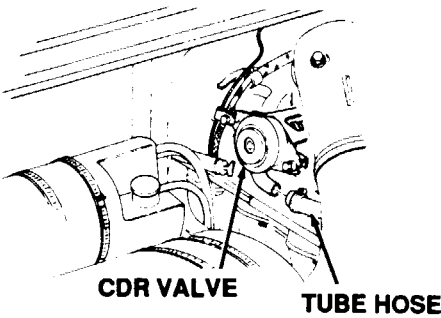
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
7	Semi-Annual	Air-Intake System	<p><b><u>WARNING</u></b></p> <p>If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your unit NBC officer or NBC NCO for appropriate handling or disposal instructions.</p> <p><b>a.</b> Inspect and clean air cleaner element and housing (para. 3-13).</p> <p><b>b.</b> Check CDR valve oil saturation. Disconnect CDR valve oil fill tube hose from CDR valve and inspect. Some oil accumulation in the CDR valve is acceptable. Correct CDR function is determined by checking vacuum with a water manometer. (para. 3-9a).</p> <p><b><u>CAUTION</u></b></p> <p>Do not clean CDR valve with solvent. This will damage the diaphragm inside the CDR valve. Wiping with a rag is the only authorized method of cleaning.</p> <p><b>c.</b> Remove and wipe off the CDR valve and hoses with a rag.</p> 	<b>b.</b> CDR fails water manometer vacuum test.



Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
8	Semi-Annual	60, 100, and 200 Amp Alternators	<p><b>a.</b> Inspect alternator and voltage regulator (200 amp only) for condition, proper installation, and security of mounting.</p> <p><b>b.</b> Inspect electrical wiring for broken strands, frayed, cracked or worn insulation, and loose connections.</p> <p><b>c.</b> Deleted</p> <p><b>d.</b> Check alternator mounting bolts for security of mounting. Tighten bolts to 40 lb-ft (54 N•m).</p>	<p><b>a.</b> Mounting bolts missing or alternator damaged.</p> <p><b>b.</b> Wiring frayed, broken, or loose connections.</p> <p><b>d.</b> Any alternator mounting bolt is loose.</p>
9	Semi-Annual	Accelerator Linkage	Inspect for bends, excessive play, cracks, and damage that could cause failure.	Linkage damaged, bent, or cracked.
10	Semi-Annual	Suspension and Steering System	<p><b>NOTE</b></p> <p>If access to locknut is a problem, remove geared hub from control arm (para. 6-11).</p> <p><b>a.</b> Remove wheel and tire assembly (para. 8-3). Check front and rear lower ball joint mounting. For M996, M997, M1042, M1037, M1097, M1123, and "A1" and "A2" series vehicles, tighten rear lower ball joint to lower control arm locknuts to 60 lb-ft (81 N•m) and front to 35 lb-ft (48 N•m). All other models, tighten front and rear lower ball joint to lower control arm locknuts to 35 lb-ft (48 N•m) and ensure cotter pin is present. Tighten ball joint slotted nut to 73 lb-ft (99 N•m) and ensure cotter pin is present.</p> <p><b>b.</b> Check front and rear upper ball joint mounting. Tighten upper ball joint to upper control arm locknuts to 21 lb-ft 29 (N•m). Tighten upper control arm to control arm bracket locknuts to 260 lb-ft (353 N•m) . Tighten ball joint slotted nut to 65 lb-ft (88 N•m) and ensure cotter pin is present.</p> <p><b>NOTE</b></p> <p>Do not over lubricate ball joints, one or two shots is adequate.</p> <p><b>c.</b> Lubricate front and rear upper ball joints with GAA.</p>	<p><b>a.</b> Capscrews or locknuts are finger or hand turnable.</p> <p><b>b.</b> Capscrews or locknuts are finger or hand turnable.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

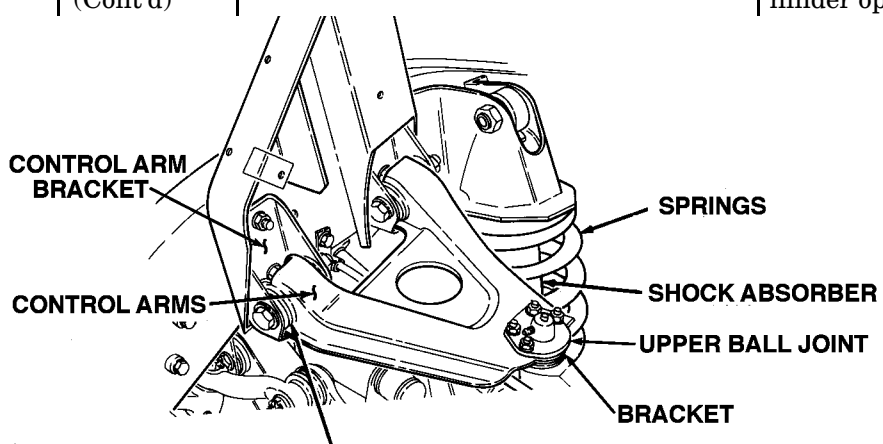
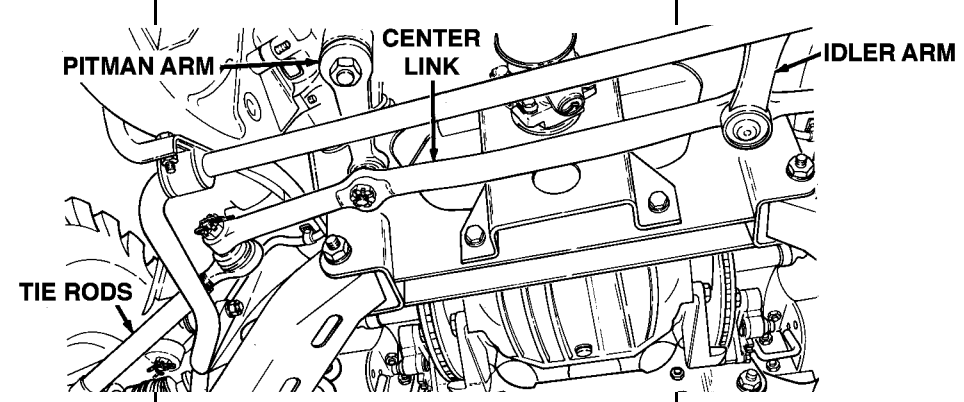
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
10	Semi-Annual	Suspension and Steering System (Cont'd)	<p><b>NOTE</b> Do not lubricate shock absorber bushings, radius rod bushings, stabilizer bar bushing, or suspension arm pivot bushing.</p> <p><b>d.</b> Inspect control arms, control arm bushings, springs, shock absorbers, and bracket for damage.</p>  <p><b>CONTROL ARM BUSHINGS</b></p> <p><b>e.</b> Inspect steering column U-joints, tie rods or radius rods, pitman arm, center link, and idler arm for breaks, cracks, and wear.</p>  <p><b>e.1.</b> Inspect steering column for security of mounting hardware.</p> <p><b>f.</b> Inspect steering gear for mounting security. Tighten mounting bolts to 60 lb-ft (81 N·m).</p>	<p><b>d.</b> Control arm bent, bushing worn or obvious damage that would hinder operation.</p> <p><b>e.</b> U-joints, tie rods, pitman arm or idler arm are worn or cracked.</p> <p><b>e.1.</b> Steering column is not secure.</p> <p><b>f.</b> Any mounting bolt missing or unserviceable.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

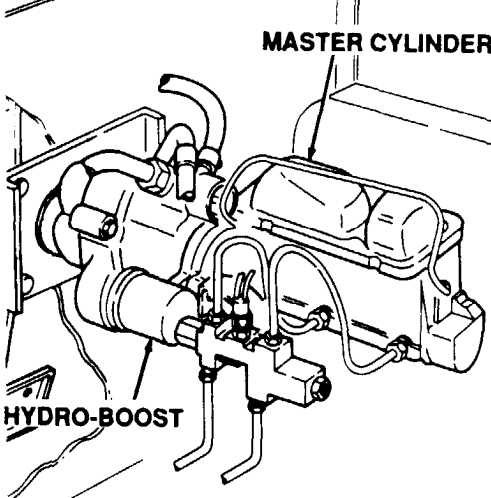
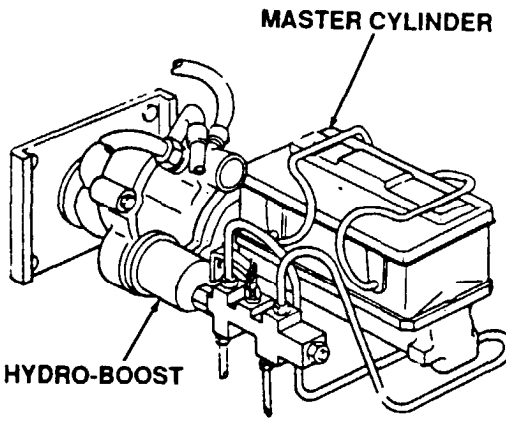
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
10	Semi-Annual	Suspension and Steering System (Cont'd)	g. Inspect power steering pump, power steering gear, hydraulic control valve, hoses, lines, and fittings for leaks or damage.	g. Any class III leak Any component damaged.
11	Semi-Annual	Brake System	a. Inspect master cylinder, hydro-boost, lines, and fittings for leaks and damage.	a. Any leak. Plugged, broken, or damaged lines and fittings.
<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>MASTER CYLINDER</p> <p>HYDRO-BOOST</p> </div> <div style="text-align: center;">  <p>MASTER CYLINDER</p> <p>HYDRO-BOOST</p> <p>NEW CONFIGURATION</p> </div> </div> <div style="margin-top: 20px;"> <p style="text-align: center;"><b>CAUTION</b></p> <ul style="list-style-type: none"> <li>• Use MIL-B-46176, Silicone Brake Fluid (BFS), for filling master brake cylinder. Failure to use BFS will cause damage to brake cylinder.</li> <li>• Thoroughly clean exterior of master cylinder cover before removing cover (table 2-1). Dirt, water, or grease will contaminate brake fluid causing brake system damage.</li> <li>• Do not use screwdriver to remove cover. Damage to bail wire will result.</li> <li>• To prevent excessive fluid spillage, ensure that rubber diaphragm is completely seated before installing cover to master cylinder.</li> </ul> <p style="text-align: center;"><b>NOTE</b></p> <p>Remove cover from brake master cylinder by moving bail wire using thumb pressure only.</p> </div>				
			<p>b. Check master brake cylinder fluid level. Level should be 1/8 inch (3.2 mm) from top of master cylinder reservoirs. Fill with BFS as necessary.</p>	<p>b. Level below 1/8 inch (3.2 mm) from top of master cylinder reservoir.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

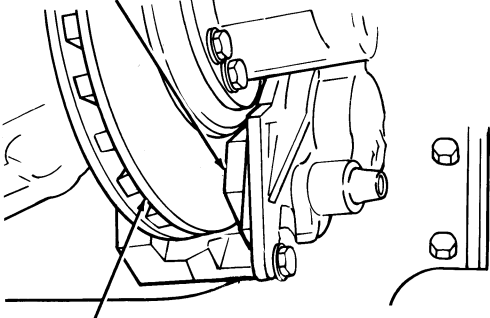
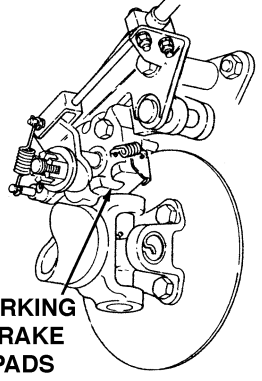
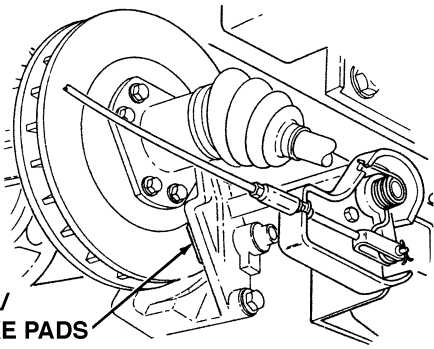
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
11	Semi-Annual	Brake System (Cont'd)	<p><b>c.</b> Inspect service brake pads and rotor disks for wear (para. 7-11).</p> <p><b>SERVICE BRAKE PADS</b></p>  <p><b>ROTOR DISK</b></p> <p><b>d.</b> Inspect parking brake pads and rotor disk for wear (para. 7-3).</p>  <p><b>PARKING BRAKE PADS</b></p> <p><b>d.1.</b> Inspect brake calipers and mounting hardware for damage or loose hardware.</p>  <p><b>SERVICE/ PARKING BRAKE PADS</b></p> <p><b>e.</b> Inspect dual service/park brake pads and rotor for wear (para. 7-21).</p>	<p><b>c.</b> Service brake pads less than 1/8 inch (3.2 mm).</p> <p><b>d.</b> Parking brake pads less than 1/8 inch (3.2 mm).</p> <p><b>d.1.</b> Brake calipers are damaged or mounting bolts are loose.</p> <p><b>e.</b> Brake pads less than 1/8 inch (3.2 mm).</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

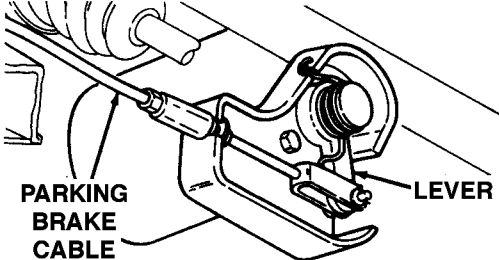
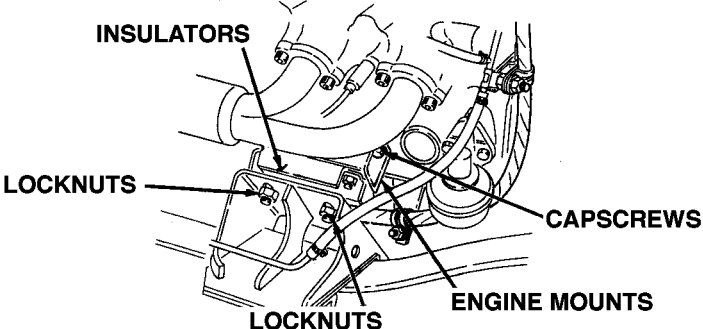
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
11	Semi-Annual	Brake System (Cont'd)	<p><b>f.</b> Inspect parking brake cable, cable clip, lever, spring, and pushrod/guide pin for binding and loose components.</p>  <p><b>PARKING BRAKE CABLE</b> <b>LEVER</b></p> <p><b>g.</b> On vehicles equipped with a single parking brake assembly mounted between the rear prop shaft and rear differential, lubricate parking brake lever, parking brake cam, parking brake push pins, and parking brake guide pins with WTR. On vehicles equipped with a left and right parking/service brake assembly mounted between the rear axle half-shafts and rear differential, lubricate the parking brake lever with WTR. The parking/service brake assembly needs no lubrication.</p> <p><b>h.</b> Inspect rear parking brake cables for damage and/or chaffing in the area of the control arm. If cables are damaged, replace cables (paragraph 7-23 or 7-24).</p> <p><b>i.</b> Inspect for presence of, or damage to, parking brake cable clamps.</p>	<p><b>f.</b> Parking brake binding or cable frayed or broken. Spring or cable clip missing.</p>
12	Semi-Annual	Engine and Transmission Mounts	<p><b>a.</b> Inspect engine mounts and insulators for loose, worn, and damaged condition.</p> <p><b>b.</b> Check for loose or missing engine mount capscrews and locknuts. If engine mount capscrews or locknuts are loose or missing, notify DS maintenance.</p>  <p><b>INSULATORS</b> <b>LOCKNUTS</b> <b>CAPSCREWS</b> <b>ENGINE MOUNTS</b></p>	<p><b>a.</b> Engine mounts or insulators cracked, damaged, loose, or worn.</p> <p><b>b.</b> Capscrews or locknuts, loose or missing.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

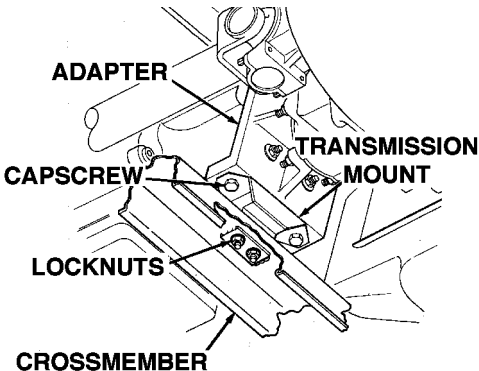
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
12	Semi-Annual	Engine and Transmission Mount (Cont'd)	<p>c. Using 3/4 inch torque adapter (reefer to Appendix B, Item 145), tighten two capscrews securing transmission mount to adapter to 65 lb-ft (88 N•m). Tighten two locknuts securing transmission mount to crossmember to 28 lb-ft (38 N•m).</p> 	c. Transmission mount loose, cracked, or damaged.
13	Semi-Annual	Starter	<p><b>CAUTION</b> Disconnect negative cable.</p> <p>a. Inspect starter for mounting security. Tighten mounting bolts to 40 lb-ft (54 N•m).</p> <p>b. Inspect cables and studs for loose nuts and damage.</p>	<p>a. Mounting bolt missing or will not torque.</p> <p>b. Stud nut loose.</p>
13.1	Semi-Annual	Neutral Start Safety Switch	<p><b>WARNING</b> Ensure vehicle parking brake is set, wheels are chocked, and rotary switch is in the ENG STOP position. Failure to comply may result in injury to personnel and/or damage to equipment.</p> <p>a. Disconnect wires 14A and 14B from wires 14 at neutral start safety switch.</p> <p>b. Check for continuity of neutral start safety switch.</p> <p>(1) With transmission shift lever in N (neutral), or P (park) (for M1123, A2 series, and up-armor models only), continuity should be present between wires 14 at neutral start safety switch.</p>	Neutral start safety switch is malfunctioning.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

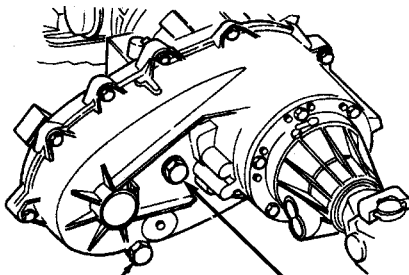
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
13.1	Semi-Annual	Neutral Start Safety Switch (Cont'd)	<p>(2) Place transmission shift lever in D (drive). There should be no continuity present between wires 14. If continuity is present, replace neutral start safety switch (para. 5-6).</p> <p>c. Connect wires 14A and 14B to wires 14 at neutral start safety switch.</p>	
14	Semi-Annual	Transmission	<p>a. Inspect vent lines and connectors for security, cracks, and deterioration.</p> <p>b. Inspect transmission shift linkage for bends, excessive play, cracks, and damage that could cause failure.</p>	<p>a. Vent line cracked, plugged, or missing.</p> <p>b. Shift linkage is unserviceable.</p>
15	Semi-Annual	Transfer	<p>a. Inspect transfer case vent lines and connectors for security, cracks, and deterioration.</p> <p>b. Inspect transfer case shift linkage for bends, excessive play, cracks, and damage that could cause failure.</p> <p style="text-align: center;"><b>CAUTION</b></p> <p>Use Dexron® II for filling transfer case. Failure to use Dexron® II will cause damage to transfer case.</p> <p>c. Check transfer case fluid level every 3,000 (4,800 km) or semiannually, whichever occurs first. Remove fill plug and gasket. Level should be within 1/2 in. (12.7 mm) of fill plug opening when vehicle is on level ground. Install fill plug and gasket, and tighten to 35 lb-ft (47 N·m).</p> <div style="text-align: center;">  <p>The diagram shows a top-down view of a transfer case. A line points to a circular drain plug on the left side, labeled 'TRANSFER CASE DRAIN'. Another line points to a larger circular opening with a mesh screen on the right side, labeled 'TRANSFER CASE CHECK AND FILL'.</p> </div>	<p>a. Vent line cracked, plugged or missing. Shift linkage is unserviceable.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

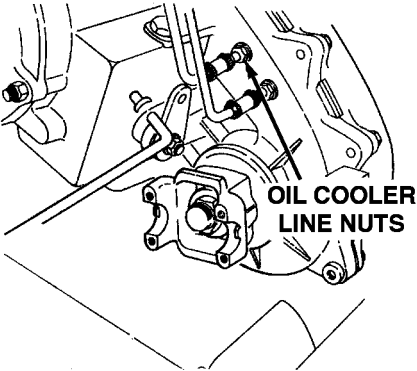
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
15	Semi-Annual	Transfer (Cont'd)	<p><b>NOTE</b></p> <p>Do not overtorque retaining nuts.</p> <p><b>d.</b> Inspect oil cooler lines for leaks or damage. Check for loose oil cooler line nuts and damage to the spiral wrap on the cooler line. If oil cooler line nuts are loose, hold end of oil cooler stationary, and tighten line nuts to 194-212 lb-in. (22-24 N•m)</p>  <p><b>OIL COOLER LINE NUTS</b></p>	<p><b>d.</b> Any class III oil leak or damage to spiral wrap.</p>
16	Semi-Annual	Driveline Components	<p><b>a.</b> Inspect geared hub vent lines and connectors for security, cracks, and deterioration.</p> <p><b>b.</b> Inspect geared hub for leaking seals and damage.</p> <p><b>CAUTION</b></p> <p>Change geared hub and differential lubricants when required by maintenance repair action, contaminated by water or foreign material, or if lubricant appears by smell, feel, or visual indication to be overheated.</p> <p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• Fill each axle differential with 2 quarts (1.9 L) of GO.</li> <li>• Fill each geared hub with 1 pint (0.5 L) of GO.</li> </ul> <p><b>c.</b> Adjust spindle bearing (paragraph 6-14).</p> <p><b>d.</b> Inspect differential vent lines and connectors for security, cracks, and deterioration.</p> <p><b>e.</b> Inspect differentials for leaking seals and cracks.</p>	<p><b>a.</b> Hub vent lines cracked, plugged, or missing.</p> <p><b>b.</b> Class III leaks or damage.</p> <p><b>c.</b> Bearing damaged.</p> <p><b>d.</b> Differential vent line has hole, plugged, or cracked.</p> <p><b>e.</b> Class III leak.</p>



Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

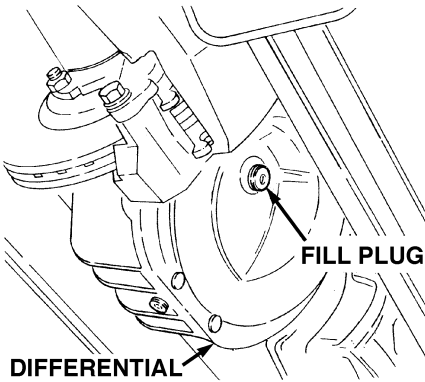
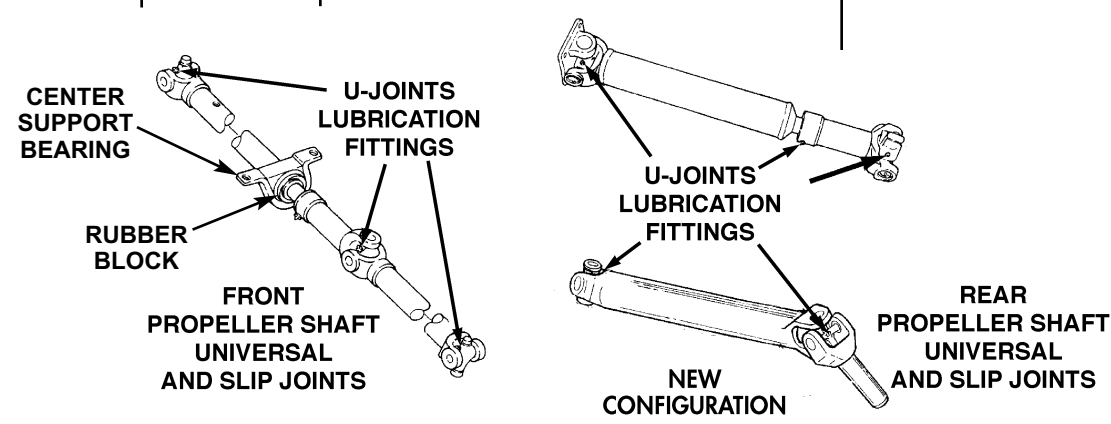
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
16	Semi-Annual	Driveline Components (Cont'd)	<p><b>f.</b> M998, M998A1, and M1121 series vehicles – Check differential lubricant level semiannually or every (3,000 miles) (4,830 km). M998A2 and M1123 series vehicles – Change differential lubricant semiannually or every 3,000 miles (4,830 km). Differential level should be within 1/4 inch (6.4 mm) of fill plug opening when lubricant is cold or to plug level when hot.</p>  <p><b>g.</b> Inspect U-joints for damage, free play, and missing or unserviceable lubrication fittings.</p> <p><b>h.</b> Tighten front prop shaft mounting capscrews to 13-18 lb-ft (18-24 N•m) and center support capscrews to 60 lb-ft (81 N•m). Tighten rear prop shaft capscrews to 13-18 lb-ft (18-24 N•m) and tighten U-bolt nuts to 21 lb-ft (29 N•m).</p> <p><b>i.</b> Inspect rubber block and center support bearing for wear and wobble in propeller shaft.</p> 	<p><b>f.</b> Lube level not within 1/4 inch (6.4 mm) of fill plug opening when cold or to plug level when hot.</p> <p><b>g.</b> U-joint is damaged, unserviceable, or missing lubrication fitting.</p> <p><b>h.</b> Loose, missing, or broken capscrews.</p> <p><b>i.</b> Rubber block or center support bearing is worn or propeller shaft wobbles.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
16	Semi-Annual	Driveline Components (Cont'd)	j. Tighten halfshaft mounting bolts to 48 lb-ft (65 N•m).	j. Loose, missing, or broken bolts.
17	Semi-Annual	Exhaust Components	Inspect for cracked and loose pipes, muffler, and hangers. Check for exhaust leaks.	Cracked, loose, or holes in pipes or muffler. Exhaust leak.
18	Semi-Annual	Frame and Cross-members	<p>a. Inspect frame side rails for cracks, breaks, bends, wear, deterioration, and missing or loose fasteners.</p> <p>b. Inspect crossmembers for cracks, breaks, bends, deterioration, and loose or missing fasteners.</p> <p>c. Inspect for missing, broken, bent, or loose bumper supports before towing a trailer.</p>	<p>a. Any loose or missing fasteners, cracks, bends, or breaks in frame.</p> <p>b. Any loose or missing fasteners. Cracks, bends (bends are defined as a condition that would affect vehicle operation) or breaks in cross-members.</p> <p>c. Any missing, broken, bent, or loose bumper supports.</p>
19	Semi-Annual	Tires	<p><b><u>WARNING</u></b></p> <ul style="list-style-type: none"> <li>Changing tire pressures or wheel alignment, out of the recommended specification, may adversely affect the vehicle's handling characteristics. Loss of vehicle control may result in serious injury or death and damage to equipment.</li> <li>Radial and bias ply tires should not be mixed on the same vehicle. Injury to personnel and damage to equipment may result.</li> </ul> <p><b><u>NOTE</u></b></p> <p>Vehicle must be up on jack stands for the following checks.</p> <p>a. Check tread depth of tires with tire gauge. If tread depth is less than 1/16 in. (1.59 mm), replace tire in approximately 400 miles (644 km), bias tires will wear 1/32 in. (0.79 mm), radial tires will take approximately 1,300 miles (2092 km) to wear 1/32 in. (0.79 mm). If mission will require the vehicle to travel this distance within a month, replace tire if it measures 3/32 in. (2.38 mm).</p>	<p>a. Tread depth is less than 1/16 in. (1.59 mm).</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

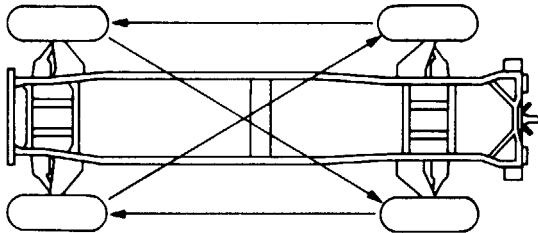
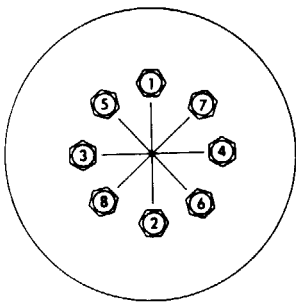
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
19	Semi-Annual	Tires (Cont'd)	<p><b>b.</b> Inspect tires for uneven wear and balance (paragraph 8-9). For normal wear, rotate tires as shown in rotation diagram. The vehicle's wheel alignment is optimally designed for GVW operation. Operating the vehicle without a load can cause excessive wear on the outer edge of the tread pattern. If this pattern develops, turn tires around on the rim (para. 8-4).</p> <p><b>c.</b> Rotate tires as diagram shows.</p> <p style="text-align: center;"><b>ROTATION DIAGRAM</b></p>  <p><b>d.</b> Tighten wheel lug nuts to 90-110 lb-ft (122-149 N·m) in tightening sequence shown.</p> <p style="text-align: center;"><b>TIGHTENING SEQUENCE</b></p> 	<p><b>b.</b> Tires exhibit excessive or uneven wear or balance.</p> <p><b>d.</b> Any broken studs, loose or missing lug nuts.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

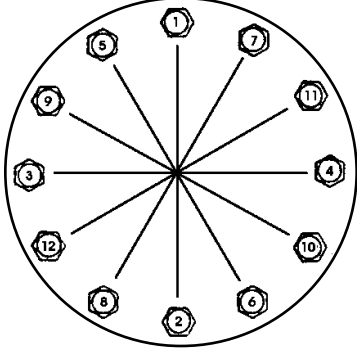
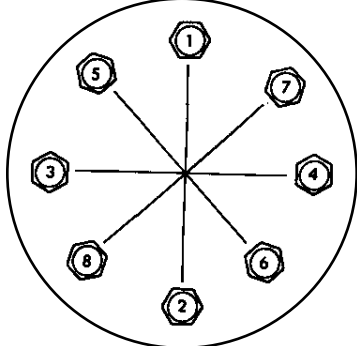
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
19	Semi-Annual	Tires (Cont'd)	<p>e. Check for loose, missing, or broken wheel studs and nuts.</p> <p><b>CAUTION</b> Prior to checking torque, the tire assembly must be deflated.</p> <p>(1) Release air pressure from tire (para. 8-4 or 8-5).</p> <p><b>CAUTION</b> Tighten locknuts gradually to avoid bent and broken studs, or damage to wheel components will result.</p> <p>(2) Wheel configurations:</p> <p>(a) 12-bolt configuration – Tighten locknuts to 85 lb-ft (115 N•m) in sequence shown; repeat torque sequence at 125 lb-ft (170 N•m).</p> <p><b>12-BOLT TIGHTENING SEQUENCE</b></p>  <p>(b) 8-bolt configuration – Tighten locknuts to 55 lb-ft (75 N•m) in sequence shown; repeat torque sequence at 65 lb-ft (88 N•m).</p> <p><b>8-BOLT TIGHTENING SEQUENCE</b></p>  <p>(3) Inflate tire to recommended tire pressure (TM 9-2320-280-10).</p>	e. Any broken studs, or loose or missing wheel nuts.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

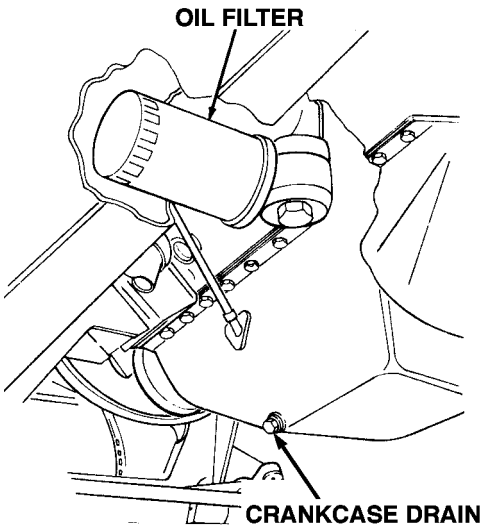
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
19	Semi-Annual	Tires (Cont'd)	<p><b>NOTE</b></p> <p>If vehicle is new and has been driven less than 3,000 miles (4,800 km), it is not necessary to align wheels unless abnormal handling is reported.</p> <p><b>f.</b> Check alignment of front and rear wheels (paras. 8-10 and 8-11).</p>	<b>f.</b> Front or rear wheels are out of alignment.
20	Semi-Annual	Engine	<p><b>a.</b> Inspect engine for leaks or damage that could cause engine failure.</p> <p><b>NOTE</b></p> <p>Oil and oil filter will be changed when they are known to be contaminated, clogged, or when service is recommended by AOAP laboratory.</p> <p><b>b.</b> Perform AOAP sample. If AOAP is not available, change oil and oil filter at 3,000 miles (4,800 km), or 100 hours (if hour meter is installed), or every six months.</p>  <p><b>OIL FILTER</b></p> <p><b>CRANKCASE DRAIN</b></p> <p><b>OIL FILTER AND CRANKCASE DRAIN</b></p>	<b>a.</b> Class III leaks. Damage evident that would cause engine failure.

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
21	Semi-Annual	Batteries	<p style="text-align: center;"><b><u>WARNING</u></b></p> <ul style="list-style-type: none"> <li>Do not perform battery system checks or inspections while smoking or near fire, flames, or sparks. Batteries may explode causing damage to vehicle, injury, or death to personnel.</li> <li>Remove all jewelry such as rings, dog tags, bracelets, etc. If jewelry or disconnected battery ground cable contacts battery terminal, a direct short will result, causing injury to personnel, or damage to equipment.</li> </ul> <p style="text-align: center;"><b><u>NOTE</u></b></p> <p>Refer to TM 9-6140-200-14 for more specific details on battery maintenance.</p> <p><b>a.</b> Inspect battery box and battery tray bolts for corrosion and debris. If any corrosion is evident, wipe bolts and/or washers clean. If corrosion cannot be removed or the surface of bolts are pitted, replace bolts and/or washers (para. 4-80).</p> <p><b>b.</b> Clean slave receptacle and coat with corrosion preventive compound (Appendix C, Item 24).</p> <p><b>c.</b> Check and record specific gravity of each cell.</p> <p><b>d.</b> Inspect battery cables for frays, splits, or looseness.</p> <p style="text-align: center;"><b><u>SPECIAL PURPOSE KITS</u></b></p>	<p><b>a.</b> Corrosion has made holes in metal battery box.</p> <p><b>b.</b> Terminals corroded.</p> <p><b>c.</b> If cell is below 1.225 specific gravity.</p> <p><b>d.</b> Cables frayed, split, or loose.</p>
22	Semi-Annual	Cargo Shell Door	Check adjustment of cargo shell door (paragraph 11-13).	
23	Semi-Annual	Rear Cargo Door	Check rear cargo door for proper operation. Rotate gas springs (para. 11-21) 180 degrees every six months and move left spring to right side and right spring to left side.	

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

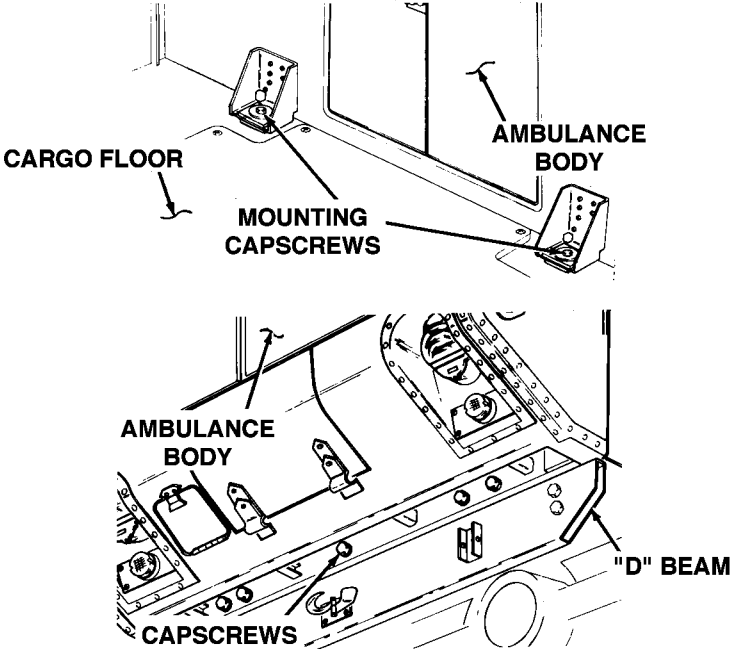
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
24	Semi-Annual	Ambulance (M996, M996A1, M997, M997A1, and M997A2)	<p><b>a.</b> Check DC outlets for proper operation. Using multimeter, check for voltage at DC receptacles. If engine is running, voltage should be 27-28 volts. If engine is not running, voltage should be 24.2-25.2 volts. Reefer to para. 2-39, electrical troubleshooting, if voltage is not within the specified range.</p> <p><b>b.</b> Inspect and tighten two mounting capscrews securing ambulance body to cargo floor to 90 lb-ft (122 N•m). Tighten seven capscrews securing ambulance body to "D" beam to 90 lb-ft (122 N•m).</p> 	<p><b>a.</b> No DC voltage at outlet, or not within range.</p> <p><b>b.</b> Body not securely mounted to floor.</p>
25	Semi-Annual	DeepWater Fording Kit	<p><b>c.</b> (M997, M997A1, and M997A2 only) Inspect compressor for security of mounting and oil leakage.</p> <p><b>a.</b> Inspect vent tubes for bends, cracks, breaks, deterioration, and restrictions.</p> <p><b>b.</b> Inspect vent tube mounting hardware for proper installation.</p> <p><b>c.</b> Inspect intake and exhaust extensions for proper installation and leaks.</p>	<p><b>c.</b> Any class III leak.</p> <p><b>c.</b> Any exhaust extension leaks.</p>

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

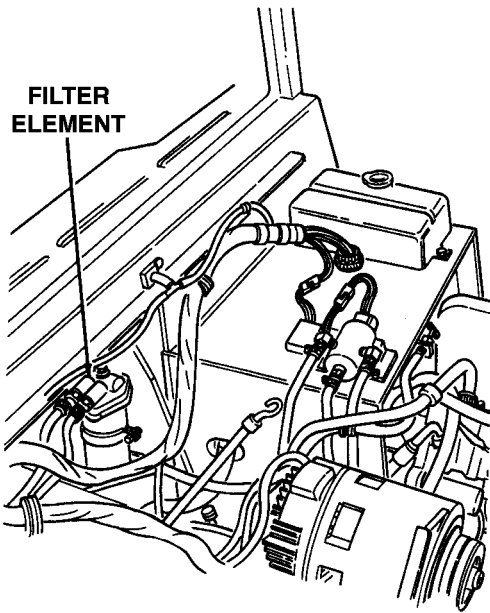
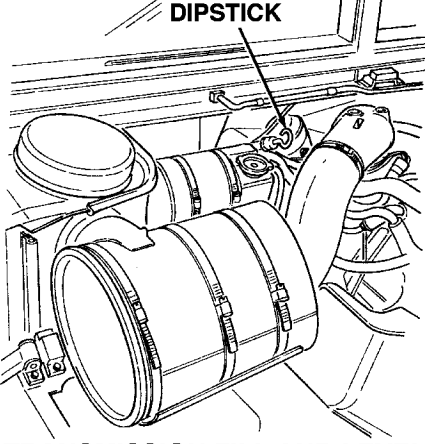
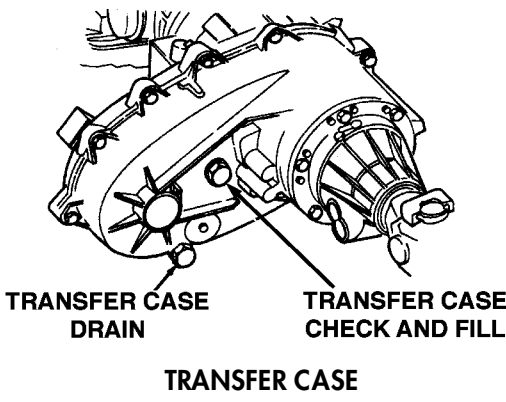
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
26	Semi-Annual	Arctic Winterization Kit and/or Troop/Cargo Winterization Kit	<p>Inspect all fuel lines for loose connections, splits, cracks, and bends that could cause leaks. Tighten loose connections and replace damaged parts.</p> <p><b>NOTE</b></p> <p>If Annual/Biennial Service is being performed, then Final Road Test will be completed after last Annual/Biennial task is complete.</p>	Any class III leak.
27	Semi-Annual	Final Road Test	Check vehicle for proper operation and performance.	Vehicle fails to operate properly.
28	Annually	Fuel System	<p>Replace filter element every 6,000 miles (9,600 km) or annually, whichever occurs first. Replace water separator element if unserviceable (para. 3-33).</p> 	
29	Annually	Air-Intake System	Test CDR valve (para. 3-9).	
29.1	Annually	Dust Unloader	Visually inspect dust unloader for presence and for cuts, tears, obstructions, worn areas, enlarged gap, or if center opening exceeds 1/8 in. (3.175 mm).	Dust unloader missing or has cuts, tears, obstructions, worn areas, enlarged gap, or if center opening exceeds 1/8 in. (3.175 mm).



Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
30	Annually	Electrical Wiring	Inspect all wiring and wiring harness for frays, splits, missing insulation, or poor connections. Repair any worn wiring (para. 4-85). If wiring cannot be repaired, notify DS maintenance.	Broken, frayed, split wires or harness.
30.1	Annually	Engine Running Test	Observe engine and vehicle operation for rough idle, rough running, lack of power, and unusual noise or vibration (para. 2-18).	Vehicle fails to operate properly.
30.2	Annually	Transmission	<p>Perform AOAP sample.</p> <p><b>CAUTION</b></p> <p>Use Dexron® II or Dexron® III for 3L80 transmission. Use only Dexron® III for 4L80-E transmission. Failure to use only Dexron® III for 4L80E transmission will cause damage to transmission.</p> <p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>Oil and oil filter will be changed when they are known to be contaminated, clogged, or when service is recommended by AOAP laboratory.</li> <li>Replace transmission oil filter each time transmission is drained. Fill 3L80 transmission with 6 quarts (5.7 L) of Dexron® II or Dexron® III. Fill 4L80-E transmission with 7.7 quarts (7.3 L) of only Dexron® III. In arctic conditions, use OEA in both model transmissions.</li> </ul>	
31	Biennially	Transmission	<p><b>CAUTION</b></p> <p>Use Dexron® II or Dexron® III for 3L80 transmission. Use only Dexron® III for 4L80-E transmission. Failure to use only Dexron® III for 4L80E transmission will cause damage to transmission.</p> <p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>Change fluid every 12,000 miles (19,300 km) or biennially, whichever occurs first (para. 5-2a). Inspect either 3L80 or 4L80-E transmission drainplug for metal particles.</li> <li>Replace transmission oil filter each time transmission is drained. Fill 3L80 transmission with 6 quarts (5.7 L) of Dexron® II or Dexron® III. Fill 4L80-E transmission with 7.7 quarts (7.3 L) of only Dexron® III. In arctic conditions, use OEA in both model transmissions.</li> </ul>	

Table 2-1. Unit Level Preventive Maintenance Checks and Services HMMWV (Cont'd)

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED	PROCEDURES	NOT FULLY MISSION CAPABLE IF:
31	Biennially	Transmission (Cont'd)	 <p><b>TRANSMISSION FILL AND LEVEL</b></p> <p><b>CAUTION</b></p> <ul style="list-style-type: none"> <li>• If water or metal particles are detected during transfer case draining, notify Direct Support Maintenance personnel before refilling transfer case.</li> <li>• Use Dexron® II for filling transfer case. Failure to use Dexron® II will cause damage to transfer case.</li> </ul> <p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• Fill transfer case (model 218) with 3.5 quarts (3.3 L) of Dexron® II.</li> <li>• Fill transfer case (model 242) with 3.35 quarts (3.17 L) of Dexron® II.</li> </ul> <p>Change fluid every 12,000 miles</p>	
32	Biennially	Transfer Case	 <p><b>TRANSFER CASE</b></p>	Metal particles are

## SEMI-ANNUAL (3,000 MILE) PMCS PARTS LIST

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
1.	MS51943-31	5305-00-061-4650	Locknut	1
2.	5593033	5310-00-252-2999	Nut and Lockwasher Assembly	4
3.	MS21245-L10	5310-00-449-2381	Locknut	4
4.	MS35756-8	5315-00-616-5526	Woodruff Key	1
5.	MS24665-355	5315-00-012-0123	Cotter Pin	1
6.	MS51943-43	5310-00-061-4651	Locknut	1
7.	MS51943-35	5310-00-935-9021	Locknut	1
8.	MS51943-39	5310-00-488-3889	Locknut	4
9.	MS51967-18	5310-00-763-8919	Locknut	2
10.	MS35338-45	5310-00-407-9566	Lockwasher	2
11.	PH13	2940-00-082-6034	Filter, Fluid, Engine Oil	1

## ANNUAL (6,000 MILE) PMCS PARTS LIST

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
1.	MS51943-31	5305-00-061-4650	Locknut	1
2.	5593033	5310-00-252-2999	Nut and Lockwasher Assembly	4
3.	MS21245-L10	5310-00-449-2381	Locknut	4
4.	MS35756-8	5315-00-616-5526	Woodruff Key	1
5.	MS24665-355	5315-00-012-0123	Cotter Pin	1
6.	MS51943-43	5310-00-061-4651	Locknut	1
7.	MS51943-35	5310-00-935-9021	Locknut	1
8.	MS51943-39	5310-00-488-3889	Locknut	4
9.	MS51967-18	5310-00-763-8919	Locknut	2
10.	MS35338-45	5310-00-407-9566	Lockwasher	2
11.	PH13	2940-00-082-6034	Filter, Fluid, Engine Oil	1
12.	5589121	4330-01-190-3579	Filter Element Kit, Fuel	1

## BIENNIALY (12,000 MILE) PMCS PARTS LIST

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
1.	MS51943-31	5305-00-061-4650	Locknut	1
2.	271172	5310-00-152-0598	Assembled Locknut	4
3.	MS21245-L10	5310-00-449-2381	Locknut	4
4.	MS35756-8	5315-00-616-5526	Woodruff Key	1
5.	MS24665-355	5315-00-012-0123	Cotter Pin	1
6.	MS51943-43	5310-00-061-4651	Locknut	1
7.	MS51943-35	5310-00-935-9021	Locknut	1
8.	MS51943-39	5310-00-488-3889	Locknut	4
9.	MS51967-18	5310-00-763-8919	Locknut	2
10.	MS35338-45	5310-00-407-9566	Lockwasher	2
11.	PH13	2940-00-082-6034	Filter, Fluid, Engine Oil	1
12.	12337210	4330-01-121-6350	Parts Kit, Fluid, Transmission (3L80)	1
13.	8655625	5330-01-148-7492	Gasket (3L80)	1
14.	8684221	2520-01-398-4589	Parts Kit, Fluid, Transmission (4L80-E) (1995, 1996)	1
15.	8677743	5330-01-360-5271	Gasket (4L80-E)	1
16.	12354864	4330-01-438-3813	Parts Kit, Fluid, Transmission (4L80-E) (1997, 1998)	1

## LUBRICATION TABLE

USAGE	FLUID/LUBRICANT	CAPACITIES	EXPECTED TEMPERATURE
Engine Oil	OE/HDO 30 OE/HDO 10 OEA	Crankcase: w/o filter 7 qt (6.6 L) w/filter 8 qt (7.6 L) Dry System 10 qt (9.5 L) (INC. oil cooler)	Above +15°F (-9°C) 40° to -15°F (4° to -26°C) 40° to -65°F (4° to -54°C)
Engine Coolant	Ethylene Glycol and Water 1/4 Ethylene Glycol/ 3/4 Water 2/5 Ethylene Glycol/ 3/5 Water 3/5 Ethylene Glycol/ 2/5 Water	Radiator: 5 qt (4.7 L) Complete System: 26 qt (24.6 L)	15°F (-9°C) and above 40° to -15°F (4° to -26°C) 40° to -65°F (4° to -54°C)
Brake System (All except M1097, "A1", "A2" series and M1123)  (M1097, "A1", "A2" series and M1123)	Fluid Silicone BFS	Master Cylinder: 0.69 pt (0.33 L) Complete System: 1.2 pt (0.56 L)  Master Cylinder: 1.12 pt (0.53 L) Complete System: 1.63 pt (0.78 L)	All Temperatures

OE/HDO 15/40 (Grade 15W-40) lubricant may be used when expected temperatures are above +5°F (-15°C). If OEA lubricant is required to meet the temperature ranges prescribed in the table, then the OEA lubricant is to be used in place of OE/HDO 10 lubricant for all temperature ranges. If operating conditions are severe or abnormal, service chassis lubrication points at 1,000 miles (1,600 kilometers).

LUBRICATION TABLE (Cont'd)

USAGE	FLUID/LUBRICANT	CAPACITIES	EXPECTED TEMPERATURE
Transmission (3L80) (4L80-E)	Dexron® II or Dexron® III Dexron® III only (Do not use Dexron® II) OEA	Dry: 11 qt (10.4 L) Drain & Refill: 6 qt (5.7 L) Dry: 13.5 qt (12.8L) Drain & Refill 7.7 qt (7.3 L)	All Temperatures Except Arctic  Arctic Temperatures
Transfer (218) Case (242)	Dexron® II or Dexron® III	3.5 qt (3.3 L) 3.35 qt (3.17 L)	All Temperatures
Steering System	Dexron® II or Dexron® III	1 qt (0.95 L) w/Cooler 1.25 qt (1.18 L)	All Temperatures
Geared Hub (4)	Multipurpose Gear GO 80/90	1 pt ea. ( 0.47 L)	All Temperatures
Axles (2)	Multipurpose Gear GO 80/90	2 qt ea. (1.9 L)	All Temperatures
Ball Joints, Tie Rod Ends, Pitman Arm, Propeller Shafts, etc.	GAA	As Required	All Temperatures
Hinges, Cables, and Linkages	OE/HDO	As Required	All Temperatures

## Section IV. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

### 2-12. GENERAL

- This section provides information to diagnose and correct malfunctions of the electrical/mechanical system.
- Principles of operation showing system operation can be found in chapter 1. It should be used as a reference when performing electrical/mechanical troubleshooting.
- Each malfunction symptom given for an individual component or system is followed by step(s) you should take to determine the cause and corrective action you must take to remedy the problem.
- Before taking any action to correct a possible malfunction, the following rules should be followed:
  - Question operator to obtain any information that might help you determine the cause of the problem.
  - Never over look the chance that the problem could be of simple origin. The problem could be corrected with minor adjustment.
  - Use all senses to observe and locate troubles.
  - Use test instruments or gauges to help you determine and isolate problem.
  - Always isolate the system where the malfunction occurs and then locate the defective component.
  - Use standard automotive theories and principles when troubleshooting the vehicles covered in this manual.
- The STE/ICE-R is an integral part of these troubleshooting procedures. It should be used whenever possible, although other options are given, when available. The Vehicle Identification Number (VIN) assigned to the M998 series vehicles is 21 (14 is the temporary VIN). On page 2-753, you will find information on STE/ICE-R description and operation. Use this information to become familiar with STE/ICE-R operation and the equipment contained in the test set. On page 2-763 you will find STE/ICE-R setup and internal checks. These must be performed prior to performing tests.

## 2-13. ELECTRICAL/MECHANICAL SYSTEMS TROUBLESHOOTING

### ELECTRICAL/MECHANICAL TROUBLESHOOTING

PARA NO.		PAGE NO.
2-14.	How to use this troubleshooting guide . . . . .	2-32
2-15.	Glossary of abbreviations and commonly used terms . . . . .	2-38
2-16.	Electrical circuit description . . . . .	2-39
2-17.	Startability tests . . . . .	2-41
2-18.	Engine running tests . . . . .	2-47
2-19.	Cooling system tests . . . . .	2-57
2-20.	Lubrication system tests . . . . .	2-65
2-21.	Electrical tests . . . . .	2-71
2-22.	Fuel system tests . . . . .	2-95
2-23.	Air intake/exhaust tests . . . . .	2-137
2-24.	Compression/mechanical tests . . . . .	2-143
2-25.	Engine cooling tests . . . . .	2-155
2-26.	Engine lubrication tests . . . . .	2-187
2-27.	Alternator tests . . . . .	2-194
2-28.	Protective control box /distribution box tests . . . . .	2-227
2-29.	Battery circuit test . . . . .	2-251
2-30.	Starter circuit tests . . . . .	2-261
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2-33.	Light tests . . . . .	2-389
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2-39.	Ambulance electrical system tests . . . . .	2-497
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2-41.	Winch system tests . . . . .	2-715
2-42.	DCA troubleshooting . . . . .	2-723
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<b>2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE</b>
--

**NOTE TO THE RECIPIENT OF THIS MANUAL**

There are 16 foldouts that are supplied with this manual. Take the foldouts and place them after the last page of diagnostics at the end of the paragraph. That way, the foldout will be with diagnostics for that system. Use the cross-reference information listed below to guide you in the placement of the foldouts.

<u>SYSTEM LEVEL TESTS</u>	<u>PARAGRAPH</u>	<u>FOLDOUT NUMBER</u>
FUEL	2-22	FO-1
AIR INTAKE/EXHAUST	2-23	FO-2
COMPRESSION/MECHANICAL	2-24	FO-3
ENGINE COOLING	2-25	FO-4
ENGINE LUBRICATION	2-26	FO-5
ALTERNATOR	2-27	FO-6
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX	2-28	
BATTERY CIRCUIT	2-29	FO-7
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GLOWPLUGS (PROTECTIVE CONTROL BOX)	2-31	FO-9
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INSTRUMENTS	2-32	FO-10
LIGHTS	2-33	FO-11
TRANSMISSION (3L80)	2-34	FO-12
TRANSMISSION (4L80-E)	2-35	
BRAKES	2-36	FO-13
STEERING	2-37	FO-14
DRIVETRAIN	2-38	FO-15
AMBULANCE ELECTRICAL SYSTEM	2-39	
AMBULANCE MECHANICAL SYSTEM	2-40	
WINCH SYSTEM	2-41	
DCA TROUBLESHOOTING	2-42	FO-16

## 2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (Cont'd)

### THERE ARE 5 TOP LEVEL TESTS.

USE THESE FOR GENERAL SYMPTOMS (HARD-TO-START, RUNS ROUGH, ETC).

### THERE ARE 21 SYSTEM LEVEL TESTS.

THESE ARE USED BY THE TOP LEVEL TESTS BUT YOU CAN GO STRAIGHT TO THEM IF YOU KNOW WHAT YOU'RE DOING.

### TROUBLESHOOTING PAGES.

THE LAYOUT IS SHOWN ON THE NEXT PAGE. THEY ARE SET UP SO THAT YOU DON'T READ ANY MORE THAN YOU HAVE TO. AFTER YOU HAVE FOUND THE FAULT, CORRECT IT AND MAKE SURE THE SYSTEM IS WORKING PROPERLY. CONTINUE IF THERE ARE ADDITIONAL PROBLEMS.

### TOP LEVEL TESTS

### PAGE

ENGINE STARTING	2-41
ENGINE RUNNING	2-47
COOLING	2-57
LUBRICATION	2-65
ELECTRICAL	2-71

### SYSTEM LEVEL TESTS

### PAGE

FUEL	2-95
AIR INTAKE/EXHAUST	2-137
COMPRESSION/MECHANICAL	2-143
ENGINE COOLING	2-155
ENGINE LUBRICATION	2-187
ALTERNATOR	2-194
PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX	2-227
BATTERY CIRCUIT	2-251
STARTER CIRCUIT	2-261
GLOWPLUGS (PCB)	2-303
GLOWPLUGS (DISTRIBUTION BOX)	2-318.1
INSTRUMENTS	2-319
LIGHTS	2-389
TRANSMISSION (3L80)	2-399
TRANSMISSION (4L80-E)	2-11
BRAKES	2-445
STEERING	2-459
DRIVETRAIN	2-79
AMBULANCE ELECTRICAL	2-497
AMBULANCE MECHANICAL	2-693
WINCH	2-715
DCA TROUBLESHOOTING	2-723



## 2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (Cont'd)

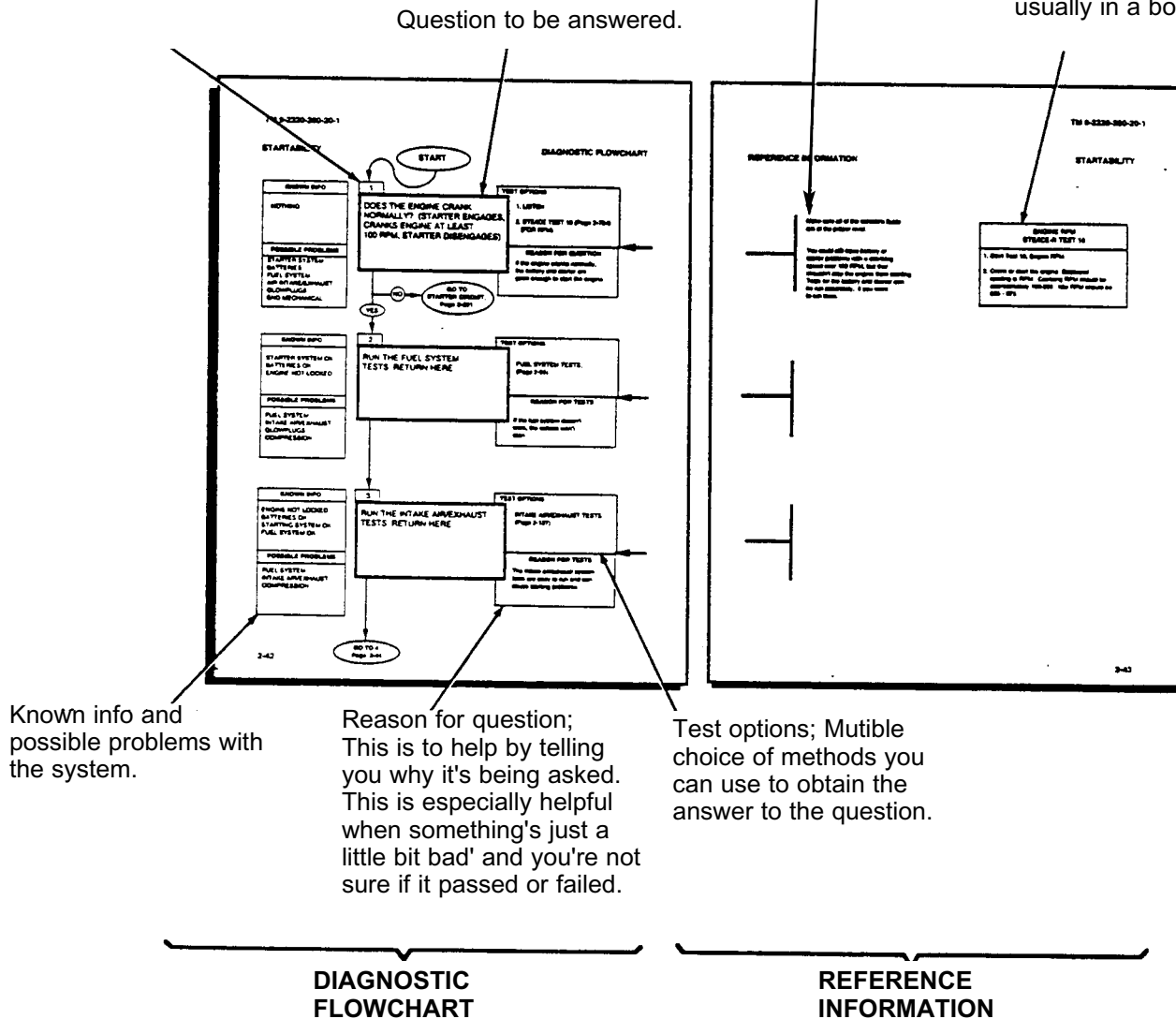
### PAGE LAYOUT

All diagnostic logic and flowcharts are on the left hand page, with supporting information, help, test, instructions and vehicle operation on the right.

Question number, so you know where you are and where to go when entering or leaving a test chain.

Notes, warnings and cautions about a particular question.

Instructions for how to perform a test or make a measurement, usually in a box.



### HOW TO TROUBLESHOOT

**PICK THE TESTS:** Select either a top level or a system level test.

### DIAGNOSTIC PROCEDURE

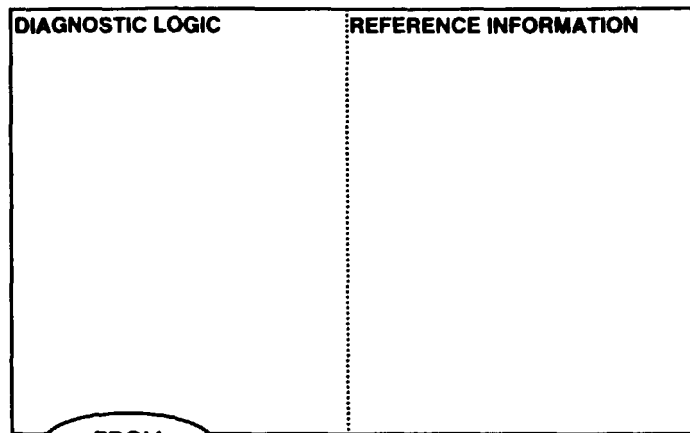
Just answer the questions on the left hand page and follow the YES or NO path. Helpful information about the question is also on the right hand page. If you aren't sure about a question or procedure, look on the right page for notes, instructions and help.

## 2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

### PAGE LAYOUT

Diagnostic logic is on the left hand page.

Related and helpful information is on the right hand page.



### DIAGNOSTIC PROCEDURE

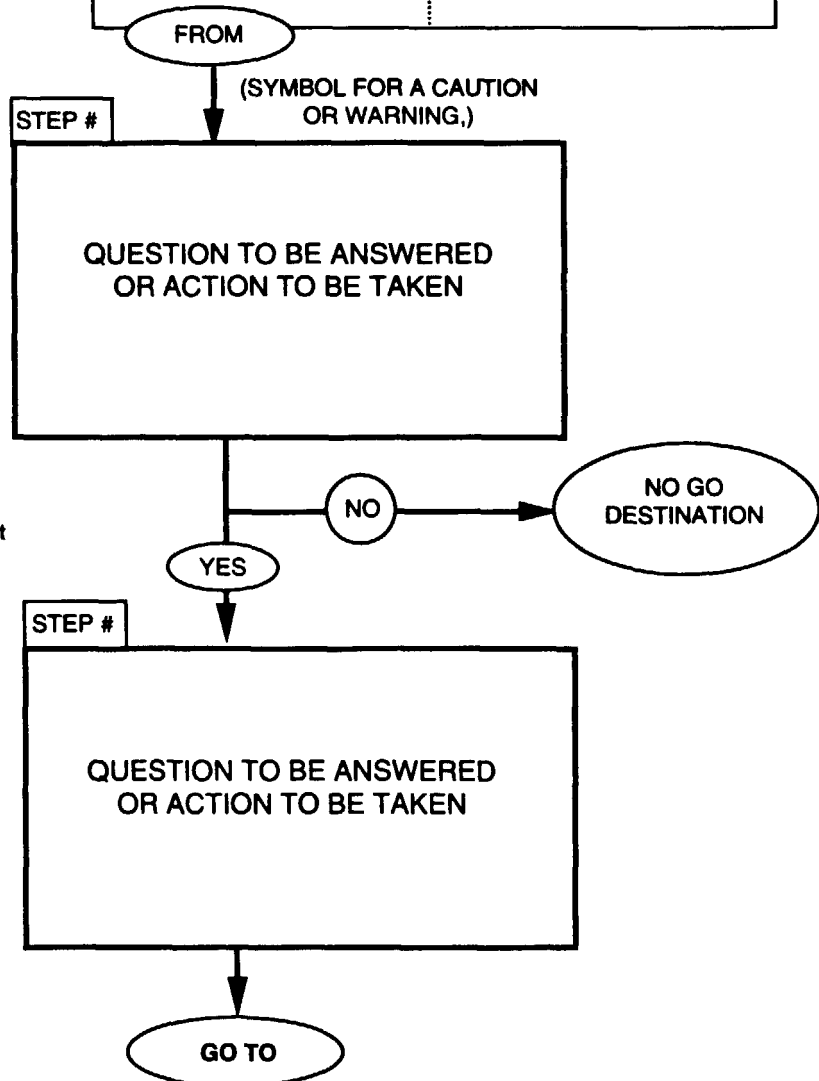
Just answer the questions on the left hand page. Follow the YES or NO path to the next step. Everything else on both pages is information to support the question. As a rule, the most important information (warnings, cautions, etc) is closest to the question, less important information is farther away.



Is the symbol for a WARNING statement. If you see this symbol above a question, look on the right hand page for the text of the message. The WARNING message on the right hand page will also have the symbol above it.



Is the symbol for a CAUTION statement. If you see this symbol above a question, look on the right hand page for the text of the message. The CAUTION message on the right hand page will also have the symbol above it.



2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

**INFORMATION ABOUT THE QUESTION**

**TEST OPTIONS:**

This box 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 option is first.

**REASON FOR QUESTION:**

If you know why the question is being asked, it should be easier to understand the diagnostic logic and easier to answer the question. This is especially helpful when a measurement is 'just a little bad'. Knowing why the question is being asked should help you decide if the answer should be 'YES' or 'NO'.

TEST OPTIONS
REASON FOR QUESTION

**INFORMATION ABOUT THE DIAGNOSTIC LOGIC**

**KNOWN INFO**

This box indicates what is known about the vehicle's condition. As you follow a test chain, parts will be listed here after they have checked ok. Sometimes this box will indicate a fault that you know exists, such as a shorted or open circuit, or a component that doesn't work. DO NOT USE THIS BOX TO PICK A 'JUMP-IN' POINT. ALWAYS RUN A COMPLETE CHAIN WHEN INSTRUCTED TO DO SO.

**POSSIBLE PROBLEMS**

This box is the opposite of 'KNOWN INFO'. Possible causes of the problem are listed here until tested and shown to be ok.

KNOWN INFO
POSSIBLE PROBLEMS

## 2-14. HOW TO USE THIS TROUBLESHOOTING GUIDE (CONT'D)

### INFORMATION ABOUT THE QUESTION



All warnings and cautions are given next to (or as close as possible to) the arrow pointing to the particular question. Look for the symbol that is in the box for the question in order to locate the particular note. Helpful notes, test procedures, or other information related to the question are provided here. These notes are provided as supporting information only, you don't usually need them to answer the question. The more skilled you become, the less you'll have to read these.

Any cross references to other manuals will be located in this area.



**NOTES, WARNINGS AND CAUTIONS ARE IN BOLD FACE TYPE.**

Additional information, notes and/or suggestions are in normal type so as not to draw too much attention.

### **TEST PROCEDURES**

These are special notes about how to make measurements with the test equipment. Occasionally, if space is limited on a page, the easiest procedure will be listed with a page reference for the other procedures if you would rather use them. The procedures presume a basic working knowledge of the equipment to be used, but references are included for the less experienced operator.

TYPE OF MEASUREMENT TYPE OF EQUIPMENT
Procedure for performing the measurement using the type of equipment listed above.

### **PICTURES**

The pictures are supposed to make it easier to find what you're looking for, such as a pin in a connector or a particular wire or component.

PICTURES ARE PROVIDED WHEREVER POSSIBLE.
--

## 2-15. GLOSSARY OF ABBREVIATIONS AND COMMONLY USED TERMS

PCB - Protective Control Box, located on the firewall above the brake pedal.

STE/ICE-R - Simplified Test Equipment for Internal Combustion Engines - Reprogrammable, a testing system used for performing tests and measurements on the vehicle. In addition to acting as a conventional digital multimeter to measure voltage, current and resistance, it is also capable of measuring pressure, speed, compression unbalance, engine power, and some specialized battery and starter evaluations. It is powered from the vehicle batteries. The complete system includes a vehicle test meter (VTM), a transducer kit (TK), cables, transit case and technical publications.

DCA - Diagnostic Connector Assembly, an electrical harness on the vehicle which allows the STE/ICE-R to be powered and to make measurements of key vehicle signals from a single connection. In addition to many basic electrical signals such as starter voltage and current, it includes engine speed and fuel supply pressure. The STE/ICE-R can make TK measurements at the same time that it is connected to the DCA.

VTM - Vehicle Test Meter, a box which performs the measurement and analysis functions of the STE/ICE-R systems.

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. This allows the STE/ICE-R to be used anywhere that you want to measure voltage, current, resistance, pressure, or speed. TK mode of operation is what you are doing when you use this kit (as opposed to DCA mode where you are using the vehicle's built-in sensors to make measurements).

Compression unbalance - A STE/ICE-R test that gives an indication of any engine cylinders that have lower compression than the average. It does this by monitoring the battery voltage during cranking. As each cylinder goes into compression, the extra load on the starter shows up as a drop in voltage. This works well for finding one or more cylinders that have a compression problem, but don't forget that it doesn't give the average compression. If all cylinders are low by the same amount, this test doesn't find it.

Troubleshooting - the process of making measurements and observing the operation of the vehicle to find out if anything is wrong with it and then to locate any problem that exists.

Diagnostics - Troubleshooting by following an exact procedure.

Test Chain - a series of tests to be followed in a particular order or sequence. It is referred to as a "chain" of tests because they are all connected one after another like the links of a chain.

System - a collection of devices which are all related to each other because they depend on each other to do some function or job. For instance, the function of the fuel system is to inject fuel into the cylinders at the correct time in the correct amount and with the correct quality. The collection of devices that are required to do this include the fuel pump, fuel lines, lift pump, fuel filter, injection pump, and injectors.

## 2-15. GLOSSARY OF ABBREVIATIONS AND COMMONLY USED TERMS (CONT'D)

Functional flow schematic - a diagram which is much like a normal electrical circuit diagram, except that its purpose is to show the flow of information through the system (or the flow of a signal or the flow of some material such as the fuel). This kind of diagram shows how each component or device depends on the others. It is called functional flow because it shows the function (purpose of each component) and how the output of one component "flows" into the next. For troubleshooting, the functional flow schematic is better than the usual circuit diagram because it allows you to quickly see how the system works and what to expect when you make measurements on a system that has faults. You can't expect the output of a device to be good when it has a bad input.

## 2-16. ELECTRIC CIRCUIT DESCRIPTION

An electrical circuit is a collection of electrical devices which are connected in a loop from a positive voltage source (the battery positive) to a negative source (the battery negative). It must be continuous, with no breaks (no opening in the loop) so that electrical current can flow from the positive to the negative. You can think of it like the plumbing in your house. There must be a source of water under pressure or nothing will flow through the pipes. Water pressure is like the positive voltage of the battery. There may be branches (tees) in the pipes going to several different places, but if you don't connect the pipes, you don't get water. The same thing is true with the electrical circuit. If the wires aren't connected, no electricity will flow through them.

In the plumbing of a house, all of the water must go to the drain (you won't permit it to be spilled on the floor). With the vehicle electrical circuit, the drain is the negative terminal of the battery. With the water pipes, the water always flows from high pressure to low pressure (another way of saying that water always flows downhill). The electrical current is the same as the water flow - it always goes from positive to negative voltage. Voltage is to electricity what pressure is to water. Just like the pressure in the water pipe, the greater the voltage, the more electricity will flow through the wires. Unlike the water pipes that will spill the water if they break, you can't "spill" the electricity. The closest thing to this in an electrical circuit is when two wires touch that aren't supposed to and the current flows to some place that it shouldn't (this is called a "short circuit" or a "short"). Shorts often happen where the wire touches the vehicle body (the body is connected to the negative terminal of the battery). Since the current always flows through the easiest path to negative, it will bypass the rest of the circuit where it was supposed to go, and go through the short directly to the battery. Because this new path to the battery negative is shorter the malfunction is called a "short circuit" or a "short".

If you put a valve in a water pipe, you can control how much water flows by closing the valve. What you are doing is pinching off the pipe with the valve which restricts the flow. If you shut it off completely, you can stop all water from flowing. In the electrical circuit, a resistor acts like a valve. If you make the resistor extremely large, you can stop the current from flowing. The resistance is measured in "ohms".

## 2-16. ELECTRIC CIRCUIT DESCRIPTION (CONT'D)

When there is no electrical connection, such as when a wire is disconnected, the resistance is infinite (too large to be measured). No current will flow through the wires, because the circuit is no longer continuously connected. This is referred to as an "open circuit" or simply an "open". Remember that an electrical circuit is formed by continuous loops of devices connected together. When you are troubleshooting you are often asked to check for "continuity", which simply means that you need to find out if there is a continuous path from one place in the circuit to another. Since you are trying to see if the path is continuous, you must check wires and switches rather than any special or active devices. You will usually just measure the resistance between two points. If the resistance is zero (or the value of any resistance that is supposed to be there), then there is continuity. In the case of looking for a short, this may mean that you have found the short. If the resistance is off-scale on the meter (infinite resistance) then there is no connection and you have found an open. A continuity test is the same whether you are looking for an open or a short, the only difference being what resistance values you are looking for and where you make the measurements.

You are familiar with the typical light switch which allows you to turn a light on and off. A switch of any kind in an electrical circuit is simply a way of opening the loop so that no current will flow through it. Something to remember while troubleshooting is that everything on the positive side of the switch still has full battery voltage while everything from the switch on through the rest of the circuit is (or should be) connected to the battery negative terminal and you will measure zero volts. This is easy to remember if you think of the faucet on a sink. If you shut off the faucet, there is no water flowing into the sink, but the water in the pipe is still under pressure.

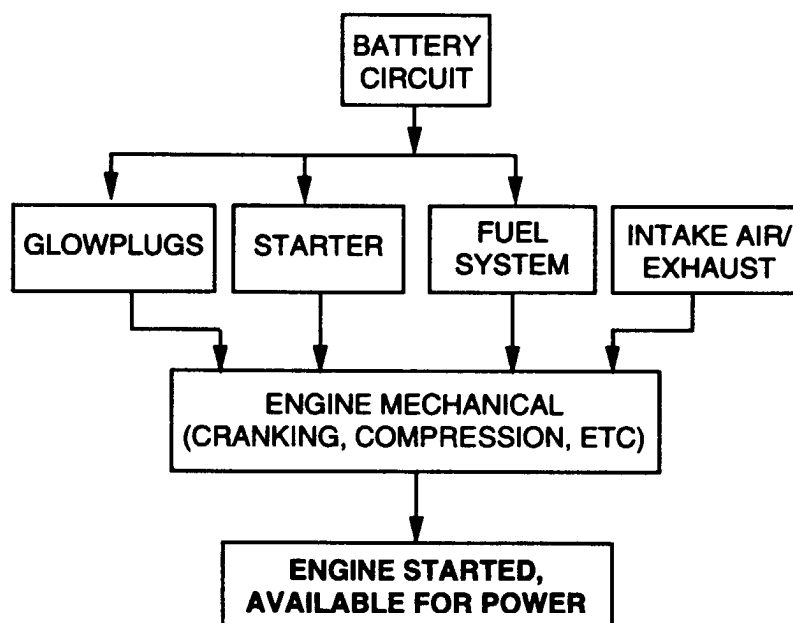
Sometimes a switch is turned on and off automatically. An example is a "circuit breaker" which is a device that measures how much current is flowing through it. If the current goes too high (possibly damaging equipment or melting the wires) then it opens an internal switch to stop the current flow. A "relay" is another form of switch that is turned on and off under remote control using a signal in another wire. When a device which requires a very large amount of current (such as the starter motor), must be turned on and off, a "power relay" is used. The idea is to use a small switch to turn on a larger switch. Thus, you don't have very large wires going all over the vehicle or large switches on the instrument panel. In the case of the starter's power relay, it is also called a "solenoid". A solenoid is any device that changes the electrical current into a forward and backward motion. It is something like an electrical motor except that instead of continuously going around in the same direction, it goes in or out. For the starter, the solenoid is used to "push" a very large switch into the "on" position.

When testing a circuit, you will need to know how much current is flowing. Current is easily measured with the STE/ICE-R. A device called a "shunt" is connected to the negative terminal of the battery. A shunt is a very precise resistor designed so that for every 1000 amps of current that flow through it there is a drop of .1 volts from one side of it to the other (different shunts may have different values). By measuring the voltage across the shunt you know how much current is flowing through the circuit. The shunt is placed on the negative side because it is safer (less chance of accidents which may short out the batteries). Since all of the current eventually goes through the negative battery terminal anyway, the shunt gives the same measurement as if it were connected to the positive terminal. You can think of the shunt as doing the same thing as the water meter in your house. As you turn devices such as lights on or off, you can use the shunt to measure how much current they are using.

## 2-17. STARTABILITY TESTS

This is a top level test for problems with an engine that doesn't start, or starts but immediately stops, or is very hard to start. If the engine starts but doesn't run well after starting, try the "STARTABILITY" tests first.

FOR THE ENGINE TO START, ALL OF THE BASIC SYSTEMS SHOWN BELOW MUST BE WORKING. THESE STARTABILITY TESTS WILL HELP YOU TO VERIFY THE CONDITION OF EACH OF THESE SYSTEMS.



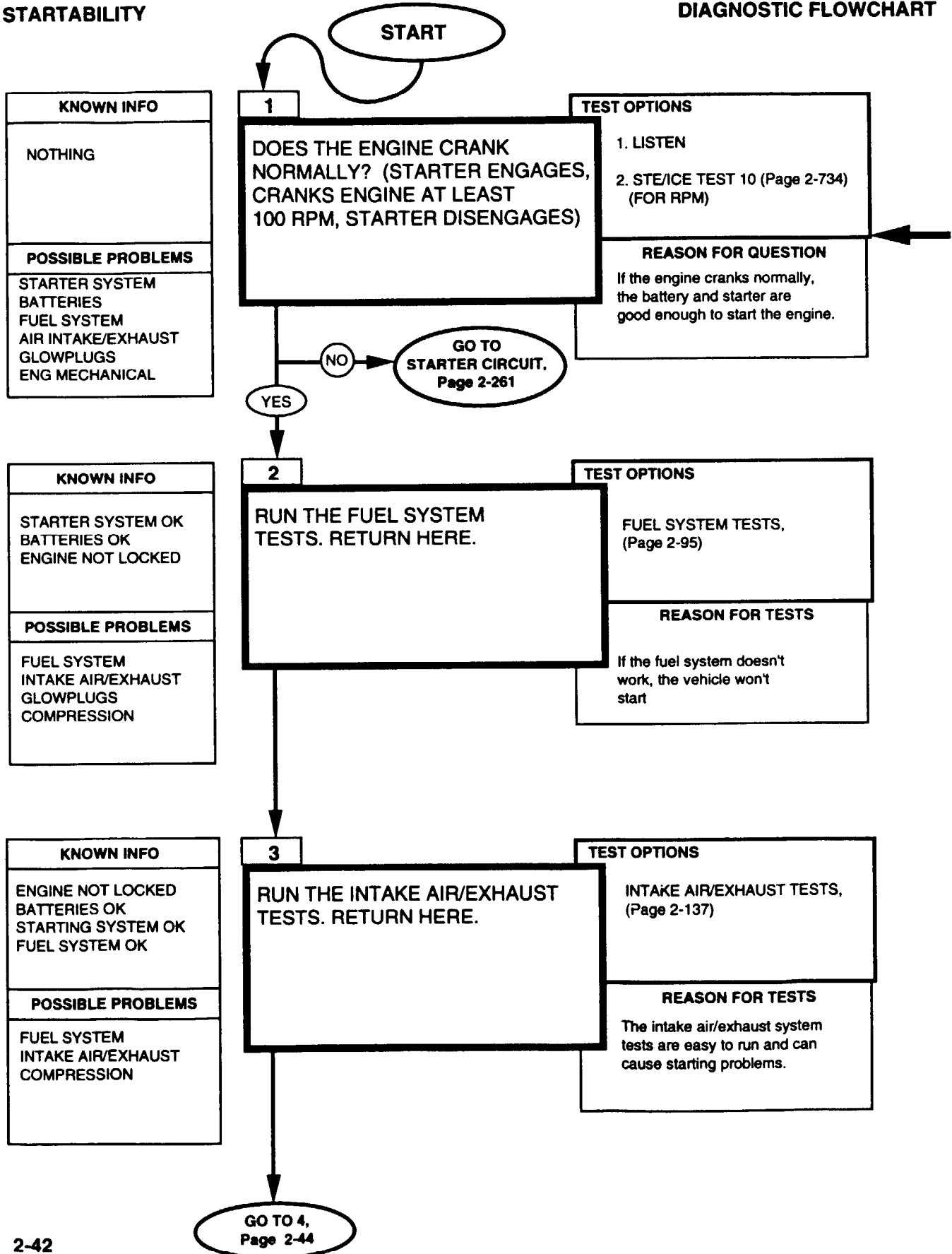
A functional flow schematic is not applicable to this section. However, so that you may refer to sections as you need them, a quick index to the systems required for starting is given here.

PARAGRAPH	PAGE
BATTERY CIRCUIT	2-251
GLOWPLUGS CIRCUIT	2-303
STARTER CIRCUIT	2-261
FUEL SYSTEM	2-95
INTAKE AIR/EXHAUST	2-137
COMPRESSION/MECHANICAL	2-143



# STARTABILITY

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## STARTABILITY

Make sure all of the vehicle's fluids are at the proper level.

You could still have battery or starter problems with a cranking speed over 100 RPM, but that shouldn't stop the engine from starting. Tests for the battery and starter can be run separately, if you want to run them.

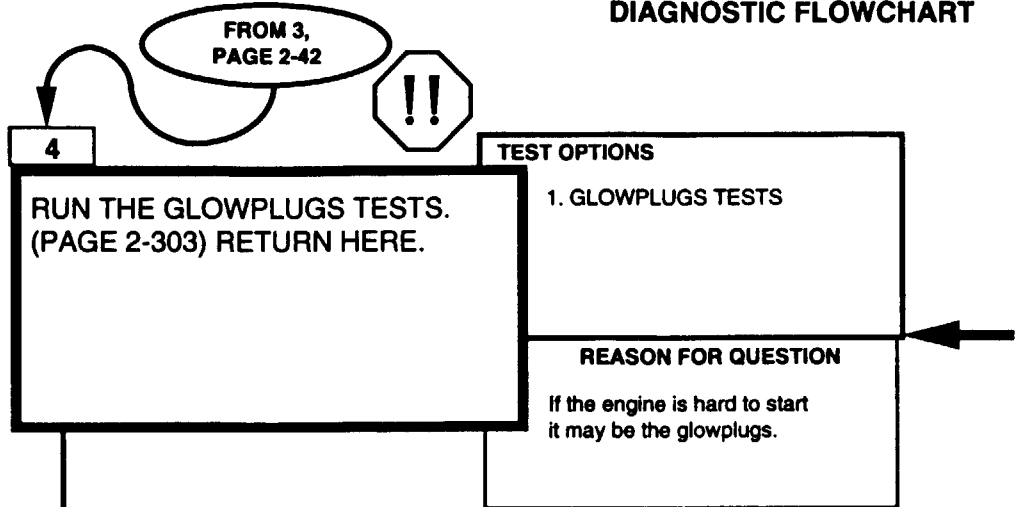
### ENGINE RPM STE/ICE-R TEST 10

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100-200. Idle RPM should be 625 - 675.

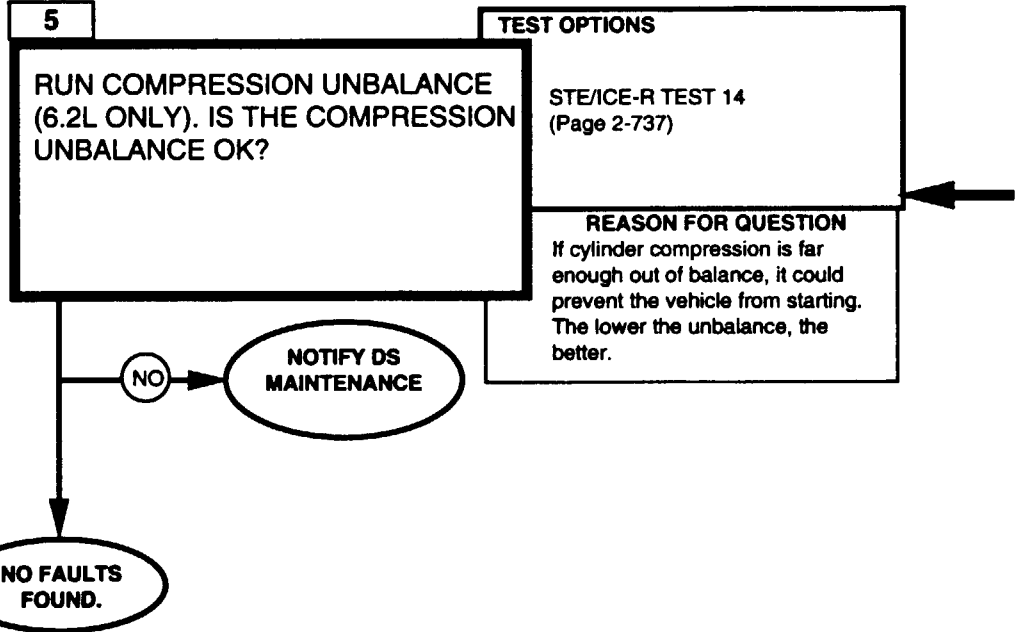
# STARTABILITY

## DIAGNOSTIC FLOWCHART

KNOWN INFO
ENGINE NOT LOCKED BATTERIES OK STARTING SYSTEM OK FUEL SYSTEM OK INTAKE AIR/EXHAUST OK
POSSIBLE PROBLEMS
GLOWPLUGS COMPRESSION



KNOWN INFO
ENGINE NOT LOCKED BATTERIES OK STARTING SYSTEM OK GLOWPLUGS OK INTAKE AIR/EXHAUST FUEL SYSTEM OK
POSSIBLE PROBLEMS
COMPRESSION



## REFERENCE INFORMATION

## STARTABILITY

**WARNING**

A HOT ENGINE MAY CAUSE SERIOUS BURNS. Always use caution when approaching a hot engine.

**NOTE**

When using the vehicle's temperature gage to determine engine temperature, don't forget to turn the rotary switch to "RUN". The gages don't work when power is off.

The colder the engine (and air temperature), the more you need the glowplugs for starting. There are some times when you don't need to run the glowplugs test. If the engine is warm and the problem is there on a hot day, then the problem is probably NOT the glowplugs or cold start advance, and these tests may be bypassed. If it's colder than 50°F, run the glowplugs test, because just a few bad glowplugs can make a minor starting problem much worse.

If the vehicle passes the STE/ICE-R compression unbalance test, it may still have a compression problem, but it would mean that every cylinder has low compression. This is possible, but not too likely. If you're confident that everything else is working properly, notify DS maintenance.

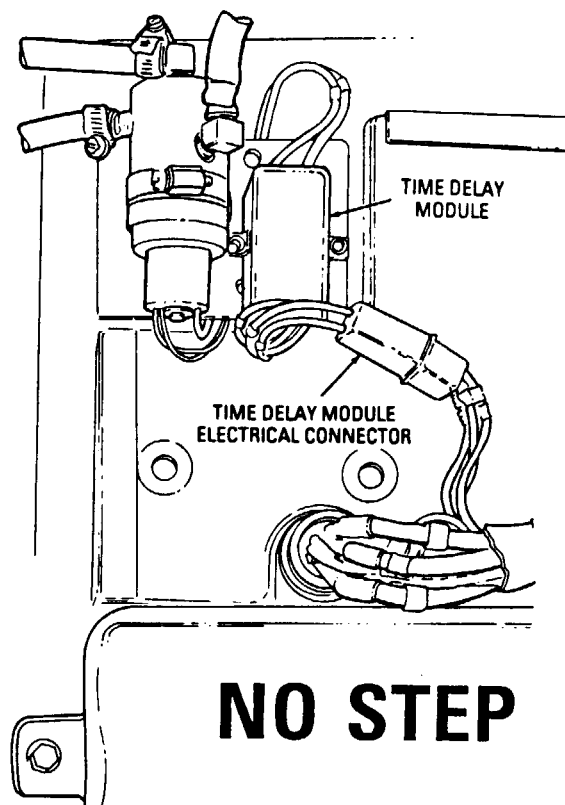
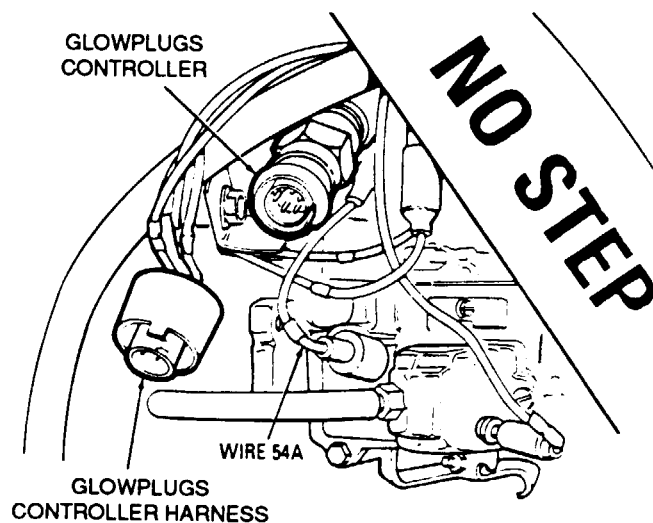
**COMPRESSION UNBALANCE  
STE/ICE-R TEST 14**

1. Run tests 72,73 and 74 to verify that the batteries are OK.

**CAUTION**

THE GLOWPLUGS CONTROLLER AND THE CONTROL VALVE ELECTRICAL CONNECTOR MUST BE DISCONNECTED PRIOR TO RUNNING THIS TEST.

2. Disconnect wire 54A at injection pump to prevent starting.
3. Disconnect glowplugs controller and control valve electrical connector. (to keep waveform clean).
4. Start Test 14, compression unbalance.
5. Wait for the GO message. Crank the engine.
6. Release the rotary switch when the VTM displays OFF. A number less than 25% is passing.



**2-18. ENGINE RUNNING TESTS**

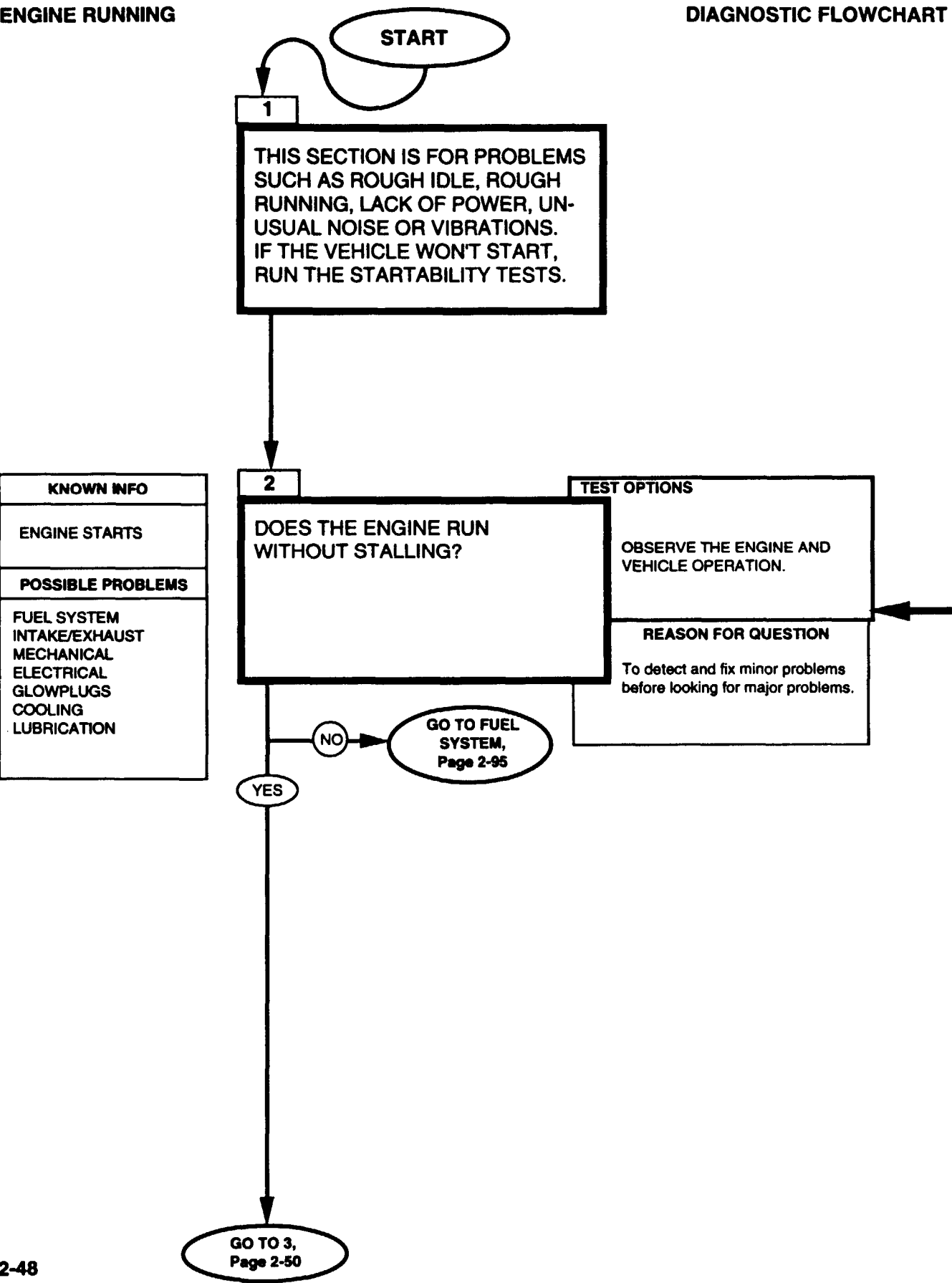
This is a top level test for problems with an engine that starts but doesn't run well after starting. This includes an engine that starts but doesn't stay running for very long. If the engine doesn't start, or starts but immediately stops, or is very hard to start, try the "STARTABILITY" tests first.

A functional flow schematic is not applicable to this section.  
However, so that you may refer to sections as you need them, a quick index to the systems relating to engine running is given here.

PARAGRAPH	PAGE
FUEL SYSTEM	2-95
INTAKE AIR/EXHAUST	2-137
COMPRESSION/MECHANICAL	2-143

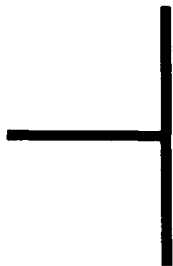
ENGINE RUNNING

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ENGINE RUNNING

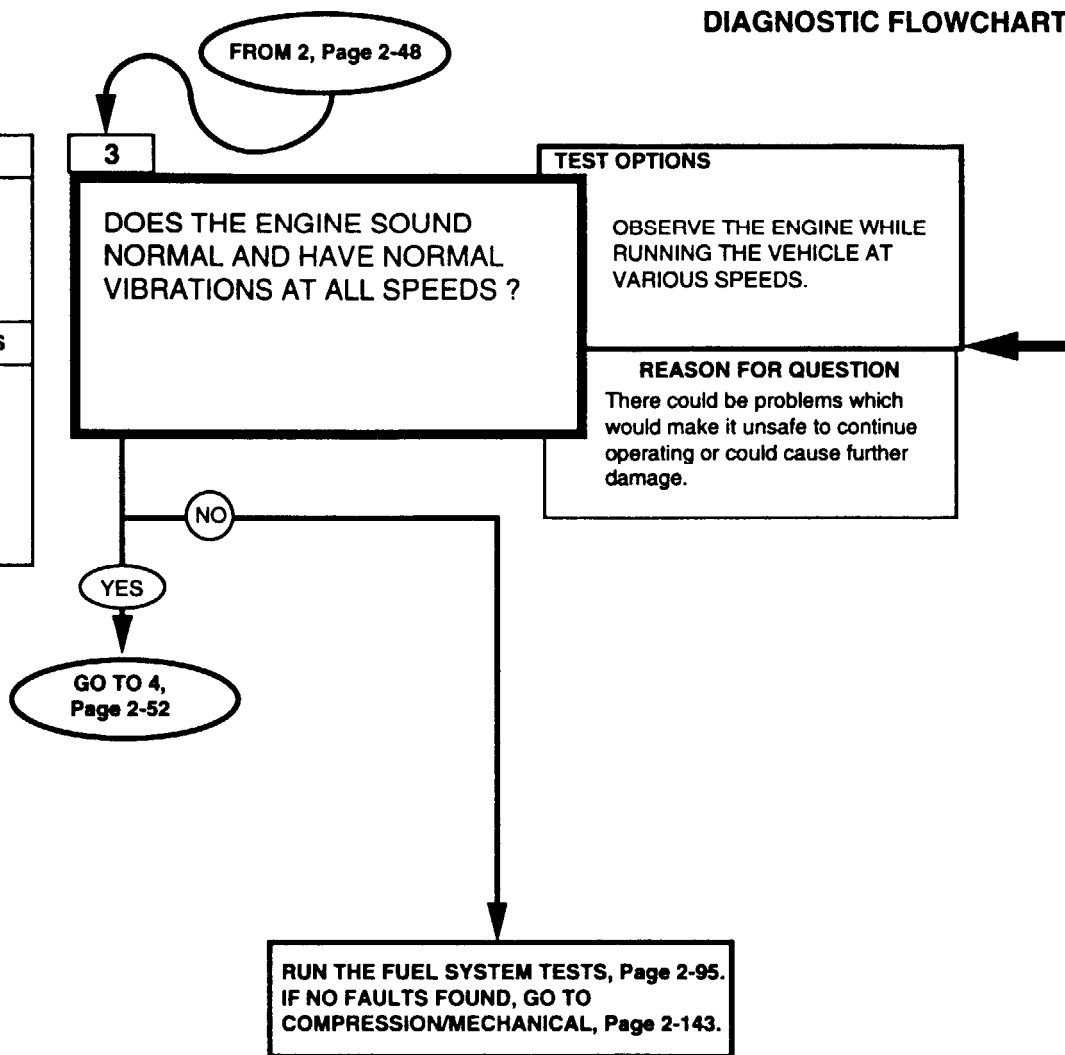


This is a check for all of those problems which can cause the engine to stop when it shouldn't. This includes fuel, air, and electrical problems. If the engine starts and then stops immediately, run the STARTABILITY tests first.

# ENGINE RUNNING

## DIAGNOSTIC FLOWCHART

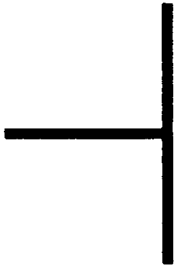
KNOWN INFO
ENGINE STARTS AND STAYS RUNNING. FUEL SYSTEM OK INTAKE/EXHAUST OK
POSSIBLE PROBLEMS
MECHANICAL ELECTRICAL GLOWPLUGS COOLING LUBRICATION





## REFERENCE INFORMATION

## ENGINE RUNNING



Listen for noises from the engine that aren't usually there when the engine is running normally. Also be alert for unusual vibrations while the engine is idling and while you accelerate to a safe and reasonable speed.

**ENGINE RUNNING**

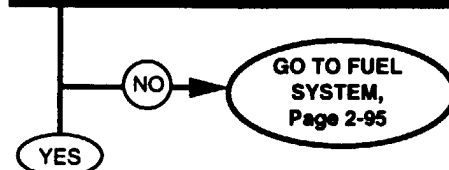
**DIAGNOSTIC FLOWCHART**

KNOWN INFO
ENGINE STARTS AND STAYS RUNNING WITH NO ABNORMAL SOUNDS OR VIBRATIONS.
POSSIBLE PROBLEMS
MECHANICAL FUEL SYSTEM



**DOES THE ENGINE PRODUCE RATED POWER ?**

TEST OPTIONS
1. STE/ICE-R TESTS 13, 12 (Page 2-736 & 2-735)
2. ACCELERATE ON A LEVEL SURFACE.
REASON FOR QUESTION
If the engine produces rated power now, then it is probably ok to use.

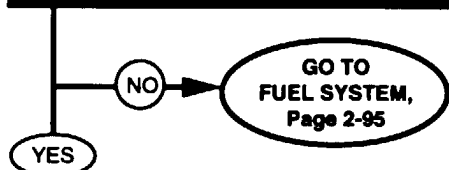


KNOWN INFO
ENGINE STARTS AND STAYS RUNNING WITH NO ABNORMAL SOUNDS OR VIBRATIONS.
POSSIBLE PROBLEMS
MECHANICAL FUEL SYSTEM

5

**IS THE EXHAUST COLORLESS?**

TEST OPTIONS
LOOK AT EXHAUST WHILE ENGINE IS RUNNING.
REASON FOR QUESTION
Abnormal exhaust is a sign of a fuel, air or mechanical problem.

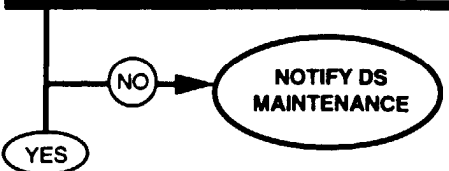


KNOWN INFO
ENGINE STARTS AND STAYS RUNNING WITH NO ABNORMAL SOUNDS OR VIBRATIONS. EXHAUST OK
POSSIBLE PROBLEMS
FUEL SYSTEM COOLING SYSTEM ELECTRICAL SYSTEM

6

**DOES THE ENGINE PASS COMPRESSION UNBALANCE? (6.2L ONLY)**

TEST OPTIONS
1. STE/ICE-R TEST 14 (Page 2-737)
REASON FOR QUESTION
Bad compression can make other systems look bad. The lower the compression unbalance number, the better the engine.



GO TO 7,  
Page 2-54

**REFERENCE INFORMATION****ENGINE RUNNING**

If STE/ICE-R is not available, accelerate under full power to a safe and reasonable speed on a level surface. For STE/ICE-R test #12, a number higher than 6700 is passing. For test #13, a number higher than 75 is passing.

It is normal for the engine to emit some black smoke when accelerating after idling for a while. Under most other conditions, exhaust smoke is usually from one of three sources;

BLUE smoke is usually oil.  
BLACK smoke is too much fuel or too little air. (Often caused by advanced injection timing).  
WHITE smoke is usually water. (Often caused by retarded injection timing).

If the smoking is continuous or appears under a particular condition, the smoke probably indicates a problem and should be investigated.

If STE/ICE-R is not available, there is no easy way to test compression. In this case, go on to the next step but remember that compression may be a problem.

**ENGINE POWER TEST (PERCENT)  
STE/ICE-R TEST #13**

1. Set TEST SELECT switches to 13.
2. Press and release TEST button.
3. Wait for prompting message CIP to appear.
4. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays OFF, release accelerator.
5. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of per cent of nominal rated power.

**ENGINE POWER TEST (RPM/SEC)  
STE/ICE-R TEST #12**

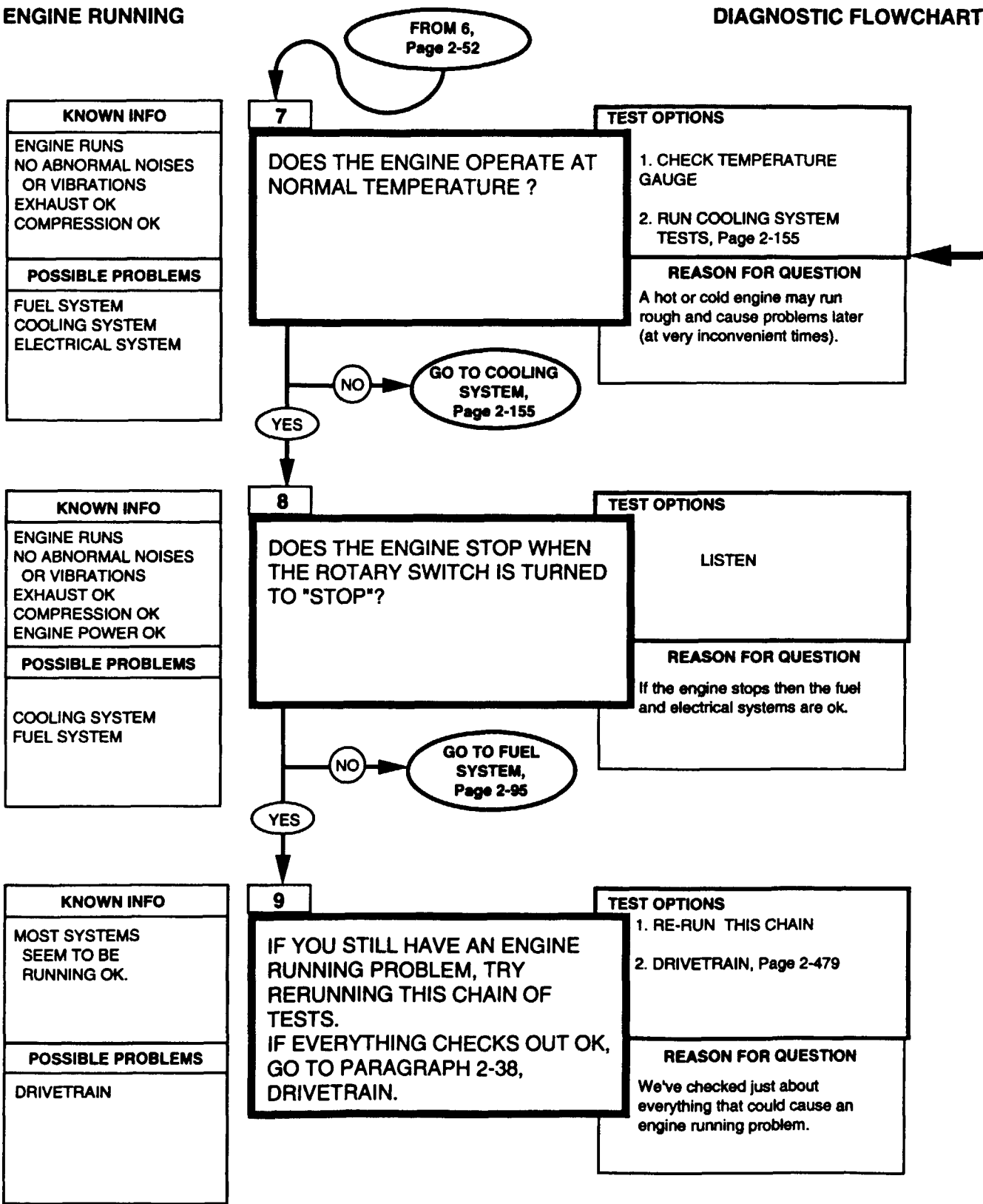
1. Set TEST SELECT switches to 12.
2. Press and release TEST button.
3. Wait for prompting message CIP to appear.
4. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays a number, release accelerator.
5. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of rpm's per second.

**COMPRESSION UNBALANCE  
STE/ICE-R TEST 14**

1. Run tests 72,73 and 74 to verify that the batteries are ok.
2. THE GLOWPLUG CONTROLLER AND THE CONTROL VALVE ELECTRICAL CONNECTOR MUST BE DISCONNECTED PRIOR TO RUNNING THIS TEST.
3. Disconnect wire 54A at injection pump to prevent starting.
4. Disconnect glowplug controller and control valve electrical connector. (to keep waveform clean).
5. Start Test 14, compression unbalance.
6. Wait for the GO message. Crank the engine.
7. Release the rotary switch when the VTM displays OFF. A number less than 25% is passing.

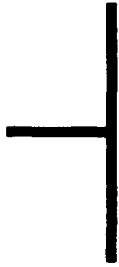
ENGINE RUNNING

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

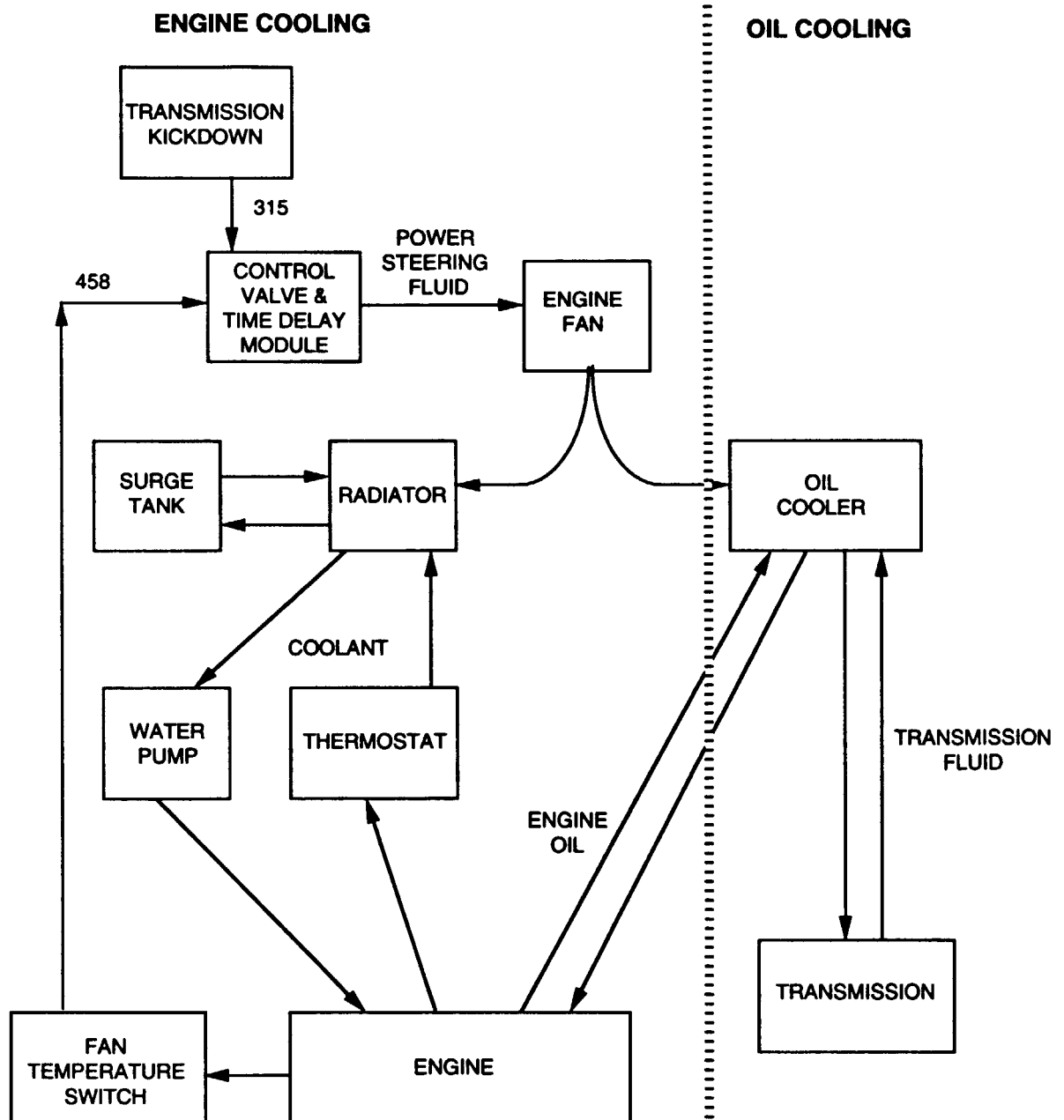
## ENGINE RUNNING



Because the Cooling System tests can take a long time (mostly letting a cold engine warm up), you don't have to run them unless there is or may be a problem in the cooling system.

## 2-19. COOLING SYSTEM TESTS

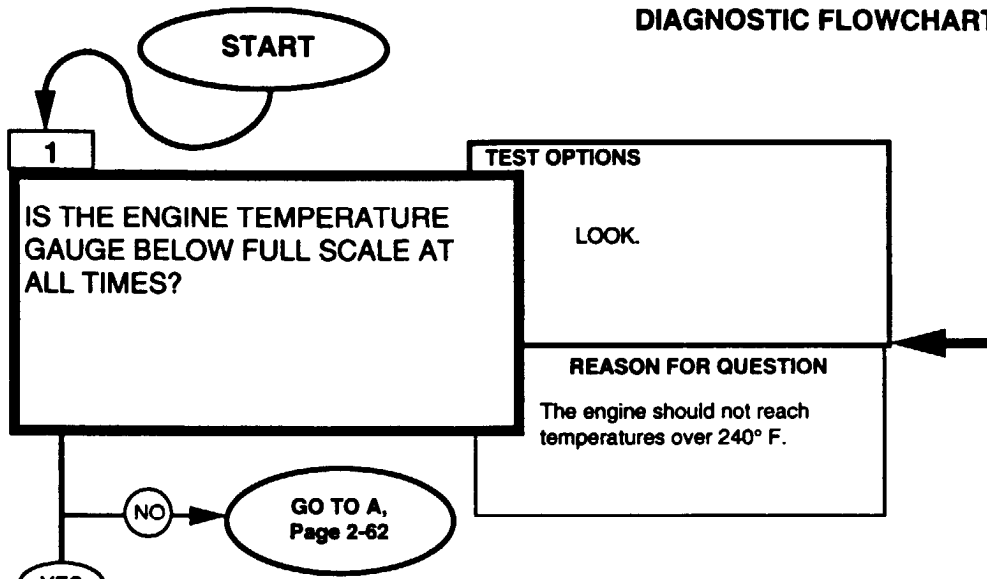
This paragraph is a top level test for problems with either the watercooling system or the oil cooling system. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary. The Cooling System consists of the oil and water radiators, the engine fan and its controller, the water pump, and the internal coolant passages in the engine.



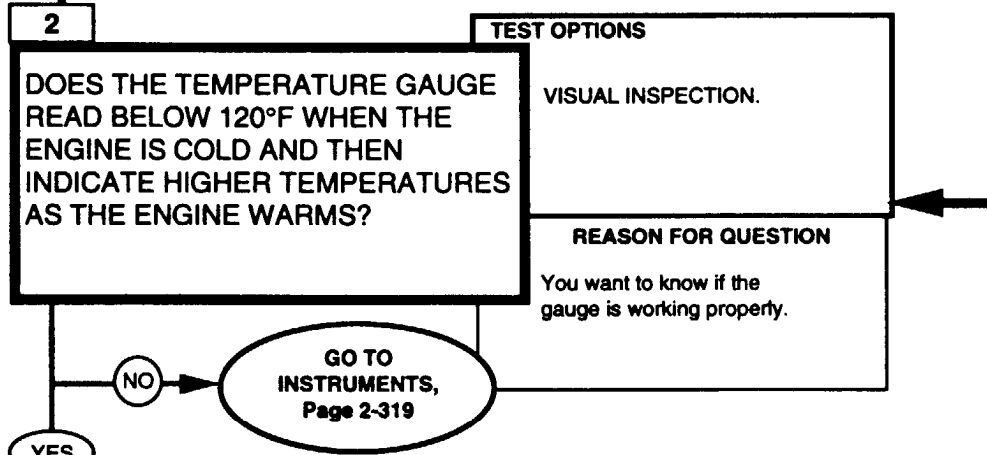
# COOLING SYSTEM

## DIAGNOSTIC FLOWCHART

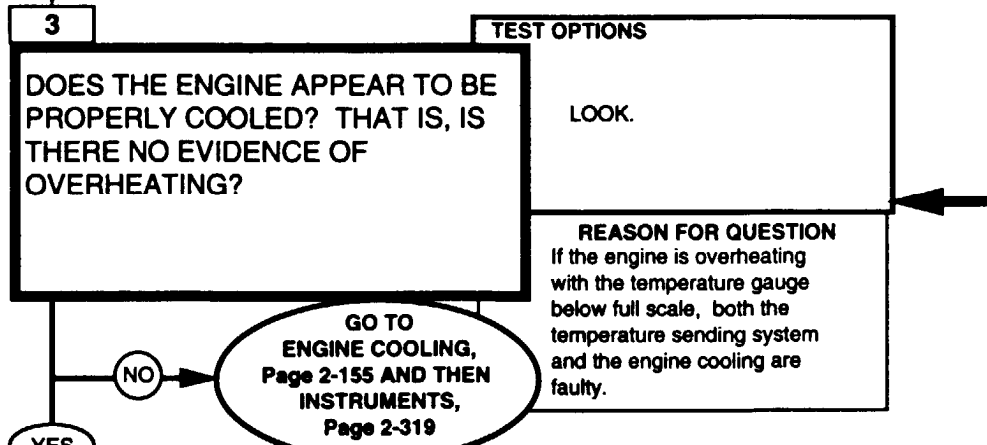
KNOWN INFO
NONE
POSSIBLE PROBLEMS
TEMPERATURE GAUGE TEMPERATURE SENDER ENGINE COOLING SYSTEM OIL COOLING SYSTEMS FAN BELTS CONTROL VALVE



KNOWN INFO
TEMPERATURE GAUGE IS BELOW 240°F AT ALL TIMES.
POSSIBLE PROBLEMS
TEMPERATURE GAUGE TEMPERATURE SENDER ENGINE COOLING SYSTEM OIL COOLING SYSTEMS FAN BELTS CONTROL VALVE

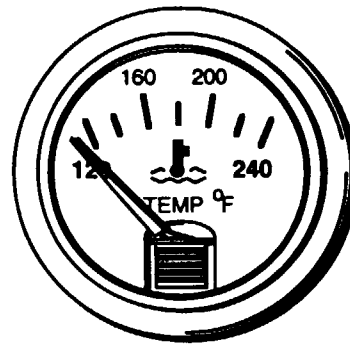
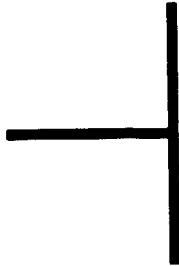


KNOWN INFO
TEMPERATURE GAUGE SEEMS TO WORK OK
POSSIBLE PROBLEMS
TEMPERATURE GAUGE TEMPERATURE SENDER ENGINE COOLING SYSTEM OIL COOLING SYSTEMS FAN BELTS CONTROL VALVE

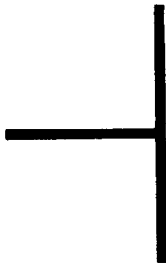


## REFERENCE INFORMATION

## COOLING SYSTEM



TEMPERATURE GAUGE



The question describes how the gauge should work. If you aren't sure if its working properly, you may want to run the instruments test anyway.



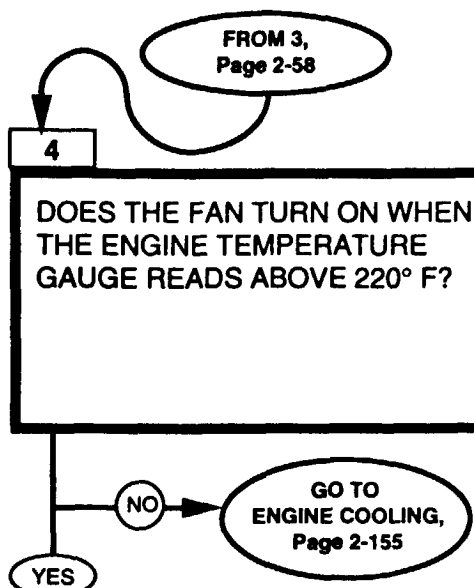
Look for boiling coolant, a blown surge tank pressure cap or leaking hoses to tell you if the engine is overheating.



# COOLING SYSTEM

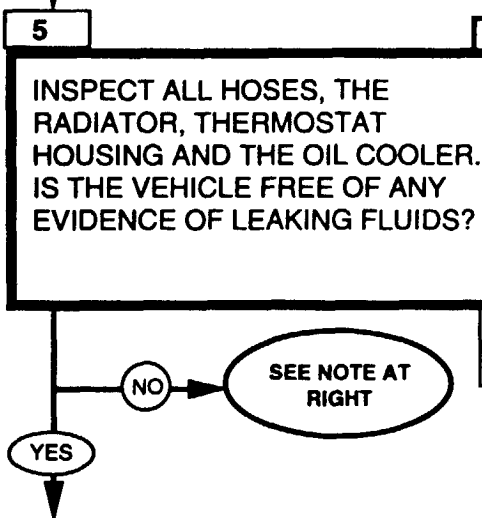
## DIAGNOSTIC FLOWCHART

KNOWN INFO
TEMPERATURE GAUGE OK TEMPERATURE SENDER OK
POSSIBLE PROBLEMS
ENGINE COOLING SYSTEM OIL COOLING SYSTEMS FAN BELTS FAN CLUTCH/TIMER




TEST OPTIONS
LOOK.
REASON FOR QUESTION
The fan clutch should turn the fan on when the temperature is above 220° F.

KNOWN INFO
FAN BELTS OK FAN CLUTCH/TIMER OK GAUGE AND SENDER OK
POSSIBLE PROBLEMS
ENGINE COOLING SYSTEM OIL COOLING SYSTEMS



TEST OPTIONS
LOOK.
REASON FOR QUESTION
The vehicle should not leak fluids.

**REFERENCE INFORMATION****COOLING SYSTEM**

220° F is the approximate temperature at which the fan should turn itself on.

The fan will turn on and off as the engine temperature varies.

**NOTE**

If the leaking fluid is red, go to the transmission Paragraph 2-34, Page 2-399 or Paragraph 2-35, Page 2-411.

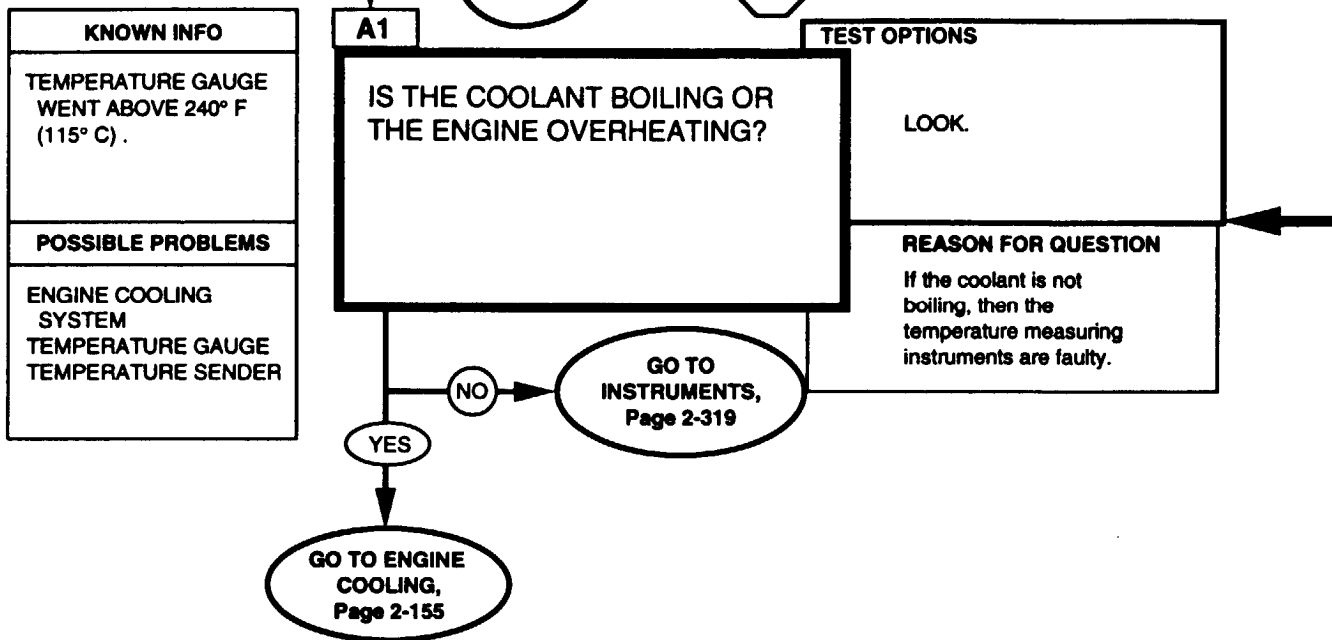


If the leaking fluid is yellow/green, go to engine cooling, Paragraph 2-25, Page 2-155.

If the oil cooler is leaking, try to determine where the leak is coming from. The oil cooler in front of the radiator cools both engine oil and transmission fluid (top half-transmission fluid, bottom half-engine oil). If the leak is in the oil cooler, go to transmission or engine cooling. If the leak is elsewhere, go to lubrication, Paragraph 2-20, Page 2-65.

# COOLING SYSTEM

# DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

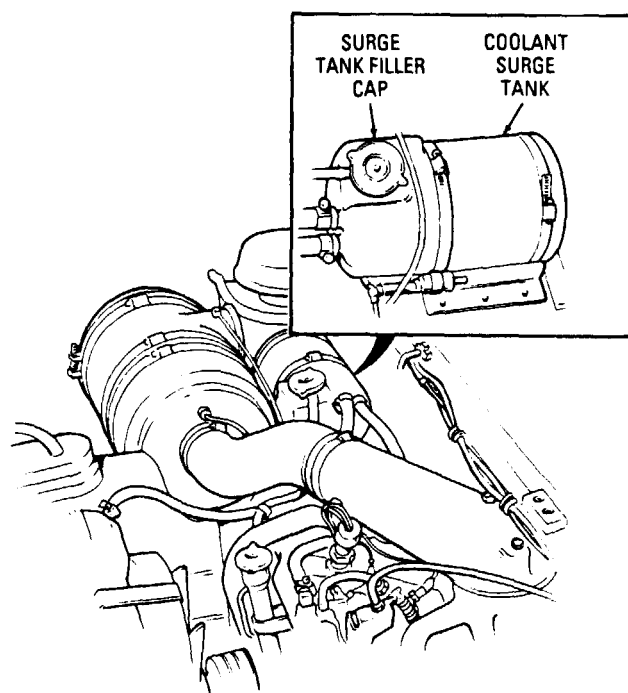


### **WARNING**

USE CAUTION WHEN INSPECTING HOT ENGINE PARTS TO AVOID BURNS. NEVER REMOVE THE PRESSURE CAP OF A HOT ENGINE.

The coolant surge tank is clear, so you can see what is happening.

## COOLING SYSTEM



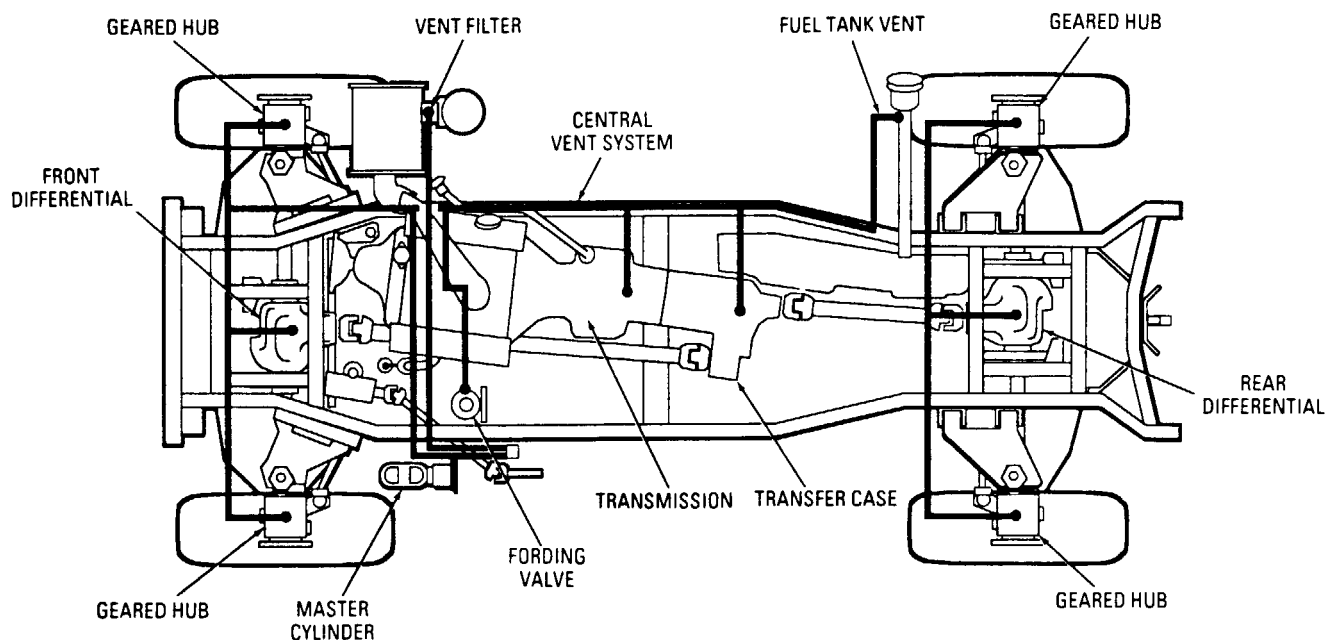
## 2-20. LUBRICATION SYSTEM TESTS

This paragraph is a top level test for all of the lubrication systems in the vehicle. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The HMMWV includes a venting system that is also checked in this paragraph. The purpose of the vent system is to allow vapor to escape to the atmosphere under normal operation, and to prevent venting during deep water fording operations. If the vents were left open, water would enter the engine and other systems and cause damage. The location of the vent lines is shown below. The location of the other parts in the lubrication system are shown in other lower level paragraph as required.

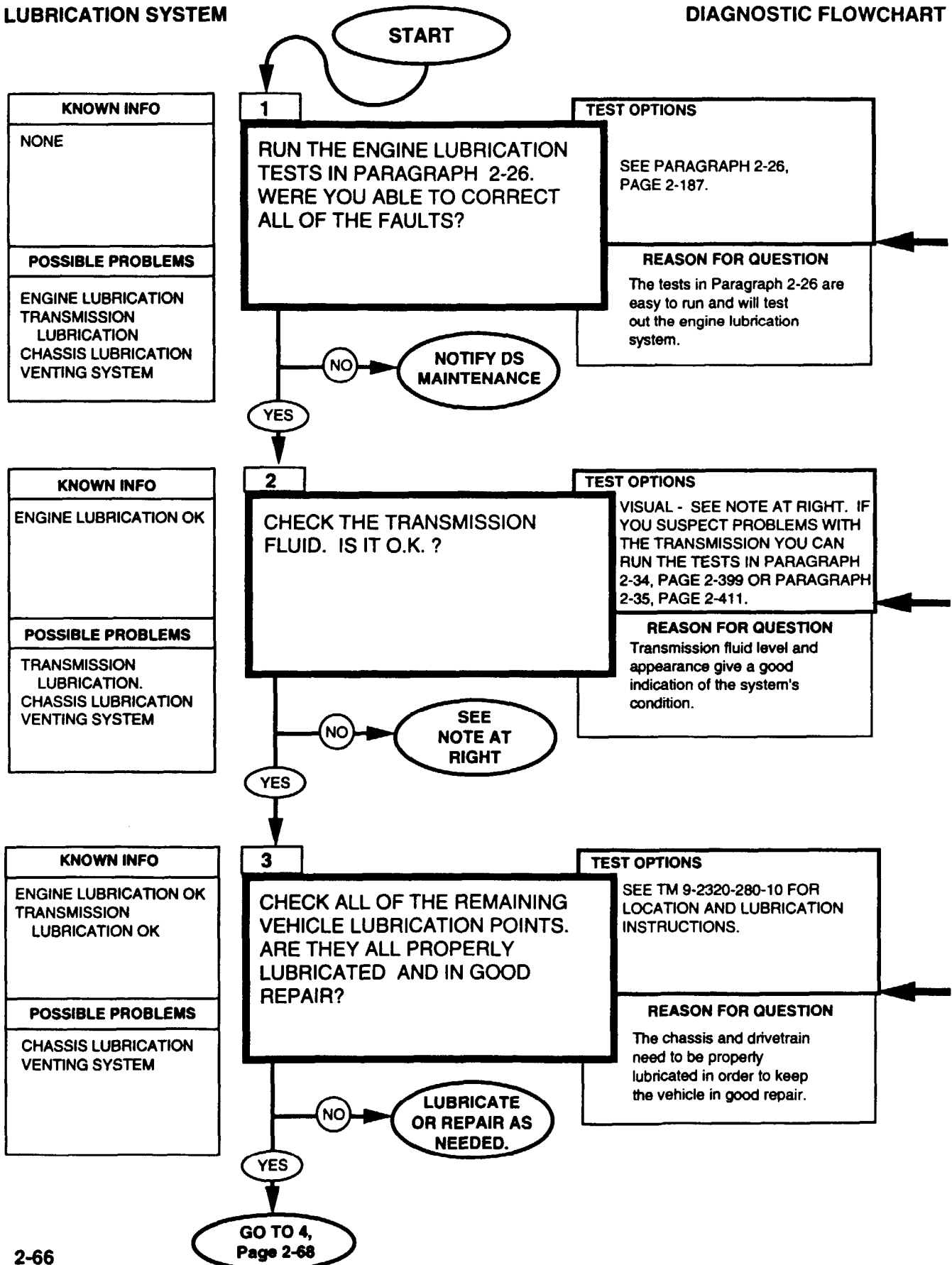
### NOTE

**Bold lines represent ventilation system.**



# LUBRICATION SYSTEM

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## LUBRICATION SYSTEM

The tests in para. 2-26 test the oil level, cleanliness, leaks in the system, and the CDR valve. Return here when you've fixed everything you can or if no faults were found.

PROCEDURE FOR CHECKING TRANSMISSION FLUID

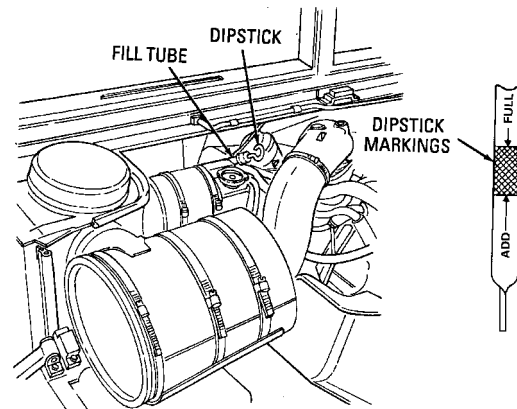
1. Start engine.
2. Hold down brake pedal and move transmission shift lever through all ranges including reverse.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between "FULL" and "ADD" marks on dipstick.

**NOTE**

CHECK FLUID FOR A BURNT SMELL, GRIT, DISCOLORATION, AIR BUBBLES, OR A MILKY APPEARANCE.

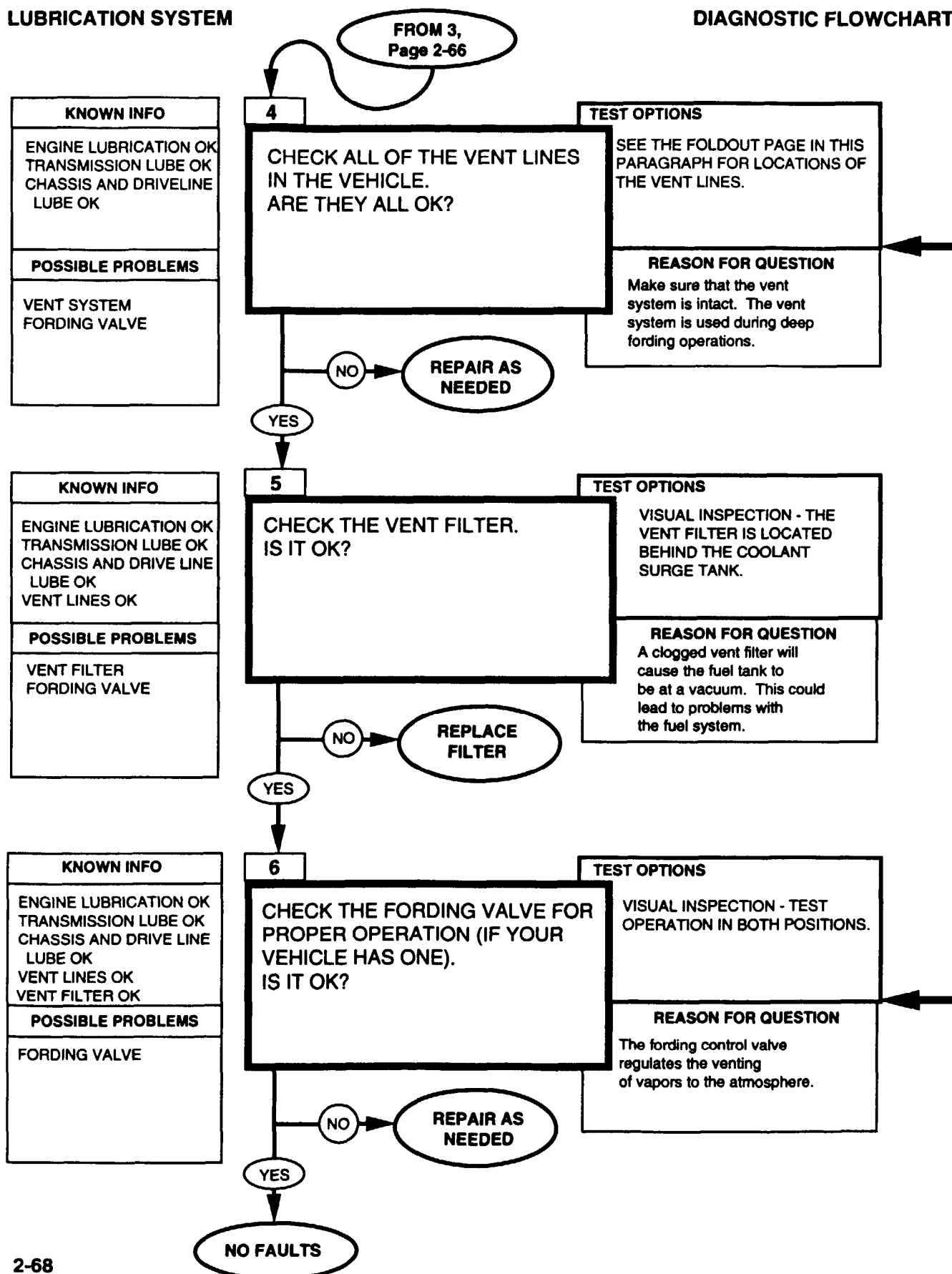
- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance.
- Bubbles indicate an overfilled system or air leaks in the system. Drain the fluid and refill to proper level. Refer to (para. 5-2).
- Milky appearance is due to water in the system. Drain the fluid from the entire transmission and transmission cooling system and install a new filter. Refer to (para 5-2).
- Check fill tube for indications of fluid being blown out. If fluid is being blown out, check vent line for obstructions, and refill transmission to proper level. Refer to (para. 5-2).
- Transmission fluid coming out of dipstick filler tube indicates a restriction in the ventilation system. Check for clogged, melted, or crushed lines and/or fittings between transmission and atmosphere vent on air cleaner canister. Replace where needed. Refer to (para. 5-16).

Among the items are the driveshafts, suspension, differentials, and geared hubs.



# LUBRICATION SYSTEM

## DIAGNOSTIC FLOWCHART

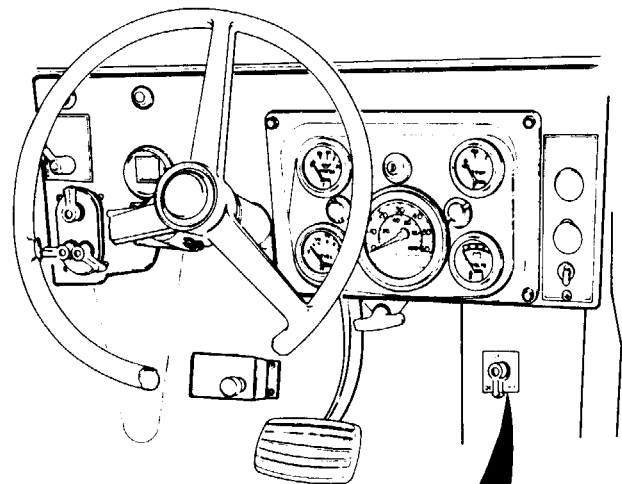
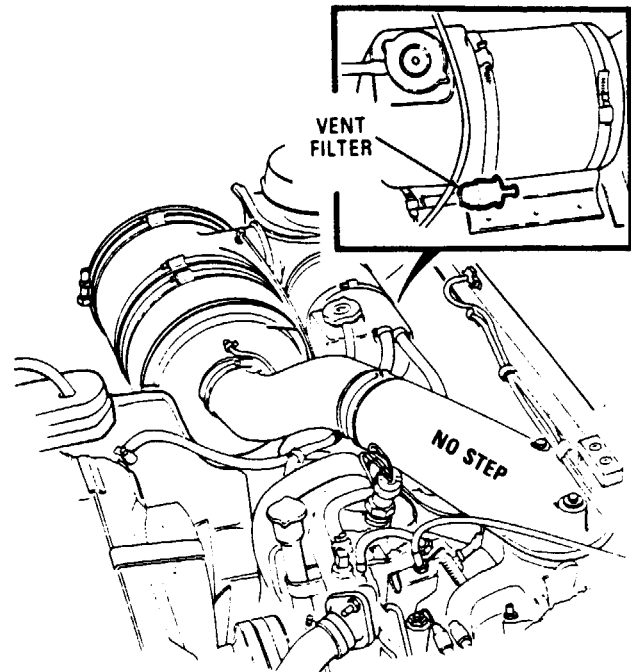




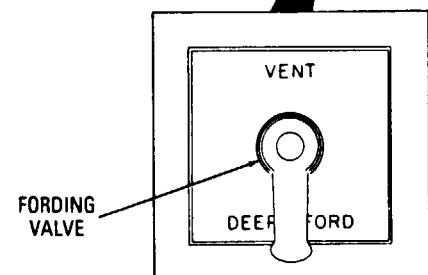
## REFERENCE INFORMATION

There are vent lines attached to all parts of the vehicle with a lubrication reservoir. These parts are the engine, transmission, transfer case, differentials, geared hubs, and the fuel tank. Removal procedures for the vent lines are given in the repair procedure for the particular component to which the line is attached.

## LUBRICATION SYSTEM



Replace the fording valve.  
Refer to (para 12-9).



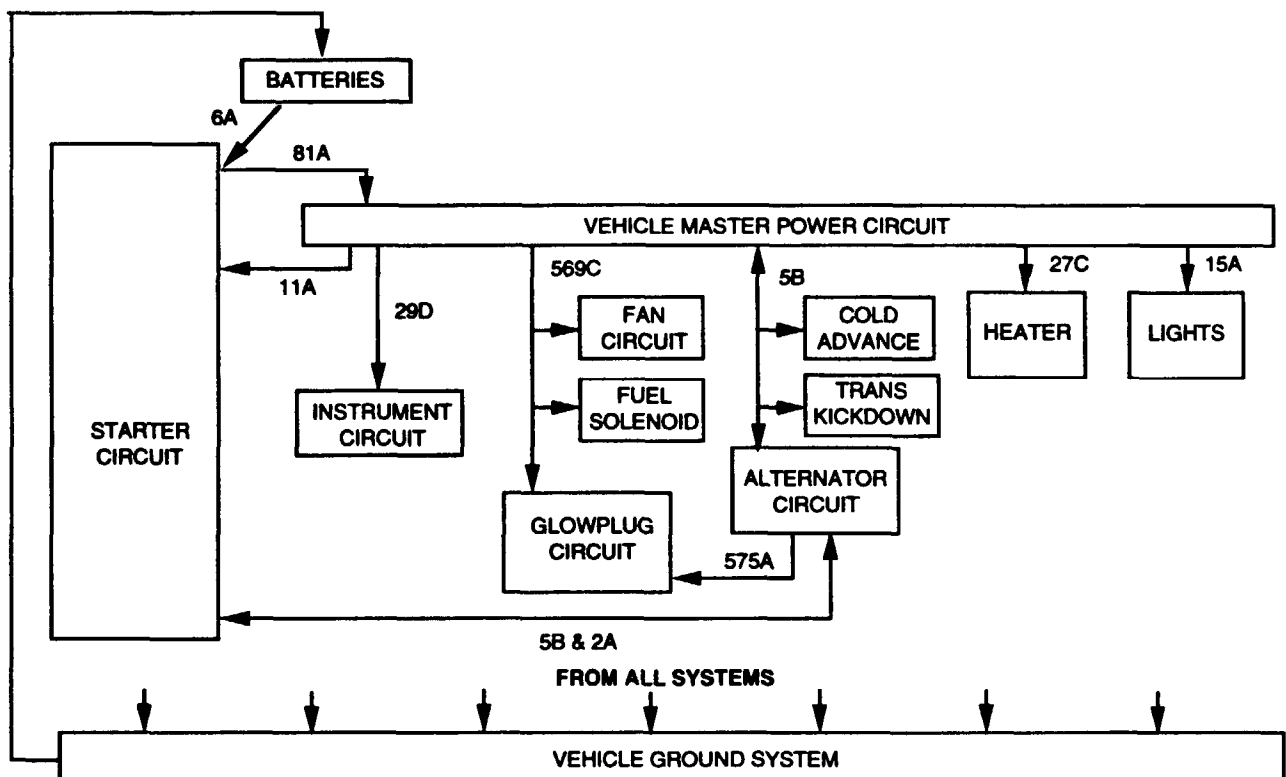
## 2-21. ELECTRICAL TESTS

Most of the electrical circuits in the vehicle are included in one of the major systems covered by this manual. This is a top level paragraph to help you pick the right one. A number of schematics are also included to help you find the problem. If you go through the flowchart and can't solve the problem, use the schematics to find wires which may be causing trouble.

The Electrical System consists of the batteries, which produce electrical power by a chemical reaction between the lead plates and the electrolyte solution (a mixture of acid and water). This power is carried by wires and cables to those parts of the vehicle which require electrical power. The batteries get recharged by the alternator, which generates electrical power by using some of the engine's mechanical power, produced when the engine is running. If you are not too confident about electrical concepts and terminology, you should read Paragraph 2-16, page 2-39.

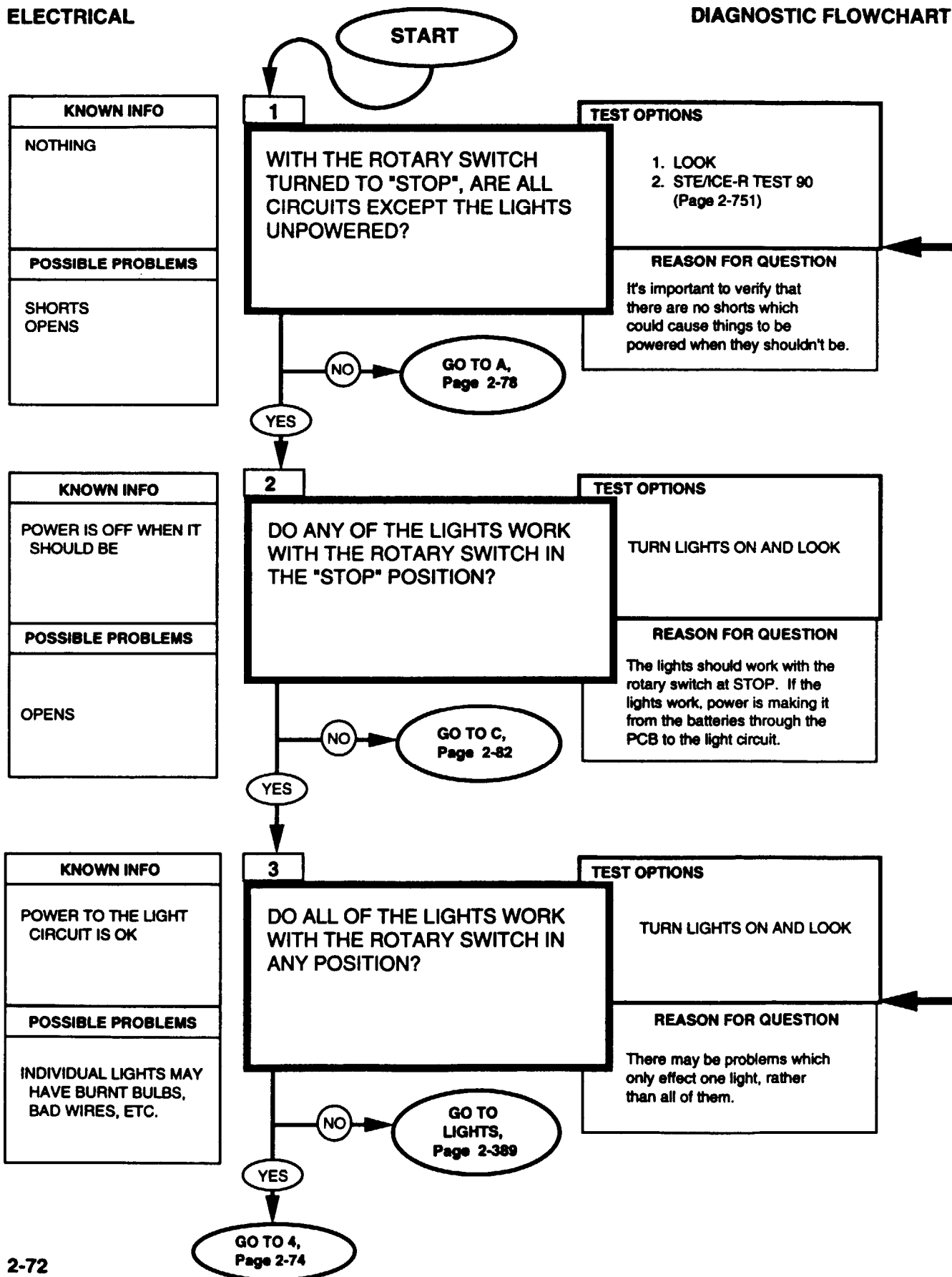
All electrical systems require a connection to ground (called grounding), which is the completion of the circuit to the battery negative. Pages 2-66, 2-67 and 2-68 are diagrams of the grounding. If your vehicle exhibits strange symptoms that seem to defy all efforts to fix them, the vehicle may have a grounding problem. Grounding problems cause strange symptoms usually because more than one circuit is using the same ground, or because a circuit has more than one ground. For example, looking at the body ground diagram, if wire 58D (a ground for the instruments) is disconnected from the left side cylinder head, the instruments may still function due to the separate ground, but they would probably be erratic and inaccurate. Usually the problem will be a loose or corroded connection between the circuit, through body ground to battery negative terminal. Be sure to check continuity to battery negative cable rather than simply to the vehicle body or engine block.

After the grounding diagrams are functional flow schematics of the major systems in the vehicle. The shaded areas are the wires and components of the vehicle master power distribution. These are designed to help you find the system giving you problems.



# ELECTRICAL

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ELECTRICAL



The lights are the only circuit on the vehicle which should work or be drawing any power when the switch is in the STOP position. Check the instruments, try turning on the heater fan, listen for any relay clicking or other sign (includes engine running) that power is on when it shouldn't be. It's best if you use the STE/ICE-R in TK mode to verify that there is no current draw from the batteries. You can't use the DCA mode for this because it will measure this current during the calibration part of the test and think that this is just an offset in the sensor.

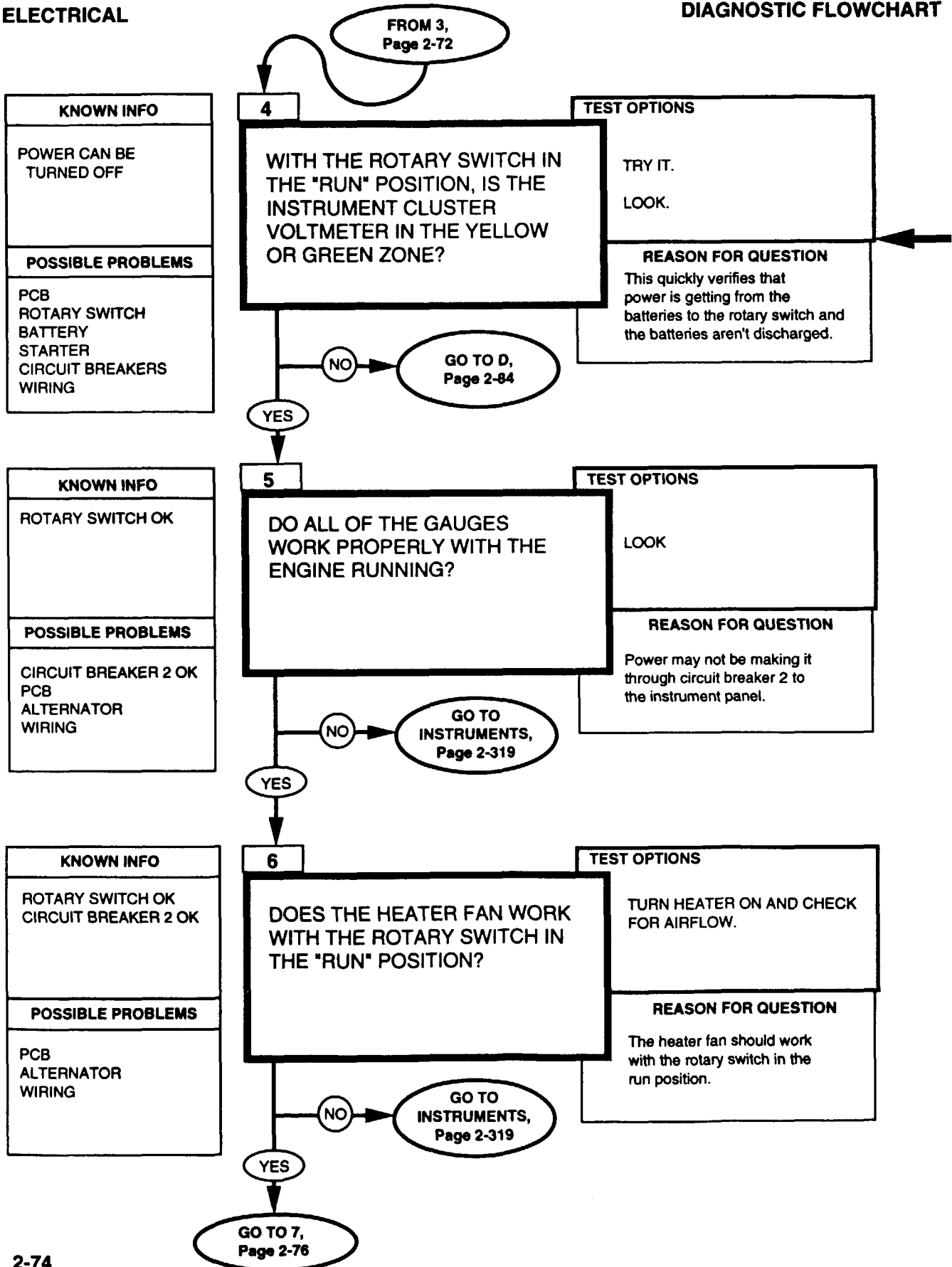
0-1500 AMPS DC STE/ICE-R TEST 90
<ol style="list-style-type: none"> <li>1. Connect probe.</li> <li>2. Start Test 90, DC amps.</li> <li>3. Displayed reading is in amps.</li> </ol>



The lights should work with the rotary switch in any position.

# ELECTRICAL

## DIAGNOSTIC FLOWCHART



**REFERENCE INFORMATION**

**ELECTRICAL**

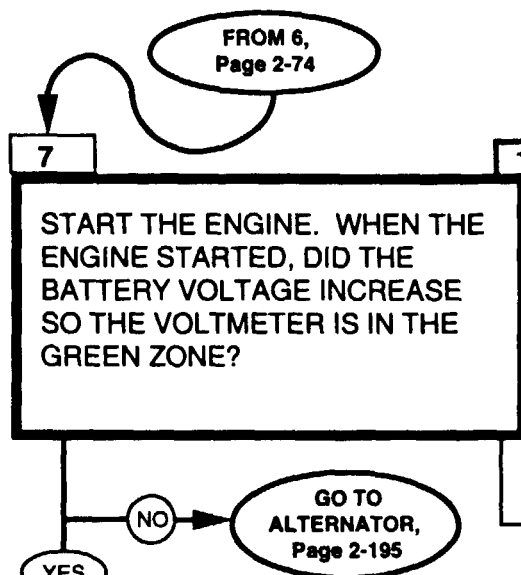


With engine off, turn switch. If the voltmeter is slightly in the yellow zone, you can continue down the YES path, but beware of possible test failures due to the low battery charge.

# ELECTRICAL

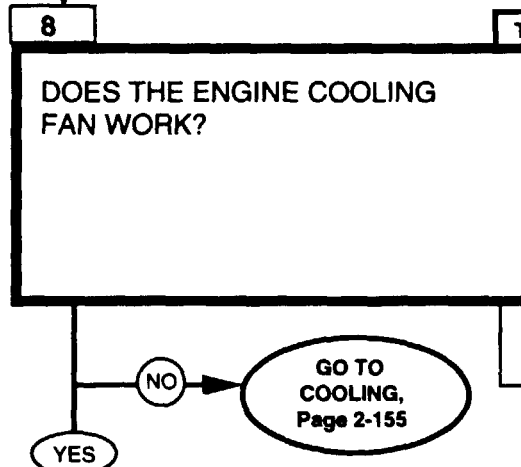
## DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
ROTARY SWITCH OK CIRCUIT BREAKER-1 OK
<b>POSSIBLE PROBLEMS</b>
BATTERY ALTERNATOR PCB RUN WIRING ACCESSORY WIRING



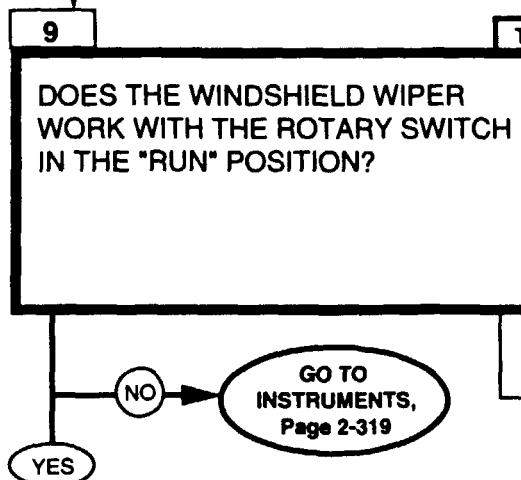
<b>TEST OPTIONS</b>
1. VOLTS GAGE 2. STE/ICE-R TEST 67 (Page 2-740) 3. MULTIMETER
<b>REASON FOR QUESTION</b>
If the voltage increases, the alternator is connected and working.

<b>KNOWN INFO</b>
BATTERY OK START WIRING OK ROTARY SWITCH OK ALTERNATOR OK.
<b>POSSIBLE PROBLEMS</b>
PCB RUN WIRING ACCESSORY WIRING



<b>TEST OPTIONS</b>
TRY IT.
<b>REASON FOR QUESTION</b>
The cooling fan should work when the rotary switch is turned to run.

<b>KNOWN INFO</b>
BATTERY OK START WIRING OK ROTARY SWITCH OK ALTERNATOR OK.
<b>POSSIBLE PROBLEMS</b>
PCB RUN WIRING ACCESSORY WIRING

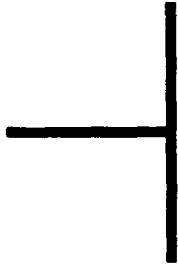


<b>TEST OPTIONS</b>
TRY IT.
<b>REASON FOR QUESTION</b>
The windshield wiper should work with the rotary switch in the run position.

NO FAULTS

**REFERENCE INFORMATION**

**ELECTRICAL**



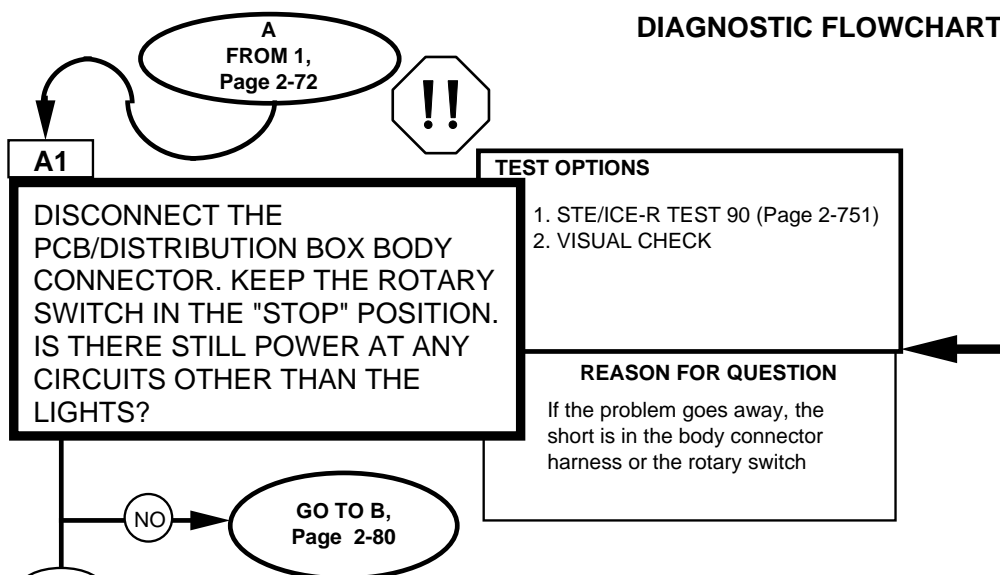
<b>BATTERY VOLTAGE STE/CE-R TEST 67</b>
<ol style="list-style-type: none"> <li>1. Start Test 67, battery voltage.</li> <li>2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.</li> </ol>



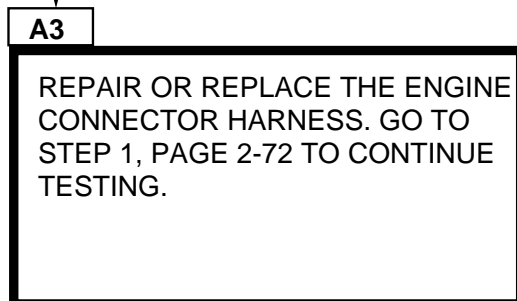
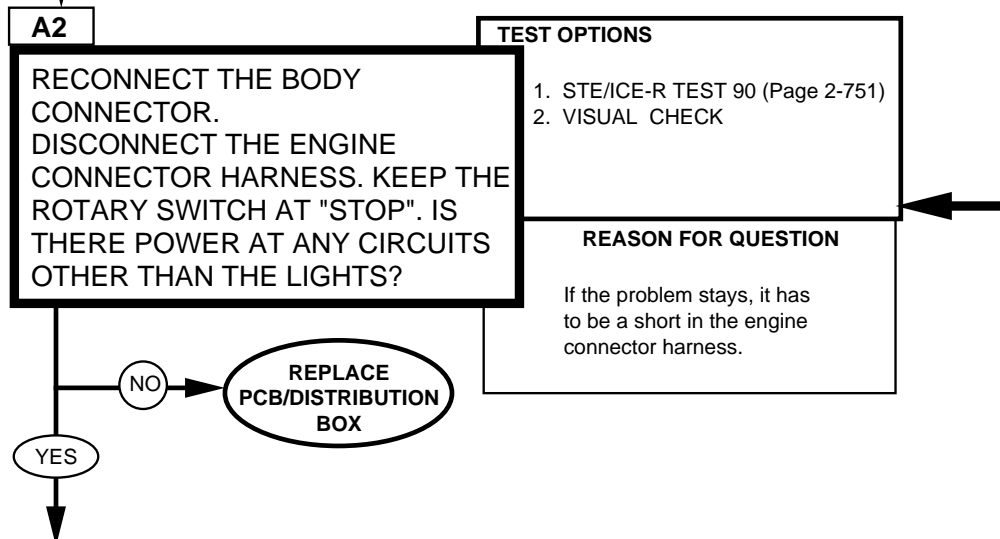
# ELECTRICAL

## DIAGNOSTIC FLOWCHART

KNOWN INFO
SHORT CIRCUIT IN POWER LINES
POSSIBLE PROBLEMS
BODY CONNECTOR HARNESS ENGINE CONNECTOR HARNESS ROTARY SWITCH



KNOWN INFO
BODY CONNECTOR HARNESS OK
POSSIBLE PROBLEMS
ENGINE CONNECTOR HARNESS ROTARY SWITCH



REFERENCE INFORMATION

ELECTRICAL



**WARNING**

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX HARNESS.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

**0-1500 AMPS DC  
STE/ICE-R TEST 90**

1. Connect probe.
2. Start Test 90, DC amps.
3. Displayed reading is in amps.

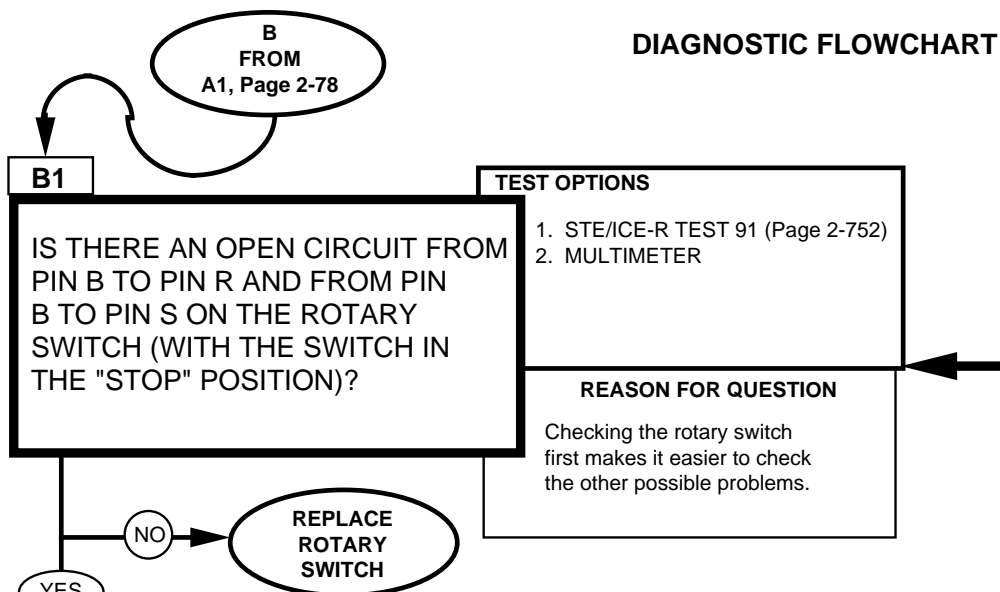
Replace PCB, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).

Repair harness, refer to (para. 4-85).  
Replace harness. Notify DS maintenance.

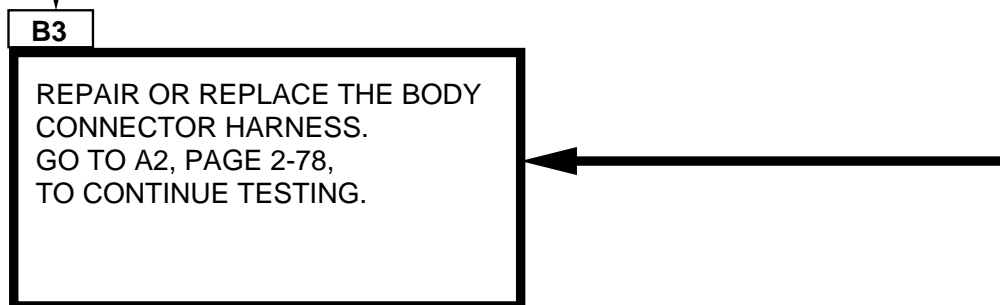
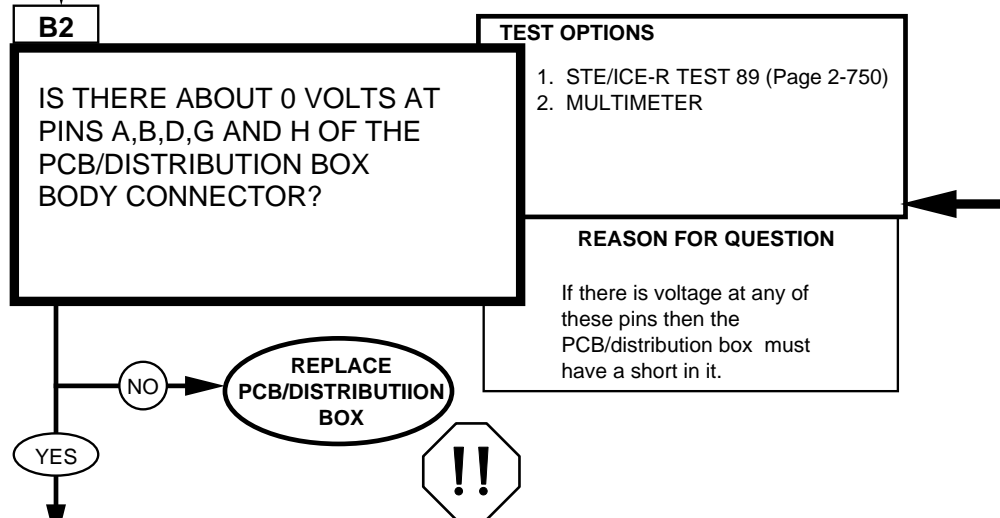
# ELECTRICAL

## DIAGNOSTIC FLOWCHART

KNOWN INFO
SHORT ON BODY CONNECTOR SIDE OF PCB/DISTRIBUTION BOX
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX BODY CONNECTOR BODY CONNECTOR CABLE HARNESS

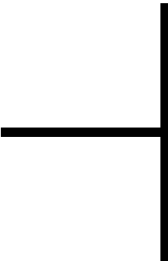


KNOWN INFO
ROTARY SWITCH OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX BODY CONNECTOR BODY CONNECTOR CABLE HARNESS



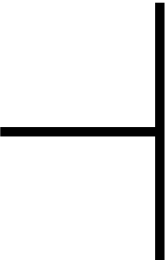
REFERENCE INFORMATION

ELECTRICAL



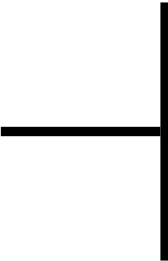
Replace rotary switch. Refer to (para. 4-7).

<b>0-4500 OHMS STE/ICE-R TEST 91</b>
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



Replace PCB. Refer to (para. 4-5).  
Replace distribution box. Refer to (para. 4-5.1).

<b>0-45 DC VOLTS STE/ICE-R TEST 89</b>
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



Repair or replace harness.  
Notify DS maintenance.



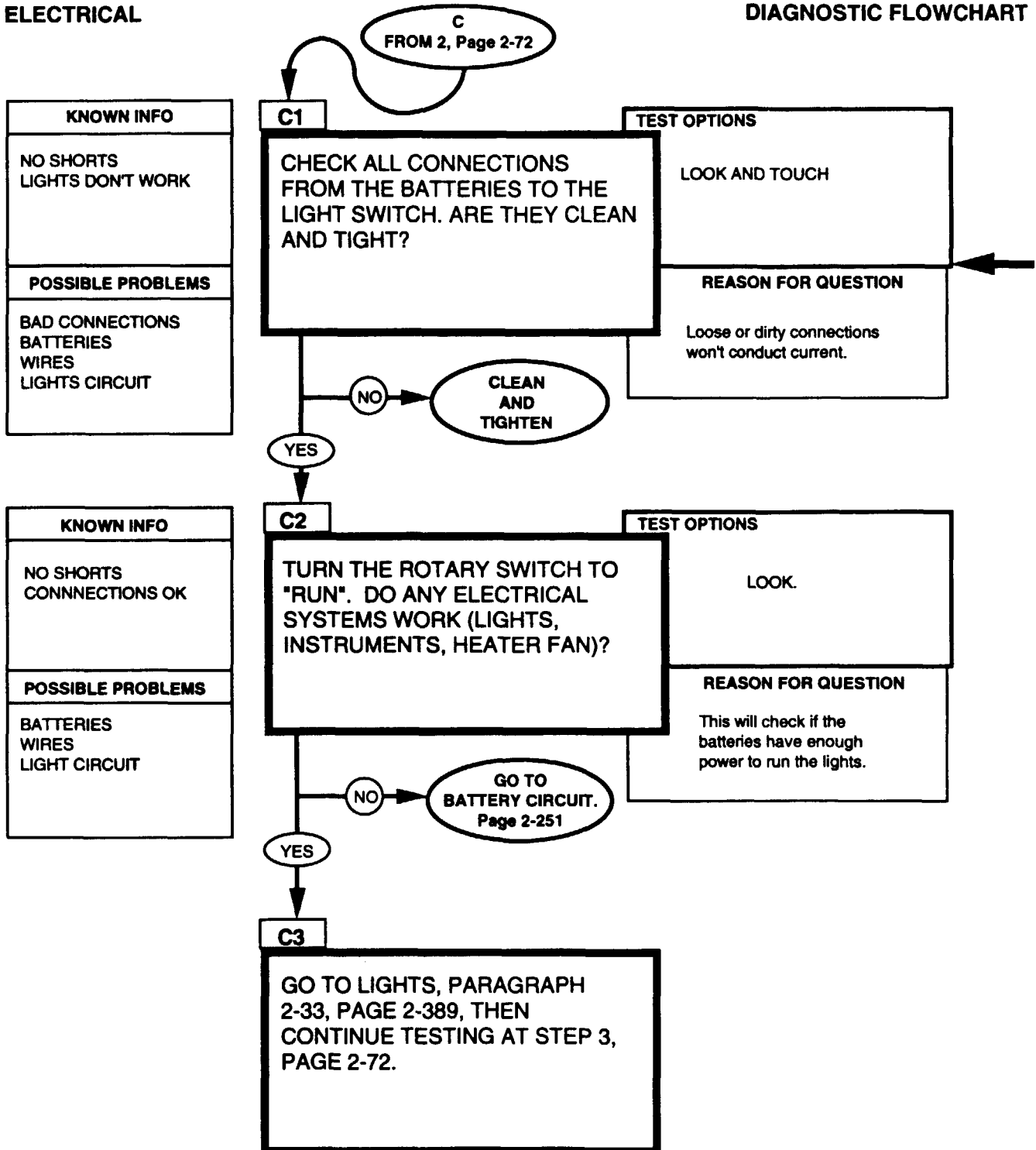
**WARNING**

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX HARNESS.

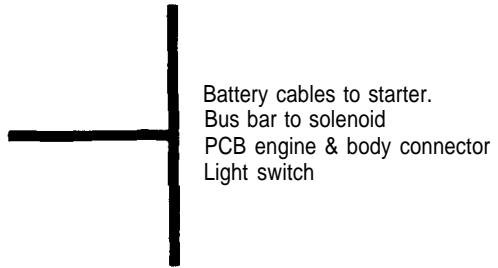
There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

# ELECTRICAL

## DIAGNOSTIC FLOWCHART

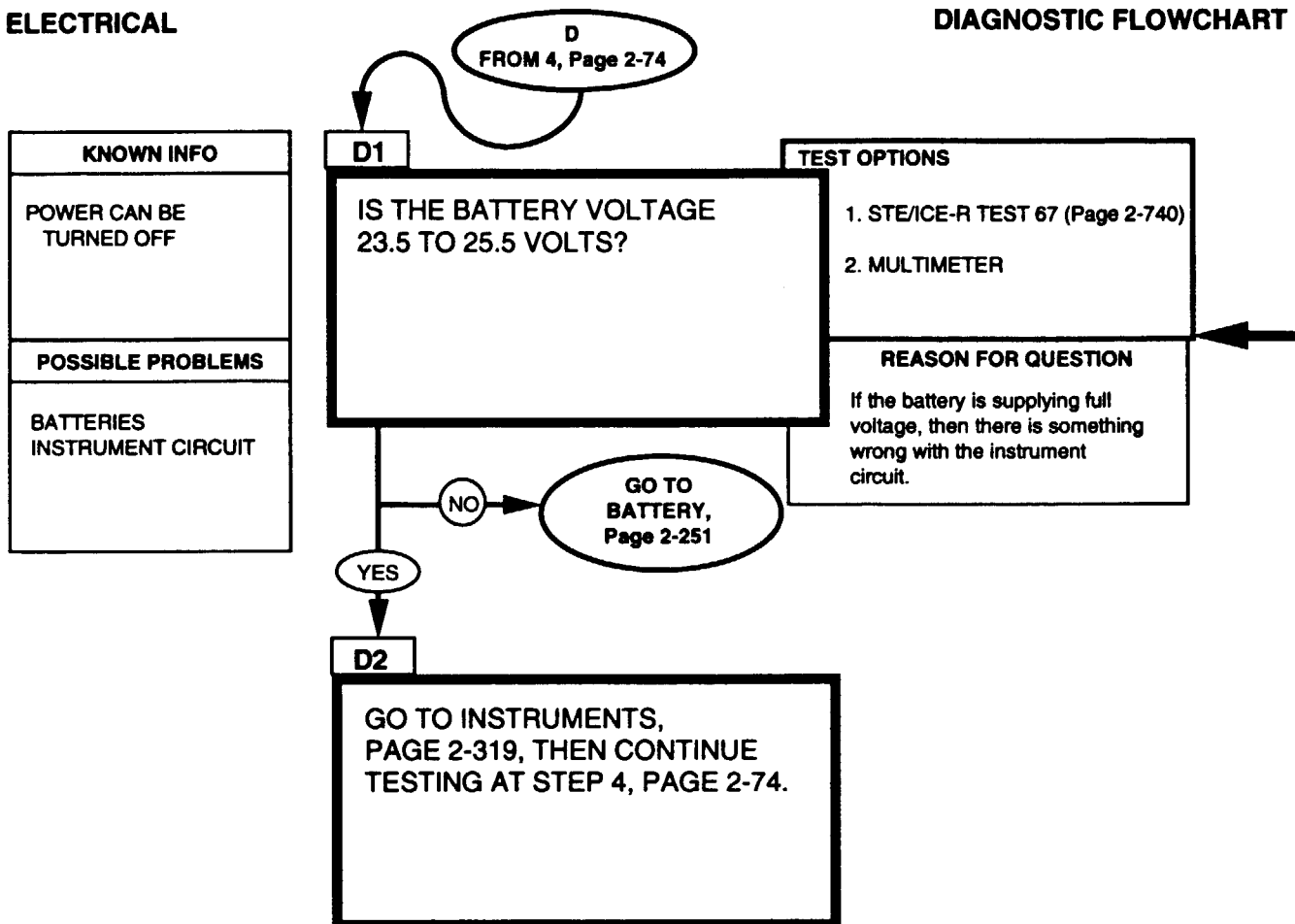


## REFERENCE INFORMATION



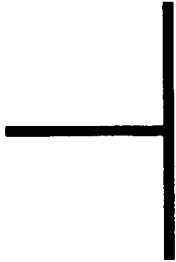
# ELECTRICAL

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ELECTRICAL

**BATTERY VOLTAGE  
STE/ICE-R TEST 67**

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries' voltage will drop when glowplugs turn on.

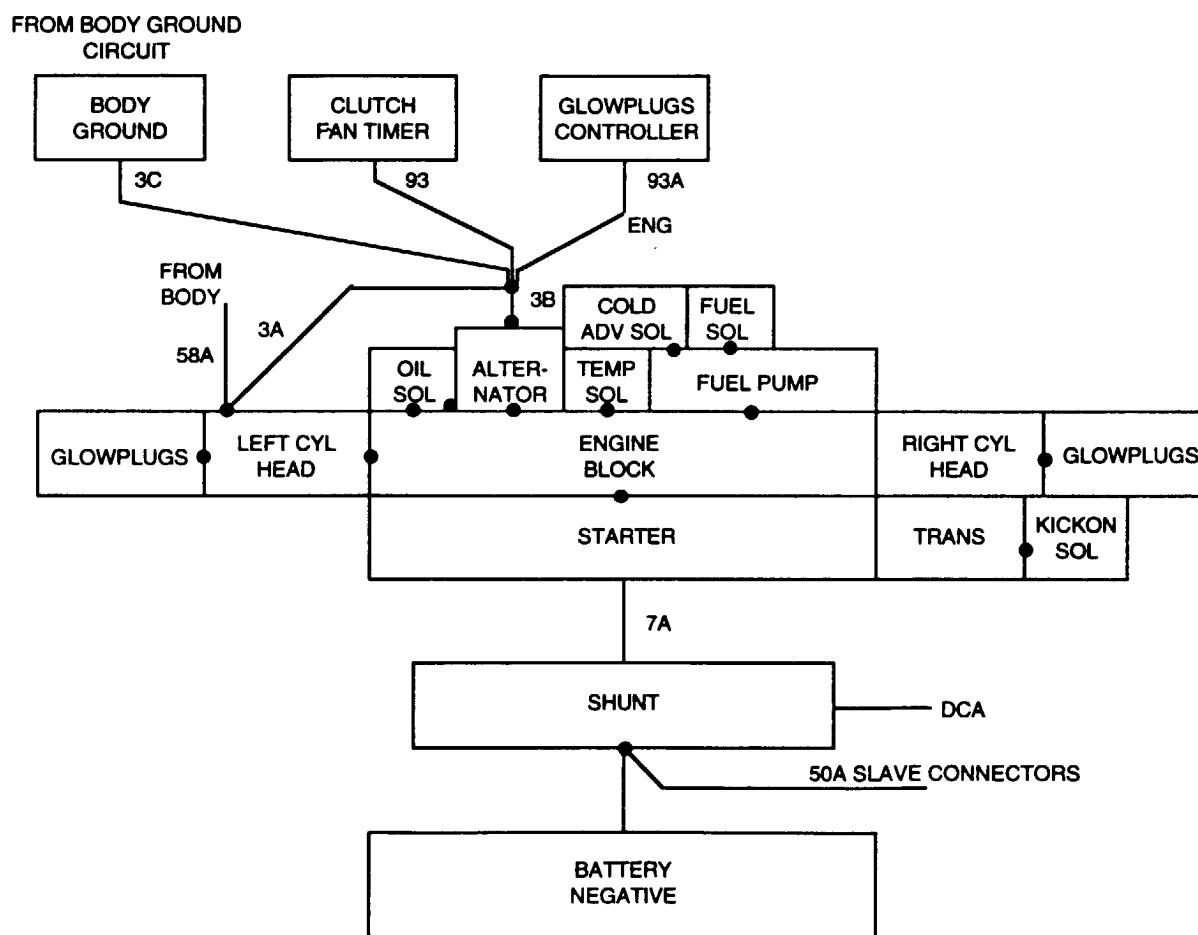
**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



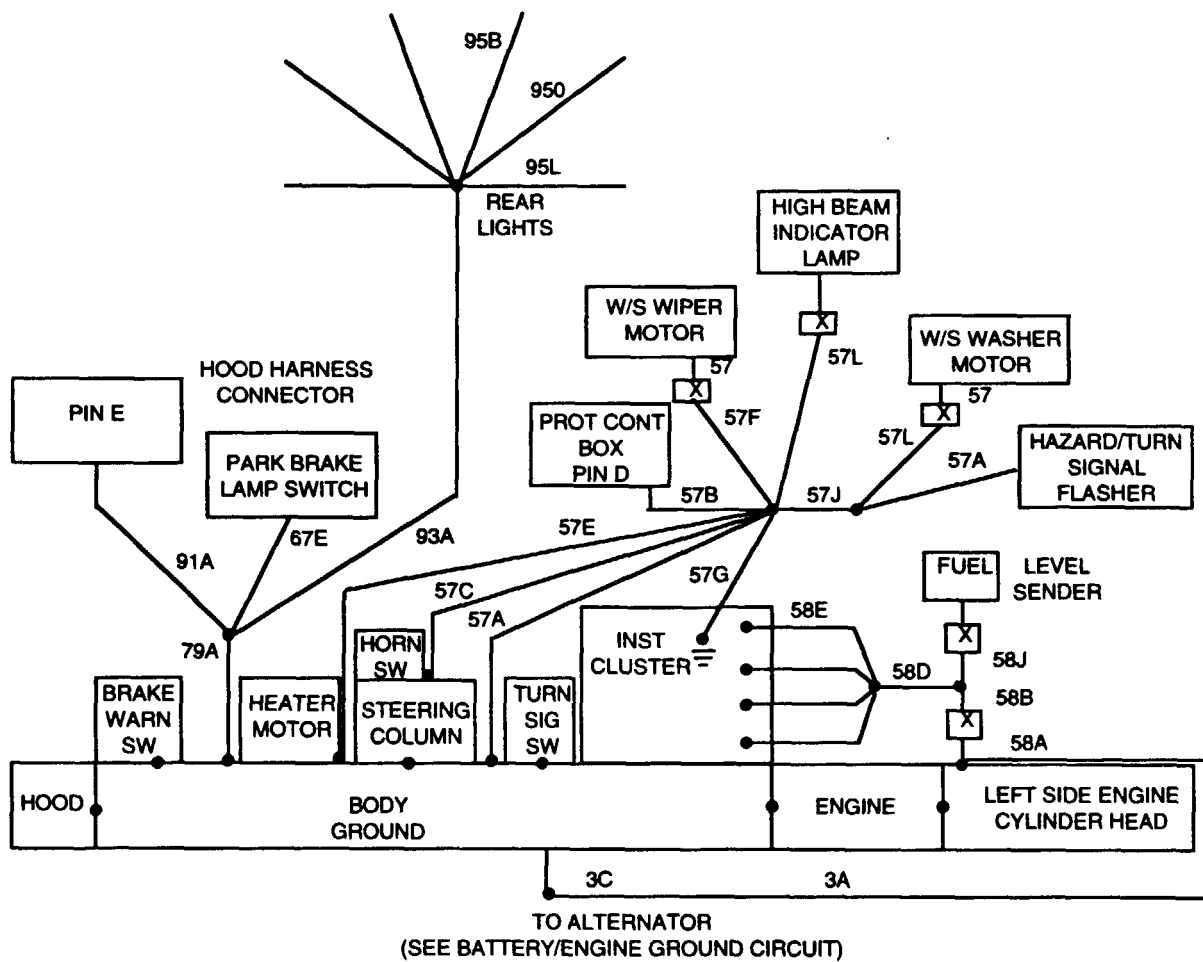
ELECTRICAL

## BATTERY/ENGINE GROUND CIRCUIT



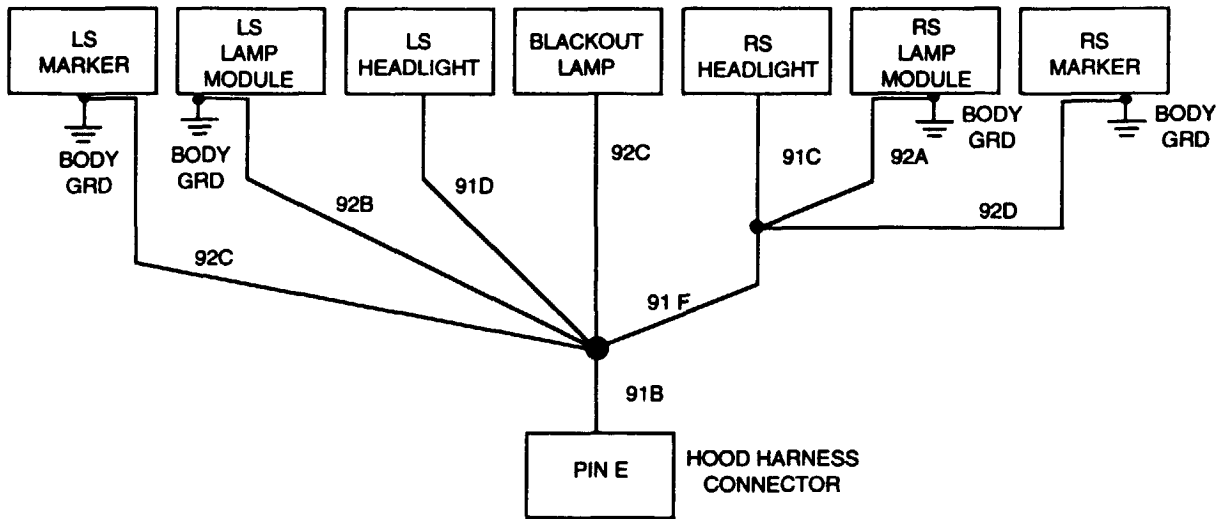
## ELECTRICAL

## BODY GROUND CIRCUIT



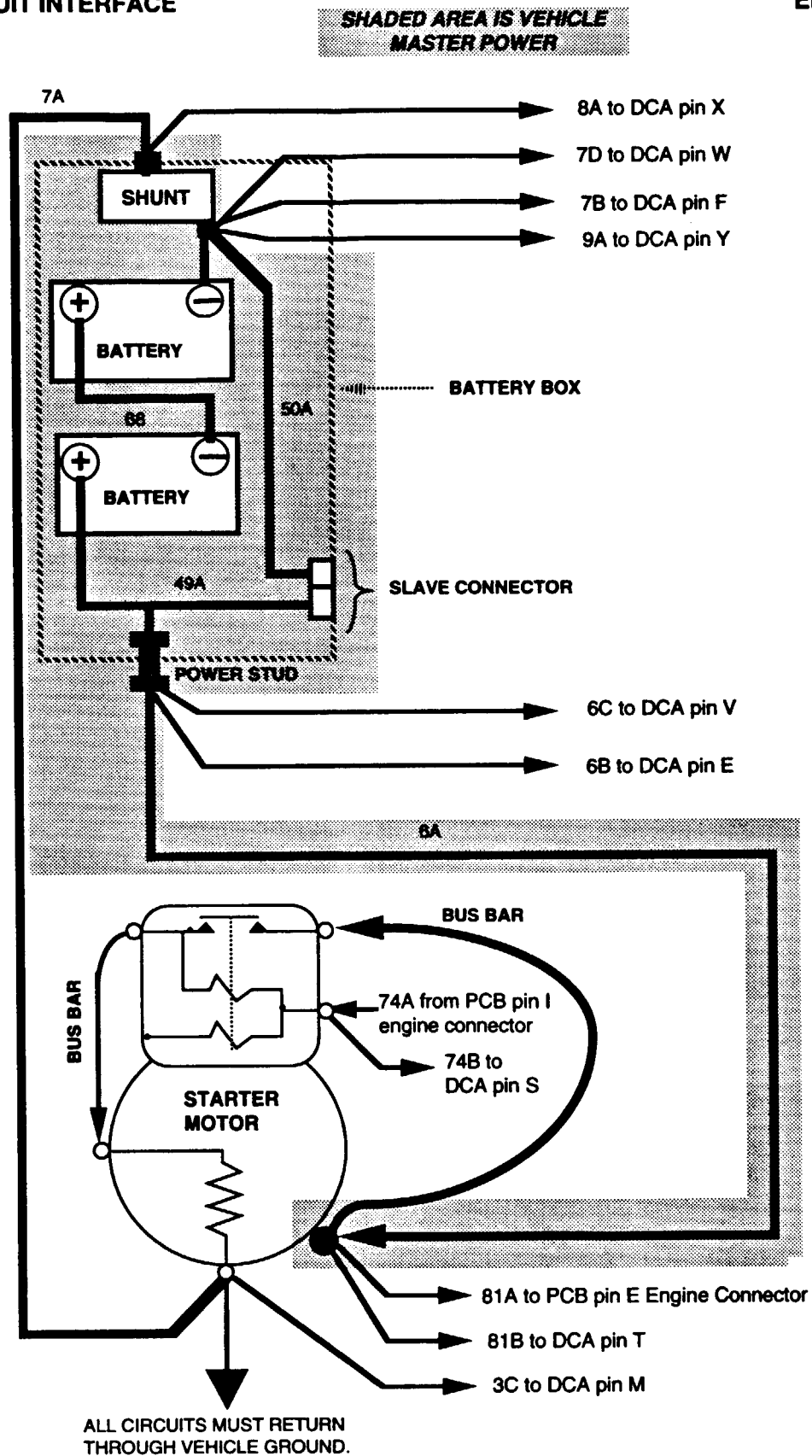
ELECTRICAL

FRONT HOOD/LIGHTS GROUND CIRCUIT



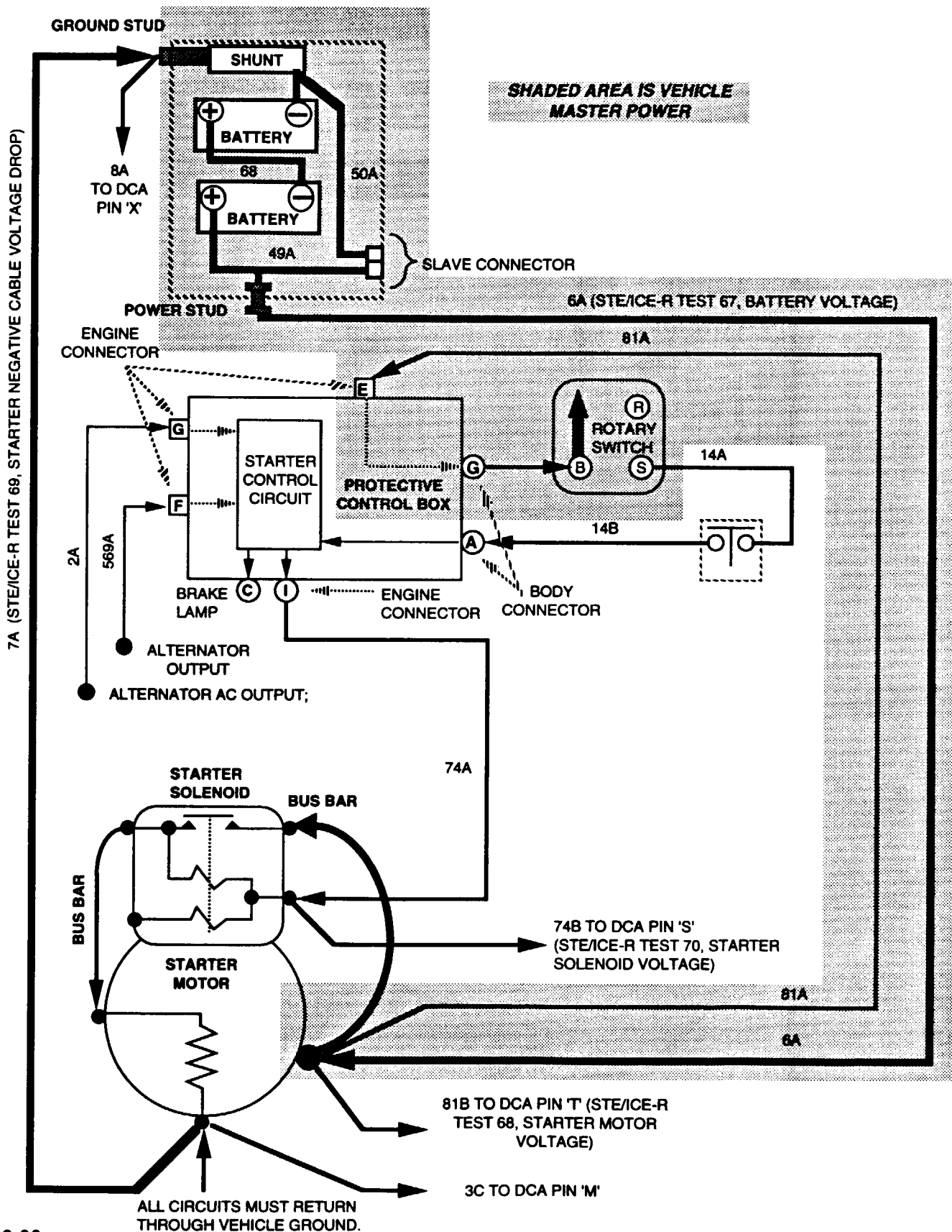
# BATTERY CIRCUIT INTERFACE

## ELECTRICAL



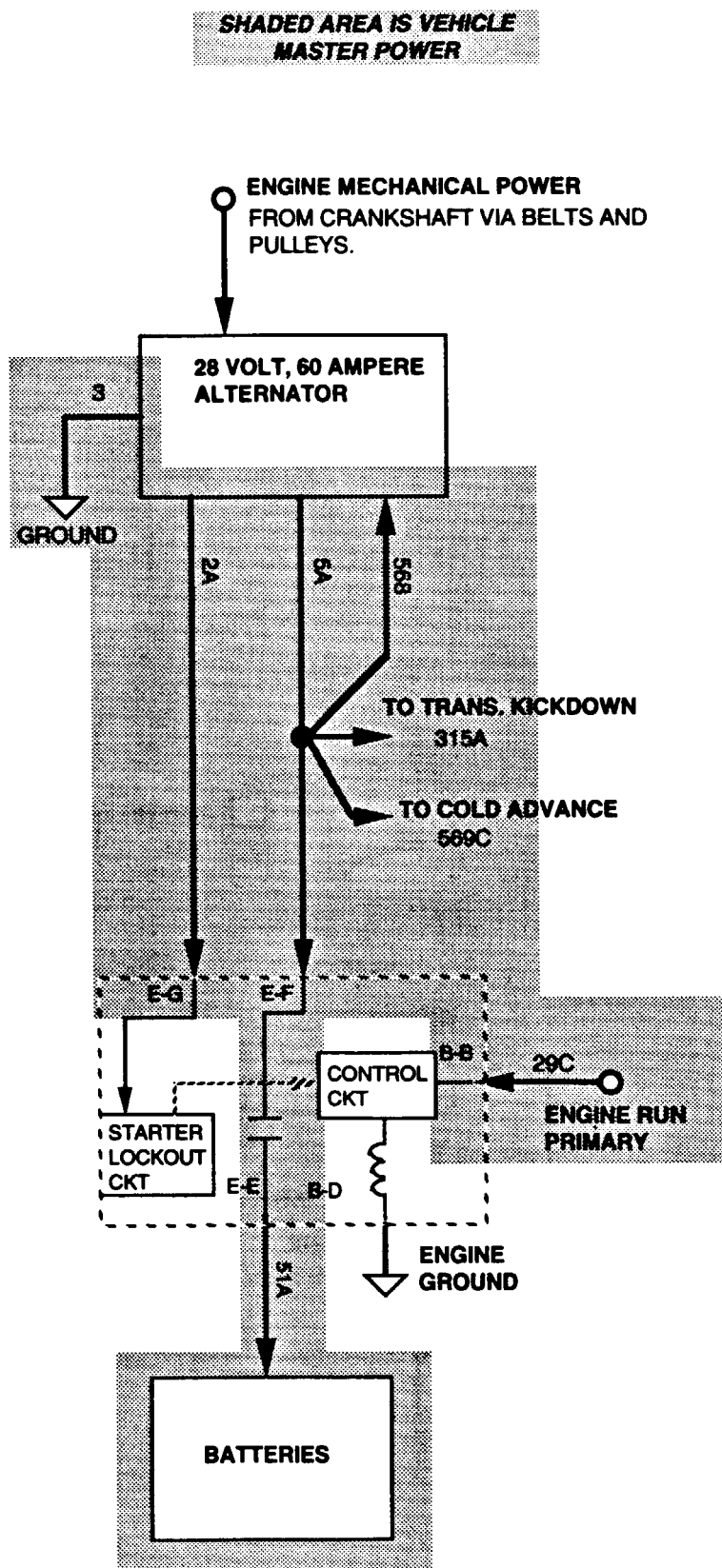
## ELECTRICAL

## STARTER CIRCUIT INTERFACE



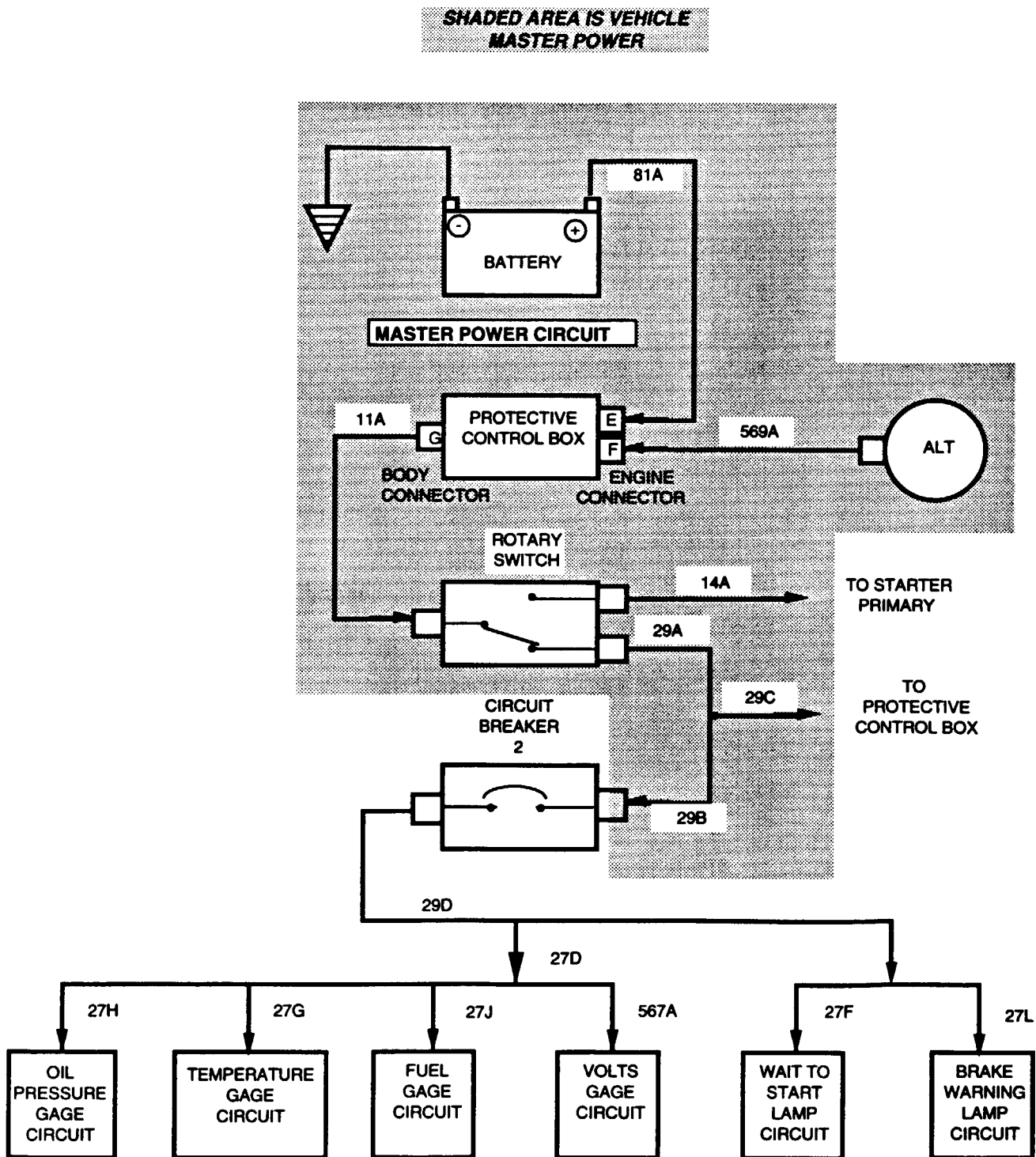
## ALTERNATOR INTERFACE

## ELECTRICAL



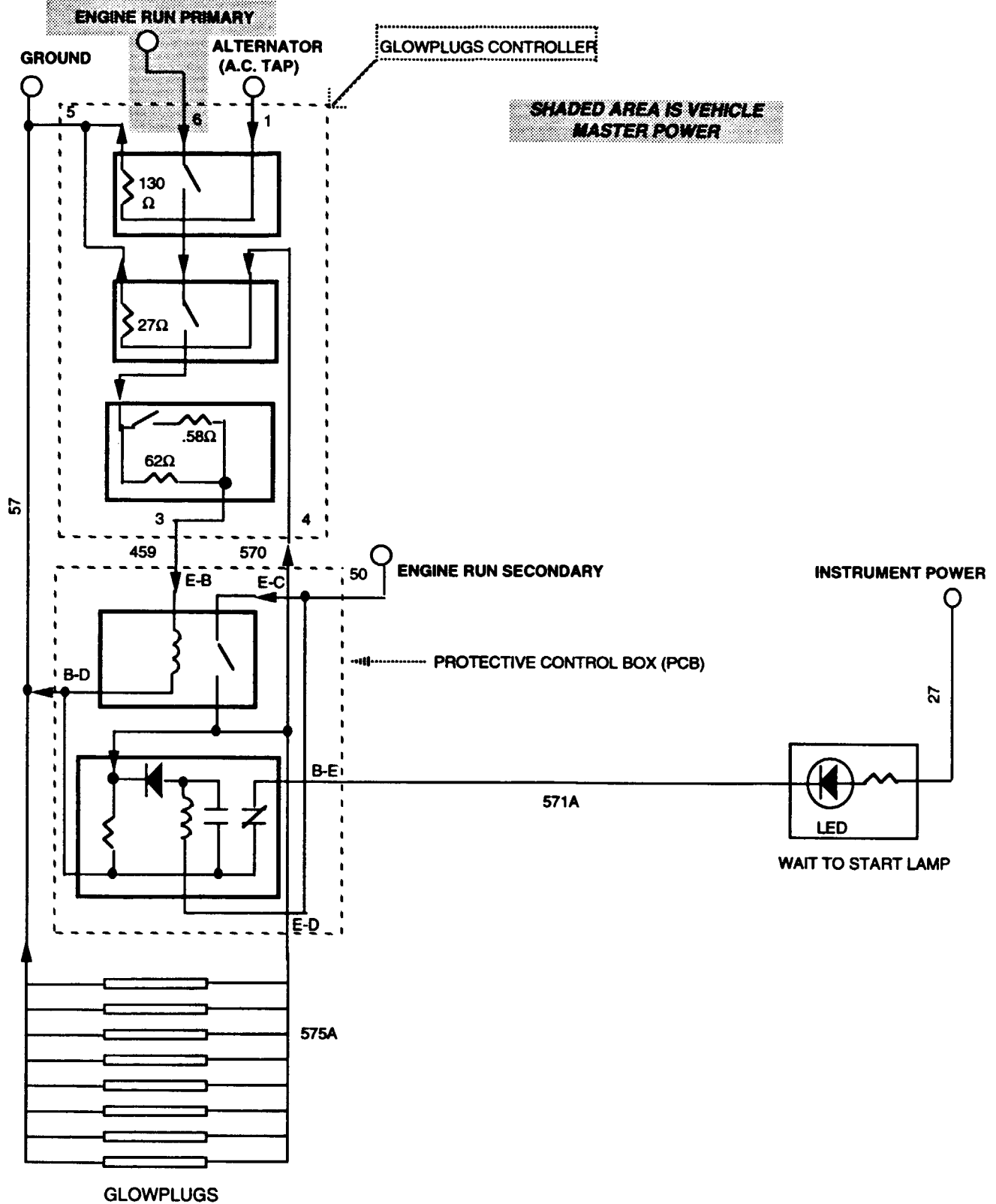
ELECTRICAL

INSTRUMENTS CIRCUIT INTERFACE



# GLOWPLUG CKT INTERFACE

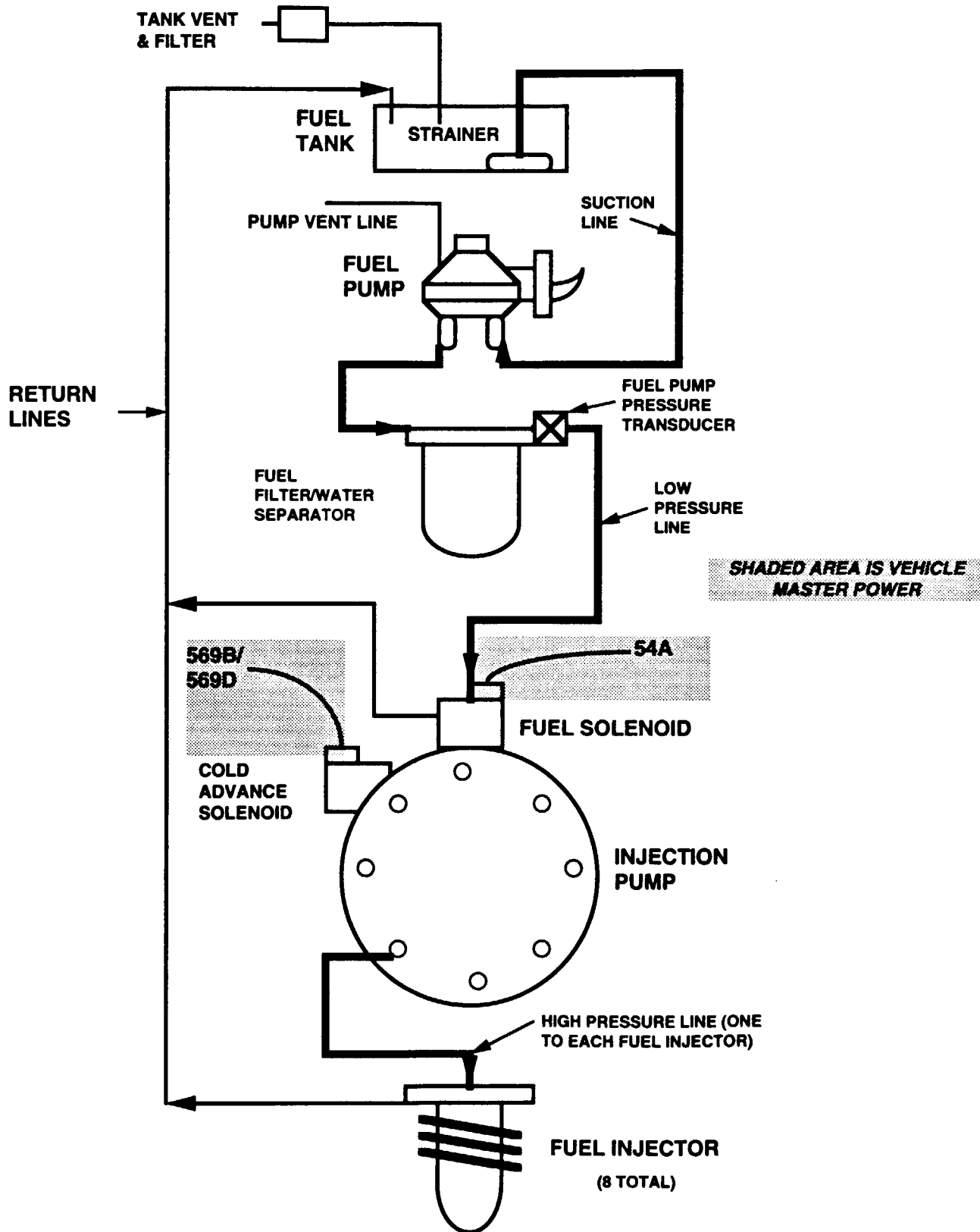
## ELECTRICAL





ELECTRICAL

FUEL SYSTEM INTERFACE

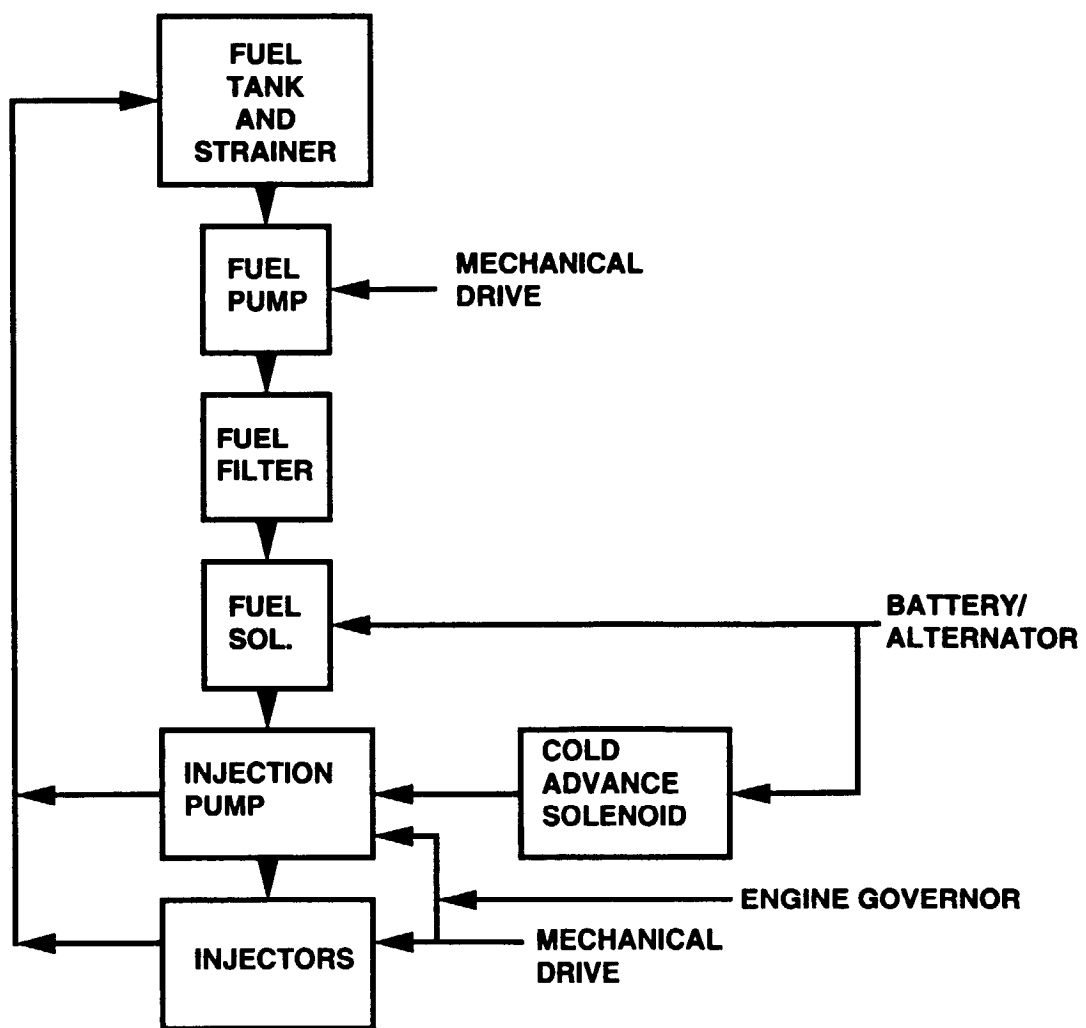


## 2-22. FUEL SYSTEM TESTS

These Fuel System tests can be run any time you think there maybe a problem with the fuel system or if you were sent here from another test.

If you are running this test because the engine runs rough remember that air intake and exhaust as well as internal mechanical problems can also cause this condition.

At the bottom of this page is a simplified block diagram which shows how the different fuel system components relate to each other. Refer to fold-out page FO-1, leave open for reference while you are testing.



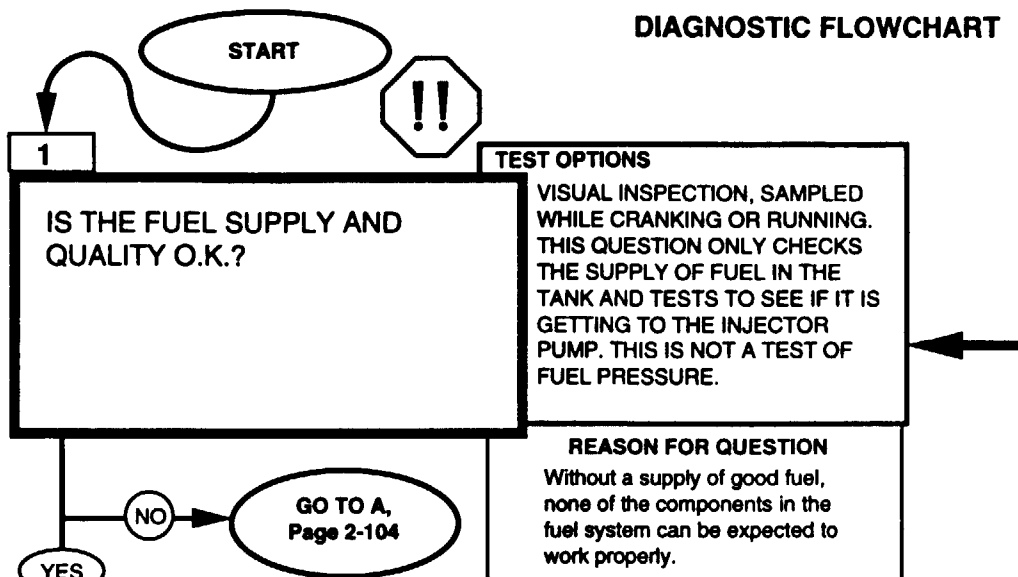
### General Information

This set of tests maybe used when the engine is hard starting, has low power or runs rough. Just follow the path, answering the questions. Additional information and notes are given on the facing page (like this one) when necessary. It is recommended that you refer to your fold-out diagram now because it will help you follow the testing.

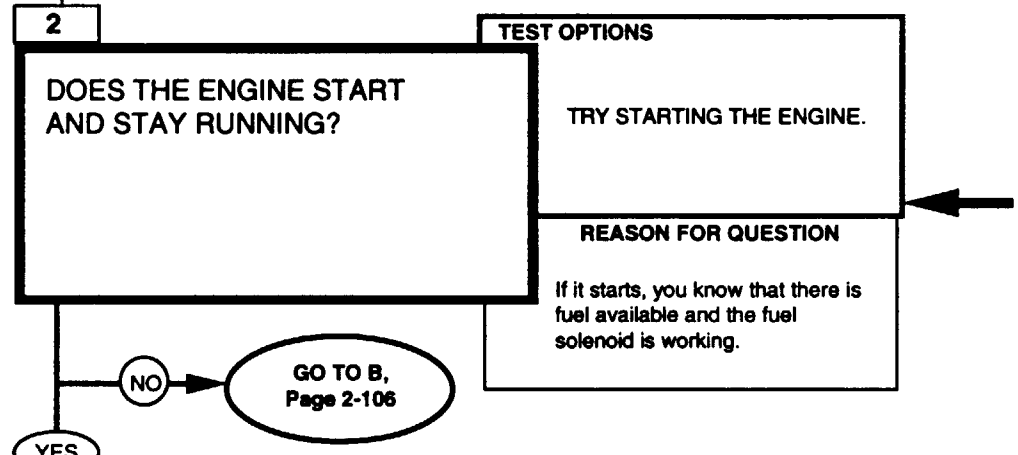
# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART

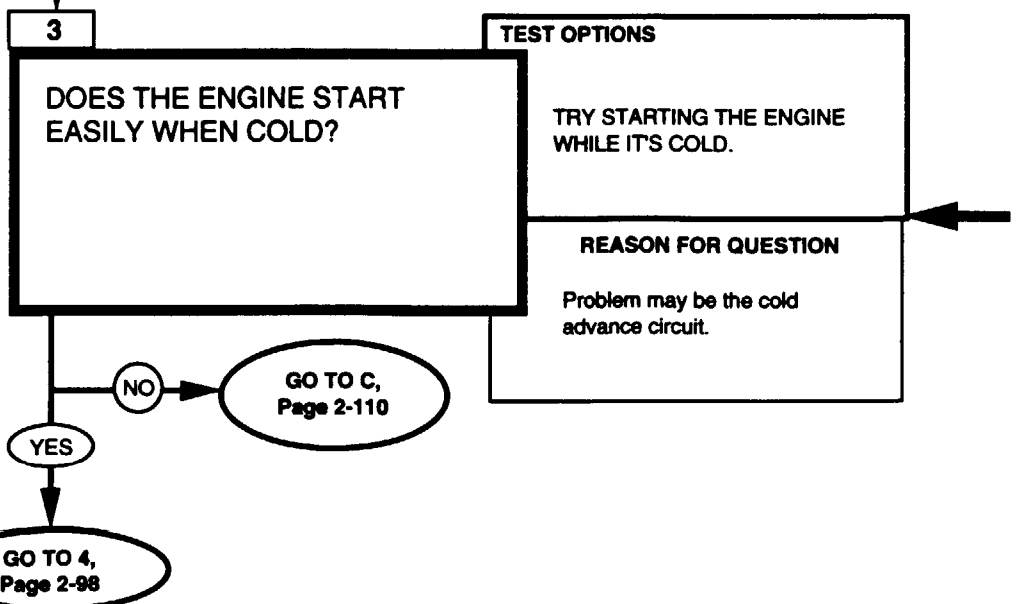
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
FUEL LINES FUEL FILTER FUEL PUMP FUEL SOLENOID INJECTION PUMP INJECTORS



KNOWN INFO
FUEL AVAILABLE AND NOT CONTAMINATED
POSSIBLE PROBLEMS
COLD ADVANCE GLOWPLUGS FUEL LINES FUEL FILTER FUEL PUMP INJECTION PUMP FUEL SOLENOID RETURN CHECK VALVE



KNOWN INFO
FUEL SOLENOID OK FUEL OK
POSSIBLE PROBLEMS
COLD ADVANCE FUEL LINES FUEL FILTER FUEL PUMP INJECTION PUMP INJECTORS



## REFERENCE INFORMATION

MAKE SURE ALL ELECTRICAL CONNECTIONS ARE CLEAN AND TIGHT. CHECK FUEL SOLENOID, COLD ADVANCE SOLENOID, BATTERIES, ROTARY SWITCH, ETC.

1. While cranking or running the engine open the drain fitting end drain some fuel into a clear container.
2. The fuel should come out of the open drain valve in a steady stream, if it doesn't, than ANSWER NO TO THIS QUESTION.
  - NOTE: Nothing will come out unless the engine is running or cranking.
3. Close the drain valve and turn the rotary switch to STOP.
4. Check the fuel that came out to be sure that it isn't contaminated with water or dirt.
5. If the fuel didn't come out in a steady stream or if it is contaminated then ANSWER NO TO THIS QUESTION.

If you have trouble starting the engine you should have entered here byway of the Statability tests. If you didn't begin there, go beck to Page 2-41 and the the Startability top level teat.

At this point you don't care how well it starts or runs but just that it will run.

THE ANSWER TO THIS QUESTION IS NO if the engine seems to start but stops almost immediately.

Engine temperature may be determined from vehicle temp. gauge (Rotary Switch must be in RUN position) or by touching **the engine**. **If it is too hot to touch comfortably** than it is above 120° F (49° C).

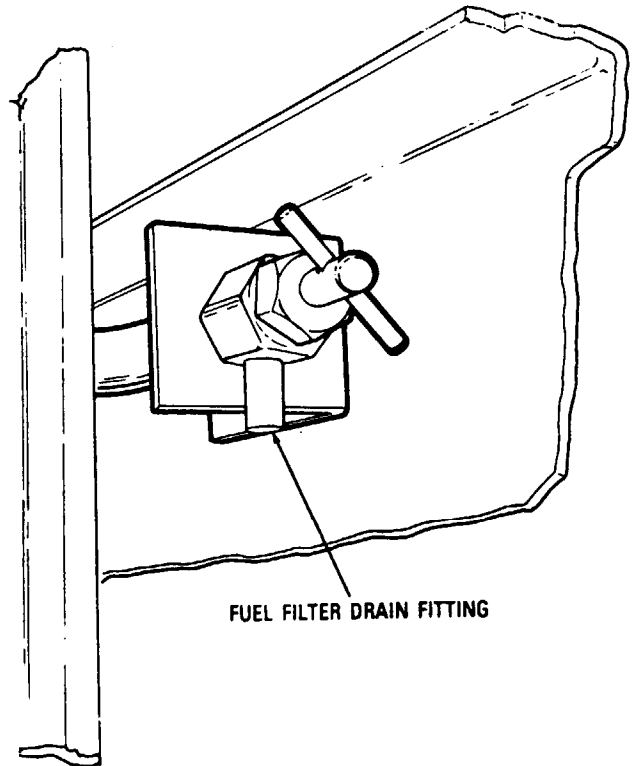
Hard stating can be caused by other things such as fuel in the lines leaking back into the tank while the engine is shut down. This will occur if there is an air leak in the lines.

**WARNING**

**Diesel fuel is highly flammable. Do not perform any procedures near fire, flames, or sparks. Severe injury or death will result**

**WARNING**

**A hot engine may cause serious bums. Always use caution when approaching a hot engine.**



FUEL FILTER DRAIN FITTING

# FUEL SYSTEM

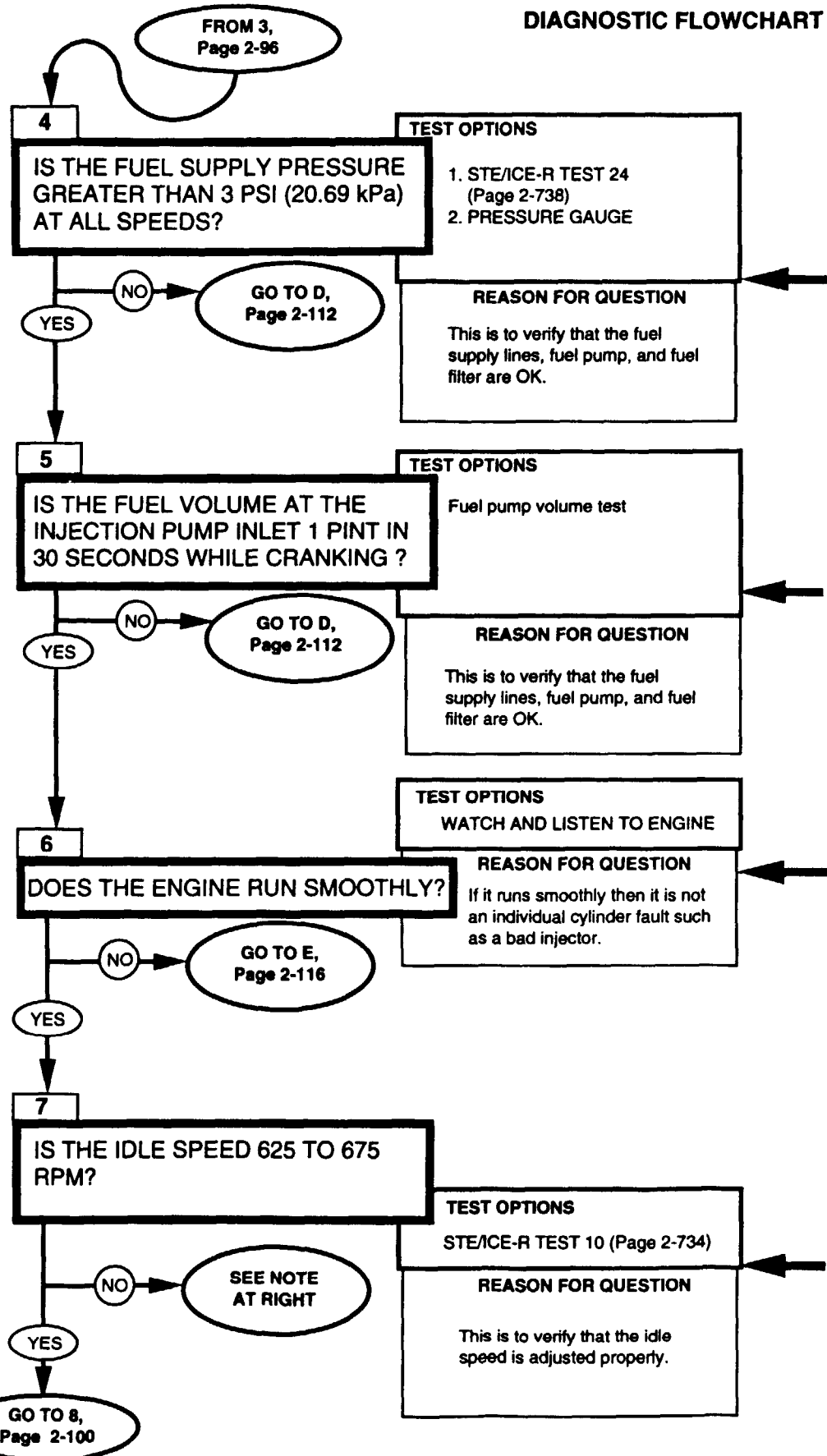
## DIAGNOSTIC FLOWCHART

KNOWN INFO
FUEL SOLENOID OK COLD ADVANCE OK
POSSIBLE PROBLEMS
FUEL LINES FUEL FILTER FUEL PUMP

KNOWN INFO
FUEL SOLENOID OK COLD ADVANCE OK
POSSIBLE PROBLEMS
FUEL LINES FUEL FILTER FUEL PUMP

KNOWN INFO
FUEL PUMP AND FILTER OK
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS FUEL SUPPLY LINES FUEL RETURN LINES RETURN CHECK VALVE

KNOWN INFO
FUEL LINES, PUMP AND FILTER OK
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS EXHAUST RESTRICTED



## REFERENCE INFORMATION

## FUEL SYSTEM

Watch the fuel pump pressure while slowly accelerating the engine from idle to maximum speed. The pressure should always be greater than zero. If

pressure, check to be sure it is still above zero even during maximum acceleration (maximum engine power). You can use STE/ICE test 24 with control function 02 (minimum).

**NOTE**

Rapidly accelerating the engine with the transmission in neutral doesn't work for this engine because the fuel supply can't increase as fast as the engine can accelerate so you won't get good test results.

Proper engine performance is dependent upon the availability of the correct fuel volume to the injection pump.

Pay attention to when the engine runs rough. If it runs rough only while warming up after a cold start it may be a glowplug problem and you should run the Glowplug Circuit tests.

Rough running may also be caused by air leaks in the fuel supply lines. Air in the fuel should purge itself while idling. If rough running occurs after a period of high speed or high power running but seems to go away after idling, then look for air leaks in the fuel supply lines and fittings. If rough running occurs while driving but idles ok, check the fuel return check valve for any malfunctions (refer to para. 3-35).

**NOTE**

Try to adjust the engine idle speed by turning the idle speed screw (refer to para 3-44). Continue testing if you can adjust the speed properly. If you cannot, notify DS maintenance.

Engine must be at normal operating temperature when making speed checks. Air filter must be in place and all accessories (lights, heater fan, etc...) must be turned off.

This engine has a min-max governor which controls engine speed at both idle and full throttle.

**FUEL PUMP VOLUME TEST**

1. Disconnect fuel line at injection pump inlet and route fuel line into a suitable, 1 quart container.
2. Crank the engine for 30 seconds.
3. If the pump and lines are ok, you should get about 1 pint (1/2 quart) (.5 L) in 30 seconds.

**FUEL PUMP PRESSURE  
STE/ICE-R TEST#24**

(STE/ICE already connected to DCA and turned on)

1. Select Fuel Supply Pressure test, Test 24.
2. Perform CAL.
3. Crank (or start) the engine.

**NOTE :** STE/ICE-R can display a pressure below 0. Be sure to notice if the display is negative.

**FUEL PUMP PRESSURE TEST  
PRESSURE GAGE**

1. Connect a Tee into the fuel line between the fuel filter outlet and the injection pump inlet.
2. Attach gauge to Tee.
3. Crank (or Start) engine.

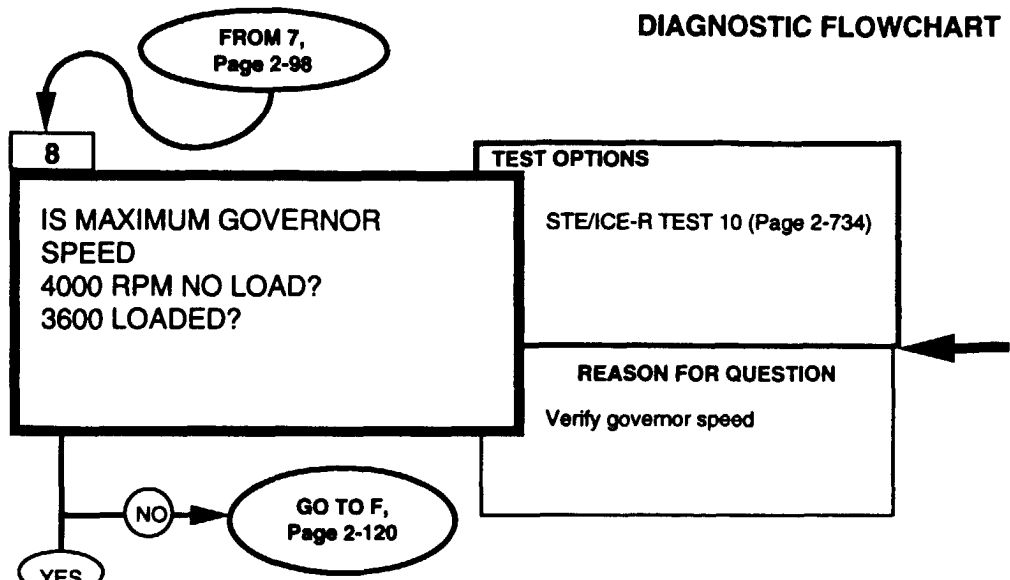
**ENGINE RPM  
STE/ICE-R TEST 10**

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be at least 100 RPM. Idle RPM should be 625 - 675.

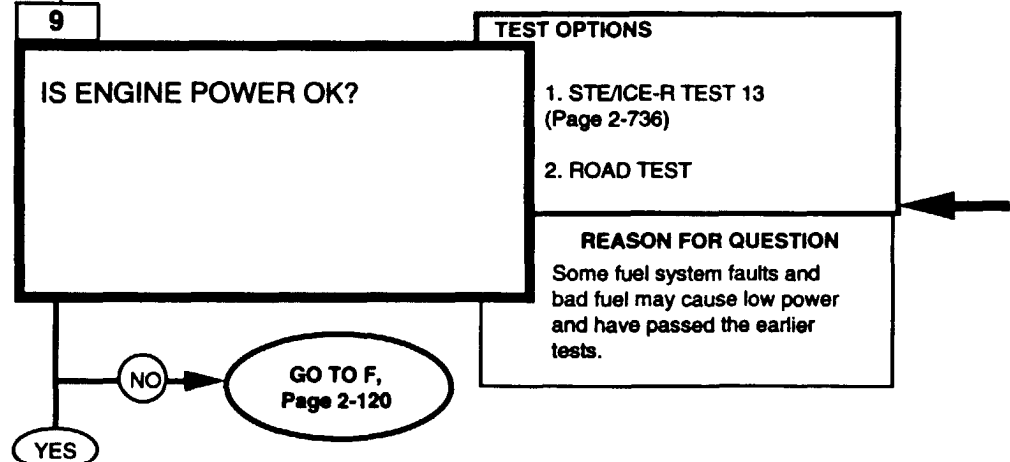
# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART

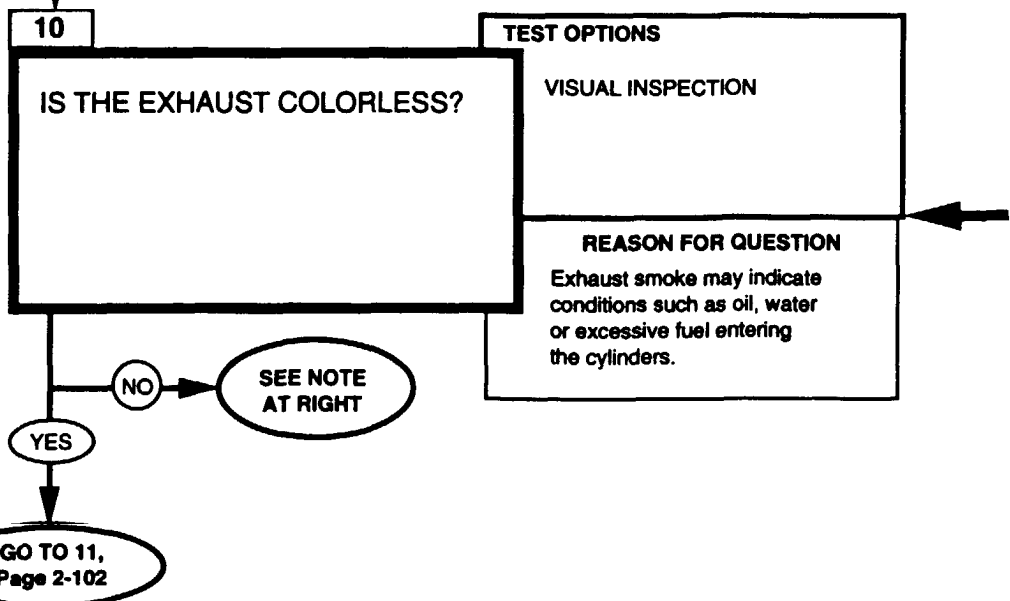
KNOWN INFO
FUEL LINES, PUMP AND FILTER OK.
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS EXHAUST RESTRICTED



KNOWN INFO
FUEL PUMP OK FUEL FILTER OK
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS RETURN CHECK VALVE



KNOWN INFO
INJECTION PUMP OK
POSSIBLE PROBLEMS
INJECTORS AIR CLEANER PUMP TIMING CDR VALVE RETURN CHECK VALVE



## REFERENCE INFORMATION

## FUEL SYSTEM

Governor no-load speed is with the transmission in neutral. Loaded speed is with the transmission in gear and the vehicle moving. It is the maximum rpm's the engine will develop. The engine will surge at governor speed since the governor will try to lower the engine speed and the accelerator is trying to increase it.

### ENGINE RPM STE/ICE-R TEST 10

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100-200. Idle RPM should be 625 - 675.

A number over 75 is passing for STE/ICE-R test 13. If the vehicle seems to be low on power while driving you have to check for other things which could cause this such as the transmission. To try a road test, accelerate the vehicle from 0 to a safe and reasonable speed on a reasonably level road.

### ENGINE POWER TEST (PERCENT) STE/ICE-R TEST #13

1. Set TEST SELECT switches to 13.
2. Press and release TEST button.
3. Wait for prompting message CIP to appear.
4. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays OFF, release accelerator.
5. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of per cent of nominal rated power.

### NOTE

If the exhaust is not colorless it must be either white, blue or black. If exhaust color is:

WHITE ..... Go to G, Page 2-122. Also could be injector timing. Notify DS maintenance.

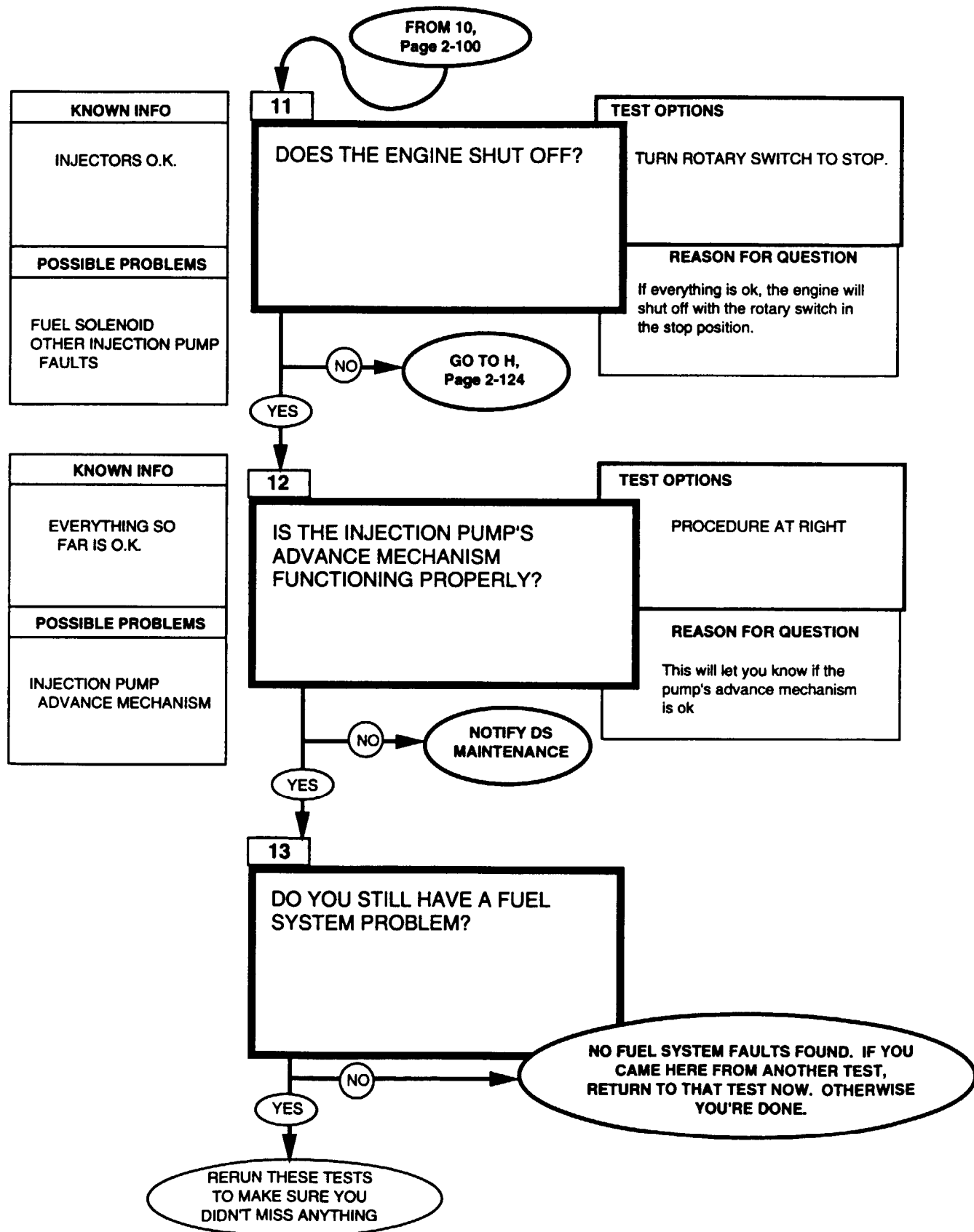
BLUE ..... Blue smoke is a sign of oil entering the combustion chambers. It usually enters past the piston rings or intake valve stem seals. This is an internal engine problem that can't be handled at this level of maintenance. You may want to run the Engine Running Mechanical tests, Page 2-47, before you notify DS Maintenance.

BLACK ..... Air Intake/exhaust, Page 2-137.




# FUEL SYSTEM

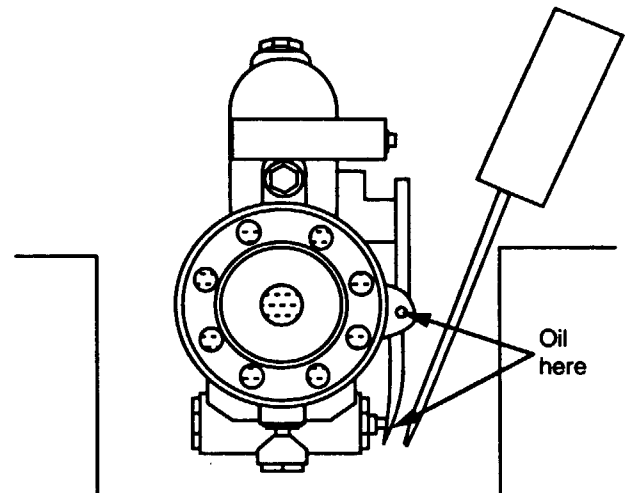
## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## FUEL SYSTEM

- 
1. Note engine rpm reading (STE/ICE-R TEST 10)
  2. Gently depress rocker arm on pump towards injection pump
  3. If mechanism is functioning properly rpms will decrease.
  4. If mechanism doesn't move freely, try putting a drop of oil in the two spots indicated. Gently try to depress rocker arm again.

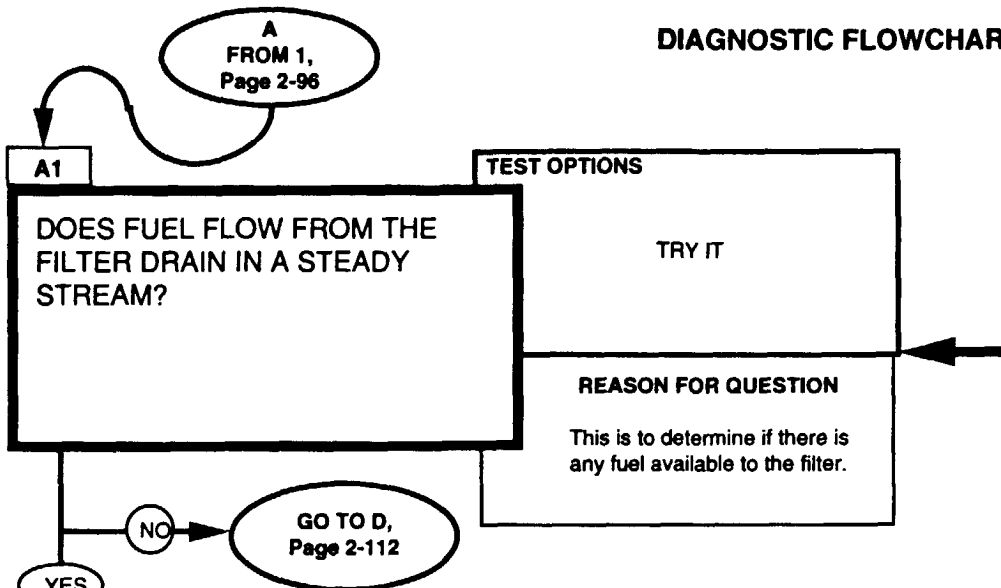


Injection pump as seen from rear of engine. Gently press screwdriver against arm. Use a ten inch screwdriver

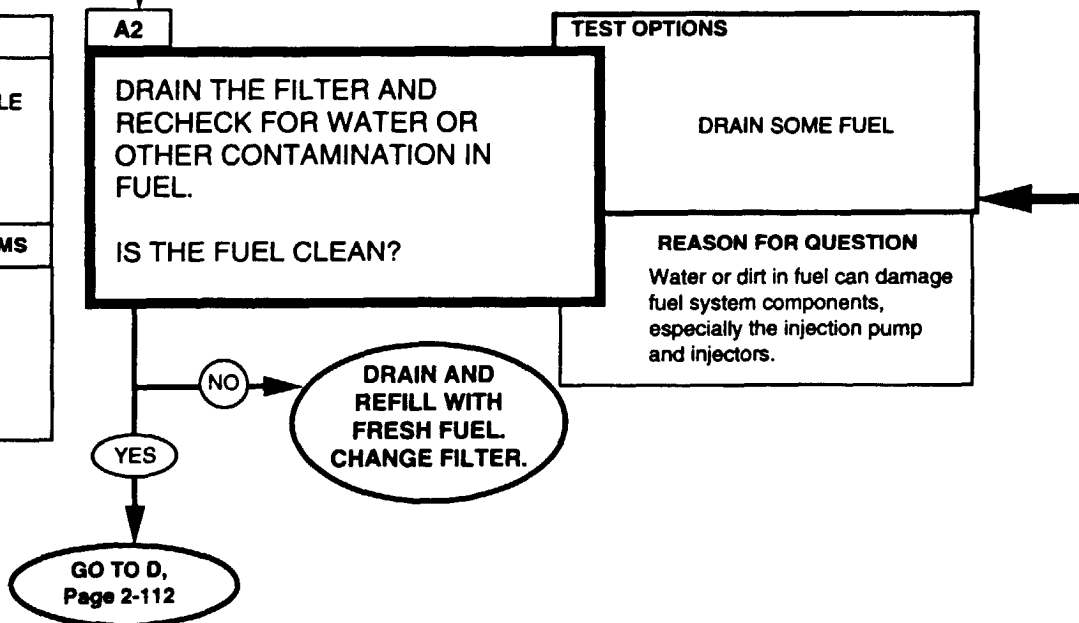
# FUEL SYSTEM

# DIAGNOSTIC FLOWCHART

KNOWN INFO
FUEL SUPPLY PROBLEM
POSSIBLE PROBLEMS
FUEL PUMP FUEL FILTER FUEL LINES VENT LINES



KNOWN INFO
SOME FUEL AVAILABLE AT FILTER
POSSIBLE PROBLEMS
FUEL PUMP FUEL FILTER FUEL LINES VENT LINES



## REFERENCE INFORMATION

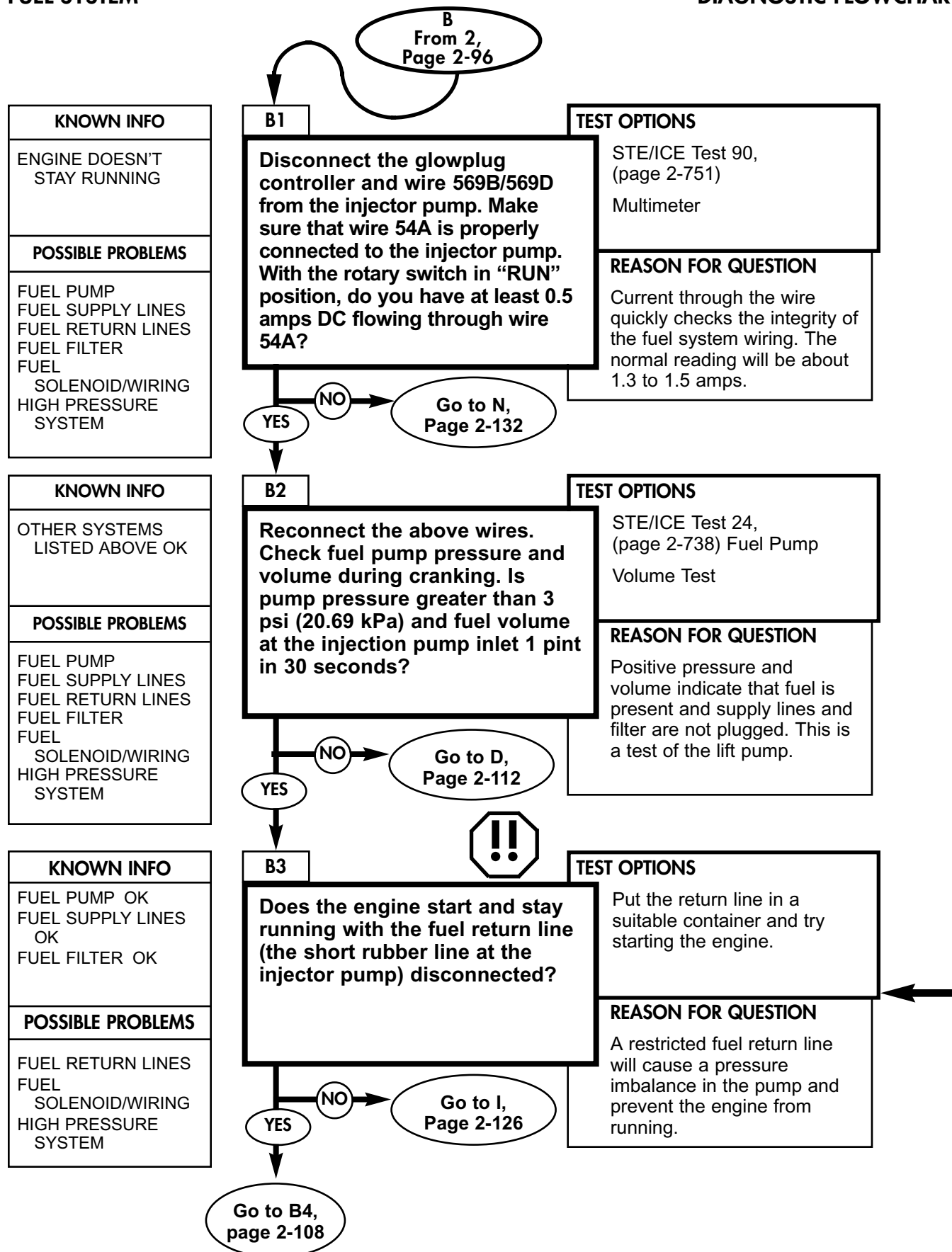
## FUEL SYSTEM

If no fuel arrives when cranking engine, the diaphragm in the lift pump may be ruptured, allowing the fuel to drain back into the tank.

There may be some water or dirt trapped in the filter already that didn't come from the fuel that is in the tank now. Open the filter drain valve and crank the engine for approximately 5 seconds to purge the filter, then take a fuel sample in a clear container. Inspect the sample for water and dirt. Replace fuel filter, refer to (para 3-33).

## FUEL SYSTEM

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## FUEL SYSTEM

**NOTE**

When using a multimeter to measure current through wire 54A, disconnect the wire. Set the ammeter to a scale of at least 5 amps DC. Connect the red lead of the multimeter to wire 54A and the black lead to ground. With the rotary switch in the RUN position, measure current. Be sure to read the correct scale. Return the switch to the STOP position. Disconnect the multimeter and reconnect wire 54A.

**FUEL PUMP PRESSURE  
STE/ICE-R TEST #24**

1. Select Fuel Supply Pressure Test (Test #24). Perform CAL.
2. Crank (or start) engine.

**FUEL PUMP VOLUME TEST**

1. Disconnect fuel line at injection pump inlet and route fuel line into a suitable, 1 quart container.
2. Crank the engine for 30 seconds.
3. If the pump and lines are ok, you should get about 1 pint (1/2 quart) (0.5L) in 30 seconds.

**WARNING**

Diesel fuel is highly flammable. Do not perform any procedures near fire, flames, or sparks. Severe injury or death may result.

1. Disconnect the return line and direct it into a suitable container.
2. Watch the fuel flow from the return line as you or an assistant try to start the engine.

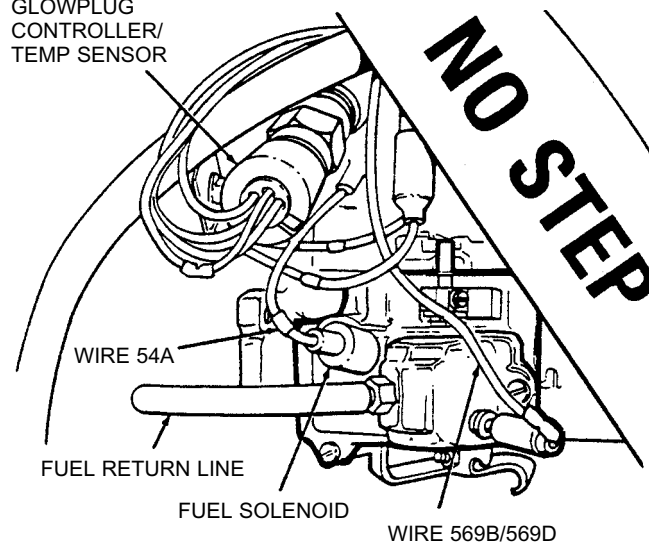
**5 AMPS DC  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point; BLACK clip to negative or ground.
2. Start Test 90.
3. Displayed reading is in amps.

**FUEL PUMP PRESSURE TEST  
PRESSURE GAUGE**

1. Connect a tee into the fuel line between the fuel filter outlet and the injection pump inlet.
2. Attach gauge to tee.
3. Crank (or Start) engine.

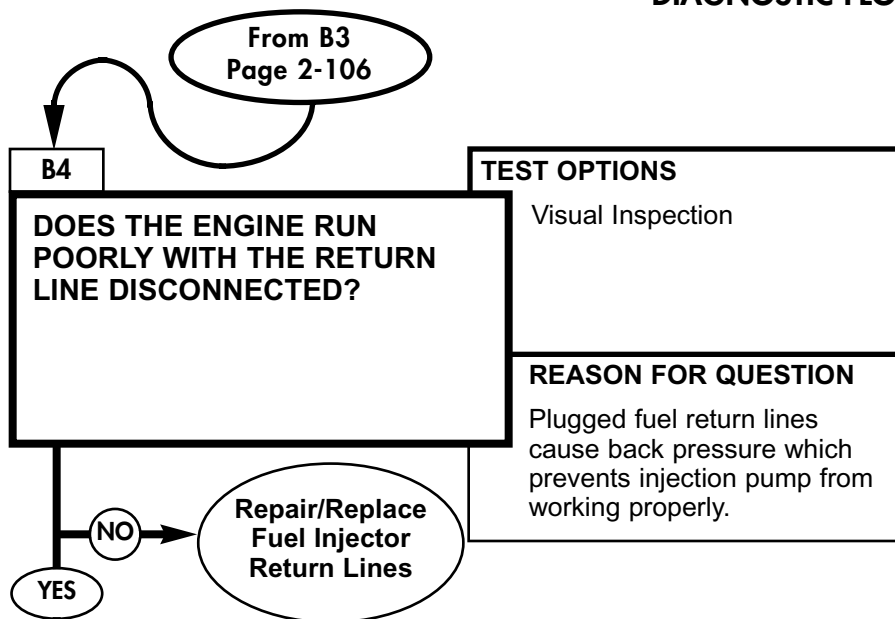
GLOWPLUG  
CONTROLLER/  
TEMP SENSOR



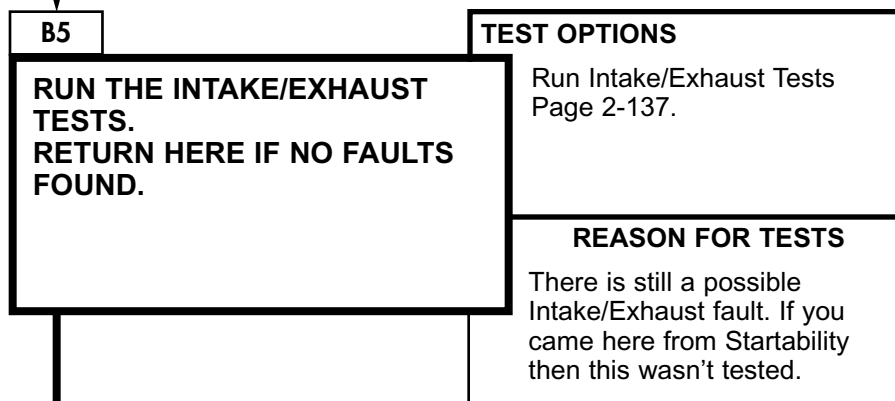
# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART

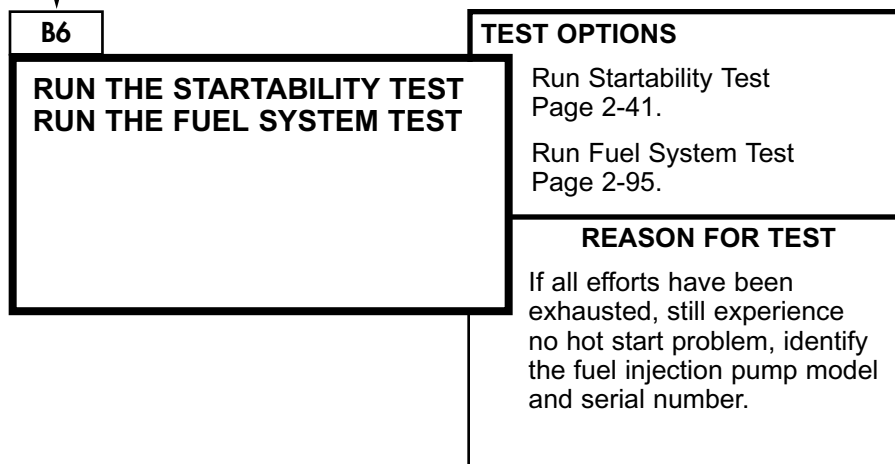
KNOWN INFO
FUEL SOLENOID AND WIRING OK
POSSIBLE PROBLEMS
FUEL RETURN LINES INJECTION PUMP INJECTORS RETURN CHECK VALVE



KNOWN INFO
RETURN LINES OK
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS



KNOWN INFO
RETURN LINES OK
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS



## REFERENCE INFORMATION

## FUEL SYSTEM

Return lines should be inspected for kinks or crushed lines or anything that might restrict fuel flow.

Inspect fuel return check valve for any restrictions. Replace valve (para. 3-35).

Replace fuel lines. Refer to (para. 3-25).

If you came here from the Startability Tests, return to STEP 5, Page 2-44.

If you haven't run the Startability Tests yet, go to STEP 1, Page 2-42.

During high temperature and humidity, early model vehicles can experience difficulty starting while using JP-8 fuel. High temperatures can cause restrictive clearances in some older fuel injection head and rotor assemblies. The engine must be allowed to cool to allow adequate clearance of the pumping plungers to ensure adequate fuel delivery for starting. If this condition persists, run the startability tests. If vehicle passes all startability tests and troubleshooting procedures and still experiences difficulty in hot starting, identify the fuel injection pump and serial numbers.

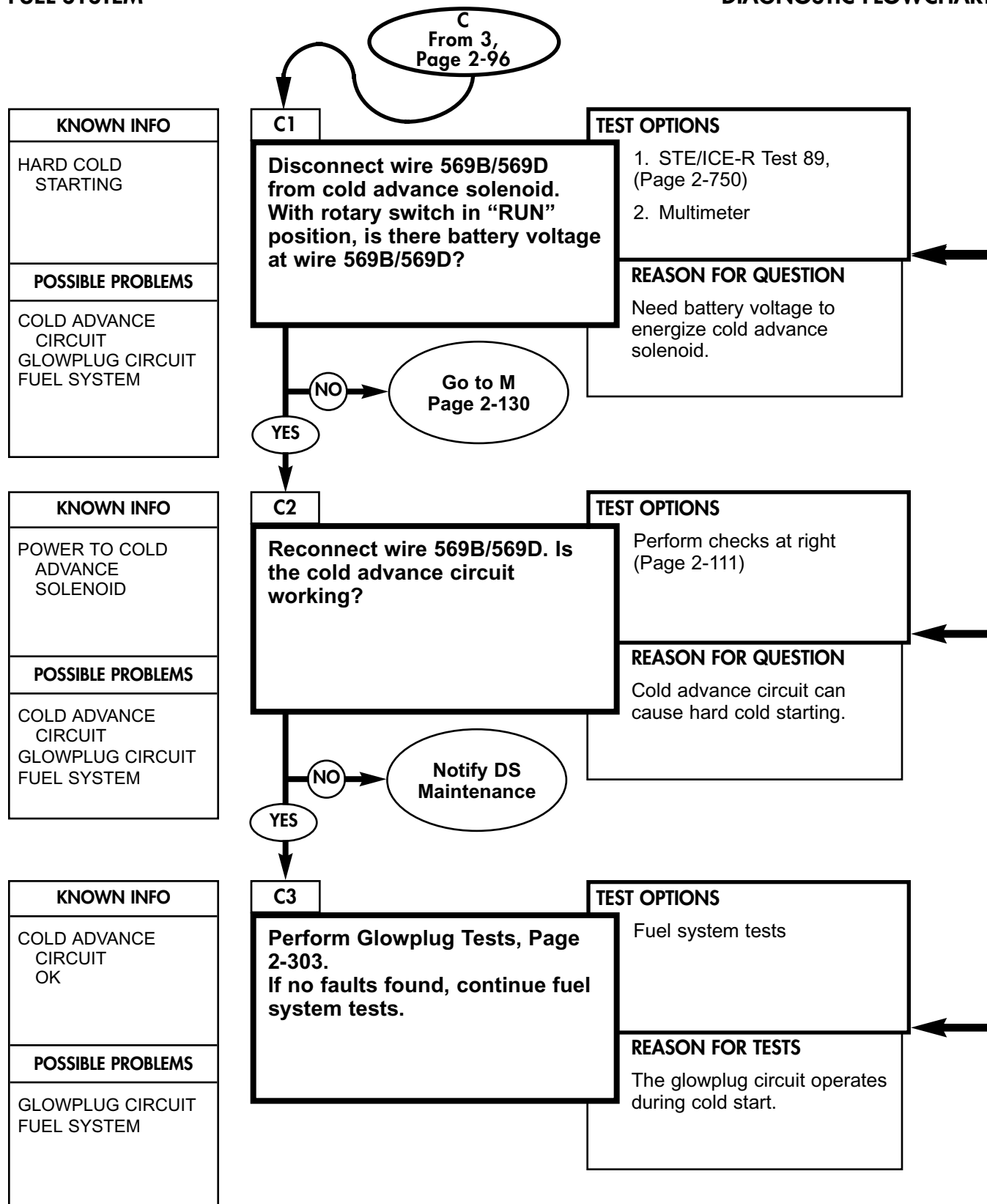
All fuel injection pumps with P/N DB2831-5209, NSN 2910-01-467-9029 incorporated the improved head and rotor assembly, P/N 31506. If your serial number is less than shown in the Serial Number Break Column of the table below, the manufacturer recommends the fuel injection pump to be replaced, tagged as a "no hot restart" condition, and forward for rebuild. Notify direct support maintenance.

Model Pump P/N (NSN)	Serial Number Break	Original P/N	New P/N (NSN)
DB2829-4523 (2910-01-199-2355)	7539307	23122 or 28396	31816/4320-01-317-0692
DB2829-4879 (2910-01-326-9221)	80644583	23122 or 28396	31816/4320-01-317-0692
DB2831-5149 (2910-01-414-1272)	776848	29124	31506/2910-01-414-5382
DB2831-5149 (2910-01-434-8597)	776848	29124	31506/2910-01-414-5382



## FUEL SYSTEM

## DIAGNOSTIC FLOWCHART



# REFERENCE INFORMATION

## FUEL SYSTEM

The engine temperature must be below 90° F (32°C) to get voltage here. If the engine is warm, either wait for it to cool, or go to step C3 at the bottom of the pegs and remember that the cold advance maybe the problem if everything else checks out OK.

The Glowplugs or the Intake/Exhaust System may be faulty, so you should test them first.

The cold advance circuit advances the fuel injection pump timing approximately 3 to 5 degrees during cold start up. If engine temperature is less than 90°F (32°C), then Advance circuit operation maybe checked as follows:

1. Start the engine.
2. Disconnect wire 569B/569D from the Advance Solenoid. If the circuit is working correctly, then engine RPM should decrease.
3. Look at the advance mechanism on the right side of the fuel injection pump while you connect and disconnect 569D/569B with the engine running. The advance mechanism should move about 1/4 inch.
4. If the advance mechanism is stuck, apply some oil at the points shown and try again.

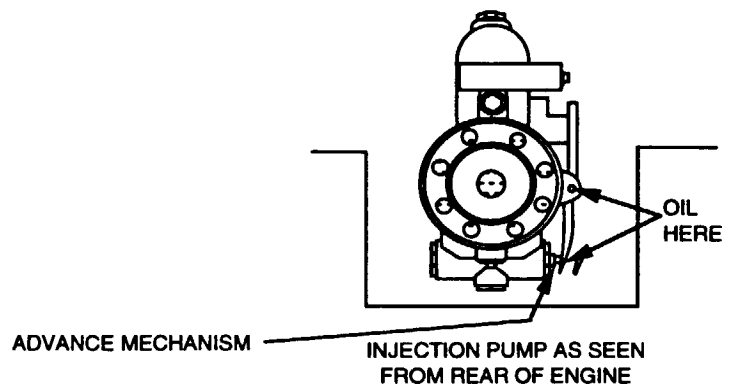
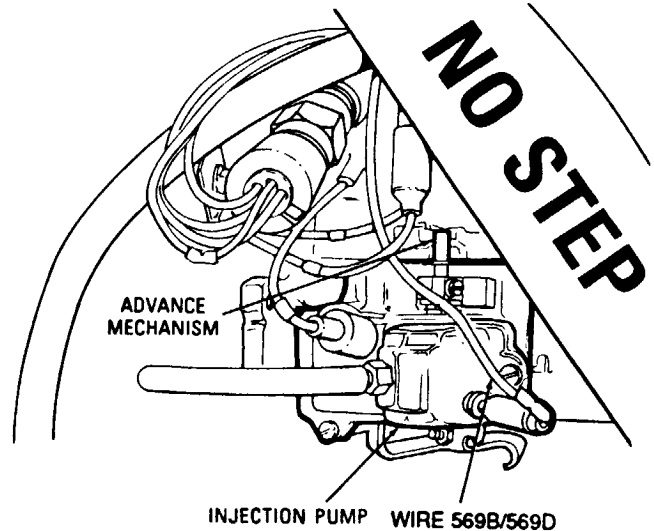
Remember to reconnect any wires that were disconnected during troubleshooting.

### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to positive, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART

KNOWN INFO
LOW FUEL PUMP PRESSURE
POSSIBLE PROBLEMS
FUEL PUMP FUEL FILTER FUEL LINES VENT LINES FUEL PRESSURE TRANSDUCER

D  
FROM 4, 5, Page 2-98;  
A1, A2, Page 2-104;  
B2, Page 2-106

**D1**

LISTEN FOR A HISS WHEN YOU REMOVE THE FILLER CAP.

CAN YOU REMOVE THE FILLER CAP WITHOUT HEARING A HISS?

TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
A plugged vent line will eventually cause enough negative pressure in the tank to prevent fuel flow.

NO → REPLACE VENT FILTER/ REPAIR LINE

YES →

KNOWN INFO
VENT LINES OK LOW FUEL PUMP PRESSURE
POSSIBLE PROBLEMS
FUEL PUMP FUEL LINES FUEL FILTER FUEL PRESSURE TRANSDUCER

**D2**

IS THE TEMPERATURE ABOVE 20°F (-7°C) ?

TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
When the temperature is less than 20°F (-7°C) wax flakes can build up on the fuel tank strainer or in the fuel filter.

NO → CHECK FOR A WAX BUILDUP IN TANK STRAINER OR FILTER. USE AN ANTIWAX AGENT IF AVAILABLE. BLEED FUEL SYSTEM AND CONTINUE TESTING

YES →

KNOWN INFO
FUEL FILTER OK NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE FUEL LINES
POSSIBLE PROBLEMS
FUEL PUMP FUEL PRESSURE TRANSDUCER

**D3**

IF YOU USED THE DCA TO MEASURE FUEL SUPPLY PRESSURE, IS THE STE/ICE-R, DCA AND TRANSDUCER OK?

TEST OPTIONS
DCA TROUBLESHOOTING (Page 2-723)
USE A PRESSURE GAUGE TO MEASURE FUEL SUPPLY
REASON FOR QUESTION
Before condemning fuel pump, make sure that the pressure transducer is working.

NO → REPAIR/REPLACE AS NECESSARY

YES → GO TO D4, Page 2-114

## REFERENCE INFORMATION

## FUEL SYSTEM

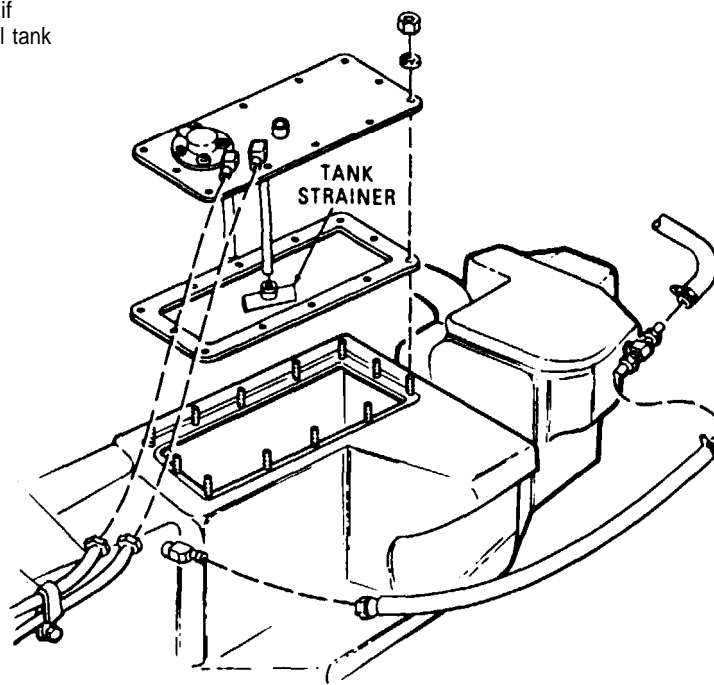
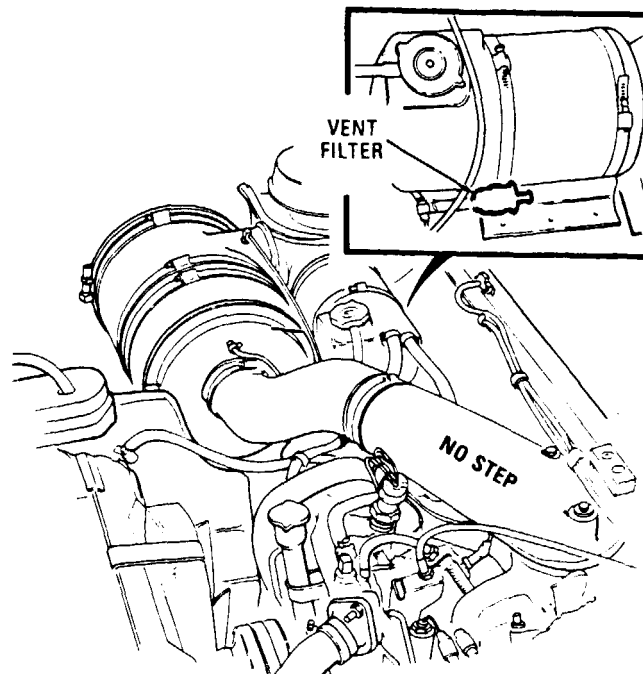
If you hear a hissing noise while removing the fuel filter cap then either the vent filter is plugged, the vent line is restricted, or the vent valve is restricted. The vent filter is located behind the coolant surge tank.

Replace vent lines or vent line filter, refer to (para. 3-27.)

Replace vent valve, refer to (para. 3-24.)

Diesel fuel is sensitive to temperature. All diesel fuel has a certain amount of paraffin-like components which have high energy value and help improve fuel economy. When temperatures are less than 20°F (-7°C) these components begin turning into wax flakes that can build upon the fuel tank strainer or in the fuel filter. If wax build-up is found, replace the fuel in the tank with a winter grade of fuel if available. You will have to remove the fuel tank if you need to inspect the tank strainer.

Replace fuel tank, refer to (para. 3-24.)



FUEL SYSTEM

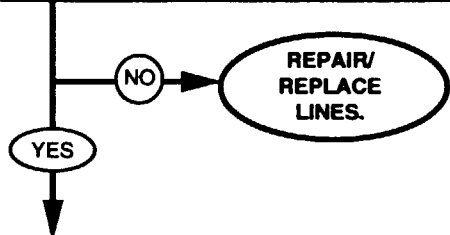
DIAGNOSTIC FLOWCHART

KNOWN INFO
FUEL FILTER OK NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE
POSSIBLE PROBLEMS
FUEL PUMP FUEL LINES FUEL PRESSURE TRANSDUCER



INSPECT THE FUEL LINES.  
ARE THE LINES OK?

TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
Kinked fuel lines will restrict fuel flow.

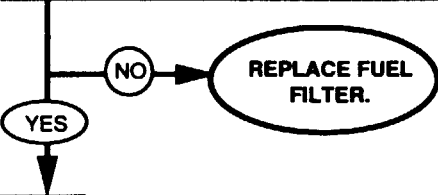


KNOWN INFO
NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE
POSSIBLE PROBLEMS
FUEL PUMP FUEL LINES FUEL FILTER FUEL PRESSURE TRANSDUCER

D5

INSPECT THE FUEL FILTER.  
REMOVE THE FILTER ELEMENT  
AND CHECK IT FOR DIRT AND  
OTHER CONTAMINATION.  
IS THE FILTER ELEMENT CLEAN?

TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
A dirty filter will restrict fuel flow.

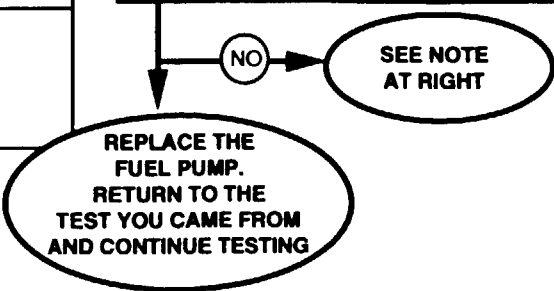


KNOWN INFO
FUEL LINES OK FUEL FILTER OK NO WAX BUILD-UP VENT LINES OK LOW FUEL PUMP PRESSURE TRANSDUCER OK
POSSIBLE PROBLEMS
FUEL PUMP

D6

REMOVE FUEL PUMP.  
INSPECT FUEL PUMP PUSHROD  
AND CAMSHAFT LOBE.  
ARE ALL OF THESE PARTS IN  
GOOD CONDITION?

TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
If the components that drive the fuel pump are worn, then the pump will not operate properly.



## REFERENCE INFORMATION

Fuel lines should be inspected for kinks, cracks or anything that would restrict fuel flow or allow air to enter the lines. Be sure to check the lines all the way back to the tank and remember that there is a strainer inside the tank which can become plugged. You will have to remove the tank if it becomes necessary to check this.

Replace fuel lines, refer to (para 3-25)

Poor starting and excessive smoke after start up can be the result of a restricted fuel supply. This restriction most likely will be from a plugged fuel filter but can also be caused by a pinched or kinked fuel line. After the engine warms up, it generally will run satisfactorily. If the restriction gets progressively worse, top speed and performance will be affected also.

**FUNGUS**

In warm or humid weather, fungi and/or bacteria in the fuel can cause fuel system damage by plugging the fuel lines, filter, or injection nozzles.

For removal, replacement and torques, refer to (para 3-33) or notify DS maintenance.

Excessive roughness on any of these parts is an indication of wear. The pushrod should slide smoothly in the engine block. If you notice any roughness on the end of the pushrod be sure to check the lobe on the camshaft.

**NOTE**

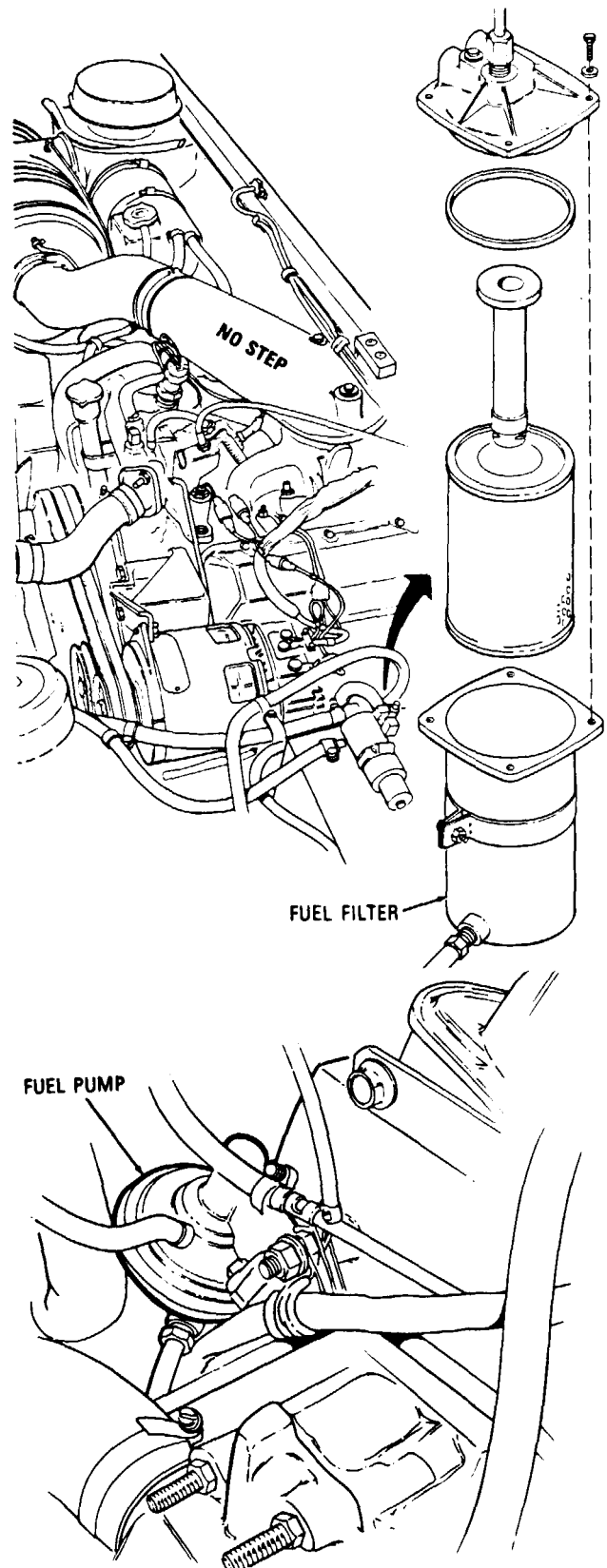
If the pump or rod is worn, replace. Refer to (para 3-23). If the lobe on the camshaft is worn, notify DS maintenance.

**Rerun Test Chain**

You may have corrected some problems but there may be others including the fuel pump.

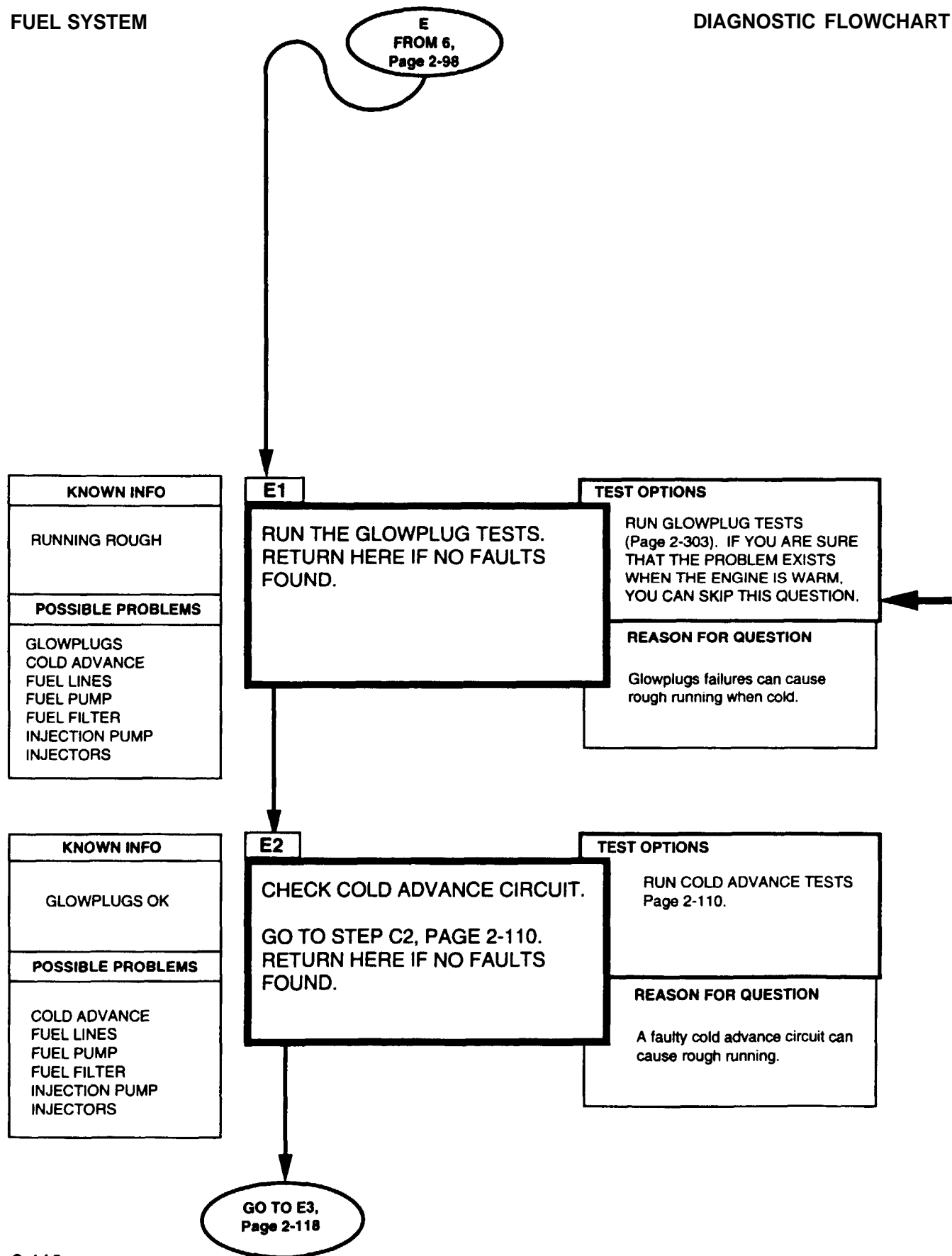
For removal, replacement and torques, refer to (para 3-23).

## FUEL SYSTEM



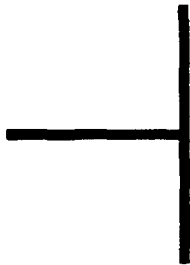
FUEL SYSTEM

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## FUEL SYSTEM



Injection pump timing that is too far advanced can cause glowplugs failure because it increases cylinder temperature. Usually several but not all glowplugs will fail.



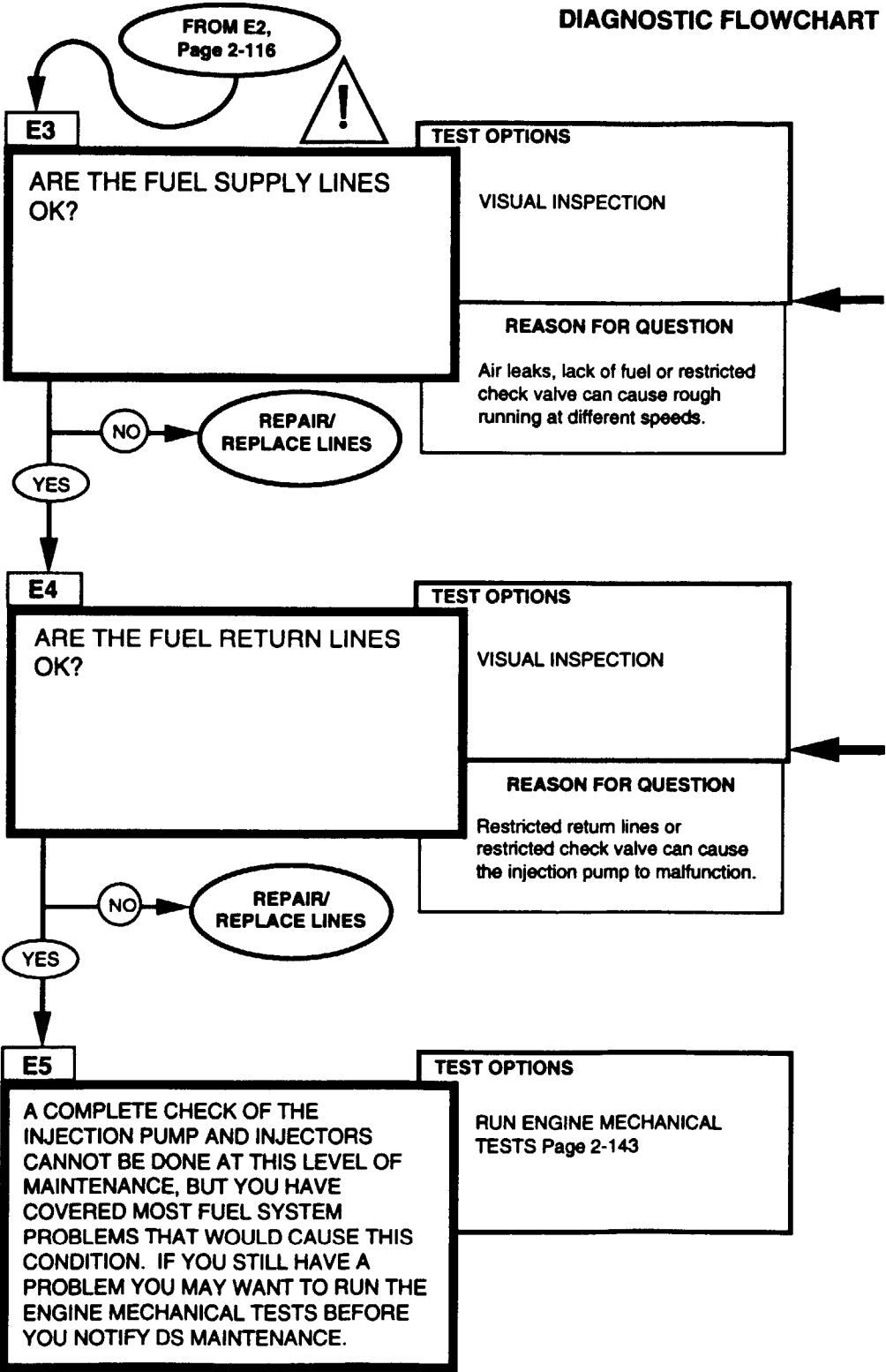
FUEL SYSTEM

DIAGNOSTIC FLOWCHART

KNOWN INFO
COLD ADVANCE OK
POSSIBLE PROBLEMS
FUEL LINES FUEL PUMP FUEL FILTER INJECTION PUMP INJECTORS RETURN CHECK VALVE

KNOWN INFO
SUPPLY LINES OK
POSSIBLE PROBLEMS
FUEL LINES FUEL PUMP FUEL FILTER INJECTION PUMP INJECTORS RETURN CHECK VALVE

KNOWN INFO
FUEL PUMP OK
POSSIBLE PROBLEMS
INJECTION PUMP INJECTORS



## REFERENCE INFORMATION

## FUEL SYSTEM

**CAUTION**

Be sure to keep the line clear of moving engine parts (fan, pulleys, etc...) and **DO NOT** place the line on the exhaust manifold.

Replace fuel lines (refer to para 3-25).

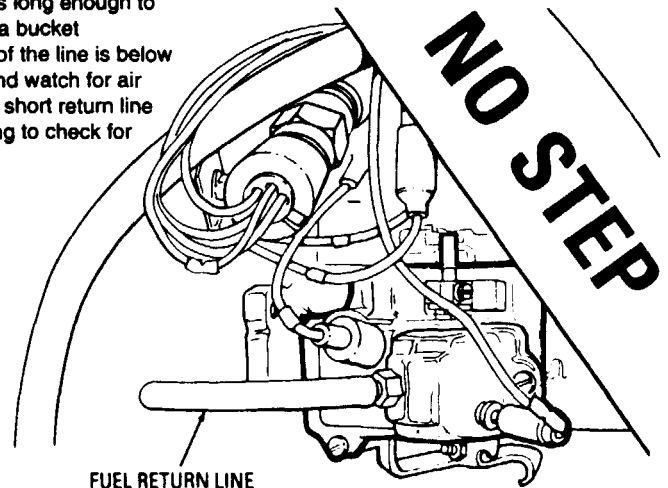
Check the filter vent screw for tightness.

Check the supply lines for kinks, cracks, leaks, or loose connections that could restrict fuel flow or allow air to enter the system. Remember that under certain operating conditions parts of the fuel system can be under vacuum so that loose connections that may not leak fuel can let air in.

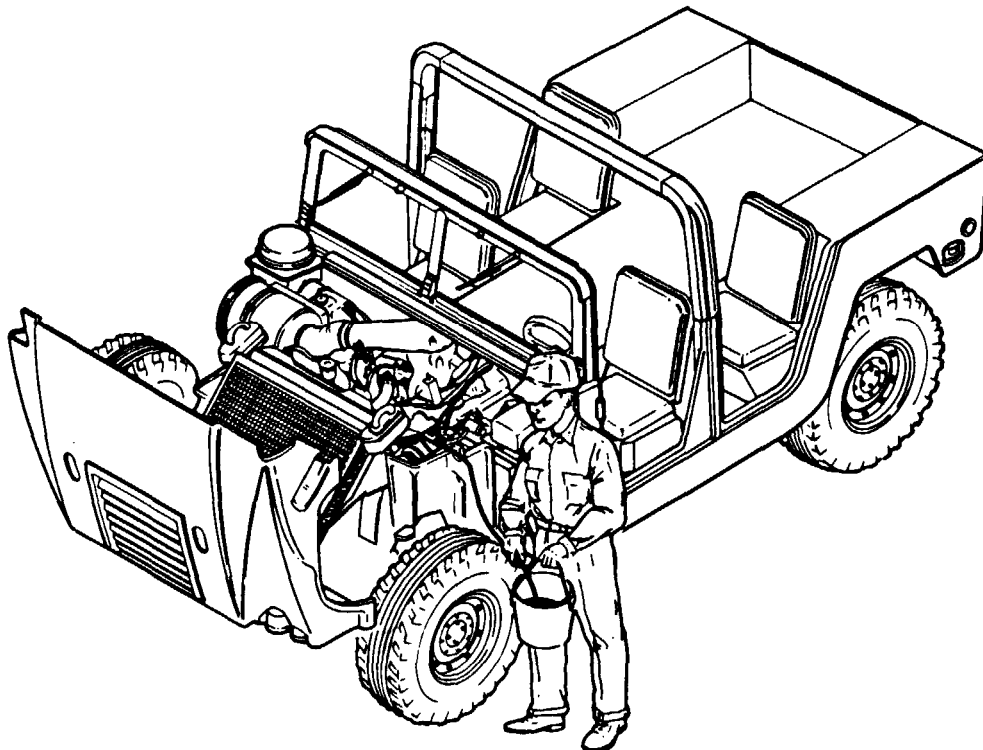
To test for air leaks in the supply lines, disconnect the return line from the injection pump and connect a line that is long enough to reach the ground. Place the end of the line into a bucket containing diesel fuel, making sure that the end of the line is below the level of fuel in the bucket. Run the engine and watch for air bubbles in the bucket. You can also replace the short return line from the injector pump with a clear piece of tubing to check for bubbles.

Inspect the return lines for kinks or any other blockage that may restrict fuel flow. Inspect fuel return check valve for any restrictions (refer to para. 3-25).

Replace fuel line (refer to para 3-25).



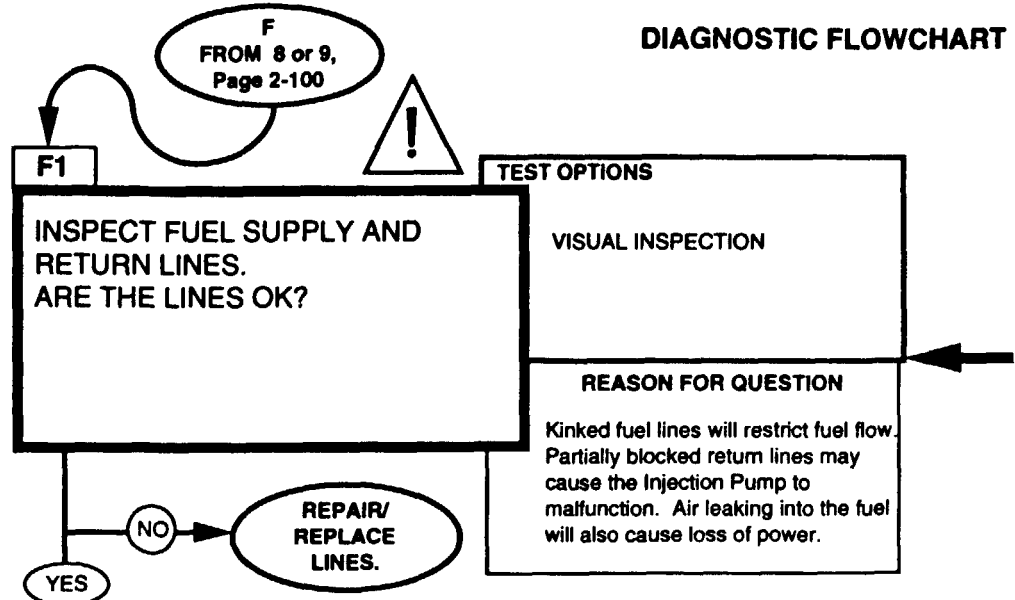
FUEL RETURN LINE



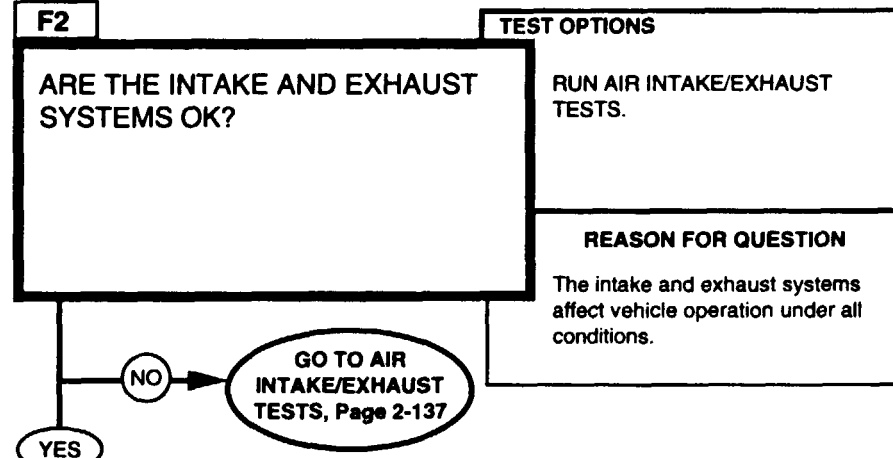
**FUEL SYSTEM**

**DIAGNOSTIC FLOWCHART**

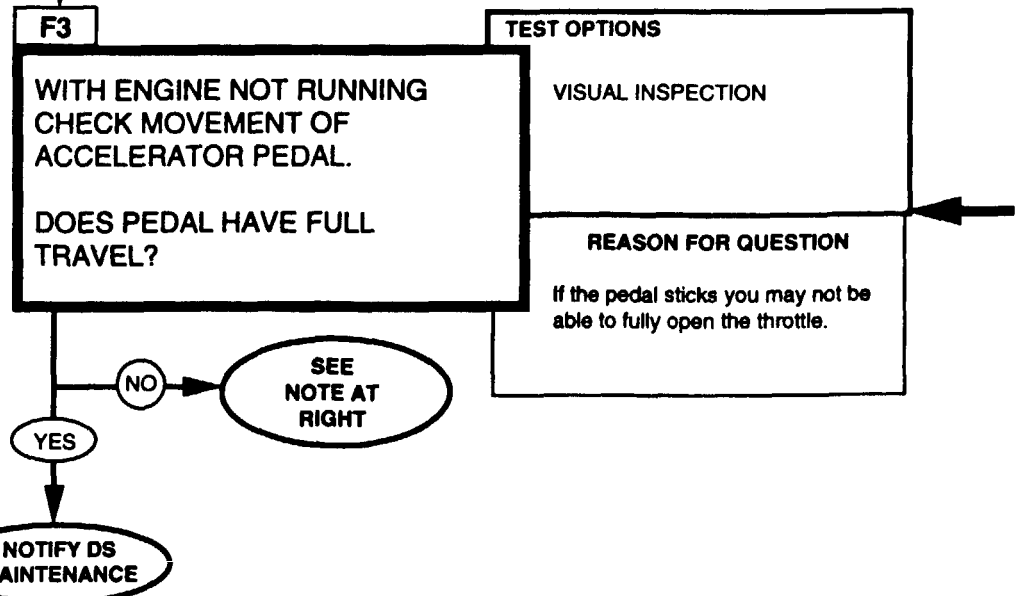
KNOWN INFO
FUEL FILTER OK
POSSIBLE PROBLEMS
FUEL PUMP ACCELERATOR LINKAGE FUEL LINES INJECTION PUMP INJECTORS INTAKE/EXHAUST RETURN CHECK VALVE



KNOWN INFO
FUEL LINES OK FUEL FILTER OK
POSSIBLE PROBLEMS
INTAKE/EXHAUST FUEL PUMP ACCELERATOR LINKAGE INJECTION PUMP INJECTORS



KNOWN INFO
FUEL PUMP OK FUEL LINES OK FUEL FILTER OK
POSSIBLE PROBLEMS
ACCELERATOR LINKAGE INJECTION PUMP INJECTORS



## REFERENCE INFORMATION

## FUEL SYSTEM

**CAUTION**

Be sure to keep the line clear of moving engine parts (fan, pulleys, etc...) and DO NOT place the line on the exhaust manifold.

Fuel lines should be inspected for kinks, cracks, or anything that would restrict fuel flow or allow air into the lines. Be sure to check the lines all the way back to the tank and remember that there is a strainer inside the tank which can also become plugged.

To test for air leaks in the supply lines, disconnect the return line from the injection pump and connect a line that is long enough to reach the ground. Place the end of the line into a bucket containing diesel fuel, making sure that the end of the line is below the level of fuel in the bucket. Run the engine and watch for air bubbles in the bucket. Replace fuel line, refer to (para 3-25).

An important function of all hoses, lines and fittings is to carry fuel without admitting air to the system. When the fuel tank cap is in place and the fuel pump and injection pump are drawing fuel through the lines a low vacuum of 0-1 PSI is created. This occurs because the fuel which the engine uses must be replaced by air. During this vacuum condition, the slightest leak, which may not leak fuel out, could draw air into the system and, depending on the volume of air, cause a wide variety of engine malfunctions.

**COLD WEATHER OPERATION**

Diesel fuel is sensitive to temperature. All diesel fuel has a certain amount of wax-like components which have high energy value and help improve fuel economy. When temperatures are less than 20°F (-7°C) these components begin turning into flakes that can build up on the fuel tank strainer or in the fuel filter.

**FUNGUS**

In warm or humid weather, fungi and/or bacteria can cause fuel system damage by plugging the fuel lines, filter, or injection nozzles.

**ODOR**

Old fuel smells like varnish.

Check the accelerator pedal for full movement with no sticking or binding. If you have sticking or binding, lubricate accelerator pedal bushing and bearing with seasonal grade OE oil (TM 9-2320-280-10). If you do not have full pedal travel then disconnect the accelerator linkage from the fuel injection pump and recheck the travel. If you now have full travel then the problem is in the fuel injection pump and cannot be handled at this level of maintenance.

Operation of the injection pump and injectors cannot be verified at this level of maintenance.

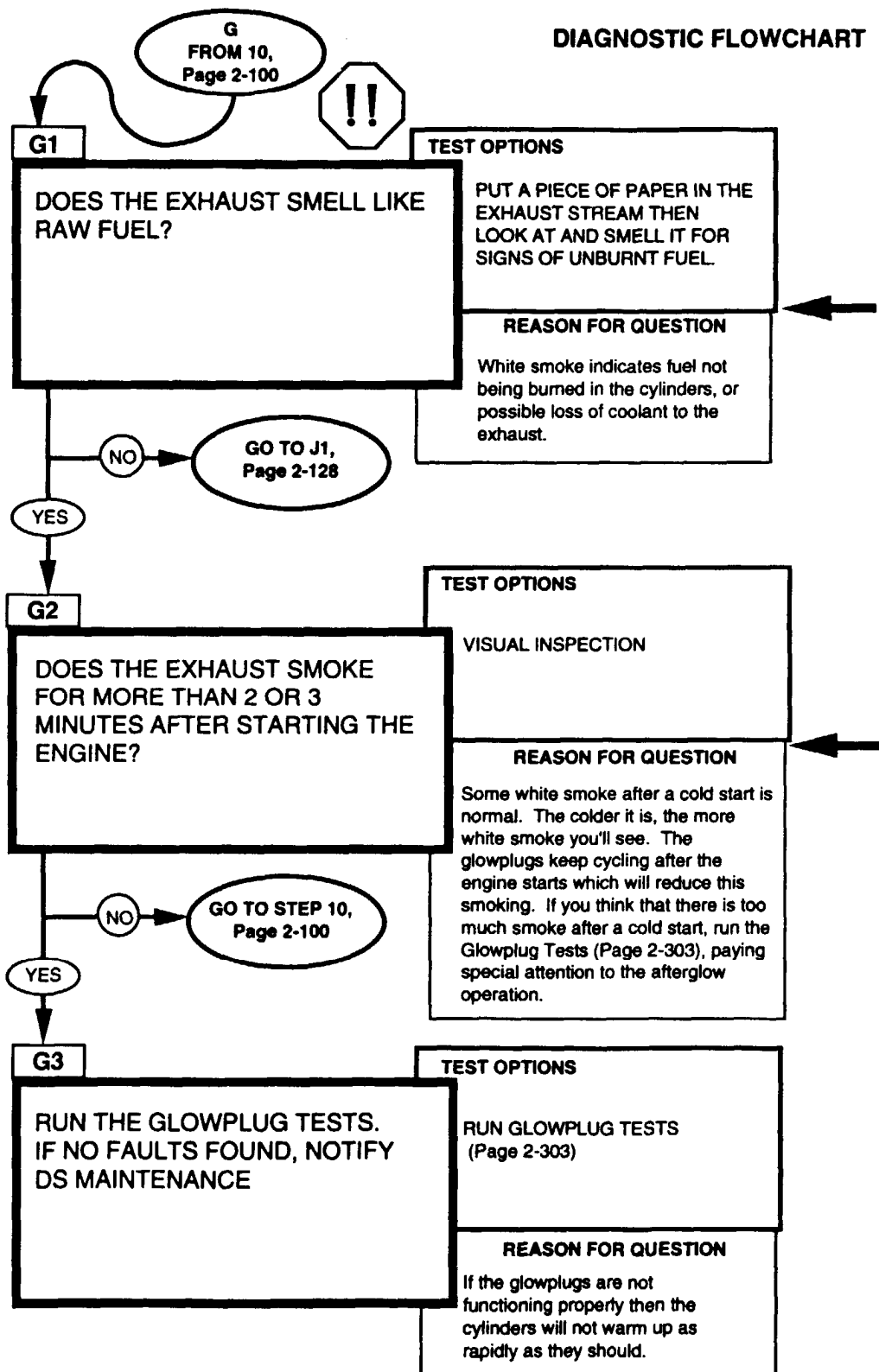
# FUEL SYSTEM

# DIAGNOSTIC FLOWCHART

KNOWN INFO
WHITE SMOKE
POSSIBLE PROBLEMS
INJECTION TIMING INTERNAL ENGINE PROBLEMS FUEL QUALITY

KNOWN INFO
WHITE SMOKE
POSSIBLE PROBLEMS
INJECTION TIMING INTERNAL ENGINE PROBLEMS FUEL QUALITY RETURN CHECK VALVE

KNOWN INFO
GLOWPLUGS OK WHITE SMOKE
POSSIBLE PROBLEMS
ENGINE MECHANICAL



## REFERENCE INFORMATION

## FUEL SYSTEM



### **WARNING**

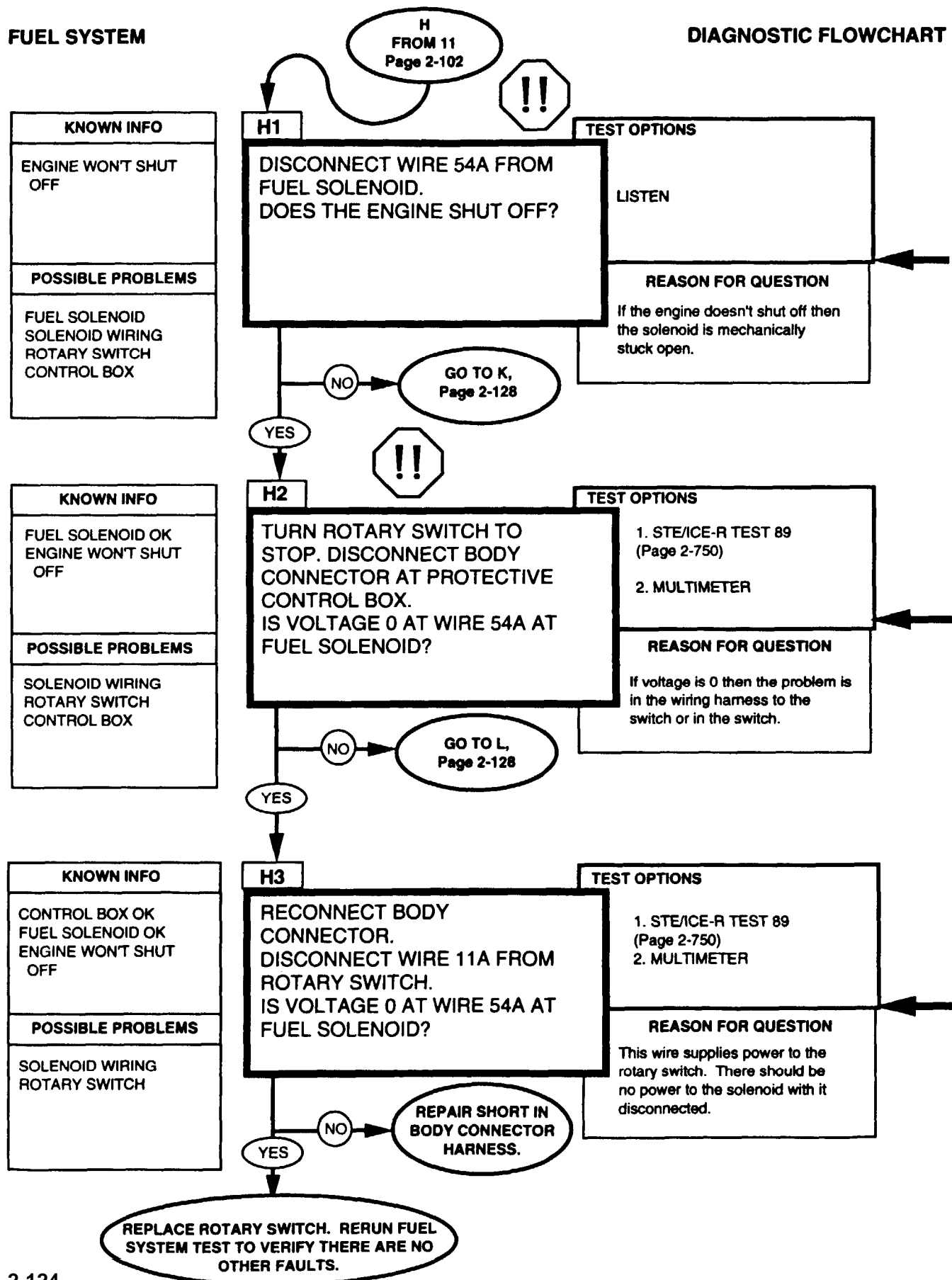
Be careful when performing this test. Exhaust gas can be extremely hot and severe burns can result.

Put a piece of paper in the exhaust stream for a few moments with the engine at idle. Then look at the paper to see if there is any condensed fuel on it. Then smell the paper to see if it smells like raw fuel. If it smells like fuel then the engine could be very cold or else it has a DS level fuel system fault or compression fault.

White smoke for a short time after start up, especially on a cold day, is a normal condition. It is caused by incomplete combustion of the fuel because of low cylinder temperature. It should clear up in a few minutes. If not you may have a bad head gasket, cracked block, or a restricted check valve. Check for restricted check valve (para. 3-35).

# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## FUEL SYSTEM

**WARNING**

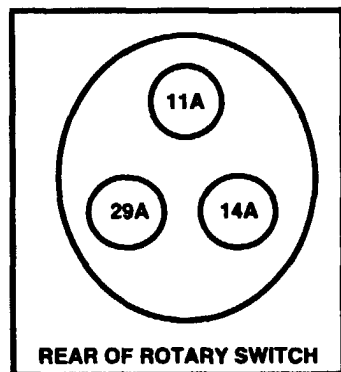
Keep hands away from engine fan! Moving fan blades can cause serious injury. Use extreme caution when engine is running.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Rotary Switch must remain in STOP position for the rest of these tests.

**NOTE**

Carefully inspect the body connector end of the harness for a short. Check for pushed out pins, broken or stripped insulation or any other bare wires. If everything checks out OK, you have to replace the harness.

Remember to reconnect any wires that may have been disconnected during troubleshooting.

For repair instructions (HARNESS REPAIR), refer to (para 4-85).

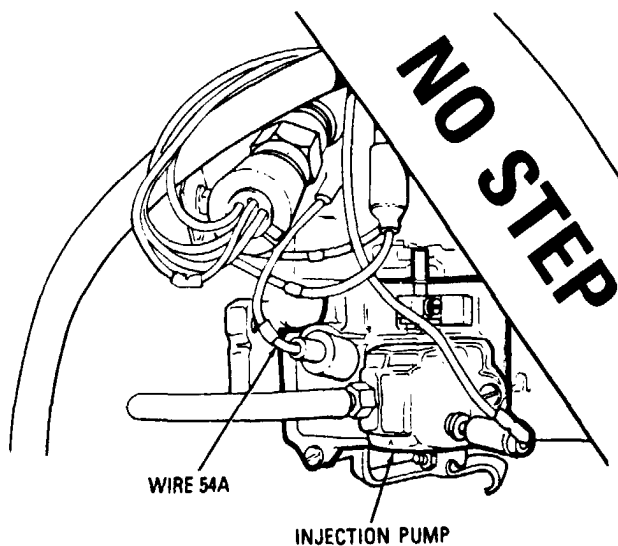
For repair/replace instructions (ROTARY SWITCH), refer to (para 4-7).

**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to positive, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**DC VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.





# FUEL SYSTEM

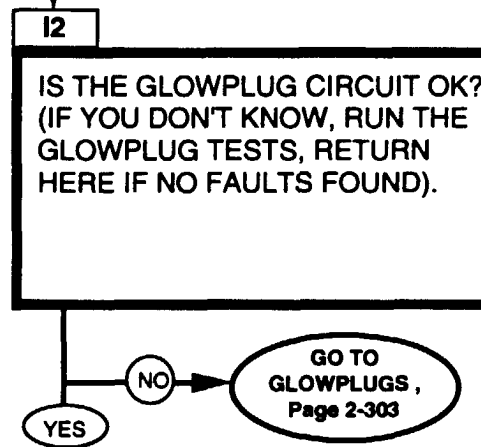
## DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
FUEL SUPPLY OK FUEL RETURN OK SOLENOID WIRING
<b>POSSIBLE PROBLEMS</b>
FUEL SOLENOID INJECTION PUMP INJECTORS



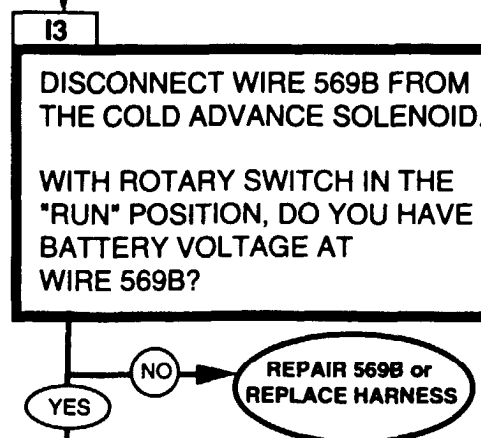
<b>TEST OPTIONS</b>
VISUAL INSPECTION
<b>REASON FOR QUESTION</b>
To see if there is fuel available to the injection pump.

<b>KNOWN INFO</b>
FUEL AVAILABLE TO THE INJECTION PUMP
<b>POSSIBLE PROBLEMS</b>
FUEL SOLENOID INJECTION PUMP INJECTORS GLOWPLUGS COLD ADVANCE



<b>TEST OPTIONS</b>
GLOWPLUGS TEST (Page 2-303)
<b>REASON FOR QUESTION</b>
On a cool day a faulty glowplug circuit will prevent the engine from starting.

<b>KNOWN INFO</b>
GLOWPLUGS OK
<b>POSSIBLE PROBLEMS</b>
FUEL SOLENOID INJECTION PUMP INJECTORS COLD ADVANCE



<b>TEST OPTIONS</b>
STE/ICE-R TEST 89 (Page 2-750)
MULTIMETER
<b>REASON FOR QUESTION</b>
On a cold day a faulty cold advance circuit will prevent the engine from starting.

## REFERENCE INFORMATION

**NOTE**

Check the rubber return line from the injection pump to the steel tubing return line.

If the rubber line is not clogged go to D1, page 2-112.

If the line is clogged, then replace it. Start the engine and see if it stays running. If it doesn't start or stay running then return to J1 and continue testing. There may be another fuel system fault preventing fuel from reaching this point.

If the cold advance solenoid is getting power then the only possibilities that would keep the engine from starting are that fuel is not reaching the cylinders due to a fault in the high pressure side of the fuel system or nearly all the cylinders have very low compression. It is unlikely that all the cylinders would lose compression at the same time, but you may want to run a Compression Unbalance test (STE/ICE-R Test #14) to check this.

For repair/replace instructions, refer to (para 4-85).

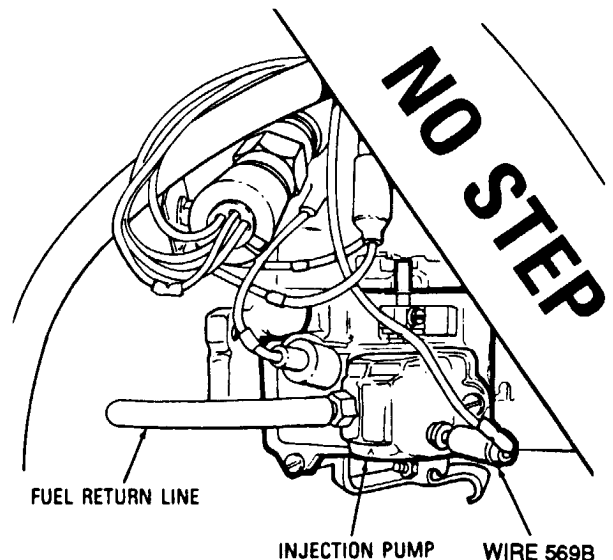
## FUEL SYSTEM

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

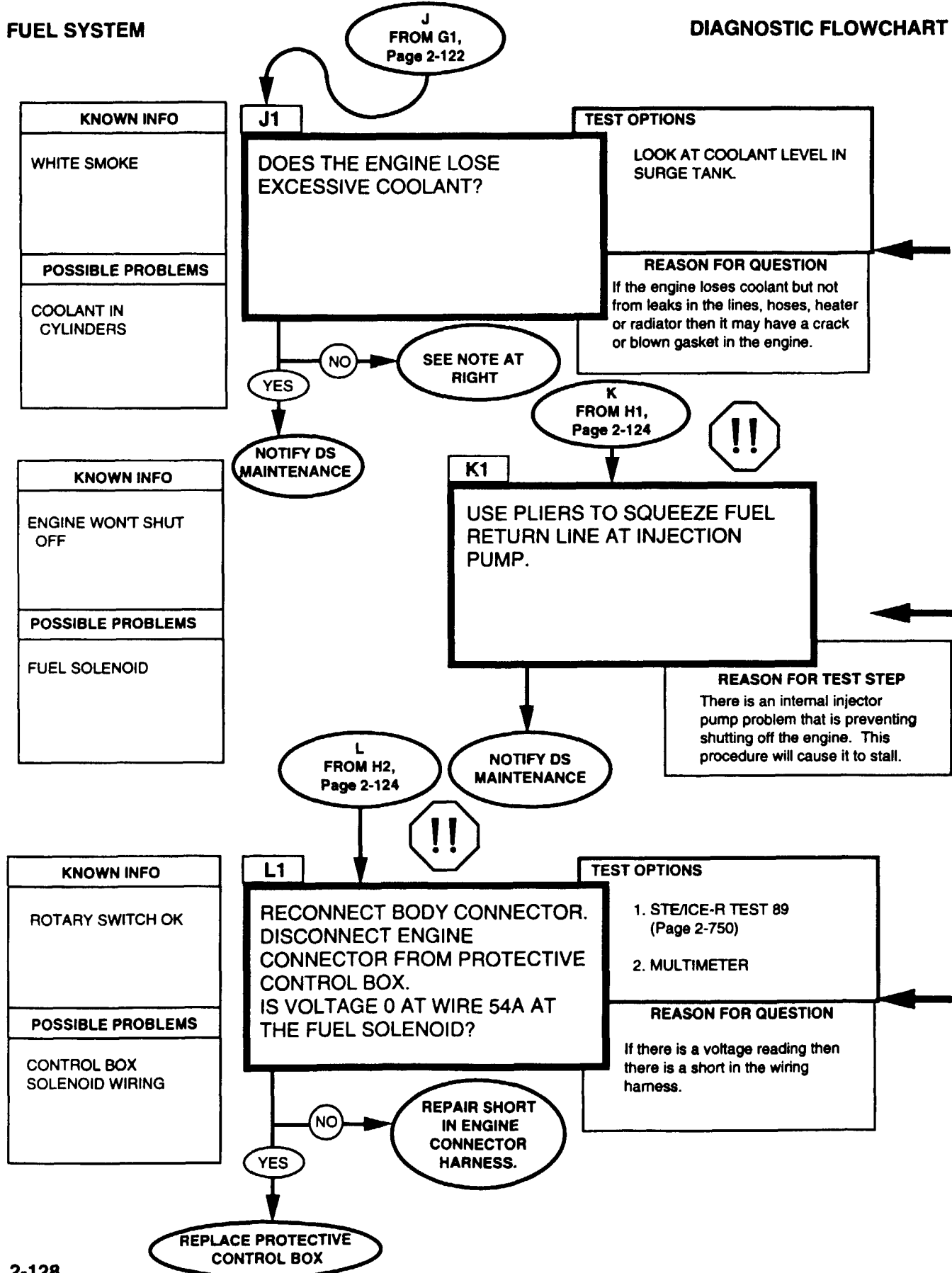
**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



FUEL SYSTEM

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## FUEL SYSTEM

## NOTE

If you are getting white smoke due to coolant entering the cylinders then you should notice a loss of coolant in the radiator or bubbles in the radiator tank while the engine is running. You may need to fill the radiator to proper level and recheck a day later to determine if there is a coolant loss.

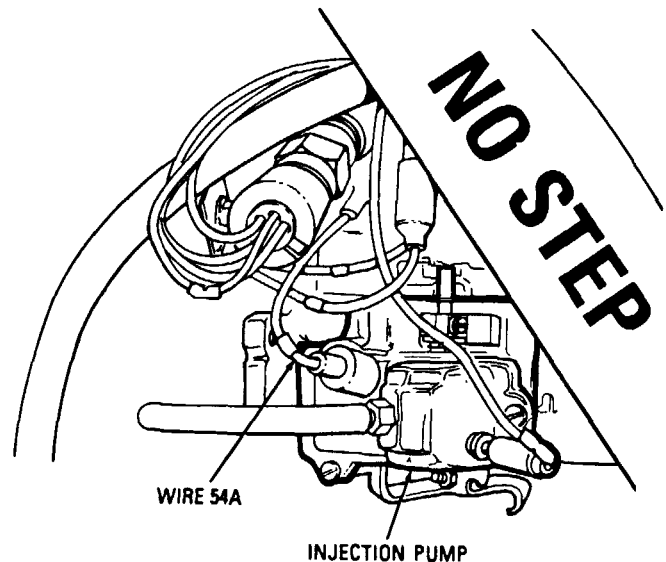
If you don't detect coolant loss then you may have missed a fuel problem. Rerun the fuel system tests paying attention for a raw exhaust smell.

If you still find nothing you may have a small or inconsistent leak. Notify DS maintenance.

**WARNING**

Keep hands away from engine fan! Moving fan blades can cause serious injury. Use extreme caution when engine is running.

If the engine doesn't shut off with the solenoid disconnected then fuel is still reaching the cylinders- probably because the fuel solenoid is stuck open. When you squeeze the return line tight enough to prevent fuel flowing through it, you create a pressure imbalance inside the injection pump that will cause the engine to stall.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Remember to reconnect any wires that may have been disconnected during troubleshooting.

For repair/replace instructions (HARNESS), refer to (para 4-85).

For repair/replace instructions (PCB), refer to (para 4-5).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

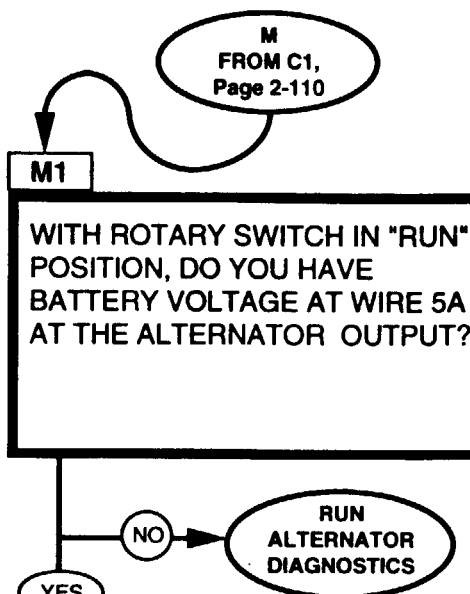
**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

# FUEL SYSTEM

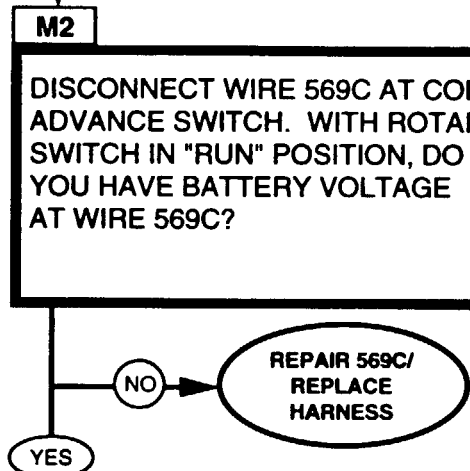
## DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
ENGINE CRANKS NO VOLTAGE AT ADVANCE SOLENOID.
<b>POSSIBLE PROBLEMS</b>
PCB COLD ADVANCE SWITCH WIRING



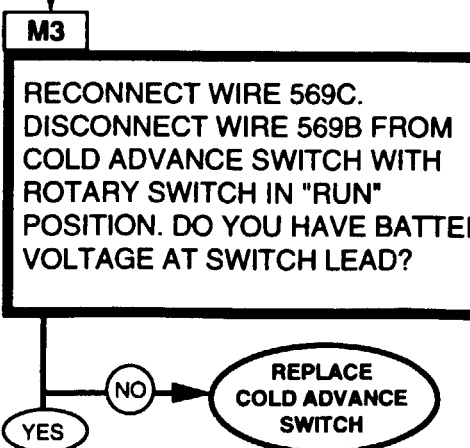
<b>TEST OPTIONS</b>
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
<b>REASON FOR QUESTION</b>
With rotary switch in run position, W5A is connected to battery voltage through the PCB and it supplies power to the cold advance switch.

<b>KNOWN INFO</b>
PCB OK ENGINE CRANKS NO VOLTAGE AT ADVANCE SOLENOID
<b>POSSIBLE PROBLEMS</b>
COLD ADVANCE SWITCH WIRING



<b>TEST OPTIONS</b>
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
<b>REASON FOR QUESTION</b>
If you have no voltage here then the problem may be the cold advance switch

<b>KNOWN INFO</b>
PCB OK ENGINE CRANKS NO VOLTAGE AT ADVANCE SOLENOID
<b>POSSIBLE PROBLEMS</b>
COLD ADVANCE SWITCH WIRING



<b>TEST OPTIONS</b>
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
<b>REASON FOR QUESTION</b>
If you don't have voltage here then the problem is the switch.

## REFERENCE INFORMATION

## FUEL SYSTEM

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

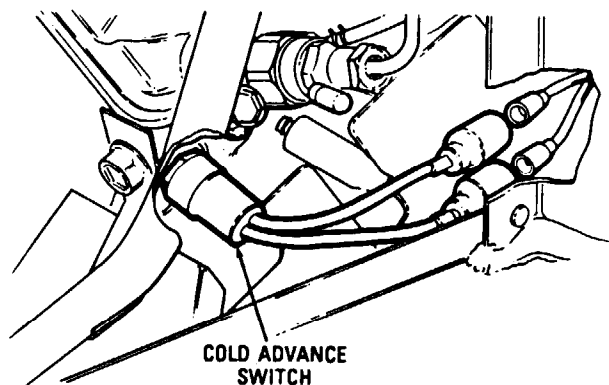
1. Connect RED clip to positive, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

You should only run the engine long enough to determine the gage reading because engine temperature must stay below 90° F (33° C) for the Cold Advance Circuit to function.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

1. Shut off engine
2. Disconnect wire 569C at Cold Advance Switch.
3. Turn Rotary Switch to Run position.
4. Check for battery voltage at wire 569C.



Repair wire or replace harness, refer to (para 4-85).

**NOTE**

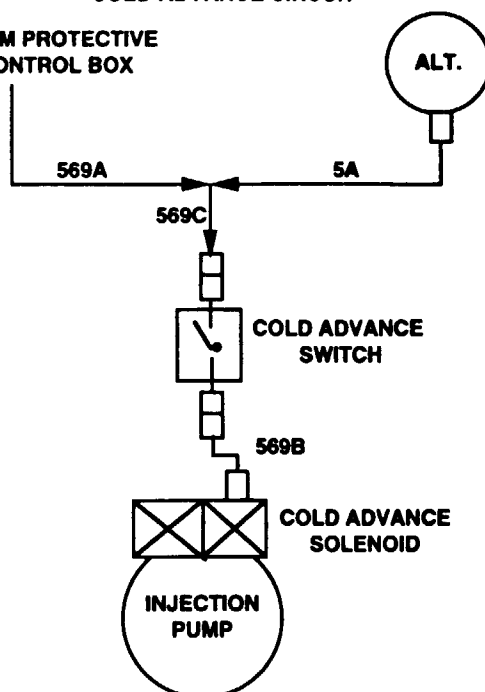
Engine temp must be less than 90°F (33° C) when testing the switch.

For repair/replace instructions, (COLD ADVANCE SWITCH), refer to (para 4-27).

For repair/replace instructions, (HARNESS), refer to (para 4-85).

**COLD ADVANCE CIRCUIT**

FROM PROTECTIVE  
CONTROL BOX



Alternator output is hot when the Rotary Switch is in the RUN position.

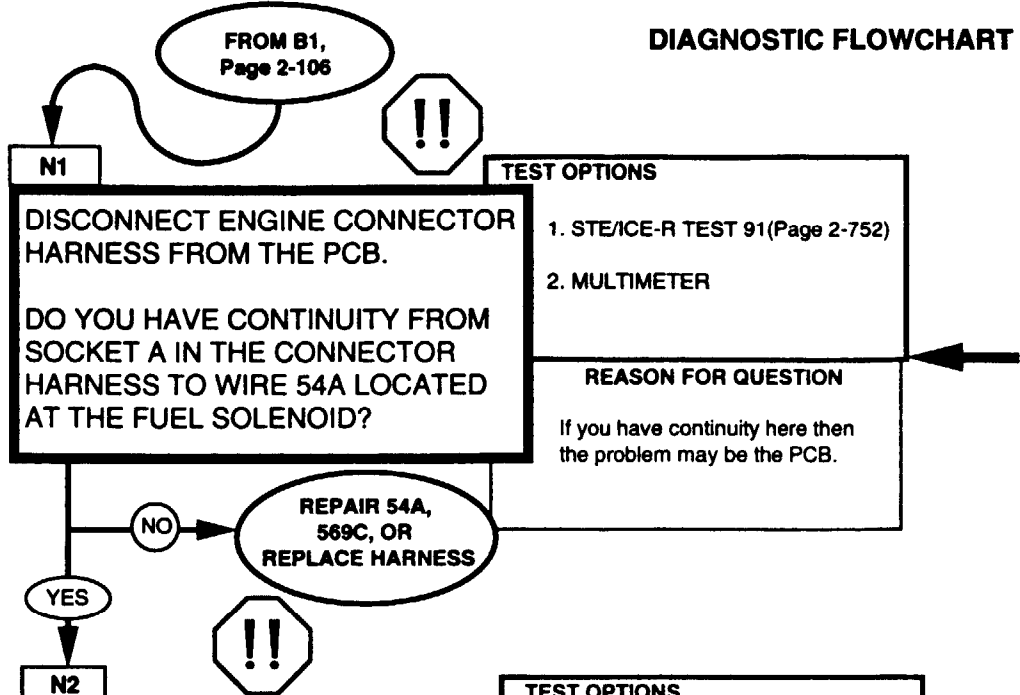
Cold Advance Switch is closed when engine temperature is below 90°F (33° C) and open when it goes above 120°F (49° C).

The Cold Advance Solenoid advances the Injection Pump timing when it receives power from the switch. This helps the engine run better when it is cold.

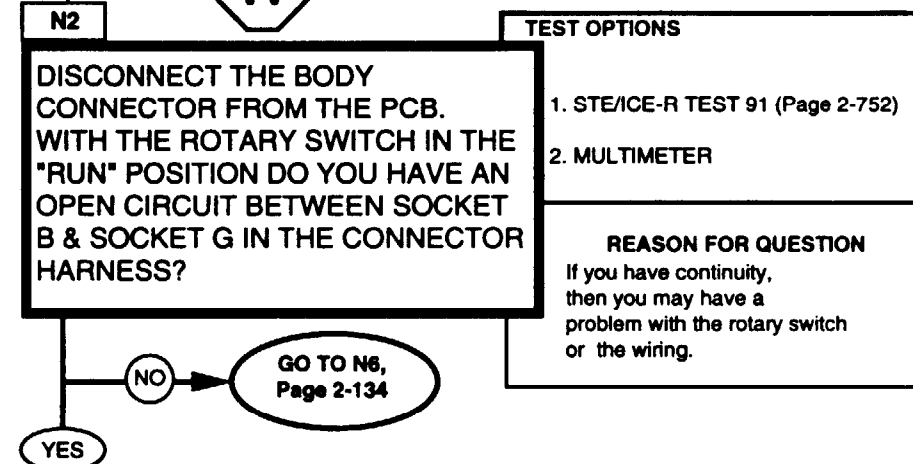
# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART

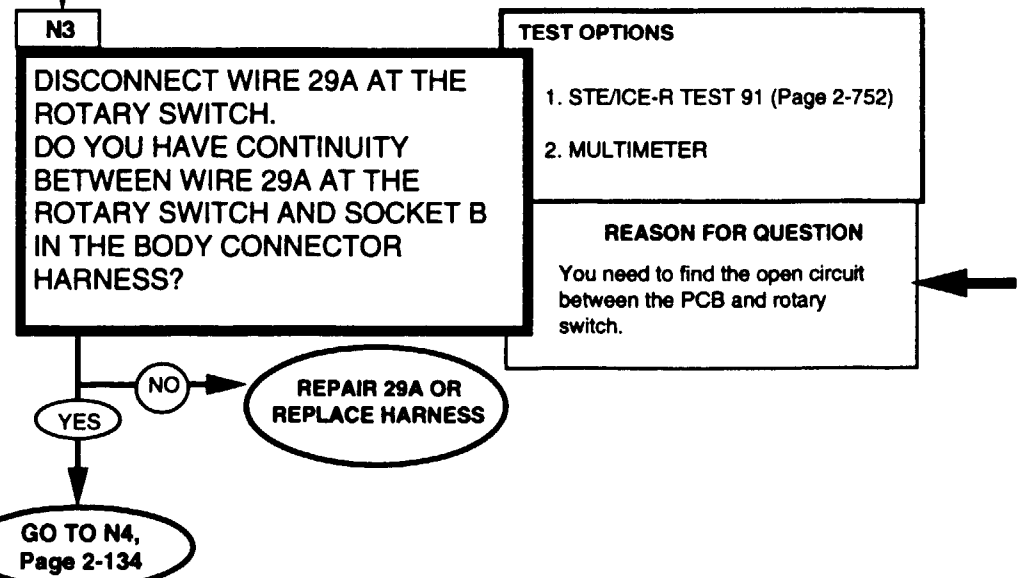
<b>KNOWN INFO</b>
NO VOLTAGE AT FUEL SOLENOID
<b>POSSIBLE PROBLEMS</b>
PCB ROTARY SWITCH WIRING



<b>KNOWN INFO</b>
WIRING TO FUEL SOLENOID OK
<b>POSSIBLE PROBLEMS</b>
PCB ROTARY SWITCH WIRING



<b>KNOWN INFO</b>
WIRING TO FUEL SOLENOID OK
<b>POSSIBLE PROBLEMS</b>
PCB ROTARY SWITCH WIRING



# REFERENCE INFORMATION

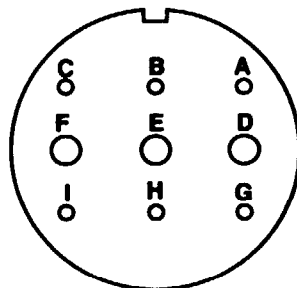


## WARNING

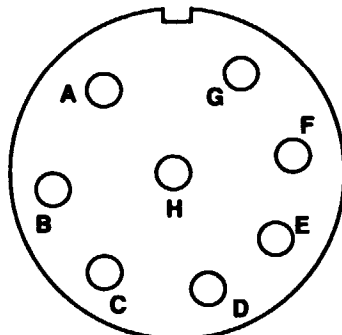
Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel. Repair wiring, refer to (para 4-85).

Inspect wiring to be sure that all the wires are connected in their proper places.



PCB ENGINE CONNECTOR (ON LEFT FENDER LINER)

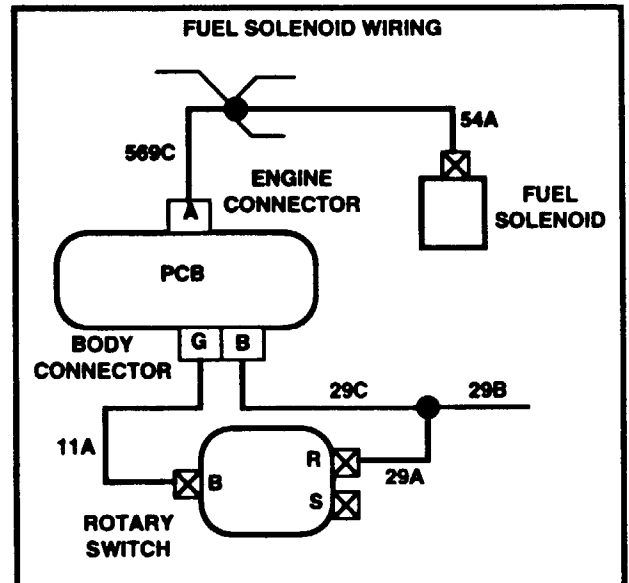


PCB BODY CONNECTOR (LOCATED UNDER DASHBOARD)

Repair wiring, refer to (para 4-85).

Remember to reconnect any wires that were disconnected during troubleshooting.

# FUEL SYSTEM

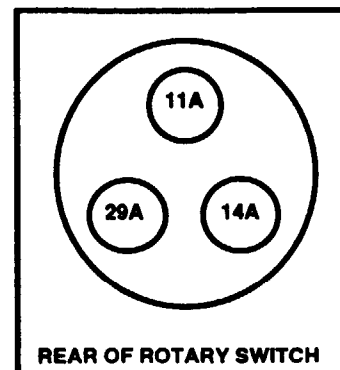


## 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



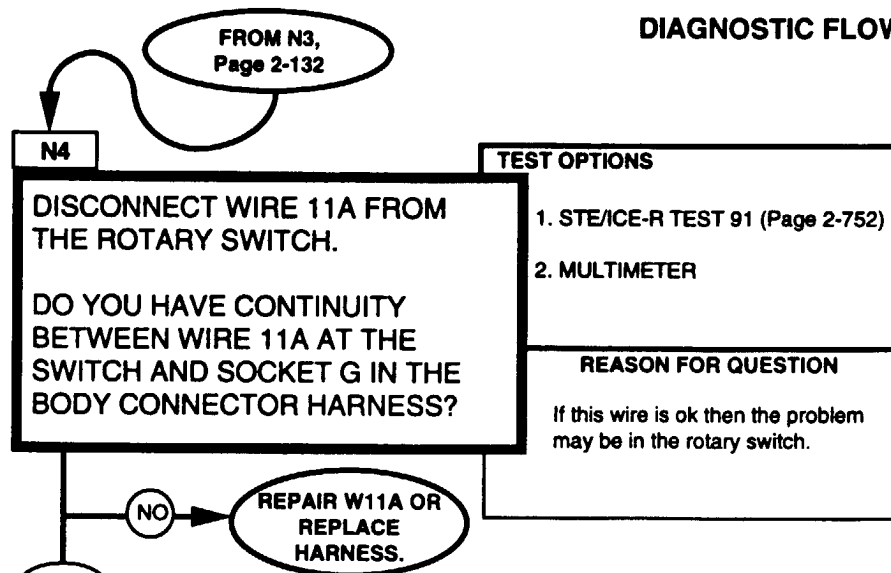
REAR OF ROTARY SWITCH



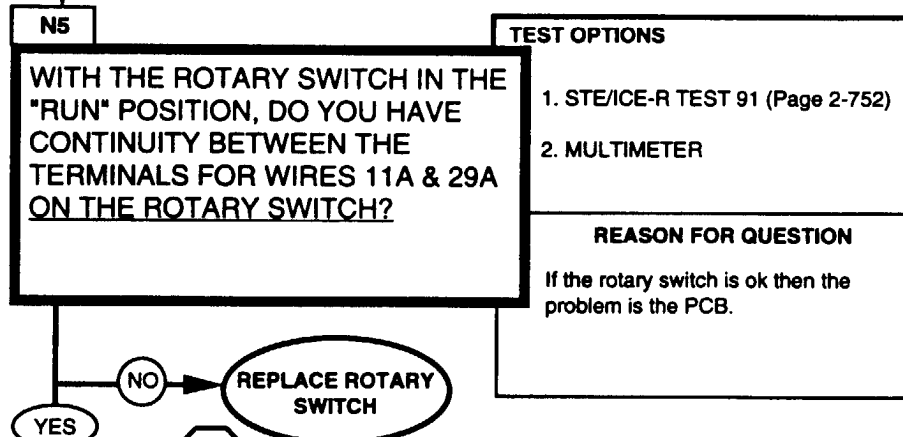
# FUEL SYSTEM

## DIAGNOSTIC FLOWCHART

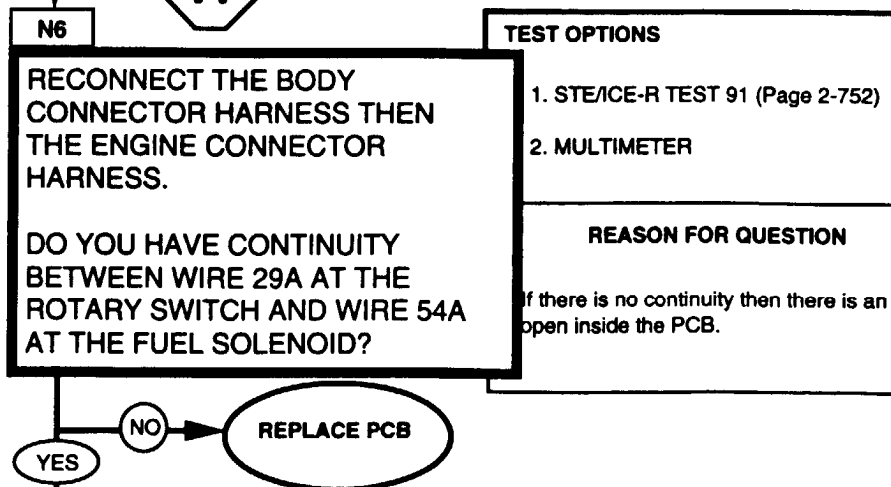
KNOWN INFO
29C OK
POSSIBLE PROBLEMS
PCB ROTARY SWITCH WIRING



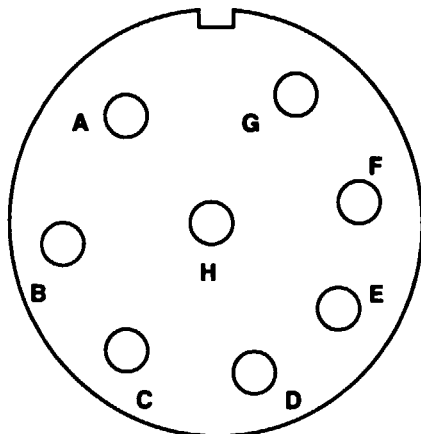
KNOWN INFO
WIRING OK
POSSIBLE PROBLEMS
PCB ROTARY SWITCH



KNOWN INFO
ROTARY SWITCH OK
POSSIBLE PROBLEMS
PCB

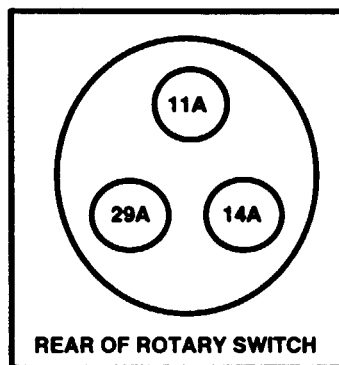


# REFERENCE INFORMATION



PCB BODY CONNECTOR

For repair/replace instructions (HARNESS), refer to (para 4-85).



REAR OF ROTARY SWITCH

For repair/replace instructions (ROTARY SWITCH), refer to (para 4-7).



## WARNING

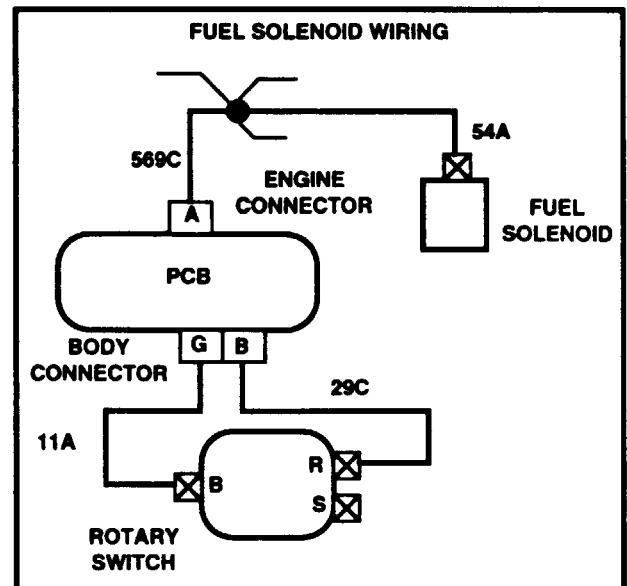
Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Be sure to reconnect the wires at the rotary switch and the fuel solenoid.

For repair/replace instructions (PCB), refer to (para 4-5).

# FUEL SYSTEM



## 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

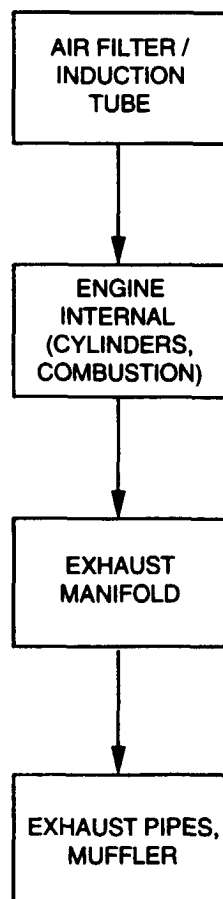
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

## 2-23. AIR INTAKE/EXHAUST TESTS

These Air Intake/Exhaust System tests can be run anytime you think there maybe a problem with the air intake or exhaust systems, or if you were sent here from another test.

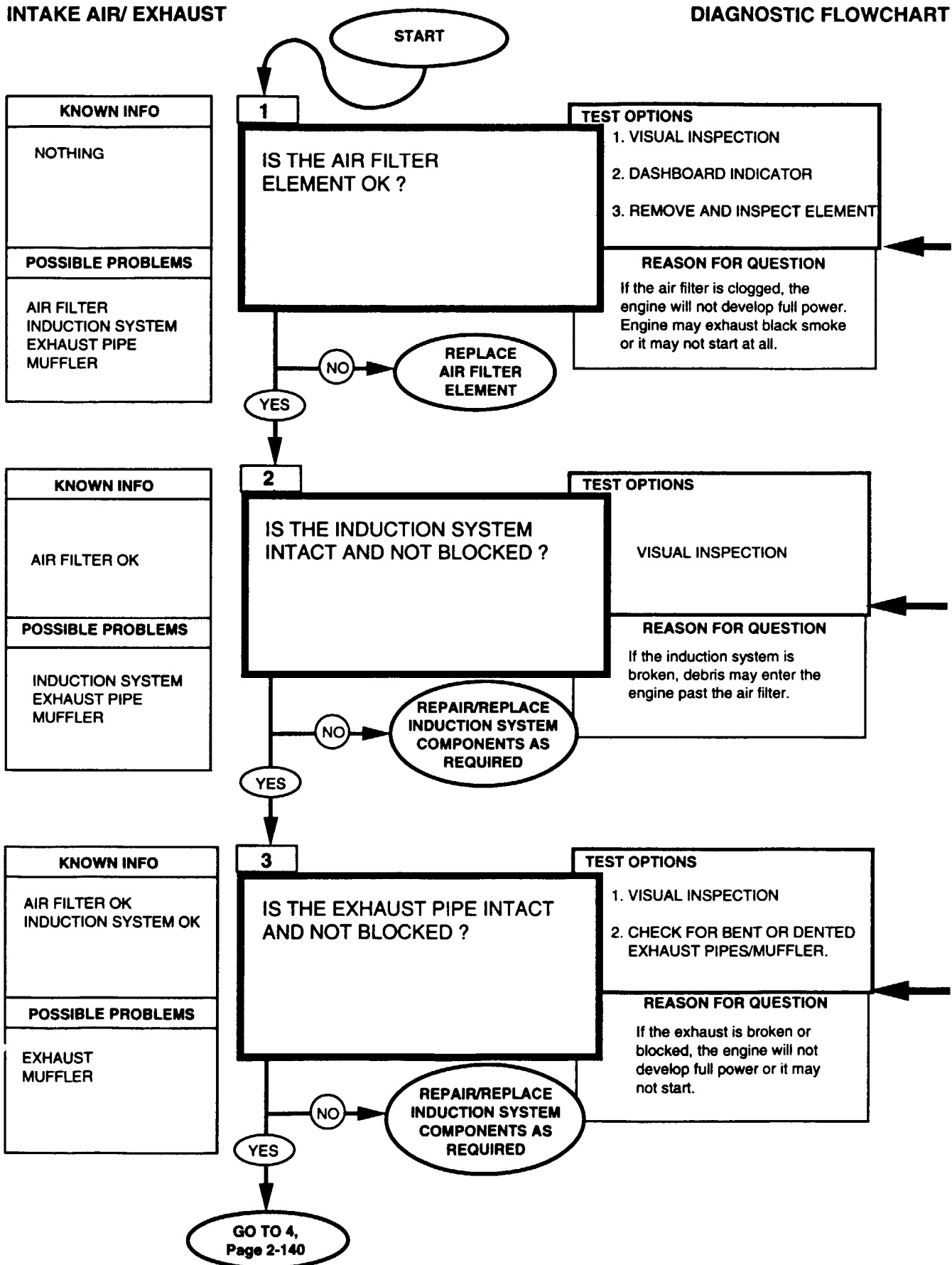
At the bottom of this page is a simplified block diagram of the Intake Air/Exhaust System. A detailed functional flow is not applicable to this system.

The Air Intake/Exhaust System is a very simple system that can cause very annoying problems. Whether the vehicle is hard to start or runs rough or never develops full power, it's worth the few minutes that it takes to check the components of this system. You can run through the diagnostic logic for this system almost anytime you open the hood or check the underside of your vehicle.



INTAKE AIR/ EXHAUST

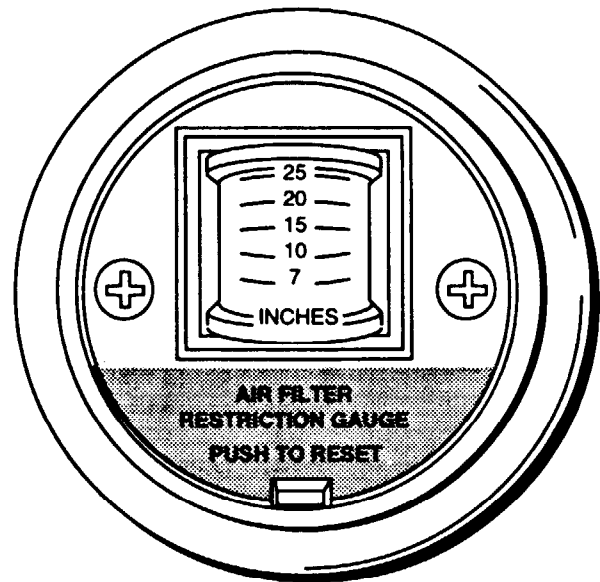
DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## INTAKE AIR/ EXHAUST

First, check the Air Filter Restriction gauge on the dashboard, just to the left of the steering wheel and make a note of its reading. Open the air cleaner cannister, remove the air cleaner element and inspect it for dirt and other contaminants. Replace air filter, refer to (para 3-13). A clean air filter is white. If the condition of the filter does not agree with the gauge on the dashboard, make a note to check the gauge, see Instruments section, page 2-319.



Make sure that all mounting bolts are in place and tight. Look for obvious things like a crushed or cracked air filter or air induction tube, check gaskets where possible. Replace induction system components, refer to (para 3-12).

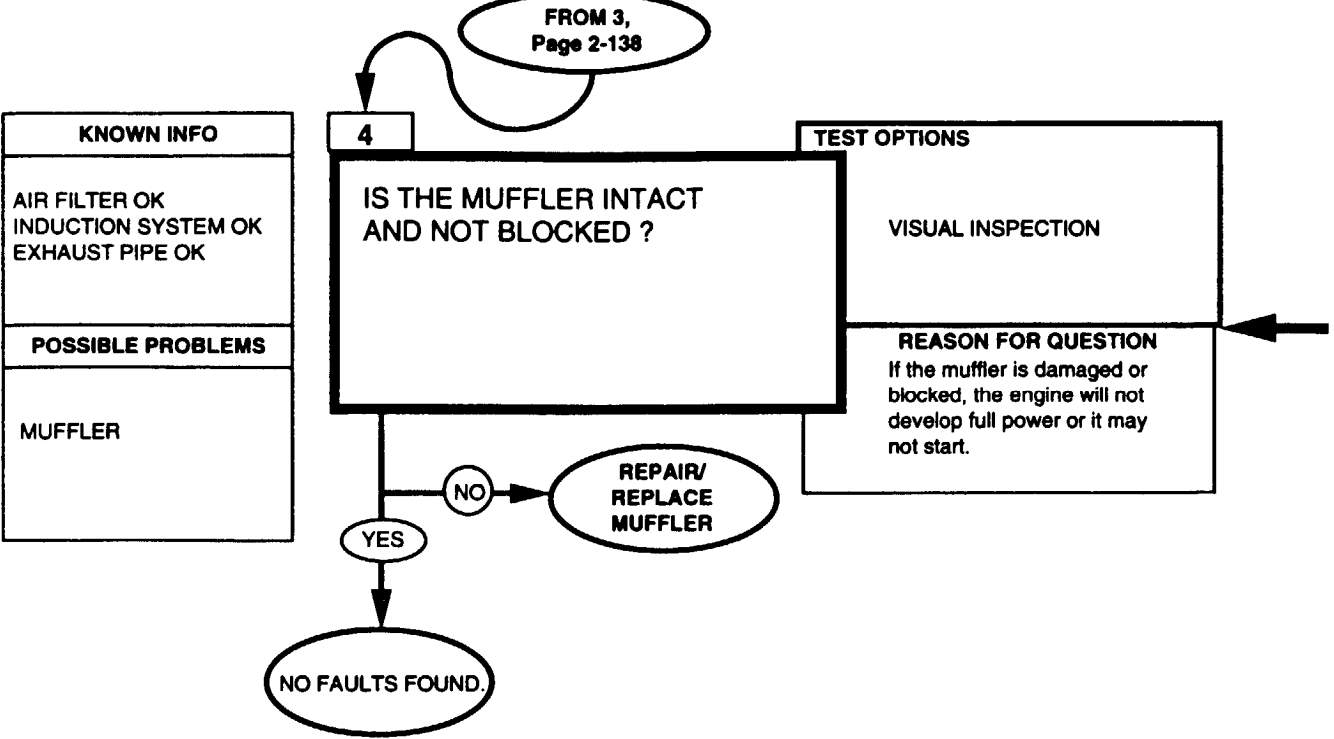
Look for damage caused by rocks such as bent pipes or holes and loose or broken clamps.

Small dents (depth less than 1/4 the diameter of the exhaust pipes) should not cause the pipes to be replaced as long as the pipes are intact.

Replace induction system components, refer to (para 3-12).

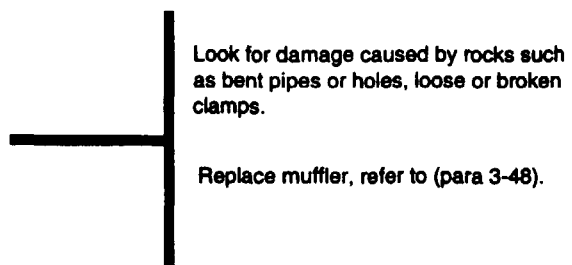
INTAKE AIR/ EXHAUST

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## INTAKE AIR/ EXHAUST



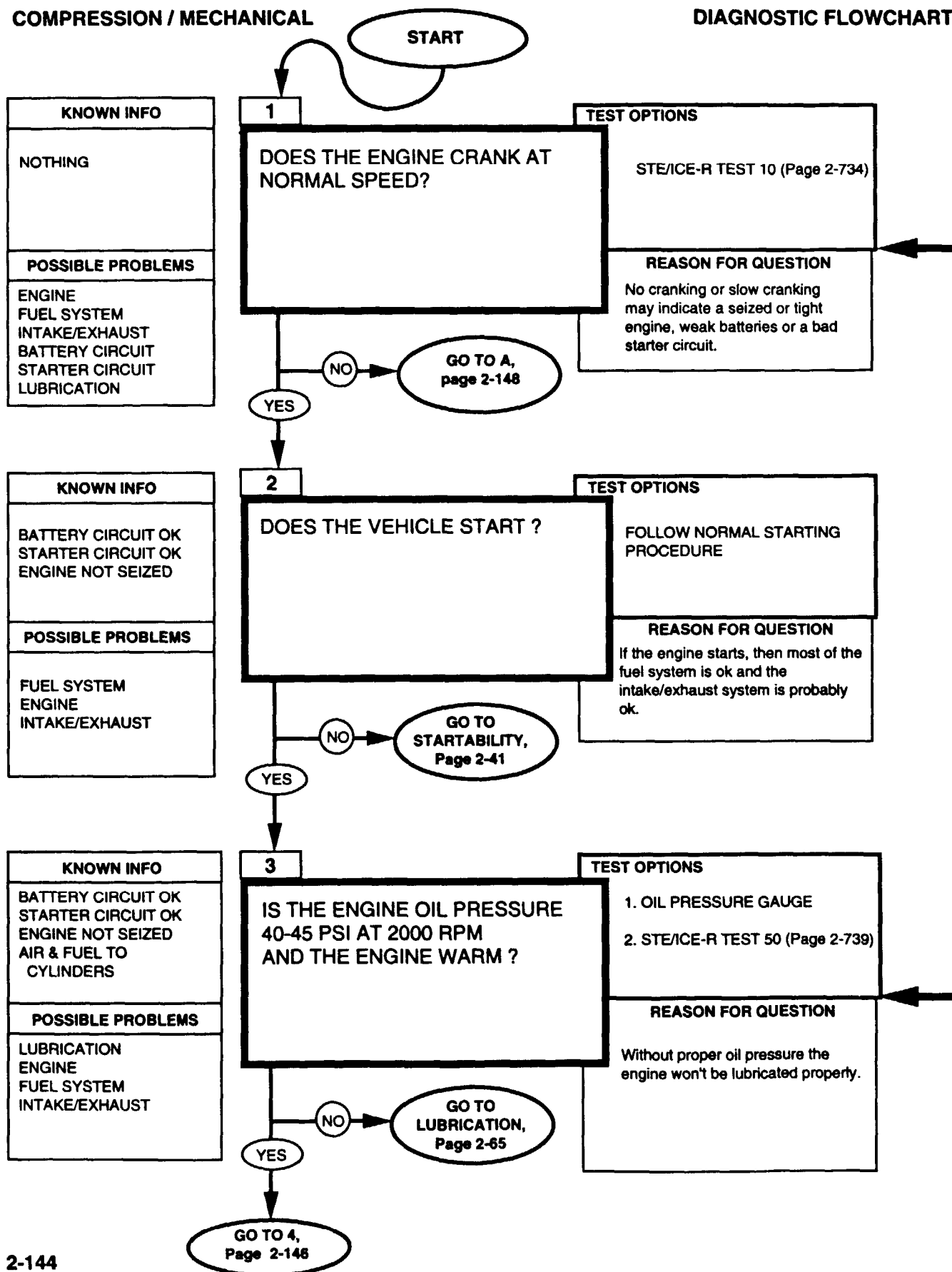
## 2-24. COMPRESSION/MECHANICAL TESTS

The main intent of this paragraph is to determine if the engine has internal compression or mechanical problems and to fix everything possible without having to notify DS maintenance.



# COMPRESSION / MECHANICAL

# DIAGNOSTIC FLOWCHART



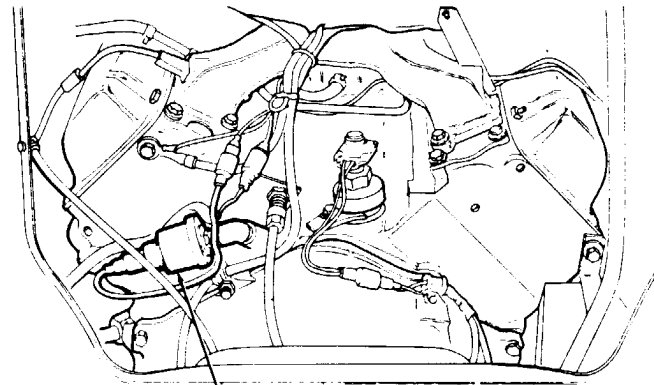
**REFERENCE INFORMATION**

A healthy engine should crank at least 100 RPM when it's cold and at least 180-200 RPM when it's warm.

If the engine doesn't crank at normal speed then it could be due to a Starter or Battery Circuit fault or it may be due to an internal engine problem.

**COMPRESSION / MECHANICAL**

ENGINE RPM STE/ICE-R TEST 10
<ol style="list-style-type: none"> <li>1. Start Test 10, Engine RPM.</li> <li>2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100-200. Idle RPM should be 625 - 675.</li> </ol>



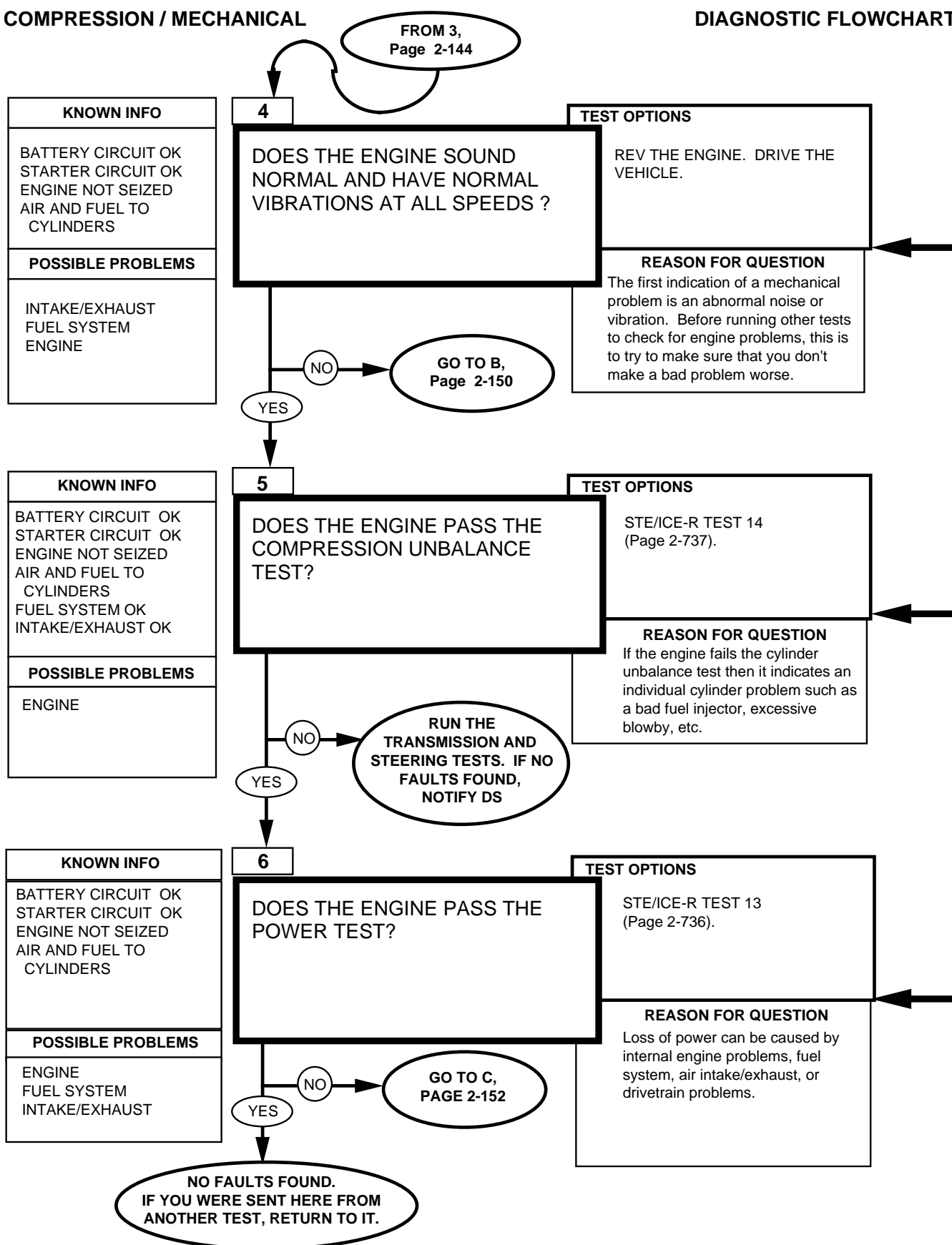
OIL PRESSURE  
SENDING UNIT

Oil pressure may go as high as 80 psi if the engine is cold and should be 10 psi minimum at idle speed. You should check the oil pressure with the STE/ICE-R (test 50) using 1000 psi transducer (blue stripe). Check pressure at idle and at 2000 RPM. If pressure is low, check oil level and condition. Add or change oil as required.

OIL PRESSURE STE/ICE-R TEST 50
<ol style="list-style-type: none"> <li>1. Install STE/ICE-R 0 to 1000 PSI transducer (blue stripe) in place of oil pressure sending unit.</li> <li>2. Connect to STE/ICE-R TK connector J2 or J3.</li> <li>3. CAL with engine off.</li> <li>4. Start engine. Run test 50. With the engine warm, oil pressure should be 10 psi minimum at idle and 40-45 psi at 2000 RPM. Pressure may go as high as 80 psi when the engine is cold.</li> </ol>

COMPRESSION / MECHANICAL

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## COMPRESSION / MECHANICAL

This is not to evaluate driving performance. If the engine or the vehicle makes strange noises or vibrations at idle speed, don't rev the engine. If there is a problem internal to the engine, revving the engine could cause major damage (like a rod coming through the engine block).

### COMPRESSION UNBALANCE STE/ICE-R TEST 14

1. Run tests 72, 73, and 74 to verify that the batteries are ok.
2. Disconnect wire 54A at injection pump to prevent starting.

#### CAUTION

The glowplug controller and the control valve electrical connector must be disconnected prior to running this test.

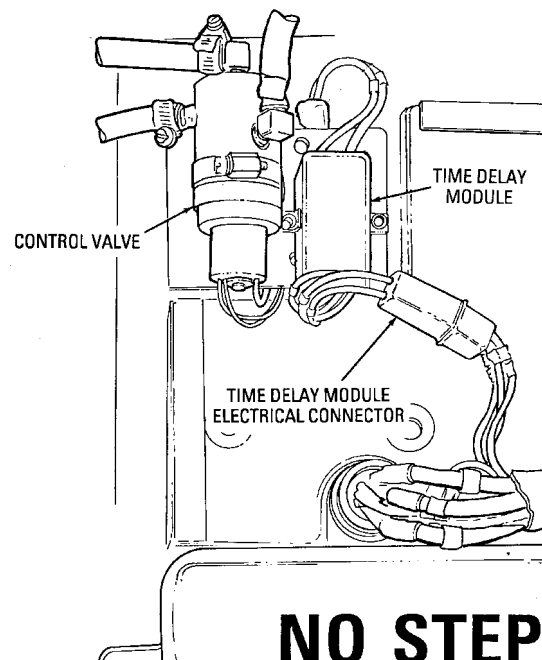
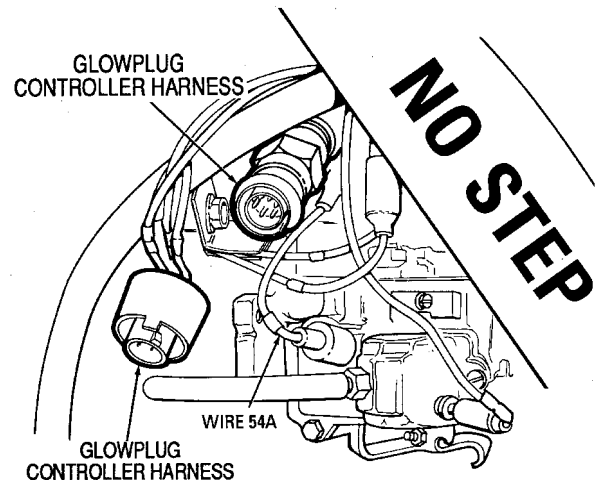
3. Disconnect glowplug controller and control valve electrical connector.
4. Start Test 14, Compression Unbalance.
5. Wait for the GO message. Crank the engine.
6. Release the rotary switch when the VTM displays OFF. A number less than 25% is passing.

If the vehicle passes the STE/ICE-R Compression Unbalance Test, it may still have a compression problem, but it would mean that every cylinder has low compression. This is possible, but not too likely. If you don't find a problem and suspect compression, notify DS maintenance to measure compression.

If STE/ICE-R is not available, accelerate under full power to a reasonable speed on a flat, level, paved surface. You have to decide from your own experience whether or not the engine is developing full power. A number greater than 75 is passing for test # 13.

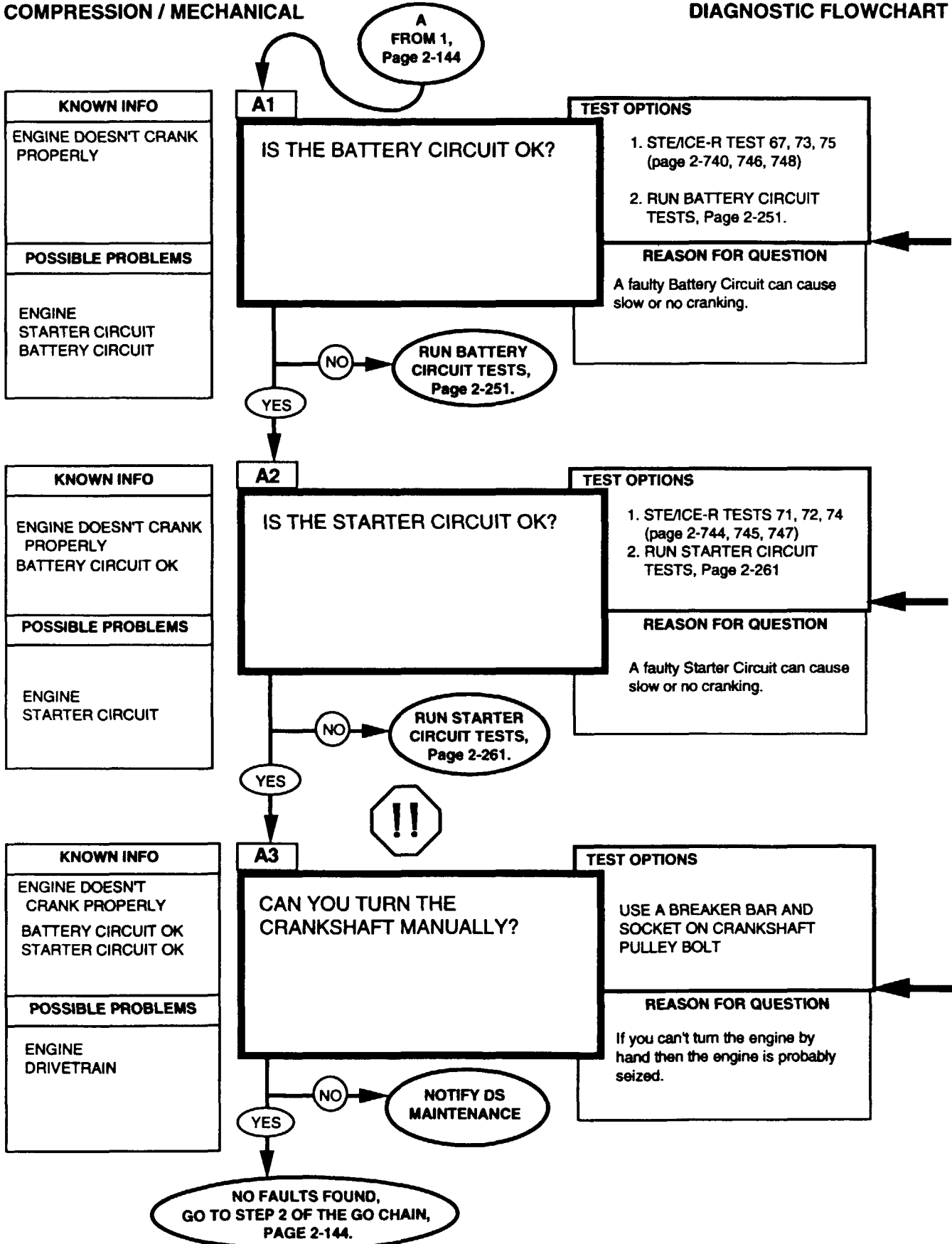
### POWER TEST (% POWER) STE/ICE-R TEST 13

1. Start and idle engine.
2. Run STE/ICE-R test #10 to set idle and governor speed as necessary.
3. Start STE/ICE-R test #13.
4. When CIP appears on the display, press down sharply on the accelerator and hold it to the floor until the VTM displays OFF.
5. Displayed value is % POWER.



COMPRESSION / MECHANICAL

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

### BATTERY VOLTAGE STE/CE-R TEST 67

1. Start Test 67, Battery Voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

### STARTER AVERAGE CURRENT STE/CE-R TEST 71

1. Start Test 71, Starter Average Current.
2. Displayed reading is in amps. The starter should draw at least 200 amps with a peak of over 400 amps.

The Starter Circuit Tests begin on page 2-261. Internal engine problems (tight main or rod bearings for example) or drivetrain problems could still cause the engine to crank slowly even if the Starter and Battery Circuits are OK.



#### **WARNING**

Be sure to disconnect fuel solenoid (wire 54A) to prevent accidental starting. Failure to do so may result in injury to personnel or damage to equipment.

A breaker bar and socket placed on the crankshaft pulley can be used to try to turn the crankshaft. The crankshaft pulley is located directly under the engine cooling fan. It can be reached from under the HMMWV.

If the engine won't turn, remove the glowplugs and try again. If the engine turns now, try cranking it and look for fuel at the eight glowplug holes. If you see fuel at any of the holes then the engine may have had hydrostatic lock. Crank the engine for about 15 seconds to clear the fuel then re-install the glowplugs and try to start the engine. If it still won't crank, notify DS maintenance.

## COMPRESSION / MECHANICAL

### STARTER FIRST PEAK CURRENT STE/CE-R TEST 72

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplugs controller and fan solenoid.
3. Start Test 72, starter first peak current.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in amps. Starter first peak should be over 400 amps.

### BATTERY INTERNAL RESISTANCE STE/CE-R TEST 73

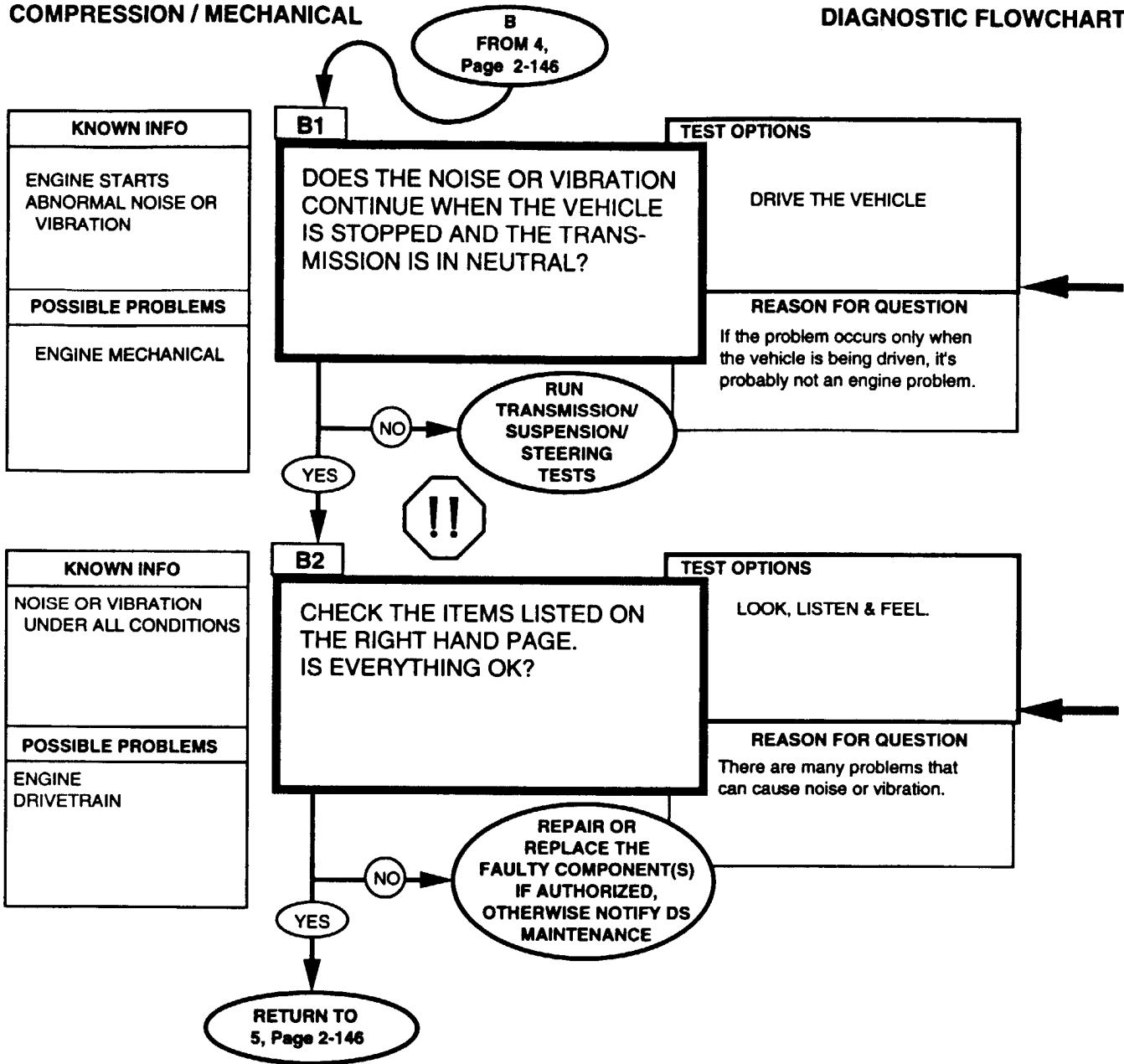
1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplugs controller and fan solenoid.
3. Start Test 73, Battery Internal Resistance.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

### STARTER CIRCUIT RESISTANCE STE/CE-R TEST 74

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplugs controller and fan solenoid.
3. Start Test 74, Starter Circuit Resistance.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms. Starter circuit resistance should be 25 milliohms max.

# COMPRESSION / MECHANICAL

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## COMPRESSION / MECHANICAL

Try the following steps:

1. Determine what noises or vibrations are there when the engine is running with the transmission in neutral.
2. Keep the engine running, put the transmission in drive and take note of any changes in the noises or vibrations.
3. If it's safe to drive, drive the vehicle and take note of any changes in the noises or vibrations. Drive vehicle through all gears and ranges within speed rates listed in TM 9-2320-280-10.



### WARNING

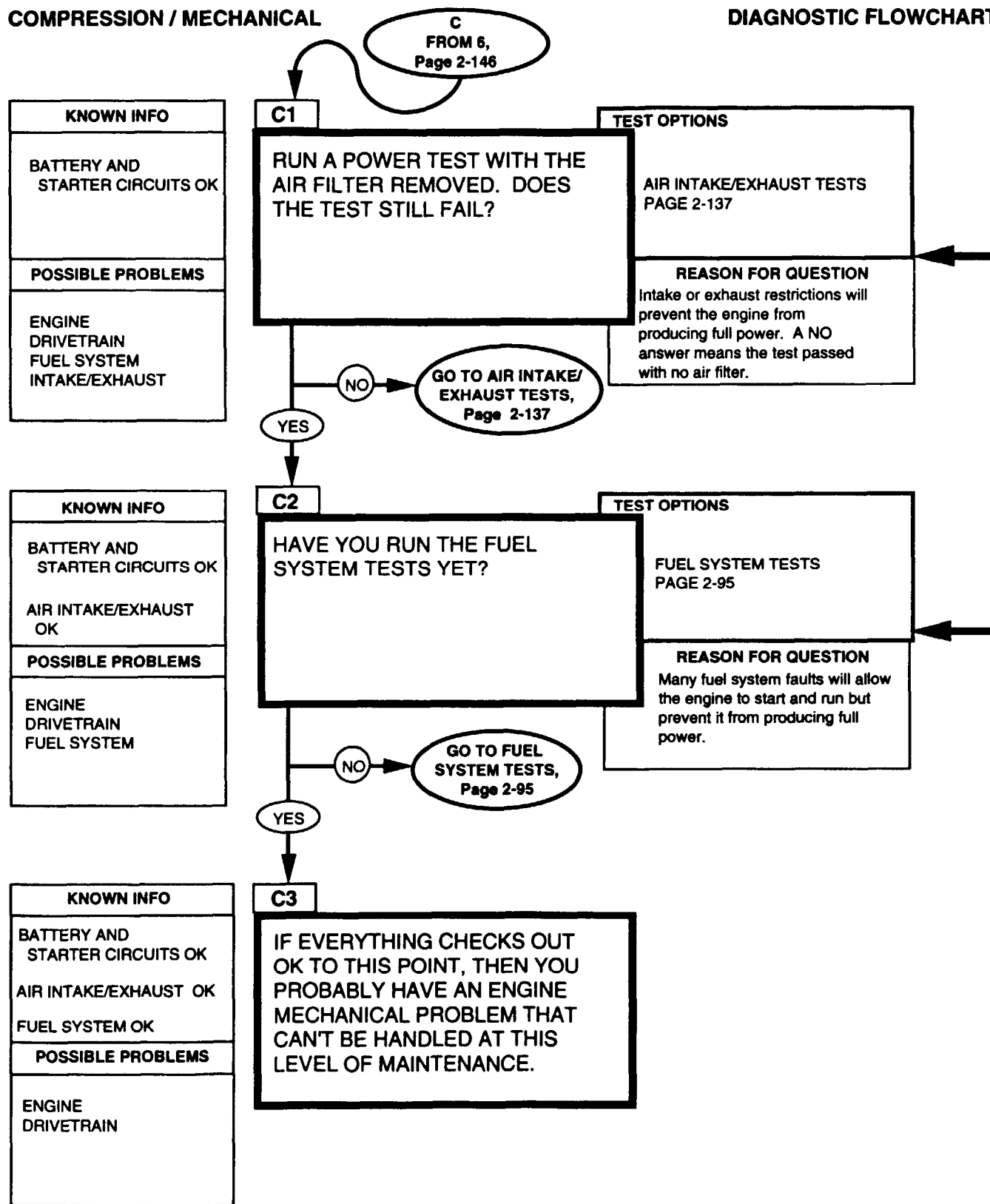
A hot engine may cause serious burns. Always use caution when approaching a hot engine.

Engine Mounts  
Transmission Mounts  
Cooling Fan  
Belts  
Water Pump  
Power Steering Pump  
Fuel Pump  
Alternator  
Air Induction Components  
Exhaust Components




# COMPRESSION / MECHANICAL

## DIAGNOSTIC FLOWCHART




**REFERENCE INFORMATION**

**COMPRESSION / MECHANICAL**



If faults are found and corrected go to  
STEP 2 of the GO CHAIN.

If no faults are found go to B2,  
page 2-150.



If faults are found and corrected go to  
STEP 2 of the GO CHAIN.

If no faults are found go to B2,  
page 2-150.

2-25. ENGINE COOLING TESTS

These Engine Cooling tests may be run any time you think you have an engine cooling problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary. Please note that this paragraph is NOT for diagnoses of problems with the temperature sending unit or the gauge.

Once you are sure that the cooling system is OK, run the instruments test in Paragraph 2-32 to find out if the gauge is OK.

Fold-out FO-4 contains a functional diagram of the engine cooling system. This page may be left open for reference while testing.

The engine cooling system is a pressure type cooling system with thermostatic control of coolant circulation. The cooling system dissipates heat generated from combustion and maintains the engine operating temperature at its most efficient level. When the engine is cold and the thermostat is closed, coolant is recirculated through the water pump and engine. As the engine coolant reaches 190°F (87.7°C), the thermostat opens allowing coolant to flow through the radiator before returning to the water pump and engine. Any air or vapor in the cooling system will be forced to the surge tank under the liquid level and leave through a vent tube. As the system cools, the extra coolant in the tank will be drawn back to the radiator. Normally a 50-50 mixture of water and ethylene glycol base antifreeze will be used. The fan is activated when coolant temperature reaches 215°F (102°C). A separate oil cooler is mounted in front of the radiator. This cooler is divided into two parts. The top half is for transmission oil. The bottom half is for engine oil. When the cooling system pressure reaches approximately 15 psi (103 kPa), a valve in the surge tank cap opens and lets excess pressure escape to the atmosphere.

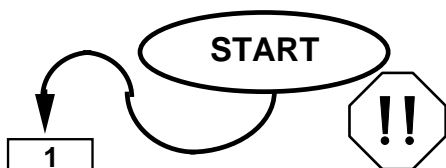
ETHYLENE GLYCOL MIXTURE TABLE

LOWEST EXPECTED AMBIENT TEMPERATURE °F °C		ETHYLENE GLYCOL (-60°F, -51.1°C) INHIBITED (MIL-A-46153)		ARCTIC GRADE ANTIFREEZE (-90°F) (-67.7°C) MIL-A-11755
		PINTS PER GALLON OF COOLANT CAPACITY	SPECIFIC GRAVITY (68°F) (20°C)	
+20	-6.7	1-1/2	1.022	Freezing point of -90°F (-67.7°C). Issued ready for use and must not be mixed with any other liquid.
+10	-12.2	2	1.036	
0	-17.7	2-3/4	1.047	
-10	-23.3	3-1/4	1.055	
-20	-28.8	3-1/2	1.062	
-30	-34.4	4	1.067	
-40	-40.0	4-1/4	1.073	
-50	-45.5	4-1/2		
-55	-48.3	4-3/4		
BELOW -60	BELOW -51.1	USE ARCTIC GRADE ANTIFREEZE (-90°F) (-67.7°C)		

# ENGINE COOLING

## DIAGNOSTIC FLOWCHART

KNOWN INFO
NONE
POSSIBLE PROBLEMS
COOLING COMPONENTS ENGINE FAN BELTS WATER PUMP AND PULLEY



**1**

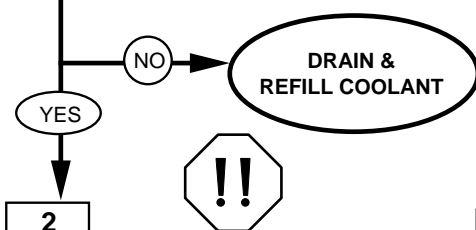
**IS THE COOLANT MIXTURE CORRECT?**  
(SEE CHART ON PAGE 2-155.)

**TEST OPTIONS**

COOLANT MIXTURE TEST KIT  
NSN 6630-00-169-1506.  
COOLANT TESTER  
NSN 6630-00-105-1418.

**REASON FOR QUESTION**

The cooling system will not operate properly if the mixture is incorrect.



KNOWN INFO
COOLANT QUALITY OK
POSSIBLE PROBLEMS
COOLANT LEVEL COOLING COMPONENTS ENGINE FAN BELTS WATER PUMP AND PULLEY

**2**

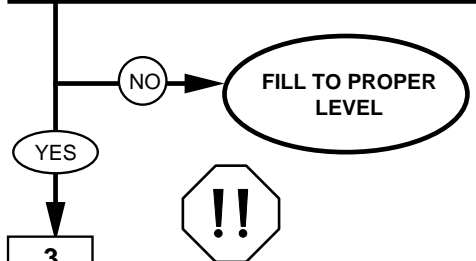
**IS THE COOLANT AT THE CORRECT LEVEL?**

**TEST OPTIONS**

VISUAL INSPECTION.

**REASON FOR QUESTION**

Low coolant levels may cause overheating.



KNOWN INFO
COOLANT OK
POSSIBLE PROBLEMS
THERMOSTAT COOLING COMPONENTS ENGINE FAN BELTS WATER PUMP AND PULLEY

**3**

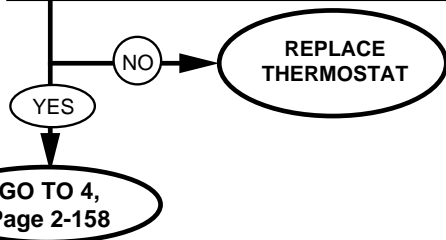
**IS THE THERMOSTAT WORKING PROPERLY?**

**TEST OPTIONS**

FEEL FOR COOLANT IN UPPER RADIATOR HOSE WHEN ENGINE IS HOT, OR REMOVE THERMOSTAT. EXPOSE IT TO 190°F (88° C) AND SEE IF IT OPENS.

**REASON FOR QUESTION**

An improperly functioning thermostat can cause operating temperatures that are either too hot or too cold.



## REFERENCE INFORMATION

## ENGINE COOLING

**WARNING**

Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190 °F (88°C). Steam or hot coolant under pressure will cause injury.

Drain and refill coolant, refer to (para 3-60).

**WARNING**

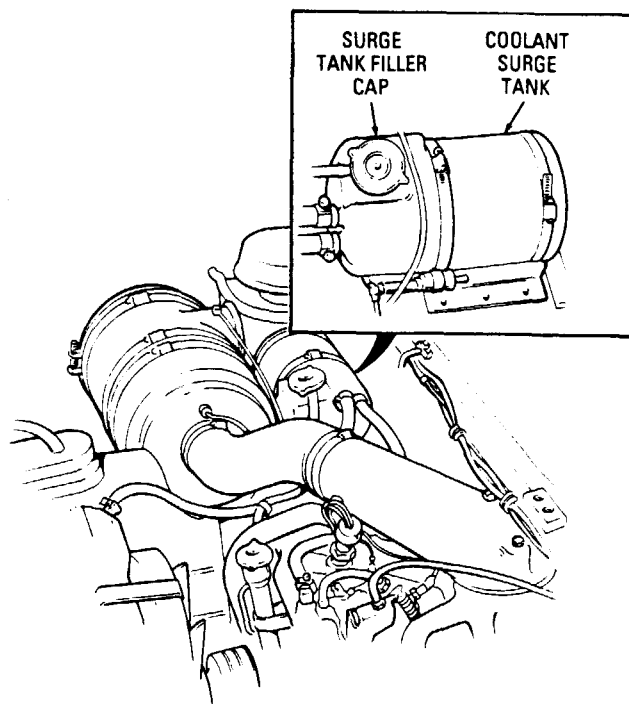
Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190 °F (88°C). Steam or hot coolant under pressure will cause injury.

Fill coolant to proper level, refer to (para 3-60).

**WARNING**

Always use caution when approaching a hot engine. Failure to do so may result in serious burns.

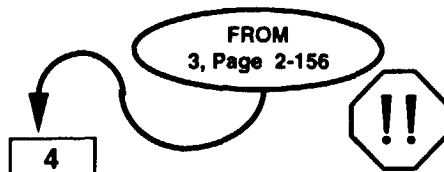
Remove and replace the thermostat, refer to (para 3-75).



# ENGINE COOLING

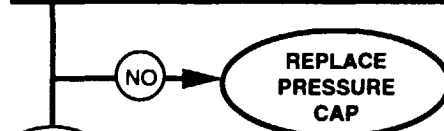
## DIAGNOSTIC FLOWCHART

KNOWN INFO
COOLANT OK THERMOSTAT OK
POSSIBLE PROBLEMS
COOLING COMPONENTS ENGINE FAN BELTS WATER PUMP & PULLEY



INSPECT THE PRESSURE CAP.  
IS IT IN GOOD CONDITION?

TEST OPTIONS
PRESSURE TESTER.
REASON FOR QUESTION
A defective pressure cap may cause overheating.

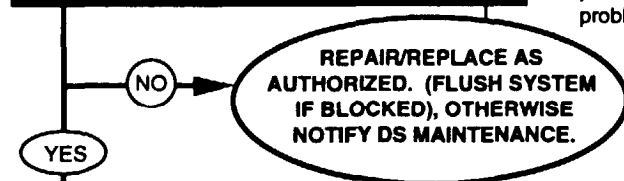


KNOWN INFO
COOLANT OK PRESSURE CAP OK THERMOSTAT OK
POSSIBLE PROBLEMS
HOSES SURGE TANK RADIATOR THERMOSTAT ENGINE FAN WATER PUMP & PULLEY

5

INSPECT ALL RADIATOR HOSES,  
COOLANT HOSES, SURGE TANK,  
RADIATOR, OIL COOLER, AND  
FITTINGS FOR DAMAGE,  
BLOCKAGE OR LARGE LEAKS IS  
EVERYTHING IN GOOD SHAPE?

TEST OPTIONS
LOOK.
REASON FOR QUESTION
Physical damage and blocked passages can cause cooling problems.

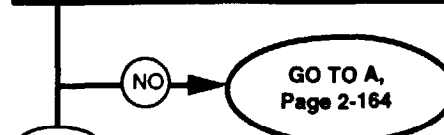


KNOWN INFO
COOLANT OK PRESSURE CAP OK THERMOSTAT OK HOSES OK SURGE TANK OK OIL COOLER OK
POSSIBLE PROBLEMS
RADIATOR ENGINE FAN WATER PUMP & PULLEY

6

IS THE ENGINE FAN WORKING PROPERLY?

TEST OPTIONS
LOOK – SEE DESCRIPTION OF OPERATION AT RIGHT.
REASON FOR QUESTION
The engine fan helps cool the engine.



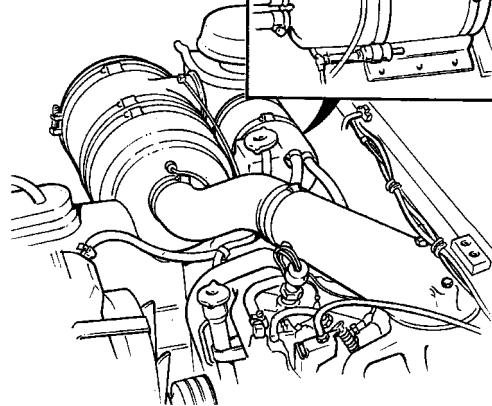
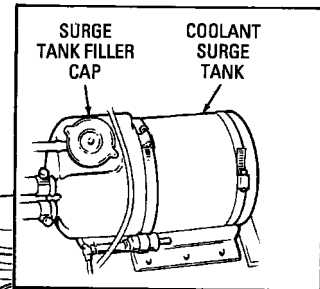
## REFERENCE INFORMATION

## ENGINE COOLING

**WARNING**

Do not remove surge tank filler cap before releasing internal pressure when engine temperature is above 190 °F (88°C). Steam or hot coolant under pressure will cause injury. Check seal and spring on pressure cap.

Replace pressure cap, refer to (para. 3-60).



Flush cooling system, refer to (para. 3-60).

For surge tank and radiator support replacement procedures, refer to (paras. 3-63 and 3-64).

For oil cooler and oil cooler hose replacement procedures, refer to (paras. 3-7 and 3-8).

Notify DS maintenance to repair radiators.

**ENGINE COOLING FAN DESCRIPTION OF OPERATION**

An external line from the power steering gear brings hydraulic fluid to the clutch fan solenoid through control valve (normally open) and then to the fan drive, keeping it disengaged. The action of the valve is controlled by the time delay module and the fan temperature switch.

During normal operation, the fan timer switch is closed. This keeps the control valve in the open position and the drive disengaged.

As the engine reaches a temperature of 215°F (102°C), the temperature switch opens and the control valve closes. This engages the fan. If the fan is engaged and the accelerator is floored, the transmission kickdown system disengages the fan drive for 20 seconds.

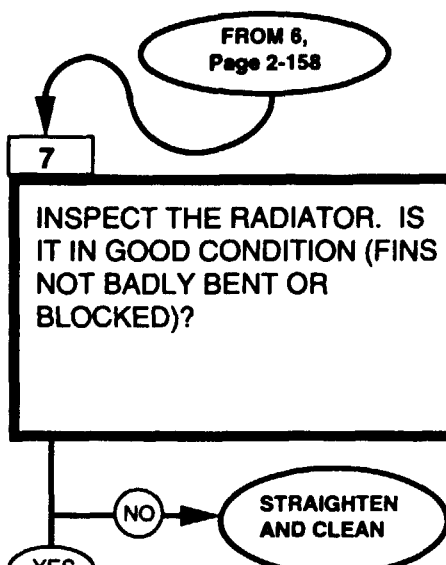
The easiest way to determine if the fan is engaged is to stand outside the driver's door and gently work the accelerator. If the fan is engaged, you will feel a breeze from the engine area. If the fan is not engaged, you won't feel the breeze.

If the vehicle's serial number is 68555 through 72541 or 100000 through 112867, and you see ADCO stamped on top of the time delay module, replace the module with part NSN 5945-01-193-7175, refer to (para. 4-31).

# ENGINE COOLING

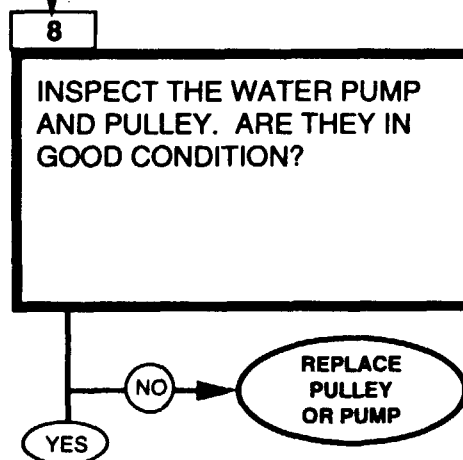
## DIAGNOSTIC FLOWCHART

KNOWN INFO
COOLANT OK PRESSURE CAP OK HOSES OK SURGE TANK OK OIL COOLER OK ENGINE FAN OK
POSSIBLE PROBLEMS
RADIATOR WATER PUMP & PULLEY BELTS



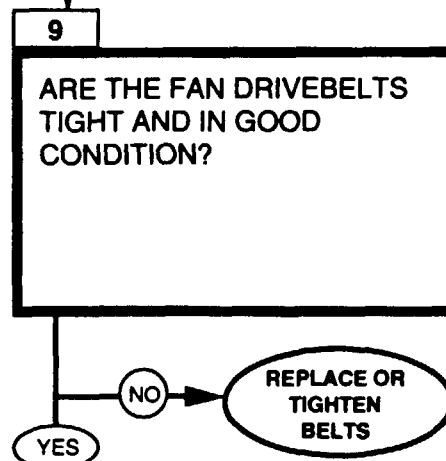
TEST OPTIONS
LOOK.
REASON FOR QUESTION
Bent or blocked fins prevent efficient cooling of the coolant.

KNOWN INFO
COOLANT OK PRESSURE CAP OK RADIATOR/HOSES OK SURGE TANK OK OIL COOLER OK ENGINE FAN OK
POSSIBLE PROBLEMS
WATER PUMP & PULLEY BELTS



TEST OPTIONS
LOOK AND LISTEN.
REASON FOR QUESTION
A bad pulley and water pump won't cool the engine efficiently.

KNOWN INFO
RADIATOR/HOSES OK SURGE TANK OK OIL COOLER OK ENGINE FAN OK PUMP & PULLEY OK
POSSIBLE PROBLEMS
BELTS INTERNAL ENGINE LEAKS



TEST OPTIONS
VISUAL INSPECTION. USE BELT TENSION GAUGE.
REASON FOR QUESTION
Loose belts will not drive the fan properly.



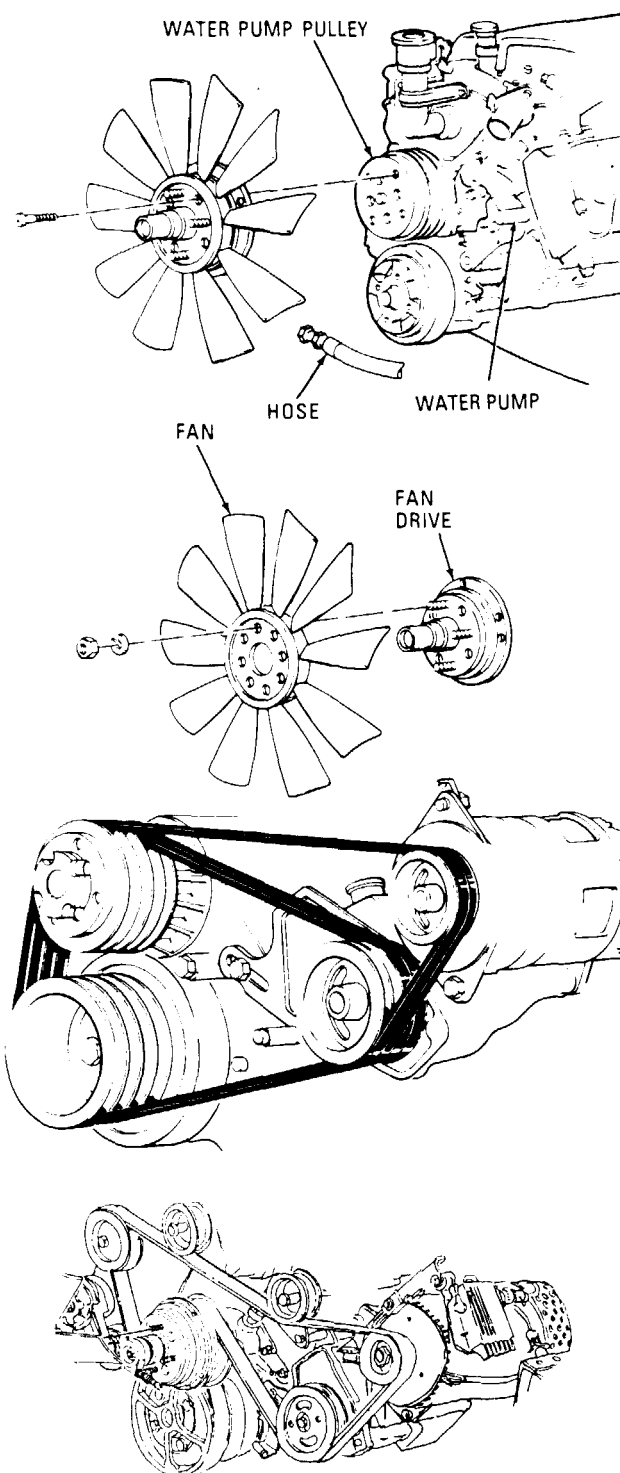
## REFERENCE INFORMATION

## ENGINE COOLING

Listen for noisy bearings in the water pump, or an in and out motion to the fan.  
You can also check the pump and pulley by trying to move it in and out or laterally with the engine off.

Replace the water pump pulley, refer to (para 3-76).  
A bad water pump needs to be replaced by DS maintenance.

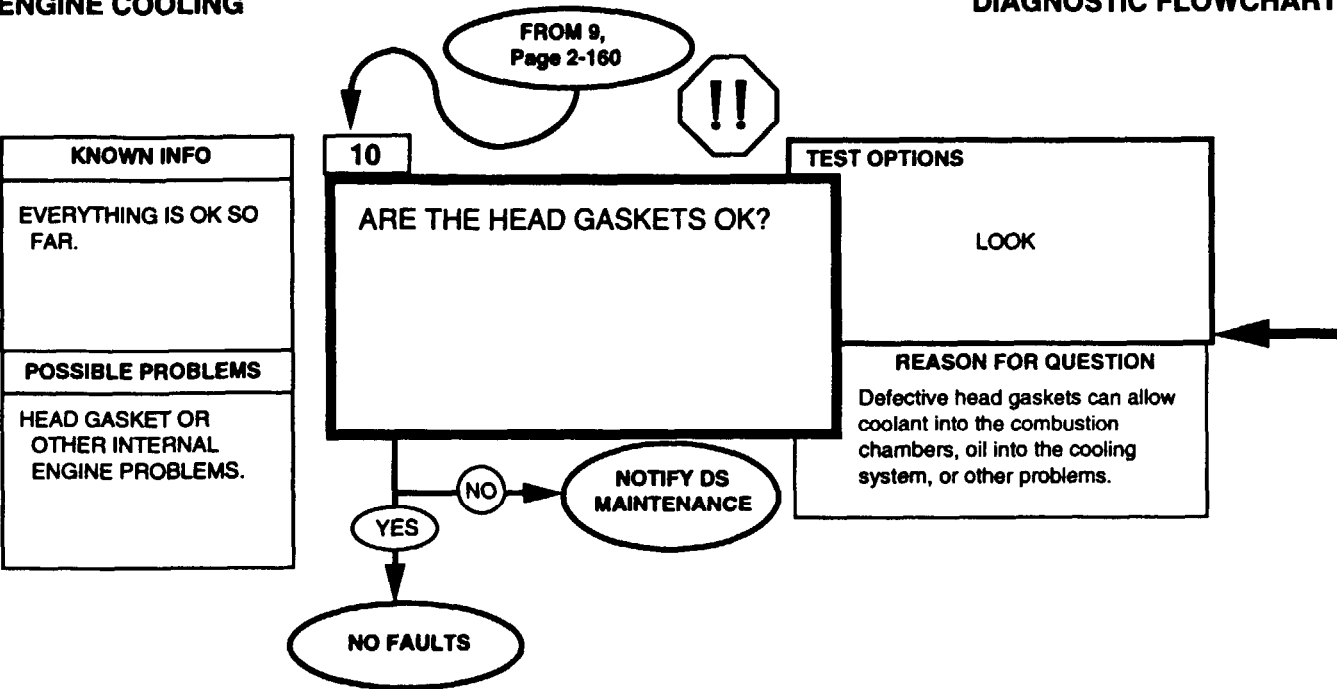
Replace belts, refer to (para. 3-81, all except "A2" vehicles) (para. 3-83, "A2" vehicles) or tighten belts, refer to (para. 3-82, all except "A2" vehicles).



"A2"  
CONFIGURATION

ENGINE COOLING

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ENGINE COOLING



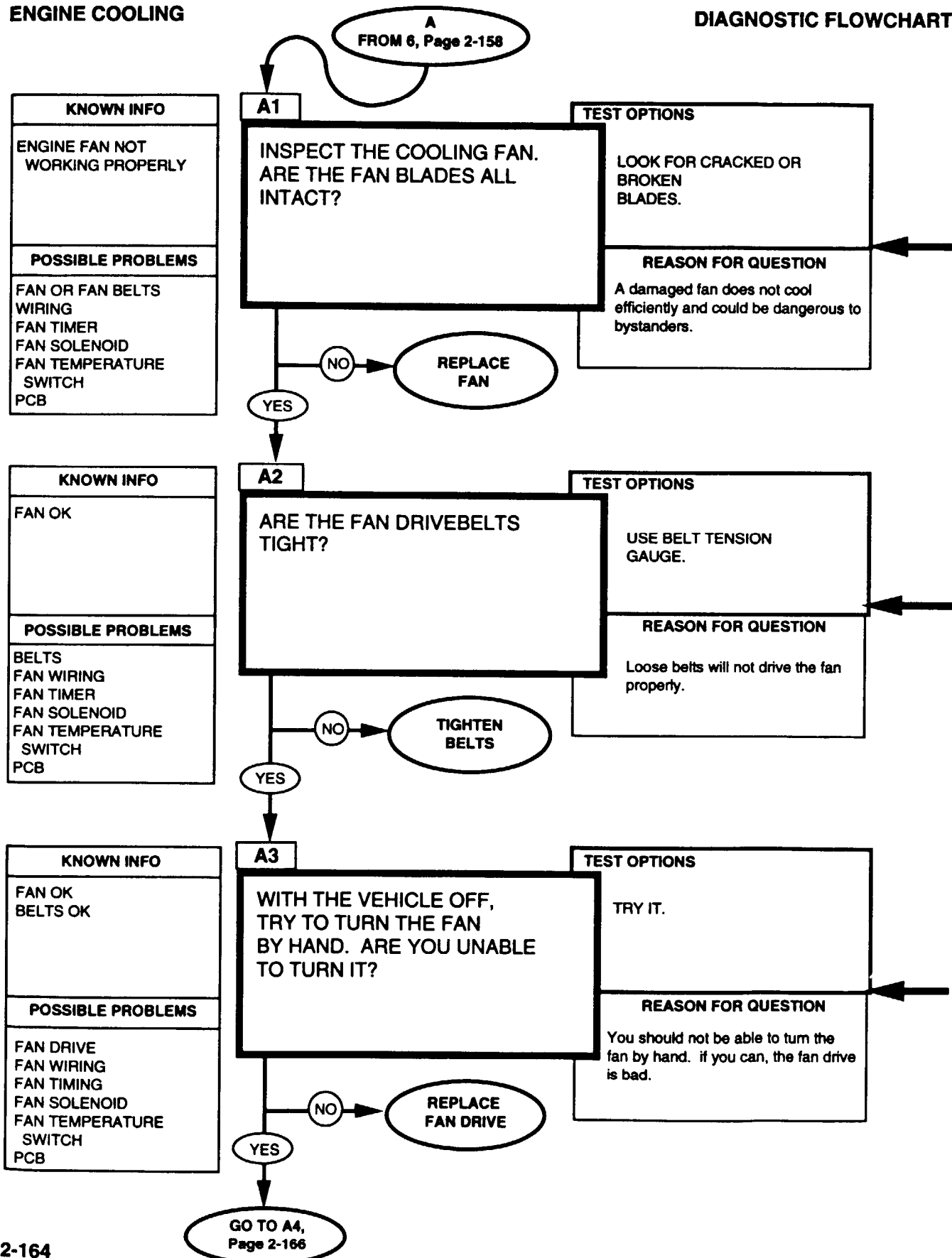
### **WARNING**

Always use caution when approaching a hot engine. Failure to do so may result in serious burns.

Look for excessive white exhaust smoke, steam leaks in the engine compartment or oil in the coolant. Other signs include excess condensation in the exhaust system, or white joints in the exhaust system. You can also feel the coolant hoses to see if they have high pressure caused by leaking combustion gases. Also, if the glowplugs turn off very quickly after starting the engine, or if the engine overheats, or has excessive coolant consumption, you may have a head gasket problem.

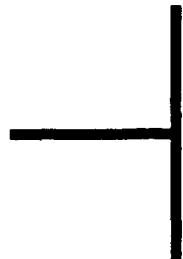
# ENGINE COOLING

## DIAGNOSTIC FLOWCHART

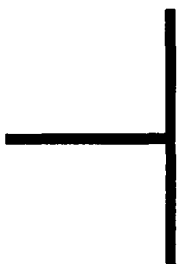


## REFERENCE INFORMATION

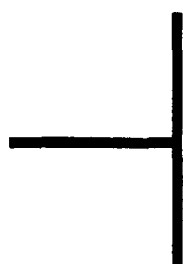
## ENGINE COOLING



Replace fan, refer to (para 3-78).



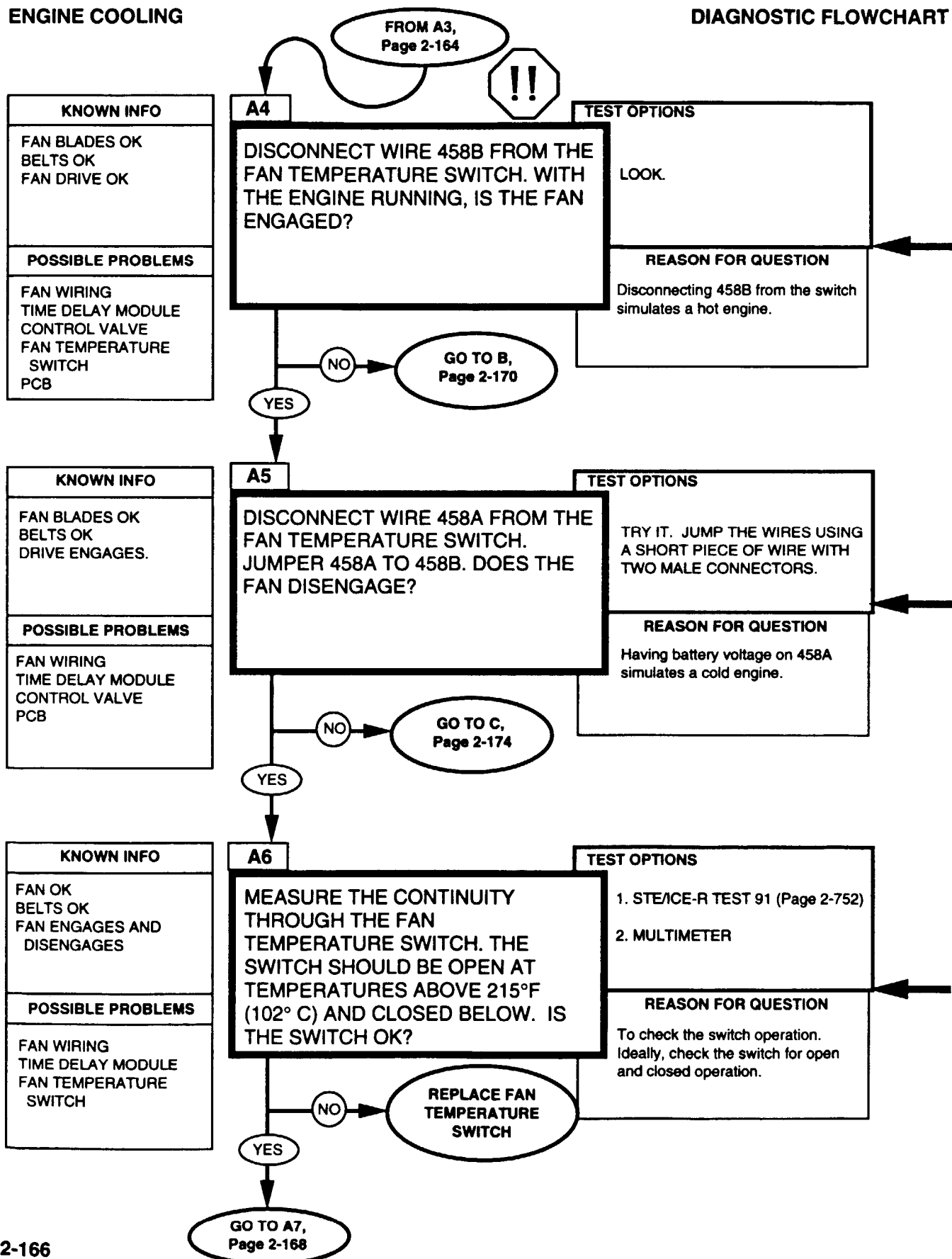
Tighten belts, refer to (para 3-82)  
(All except "A2" vehicles).



Replace fan drive, refer to (para 3-78).  
A YES answer to this question means  
that you were not able to turn the fan  
by hand.

## ENGINE COOLING

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

**WARNING**

Keep hands and arms away from fan blades and drive belts when engine is running or serious injury may result.

See page 2-159 for a description of the operation of the fan system and an easy way to tell if it's engaged or not.

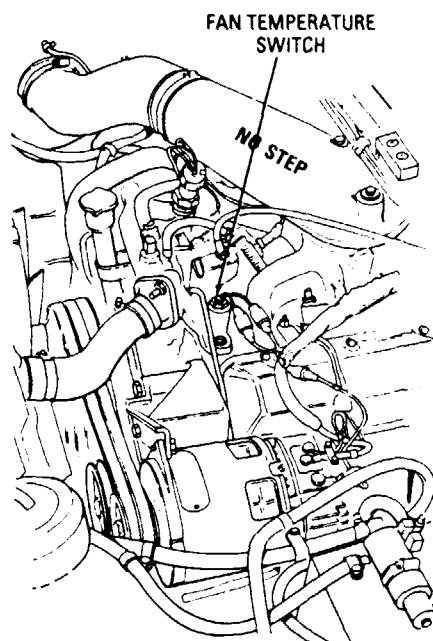
See page 2-159 for a description of the operation of the fan system and an easy way to tell if it's engaged or not.

If you know the engine is cold and the fan temperature switch is good, you can reconnect 458B to the switch and see if the fan disengages.

Replace the switch, refer to (para 4-30).

You can also remove the switch to test it hot and cold.

## ENGINE COOLING


**0-4500 OHMS  
STE/ICE-R TEST 91**

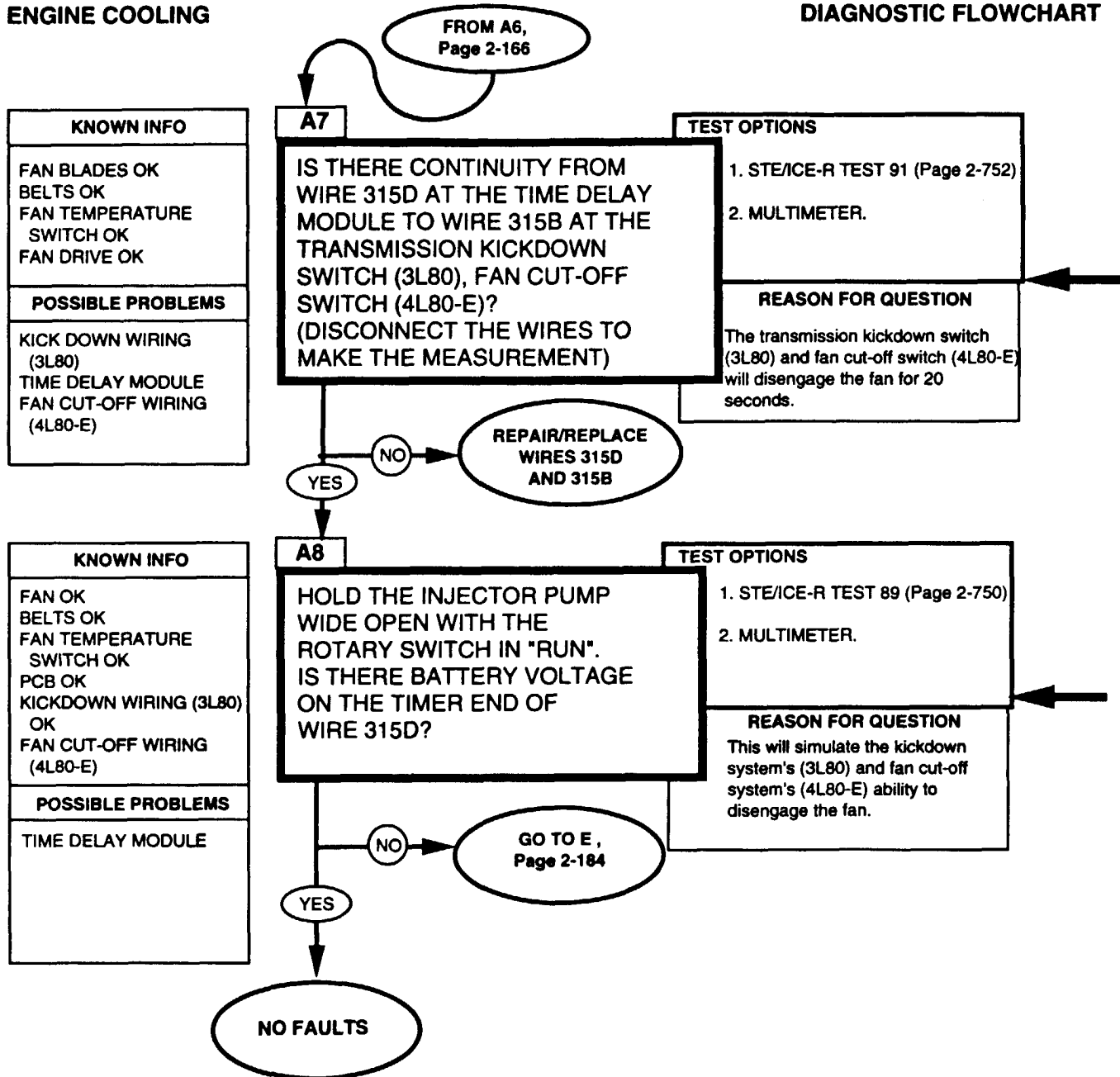
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# ENGINE COOLING

## DIAGNOSTIC FLOWCHART





## REFERENCE INFORMATION

## ENGINE COOLING

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

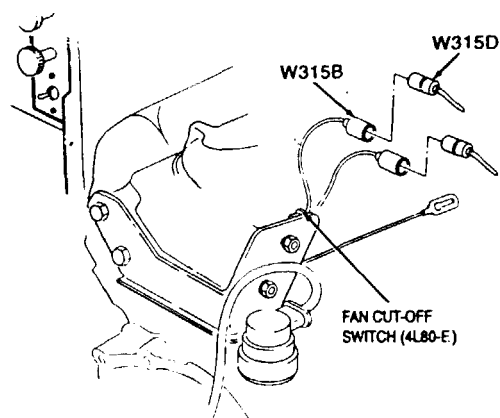
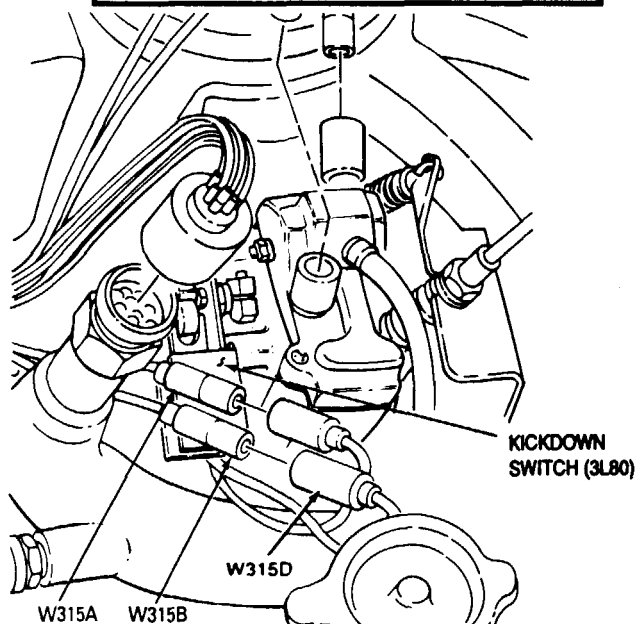
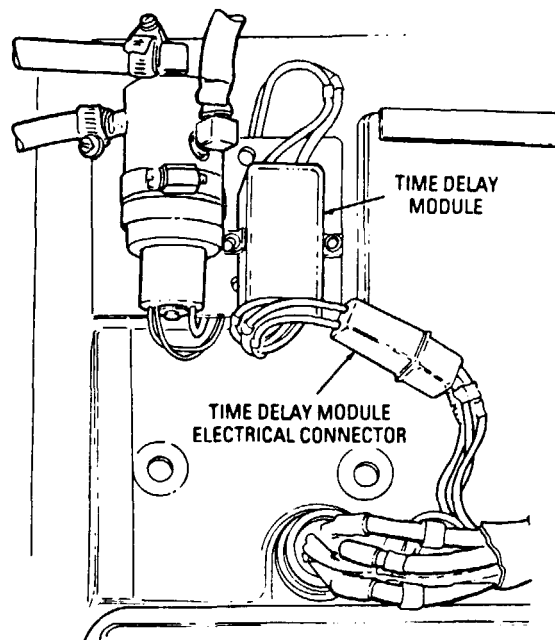
**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Disconnect the four-way connector at the time delay module and measure the voltage on wire 315D.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

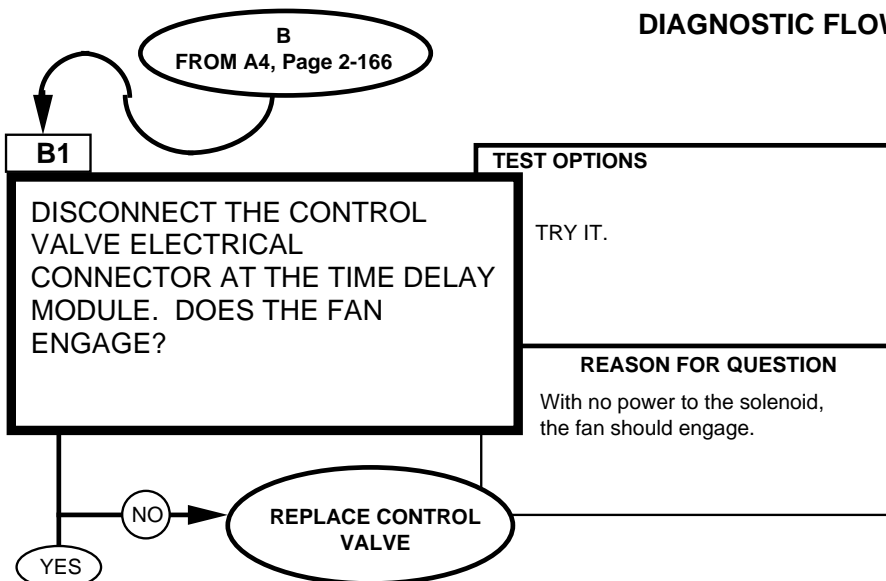
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



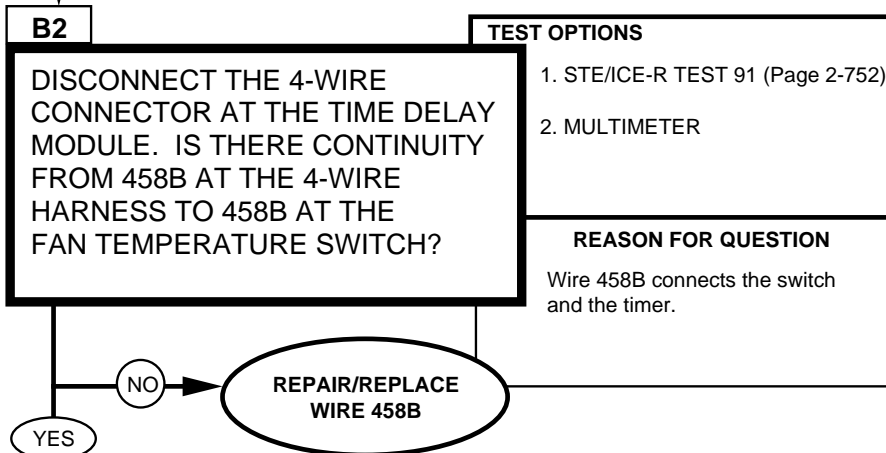
# ENGINE COOLING

## DIAGNOSTIC FLOWCHART

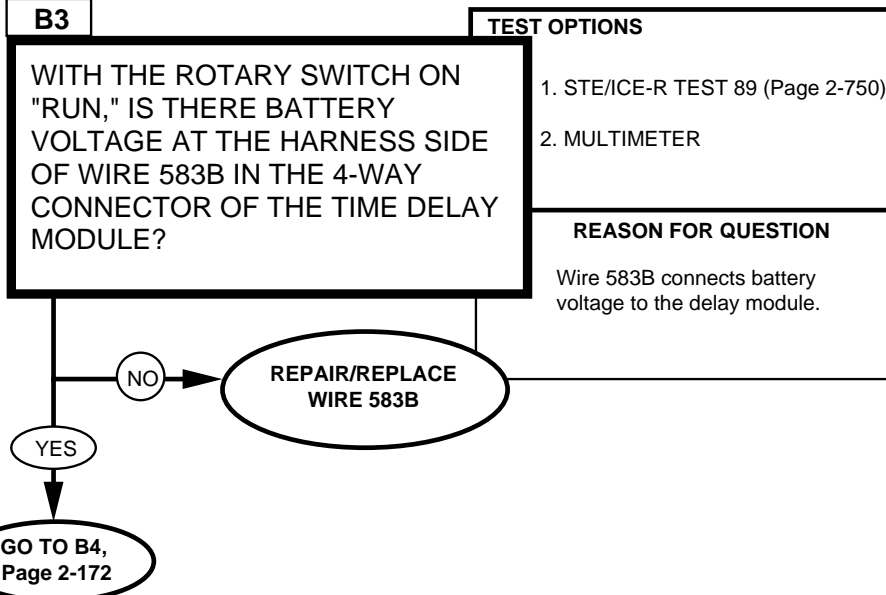
KNOWN INFO
FAN DRIVE OK FAN DOESN'T ENGAGE VIA WIRE 458
POSSIBLE PROBLEMS
FAN WIRING TIME DELAY MODULE FAN CONTROL VALVE PCB/DISTRIBUTION BOX



KNOWN INFO
FAN ENGAGES CONTROL VALVE OK
POSSIBLE PROBLEMS
WIRING



KNOWN INFO
FAN ENGAGES CONTROL VALVE OK
POSSIBLE PROBLEMS
WIRING



## REFERENCE INFORMATION

## ENGINE COOLING

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

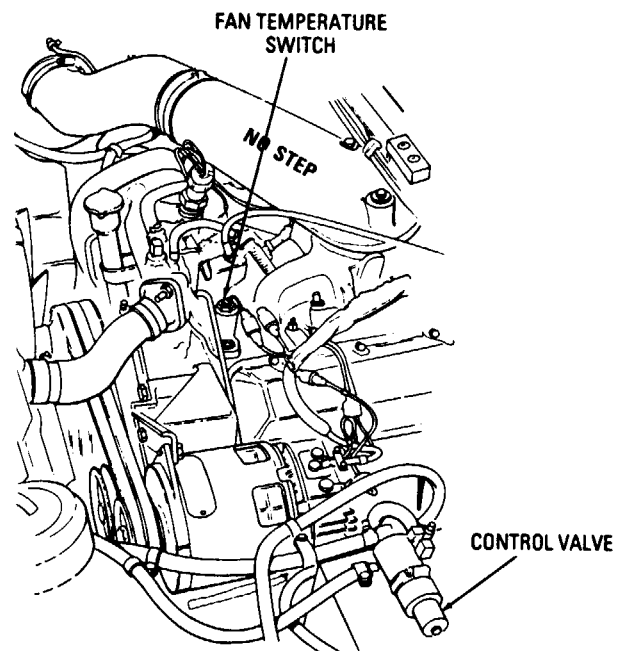
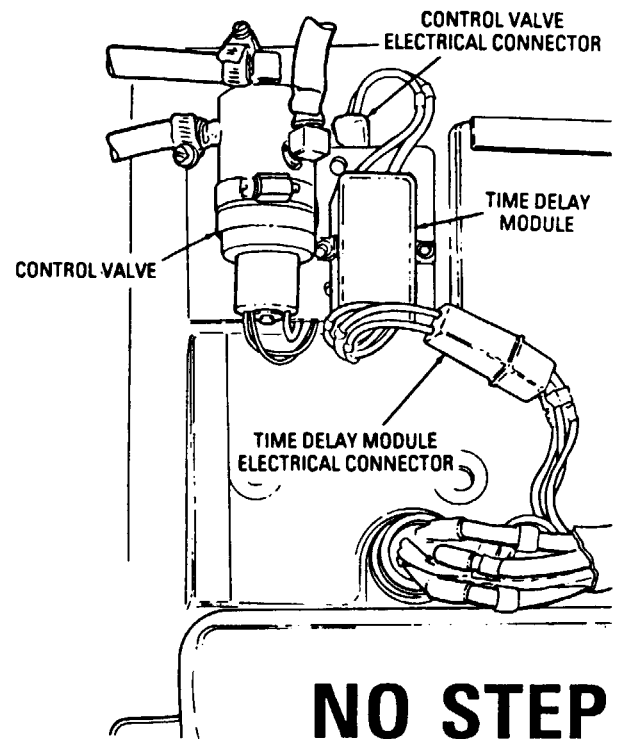
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**VOLTAGE  
MULTIMETER**

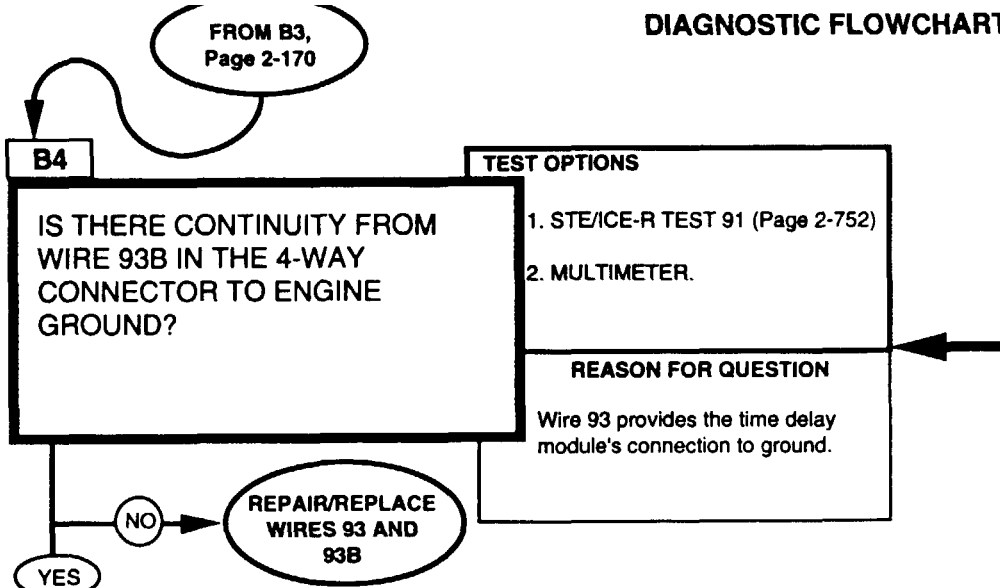
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



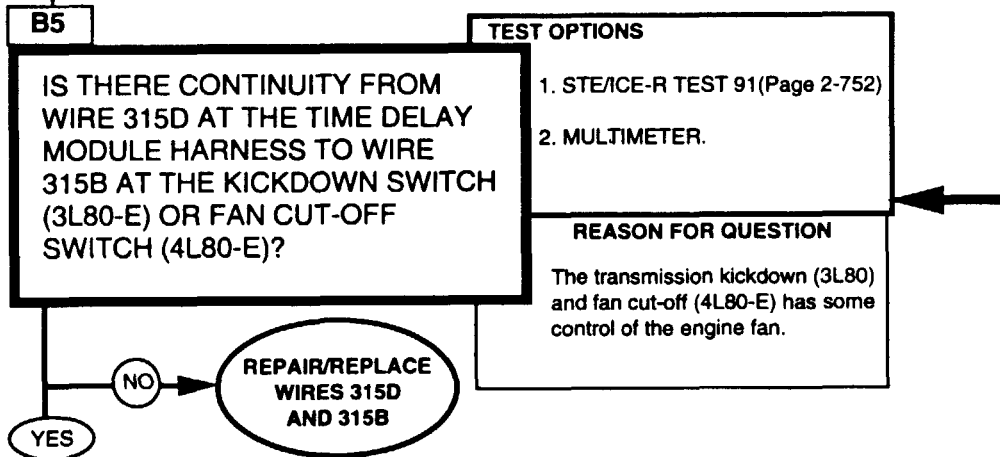
ENGINE COOLING

DIAGNOSTIC FLOWCHART

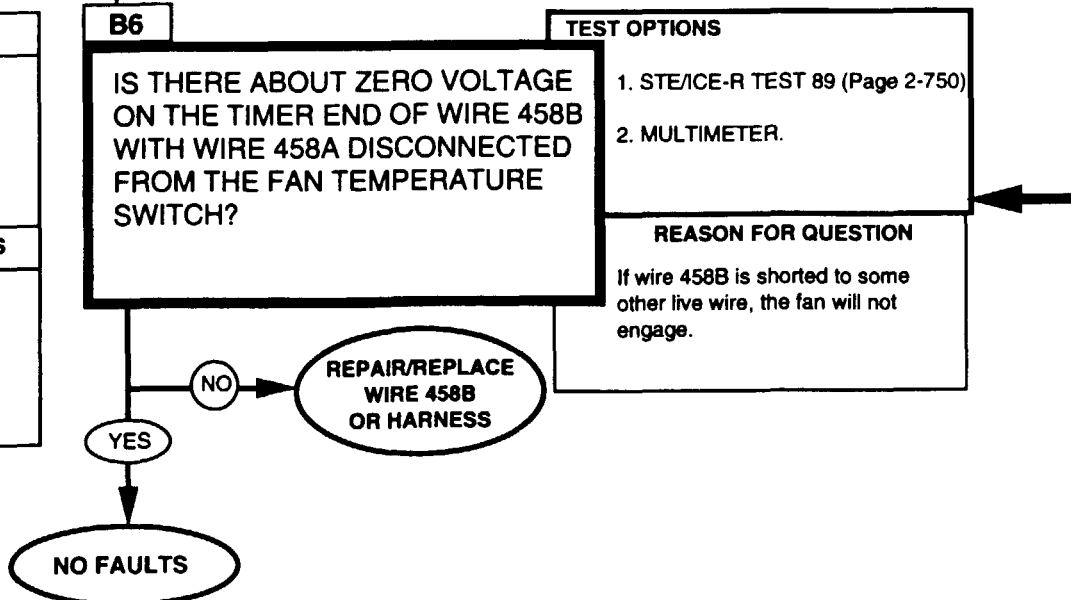
<b>KNOWN INFO</b>
FAN ENGAGES CONTROL VALVE OK
<b>POSSIBLE PROBLEMS</b>
WIRING



<b>KNOWN INFO</b>
FAN ENGAGES CONTROL VALVE OK
<b>POSSIBLE PROBLEMS</b>
WIRING



<b>KNOWN INFO</b>
FAN ENGAGES CONTROL VALVE OK
<b>POSSIBLE PROBLEMS</b>
WIRING



## REFERENCE INFORMATION

## ENGINE COOLING

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

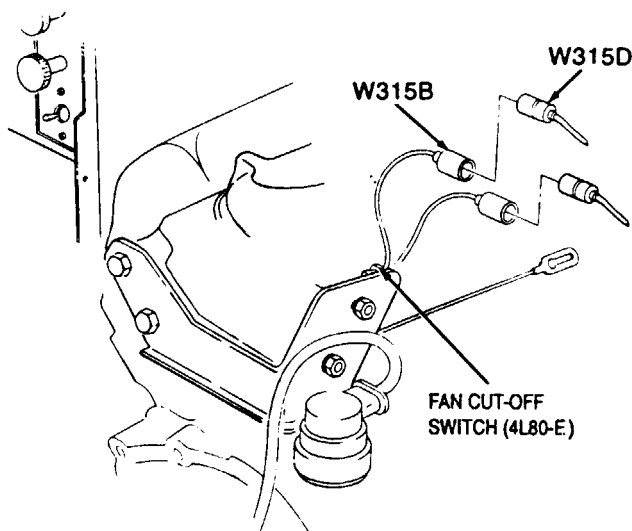
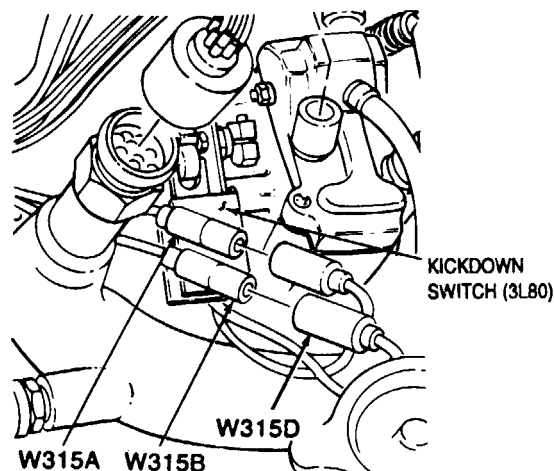
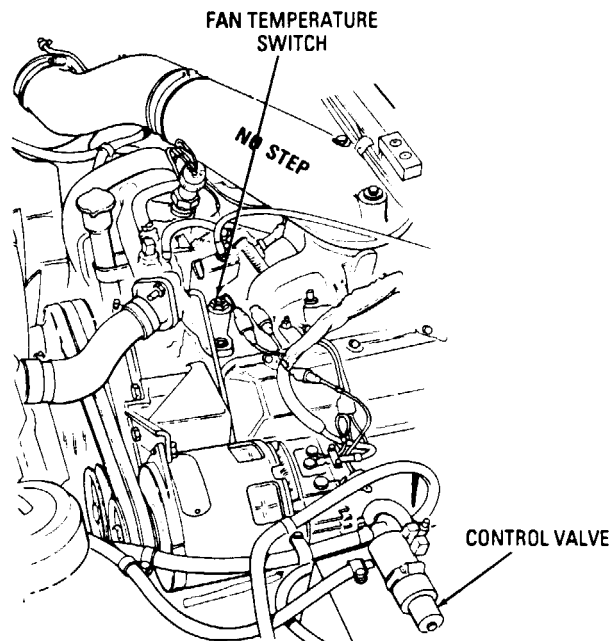
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**VOLTAGE  
MULTIMETER**

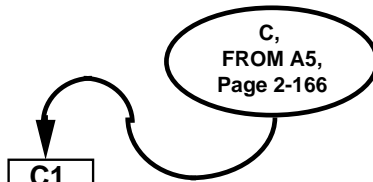
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



# ENGINE COOLING

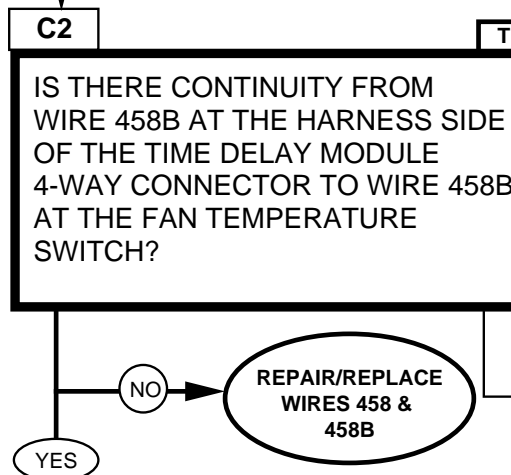
## DIAGNOSTIC FLOWCHART

KNOWN INFO
DRIVE OK FAN ENGAGES BUT WON'T DISENGAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX TIME DELAY MODULE WIRING HYDRAULIC SYSTEM



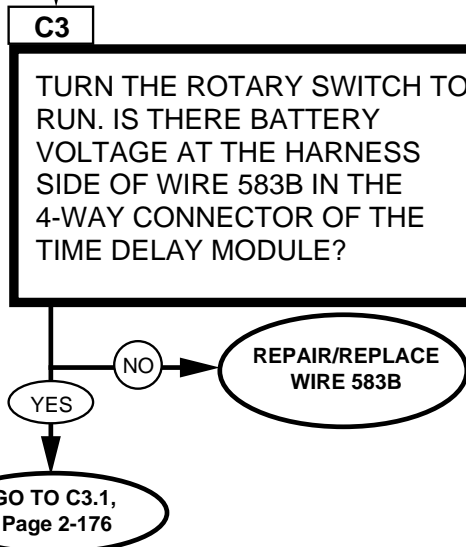
TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
REASON FOR QUESTION
Wire 458A connects battery voltage to the switch.

KNOWN INFO
DRIVE OK FAN ENGAGES BUT WON'T DISENGAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX TIME DELAY MODULE WIRING HYDRAULIC SYSTEM



TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
Wire 458B connects the switch and the time delay module.

KNOWN INFO
DRIVE OK FAN ENGAGES BUT WON'T DISENGAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX TIME DELAY MODULE WIRING HYDRAULIC SYSTEM



TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
REASON FOR QUESTION
Wire 583B connects battery voltage to the time delay module.

## REFERENCE INFORMATION

## ENGINE COOLING

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**VOLTAGE  
MULTIMETER**

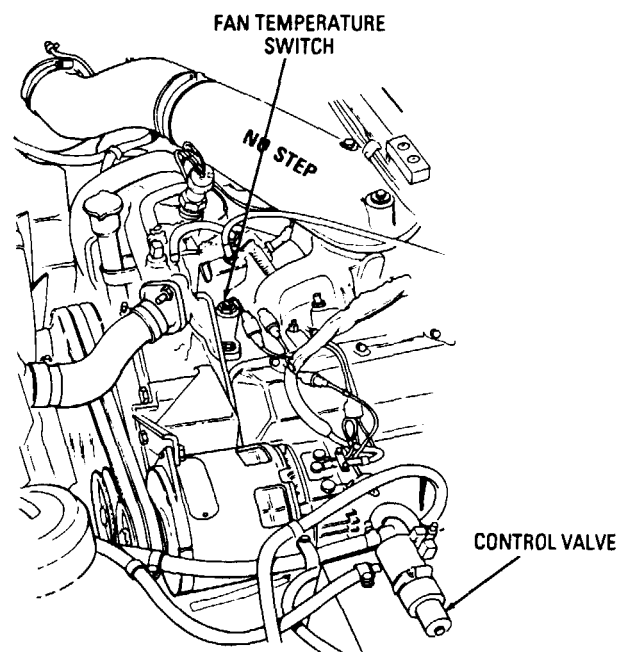
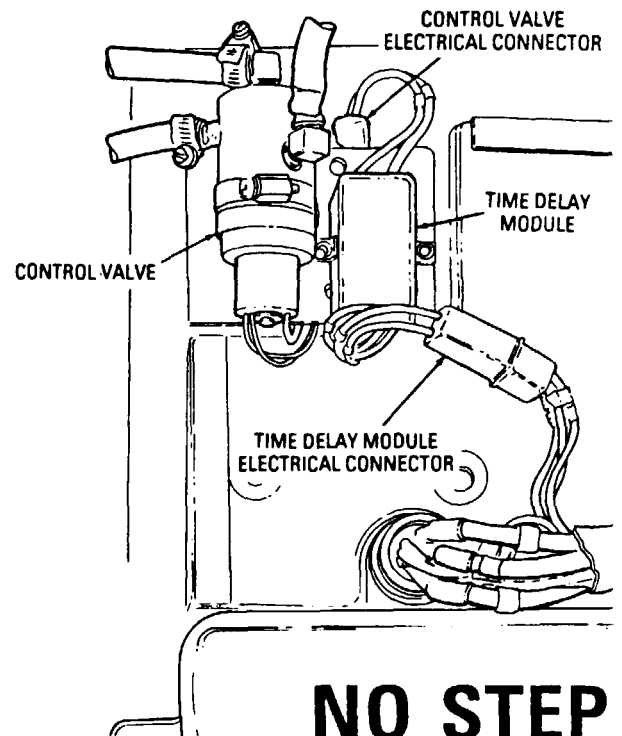
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

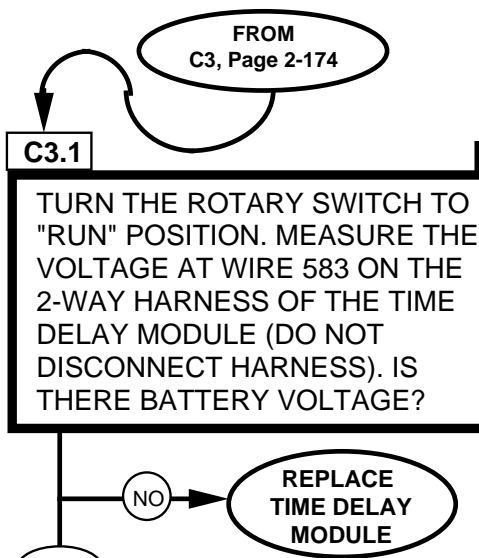
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



# ENGINE COOLING

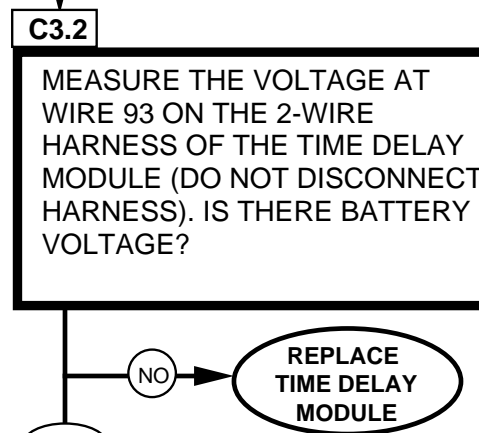
## DIAGNOSTIC FLOWCHART

KNOWN INFO
ENGINE COOLANT TEMPERATURE BELOW NORMAL (215°F) (102°C)
POSSIBLE PROBLEMS
TIME DELAY MODULE



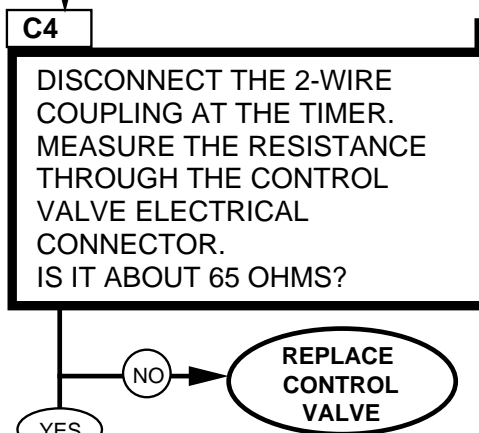
TEST OPTIONS
MULTIMETER
REASON FOR QUESTION
WIRE 583 SHOULD INDICATE BATTERY VOLTAGE.

KNOWN INFO
ENGINE COOLANT TEMPERATURE BELOW NORMAL (215°F) (102°C)
POSSIBLE PROBLEMS
TIME DELAY MODULE



TEST OPTIONS
MULTIMETER
REASON FOR QUESTION
WIRE 93 SHOULD INDICATE 0 VOLTAGE.

KNOWN INFO
FAN DRIVE OK FAN WON'T DISENGAGE
POSSIBLE PROBLEMS
TIME DELAY MODULE WIRING CONTROL VALVE HYDRAULIC SYSTEM



TEST OPTIONS
MULTIMETER – WITH AN ANALOG MULTIMETER, YOU MAY GET 65 TO 100 OHMS ONE WAY AND UNDER 30 OHMS THE OTHER WAY. THIS IS OK.
REASON FOR QUESTION
The need to check out the windings in the control valve to see if they're OK.

GO TO C5, Page 2-178

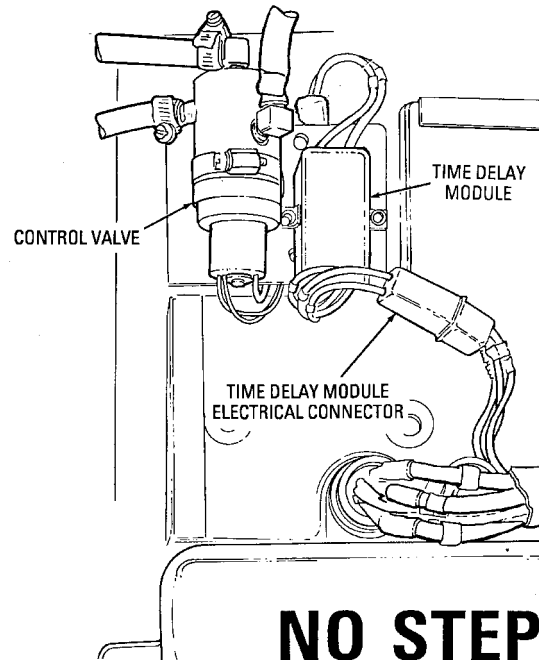


## REFERENCE INFORMATION

## ENGINE COOLING

Replace time delay module, refer to (para. 4-31).

Replace time delay module, refer to (para. 4-31).



When checking coil resistance, use an analog type multimeter.

For an accurate ohms reading, perform this check when the system is at room temperature. Heat will increase resistance, resulting in a higher ohms reading.

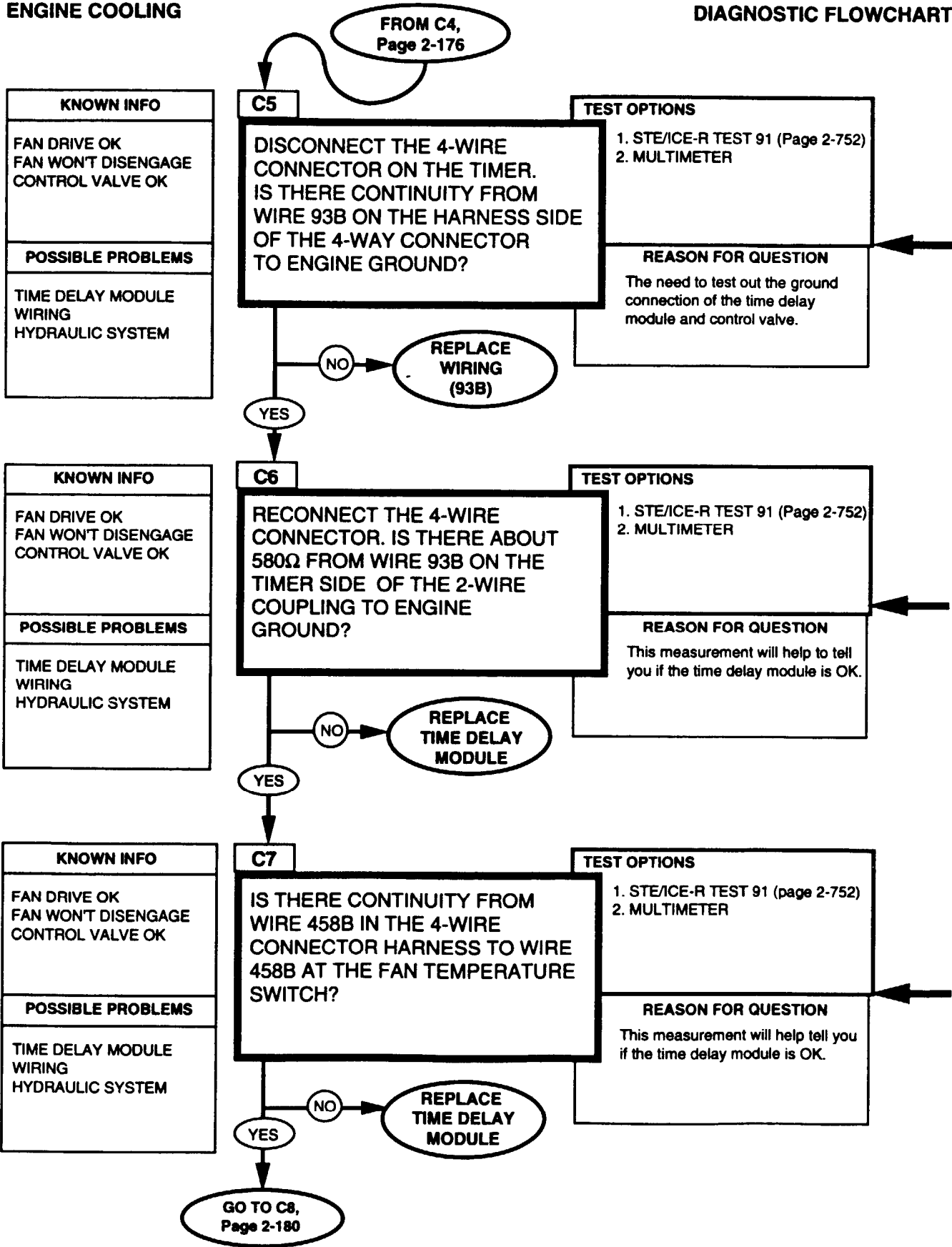
Replace the control valve, refer to (para. 8-26).

### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

ENGINE COOLING

DIAGNOSTIC FLOWCHART



# REFERENCE INFORMATION

## ENGINE COOLING

Repair wire refe to (para. 4-85) or notify DS maintenance.

### 0-4500 OHMS STE/ICE-R TEST 91

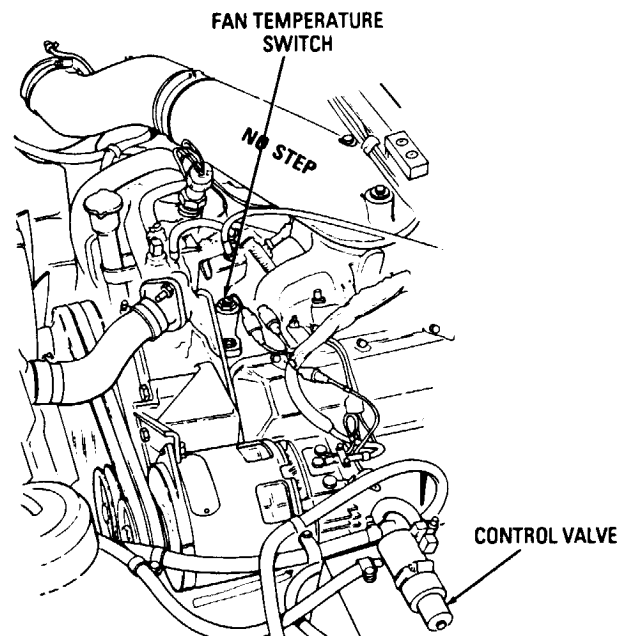
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replce the time delay rmodule, refer to (para 4-31).

### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit the meter should peg full scale (needle all the way to the left).

Replace the time delay module, refer to (para 4-31).



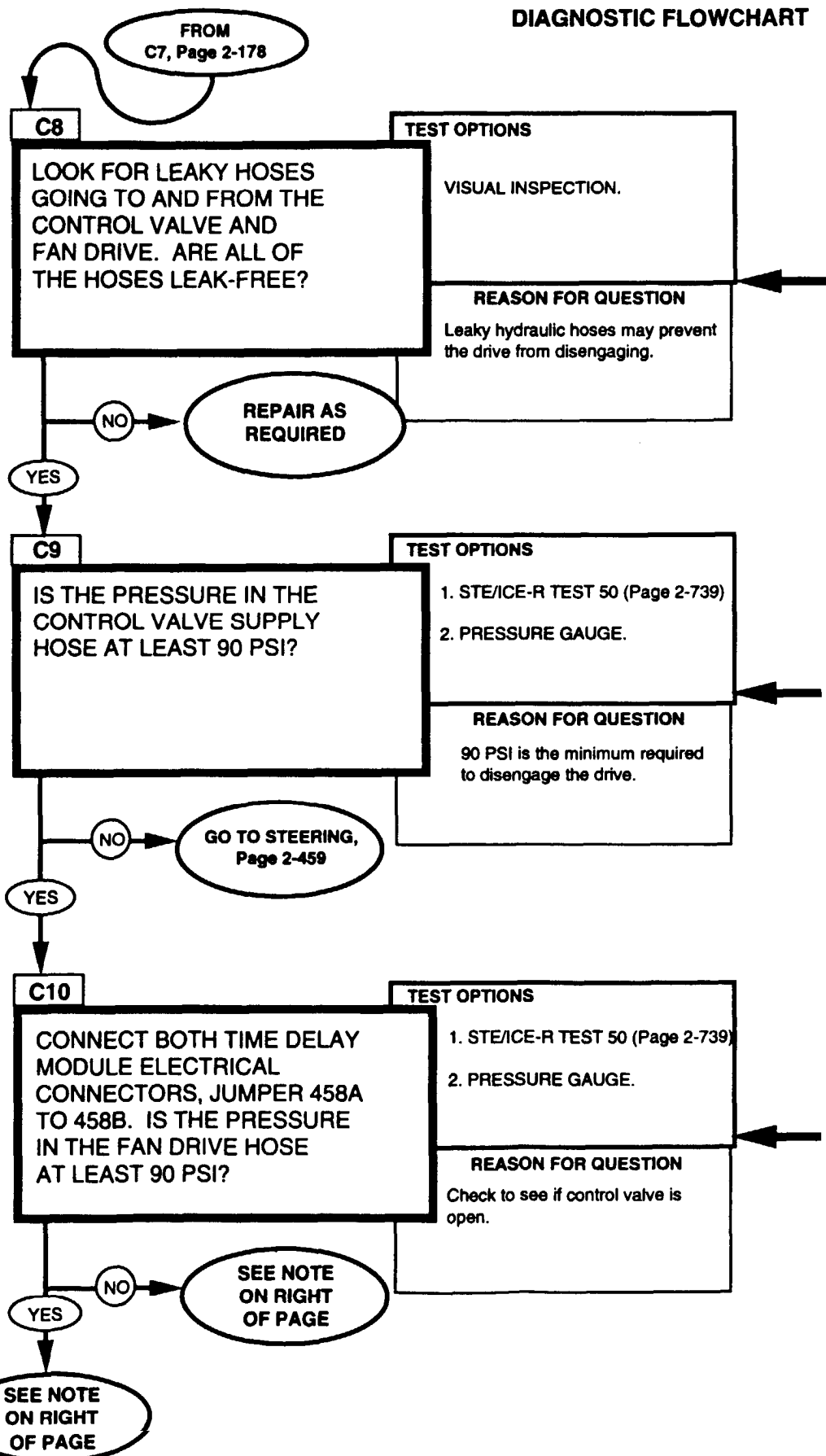
# ENGINE COOLING

## DIAGNOSTIC FLOWCHART

KNOWN INFO
FAN WON'T DISENGAGE WIRING OK
POSSIBLE PROBLEMS
LOW POWER STEERING PRESSURE LEAKS CONTROL VALVE

KNOWN INFO
FAN WON'T DISENGAGE WIRING OK HOSES ARE LEAK-FREE
POSSIBLE PROBLEMS
LOW POWER STEERING PRESSURE CONTROL VALVE

KNOWN INFO
FAN WON'T DISENGAGE WIRING OK HOSES ARE LEAK-FREE
POSSIBLE PROBLEMS
LOW POWER STEERING PRESSURE CONTROL VALVE FAN DRIVE



## REFERENCE INFORMATION

## ENGINE COOLING

Replace hoses, refer to (para 8-26).

**STE/ICE-R TEST #50  
0 TO 1000 PSIG PRESSURE**

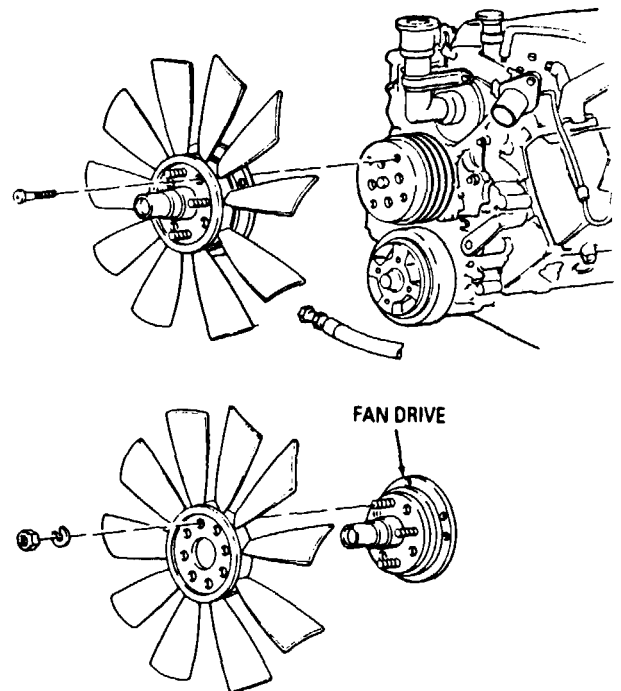
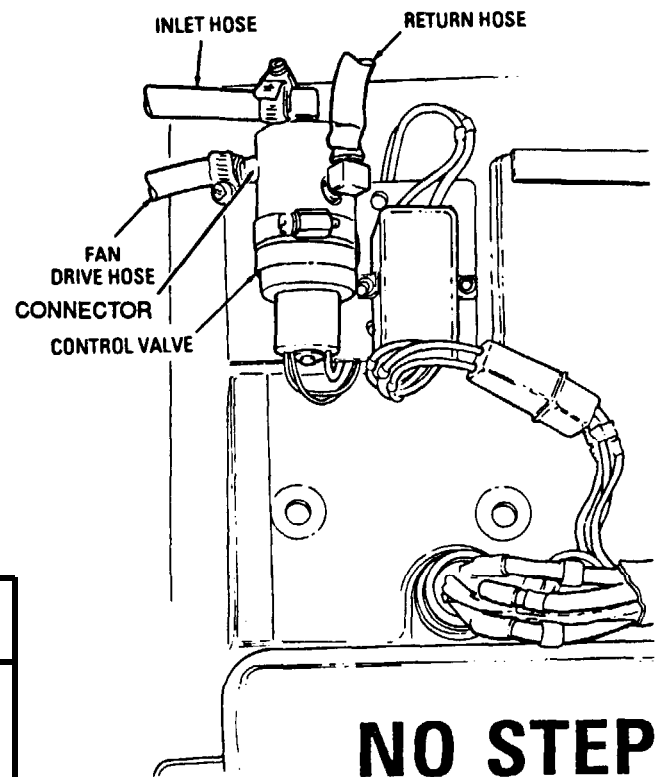
1. Connect transducer to valve after removing connector, refer to (para 8-26). Do offset test.
2. Connect BLUE pressure transducer to A W4 cable. Make sure the system under test is not pressurized.
3. Turn on system and read pressure.

Measure the pressure at the valve outlet. Remove the fan drive hose and connector from the valve body and screw transducer into the valve. Start the engine and look for leaks.

Replace control valve and/or fan drive, refer to (para 8-26 or 3-78). Check to sea if hoses are blocked prior to replacing parts, and perform back flush procedure (para 8-26).

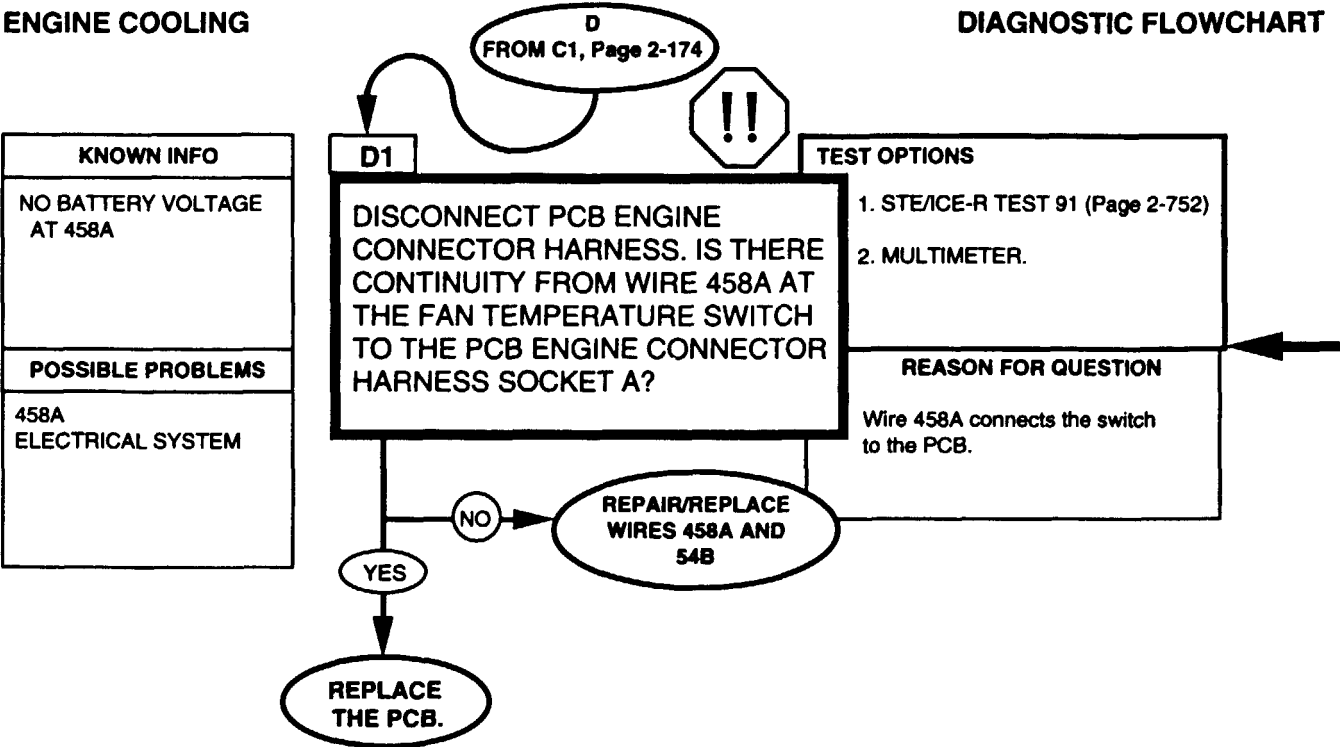
If pressure in the fan drive hose is not at least 90 psi, (620.5 kPa) perform back flush procedure (para 8-26). Recheck pressure. If pressure is not at least 90 psi, replace control valve.

If pressure in the fan drive hose is at least 90 psi, (620.5 kPa) check for blockage in hose between the control valve and fan drive. If hose is not blocked, replace fan drive (para. 3-78).



ENGINE COOLING

DIAGNOSTIC FLOWCHART



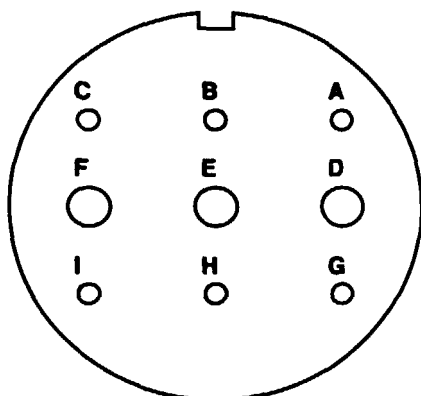
## REFERENCE INFORMATION

**WARNING**

DISCONNECT NEGATIVE  
BATTERY CABLE BEFORE  
DISCONNECTING AND  
RECONNECTING PROTECTIVE  
CONTROL BOX HARNESS.

There is battery voltage at the PCB at all times.  
Failure to disconnect battery cable will result in  
damage to equipment or injury to personnel.

Replace PCB, refer to (para 4-5).



**PCB ENGINE CONNECTOR**

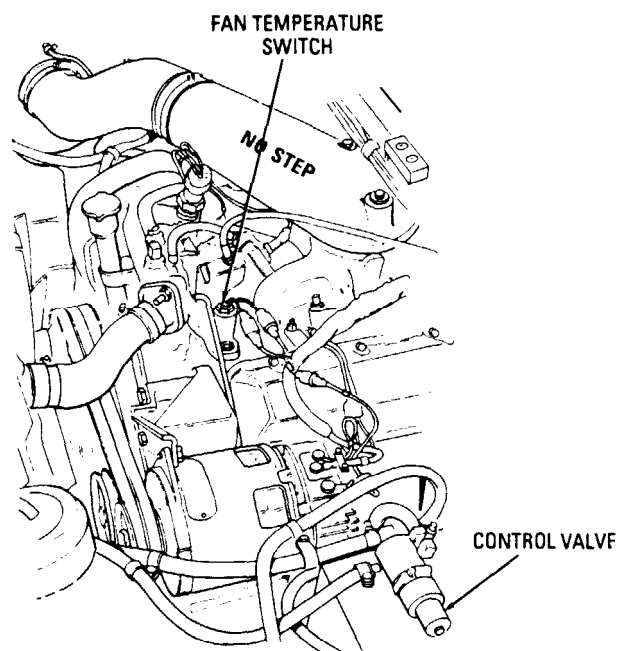
## ENGINE COOLING

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED dip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Teat 91,0-4500 ohms.
3. Displayed reading is in ohms. Leas than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

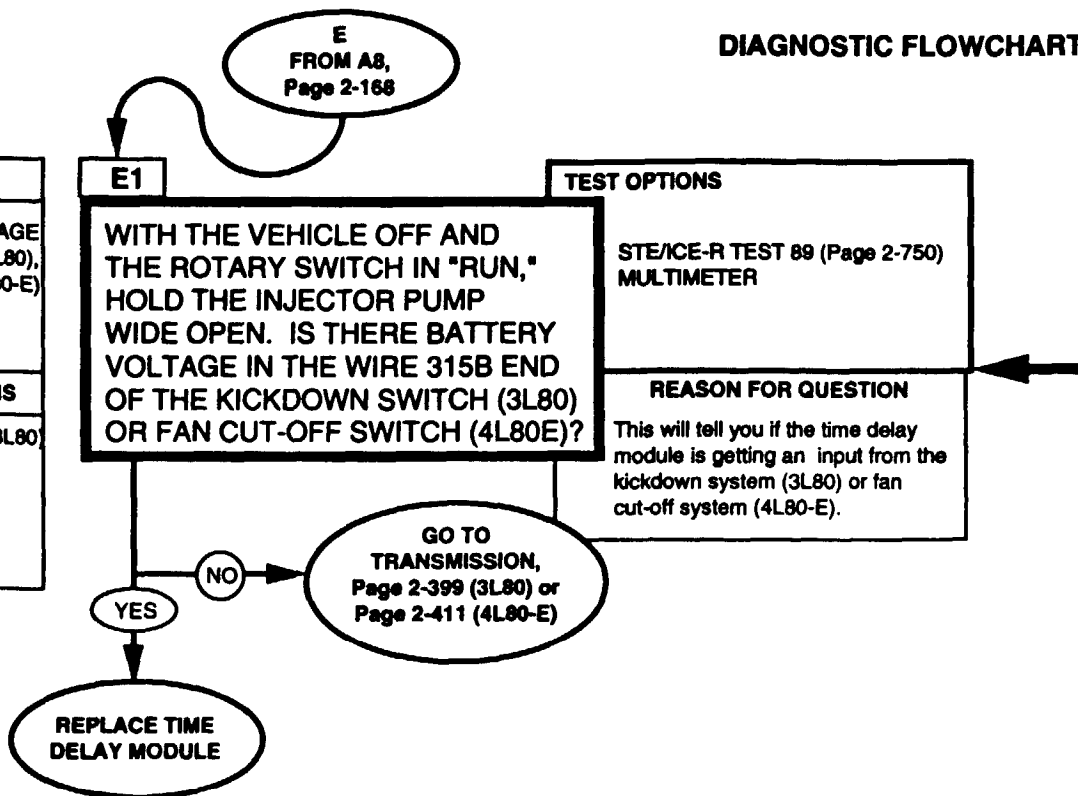
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Leas than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



# ENGINE COOLING

## DIAGNOSTIC FLOWCHART

KNOWN INFO
FAN DOESN'T DISENGAGE WHEN KICKDOWN (3L80), OR FAN CUT-OFF(4L80-E) ACTIVATES
POSSIBLE PROBLEMS
KICKDOWN SWITCH (3L80) TIME DELAY MODULE WIRING FAN CUT-OFF SWITCH (4L80-E)





# REFERENCE INFORMATION

# ENGINE COOLING



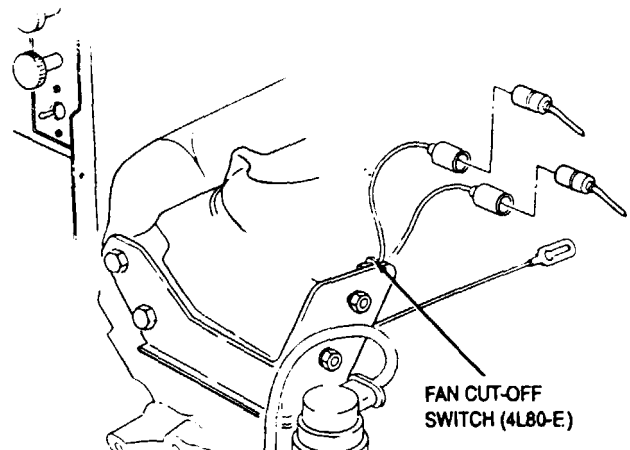
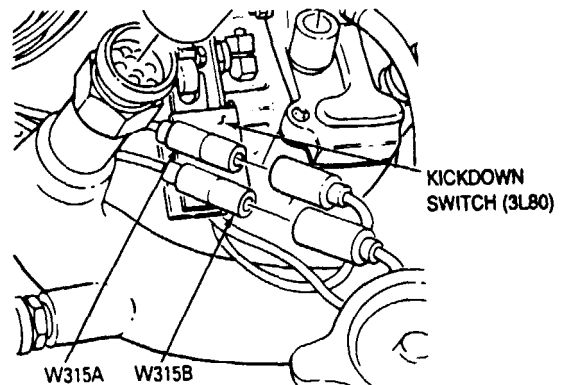
Replace time delay module, refer to (para 4-31).

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



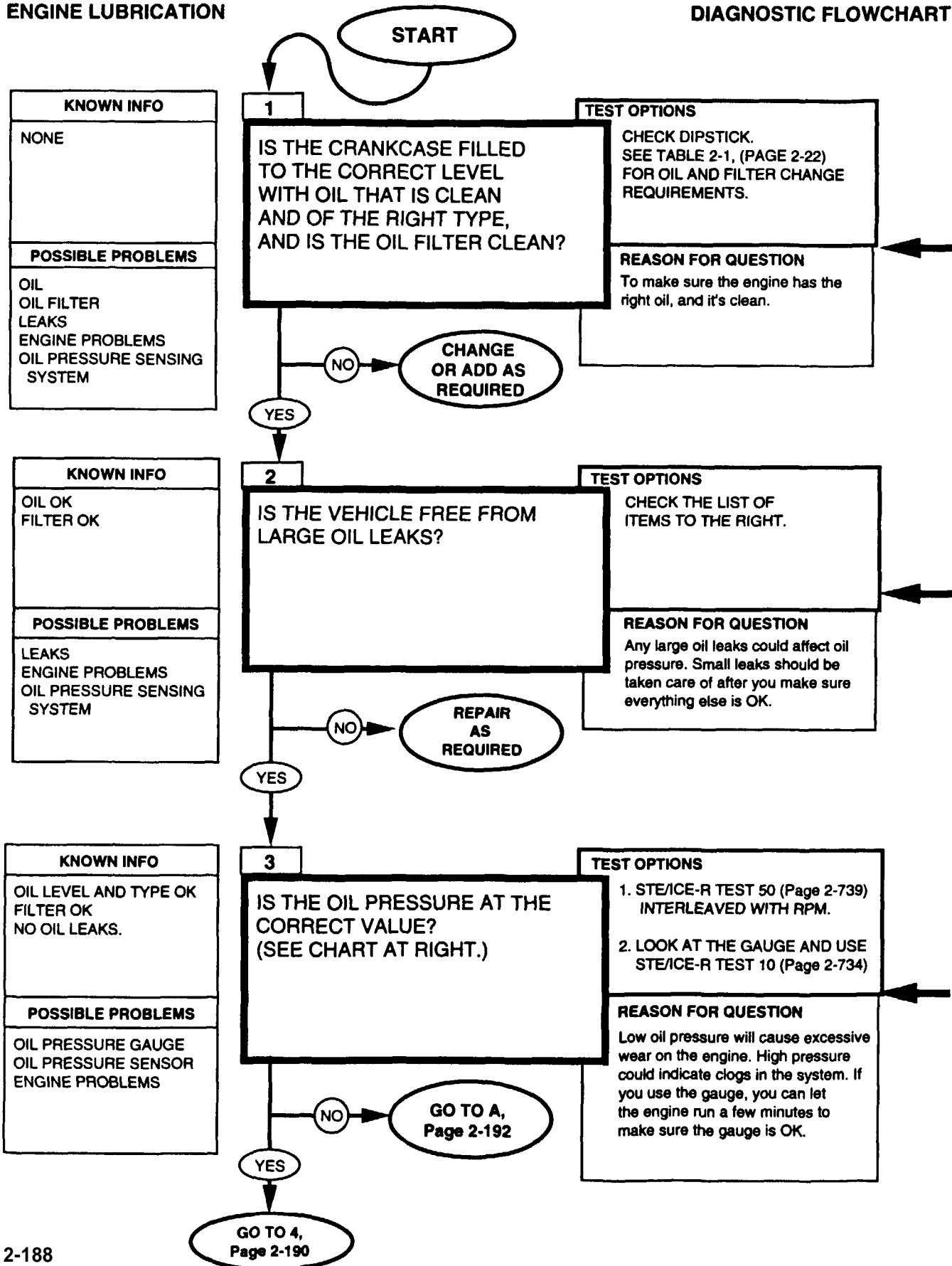
**2-26. ENGINE LUBRICATION TESTS**

These Engine Lubrication tests may be run any time there is an engine lubrication problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

Fold-out page FO-5 shows the location of the major components of the Engine Lubrication system in case you are not familiar with them. This page may be left open for reference while testing.

ENGINE LUBRICATION

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ENGINE LUBRICATION

Incorrect oil level and type can cause pressure problems, leaks, excessive blowby, and other problems.

Inspect the oil cooler, oil cooler supply return lines, CDR valve hoses, oil pan, and oil filter. Test CDR valve, (para. 3-9). See the location on parts page to find these parts.

### ENGINE RPM STE/ICE-R TEST 10

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 200. Idle RPM should be 625-675.

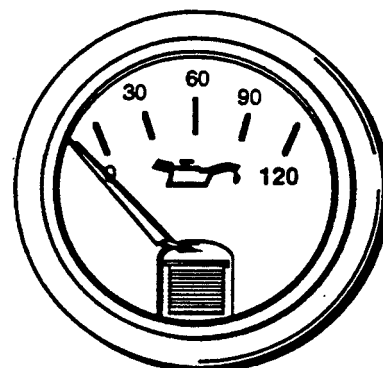
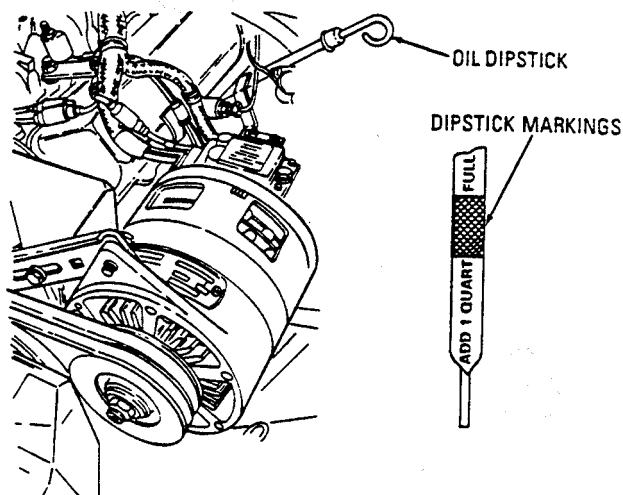
### OIL PRESSURE CHART

ENGINE RPM	APPROXIMATE OIL PRESSURE
STOP	0 PSI
6.2L IDLE (650 $\pm$ 25)	10-15 PSI
6.5L IDLE (700 $\pm$ 25)	10-15 PSI
6.5L DETUNED IDLE (700 $\pm$ 25)	10-15 PSI
2000	40-50 PSI

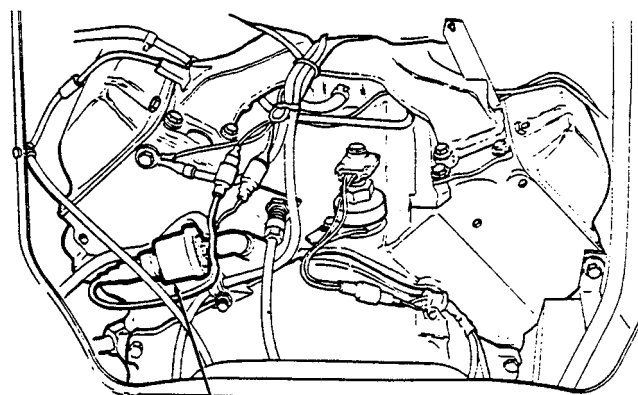
Remove sending unit, refer to (para. 4-25).

### ENGINE RPM INTERLEAVE WITH 0-1000 PSI PRESSURE

1. Connect BLUE Transducer in place of oil pressure sending unit. Dial test 50 (0-1000 psi). Perform offset test.
2. Dial test 01, interleave with RPM. Dial test 50.
3. Start engine and observe display. VTM will display RPM's, then PSI.

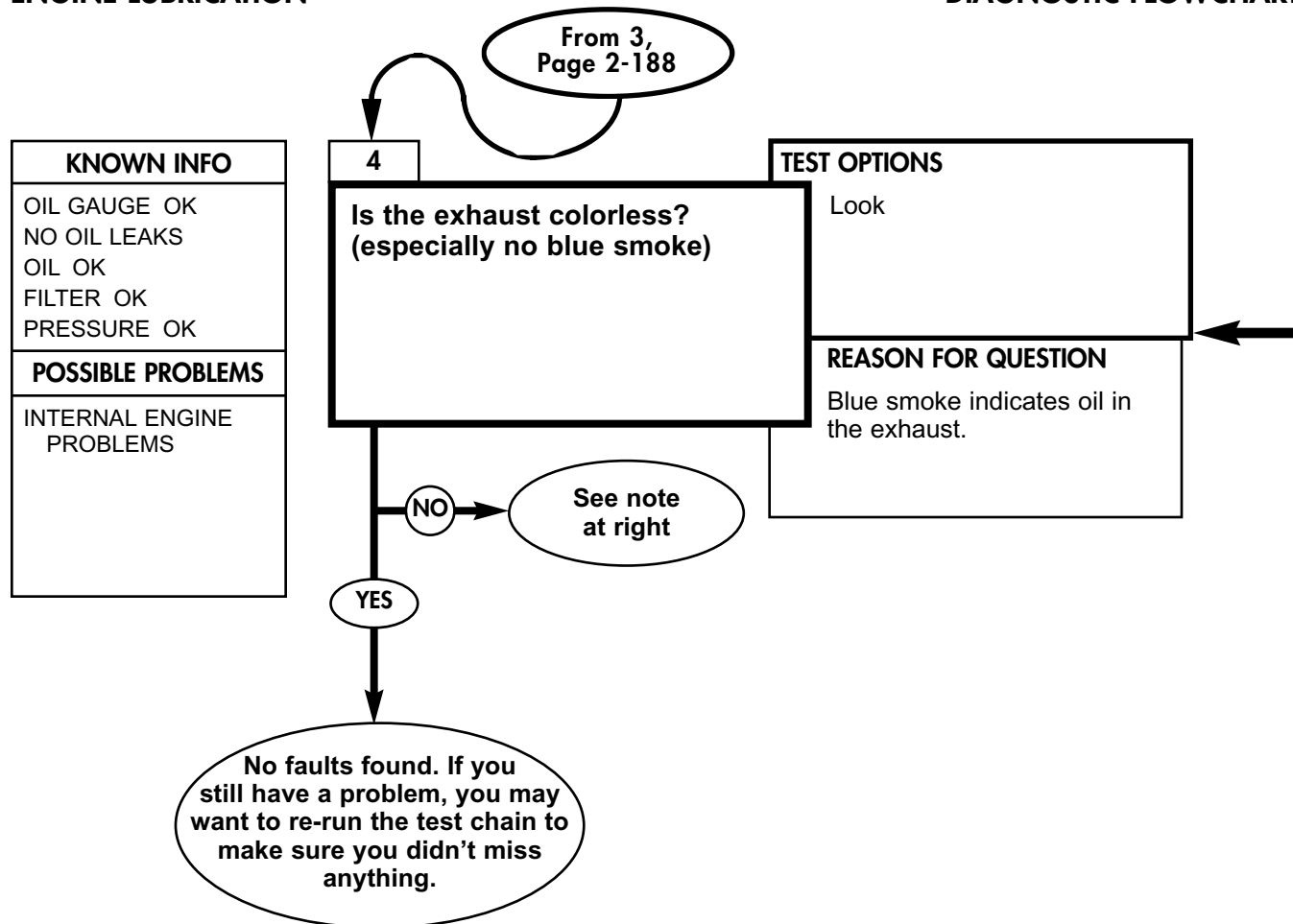


OIL PRESSURE GAUGE



# ENGINE LUBRICATION

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ENGINE LUBRICATION

**NOTE**

If the exhaust is not colorless it must be either white, blue or black.  
If exhaust color is:

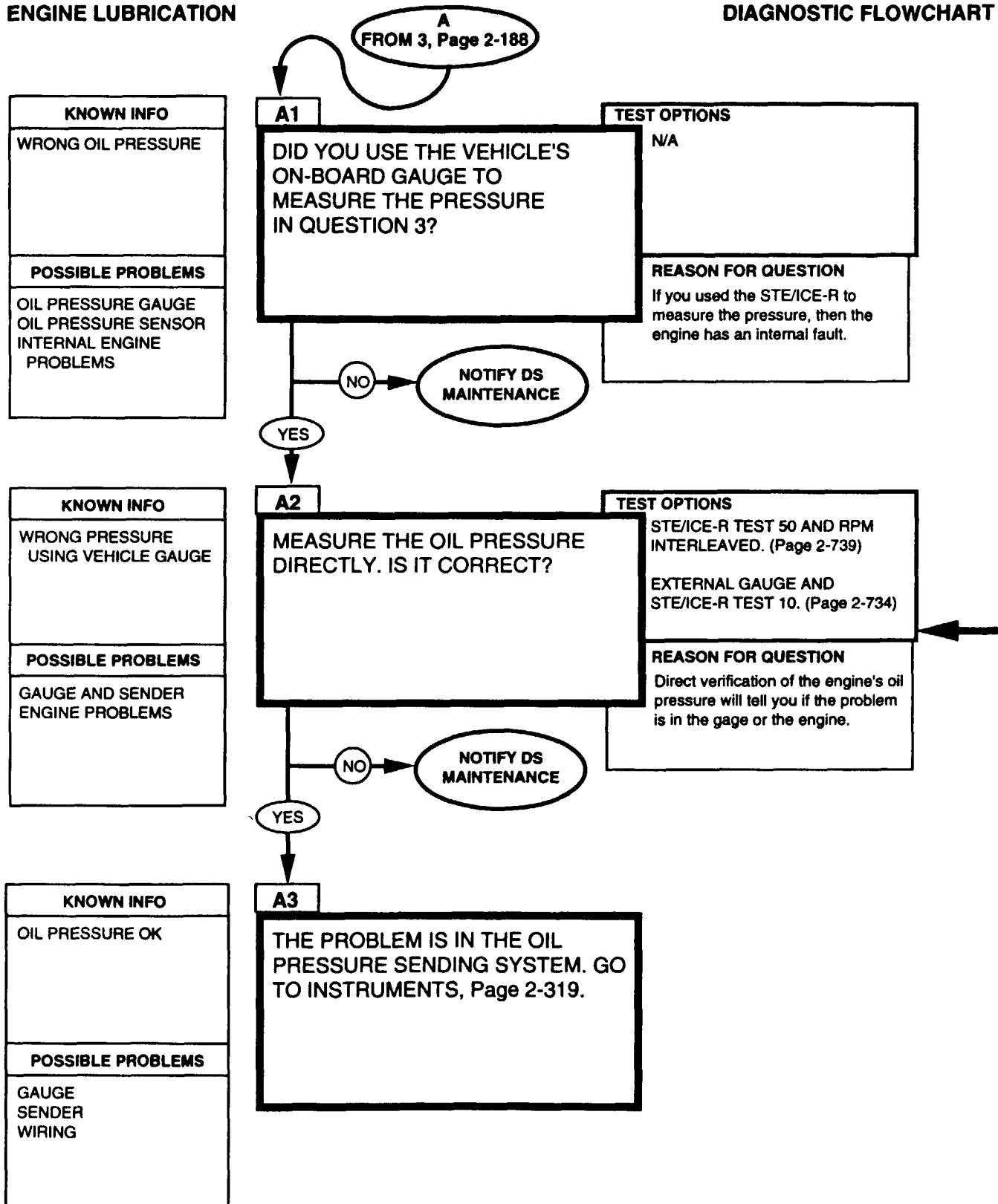
WHITE . . . . . Go to fuel system, Paragraph 2-22. Could be injector timing, DS level fault.

BLUE . . . . . Blue smoke is a sign of oil entering the combustion chambers. It usually enters past the piston rings or intake valve stem seals. This is an internal engine problem that can't be handled at this level of maintenance. You may want to run the Engine Mechanical Tests, Paragraph 2-18 before you notify DS Maintenance.

BLACK . . . . . Intake/exhaust. Para. 2-23

# ENGINE LUBRICATION

## DIAGNOSTIC FLOWCHART

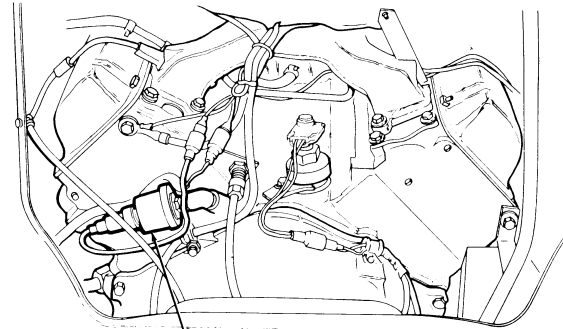


## REFERENCE INFORMATION

## ENGINE LUBRICATION

OIL PRESSURE CHART

ENGINE RPM	APPROXIMATE OIL PRESSURE
STOP	0 PSI
6.2L IDLE ( $650 \pm 25$ )	10-15 PSI
6.5L IDLE ( $700 \pm 25$ )	10-15 PSI
6.5L DETUNED IDLE ( $700 \pm 25$ )	10-15 PSI
2000	40-50 PSI

OIL PRESSURE  
SENDING UNIT

Remove sending unit, refer to (para. 4-25)

**ENGINE RPM  
INTERLEAVE WITH 0-1000 PSI PRESSURE**

1. Connect BLUE Transducer in place of oil pressure sending unit. Dial test 50 (0-1000 psi). Perform offset test.
2. Dial test 01, interleave with RPM. Dial test 50.
3. Start engine and observe display. VTM will display RPM's, then PSI.



## 2-27. ALTERNATOR TESTS

These Alternator tests can be run any time you think there may be a problem with the alternator or battery charging or if you were sent here from another system chain.

These tests are NOT for the batteries. These tests are strictly for the alternator, its operation, and its associated wiring. Tests for the batteries are in Battery Circuit, Paragraph 2-29.

A simplified block diagram for the alternator system is given on page 2-195. A detailed functional flow schematic is provided as foldout FO-6 to help you understand the system as you perform the tests.

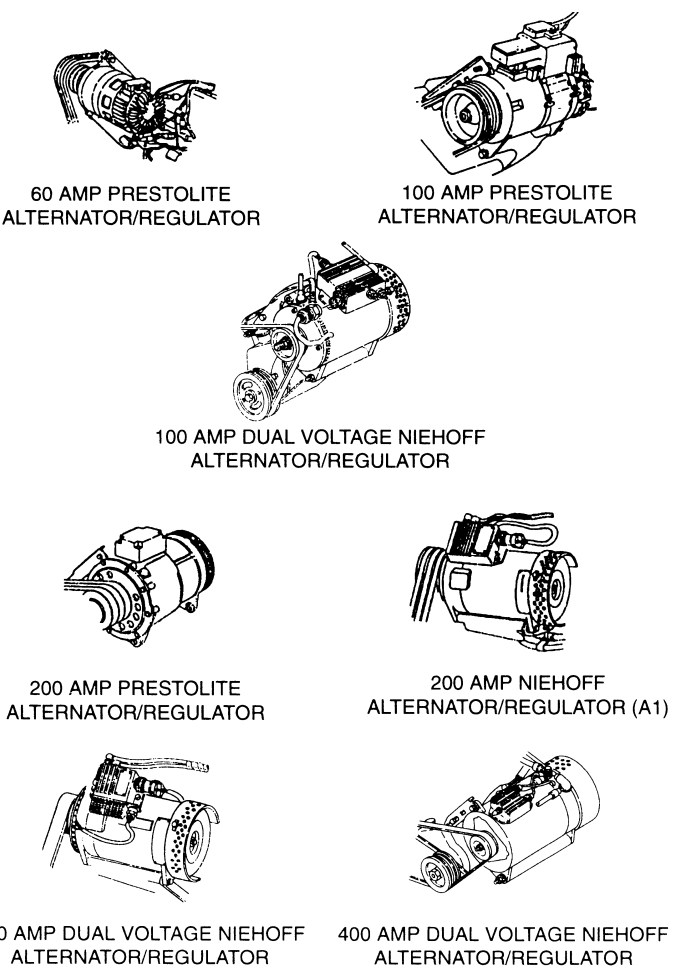
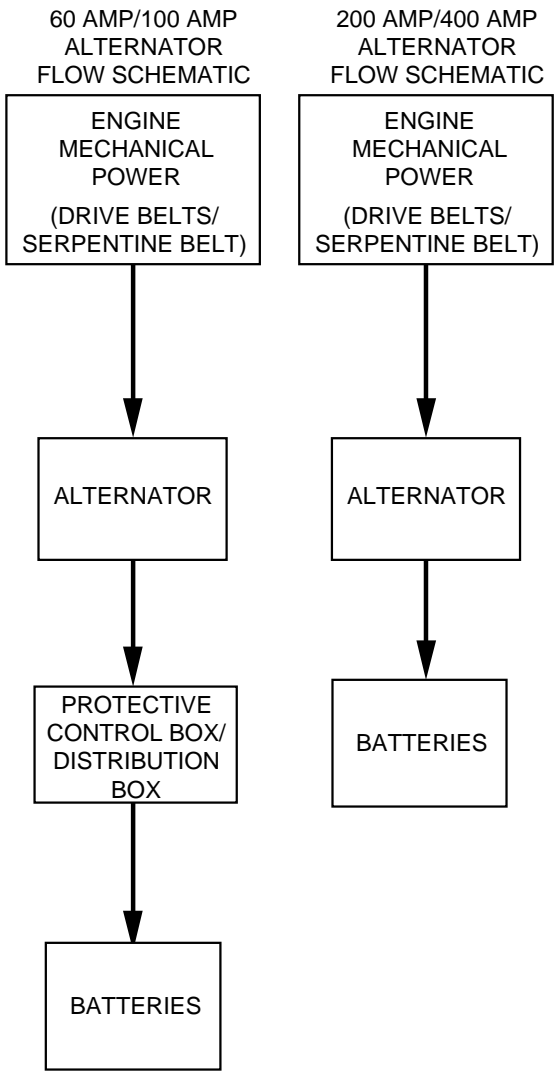
### NOTE

Dual voltage 100, 200, and 400 amp alternators can be installed in a single voltage system. See Table 2-2 for hookup procedures.

After preliminary common tests, the model of alternator must be identified for specific testing to determine if alternator or regulator is defective.

Table 2-2. Adaption of dual voltage alternator on a single voltage system

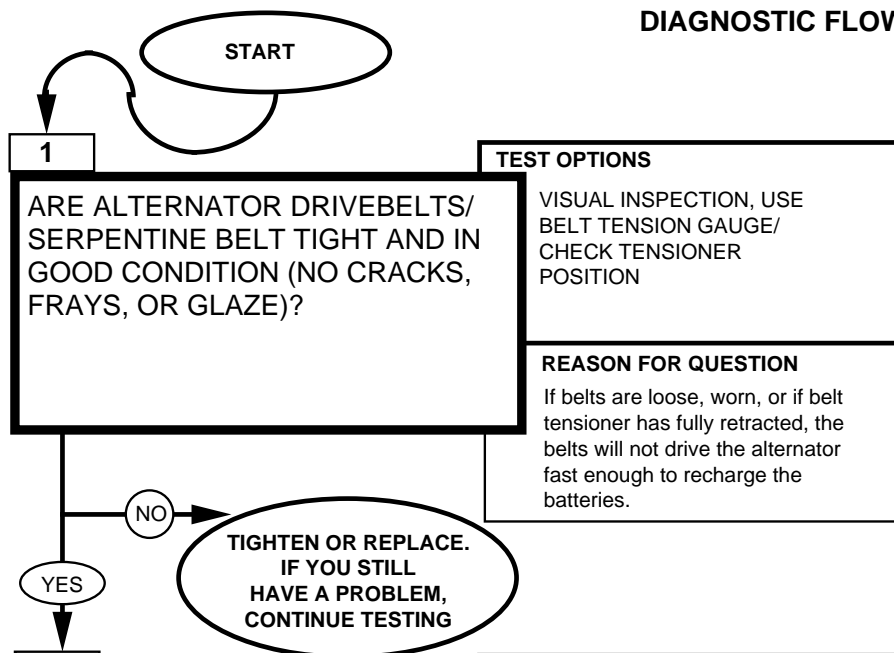
Dual Voltage Alternator	Single Voltage System
100 Amp	Ground wire afixed to regulator base and 14 volt power stud
200 Amp	Ground wire afixed to regulator base and 14 volt power stud
400 Amp	No ground wire afixed to regulator or 14 volt power stud



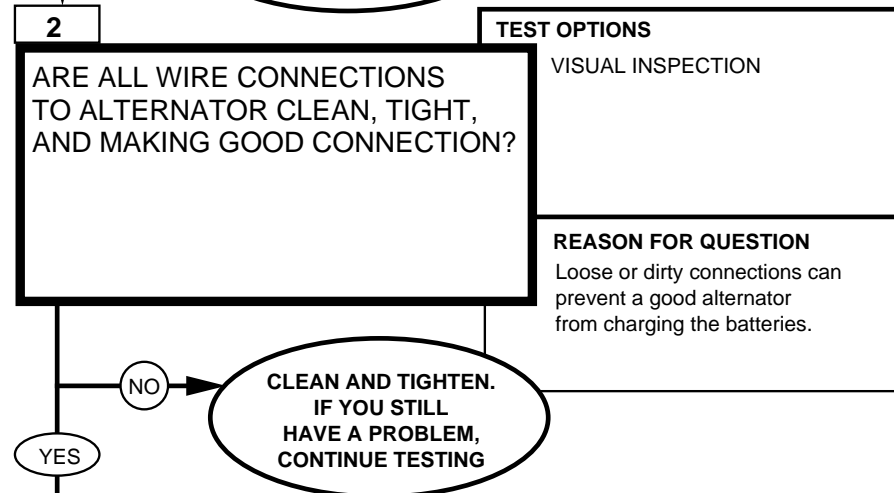
# ALTERNATOR

## DIAGNOSTIC FLOWCHART

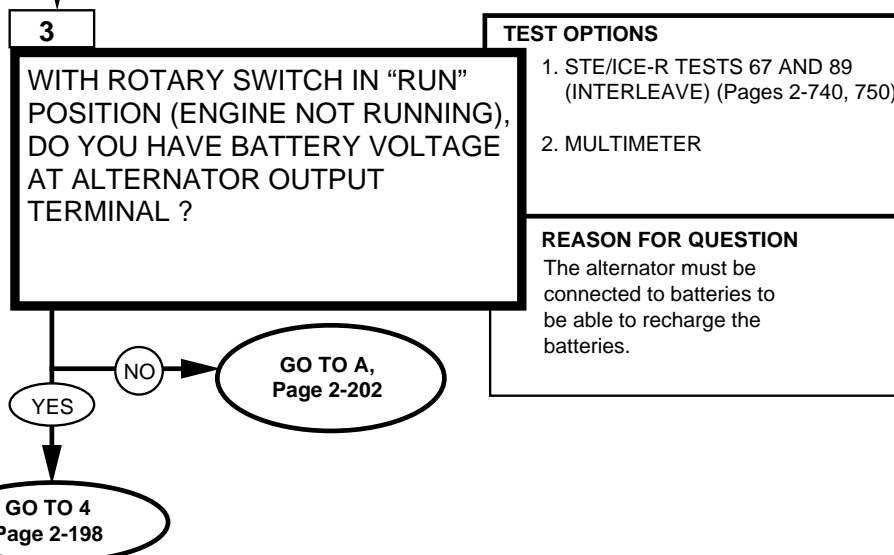
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
ALTERNATOR PROTECTIVE CONTROL BOX/DISTRIBUTION BOX WIRING BELTS



KNOWN INFO
BELTS OK
POSSIBLE PROBLEMS
WIRING ALTERNATOR PCB/DISTRIBUTION BOX



KNOWN INFO
BELTS OK WIRING CONNECTIONS OK
POSSIBLE PROBLEMS
ALTERNATOR PCB/DISTRIBUTION BOX WIRING



## REFERENCE INFORMATION

## NOTE

Cracks, glaze, and frays indicate worn belts, which should be replaced (para. 3-81, all except M1123 and "A2" vehicles) (para. 3-83, M1123 and "A2" vehicles). Use a belt tension gauge to determine if the belts need to be tightened, refer to (para 3-82, all except M1123 and "A2" vehicles).

**BAD CONNECTIONS ARE THE MOST COMMON PROBLEM!**

Sometimes just disconnecting, cleaning, and reconnecting will solve a problem. BE THOROUGH! The time you save may be your own.

Refer to the functional flow schematic and check the following;

1. BATTERY - make sure all connections are clean and tight, including the shunt and power stud.
2. STARTER - check the high current (heavy gauge wire 6A) wire at the starter. Don't just check for voltage; a loose connection will have voltage but can't carry much current.

3. PCB/DISTRIBUTION BOX



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

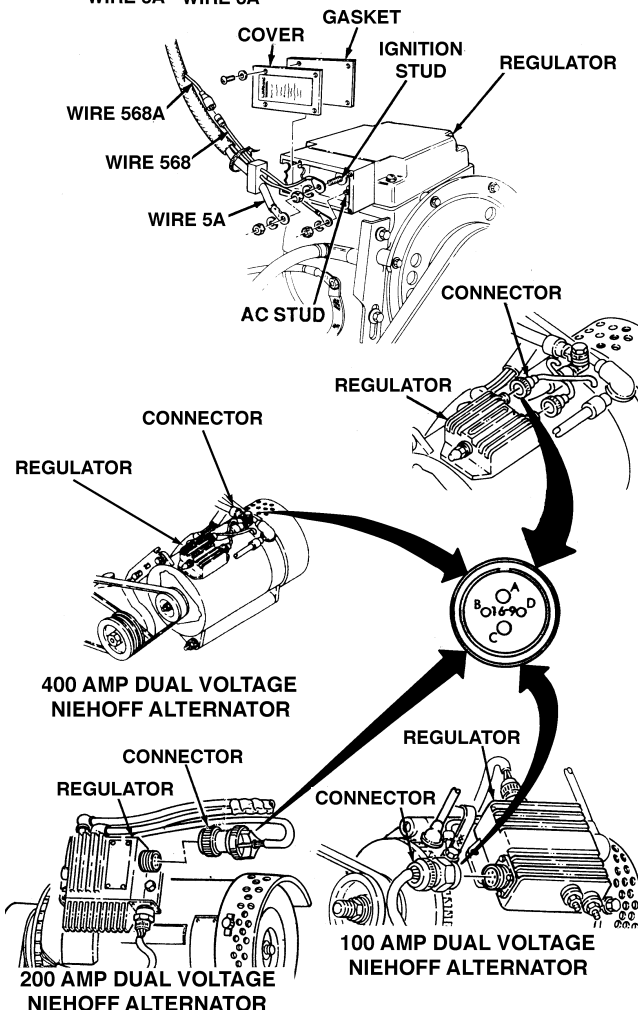
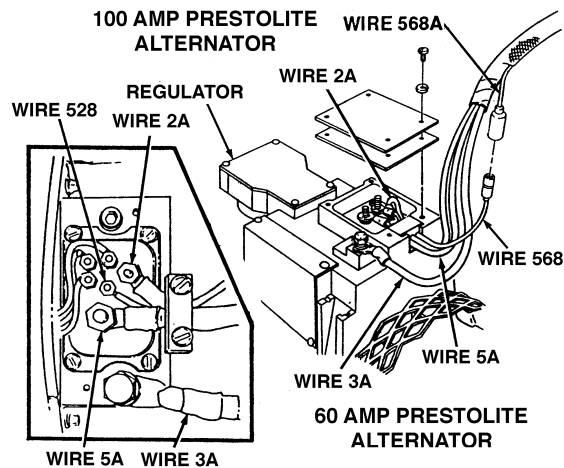
There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Unscrew BOTH connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.

**INTERLEAVE TESTS 67 AND 89  
BATTERY VOLTAGE AND DC VOLTAGE**

USE CONTROL FUNCTION 06 TO INTERLEAVE TESTS ON THE STE/ICE-R. DIAL 06, PRESS THE TEST BUTTON. WHEN PROMPTED BY THE VTM, DIAL IN TEST 67 AND PRESS THE BUTTON. WHEN PROMPTED AGAIN, DIAL IN TEST 89 AND PRESS THE BUTTON. VTM WILL DISPLAY RESULT FOR TEST 67, THEN 89 THEN 6789, AND THEN REPEAT. SEE TM 9-4910-571-12&P FOR MORE INFORMATION.

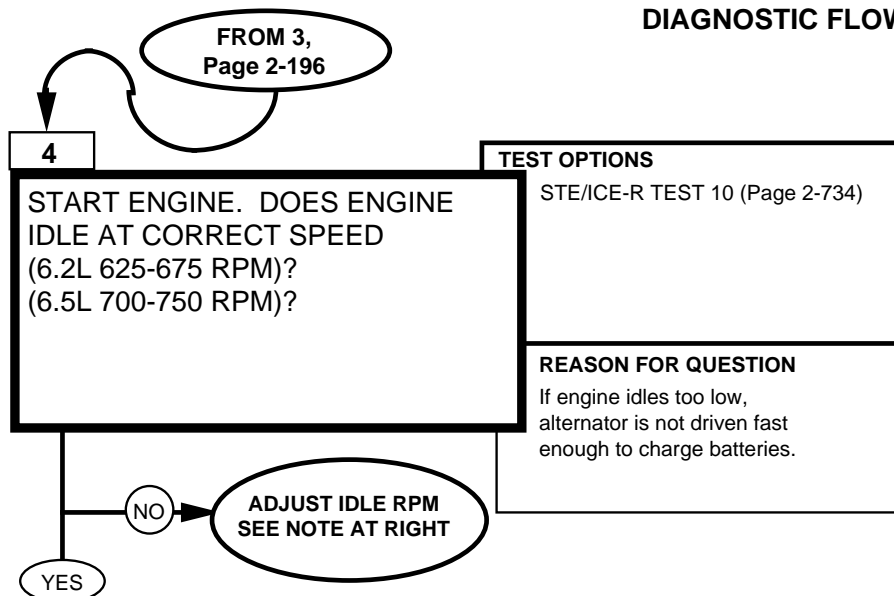
## ALTERNATOR



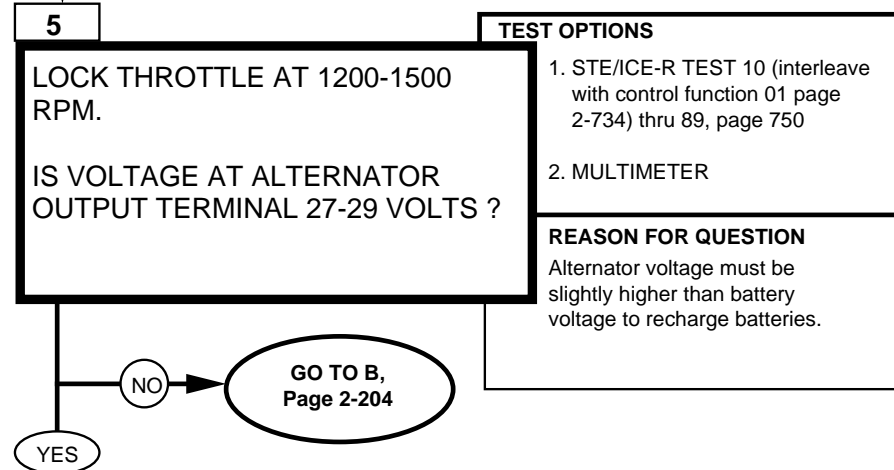
# ALTERNATOR

## DIAGNOSTIC FLOWCHART

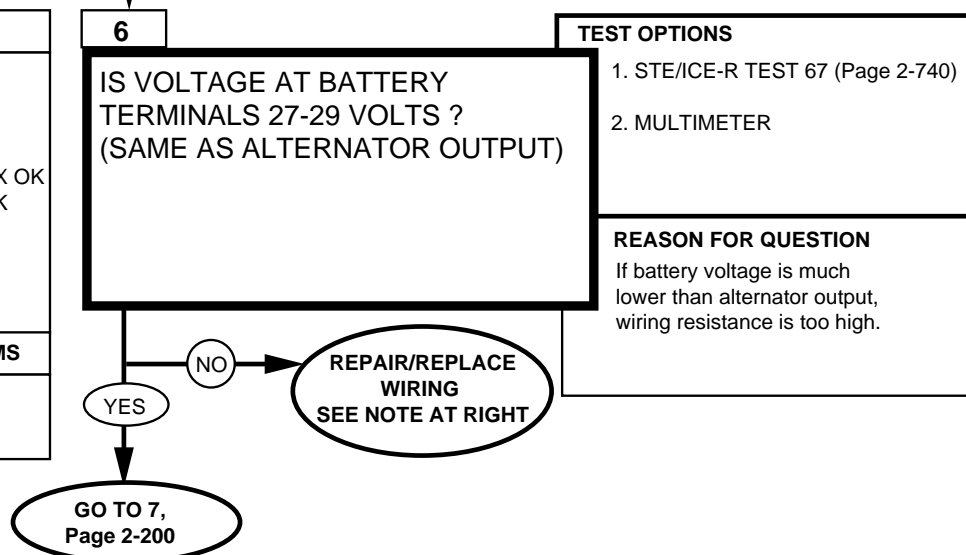
KNOWN INFO
BATTERIES OK BELTS OK ALTERNATOR CONNECTIONS OK PCB/DISTRIBUTION BOX OK
POSSIBLE PROBLEMS
ALTERNATOR ALTERNATOR DRIVE WIRING



KNOWN INFO
BATTERIES OK BELTS OK ALTERNATOR CONNECTIONS OK PCB/DISTRIBUTION BOX OK ALTERNATOR DRIVE OK
POSSIBLE PROBLEMS
ALTERNATOR WIRING



KNOWN INFO
BATTERIES OK BELTS OK ALTERNATOR CONNECTIONS OK PCB/DISTRIBUTION BOX OK ALTERNATOR DRIVE OK ALTERNATOR OUTPUT OK
POSSIBLE PROBLEMS
ALTERNATOR WIRING



REFERENCE INFORMATION

ALTERNATOR

If the engine doesn't start on its own power, you should check the battery and starter circuits.

**NOTE**

A charged battery in good condition is a prerequisite for testing an alternator/regulator system. If battery is suspect, substitute a known good battery in the vehicle.

Output for 60 amp alternator is wire 5A and stud. All other alternators have a large stud on side of housing as output terminal to connect wire 6.

**NOTES**

Check the wiring and the pins at sockets E & F at PCB/distribution box engine connector.

Check the wiring and the pins at sockets D & G at PCB/distribution box body connector.

Check and clean starter solenoid and battery box power stud.

Check and clean battery cables and clamps.

Look for loose, dirty, or broken connections and repair as necessary. If terminal voltage is still low, harness should be replaced. Notify DS maintenance.

**NOTES ON IDLE ADJUSTMENT**

If idle can be adjusted to within limits, go to step 5.

If idle CANNOT be adjusted to within limits, you may have a problem with the fuel system. You can either continue here or run the fuel system tests and return here.

<b>ENGINE RPM STE/ICE-R TEST 10</b>
1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be at least 100. Idle RPM should be 625 - 675.

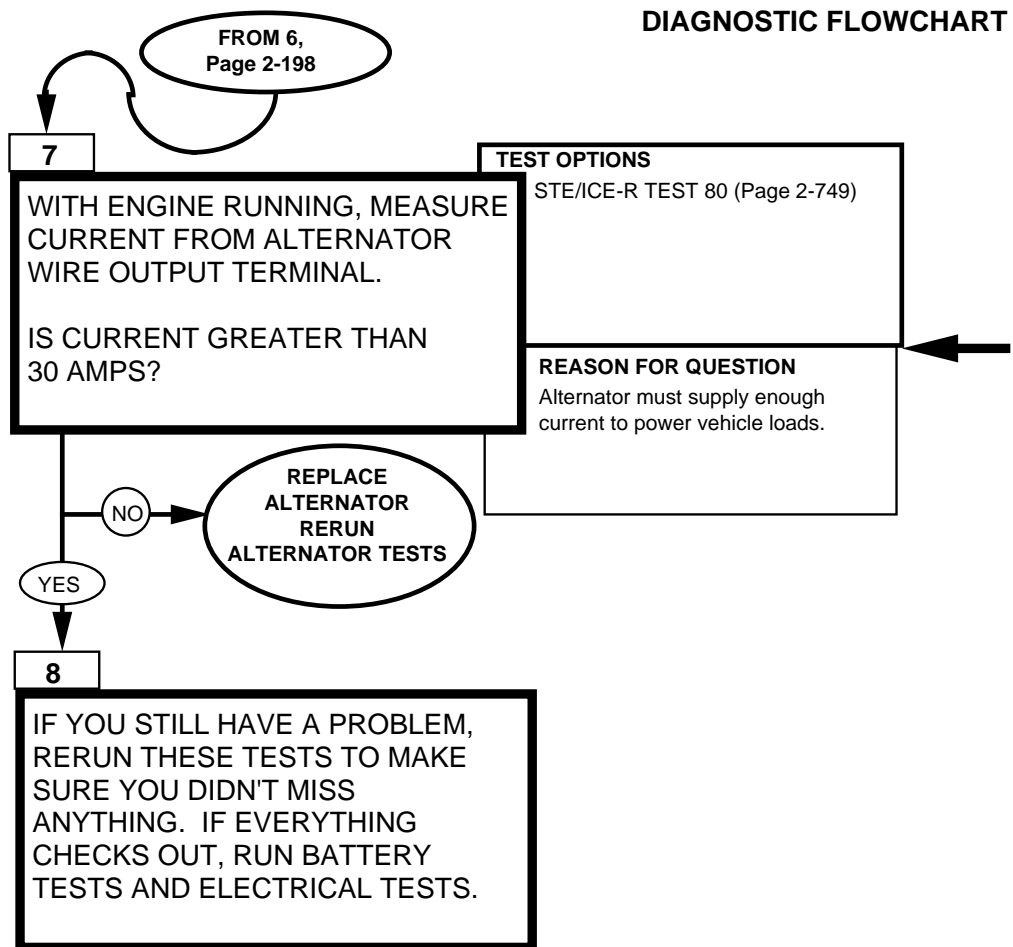
<b>0-45 DC VOLTS STE/ICE-R TEST 89</b>
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

<b>BATTERY VOLTAGE STE/ICE-R TEST 67</b>
1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Battery voltage will drop when glowplugs turn on.

# ALTERNATOR

## DIAGNOSTIC FLOWCHART

KNOWN INFO
BATTERIES OK BELTS OK ALTERNATOR CONNECTIONS OK PROTECTIVE CONTROL BOX/DISTRIBUTION BOX OK ALTERNATOR DRIVE OK ALTERNATOR OUTPUT OK
POSSIBLE PROBLEMS
ALTERNATOR



REFERENCE INFORMATION

ALTERNATOR

NOTE

Wire 5A is output path for 60 amp alternator. All other alternators have large stud on alternator case as output connector for wire 6. Alternator current will go up as you turn on vehicle accessories.

Turn on the lights, wipers, heater, etc. to make sure alternator can supply enough current to power the loads.

To replace 60 and 200 amp alternators, (refer to chapter 4). To replace 100 amp alternator, (refer to chapter 12). To replace 100, 200, and 400 amp dual voltage alternators, (refer to chapter 4).

BATTERY CURRENT  
STE/ICE-R TEST 80

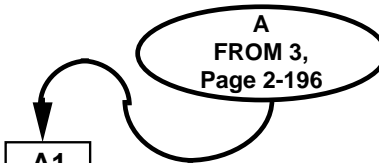
1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART

KNOWN INFO
BATTERY IS NOT CONNECTED TO ALTERNATOR WHEN ROTARY SWITCH IS IN RUN POSITION
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING



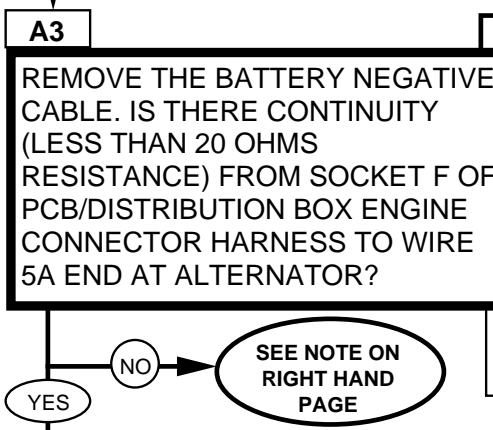
TEST OPTIONS
1. STE/ICE-R TESTS 67, 68 (Pages 2-740 -741)
2. MULTIMETER
REASON FOR QUESTION
The cable connecting the batteries to the alternator goes to the starter first.

KNOWN INFO
BATTERY IS NOT CONNECTED TO ALTERNATOR WHEN ROTARY SWITCH IS IN RUN POSITION, BATTERIES CONNECTED TO STARTER
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING



TEST OPTIONS
1. STE/ICE-R TESTS 67, 89 (Pages 2-740, -750)
2. MULTIMETER
REASON FOR QUESTION
This checks the wire from the starter to the PCB/distribution box engine connector.

KNOWN INFO
BATTERY IS NOT CONNECTED TO ALTERNATOR WHEN ROTARY SWITCH IS IN RUN POSITION, BATTERIES CONNECTED TO STARTER
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING



TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
If the box is connected to the alternator, then the relay in the PCB/distribution box is no good.

## REFERENCE INFORMATION

## ALTERNATOR

**INTERLEAVE TEST 67 AND 68.  
BATTERY VOLTAGE AND DC VOLTAGE**

USE CONTROL FUNCTION 06 TO INTERLEAVE TESTS ON THE STE/ICE-R. DIAL 06, PRESS THE TEST BUTTON. WHEN PROMPTED BY THE VTM, DIAL IN TEST 67 AND PRESS THE BUTTON. WHEN PROMPTED AGAIN, DIAL IN TEST 68 AND PRESS THE BUTTON. VTM WILL DISPLAY RESULT FOR TEST 67, THEN 68 THEN 6768, AND THEN REPEAT. SEE TM 9-4910-571-12&P FOR MORE INFORMATION.

**WARNING**

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX/DISTRIBUTION BOX HARNESS.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

**NOTE**

When checking for voltage or continuity in a harness connector (steps A2 and A3), check the wiring at the connector carefully for broken wires. Check to see that the connector pins are not bent, broken, or pushed out of place. Check that the connections are clean and tight. Use the STE/ICE-R in TK mode for this measurement. DO NOT USE THE DCA. Leave the negative battery cable off for the measurement. If there is an open circuit, the STE/ICE-R will measure close to 500 ohms. If you don't have continuity or voltage, and the wires and connections are all ok, then the harness must have a broken wire. In this case you have to replace the wiring harness. Replace harness, notify DS Maintenance.

Replace PCB, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).

**INTERLEAVE TEST 67 AND 89.  
BATTERY VOLTAGE AND DC VOLTAGE**

USE CONTROL FUNCTION 06 TO INTERLEAVE TESTS ON THE STE/ICE-R. DIAL 06, PRESS THE TEST BUTTON. WHEN PROMPTED BY THE VTM, DIAL IN TEST 67 AND PRESS THE BUTTON. WHEN PROMPTED AGAIN, DIAL IN TEST 89 AND PRESS THE BUTTON. VTM WILL DISPLAY RESULT FOR TEST 67, THEN 89 THEN 6789, AND THEN REPEAT. SEE TM 9-4910-571-12&P FOR MORE INFORMATION.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9".

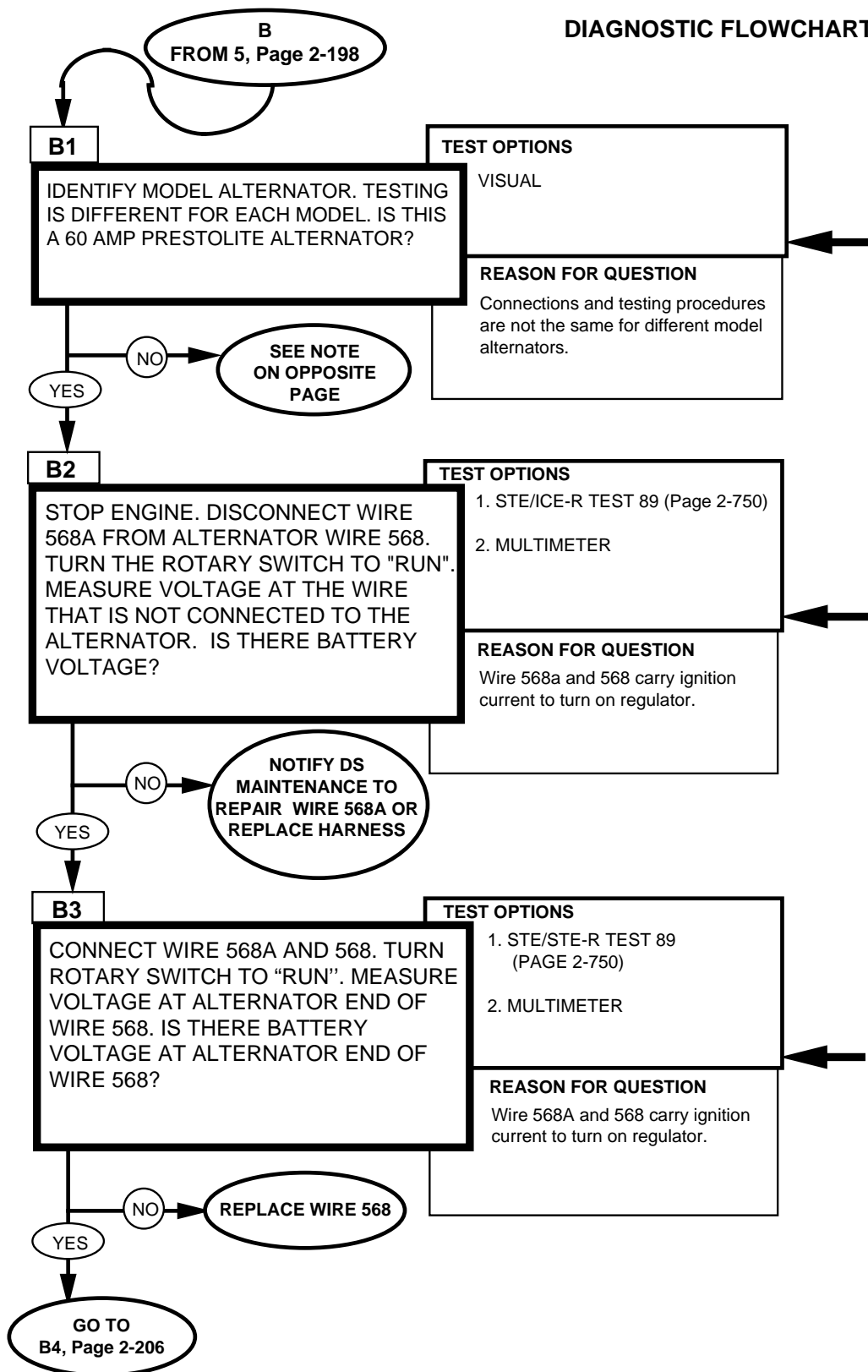
# ALTERNATOR

## DIAGNOSTIC FLOWCHART

KNOWN INFO
ALTERNATOR OUTPUT VOLTAGE IS NOT CORRECT
POSSIBLE PROBLEMS
ALTERNATOR WIRING

KNOWN INFO
ALTERNATOR OUTPUT VOLTAGE IS NOT CORRECT
POSSIBLE PROBLEMS
ALTERNATOR WIRING

KNOWN INFO
ALTERNATOR OUTPUT VOLTAGE IS NOT CORRECT
POSSIBLE PROBLEMS
ALTERNATOR



## REFERENCE INFORMATION

## ALTERNATOR

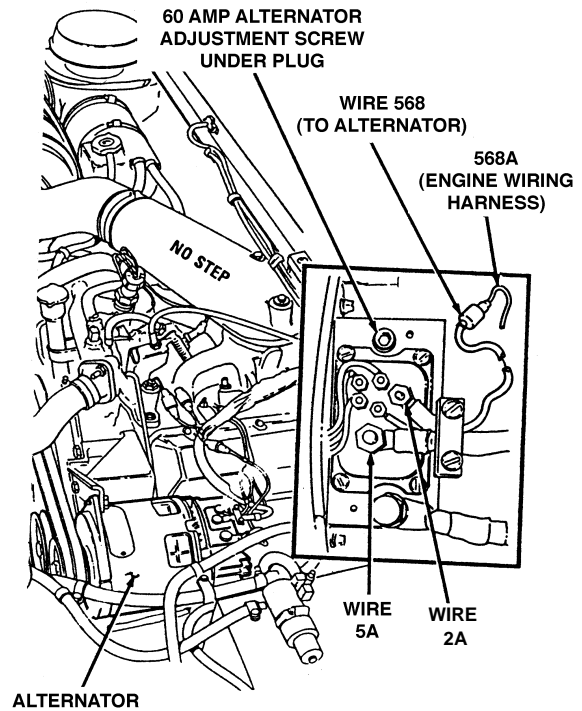
### NOTE

For 60 amp Prestolite alternator, continue B.  
 For 100 amp Prestolite alternator, go to C, page 2-208.  
 For 200 amp Prestolite alternator, go to D, page 2-212.  
 For 200 amp single voltage Niehoff alternator, go to E, page 2-218.  
 For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
 For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.  
 For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.  
 For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

### NOTE

Voltage on wire 568 signals regulator to turn on. Without voltage, regulator can't operate. Wire 568A is connected with wire 5A inside engine wire harness. If there is no loose end on wire 568A, wire harness repair is required. Notify DS Maintenance.

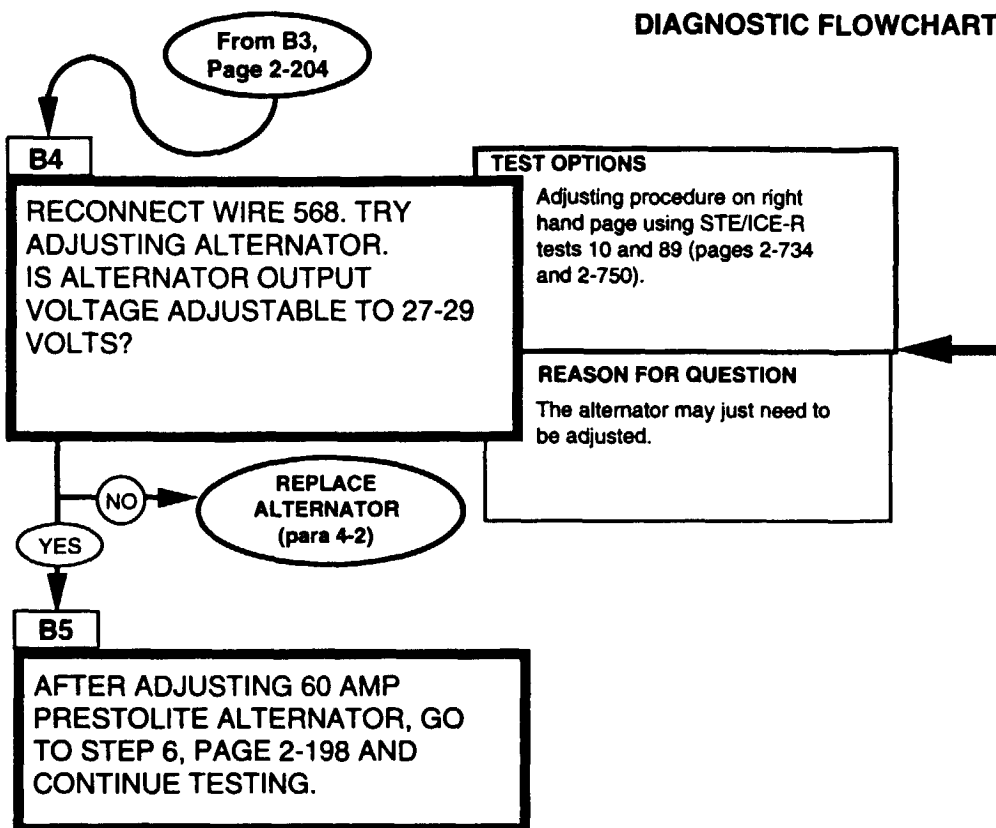
0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART

KNOWN INFO
ALTERNATOR OUTPUT NOT CORRECT FIELD VOLTAGE OK
POSSIBLE PROBLEMS
ALTERNATOR



REFERENCE INFORMATION

ALTERNATOR

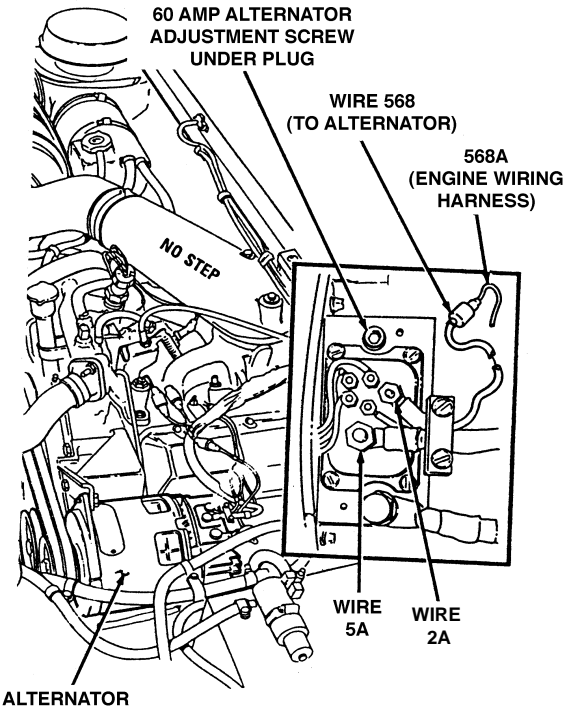
1. Turn engine off.
2. Remove protective cover from alternator wiring.
3. Remove the potting material.
4. Remove hex head plug to expose adjustment screw.
5. Start engine and lock throttle at 1200-1500 RPM by using STE/ICE-R test 10.
6. Connect the Red test lead to wire 5A and the Black lead to engine ground.
7. Monitor alternator output voltage with STE/ICE-R test 89.
8. Use a cross tip screwdriver to adjust the alternator output voltage  $28.0 \pm 0.5$  Volts.
9. Unlock throttle, replace hex head plug, repot the area with silicon caulk, and replace the protective cover.

<b>ENGINE RPM</b> <b>STE/ICE-R TEST 10</b>
1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100. Idle RPM should be 625-675.

<b>0-45 DC VOLTS</b> <b>STE/ICE-R TEST 89</b>
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

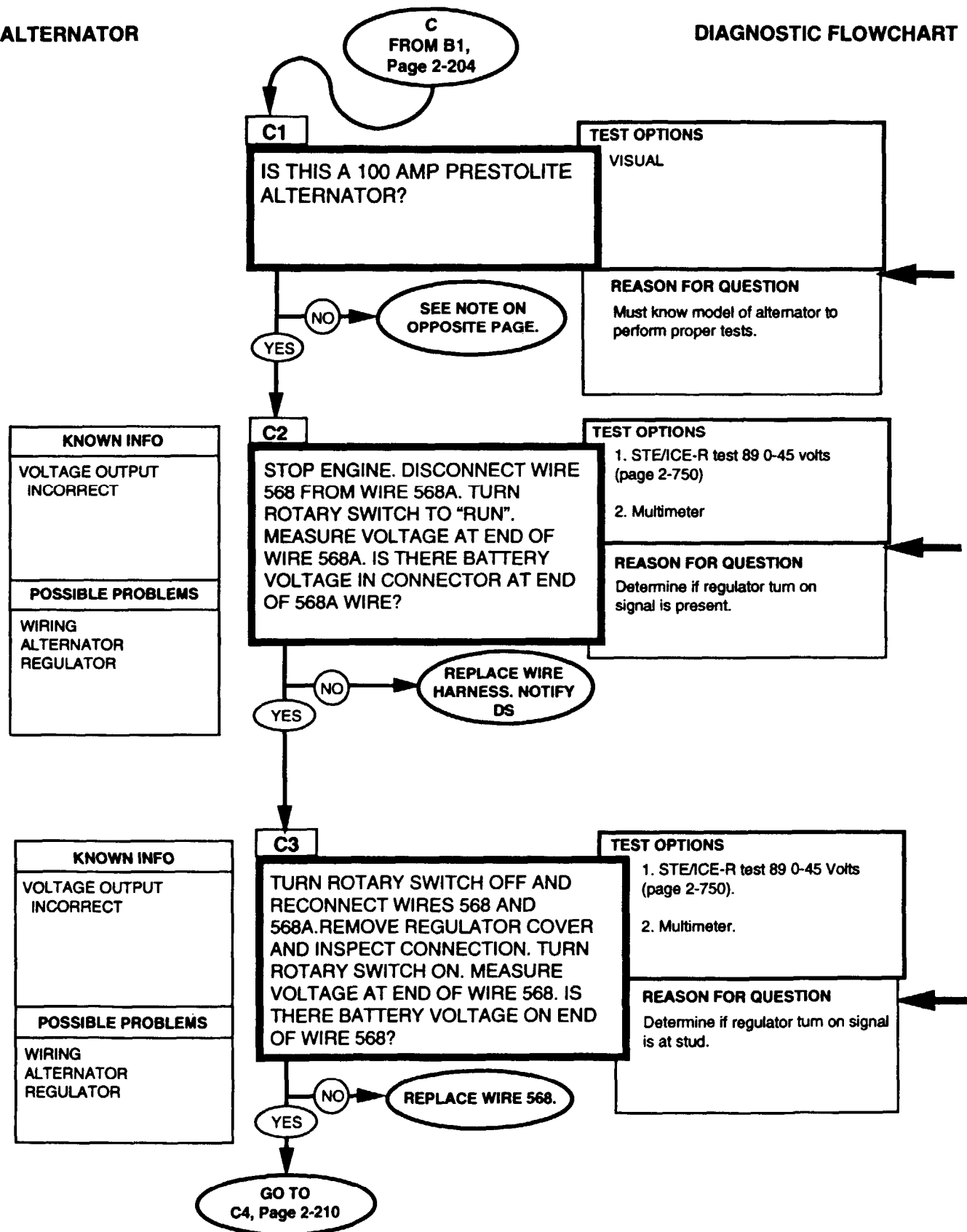
NOTE

Regulator cannot be tested independently from alternator on 60 amp alternator system.



## ALTERNATOR

## DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

ALTERNATOR

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.  
For 100 amp Prestolite alternator, continue C.  
For 200 amp Prestolite alternator, go to D, page 2-212.  
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.  
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.  
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.  
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

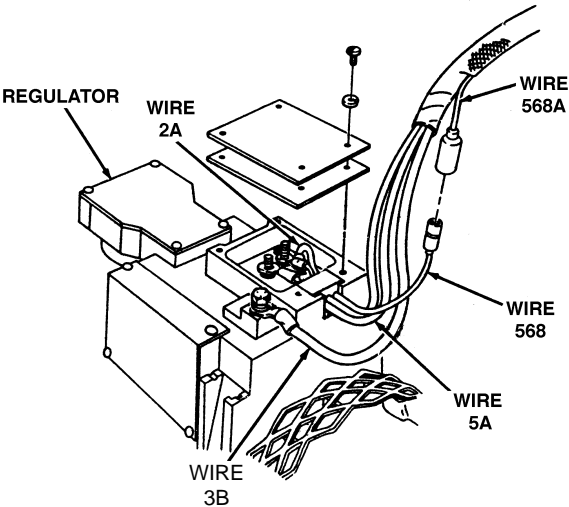
NOTE

Voltage on wire 568 signals regulator to turn on. Without voltage, regulator can't operate. Wire 568A is connected with wire 5A inside engine wire harness. If there is no loose end on wire 568A, wire harness repair is required. Notify DS Maintenance.

0-45 DC VOLTS  
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

NEWER MODEL REGULATOR



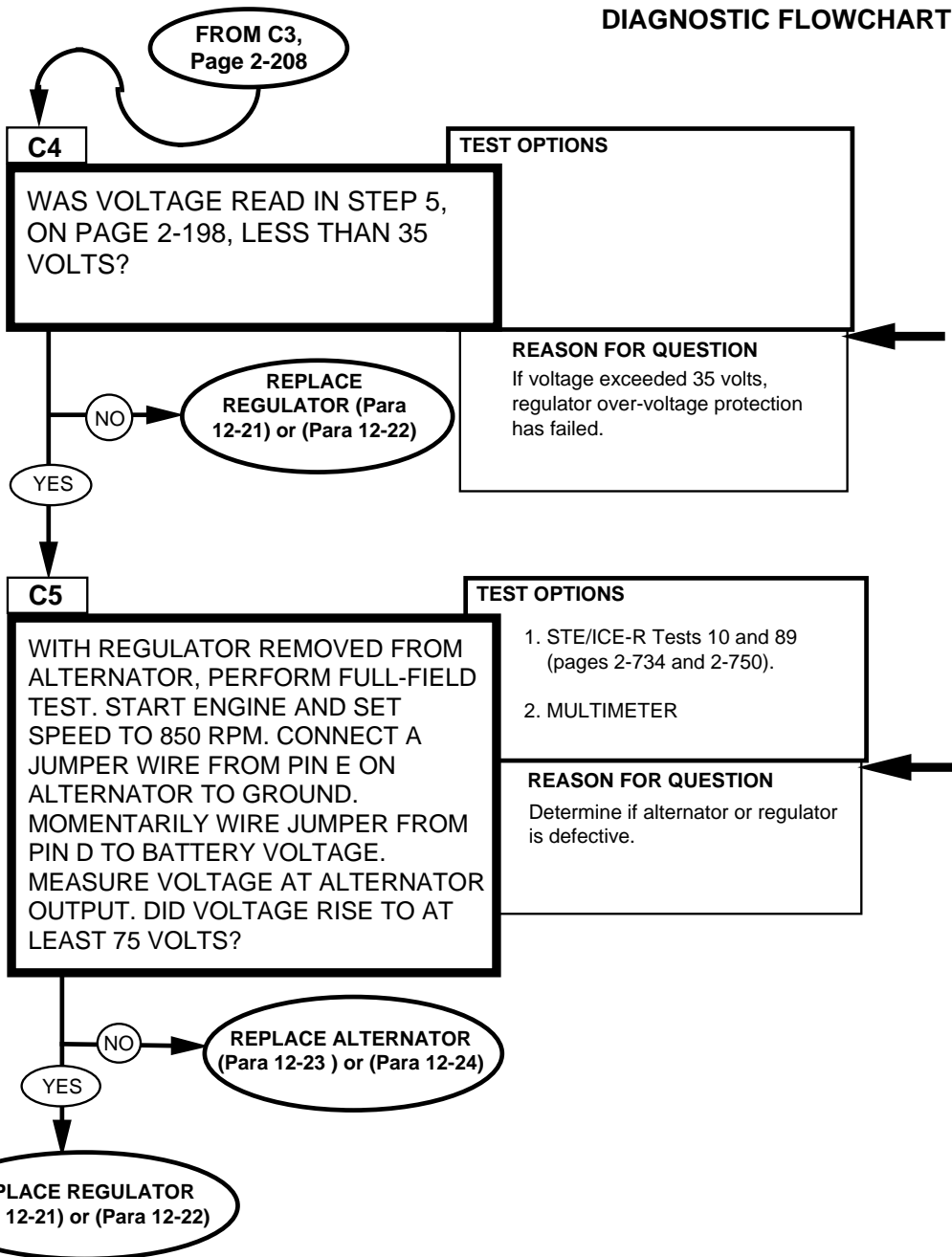


# ALTERNATOR

# DIAGNOSTIC FLOWCHART

KNOWN INFO
VOLTAGE OUTPUT INCORRECT
WIRING OR IGNITION OK
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR

KNOWN INFO
VOLTAGE OUTPUT INCORRECT
WIRING OR IGNITION OK
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR



## REFERENCE INFORMATION

### CAUTION

Ensure all electrical loads are disconnected or turned off. Higher voltage could damage components in other devices.

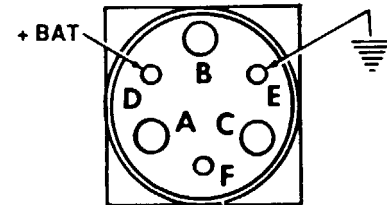
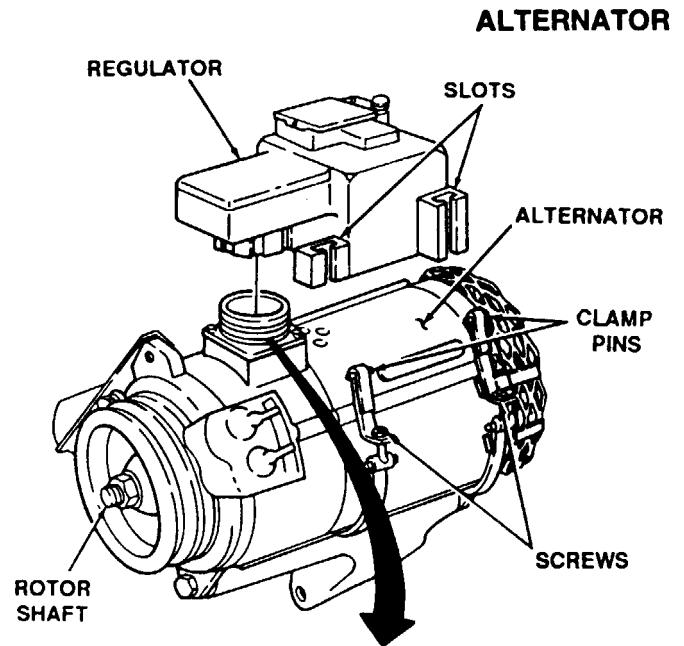
1. Disconnect battery ground cable.
2. Loosen screws.
3. Remove clamp pins from slots.
4. Loosen connector nut.
5. Remove regulator from alternator. Secure regulator out of the way.
6. Connect battery ground cable.

### NOTE

Jumper wires must be able to handle 15 amp current (14 gauge or larger diameter).

### NOTE

Multimeter set to read over 75 vdc.



### ENGINE RPM STE/ICE-R TEST 10

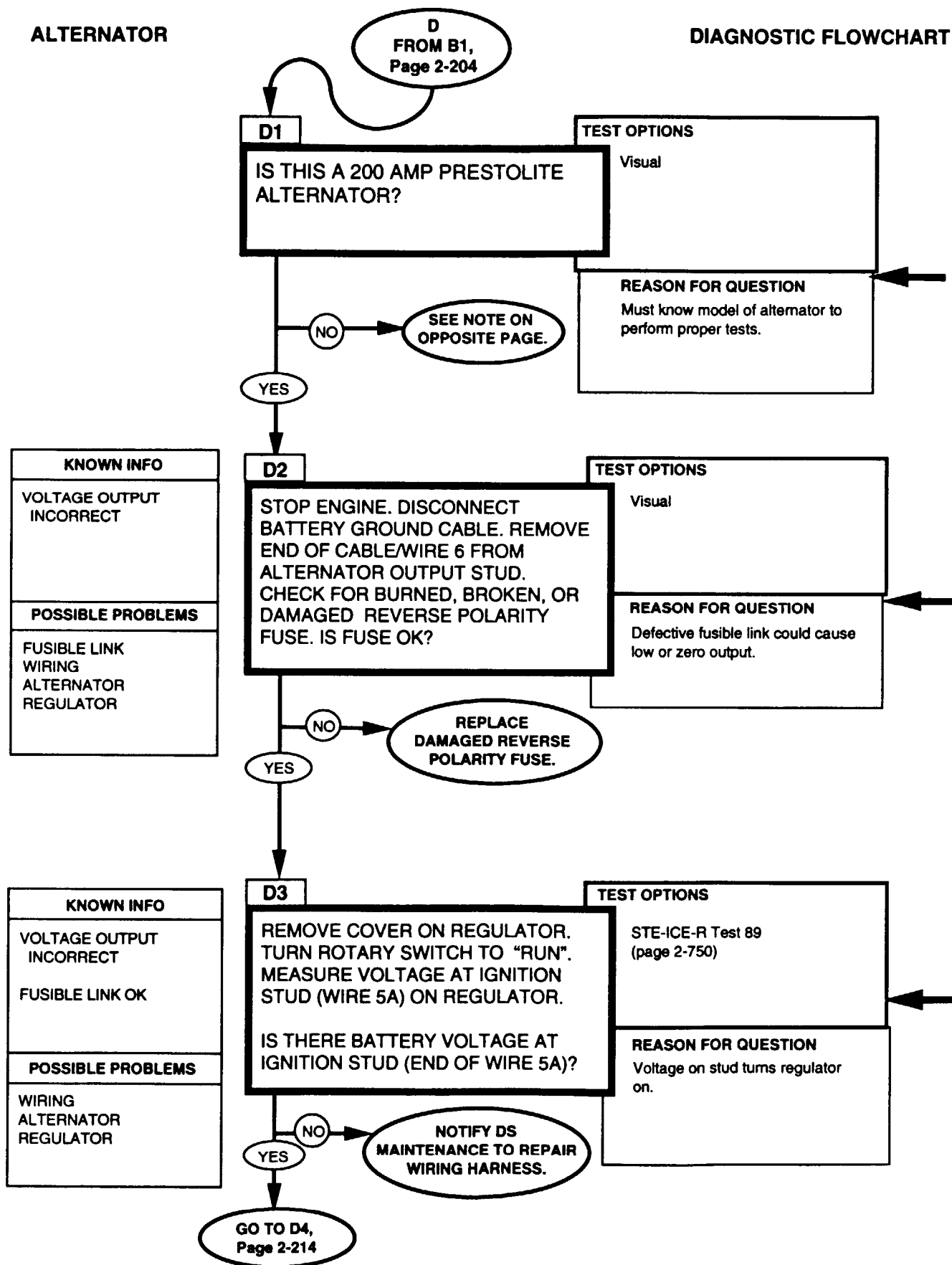
1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 100. Set idle speed to 850 RPM.

### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

# ALTERNATOR

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.  
 For 100 amp Prestolite alternator, go to C, page 2-208.  
 For 200 amp Prestolite alternator, continue D.  
 For 200 amp single voltage Niehoff alternator, go to E, page 2-218.  
 For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
 For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.  
 For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.  
 For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

**Replacement of Reverse Polarity Fuse**

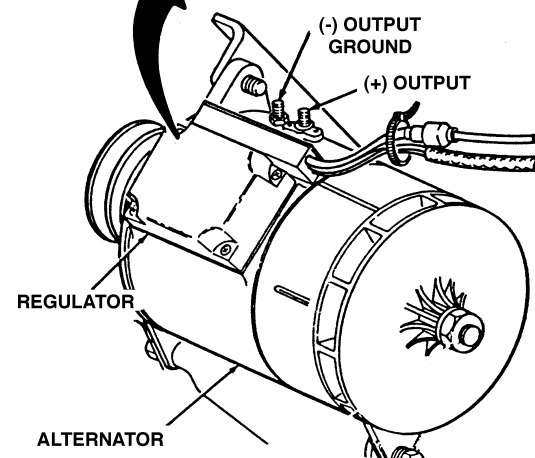
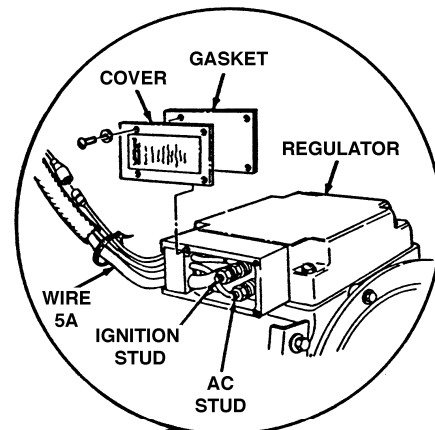
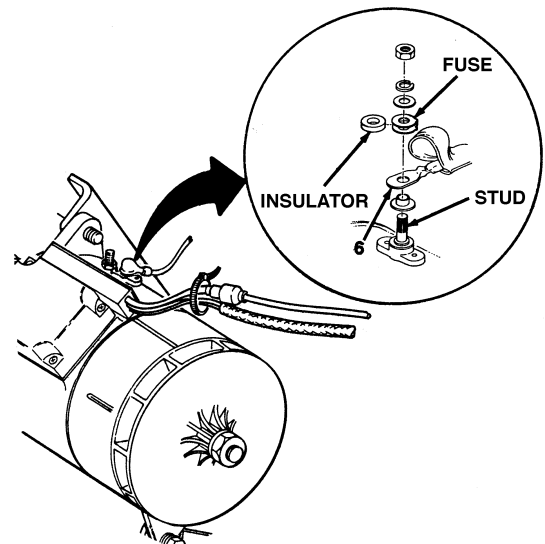
1. Remove nut, lockwasher, washer, fuse, insulator and cable 6 from output stud.
2. Examine fuse for burns and breaks. Replace fuse and insulator if damaged.
3. Install new fuse and insulator on output stud with washer, lockwasher, and nut. Tighten nut 10-15 lb-in. (14-20 N•m).

1. Disconnect battery ground cable.
2. Remove four screws, lockwashers, gasket, and cover from regulator.
3. Remove potting material as necessary to gain access to studs.

**0-45 DC VOLTS  
 STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## ALTERNATOR



# ALTERNATOR

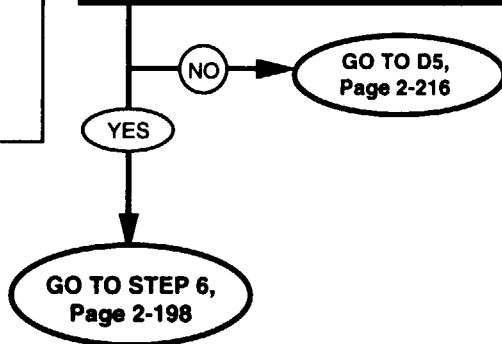
# DIAGNOSTIC FLOWCHART

KNOWN INFO
VOLTAGE OUTPUT INCORRECT FUSIBLE LINK OK
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR TEMPERATURE COMPENSATION ERROR



CHECK IF ALTERNATOR HAS BEEN ADJUSTED FOR TEMPERATURE EXTREMES (ARCTIC OR DESERT). IF SO, RESET REGULATOR FOR 28 VOLT OUTPUT. START ENGINE AND CHECK OUTPUT VOLTAGE AT 850 RPM. IS OUTPUT VOLTAGE 27-29 VOLTS?

TEST OPTIONS
STE/ICE-R Tests 10 and 89 (pages 2-734 and 2-750).
REASON FOR QUESTION
Regulator may have wrong temperature compensation setting.



## REFERENCE INFORMATION

## ALTERNATOR

## TEMPERATURE-ENVIRONMENT ADJUSTMENT

1. Disconnect battery ground cable.
2. Remove four screws securing regulator to alternator.
3. Position regulator to allow access to the buss bar link. The buss bar link and voltage setting terminals are located under sealant. It may be necessary to scrape away some of the sealant to access the buss bar link and terminals.
4. To adjust the voltage setting to 27.2 volts (for hot or desert condition), loosen screw E0 and remove screws E1 and E2. Rotate bus bar link to E2. Reinstall screws E1 and E2 and tighten screw E0.
5. Apply RTV sealant to fully cover buss bar link and voltage setting terminals.
6. Install regulator to alternator with four screws.
7. Connect battery ground cable.
8. Check output voltage, it should read 27.2 volts.

## NOTE

To reset alternator output voltage to 28 volts, the buss bar link should be connected between E0 and E1. The terminal connection E0 and E3 provides an output voltage of 28.8 volts (for arctic conditions). When operation in hot weather or arctic conditions cease, the alternator output voltage should be reset to its normal 28.0 volt setting.

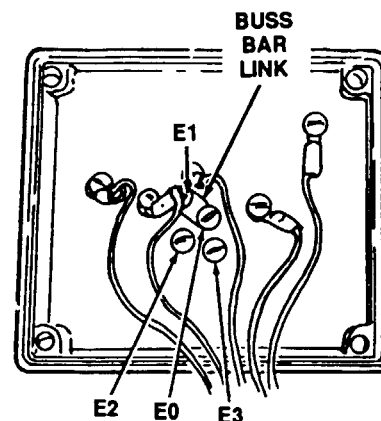
9. Mark the output voltage setting on the alternator and annotate the information in the vehicle log book for future reference.

## NOTE

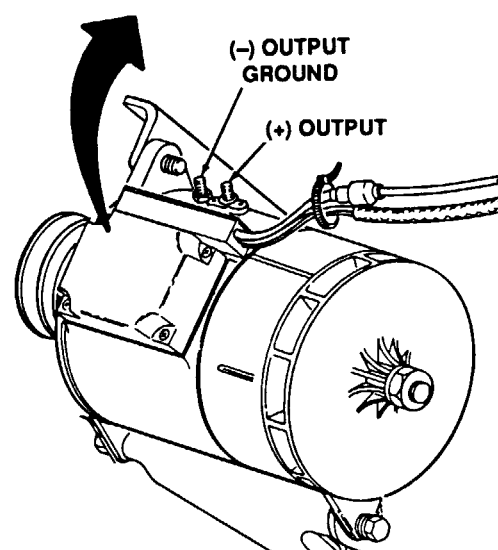
This procedure resets the alternator output approximately 0.8 volts on either side of 28 volts, but will not correct for larger errors.

## NOTE

If an overcharge condition exists, wiring to regulator is satisfactory.



BOTTOM OF REGULATOR

200 AMP  
PRESTOLITE ALTERNATORENGINE RPM  
STE/ICE-R TEST 10

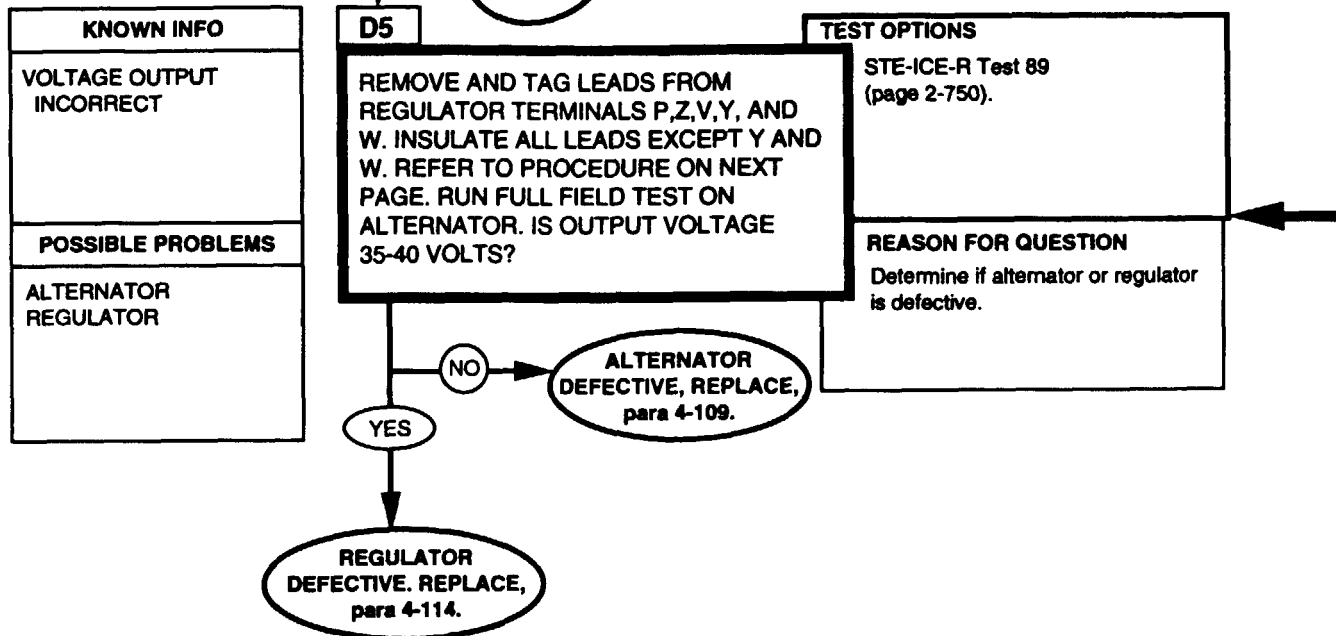
1. Start test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 850.

0-45 DC VOLTS  
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

# ALTERNATOR

## DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

ALTERNATOR

FULL FIELD TEST

- 1. Disconnect battery ground cable.

NOTE

Tag leads before removal.

- 2. Remove five screws, lockwashers, and leads from bottom of regulator.
- 3. Insulate leads from V,P, and Z terminals.
- 4. Connect 6 volt lantern battery NSN 6135-00-643-1310, (or equivalent that can supply 1.0 amp current at 6 volts) with (+) battery and lead connector to W lead and (-) battery and lead connector to Y lead. Insulate all connections.
- 5. Monitor voltage across alternator output studs. Meter must be capable of reading 50 volts.

CAUTION

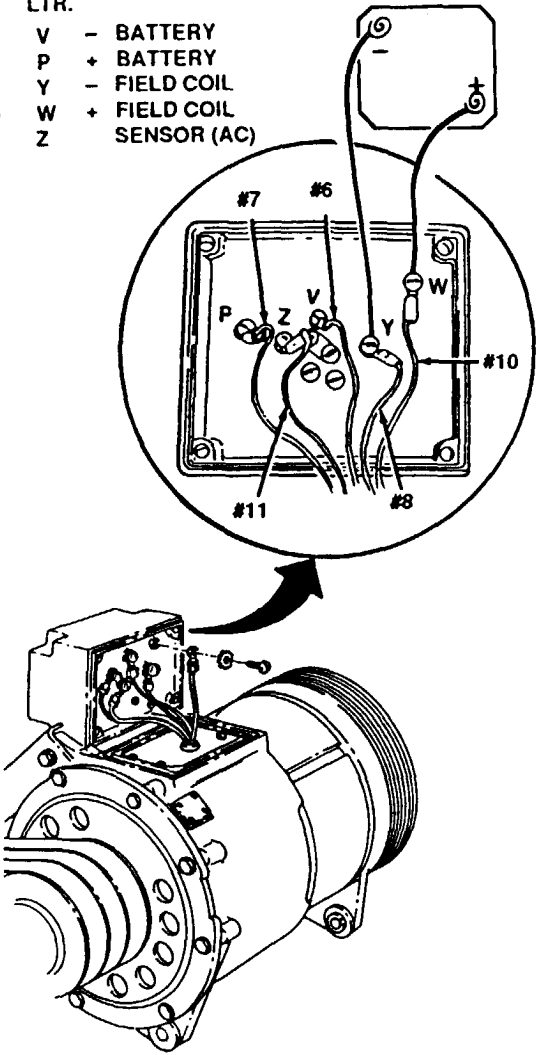
Ensure all vehicle and on board equipment are turned off. Higher voltages could damage components.

- 6. Connect battery ground cable.
- 7. Start vehicle and run engine to 900 rpm. Run only long enough to obtain a stable output voltage reading.
- 8. Stop engine, remove 6 volt battery and leads.

NOTE

If installing alternator, reconnect regulator (para 4-114).

WIRE NO.	TERM. LTR.	FUNCTION
#6 to	V	- BATTERY
#7 to	P	+ BATTERY
#8 to	Y	- FIELD COIL
#10 to	W	+ FIELD COIL
#11 to	Z	SENSOR (AC)



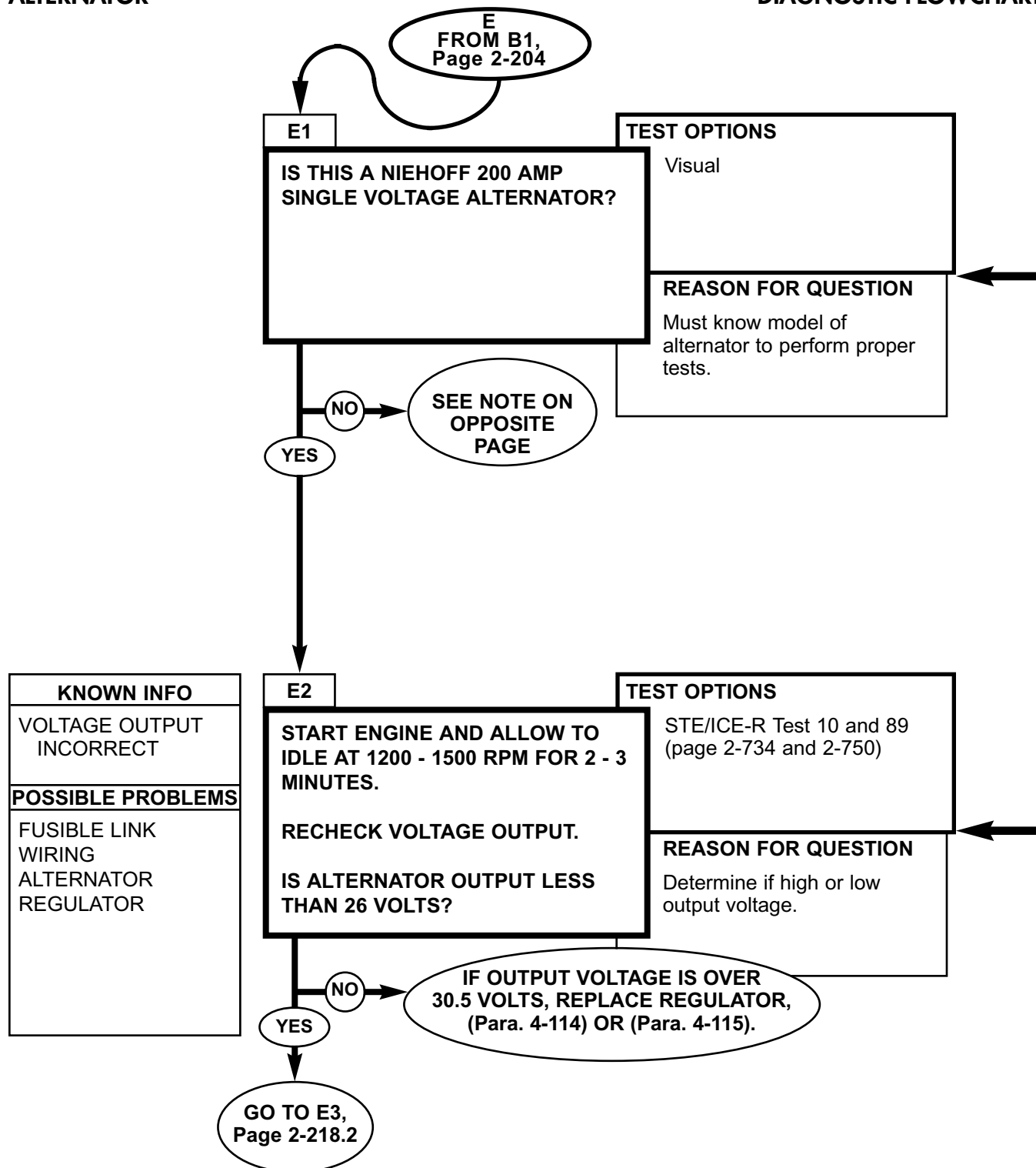
0-45 DC VOLTS  
STE/ICE-R TEST 89

- 1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
- 2. Start Test 89, DC volts.
- 3. Displayed reading is in volts.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ALTERNATOR

### NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.  
 For 100 amp Prestolite alternator, go to C, page 2-208.  
 For 200 amp Prestolite alternator, go to D, page 2-212.  
 For 200 amp single voltage Niehoff alternator, continue with E.  
 For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
 For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.  
 For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.  
 For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

### NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.  
 Output voltage of 26 - 30.5 is acceptable for this alternator.

#### ENGINE RPM STE/ICE-R TEST 10

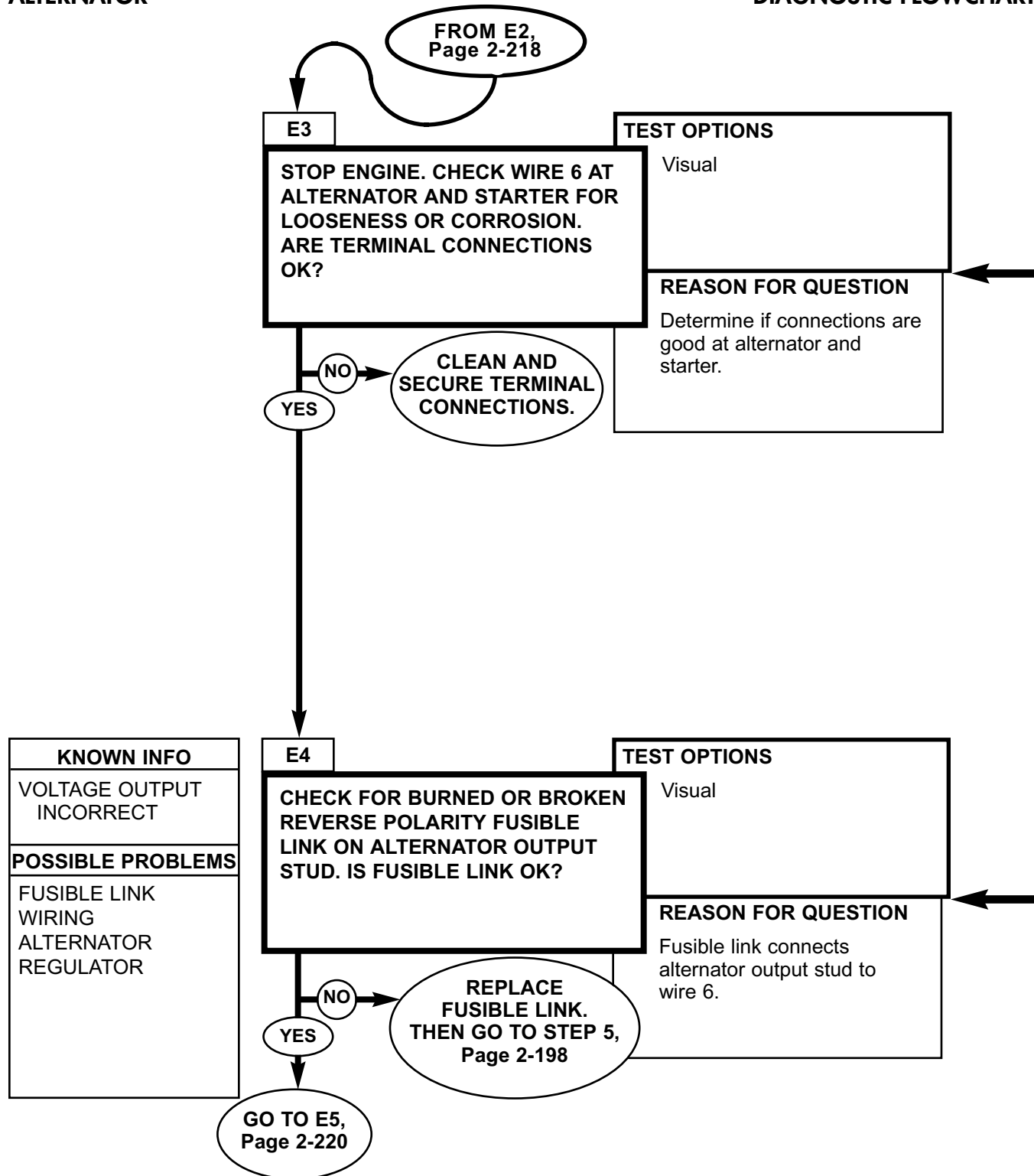
1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200 - 1500.

#### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

# ALTERNATOR

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

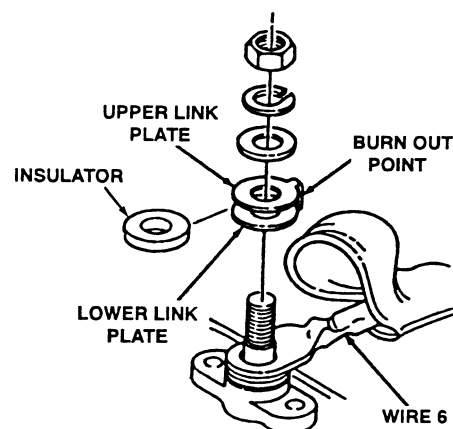
## ALTERNATOR

**NOTE**

Wire 6 connects alternator output stud to starter terminal. A poor connection at these points will cause a low or no alternator output condition.

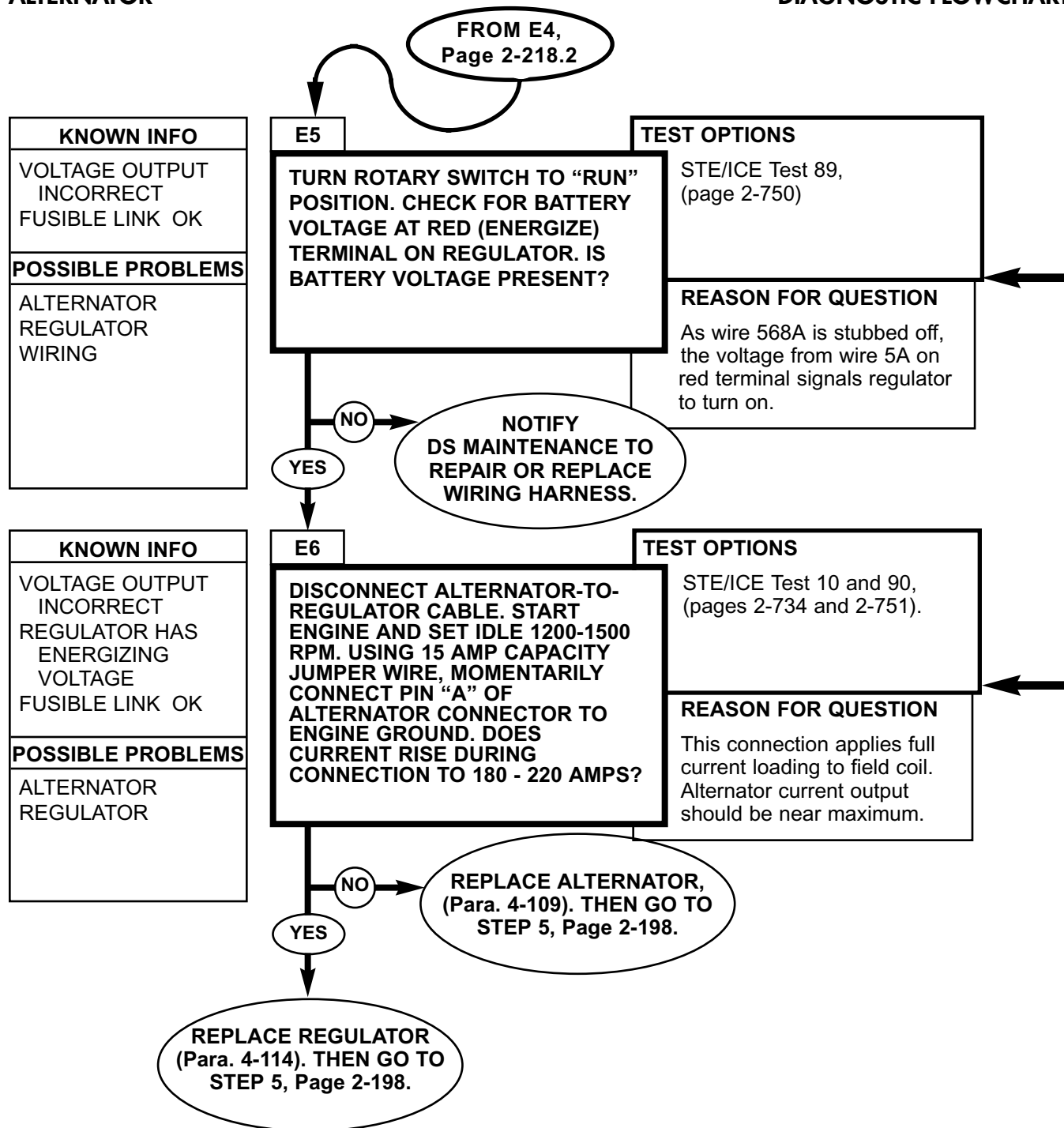
**FUSIBLE LINK REPLACEMENT**

1. Disconnect battery ground cable.
2. Remove boot from alternator output terminal.
3. Remove nut, lockwasher, washers, and fusible link from terminal.
4. Inspect fusible link.
5. Replace fusible link if damaged or appears burned.
6. Connect battery ground cable.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ALTERNATOR

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

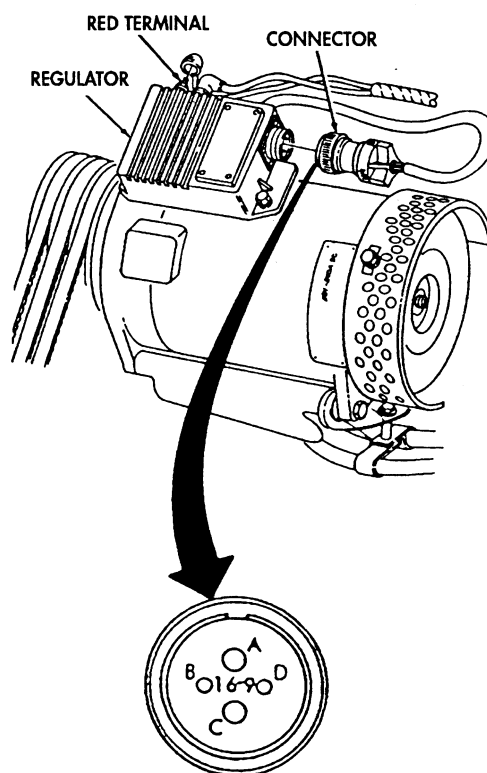
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.

**ENGINE RPM  
STE/ICE-R TEST 10**

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Set engine to fast idle of 1200 - 1500 RPM.

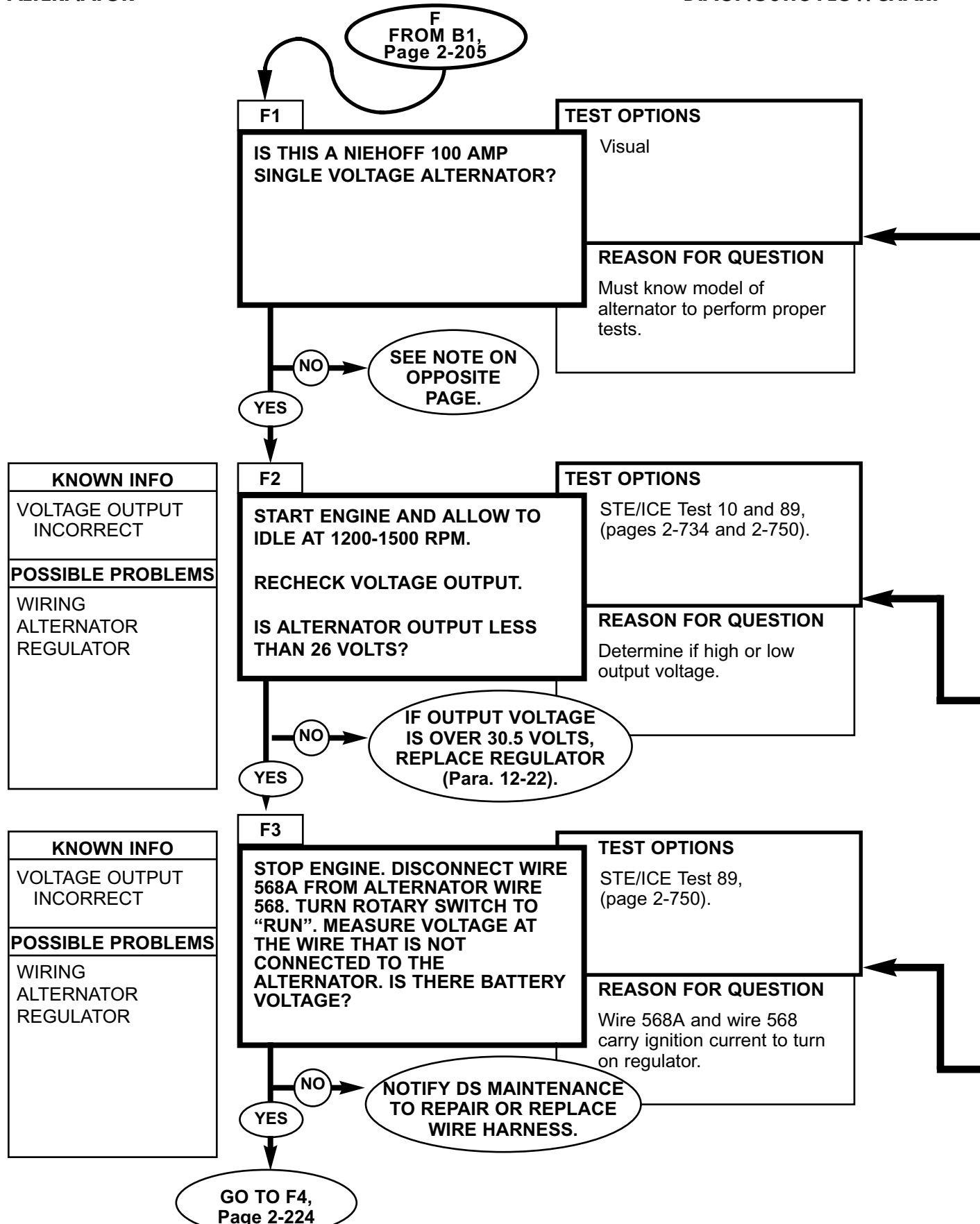
**0-1500 AMPS DC  
STE/ICE-R TEST 90**

1. Connect probe.
2. Start Test 90, DC amps.
3. Displayed reading is in amps.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ALTERNATOR

**NOTE**

For 60 amp Prestolite alternator, go to B, page 2-204.

For 100 amp Prestolite alternator, go to C, page 2-208.

For 200 amp Prestolite alternator, go to D, page 2-212.

For 200 amp single voltage Niehoff alternator, continue with E.

For 100 amp single voltage Niehoff alternator, continue with F.

For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.

For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.

For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

**NOTE**

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 25-30.5 is acceptable for this alternator.

ENGINE RPM STE/ICE-R TEST 10
<ol style="list-style-type: none"> <li>1. Start Test 10, Engine RPM.</li> <li>2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200 - 1500.</li> </ol>



0-45 DC VOLTS STE/ICE-R TEST 89
<ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC Volts.</li> <li>3. Displayed reading is in volts.</li> </ol>

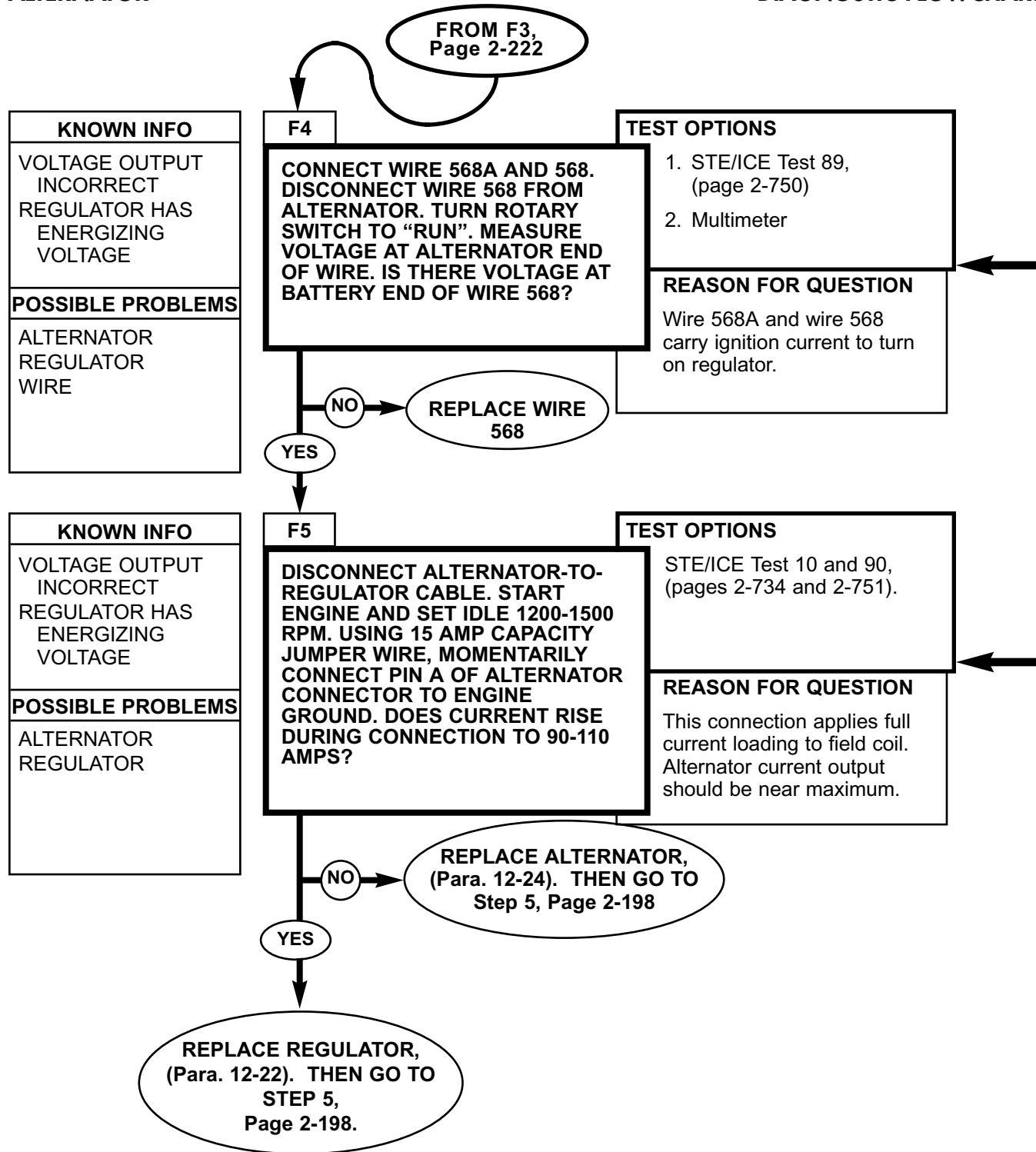
**NOTE**

Voltage on wire 568 signals regulator to turn on. Without voltage, regulator can't operate. Wire 568A is connected with wire 5A inside engine wire harness. If there is no loose end on wire 568A, wire harness repair is required.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## ALTERNATOR

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

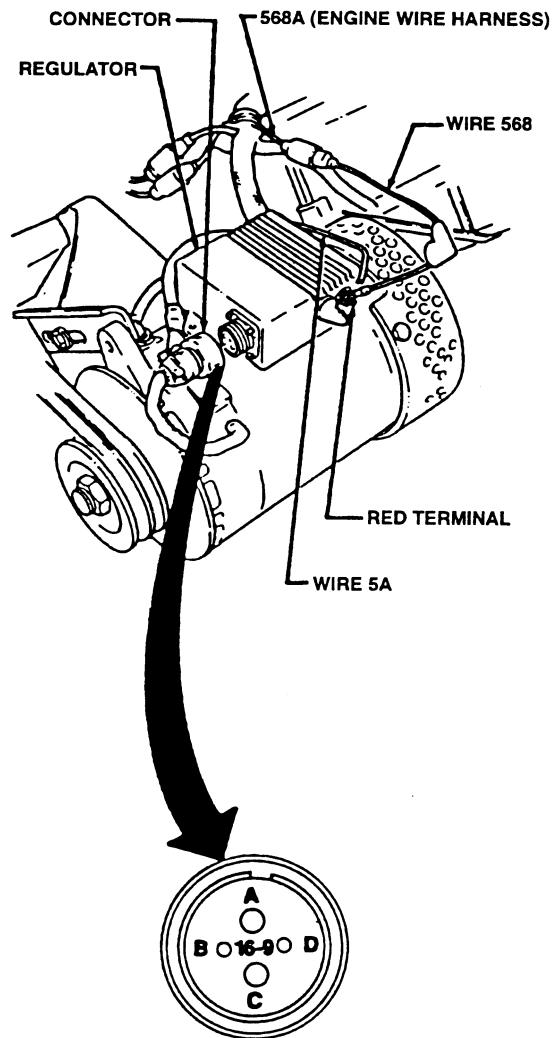
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.

**ENGINE RPM  
STE/ICE-R TEST 10**

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Set engine to fast idle of 1200 - 1500 RPM.

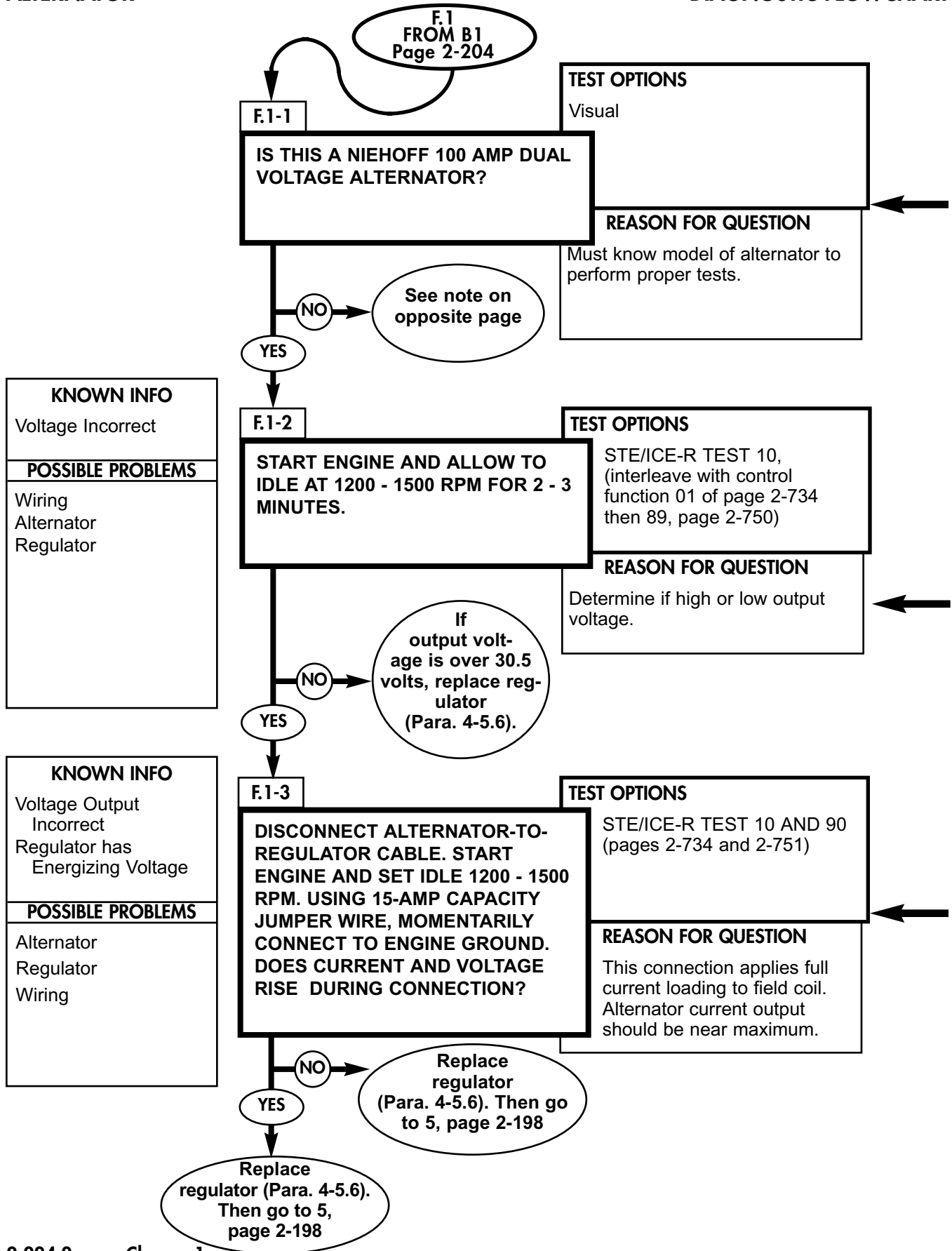
**0-1500 AMPS DC  
STE/ICE-R TEST 90**

1. Connect probe.
2. Start Test 90, DC amps.
3. Displayed reading is in amps.



# ALTERNATOR

## DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.  
For 100 amp Prestolite alternator, go to C, page 2-208.  
For 200 amp Prestolite alternator, go to D, page 2-212.  
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.  
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
For 100 amp dual voltage Niehoff alternator, continue with F.1.  
For 200 amp dual voltage Niehoff alternator, go to G, page 2-224.6.  
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

NOTE

The regulator for this alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ALTERNATOR

ENGINE RPM  
STE/ICE-R TEST 10

1. Start test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

0-1,500 AMPS DC  
STE/ICE-R TEST 90

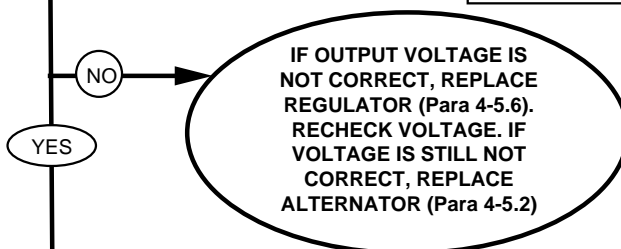
1. Connect probe.
2. Start Test 90, DC amps.
3. Displayed reading is in amps.

## ALTERNATOR

## DIAGNOSTIC FLOWCHART

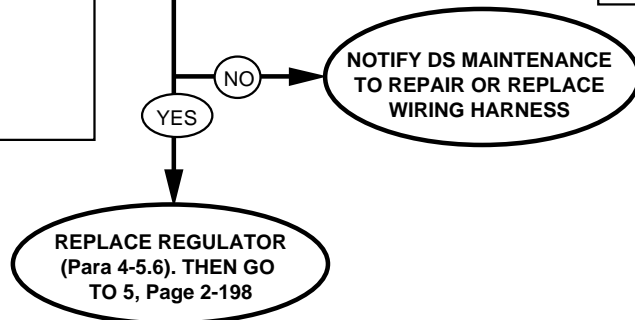
KNOWN INFO
VOLTAGE OUTPUT INCORRECT REGULATOR HAS ENERGIZING VOLTAGE
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR WIRING

<b>F.1-4</b>	<b>TEST OPTIONS</b>
IDLE ENGINE AT 1200-1500 RPM. DOES VOLTAGE ON 14 VOLT OUTPUT TERMINAL (YELLOW INSULATOR) MEASURE BETWEEN 13.4-14.6 VOLTS?	MULTIMETER
	<b>REASON FOR QUESTION</b> Determine if high or low output voltage.



KNOWN INFO
VOLTAGE OUTPUT INCORRECT REGULATOR HAS ENERGIZING VOLTAGE
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR WIRING

<b>F.1-5</b>	<b>TEST OPTIONS</b>
TURN ROTARY SWITCH TO RUN POSITION. CHECK FOR BATTERY VOLTAGE AT RED (ENERGIZE) TERMINAL ON REGULATOR. IS BATTERY VOLTAGE PRESENT?	1. STE/ICE-R TEST 10 AND 89 (Page 2-750)  2. MULTIMETER
	<b>REASON FOR QUESTION</b> As wire 568A is stubbed off, the voltage from wire 5A on red terminal signals regulator to turn on.



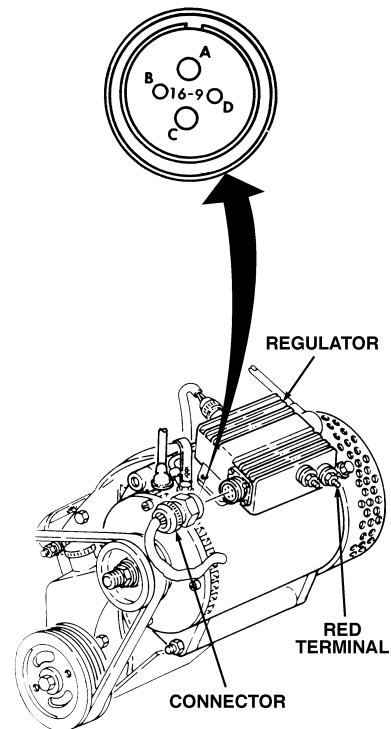
## REFERENCE INFORMATION

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

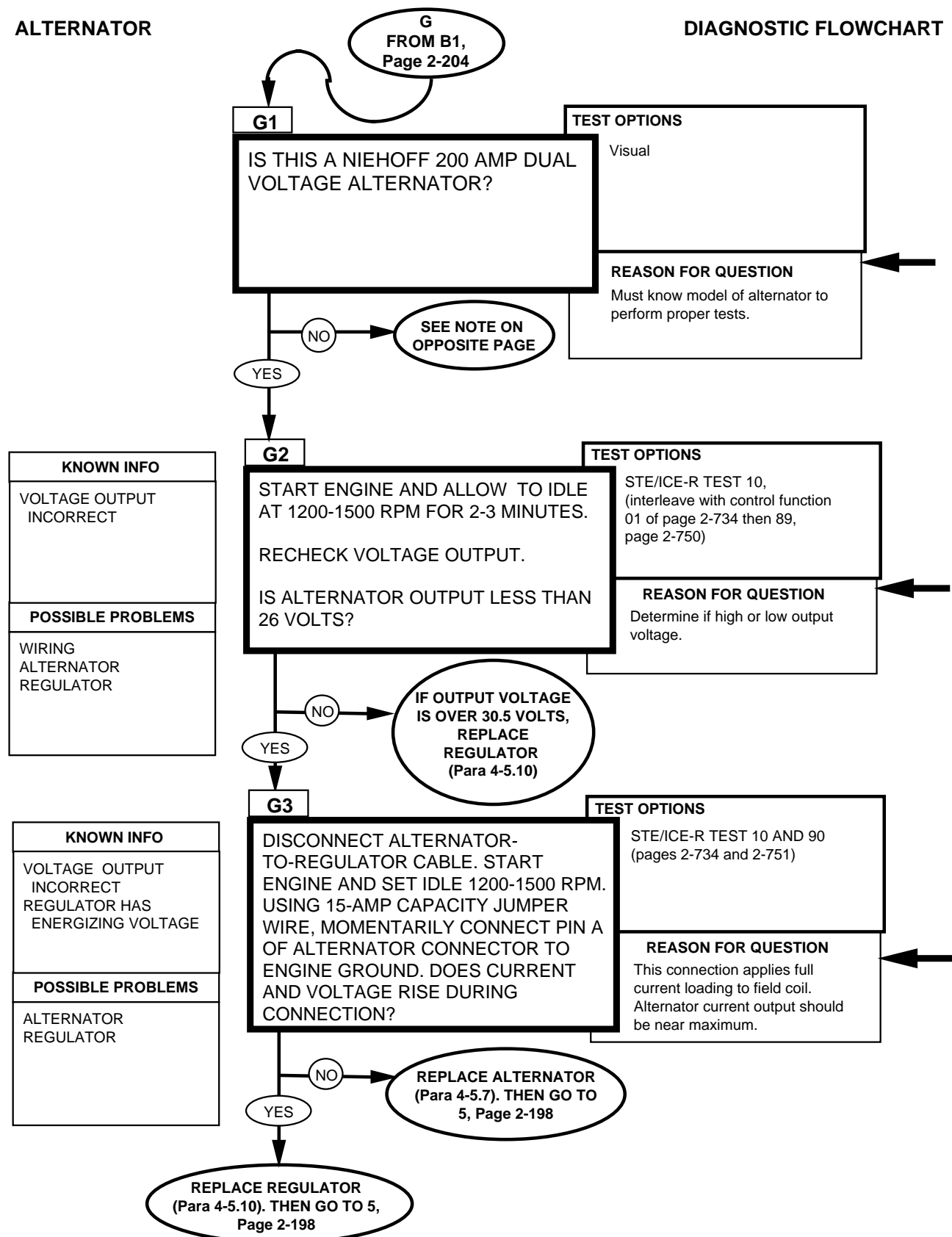
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.

## ALTERNATOR



## ALTERNATOR

## DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

ALTERNATOR

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.  
For 100 amp Prestolite alternator, go to C, page 2-208.  
For 200 amp Prestolite alternator, go to D, page 2-212.  
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.  
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.  
For 200 amp dual voltage Niehoff alternator, continue with G.  
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

NOTE

The regulator for this alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ENGINE RPM  
STE/ICE-R TEST 10

1. Start test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

0-45 DC VOLTS  
STE/ICE-R TEST 89

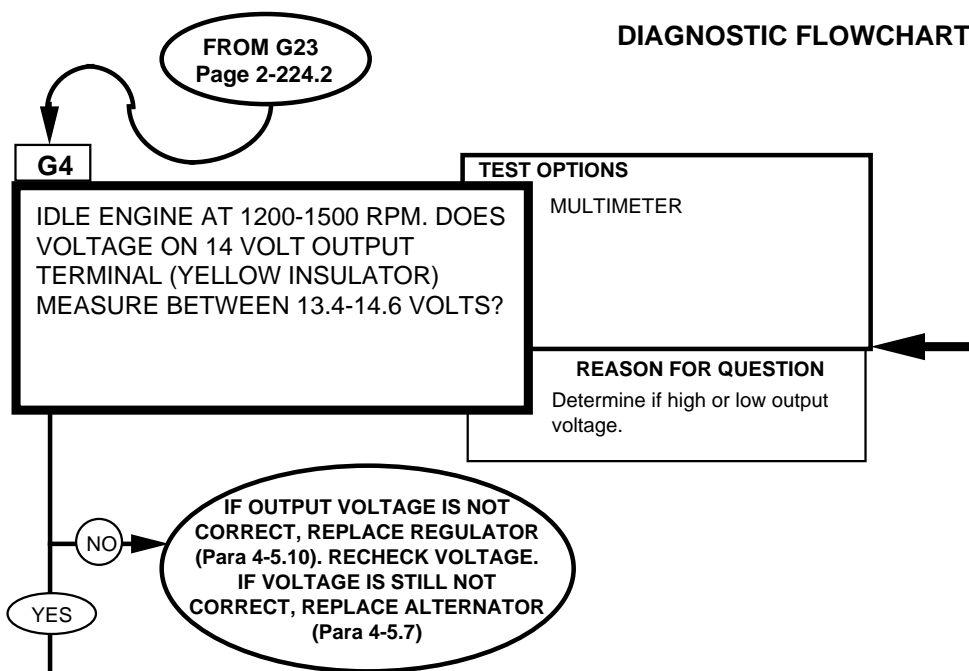
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.



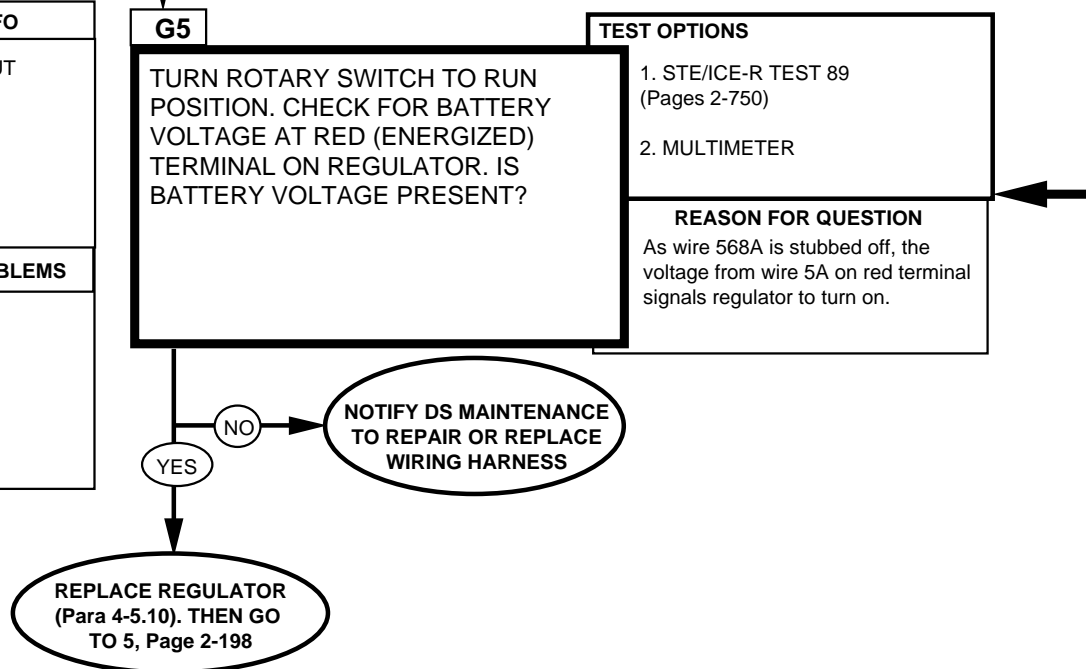
## ALTERNATOR

## DIAGNOSTIC FLOWCHART

KNOWN INFO
VOLTAGE OUTPUT INCORRECT REGULATOR HAS ENERGIZING VOLTAGE
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR WIRING



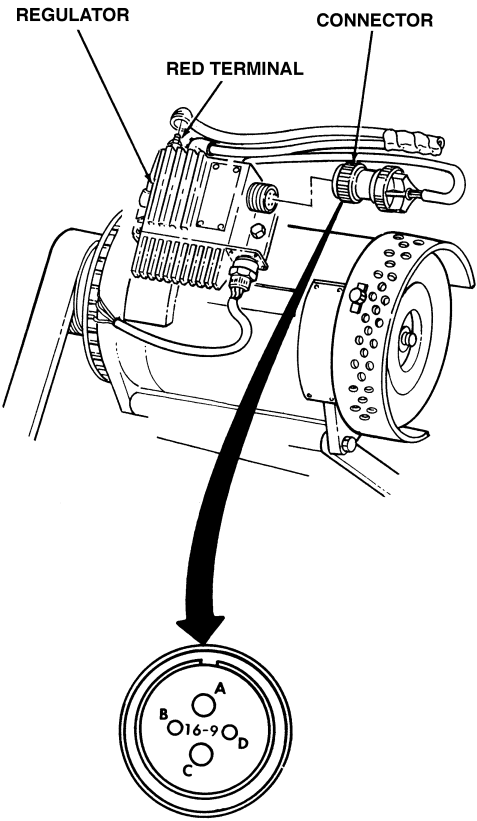
KNOWN INFO
VOLTAGE OUTPUT INCORRECT
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR



REFERENCE INFORMATION

ALTERNATOR

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

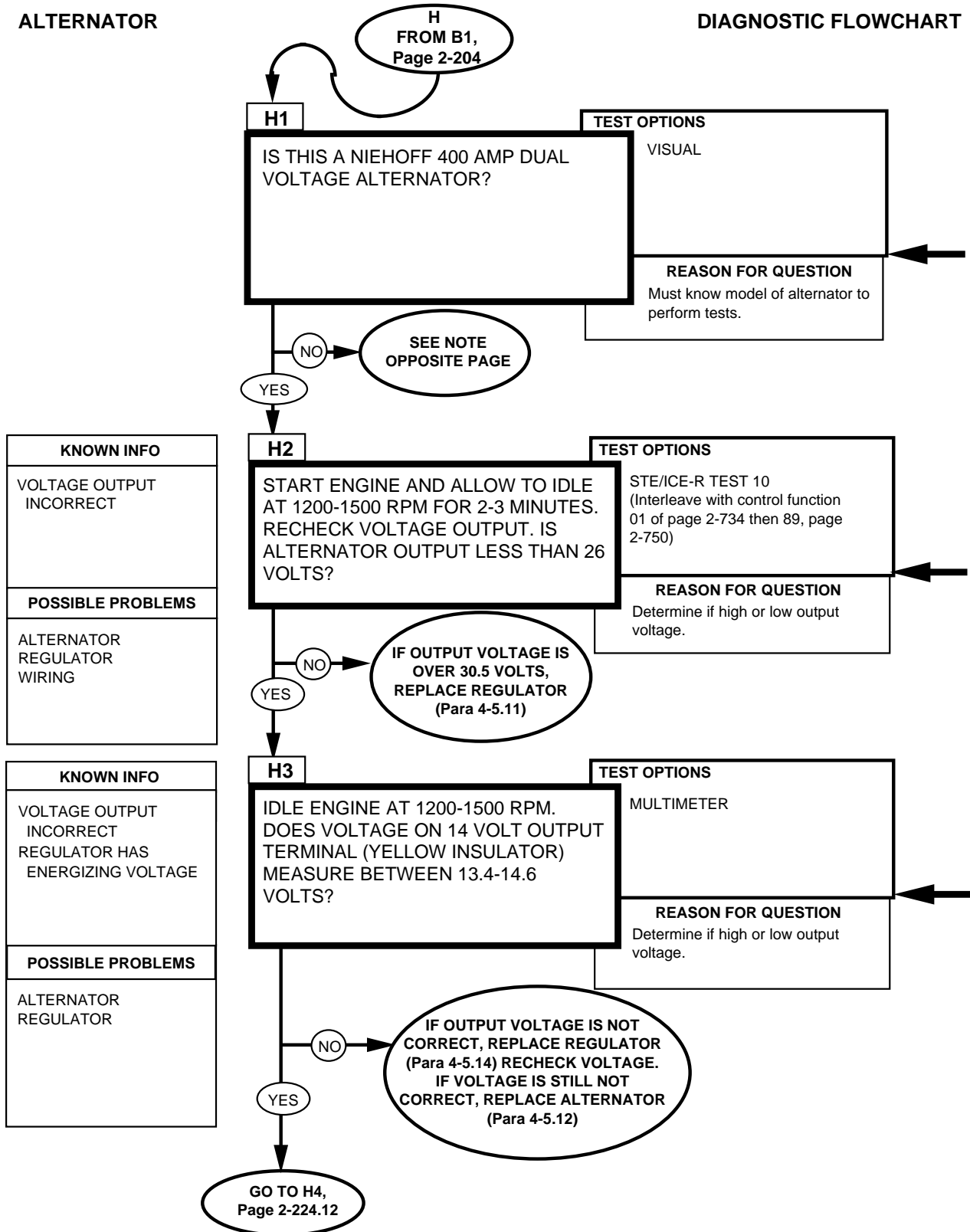


**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

# ALTERNATOR

## DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

ALTERNATOR

NOTE

For 60 amp Prestolite alternator, go to B, page 2-204.  
For 100 amp Prestolite alternator, go to C, page 2-208.  
For 200 amp Prestolite alternator, go to D, page 2-212.  
For 200 amp single voltage Niehoff alternator, go to E, page 2-218.  
For 100 amp single voltage Niehoff alternator, go to F, page 2-222.  
For 100 amp dual voltage Niehoff alternator, go to F.1, page 2-224.2.  
For 200 amp dual voltage Niehoff alternator, continue with G.  
For 400 amp dual voltage Niehoff alternator, go to H, page 2-224.10.

NOTE

The regulator for this model alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

NOTE

The regulator for this alternator has overvoltage protection. Any output voltage over 30.5 volts is an overvoltage.

Output voltage of 26-30.5 is acceptable for this alternator.

ENGINE RPM  
STE/ICE-R TEST 10

1. Start test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Engine RPM should be 1200-1500.

0-45 DC VOLTS  
STE/ICE-R TEST 89

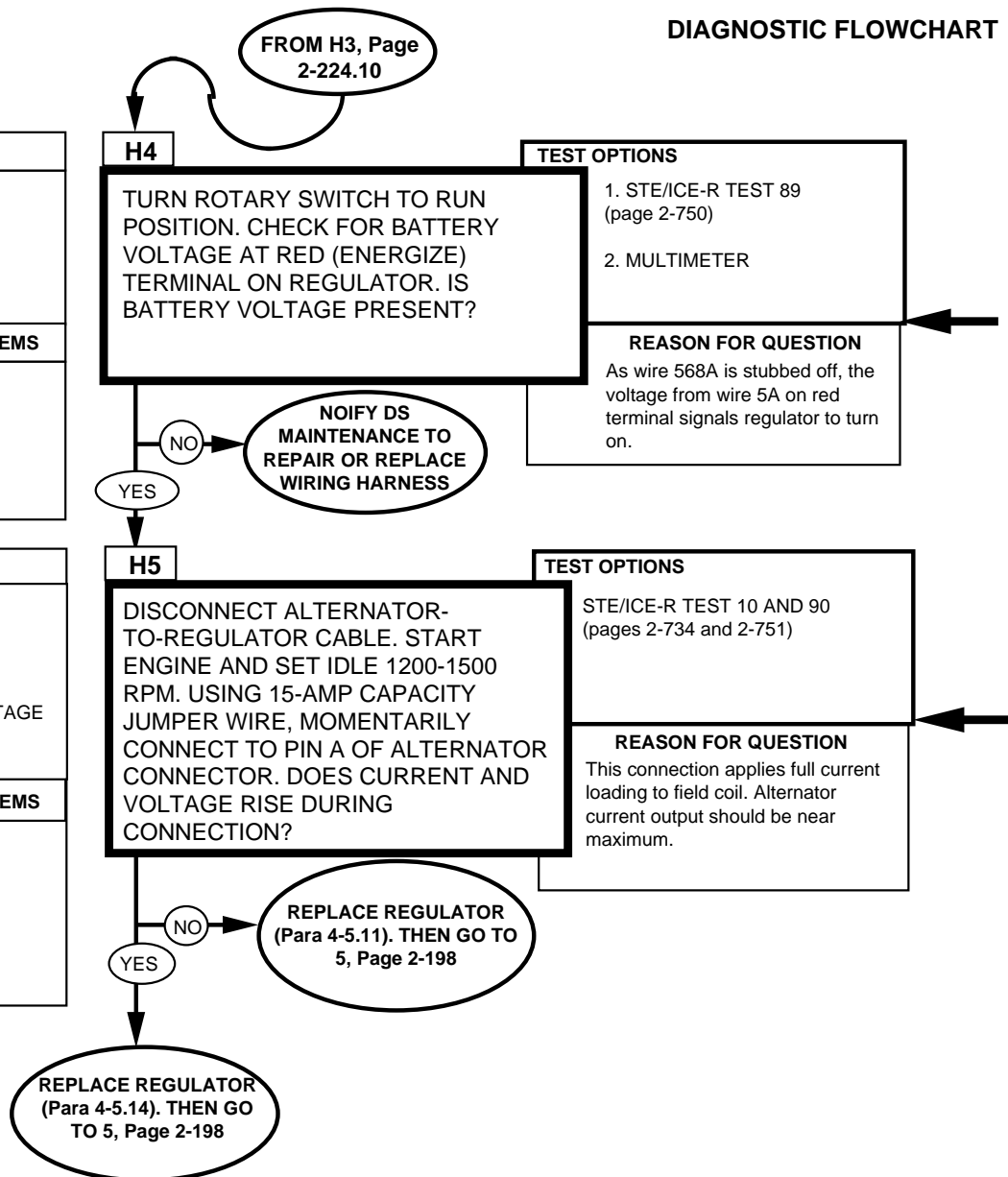
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.

## ALTERNATOR

## DIAGNOSTIC FLOWCHART

KNOWN INFO
VOLTAGE OUTPUT INCORRECT
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR WIRING

KNOWN INFO
VOLTAGE OUTPUT INCORRECT
REGULATOR HAS ENERGIZING VOLTAGE
POSSIBLE PROBLEMS
ALTERNATOR REGULATOR



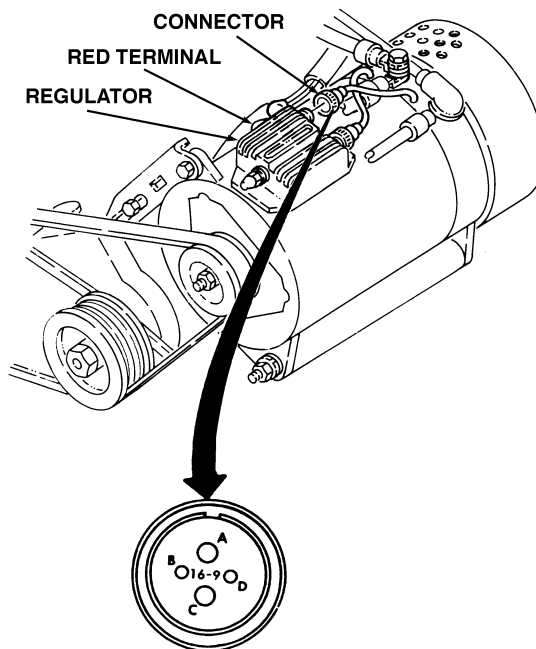
## REFERENCE INFORMATION

## ALTERNATOR

1. Slide boot back from wire lug to expose red terminal.
2. Make contact at stud.

**0-45 DC VOLTS**  
**STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.



**ENGINE RPM**  
**STE/ICE-R TEST 10**

1. Start Test 10, Engine RPM.
2. Crank or start the engine. Displayed reading is RPM. Set engine to fast idle of 1200-1500 RPM.

**0-1500 AMPS DC**  
**STE/ICE-R TEST 90**

1. Connect probe.
2. Start Test 90, DC amps.
3. Displayed reading is in amps.

**2-28. PROTECTIVE CONTROL BOX/DISTRIBUTION BOX TESTS**

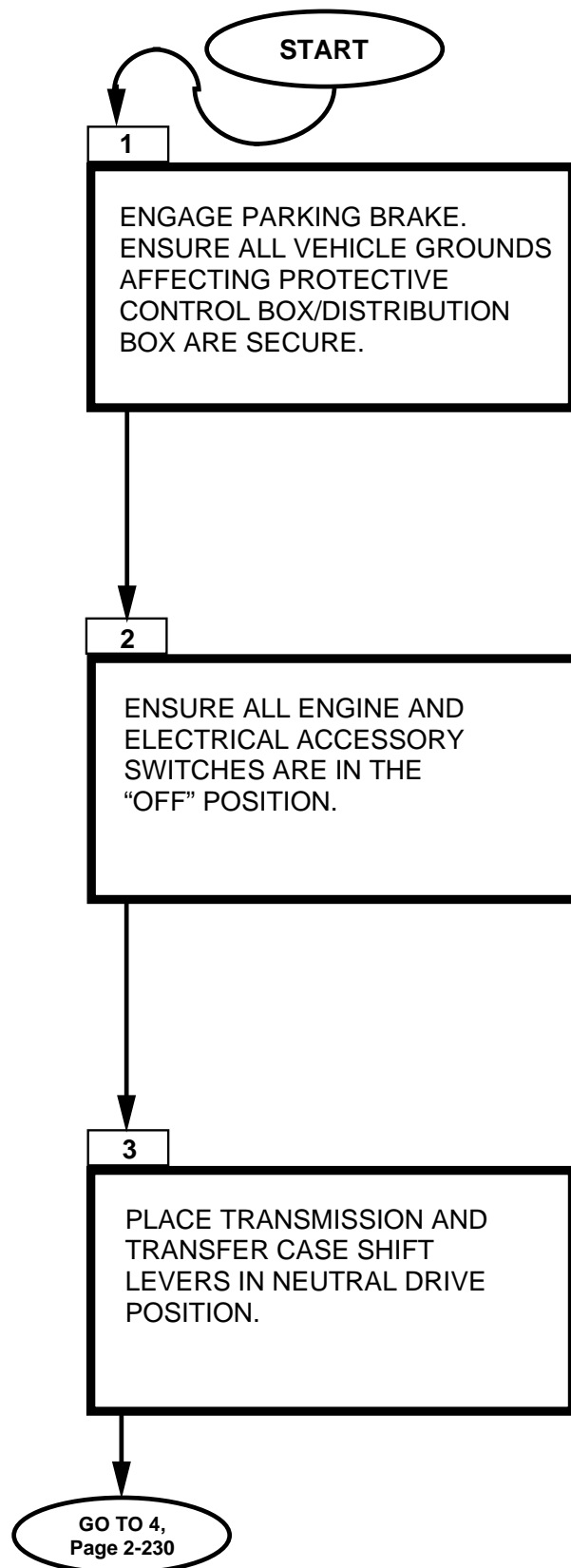
This protective control box /distribution box test can be run any time you think there may be a problem with the protective control box or distribution box, or if you were sent here from another system chain.

**NOTE**

- To perform PCB/distribution box diagnostics, a PCB test module is needed.
- For fabrication of PCB/distribution box test module, refer to Appendix D, Figs. 96-113, or requisitioned with NSN 6625-01-440-4522.

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART

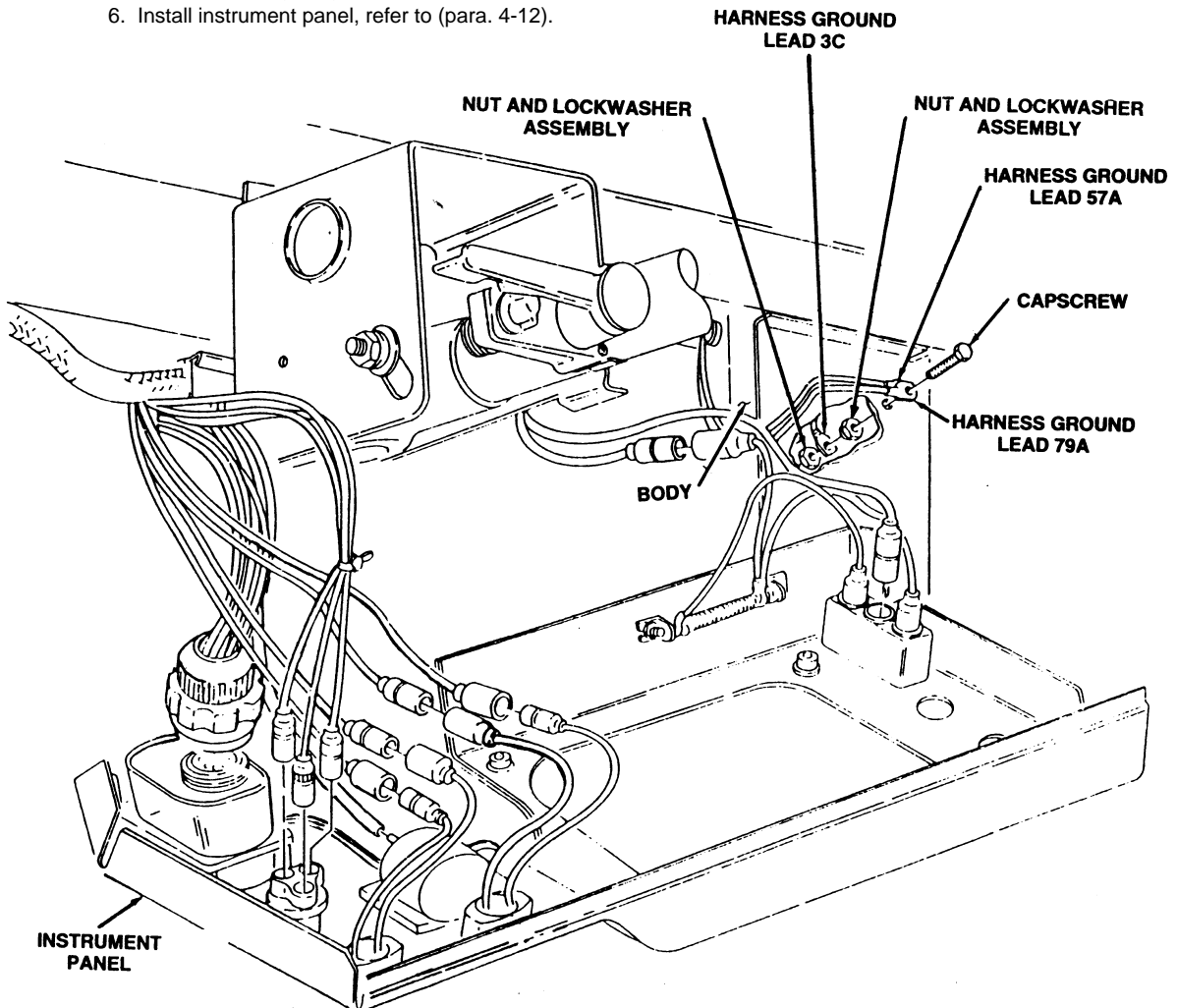




## REFERENCE INFORMATION

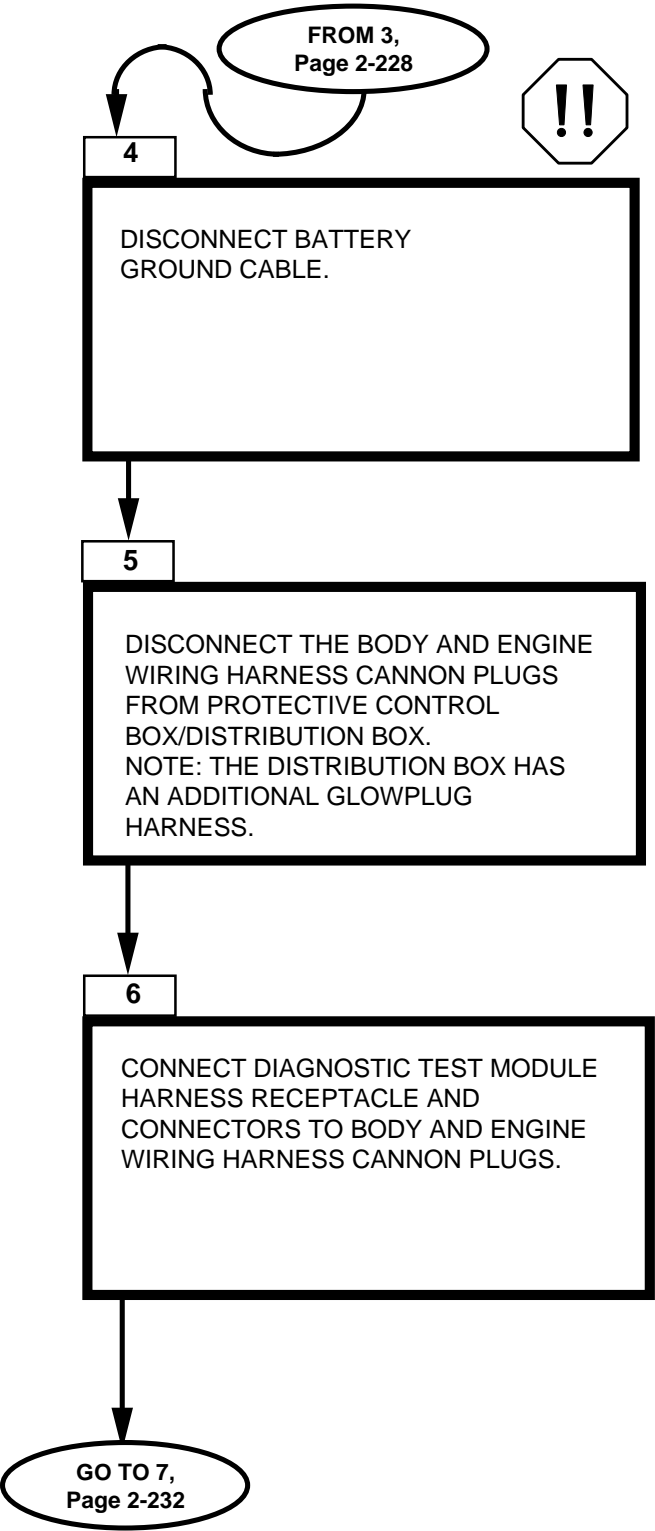
## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

1. Remove instrument panel, refer to (para. 4-12).
2. Remove nut and lockwasher assembly and engine harness ground lead 3C from body. Remove nut and lockwasher assembly, cap screw, and harness ground leads 57A and 79A from body. Discard nut and lockwasher assemblies.
3. Inspect and clean wires and connection points.
4. Apply antiseize compound to harness ground leads 57A and 79A and install on body with cap screw and nut and lockwasher assembly. Apply antiseize compound to engine harness ground lead 3C and install on body with nut and lockwasher assembly.
5. Cover leads 3C, 57A, and 79A with RTV.
6. Install instrument panel, refer to (para. 4-12).



PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

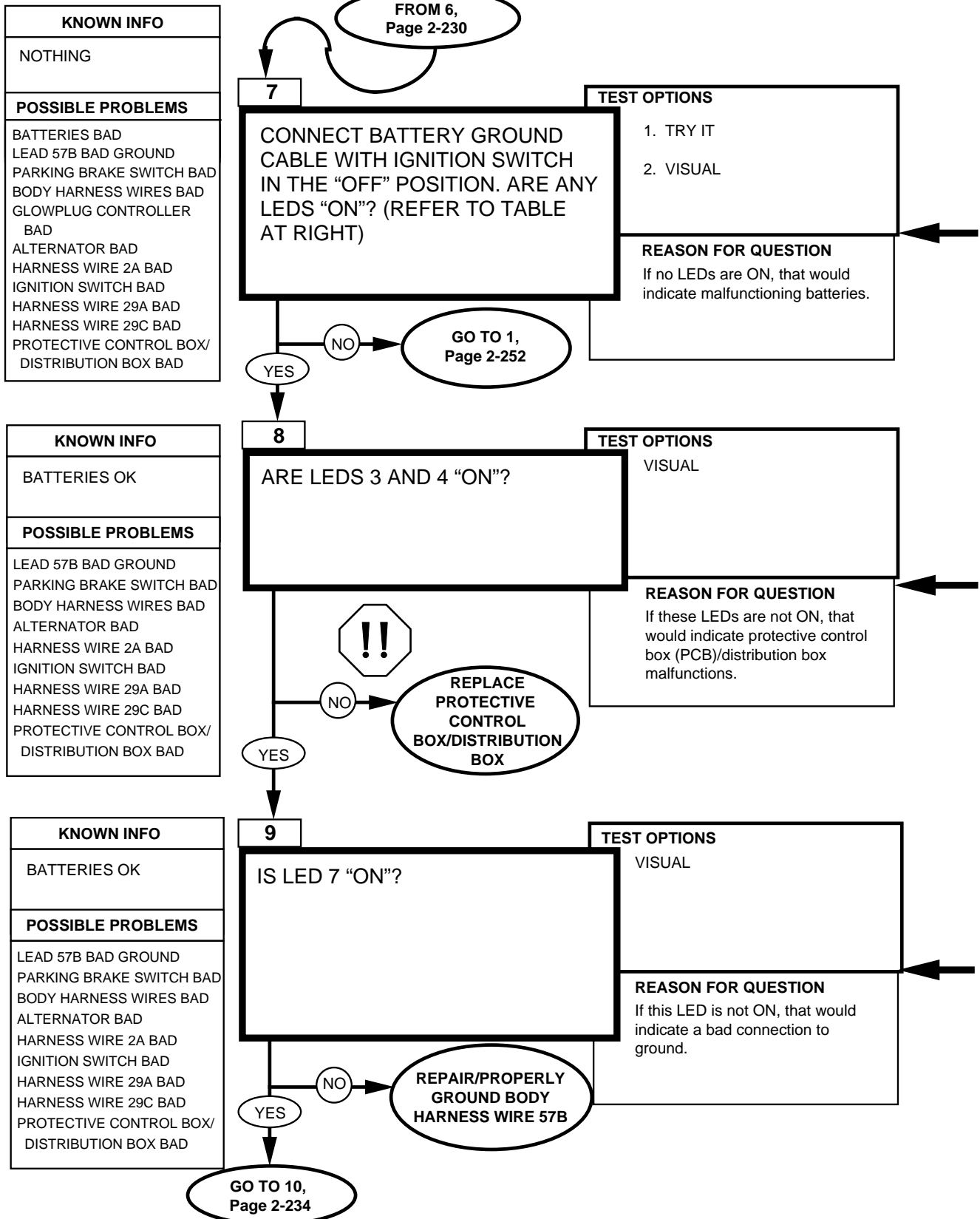
## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

# PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## NOTE

This analyzer requires all glow plugs be serviceable and the batteries fully charged in order to operate properly. Prior to performing diagnostic checks ensure these two items are checked. If either of these two items are found to be faulty, repair/replace prior to beginning checks. Failure to do so will cause the analyzer to give false readings, therefore causing the needless replacement of serviceable components.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).

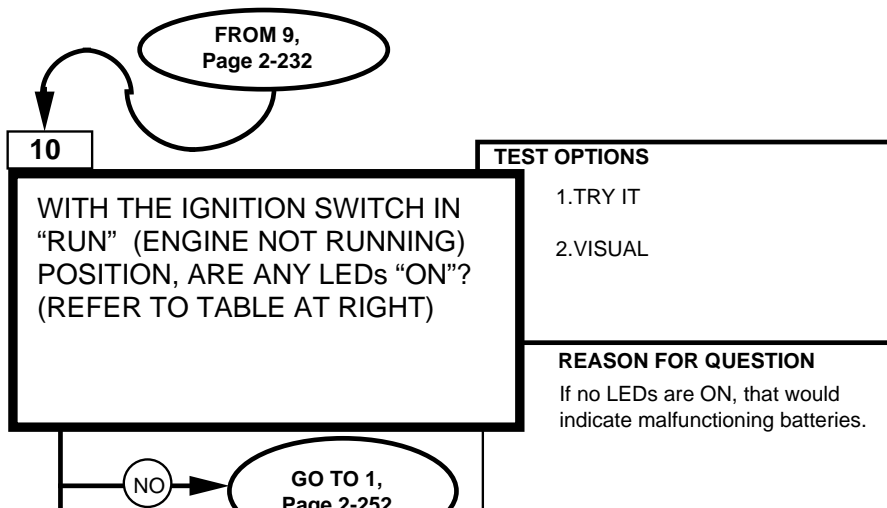
Repair lead connectors, refer to (para. 4-85).  
Repair lead, refer to (para. 4-85).

IGNITION SWITCH POSITION	DIAGNOSTIC CHECKS (GO TASKS) (For vehicles with protective control box/distribution box)
OFF	LED's 1, 3, 4, 6, 7, "ON"; Remaining LED's "OFF" If all LED's are "OFF", battery power is not available. If LED 3 or 4 is "OFF", replace the PCB/distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded.
RUN - (PCB)  (ENGINE NOT RUNNING-PCB)	LED's 1,2,3,4,5,6,7,8,11,13 "ON". LED 13 "OFF" after a few seconds (glow plug warm up time).  LED 13 "OFF" if engine is at operating temperature. LED 11 cycling "ON" and "OFF" (glow plug controller operation) LED's 9, 10, 12 "OFF". Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If all LED's are "OFF", no battery power is available. If LED 3 or 4 is "OFF", replace the PCB. If LED 7 is "OFF", harness wire 57B is not grounded If LED 2 is "OFF", and all glow plugs are serviceable, replace the PCB. If LED 5 is "OFF", replace the PCB is LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch is defective and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" and LED 5 is "ON" and the engine is not at operating temperature from a previous run, replace the PCB. The PCB is operational if the engine is at operating temperature from a previous run. If LED 6 is "OFF" and the parking brake lever is engaged the parking brake switch is defective or the wires in the body harness are defective If LED 8 is "OFF", replace the PCB. If LED 11 is "OFF", check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.
RUN - (Distribution Box)  (ENGINE NOT RUNNING-Distribution Box)	LED's 1, 2, 3, 4, 5, 6, 7, 8,13 "ON"; remaining LED's "OFF" LED 13 "OFF" after a few seconds (glow plug warm up time).  LED 13 "OFF" if engine is at operating temperature. LED 6 "OFF" if parking brake lever is released. LED 6 "ON" if parking brake lever is engaged If LED 2, 3, 4, or 8 is "OFF", replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 5 is "OFF", replace distribution box if LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" and LED 5 is "ON", and engine is not at operating temperature from a previous run, replace distribution box. Distribution box is operation if engine is at operating temperature from a previous run. If LED 6 is "OFF" and the parking brake lever is engaged the parking brake switch and/or the wires in the body harness are defective.
START (ENGINE CRANKING-PCB)	LED 10 momentarily "ON" and then remains "OFF" (starter motor frequency lockout). If LED 11 and 13 remain "ON" or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", replace PCB.
START (ENGINE CRANKING-Distribution Box)	LED 10 momentarily "ON". If LED 13 is "ON" or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", and ignition switch is operating properly, replace distribution box.
RUN (ENGINE RUNNING-PCB)	LED's 1,2,3,4,5,6,7,8,9,12 "ON" LED 11 cycling "ON" and "OFF" (glow plug controller operation): "OFF" time interval increases as engine warms up. LED 11 "OFF" (when engine is at operating temperature). LED 11 may remain "OFF" (when engine is at operating temperature from previous run). LED 13 "OFF" Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If LED 2, 3, 4, 5, or 8 is "OFF" and all glow plugs are serviceable replace the PCB. If LED 7 is "OFF", the body harness wire 57B is not grounded. If LED 9 is "OFF" and LED 12 is "ON", replace the PCB. If LED's 9 and 12 are "OFF", there is no alternator output (alternating current tap) available and/or the engine harness wire 2A is defective. If LED 11 is "OFF" and the engine is not at operating temperature, check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.
RUN (ENGINE RUNNING-Distribution Box)	LED's 1, 2, 3, 4, 5, 6, 7, 8, 12 "ON", remaining LED's "OFF" LED 6 "OFF" if parking brake lever is released. LED 6 "ON" if parking brake lever is released If LED's 2, 3, 4, 5 or 8 is "OFF" replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 12 is "OFF", there is no alternator output (alternating current tap) available and/or engine harness wire 2A is defective.

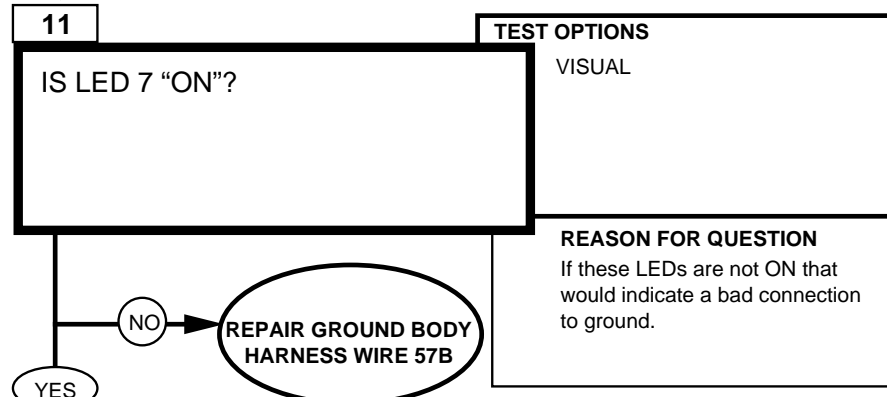
# PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART

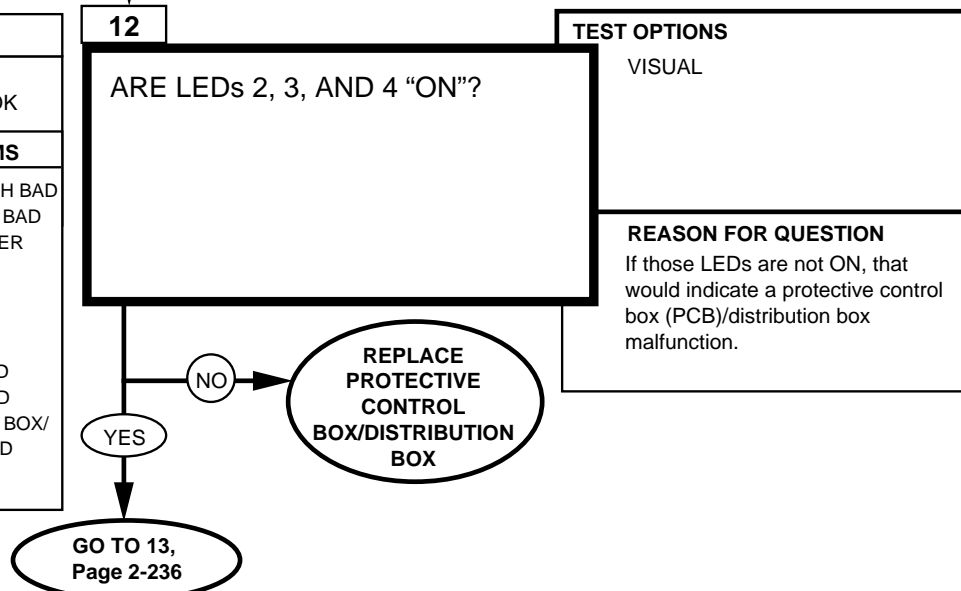
KNOWN INFO
BATTERIES OK LEAD 57B GROUND OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH BAD BODY HARNESS WIRES BAD GLOWPLUG CONTROLLER BAD ALTERNATOR BAD HARNESS WIRE 2A BAD IGNITION SWITCH BAD HARNESS WIRE 29A BAD HARNESS WIRE 29C BAD PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD



KNOWN INFO
BATTERIES OK LEAD 57B GROUND OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH BAD BODY HARNESS WIRES BAD GLOWPLUG CONTROLLER BAD ALTERNATOR BAD HARNESS WIRE 2A BAD IGNITION SWITCH BAD HARNESS WIRE 29A BAD HARNESS WIRE 29C BAD PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD



KNOWN INFO
BATTERIES OK LEAD 57B GROUND OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH BAD BODY HARNESS WIRES BAD GLOWPLUG CONTROLLER BAD ALTERNATOR BAD HARNESS WIRE 2A BAD IGNITION SWITCH BAD HARNESS WIRE 29A BAD HARNESS WIRE 29C BAD PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD



# REFERENCE INFORMATION

# PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## NOTE

This analyzer requires all glow plugs be serviceable and the batteries fully charged in order to operate properly. Prior to performing diagnostic checks ensure these two items are checked. If either of these two items are found to be faulty, repair/replace prior to beginning checks. Failure to do so will cause the analyzer to give false readings, therefore causing the needless replacement of serviceable components.

Repair lead connectors, refer to (para. 4-85).  
Repair lead, refer to (para. 4-85).



## WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

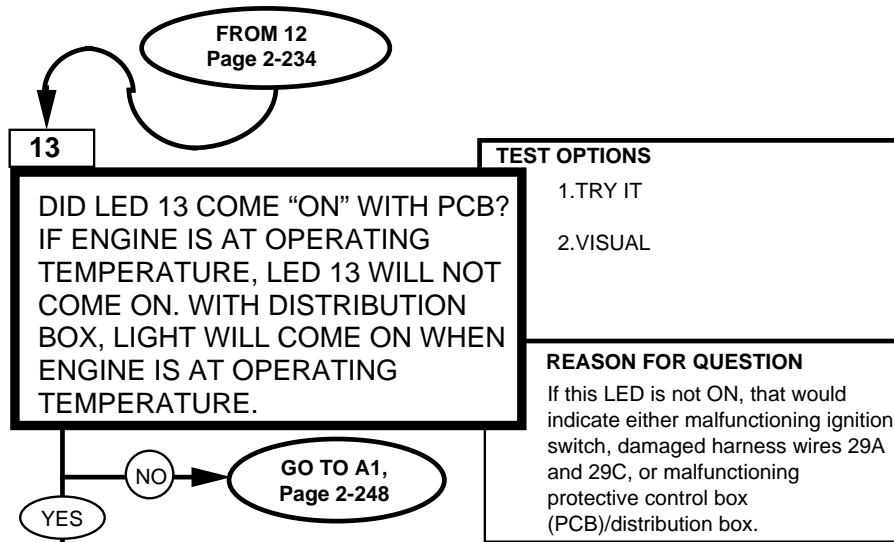
Replace protective control box, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).

DIAGNOSTIC CHECKS (GO TASKS) (For Vehicles with protective control box/distribution box)	
OFF	LED's 1, 3, 4, 6, 7, "ON"; Remaining LED's "OFF" If all LED's are "OFF", battery power is not available. If LED 3 or 4 is "OFF", replace the PCB/distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded.
RUN - (PCB)	LED's 1, 2, 3, 4, 5, 6, 7, 8, 11, 13 "ON". LED 13 "OFF" after a few seconds (glow plug warm up time).
(ENGINE NOT RUNNING- PCB)	LED 13 "OFF" if engine is at operating temperature. LED 11 cycling "ON" and "OFF" (glow plug controller operation) LED's 9, 10, 12 "OFF" Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If all LED's are "OFF", no battery power is available. If LED 3 or 4 is "OFF", replace the PCB. If LED 7 is "OFF", harness wire 57B is not grounded If LED 2 is "OFF", and all glow plugs are serviceable, replace the PCB. If LED 5 is "OFF", replace the PCB is LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch is defective and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" and LED 5 is "ON" and the engine is not at operating temperature from a previous run, replace the PCB. The PCB is operational if the engine is at operating temperature from a previous run. If LED 6 is "OFF" and the parking brake lever is engaged the parking brake switch is defective or the wires in the body harness are defective If LED 8 is "OFF", replace the PCB. If LED 11 is "OFF", check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.
RUN - (Distribution Box)	LED's 1, 2, 3, 4, 5, 6, 7, 8, 13 "ON"; remaining LED's "OFF" LED 13 "OFF" after a few seconds (glow plug warm up time).
(ENGINE NOT RUNNING- Distribution Box)	LED 13 "OFF" if engine is at operating temperature. LED 6 "OFF" if parking brake lever is released. LED 6 "ON" if parking brake lever is engaged If LED 2, 3, 4, or 8 is "OFF", replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 5 is "OFF", replace distribution box if LED 13 is "ON". If LED's 5 and 13 are "OFF", the ignition switch and/or harness wires 29A and 29C are defective. If LED 13 is "OFF" and LED 5 is "ON", and engine is not at operating temperature from a previous run, replace distribution box. Distribution box is operation if engine is at operating temperature from a previous run. If LED 6 is "OFF" and the parking brake lever is engaged the parking brake switch and/or the wires in the body harness are defective.
START (ENGINE CRANKING- PCB)	LED 10 momentarily "ON" and then remains "OFF" (starter motor frequency lockout). If LED 11 and 13 remain "ON" or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", replace PCB.
START (ENGINE CRANKING- Distribution Box)	LED 10 momentarily "ON". If LED 13 is "ON" or engine does not crank; check battery voltage; charge is low. If LED 10 does not momentarily come "ON" and then stays "OFF", and ignition switch is operating properly, replace distribution box.
RUN (ENGINE RUNNING- PCB)	LED's 1, 2, 3, 4, 5, 6, 7, 8, 9, 12 "ON" LED 11 cycling "ON" and "OFF" (glow plug controller operation): "OFF" time interval increases as engine warms up. LED 11 "OFF" (when engine is at operating temperature). LED 11 may remain "OFF" (when engine is at operating temperature from previous run). LED 13 "OFF" Release parking brake lever. LED 6 "OFF". Engage parking brake lever. LED 6 "ON". If LED 2, 3, 4, 5, or 8 is "OFF" and all glow plugs are serviceable replace the PCB. If LED 7 is "OFF", the body harness wire 57B is not grounded. If LED 9 is "OFF" and LED 12 is "ON", replace the PCB. If LED's 9 and 12 are "OFF", there is no alternator output (alternating current tap) available and/or the engine harness wire 2A is defective. If LED 11 is "OFF" and the engine is not at operating temperature, check the glow plug controller. If the glow plug controller is functioning properly, replace the PCB.
RUN (ENGINE RUNNING- Distribution Box)	LED's 1, 2, 3, 4, 5, 6, 7, 8, 12 "ON", remaining LED's "OFF" LED 6 "OFF" if parking brake lever is released. LED 6 "ON" if parking brake lever is released If LED's 2, 3, 4, 5 or 8 is "OFF" replace distribution box. If LED 7 is "OFF", body harness wire 57B is not grounded If LED 12 is "OFF", there is no alternator output (alternating current tap) available and/or engine harness wire 2A is defective.

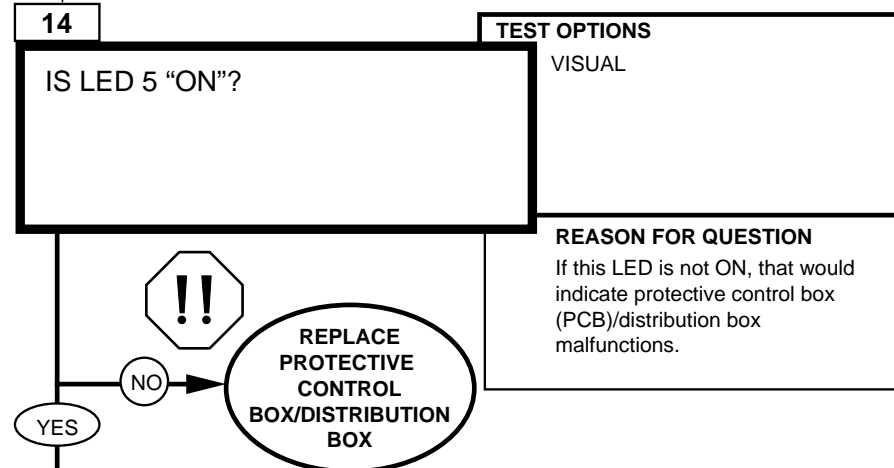
## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART

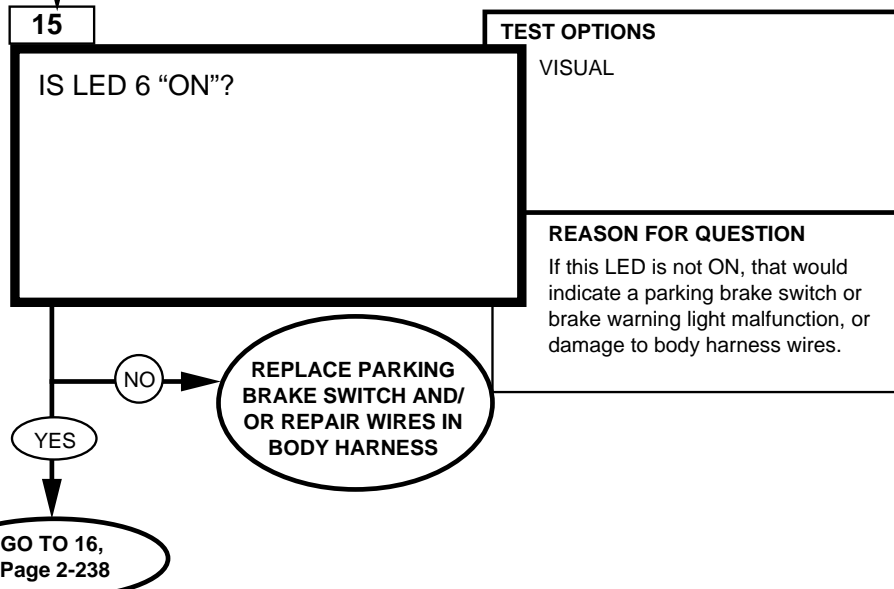
KNOWN INFO
BATTERIES OK LEAD 57B GROUND OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH BAD BODY HARNESS WIRES BAD GLOWPLUG CONTROLLER BAD ALTERNATOR BAD HARNESS WIRE 2A BAD IGNITION SWITCH BAD HARNESS WIRE 29A BAD HARNESS WIRE 29C BAD PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD



KNOWN INFO
BATTERIES OK LEAD 57B GROUND OK IGNITION SWITCH OK HARNESS WIRE 29A OK HARNESS WIRE 29C OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH BAD BODY HARNESS WIRES BAD GLOWPLUG CONTROLLER BAD ALTERNATOR BAD HARNESS WIRE 2A BAD PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD



KNOWN INFO
BATTERIES OK LEAD 57B GROUND OK IGNITION SWITCH OK HARNESS WIRE 29A OK HARNESS WIRE 29C OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH BAD BODY HARNESS WIRES BAD GLOWPLUG CONTROLLER BAD ALTERNATOR BAD HARNESS WIRE 2A BAD PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX BAD





## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).

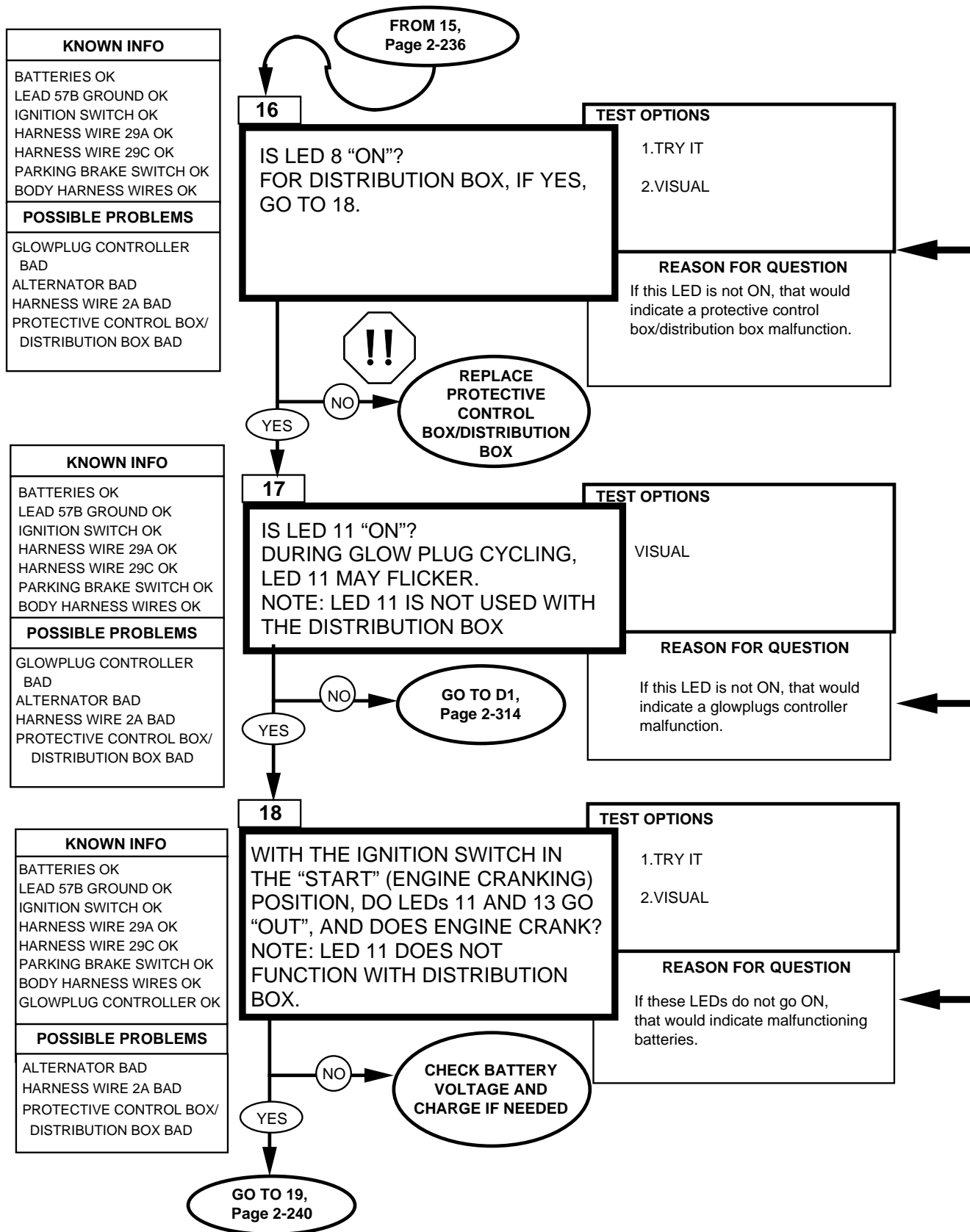
Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).

Repair leads, refer to (para. 4-85).

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).

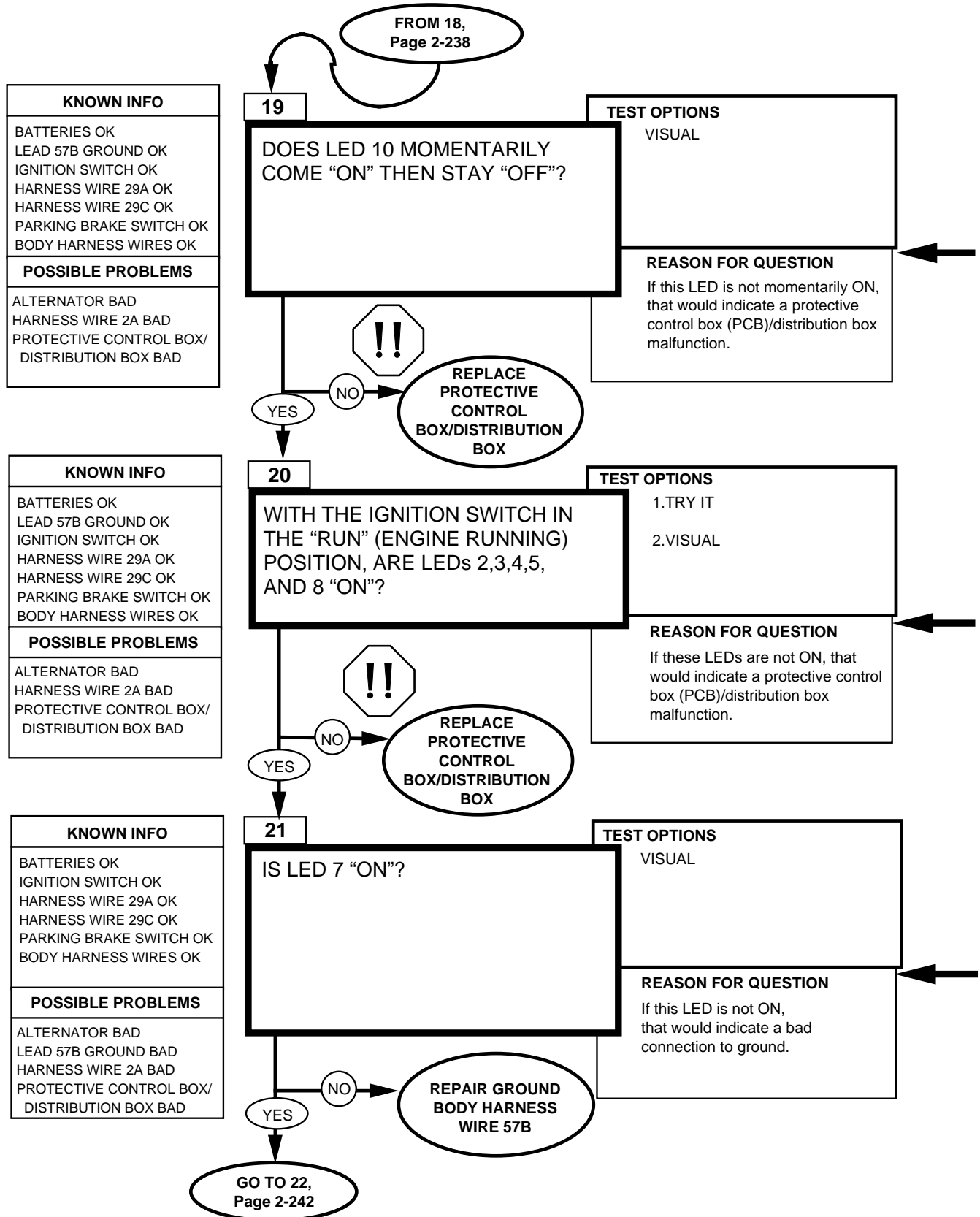
Replace distribution box, refer to (para. 4-5.1).

Replace glowplug controller. refer to (para. 4-29).

Service/repair batteries. refer to (para. 4-79).

# PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

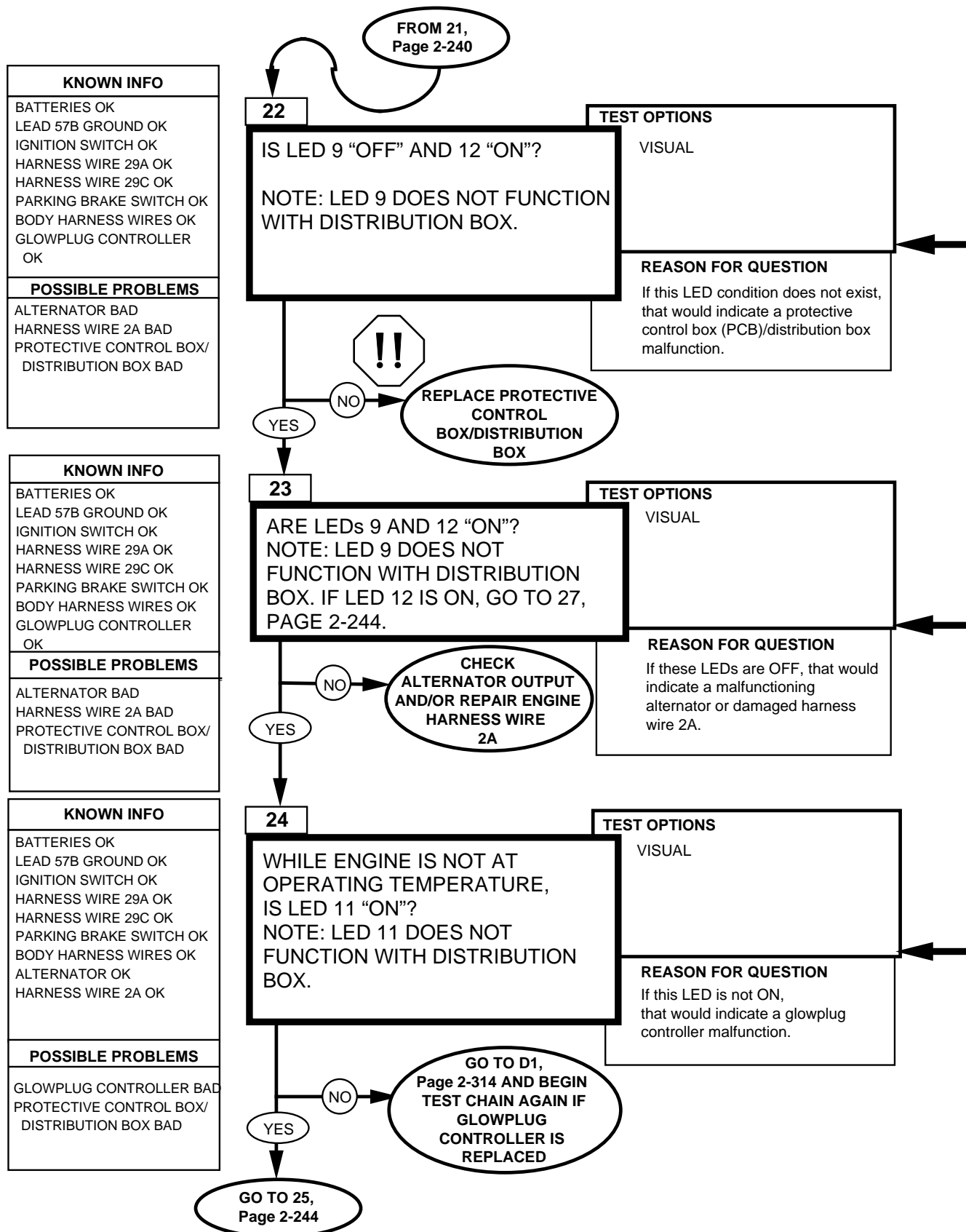
Replace protective control box, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).

Repair leads, refer to (para. 4-85).

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX



### WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).

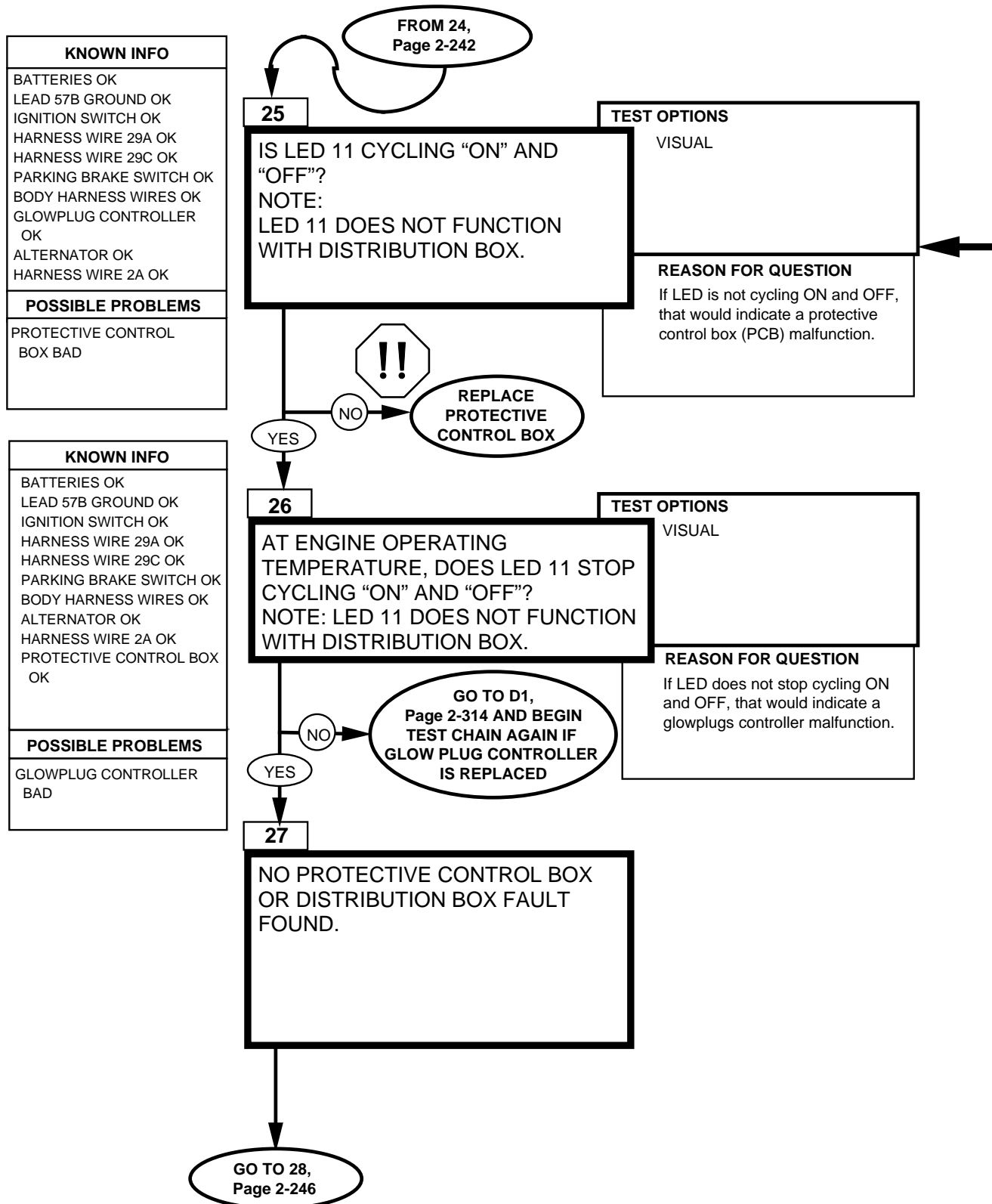
Replace distribution box, refer to (para. 4-5.1).

Repair lead connectors, refer to (para. 4-85).  
Repair leads, refer to (para. 4-85).

Repair glowplug controller, refer to (para. 4-29).

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

## DIAGNOSTIC FLOWCHART





## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

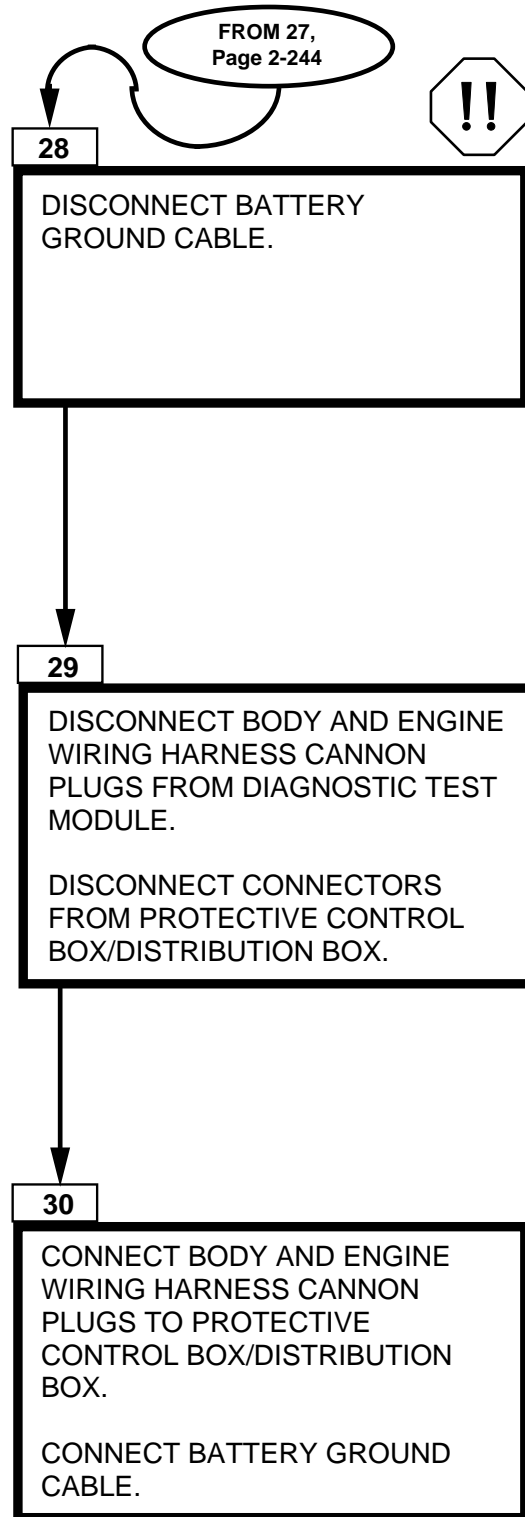
**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

Replace protective control box, refer to (para. 4-5).

PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

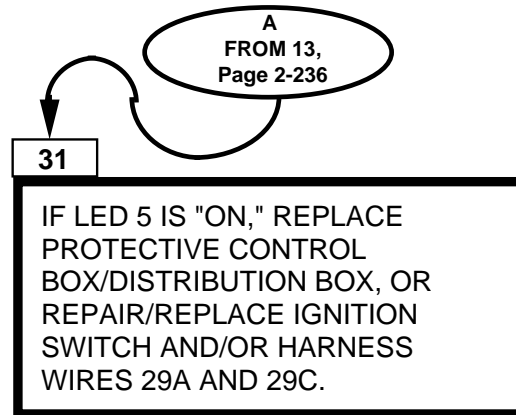
## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box or distribution box harness. Failure to do so may result in injury to personnel or damage to equipment.

**PROTECTIVE CONTROL BOX/DISTRIBUTION BOX**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

## PROTECTIVE CONTROL BOX/DISTRIBUTION BOX

Replace protective control box, refer to (para. 4-5).  
 Replace distribution box, refer to (para. 4-5.1).  
 Repair/replace rotary switch, refer to (para. 4-7).  
 Repair/replace leads 29A and 29C, refer to (para. 4-85).

## 2-29. BATTERY CIRCUIT TEST

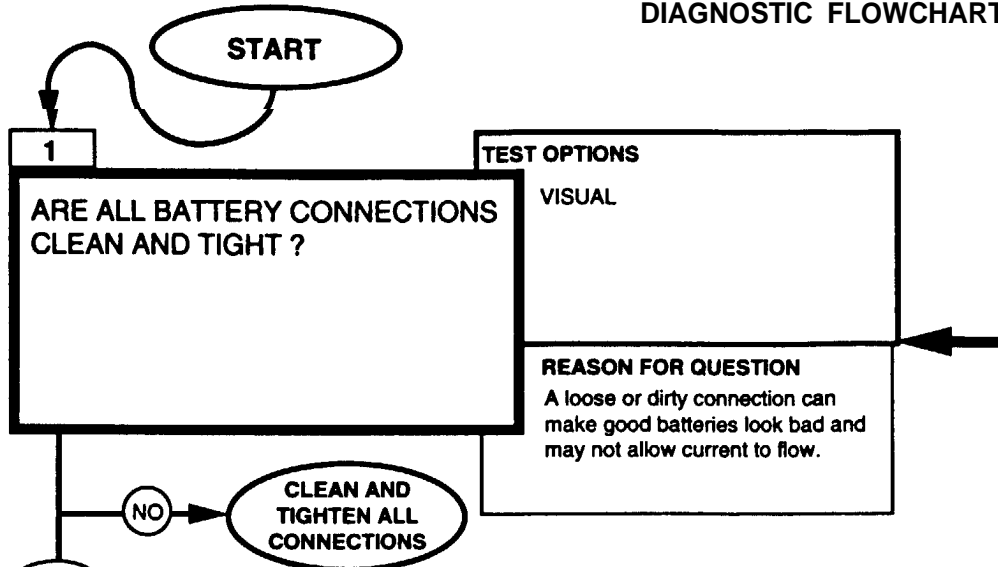
These Battery Circuit tests maybe run any time you think you have a battery problem of if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The fold-out page shows the location of the major components of the Battery Circuit in case you are not familiar with them. Fold-out page FO-7 may be left open for reference while testing.

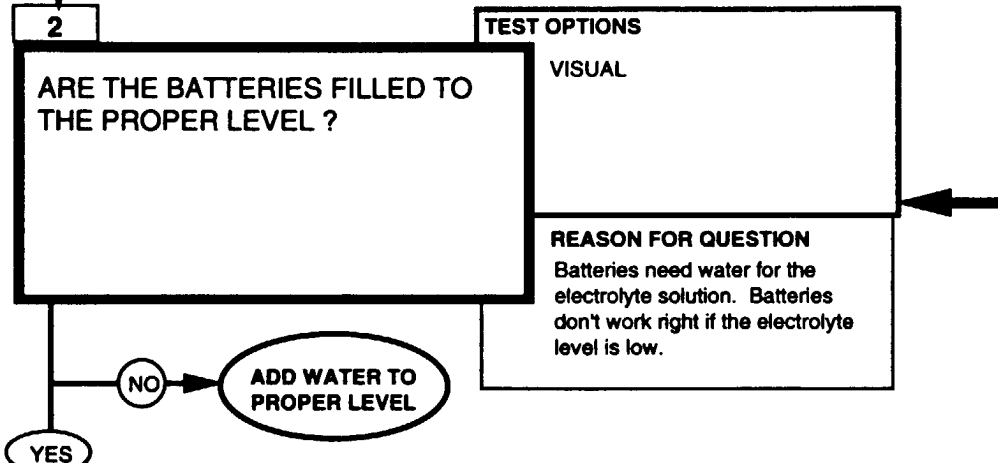
# BATTERY CIRCUIT

## DIAGNOSTIC FLOWCHART

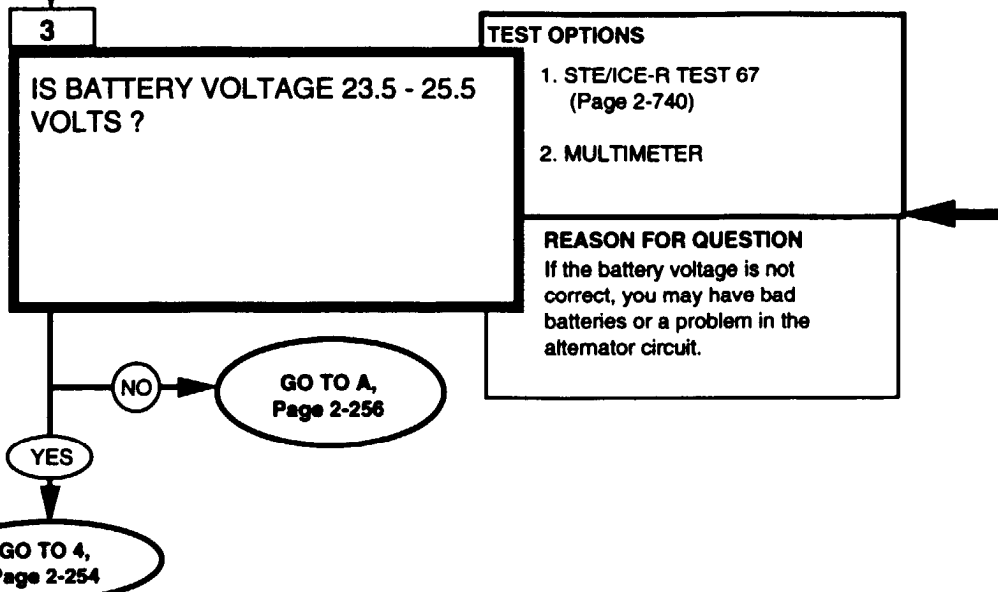
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
BATTERIES CABLES ALTERNATOR CIRCUIT CABLE CONNECTIONS



KNOWN INFO
CONNECTIONS OK
POSSIBLE PROBLEMS
BATTERIES CABLES ALTERNATOR CIRCUIT



KNOWN INFO
CONNECTIONS OK WATER LEVEL OK
POSSIBLE PROBLEMS
BATTERIES CABLES ALTERNATOR CIRCUIT



# REFERENCE INFORMATION

## BATTERY CIRCUIT

### BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH ! The time you save may be your own.

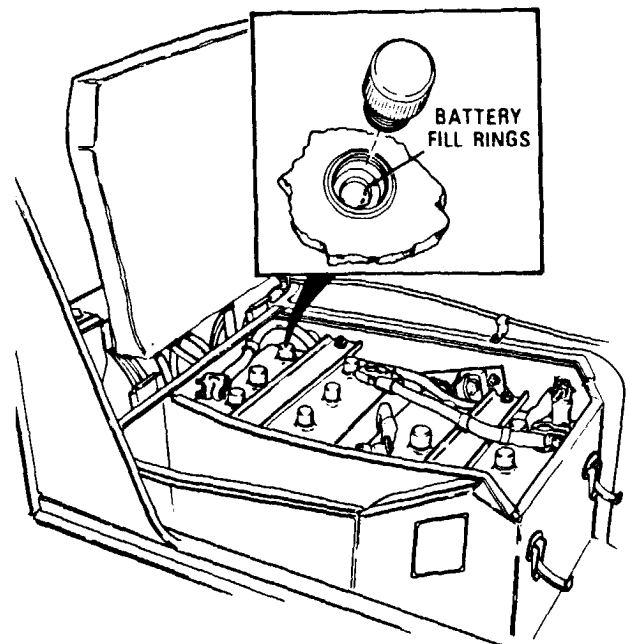
Refer to the functional flow schematic and check the following;

1. BATTERY - make sure all connections are clean and tight. This includes the interconnect cables, clamps, shunt, power stud and the slave connector. Also check wires 6A and 7A under vehicle where they enter shunt.
2. STARTER - check the high current (heavy gauge) wire at the starter. Don't just check for voltage; a loose connection will have voltage but can't carry much current.

There is a ring inside the battery fill plugs. The water level should be at the ring.

### BATTERY VOLTAGE STE/CE-R TEST 67

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

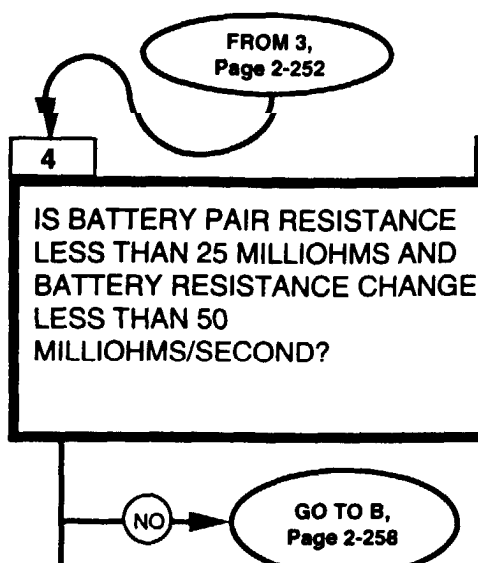




BATTERY CIRCUIT

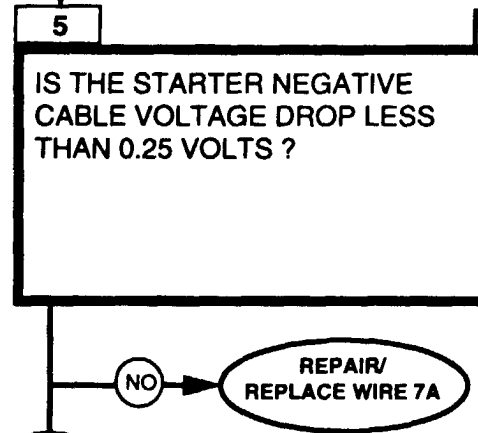
DIAGNOSTIC FLOWCHART

KNOWN INFO
CONNECTIONS OK WATER LEVEL OK BATTERY VOLTAGE OK ALTERNATOR CIRCUIT OK
POSSIBLE PROBLEMS
BATTERIES CABLES



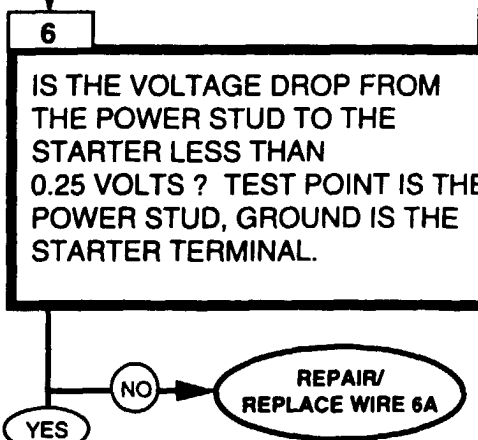
TEST OPTIONS
STE/ICE-R TESTS 73, 75 (Page 2-746, 748)
REASON FOR QUESTION
If either resistance reading is too high, the batteries are probably weak and may not produce enough power.

KNOWN INFO
BATTERIES OK ALTERNATOR CIRCUIT OK
POSSIBLE PROBLEMS
CABLES



TEST OPTIONS
1. STE/ICE-R TEST 69 (Page 2-742) 2. MULTIMETER
REASON FOR QUESTION
A large voltage drop indicates high resistance. High resistance means less current flow.

KNOWN INFO
BATTERIES OK NEGATIVE CABLE OK ALTERNATOR CIRCUIT OK
POSSIBLE PROBLEMS
CABLES



TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
REASON FOR QUESTION
A large voltage drop indicates high resistance. High resistance means less current flow.

## REFERENCE INFORMATION

## BATTERY CIRCUIT

These tests check the strength of the batteries during engine cranking. If you don't have STE/ICE-R, skip this step, but remember that you haven't tested the batteries under load.

**BATTERY INTERNAL RESISTANCE  
STE/ICE-R TEST 73**

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid.
3. Start Test 73, battery internal resistance.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

**BATTERY RESISTANCE CHANGE  
STE/ICE-R TEST 75**

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid.
3. Start Test 75, battery resistance change.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms/second. Battery resistance change should be 50 milliohms/second max.

**STARTER NEG. CABLE VOLTAGE DROP  
STE/ICE-R TEST 69**

1. Start Test 69, starter negative cable voltage drop.
2. Displayed reading is in volts. The cable voltage drop should be less than 0.25 volts maximum.

**0-45 DC VOLTS  
STE/ICE-R TEST 69**

1. Connect RED dip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.

# BATTERY CIRCUIT

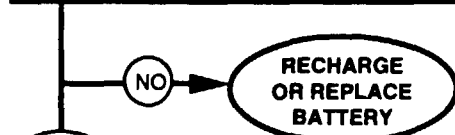
## DIAGNOSTIC FLOWCHART

KNOWN INFO
BATTERY VOLTAGE IS NOT CORRECT
POSSIBLE PROBLEMS
BATTERY OR BATTERIES CABLES ALTERNATOR



**DOES EACH BATTERY MEASURE 11-13 VOLTS?**

TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER
REASON FOR QUESTION
A good battery has 12 volts at 70° F (22° C).



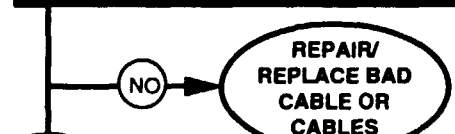
YES

KNOWN INFO
BATTERIES OK
POSSIBLE PROBLEMS
CABLES

A2

**CHECK THE VOLTAGE DROP ACROSS EACH CABLE IN THE BATTERY BOX (SEE NOTE AT RIGHT). ARE ALL VOLTAGE DROPS LESS THAN 0.25 VOLTS MAX?**

TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER
REASON FOR QUESTION
Everything else checks out OK. These cables are the only thing in the battery circuit we haven't tested.



YES

KNOWN INFO
BATTERY VOLTAGE NOT CORRECT
POSSIBLE PROBLEMS
BATTERIES ALTERNATOR

A3

**YOUR BATTERIES ARE OVER-CHARGED OR DISCHARGED. RUN THE ALTERNATOR TESTS. IF NO FAULTS ARE FOUND, REPLACE THE DEFECTIVE BATTERY OR BATTERIES.**

## REFERENCE INFORMATION

## BATTERY CIRCUIT

Measure from the positive post to the negative post of each battery.

For battery replacement instructions, refer to (para. 4-79).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**NOTE**

Check these cables:

WIRE 68, connecting the batteries together. Test point is the positive terminal of one of the batteries.

WIRE 49A, connecting the batteries to the power stud. Test point is the power stud.

Wire connecting the battery to the shunt. Test point is the shunt.

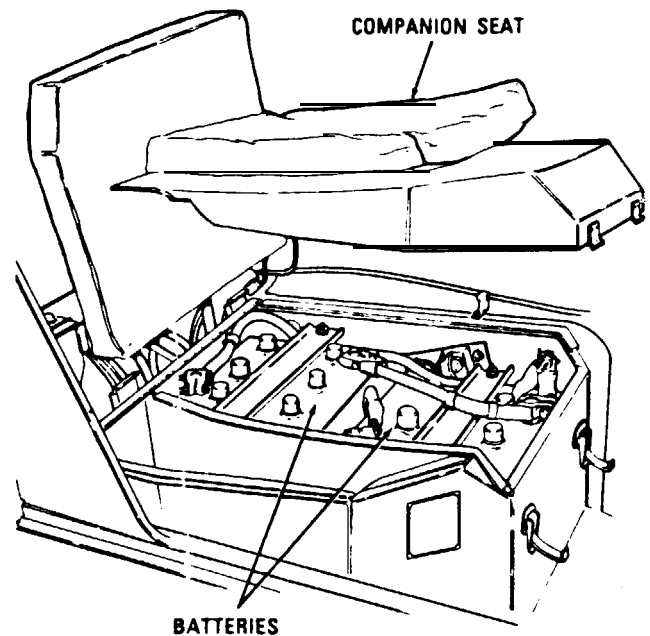
Wire connecting shunt to ground stud. Test point is the shunt.

For repair or replacement of cables, refer to (para. 4-73).

If you use STE/ICE-R test 67 in Step 3 on page 2-252, you may have a faulty DCA. Try running the tests using STE/ICE-R test 89 with the W2 cable.

See paragraph 4-79. (Also check each battery's specific gravity in accordance with TM 9-6140-200-14.)

Replace battery refer to (para. 4-79).

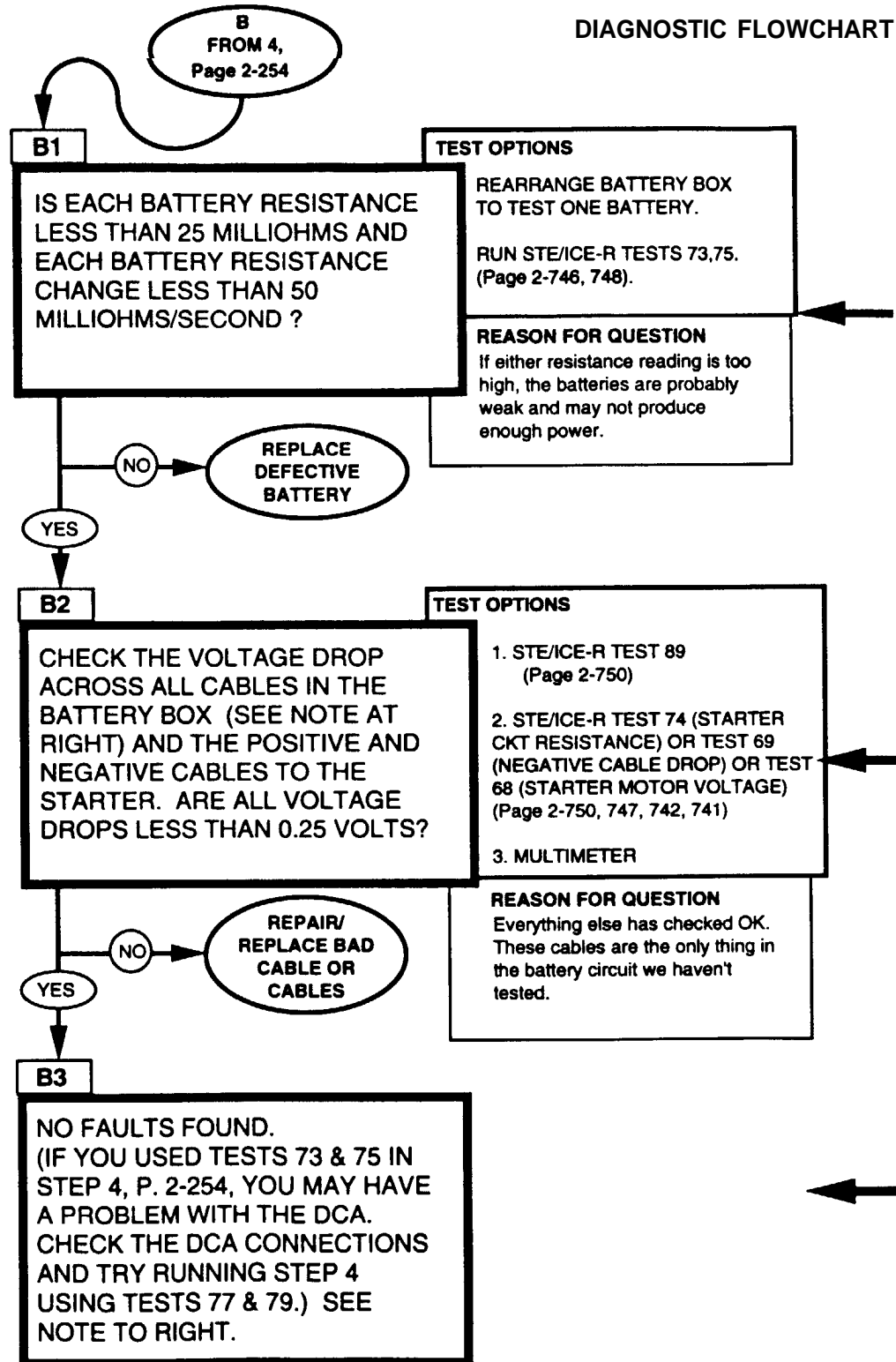


BATTERY CIRCUIT

DIAGNOSTIC FLOWCHART

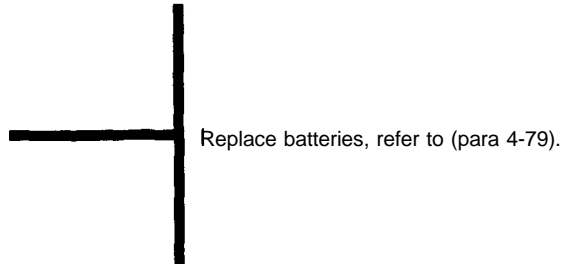
KNOWN INFO
BATTERY RESISTANCE NO GOOD
POSSIBLE PROBLEMS
BATTERIES CABLES

KNOWN INFO
BATTERIES OK
POSSIBLE PROBLEMS
CABLES



## REFERENCE INFORMATION

## BATTERY CIRCUIT



Replace batteries, refer to (para 4-79).

### NOTE

Check these cables  
 WIRE 68, correcting the batteries together. Test point is the positive terminal of one of the batteries.  
 WIRE 49A, connecting the battery to the power stud. Test point is the power stud.  
 Wire connecting the battery to the shunt. Test point is the negative terminal of the battery.  
 Wire connecting shunt to ground stud. Test point is the shunt.

Replace batteries, refer to (para 4-79).

### NOTE

Tests 77 and 79 are TK tests that do the same thing that DCA tests 73 and 75 do. See TM 9-4910-571-12&P for instructions on how to run these tests.

### BATTERY INTERNAL RESISTANCE STE/ICE-R TEST 73

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).
3. Start Test 73, battery internal resistance.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

### BATTERY RESISTANCE CHANGE STE/ICE-R TEST 75

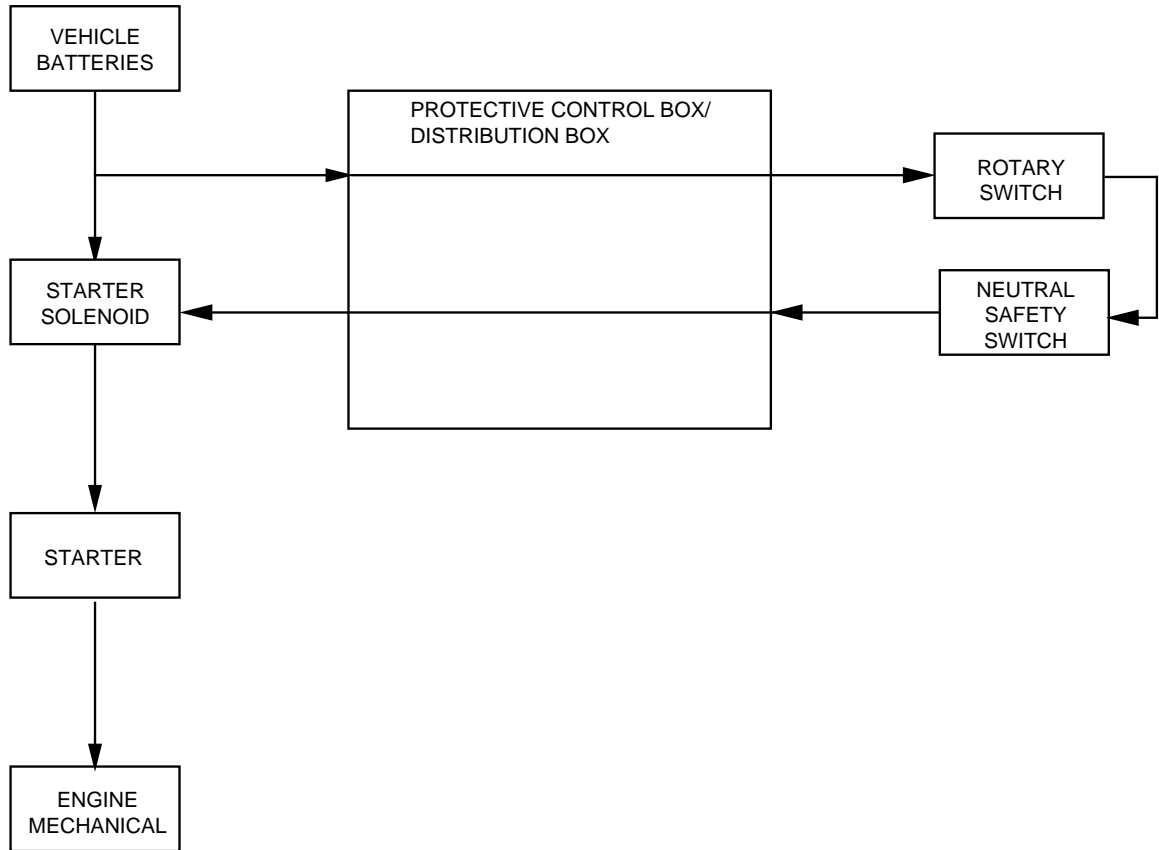
1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).
3. Start Test 75, battery resistance change.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms/second. Battery resistance change should be 50 milliohms/second max.

### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## 2-30. STARTER CIRCUIT TESTS

### STARTER CIRCUIT WITHOUT STARTER LOCKOUT



#### GENERAL DESCRIPTION

The Starter Circuit consists of the batteries, starter solenoid, starter motor, rotary switch, neutral safety switch, protective control box/distribution box, and related electrical wiring. The relationship of these parts is shown in the block diagram above, and a simplified functional flow schematic is provided on the foldout FO-8.

The starter solenoid and starter motor are enclosed in housings to protect them from dirt, icing conditions, and other road hazards.

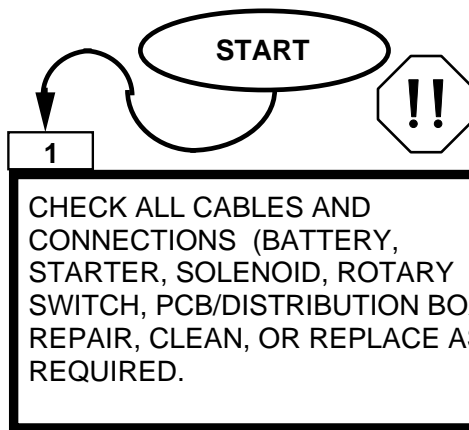
When the rotary switch is turned to "START," the starter solenoid is energized. The solenoid contacts close, sending battery power to the starter motor. The battery power causes the starter motor pinion gear to engage the engine flywheel ring gear and the engine cranks. When the engine starts, the rotary switch should be released, allowing it to return to the "RUN" position. This deenergizes the starter solenoid which, in turn, disengages the starter motor from the engine.

Solenoid current flows from the rotary switch through the neutral safety switch and protective control box/distribution box to the solenoid.

# STARTER CIRCUIT

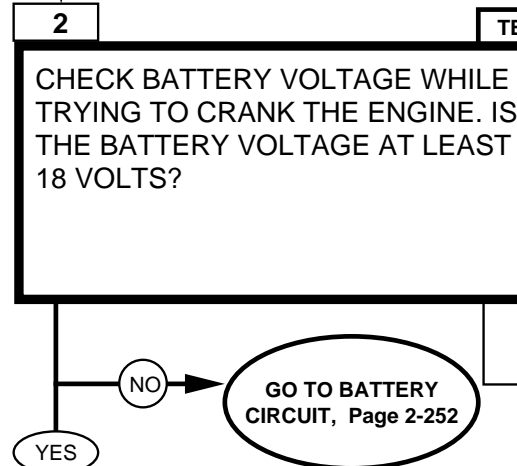
## DIAGNOSTIC FLOWCHART

KNOWN INFO
ENGINE WON'T CRANK OR CRANKS SLOWLY
POSSIBLE PROBLEMS
WIRING BATTERIES STARTER SOLENOID ROTARY SWITCH ENGINE LOCKED PCB/DISTRIBUTION BOX

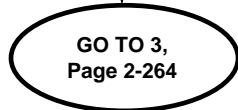


TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
Bad connections are a very common problem.

KNOWN INFO
CABLES & CONNECTORS APPEAR OK
POSSIBLE PROBLEMS
WIRING BATTERIES STARTER/SOLENOID ROTARY SWITCH ENGINE LOCK PCB/DISTRIBUTION BOX



TEST OPTIONS
1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER
3. VOLTS GAUGE
REASON FOR QUESTION
If the engine cranks you know the engine is not locked and the rotary switch is OK.





## REFERENCE INFORMATION

### BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH! The time you save may be your own.

Refer to the functional flow schematic and check the following:

1. BATTERY - make sure all connections are clean and tight, including the shunt and power stud.
2. STARTER - check the high current (heavy gauge wire 6A) wire at the starter. Don't just check for voltage; a loose connection will have voltage but can't carry much current.



### WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

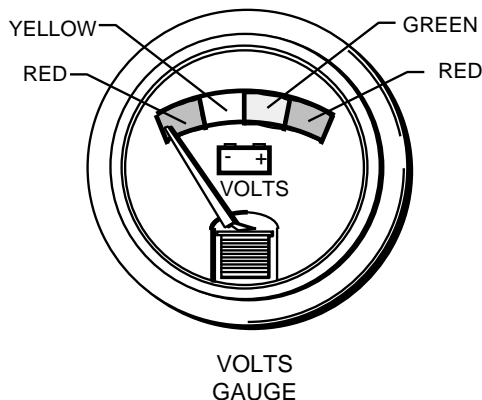
There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

2

3. PROTECTIVE CONTROL BOX/ DISTRIBUTION BOX - Unscrew BOTH connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.

4. ROTARY SWITCH - Check the wires at the switch. Don't just look. Feel the connections to make sure they're snug. Many problems can be solved by seeing with your fingers, not just your eyes.

A cold engine should crank at least 100 RPM.  
A warm engine should crank at least 180 RPM.



## STARTER CIRCUIT

### **BATTERY VOLTAGE STE/ICE-R TEST 67**

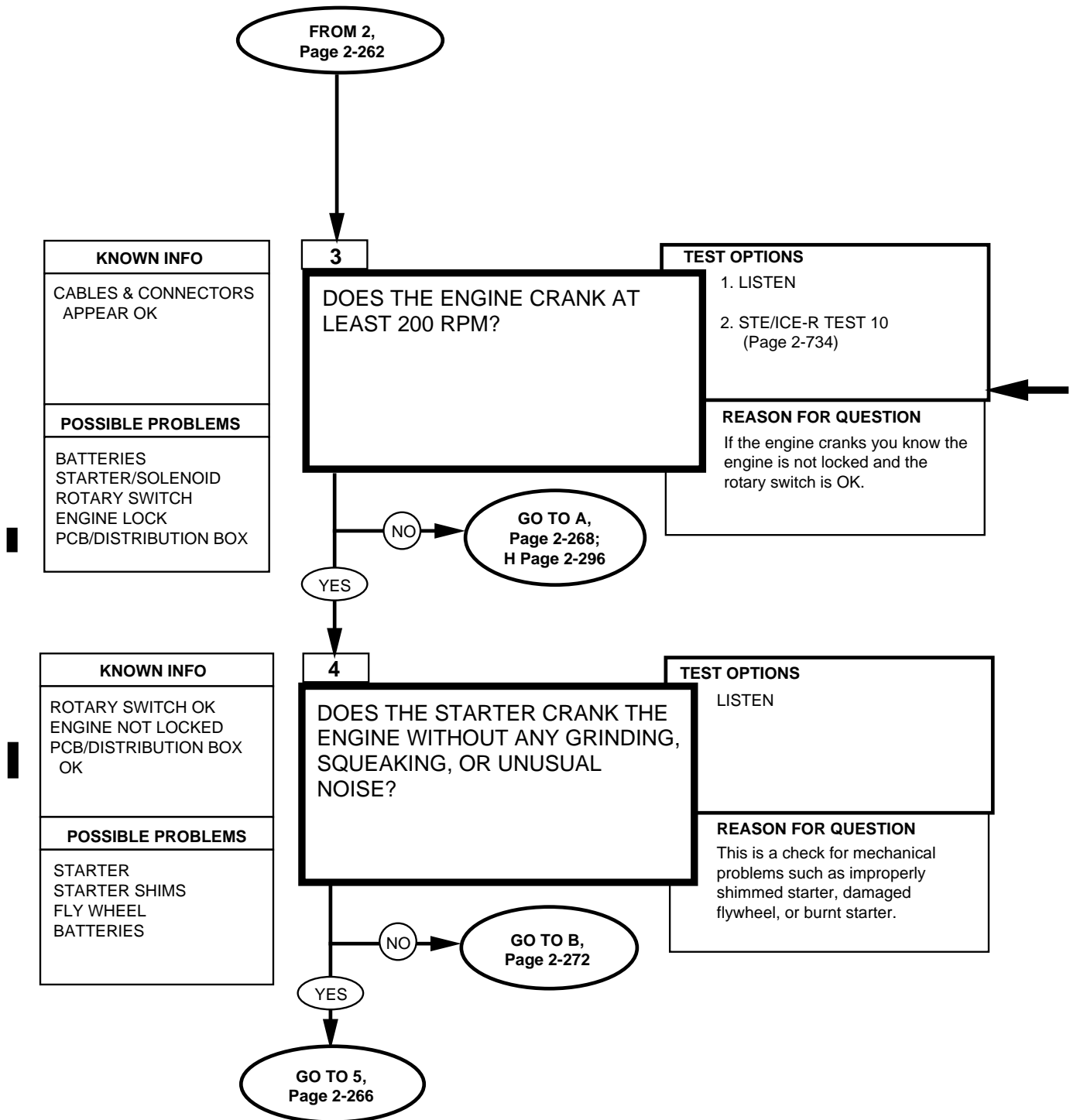
1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

### **BATTERY VOLTAGE MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

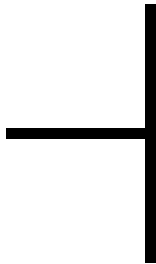
STARTER CIRCUIT

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## STARTER CIRCUIT

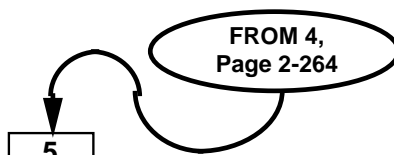


ENGINE RPM STE/ICE-R TEST 10
<ol style="list-style-type: none"> <li>1. Start Test 10, Engine RPM.</li> <li>2. Crank or start the engine. Displayed reading is RPM. Cranking RPM should be approximately 200. Idle RPM should be 625-675 (6.2L and 6.5L).</li> </ol>

# STARTER CIRCUIT

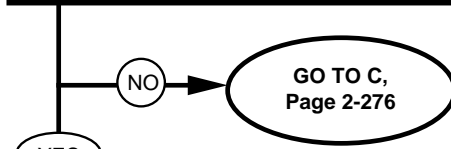
# DIAGNOSTIC FLOWCHART

KNOWN INFO
CRANKS OK
POSSIBLE PROBLEMS
ROTARY SWITCH STARTER PCB/DISTRIBUTION BOX



DOES THE STARTER STOP  
CRANKING WHEN THE ROTARY  
SWITCH IS RETURNED TO THE  
"RUN" OR "STOP" POSITIONS?

TEST OPTIONS
LISTEN
REASON FOR QUESTION
The starter solenoid could be stuck or, more likely there may be a short to the solenoid.



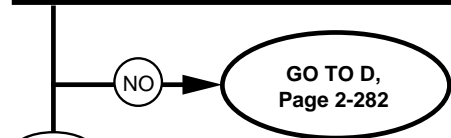
YES

KNOWN INFO
ROTARY SWITCH OK ENGINE NOT LOCKED PCB/DISTRIBUTION BOX OK
POSSIBLE PROBLEMS
BATTERIES STARTER/SOLENOID

6

IS THE AVERAGE STARTER  
CURRENT BETWEEN 200 & 300  
AMPS?

TEST OPTIONS
1. STE/ICE-R TEST 71 (Page 2-744)
2. MULTIMETER
REASON FOR QUESTION
This will tell if the starter is OK and if the batteries have enough power to crank the engine.



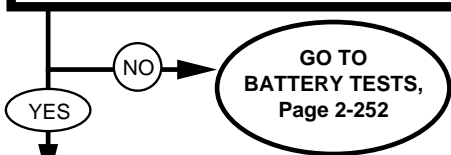
YES

KNOWN INFO
ROTARY SWITCH OK ENGINE NOT LOCKED STARTER OK
POSSIBLE PROBLEMS
BATTERIES

7

IS THE BATTERY VOLTAGE  
AT LEAST 18.5 VOLTS WHILE  
CRANKING?

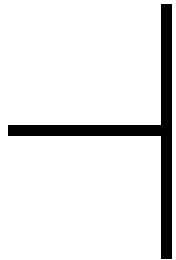
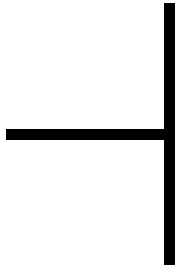
TEST OPTIONS
1. STE/ICE-R TEST 67 (Page 2-740)
2. MULTIMETER
REASON FOR QUESTION
A good cranking voltage, combined with a good starter current shows that the batteries are OK.



YES

NO FAULTS  
FOUND

## REFERENCE INFORMATION



## STARTER CIRCUIT

**STARTER AVERAGE CURRENT  
STE/ICE-R TEST 71**

1. Start Test 71, starter average current.
2. Displayed reading is in amps. The starter should draw at least 200 amps with a peak of over 400 amps.

**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts. 1000 amps. To get current, multiply millivolts x 10.

**BATTERY VOLTAGE  
STE/ICE-R TEST 67**

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

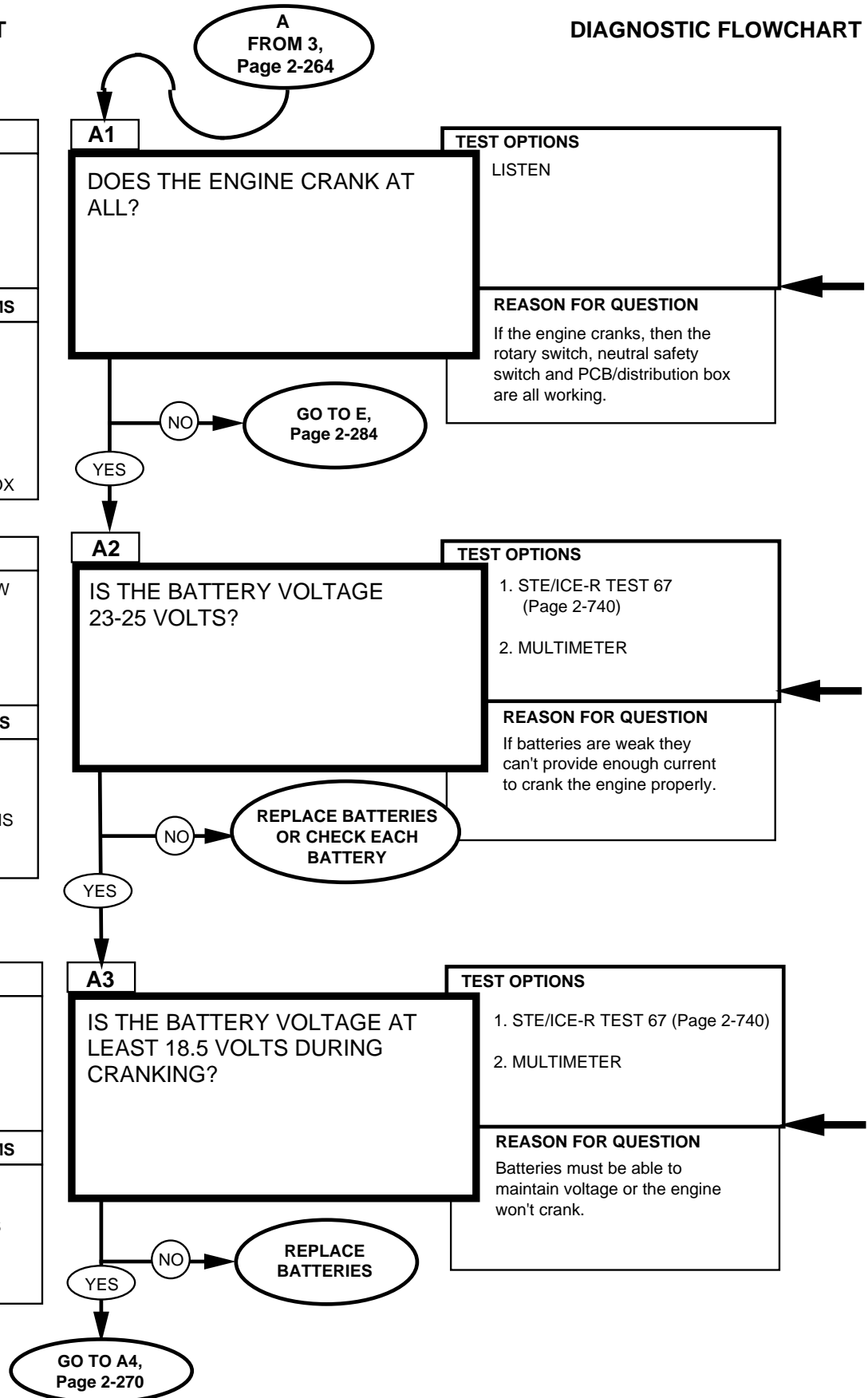
# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
ENGINE DOESN'T CRANK AT 200 RPM
POSSIBLE PROBLEMS
BATTERIES STARTER NEUTRAL SAFETY SWITCH CABLES/WIRING ENGINE MECHANICAL ROTARY SWITCH PCB/DISTRIBUTION BOX

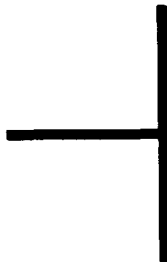
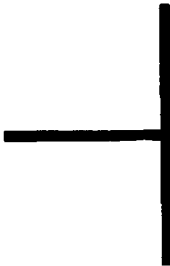
KNOWN INFO
ENGINE CRANKS SLOW
POSSIBLE PROBLEMS
BATTERIES STARTER ENGINE MECHANICAL CABLES/CONNECTIONS

KNOWN INFO
BATTERY VOLTS OK STARTER OK
POSSIBLE PROBLEMS
WEAK BATTERIES ENGINE MECHANICAL CABLES/CONNECTORS STARTER



REFERENCE INFORMATION

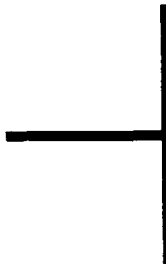
STARTER CIRCUIT



Connect red to  
positive = power stud

Connect black to  
negative = battery side of current shunt

Replace batteries, refer to (para 4-79).



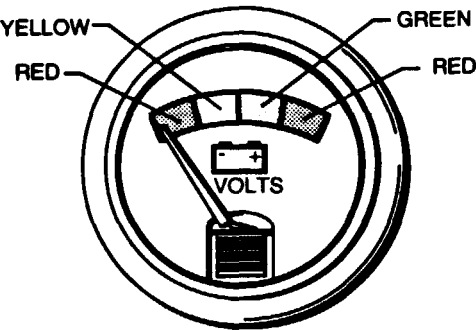
Connect red to  
positive = power stud

Connect black to  
negative = battery side of current shunt

Replace batteries, refer to (para 4-79).

<b>BATTERY VOLTAGE STE/ICE-R TEST 67</b>
1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

<b>VOLTAGE MULTIMETER</b>
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



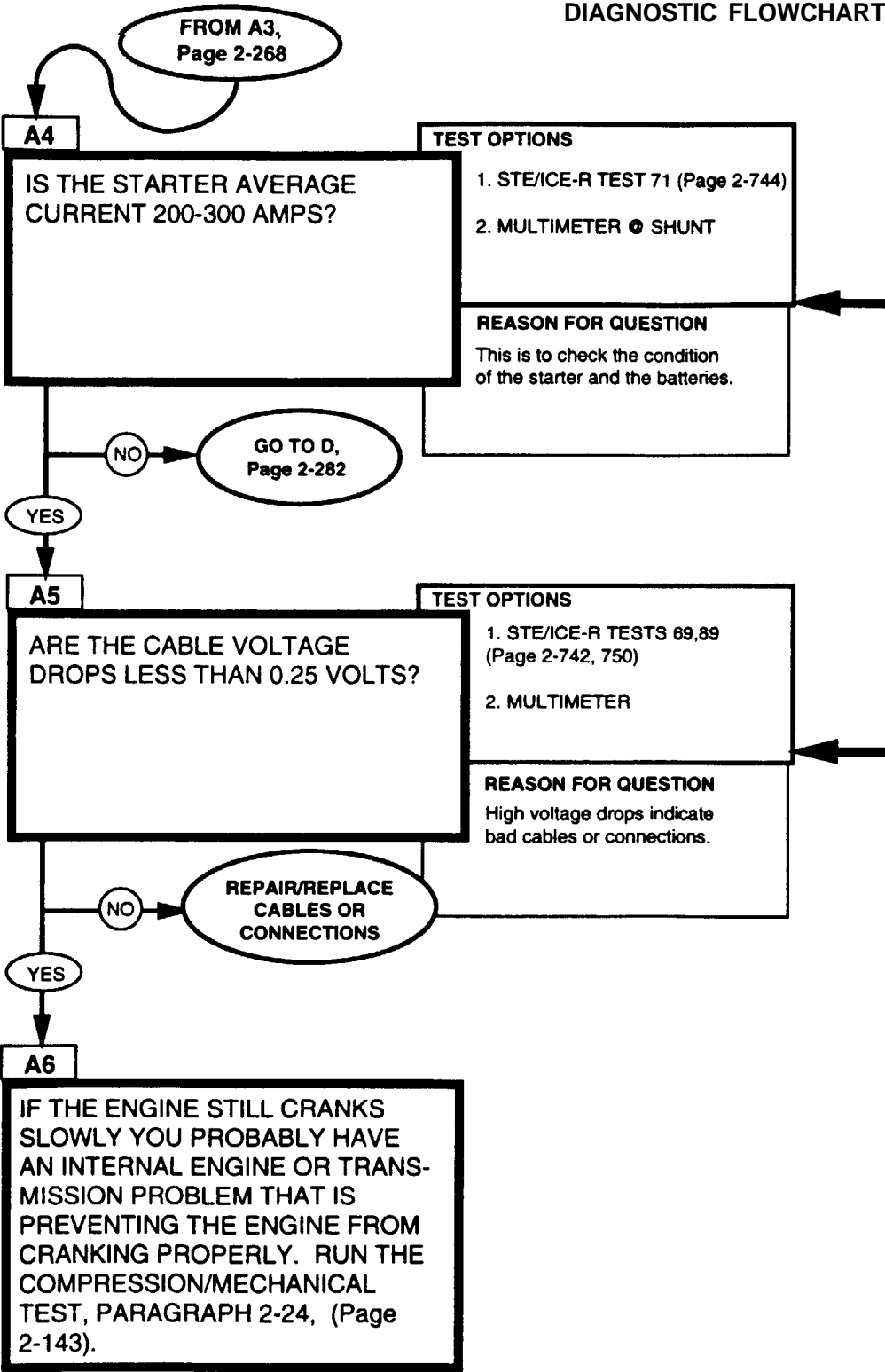
VOLTS GAUGE

STARTER CIRCUIT

DIAGNOSTIC FLOWCHART

KNOWN INFO
BATTERY VOLTAGE OK ENGINE CRANKS SLOW
POSSIBLE PROBLEMS
WEAK BATTERIES STARTER ENGINE MECHANICAL CABLES/CONNECTIONS

KNOWN INFO
BATTERIES OK STARTER OK
POSSIBLE PROBLEMS
CABLES/CONNECTIONS





## REFERENCE INFORMATION

## STARTER CIRCUIT

**STARTER AVERAGE CURRENT  
STE/ICE-R TEST 71**

1. Start Test 71, starter average current.
2. Displayed reading is in amps. The starter should draw at least 200 amps with a peak of over 400 amps.

**STARTER NEG. CABLE VOLTAGE DROP  
STE/ICE-R TEST 69**

1. Start Test 69, starter negative cable voltage drop.
2. Displayed reading is in volts. The cable voltage drop should be less than 0.25 volts max.

Check these cables;

Starter negative cable - STE/ICE-R test 69

Wire 68, connecting the batteries together.  
Test point is the positive battery post.

Wire 49A, connecting battery to power stud.  
Test point is the power stud.

Wire connecting battery to shunt (50A).  
Test point is the positive battery post.

Power stud to starter motor (6A). Test  
point is the power stud.

Replace or repair cables, refer to (para 4-73).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

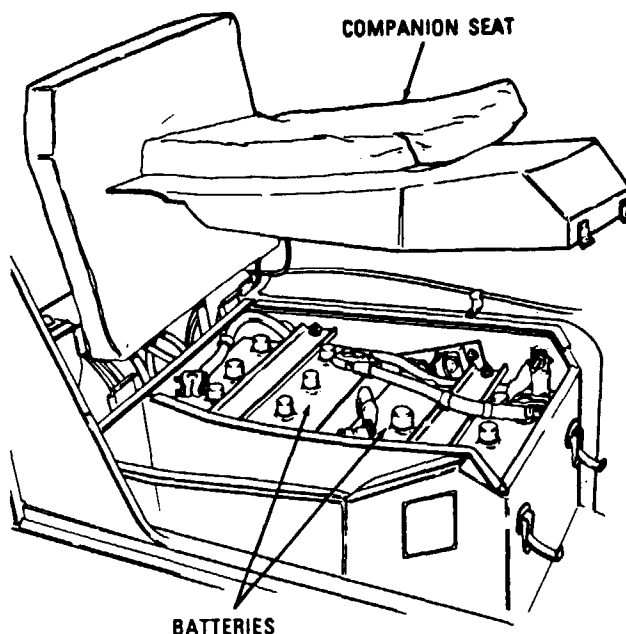
1. connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC Volts.
3. Displayed reading is in volts.

**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

**VOLTAGE  
MULTIMETER**

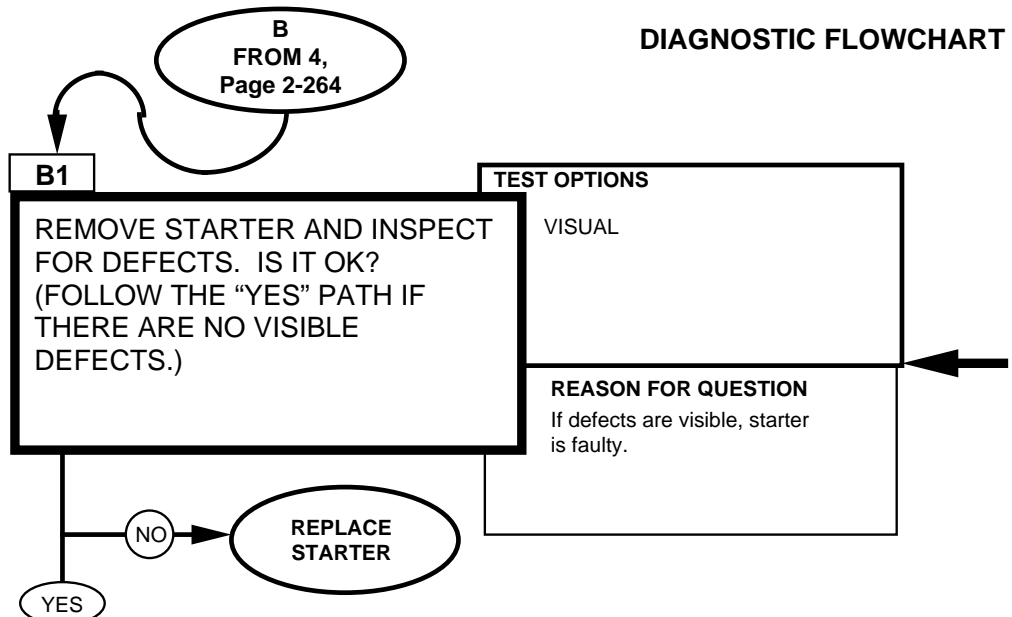
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



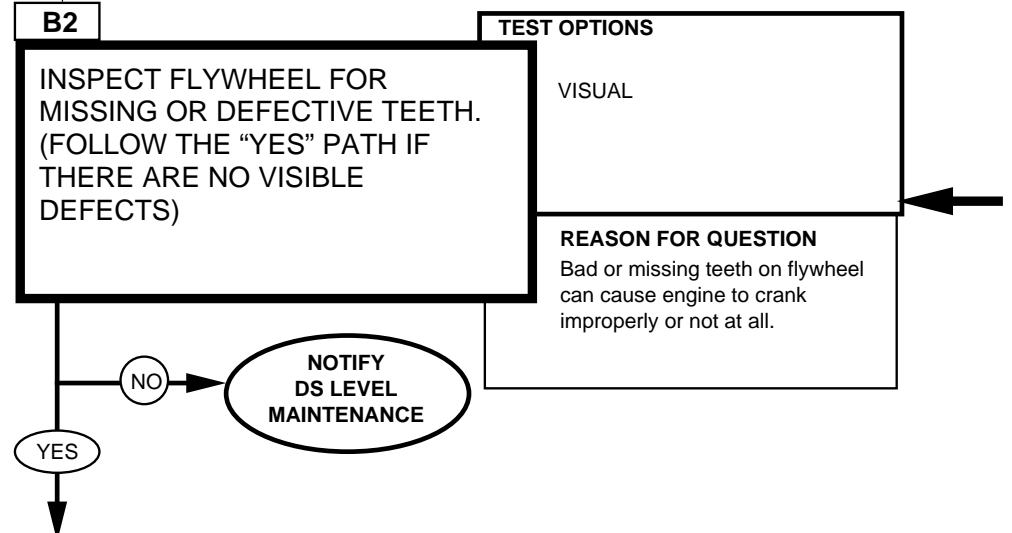
# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

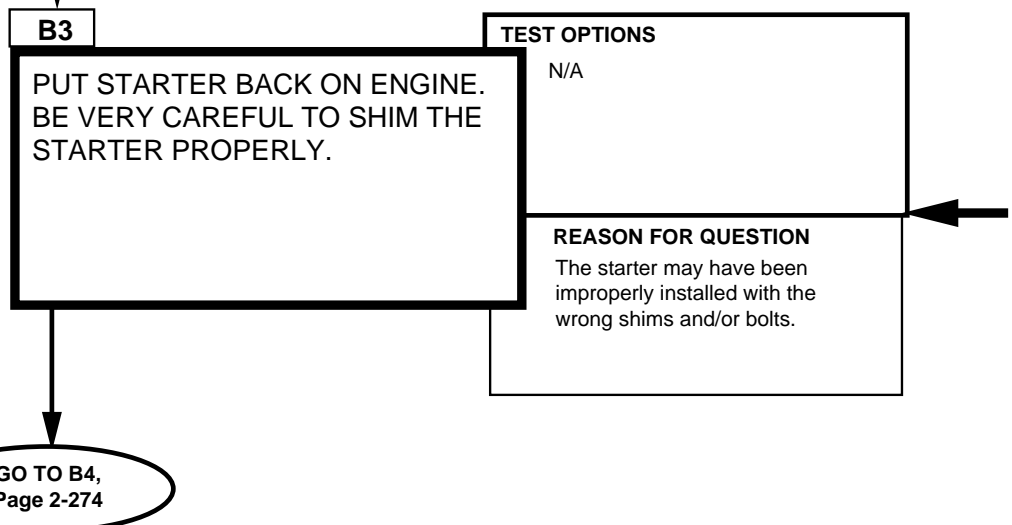
KNOWN INFO
BATTERIES OK PCB/DISTRIBUTION BOX OK NEUTRAL SAFETY SWITCH ROTARY SWITCH
POSSIBLE PROBLEMS
STARTER FLYWHEEL WIRING



KNOWN INFO
BATTERIES OK STARTER NOT VISIBLY DEFECTIVE
POSSIBLE PROBLEMS
STARTER FLYWHEEL WIRING

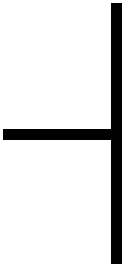


KNOWN INFO
BATTERIES OK FLYWHEEL OK STARTER NOT VISIBLY DEFECTIVE
POSSIBLE PROBLEMS
STARTER




## REFERENCE INFORMATION

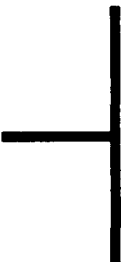
## STARTER CIRCUIT



Remove Starter motor.  
 Check the pinion and gear for missing or broken teeth, unusual wear, bent pieces, etc.  
 Check the pinion by turning it on the screw shaft.  
 Check the armature by prying the pinion with a screwdriver. The armature should turn freely.  
 Replace starter, refer to (para 4-8).



Disconnect the fuel solenoid, wire 54A, to prevent accidental starting. Rotate the engine with a breaker bar and socket on the crankshaft pulley to inspect the engine flywheel for missing or defective teeth.

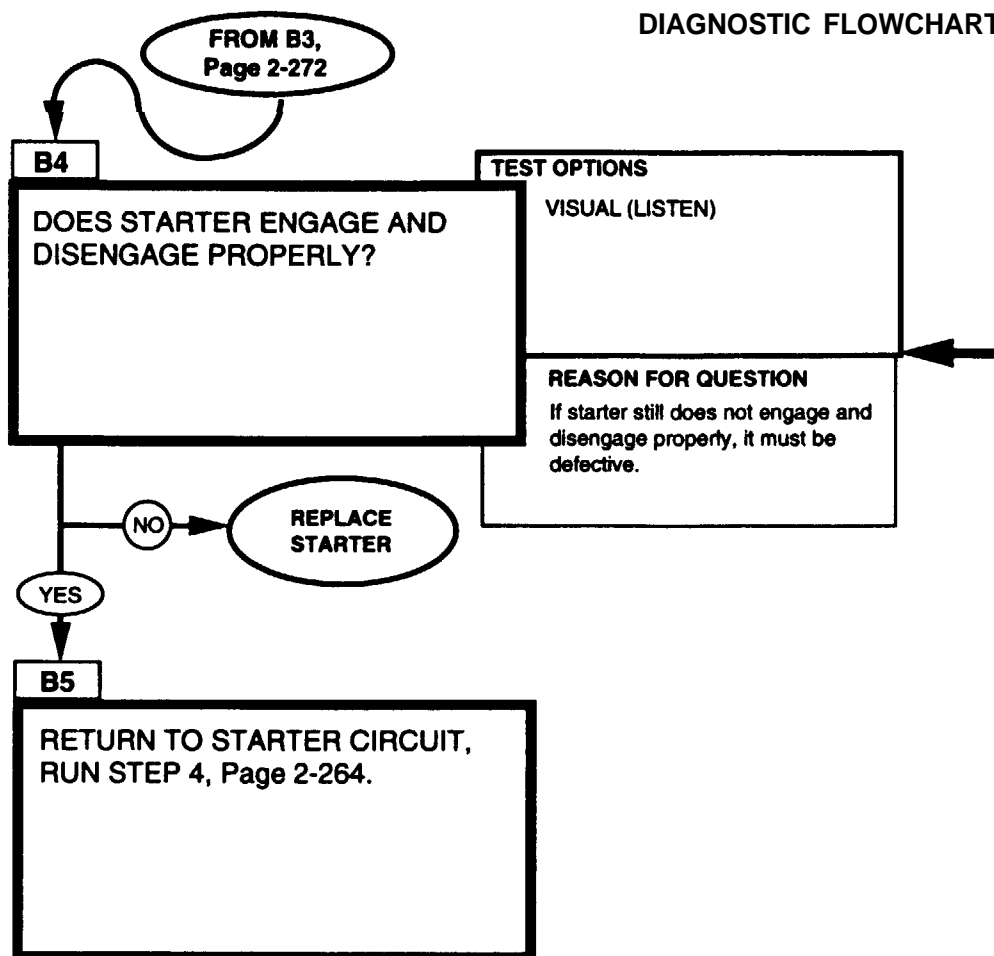


Replace starter, refer to (para 4-8).

# STARTER CIRCUIT

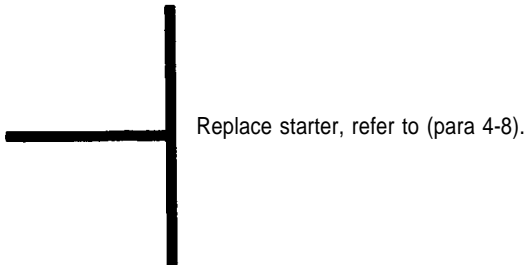
KNOWN INFO
BATTERIES OK WIRING OK STARTER NOT VISIBLY DEFECTIVE
POSSIBLE PROBLEMS
STARTER ENGINE

## DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

STARTER CIRCUIT



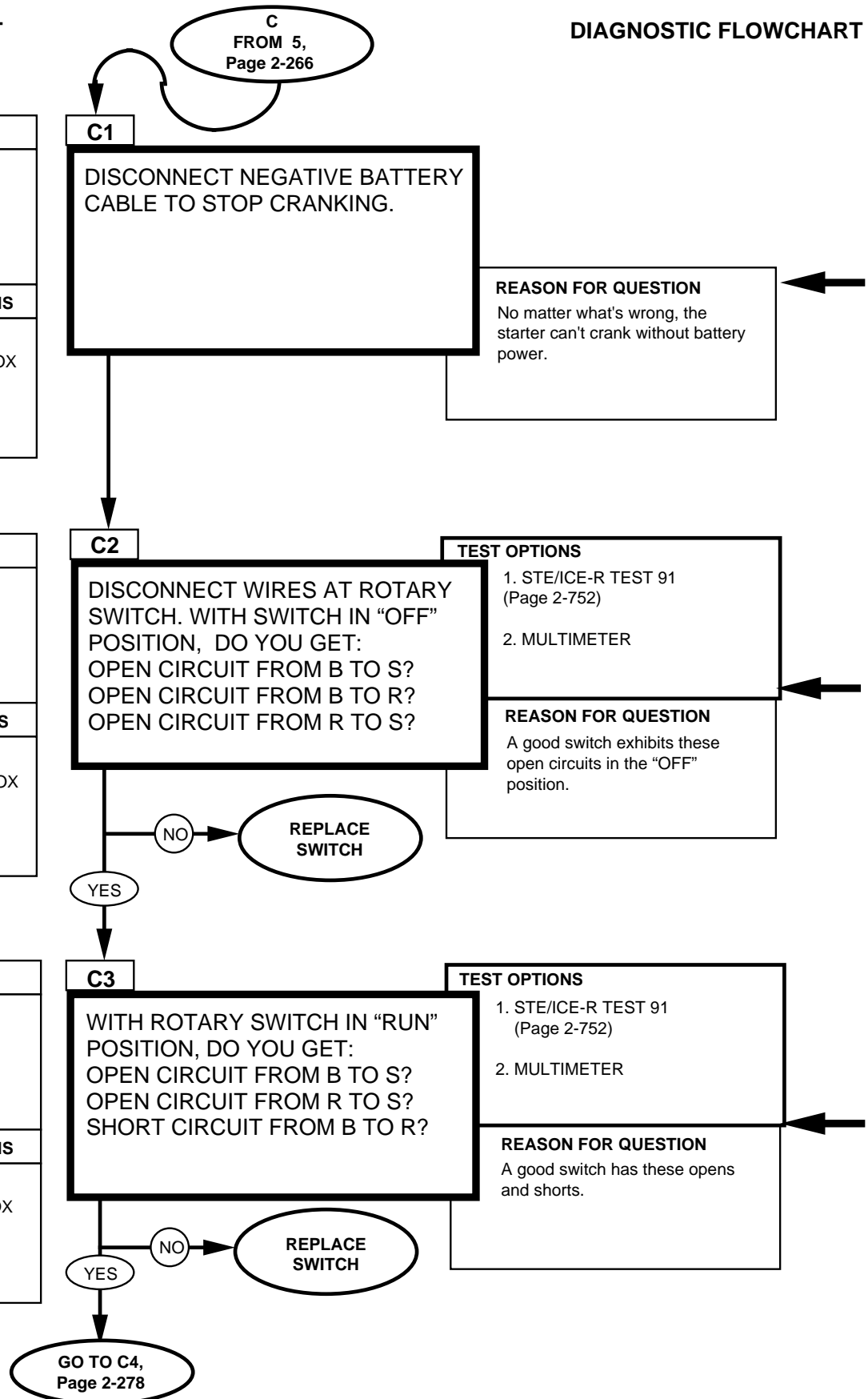
# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
ENGINE WON'T STOP CRANKING
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING STARTER

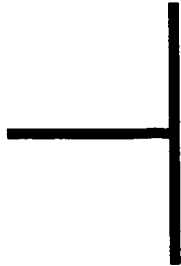
KNOWN INFO
ENGINE WON'T STOP CRANKING
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING STARTER

KNOWN INFO
ENGINE WON'T STOP CRANKING
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING STARTER

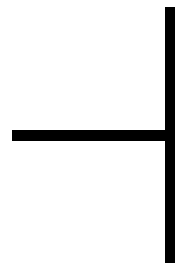


## REFERENCE INFORMATION

## STARTER CIRCUIT



<p align="center"><b>0-4500 OHMS STE/ICE-R TEST 91</b></p>
<p>1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.</p> <p>2. Start Test 91, 0-4500 ohms.</p> <p>3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."</p>

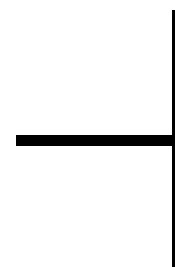


Don't forget that your vehicle batteries are disconnected, so you can't run the STE/ICE-R from the DCA, you have to use the power cable and connect directly to the batteries.

When the resistance is too high for STE/ICE-R to measure, as in the case of an open circuit, STE/ICE-R displays "9.9.9.9."

Replace rotary switch, refer to (pare 4-7).

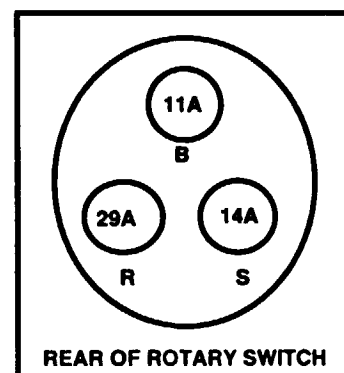
<p align="center"><b>CONTINUITY (RESISTANCE) MULTIMETER</b></p>
<p>1. Set the voltmeter to an ohms scale of about 1000 ohms.</p> <p>2. Connect the RED and BLACK leads to the connections stated in the question.</p> <p>3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).</p>



Don't forget that your vehicle batteries are disconnected, so you can't run the STE/ICE-R from the DCA, you have to use the power cable and connect directly to the batteries.

When the resistance is too high for STE/ICE-R to measure, es in the case of an open circuit, STE/ICE-R displays "9.9.9.9."

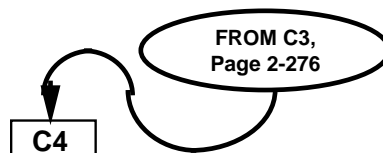
Replace rotary switch, refer to (para 4-7).



# STARTER CIRCUIT

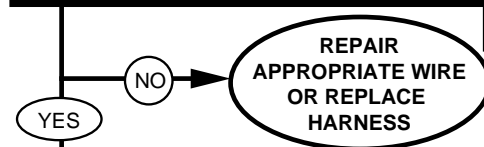
# DIAGNOSTIC FLOWCHART

KNOWN INFO
ROTARY SWITCH OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING STARTER



RECONNECT ROTARY SWITCH. TURN SWITCH TO "STOP." CHECK FOR OPEN CIRCUIT IN THE PCB BODY CONNECTOR HARNESS BETWEEN THE FOLLOWING SOCKETS; G-A, G-B, A-B, F-A, AND F-B. ARE THEY ALL OPEN CIRCUITS ?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
Continuity between any of these pins indicates a short between the wires in body harness

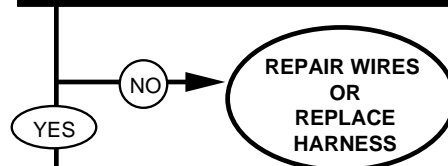


KNOWN INFO
ROTARY SWITCH OK BODY HARNESS OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING STARTER

**C5**

RECONNECT BODY CONNECTOR. DISCONNECT ENGINE CONNECTOR. DISCONNECT WIRE 74A AT STARTER. IS THERE AN OPEN CIRCUIT FROM SOCKET E TO SOCKET I ENGINE CONNECTOR HARNESS?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
Continuity between these pins indicates a short in the engine harness.

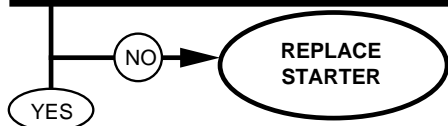


KNOWN INFO
ROTARY SWITCH OK BODY HARNESS OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING STARTER

**C6**

IS THERE AN OPEN CIRCUIT FROM SOCKET E OF PCB/DISTRIBUTION BOX ENGINE CONNECTOR HARNESS TO ENGINE GROUND?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
Continuity indicates shorted connector in the starter solenoid.



GO TO C7,  
Page 2-280



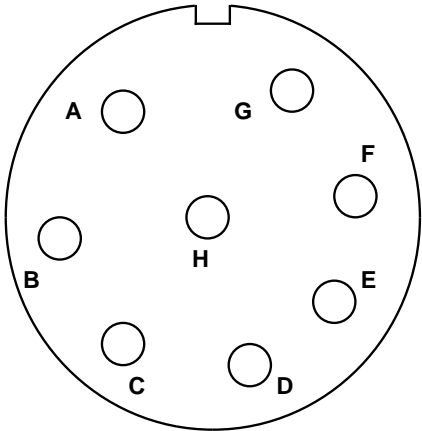
REFERENCE INFORMATION

STARTER CIRCUIT

Don't forget that your vehicle batteries are disconnected, so you can't run the STE/ICE-R from the DCA, you have to use the power cable and connect directly to the batteries.

When the resistance is too high for STE/ICE-R to measure, as in the case of an open circuit, STE/ICE-R displays "9.9.9.9."

Repair wiring or replace harness, refer to (para. 4-85).



PCB/DISTRIBUTION BOX BODY CONNECTOR

Check the wires at the connectors for shorts. If there are no visible shorts, you have to replace the harness.

Repair wiring or replace harness, refer to (para. 4-85).

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

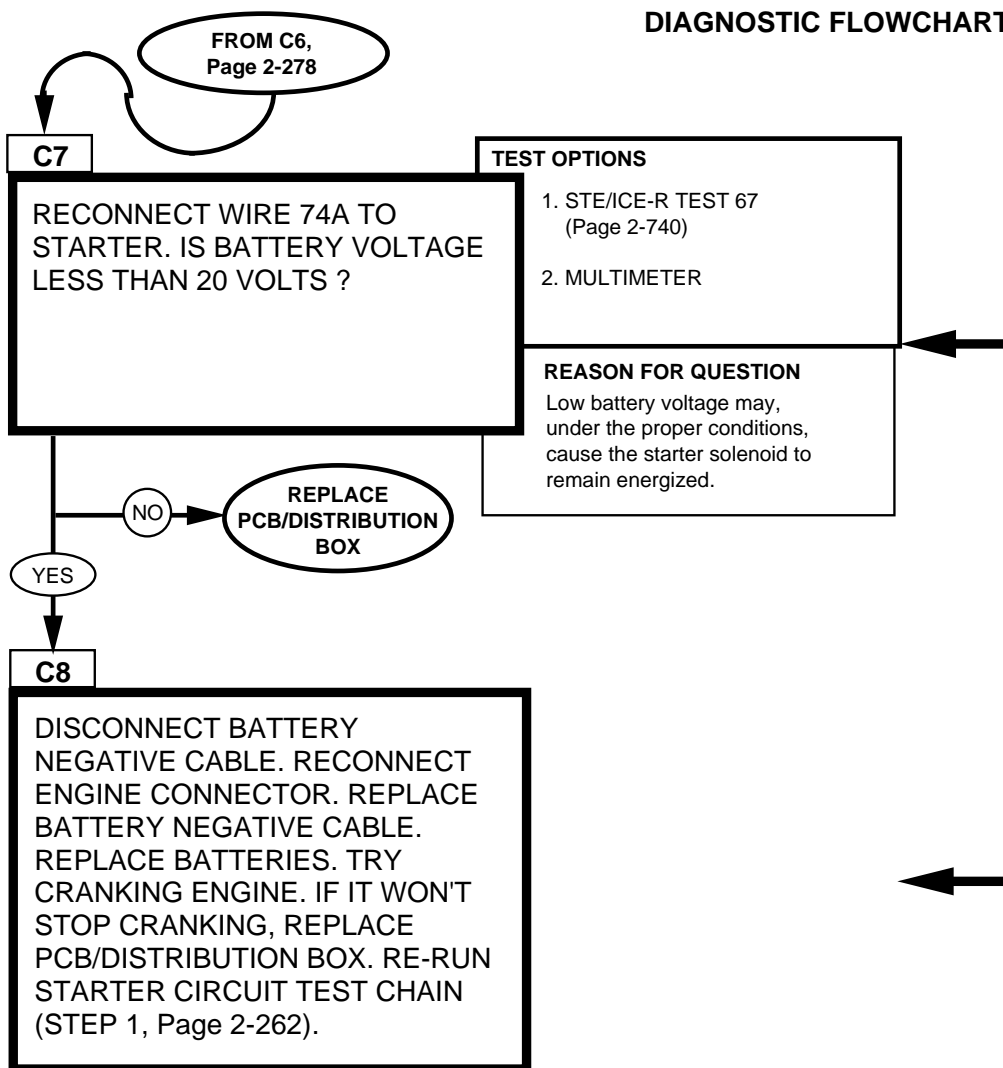
Replace starter, refer to (para. 4-8).

# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
ENGINE HARNESS OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX BATTERY

KNOWN INFO
ENGINE HARNESS OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX BATTERY



REFERENCE INFORMATION

STARTER CIRCUIT

Replace PCB, refer to (para. 4-5).  
Replace distribution box (para. 4-5.1).

BATTERY VOLTAGE  
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.  
  
2. Connect the RED lead to positive and the BLACK lead to negative.  
  
3. Be sure to read the correct scale.

Replace batteries, refer to (para. 4-79).  
Replace distribution box (para. 4-5.1).

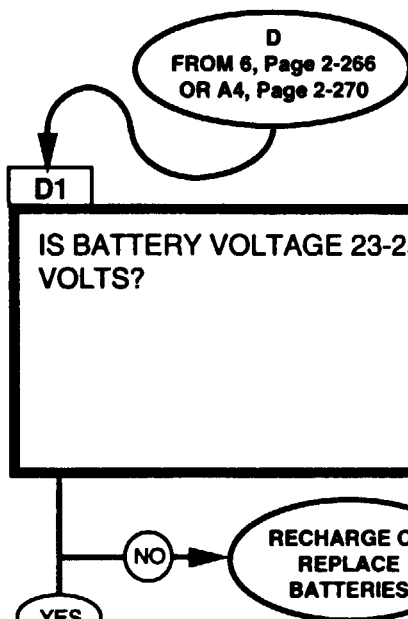
BATTERY VOLTAGE  
STE/ICE-R TEST 67

1. Start Test 67, battery voltage.  
  
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

# STARTER CIRCUIT

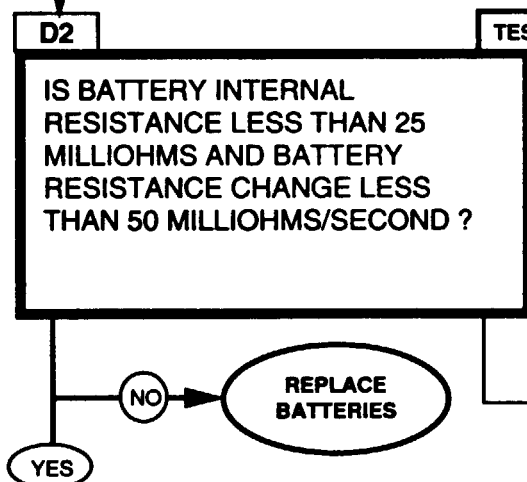
## DIAGNOSTIC FLOWCHART

KNOWN INFO
CURRENT DRAW TOO HIGH OR LOW.
POSSIBLE PROBLEMS
BATTERIES STARTER CABLES



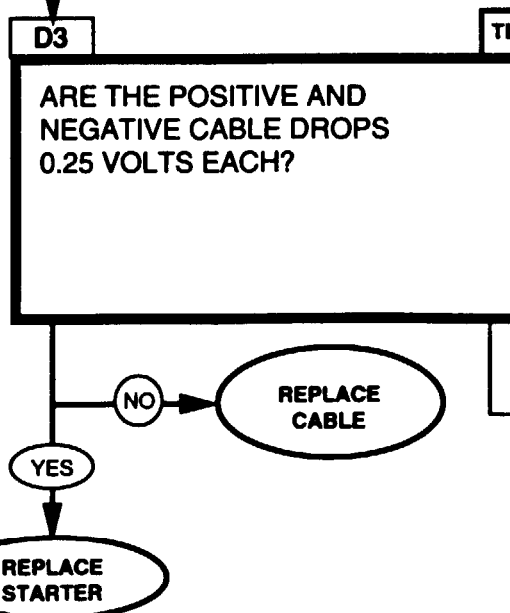
TEST OPTIONS
1. STE/ICE-R TEST 67 (Page 2-740) 2. MULTIMETER
REASON FOR QUESTION
Low voltage may indicate low battery capacity.

KNOWN INFO
BATTERY VOLTAGE OK
POSSIBLE PROBLEMS
BATTERIES STARTER CABLES



TEST OPTIONS
STE/ICE-R TESTS 73,75 (Page 2-746, 748)
REASON FOR QUESTION
Battery resistance and resistance change is an indication of the ability of the battery to supply current.

KNOWN INFO
BATTERIES OK
POSSIBLE PROBLEMS
STARTER CABLES



TEST OPTIONS
1. STE/ICE-R TESTS 69,89 (Page 2-742, 750) 2. MULTIMETER
REASON FOR QUESTION
High cable resistance may limit current flow.

## REFERENCE INFORMATION

## STARTER CIRCUIT

Replace batteries, refer to (para 4-79).

### BATTERY VOLTAGE STE/ICE-R TEST 67

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

Replace batteries, refer to (para 4-79).

### BATTERY INTERNAL Resistance STE/ICE-R TEST 73

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).
3. Start Test 73, battery internal resistance.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms. Battery resistance should be 25 milliohms max.

Replace cables or starter, refer to (para 4-77 or 4-8).

### STARTER NEG. CABLE VOLTAGE DROP STE/ICE-R TEST 69

1. Start Test 69, starter negative cable voltage drop.
2. Displayed reading is in volts. The cable voltage drop should be less than 0.25 volts max.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

### BATTERY RESISTANCE CHANGE STE/ICE-R TEST 75

1. Disconnect wire 54A at injection pump to prevent starting.
2. Disconnect glowplug controller and fan solenoid (to keep waveform clean).
3. Start Test 75, battery resistance change.
4. Wait for the GO message. Crank the engine.
5. Result is displayed in milliohms/second. Battery resistance change should be 50 milliohms/second max.

### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volta scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

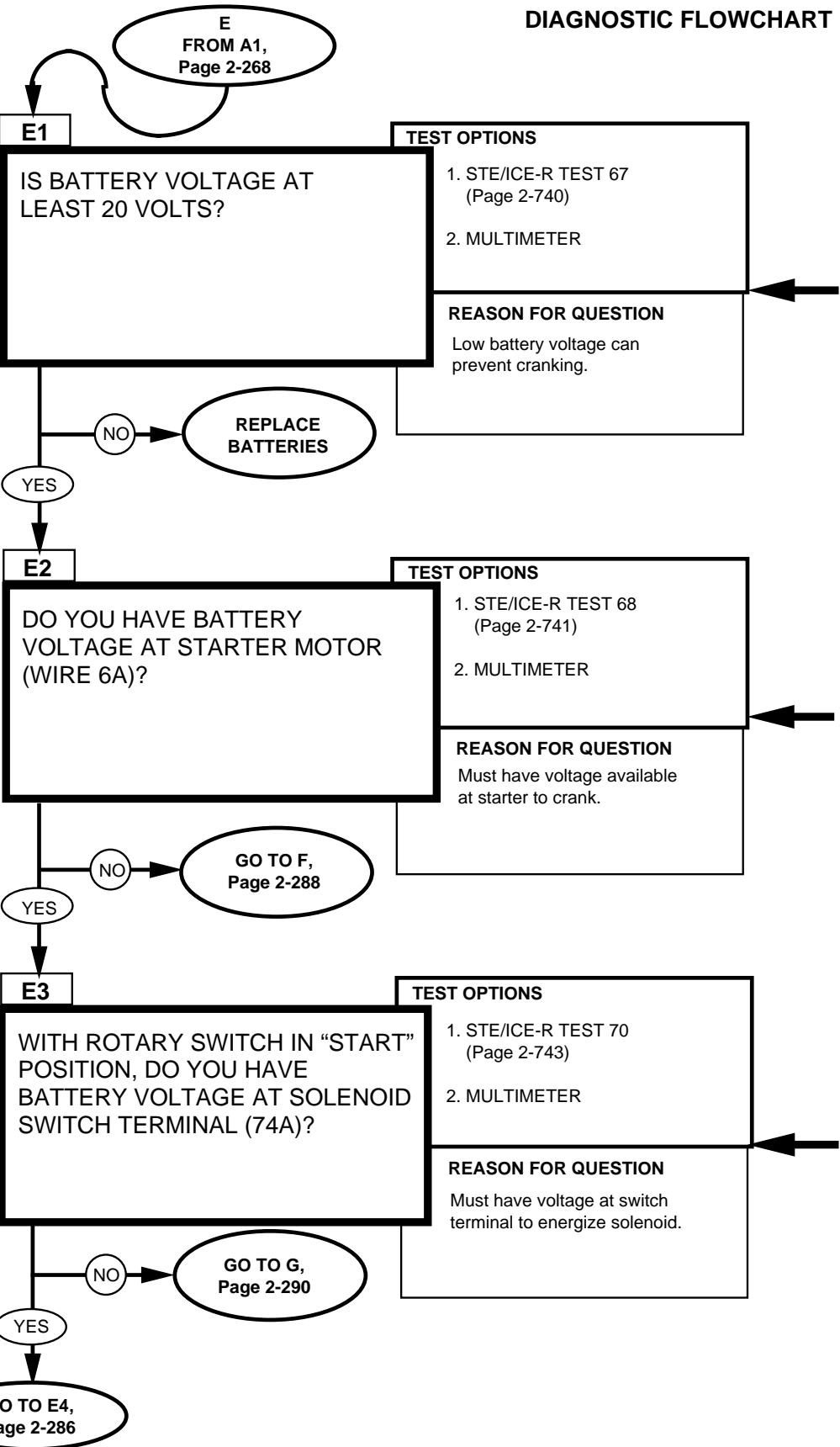
STARTER CIRCUIT

DIAGNOSTIC FLOWCHART

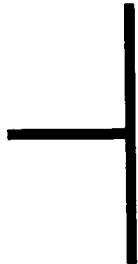
KNOWN INFO
ENGINE WON'T CRANK
POSSIBLE PROBLEMS
BATTERY STARTER PCB/DISTRIBUTION BOX ROTARY SWITCH NEUTRAL SAFETY SWITCH WIRING/CABLES LOCKED ENGINE

KNOWN INFO
BATTERY SHOULD AT LEAST CRANK ENGINE SLOWLY.
POSSIBLE PROBLEMS
STARTER PCB/DISTRIBUTION BOX ROTARY SWITCH NEUTRAL SAFETY SWITCH WIRING/CABLES LOCKED ENGINE

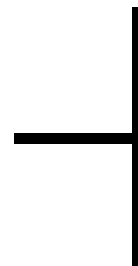
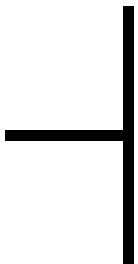
KNOWN INFO
VOLTAGE AVAILABLE AT STARTER
POSSIBLE PROBLEMS
BATTERY STARTER PCB/DISTRIBUTION BOX ROTARY SWITCH NEUTRAL SAFETY SWITCH WIRING/CABLES LOCKED ENGINE



## REFERENCE INFORMATION



Replace batteries, refer to (para 4-79).



## STARTER CIRCUIT

### BATTERY VOLTAGE STE/ICE-R TEST 67

1. Start Test 67, battery voltage.
2. Displayed reading is in volts. Batteries should be 23-25.5 volts. Batteries voltage will drop when glowplugs turn on.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

### STARTER MOTOR VOLTAGE STE/ICE-R TEST 68

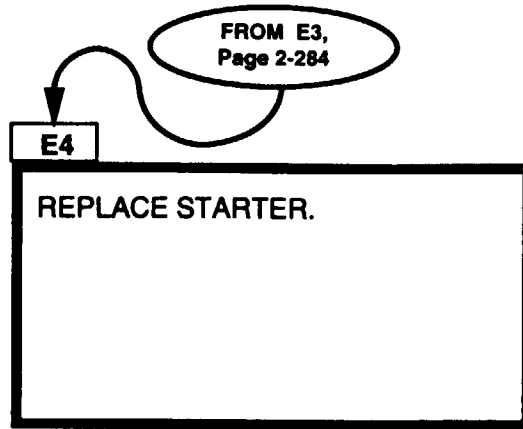
1. Start Test 68, starter motor voltage.
2. Displayed reading is in volts. Starter motor voltage should be the same as battery voltage, 23-25.5 volts. During cranking the starter motor voltage should be at least 18 volts.

### STARTER SOLENOID VOLTAGE STE/ICE-R TEST 70

1. Start Test 70, starter solenoid voltage.
2. Displayed reading is in volts. Starter solenoid voltage should be the same as battery voltage, 23-25.5 volts. During cranking the starter solenoid voltage should be at least 18 volts.

## STARTER CIRCUIT

KNOWN INFO
ENGINE FREE
POSSIBLE PROBLEMS
STARTER



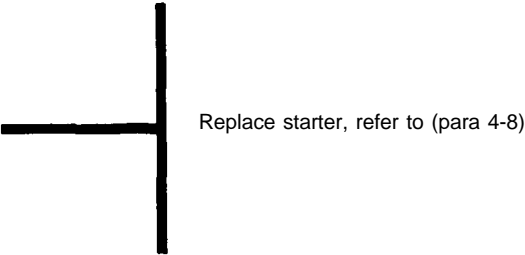
## DIAGNOSTIC FLOWCHART





REFERENCE INFORMATION

STARTER CIRCUIT

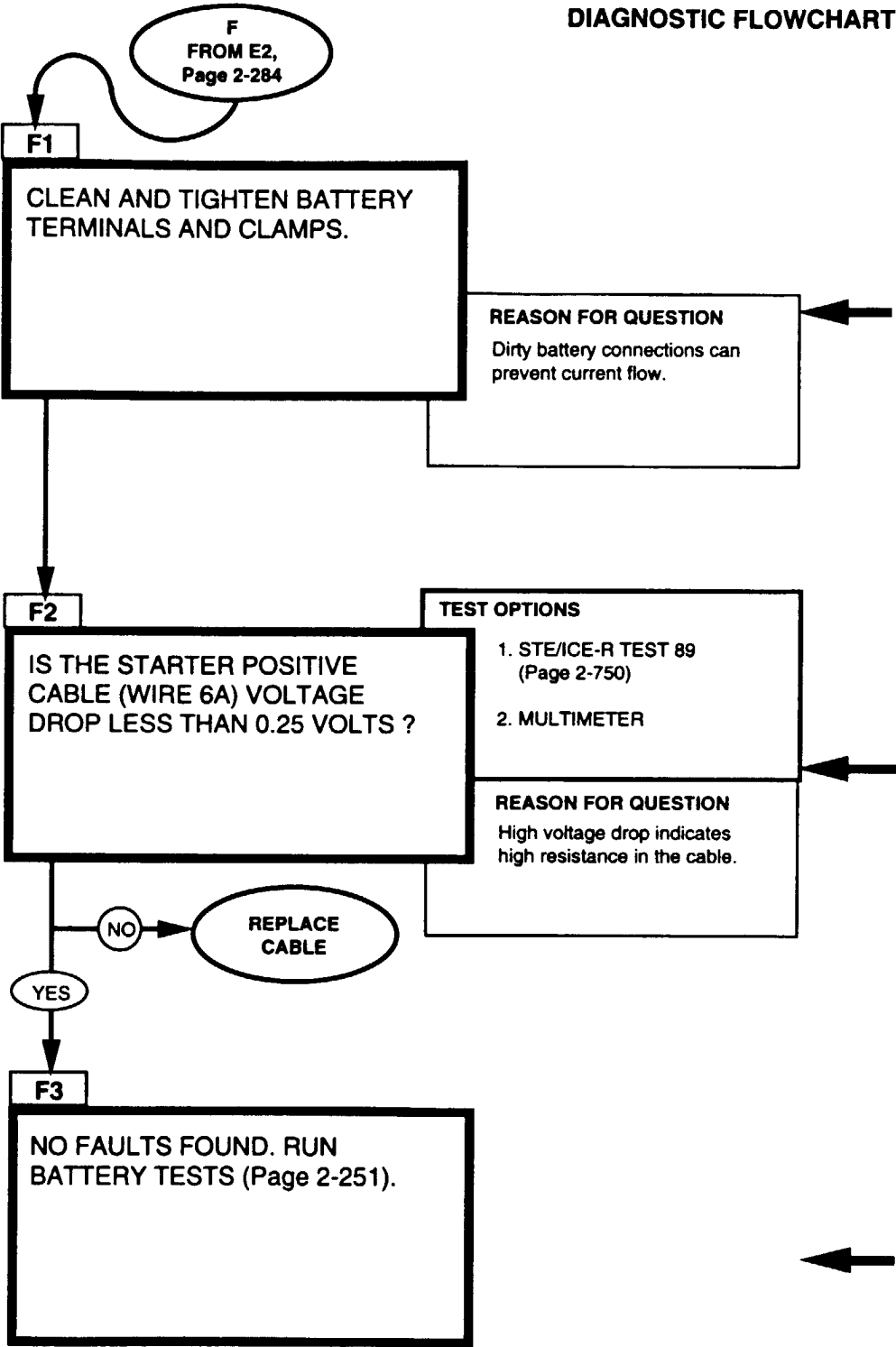


STARTER CIRCUIT

DIAGNOSTIC FLOWCHART

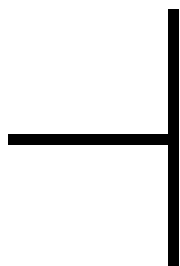
KNOWN INFO
BATTERY VOLTAGE NOT AVAILABLE AT SOLENOID STUD.
POSSIBLE PROBLEMS
CABLES, CONNECTIONS

KNOWN INFO
BATTERY CONNECTIONS OK
POSSIBLE PROBLEMS
CABLE



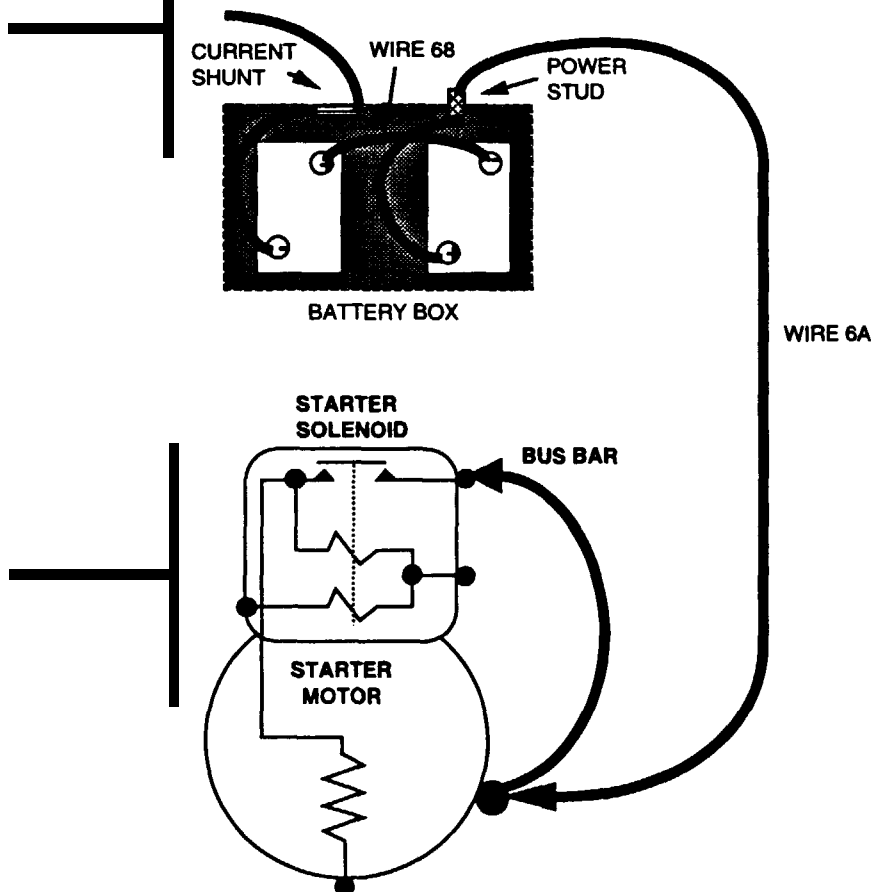
# REFERENCE INFORMATION

# STARTER CIRCUIT



Replace cable, refer to (para 4-77).

Put the red lead on the power stud, and the black on the terminal of the starter in order to measure the voltage along wire 6A.



## 0-45 DC VOLTS ST/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

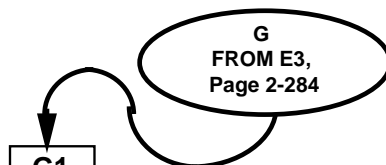
## VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
NO SOLENOID CONTROL VOLTAGE
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING ROTARY SWITCH NEUTRAL SAFETY SWITCH



DISCONNECT WIRE 14A AT THE  
NEUTRAL SAFETY SWITCH.  
TURN ROTARY SWITCH TO  
START. IS THERE BATTERY  
VOLTAGE AT WIRE 14A (THE  
NEUTRAL SAFETY SWITCH END)?

TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
REASON FOR QUESTION
Current flows to neutral safety switch before reaching solenoid.

NO → GO TO I,  
Page 2-298

YES

KNOWN INFO
VOLTAGE AVAILABLE ROTARY SWITCH OK
POSSIBLE PROBLEMS
NEUTRAL SAFETY SWITCH PCB/DISTRIBUTION BOX WIRING

G2

DISCONNECT WIRE 14B AT  
NEUTRAL SAFETY SWITCH.  
IS THERE CONTINUITY ACROSS  
NEUTRAL SAFETY SWITCH?  
(WIRE 14 TO WIRE 14)

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
If there is no continuity, then current will not flow through switch.

NO → REPLACE  
NEUTRAL SAFETY  
SWITCH

YES



KNOWN INFO
NEUTRAL SAFETY SWITCH OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX WIRING

G3

DISCONNECT BODY CONNECTOR  
FROM PROTECTIVE CONTROL  
BOX/DISTRIBUTION BOX. IS THERE  
CONTINUITY FROM WIRE 14B AT  
NEUTRAL SAFETY SWITCH TO  
BODY CONNECTOR HARNESS  
SOCKET "A"?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
An open wire here could have prevented current flow between PCB/distribution box and neutral switch.

NO → REPAIR 14B  
OR REPLACE  
HARNESS

YES

GO TO G4,  
Page 2-292

REFERENCE INFORMATION

STARTER CIRCUIT

The connections for the neutral safety switch can be reached by removing the engine cover. The connections are near the gear shift lever.

Replace rotary switch, refer to (para. 4-7).



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Repair wiring or replace switch, refer to (para. 4-7).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

**VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.

2. Connect the RED lead to positive and the BLACK lead to negative.

3. Be sure to read the correct scale.

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

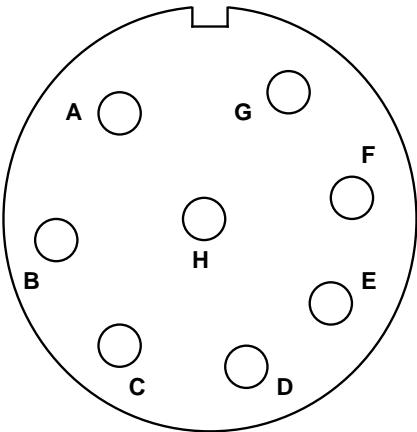
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

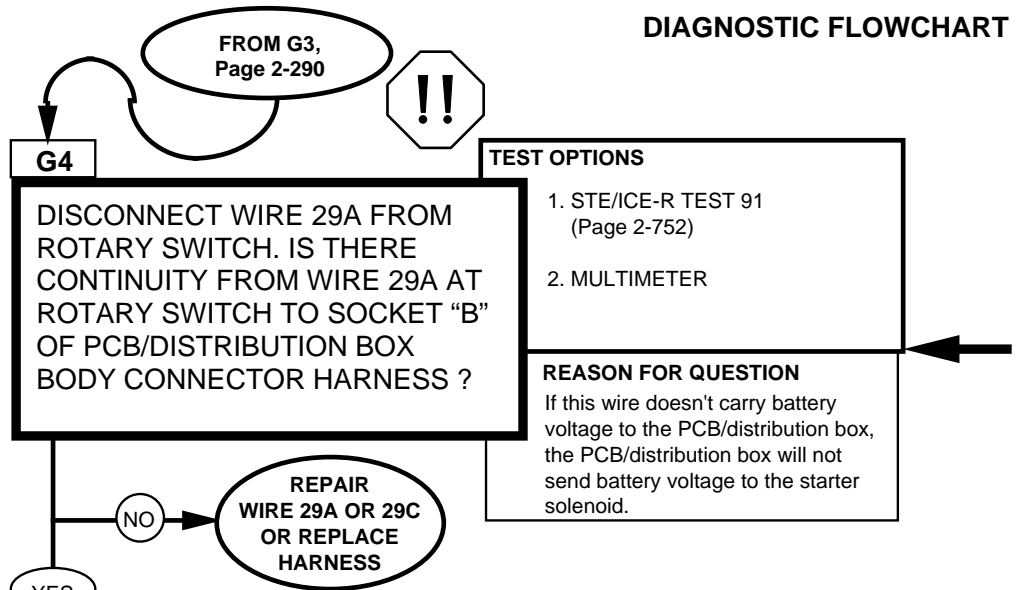
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



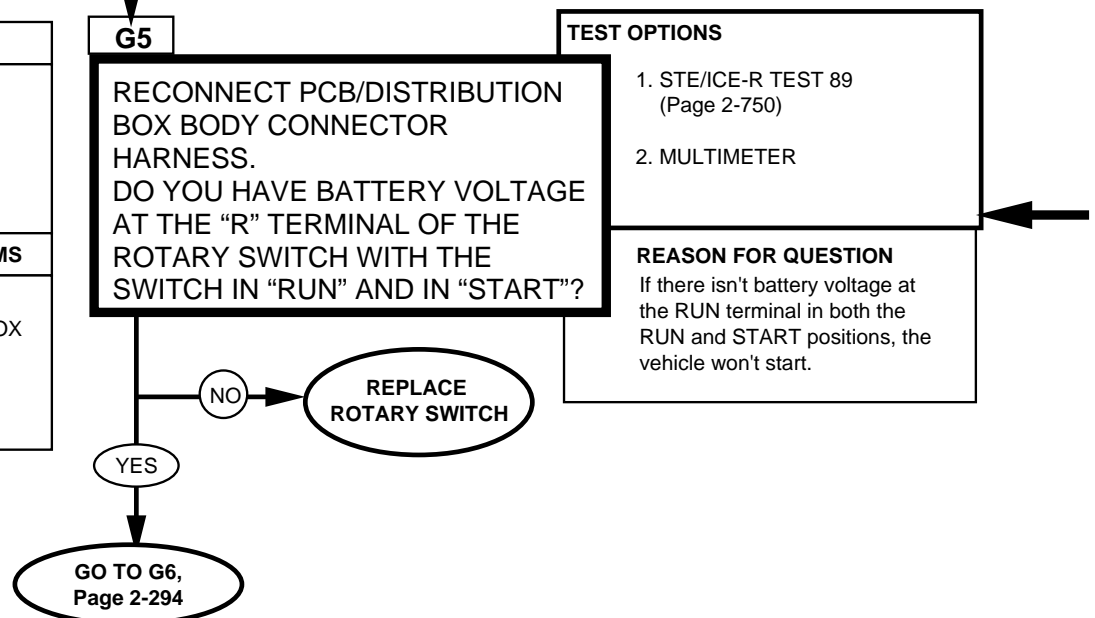
# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
NEUTRAL SAFETY SWITCH OK
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING



KNOWN INFO
NEUTRAL SAFETY SWITCH OK
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING



REFERENCE INFORMATION

STARTER CIRCUIT



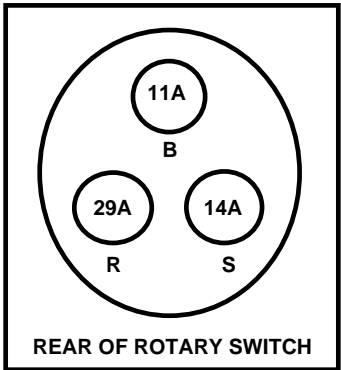
**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Check the wires and connections at both ends for broken wires or any kind of bad connection. Repair whatever you can. If the wires and connections seem OK, you have to replace the harness.

Repair wiring or replace harness, refer to (para. 4-85).



Replace rotary switch, refer to (para. 4-7).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**VOLTAGE  
MULTIMETER**

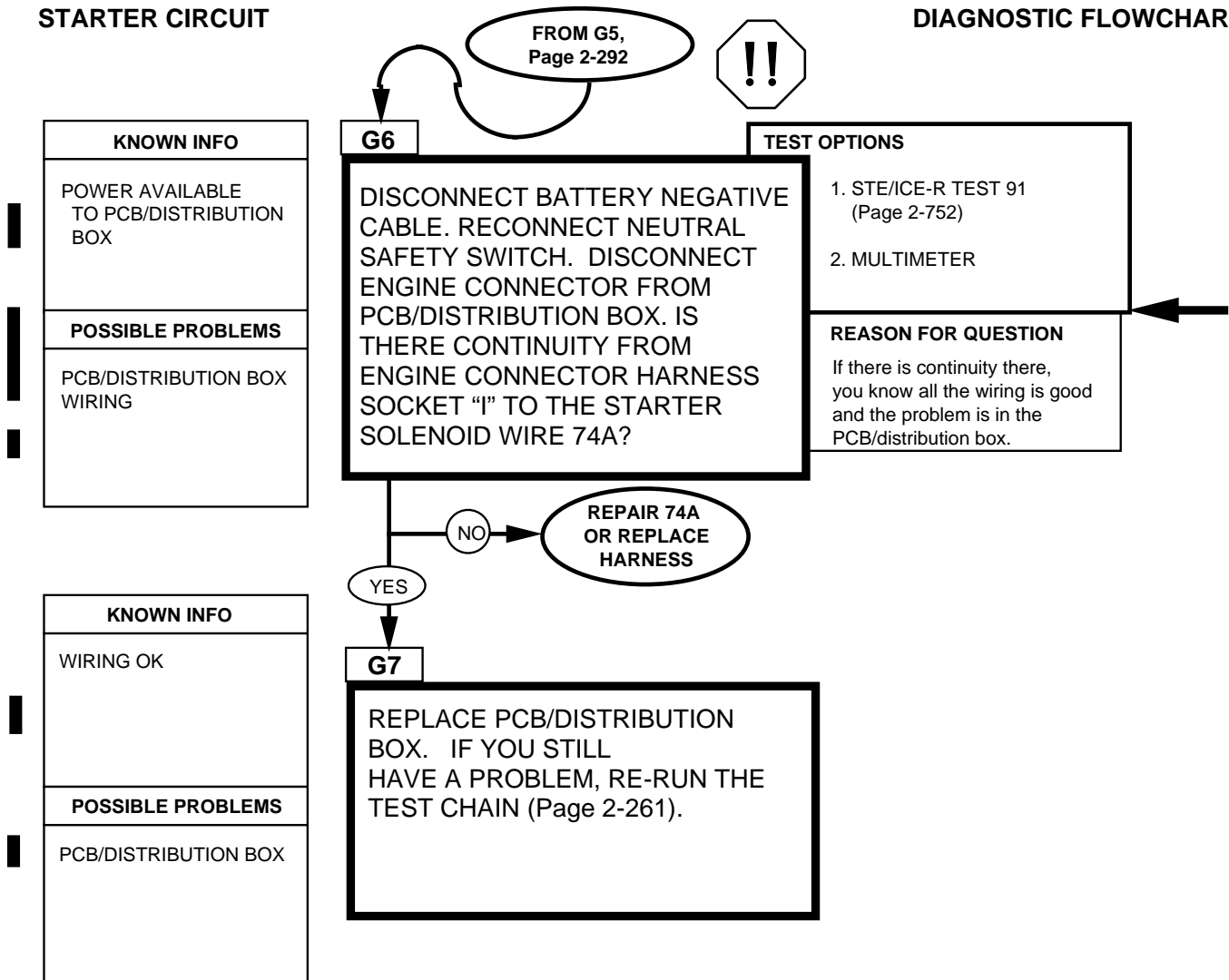
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# STARTER CIRCUIT

## DIAGNOSTIC FLOWCHART





REFERENCE INFORMATION

STARTER CIRCUIT



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace PCB, refer to (para. 4-5).  
Replace distribution box, refer to (para. 4-5.1).

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminals indicated in the question.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE-R displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

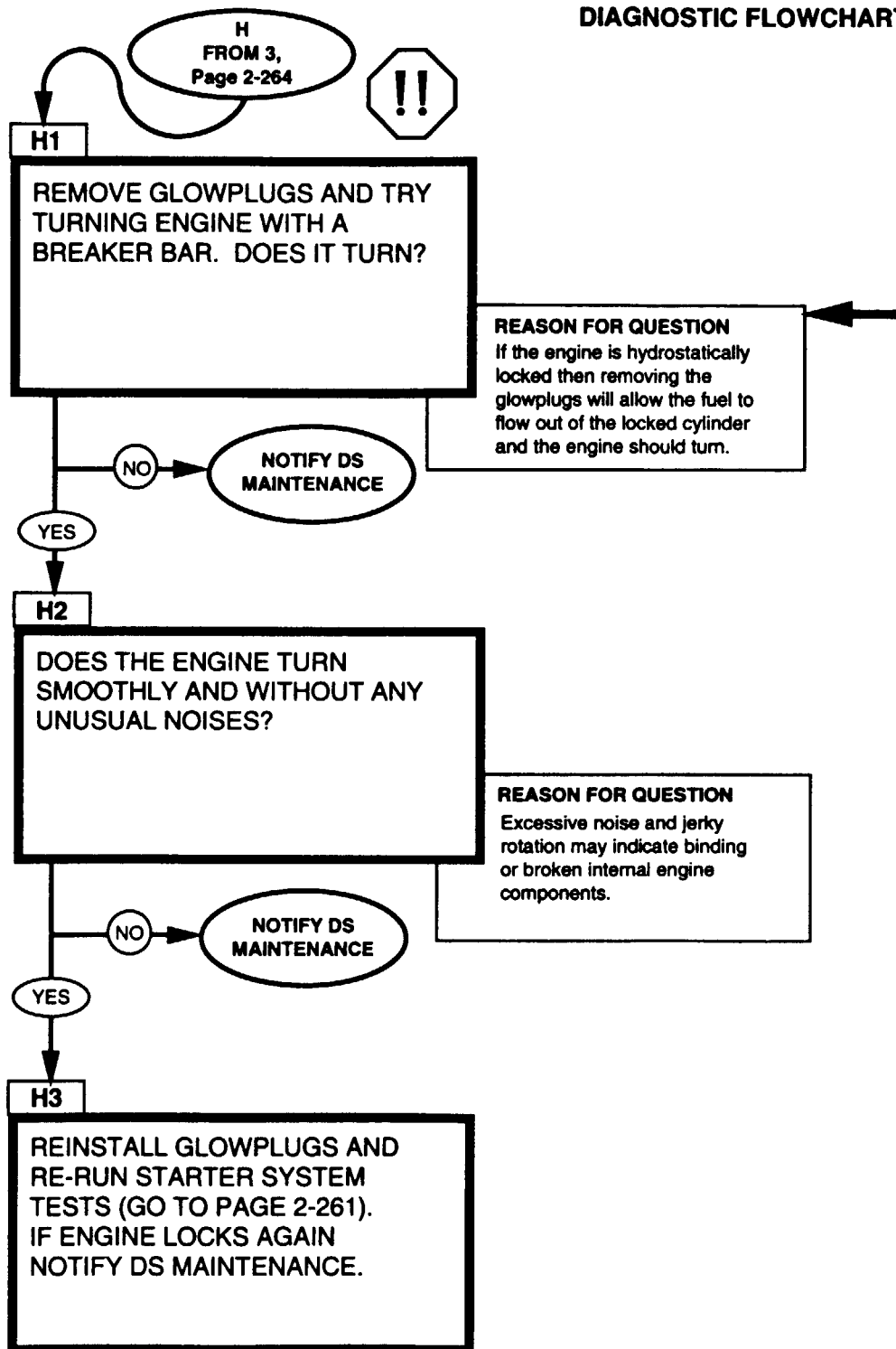
# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
CAN'T TURN ENGINE MANUALLY
POSSIBLE PROBLEMS
INTERNAL MECHANICAL PROBLEM HYDRAULIC LOCK

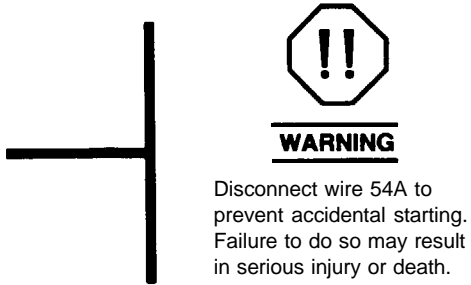
KNOWN INFO
HYDRAULIC LOCK REMOVED
POSSIBLE PROBLEMS
INTERNAL MECHANICAL PROBLEM

KNOWN INFO
ENGINE CAN ROTATE SMOOTHLY
POSSIBLE PROBLEMS



REFERENCE INFORMATION

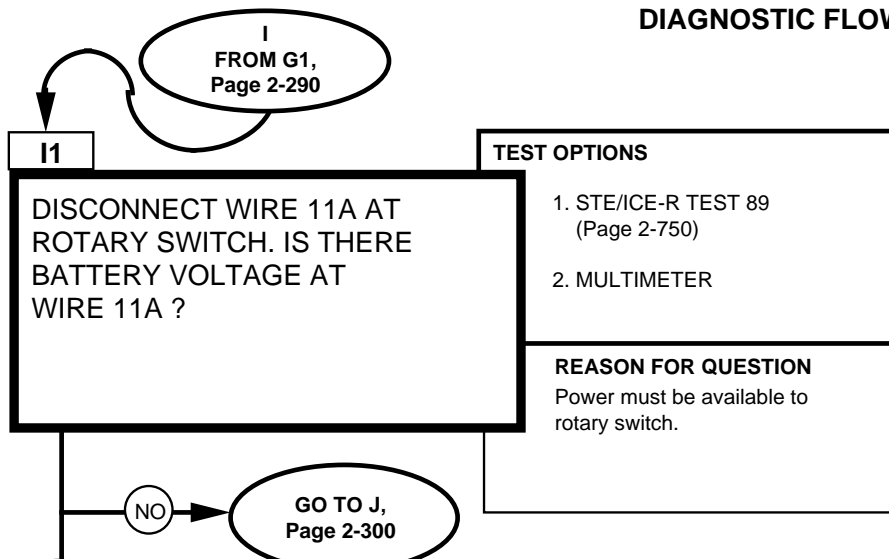
STARTER CIRCUIT



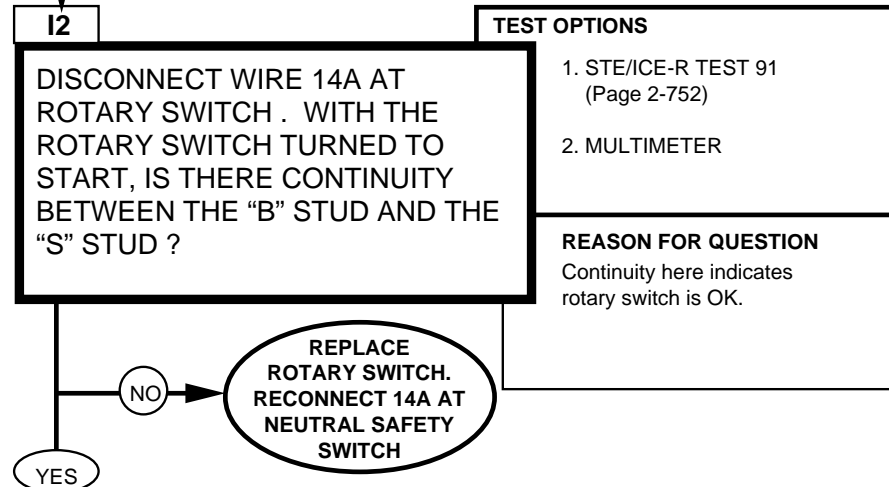
# STARTER CIRCUIT

# DIAGNOSTIC FLOWCHART

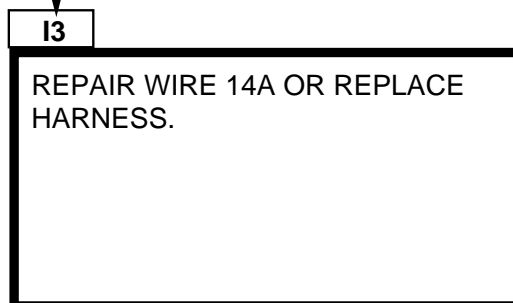
KNOWN INFO
NO VOLTAGE AVAILABLE AT NEUTRAL SAFETY SWITCH.
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING



KNOWN INFO
BATTERY VOLTAGE AVAILABLE TO ROTARY SWITCH.
POSSIBLE PROBLEMS
ROTARY SWITCH PCB/DISTRIBUTION BOX WIRING

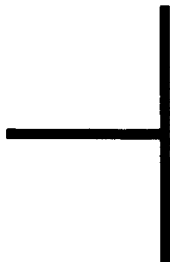


KNOWN INFO
ROTARY SWITCH OK
POSSIBLE PROBLEMS
WIRING



## REFERENCE INFORMATION

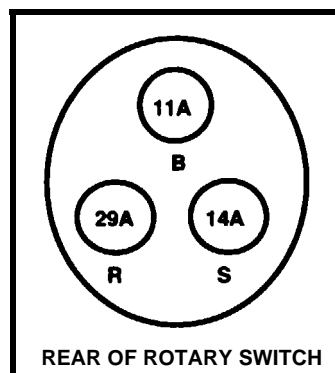
## STARTER CIRCUIT



Replace rotary switch, refer to (para 4-7).



Repair wiring or replace harness, refer to (para 4-85).



### VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

### 0-45 DC VOLTS STE/ICE-R TEST 89

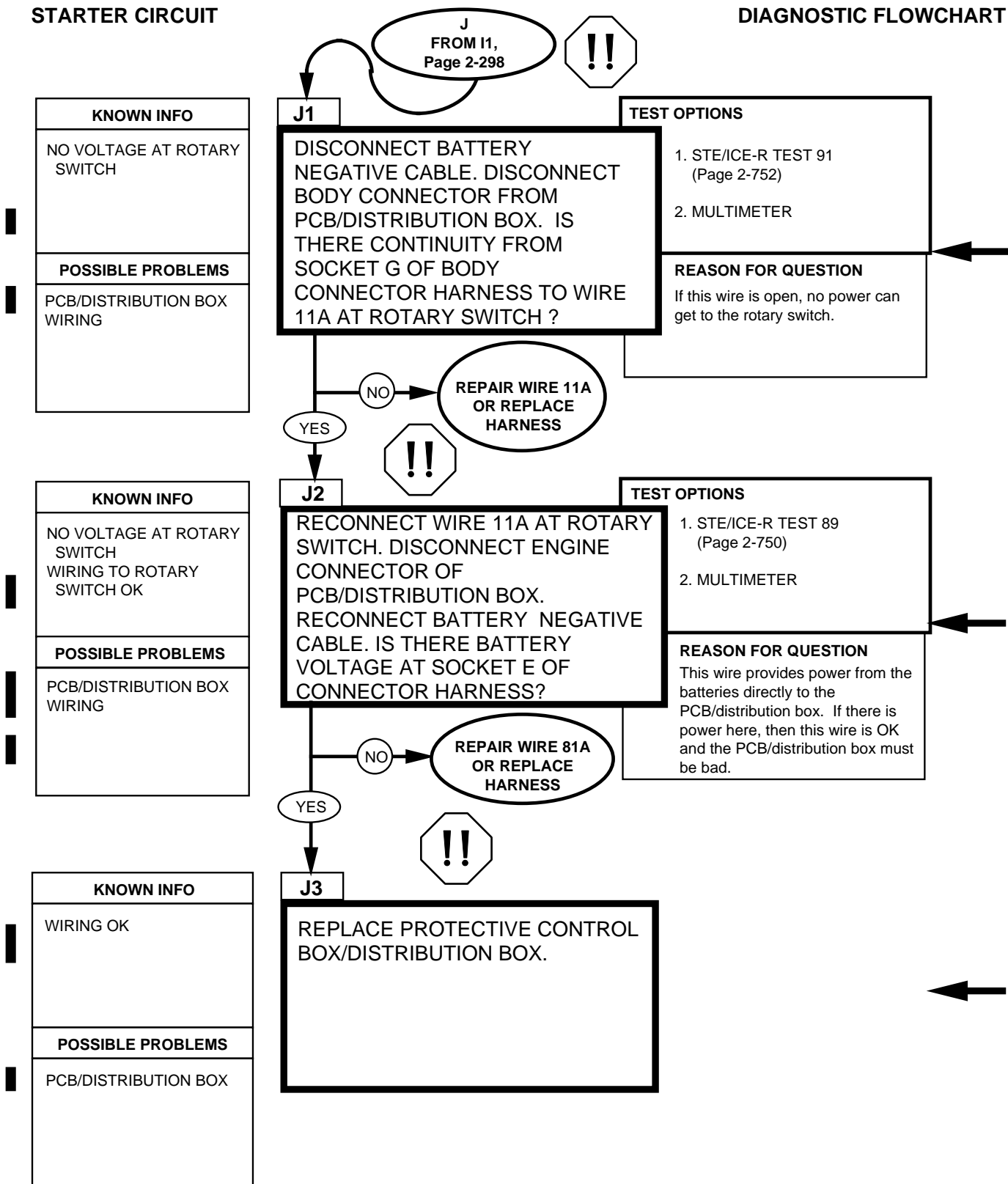
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

STARTER CIRCUIT

DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

STARTER CIRCUIT



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace harness or repair wiring, refer to (para. 4-85).

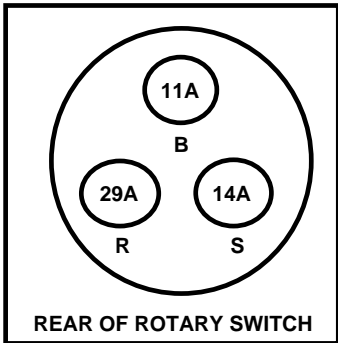


**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace harness or repair wiring, refer to (para. 4-85).



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting PCB/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace PCB, refer to (para. 4-5).

Replace distribution box, refer to (para. 4-5.1)

**VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

## 2-31. GLOWPLUGS CIRCUIT TESTS (PROTECTIVE CONTROL BOX)

These tests of the Glowplugs Circuit can be run anytime you think there may be a problem with the glowplugs, or if you were sent here from another test.

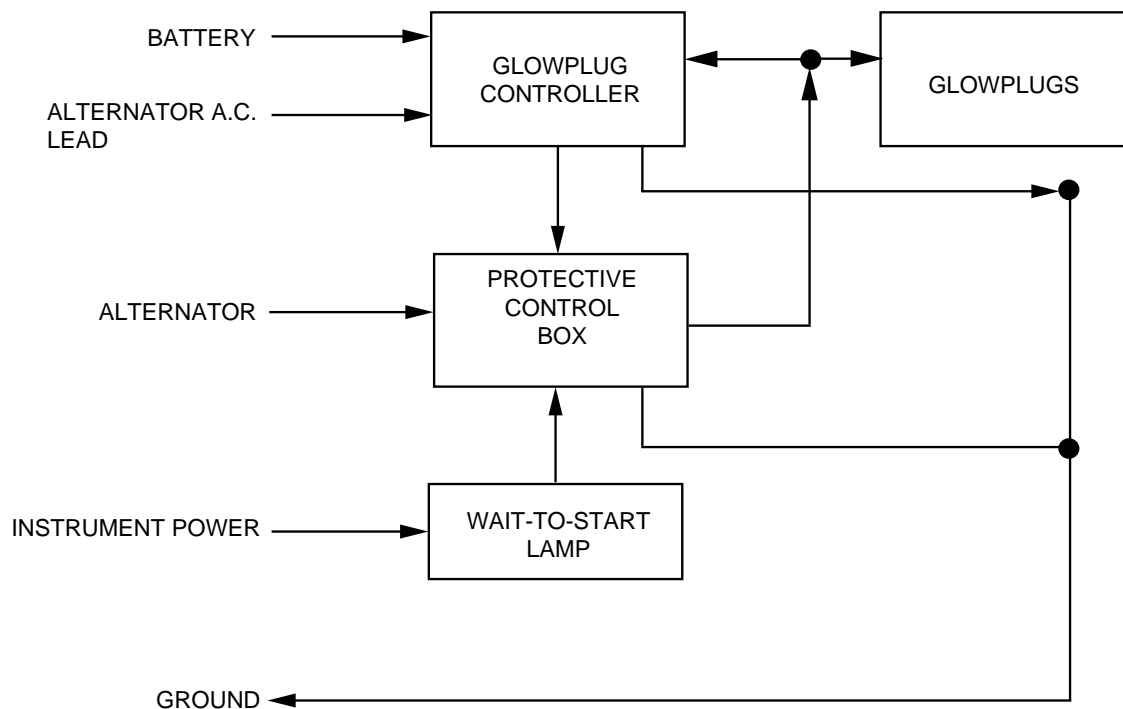
If you were sent from another test, be sure to mark where you came from so you will be able to return.

If you are running this test because the engine is hard to start when cold, remember that there is also a cold start advance circuit (part of the fuel system) which is not checked here.

For any starting problem, we recommend running the "STARTABILITY" test chain just to be sure you don't miss anything.

At the bottom of this page is a simplified block diagram which shows how the different parts of the glowplug circuit depend on each other and on other engine circuits.

Refer to fold-out page FO-9 and leave it open for reference while performing these tests. The fold-out diagram is arranged to allow you to follow the diagnostic logic and understand what you are testing, when and why.

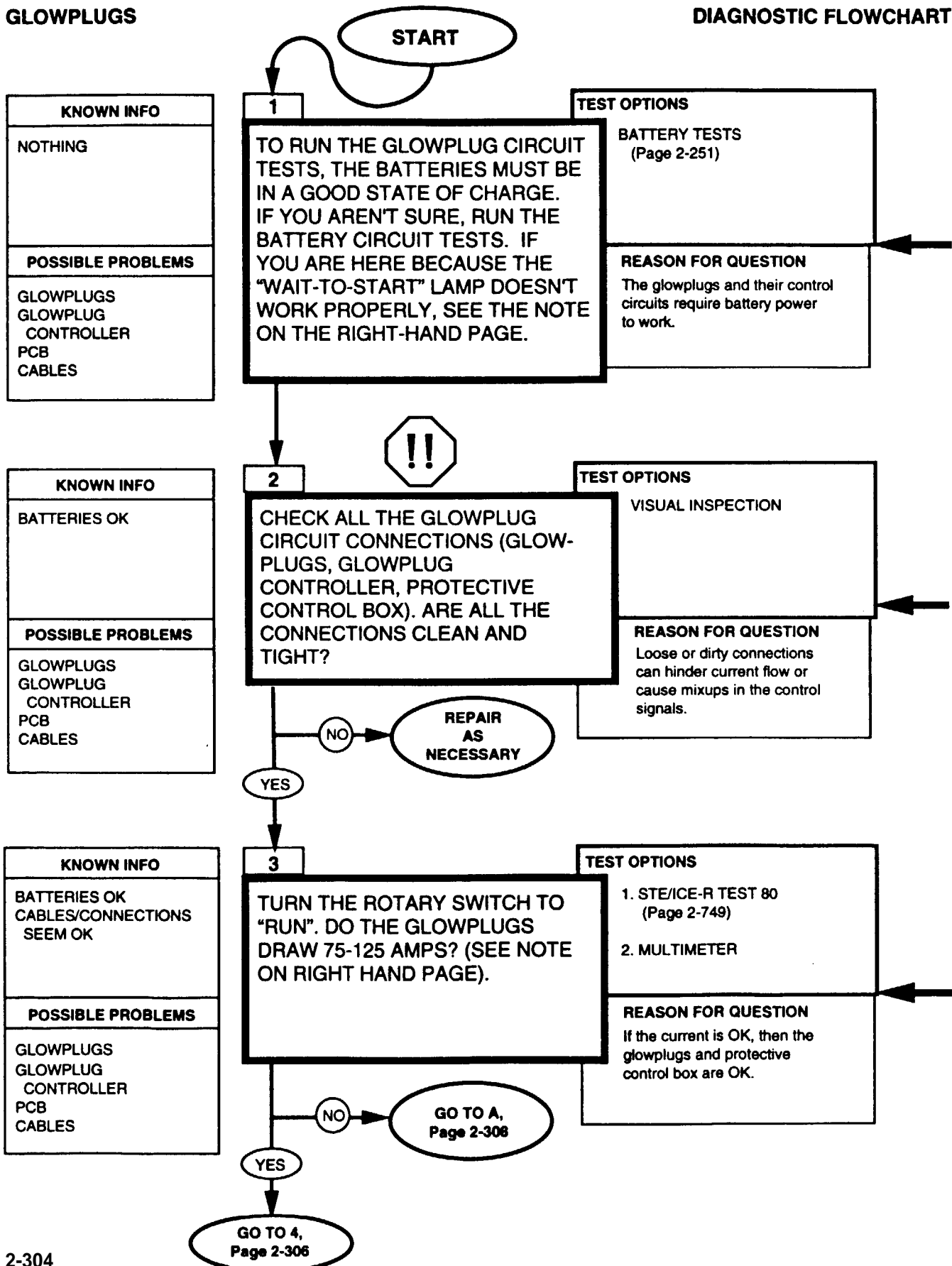


**GLOWPLUGS CIRCUIT SIMPLIFIED BLOCK DIAGRAM  
FOR PROTECTIVE CONTROL BOX**



# GLOWPLUGS

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## GLOWPLUGS

If the engine cranks ok (or starts), then the batteries are good enough for testing the glowplugs. If the engine starts, shut it off.

You can use STE/ICE Test 10 to measure cranking speed. The engine should crank at least 100 RPM in cold weather and at least 180 RPM in warm weather.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCS at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

**BAD CONNECTIONS ARE THE MOST COMMON PROBLEM!**

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH ! The time you save may be your own. Refer to the functional flow schematic and check the following

1. BATTERY - make sure all connections are dean and tight, including the shunt and power stud.
2. PROTECTIVE CONTROL BOX - unscrew BOTH connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.
3. GLOWPLUG CONTROLLER - pop the controller connector off (squeeze the sides) and check the pins in both the controller and the connector. Look for bent, broken or pushed out pins, dirt or corrosion. Check for broken wires at the connector. Take note that pin 2 of the glowplugs controller connector has no pin in it.
4. GLOWPLUGS - Check that all the glowplug wires are snug. Don't just look with your eyes. Many problems are solved by looking with your fingers to be sure a connection is snug.

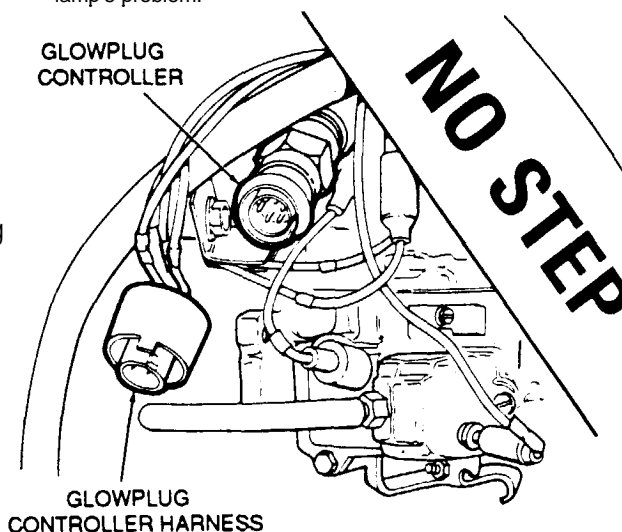
**NORMAL GLOWPLUG OPERATION**

The glowplugs first come ON when the engine temperature is below 120 °F (49°C) and the rotary switch is turned to "RUN". They stay ON for up to 9 seconds and then go OFF. They will stay OFF for about 7-15 seconds then come ON again for about 1 second.

**NOTE**

The WAIT-TO-START lamp is NOT diagnosed in this section. If the lamp does not work properly, the glowplug circuit may be affecting its operation. Run these tests to check out the glowplug circuit. If the lamp still does not work properly, go to the INSTRUMENTS section for a full diagnosis of the lamp's problem.

GLOWPLUG  
CONTROLLER



GLOWPLUG  
CONTROLLER HARNESS

**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

**BATTERY CURRENT  
STE/ICE-R TEST 80**

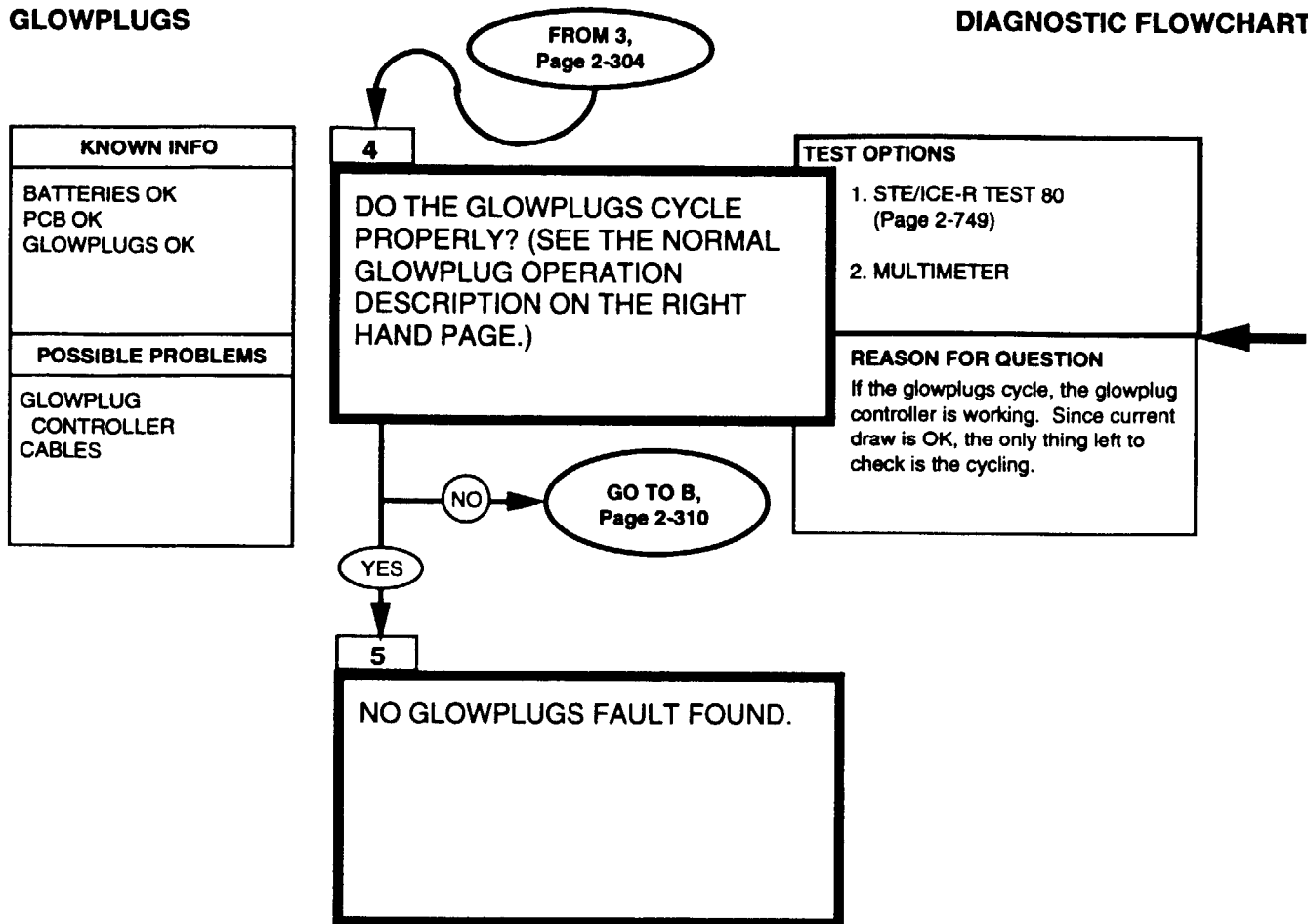
1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

**NOTE**

To check for glowplug current draw, start STE/ICE-R Test 80, battery current. Turn off all accessories (lights, heater, wipers etc). STE/ICE-R should immediately measure at least 74 amps. Take note, however, that if all your glowplugs are working, the current draw should be close to or more than 100 amps, especially if it's cold. If it's near freezing and the glowplugs only draw 75-80 amps, you probably have a few bad glowplugs.

# GLOWPLUGS

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## GLOWPLUGS

**NORMAL GLOWPLUG OPERATION**

The glowplugs first come ON when the engine temperature is below 120 °F (49 °C) and the rotary switch is turned to RUN. They stay ON for up to 9 seconds and then go OFF. They will stay OFF for about 7-15 seconds then come ON again for about 1 second, than go OFF again. If you don't start the engine, the glowplugs should keep cycling like this, due to the glowplug cycle timer in the glowplugs controller. If you start the engine, they will cycle until the engine is warm, due to the afterglow cycle timer in the glowplug controller. When the engine gets up to 120 °F (49 °C), the glowplugs should stop cycling completely.

**ENGINE NOT RUNNING  
ROTARY SWITCH IN RUN.**

If the glowplugs are cycling property, you should hear a click from the protective control box (PCB) when the glowplugs turn on and when they turn off. This is the glowplug cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, the STE/ICE-R will measure 3-8 amps.

**ENGINE RUNNING.  
ROTARY SWITCH IN RUN**

If the glowplugs are cycling properly, you can hear a click from the protective control box (PCB) when the glowplugs turn on and when they turn off (you may have to duck your head under the dash). This is the afterglow cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, STE/ICE-R will measure 3-8 amps. As the engine gets warmer, the glowplugs turn on less frequently and for less time.

**NOTE**

If you don't have a STE/ICE-R or a multimeter for measuring current, you can watch the vehicle volts gauge for indication of glowplug operation. The glowplugs drew so much current that the volts gage should jump about half-an-inch to the left when the glowplugs come on. Before starting the engine, you should hear the glowplug power relay click open and closed as the glowplugs cycle. (You can hear the relay after the engine has started by leaning your head under the dash near the protective control box.) This method won't tell you if all the glowplugs are working property, but it at least shows that the glowplugs are trying to work and that the glowplug power relay is working.

**EXPECTED GLOWPLUG CURRENT****ROTARY SWITCH IN RUN POSITION;**

**GLOWPLUGS ON : 74 - 125 AMPS** 74 is only for weak batteries. You should get at least 100 amps when glowplugs are working properly.

**GLOWPLUGS OFF : AT or NEAR ZERO** With the rotary switch in the RUN position, other parts of the vehicle are drawing current. You might measure up to 8 amps.

**BATTERY CURRENT  
STE/ICE-R TEST 80**

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

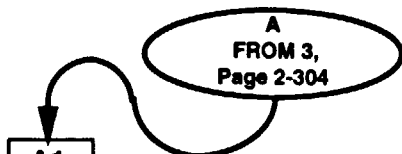
**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

# GLOWPLUGS

## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUGS DO NOT DRAW ENOUGH CURRENT
POSSIBLE PROBLEMS
GLOWPLUGS GLOWPLUG CONTROLLER CABLES



**A1**

TURN THE ROTARY SWITCH TO "RUN". DO THE GLOWPLUGS DRAW AT LEAST 15 AMPS?

TEST OPTIONS
1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER
REASON FOR QUESTION
A working glowplug draws 12-15 amps. If at least one glowplug is working, the protective control box is OK.

KNOWN INFO
GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT. PCB OK
POSSIBLE PROBLEMS
GLOWPLUGS GLOWPLUG CONTROLLER CABLES

**A2**

DO THE GLOWPLUGS CYCLE PROPERLY?

TEST OPTIONS
1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER
REASON FOR QUESTION
If the glowplugs cycle properly, the glowplug controller is OK.

KNOWN INFO
GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT PCB OK GLOWPLUG CONTROLLER OK
POSSIBLE PROBLEMS
GLOWPLUGS CABLES

**A3**

CHECK THE GLOWPLUGS AND WIRES USING THE PROCEDURE ON THE RIGHT-HAND PAGE. REPAIR OR REPLACE PARTS AS REQUIRED. RE-RUN THE MAIN TEST CHAIN.

TEST OPTIONS
SEE THE PROCEDURE ON THE RIGHT HAND PAGE AND USE: 1. STE/ICE-R TEST #91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
Since the glowplugs draw some current and cycle properly, the only reason they wouldn't draw enough current is that the glow-plugs themselves are bad or the wires are no good.

## REFERENCE INFORMATION

Dead glowplugs draw virtually no current, but other parts of the vehicle are drawing some current, up to 8 amps. If any glowplugs are drawing any current, then the protective control box is probably OK.

For a good description of how glowplugs cycle and how to check for proper cycling, refer to page 2-307.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

If most or all of the glowplugs are bad, you may also have a problem with the protective control box or the glowplug controller which caused them to go bad (usually they burn out from being on too long or not turning off at all). After replacing the bad glowplugs, rerun the glowplugs test chain paying special attention to the glowplugs cycling, especially that they turn OFF when they should.

Replace glowplugs, wires, or harness, refer to (para 3-38).

## GLOWPLUGS

**BATTERY CURRENT  
STEACE-R TEST 80**

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

**CHECKING GLOWPLUGS & THEIR WIRES**

1. Disconnect ALL the glowplugs.



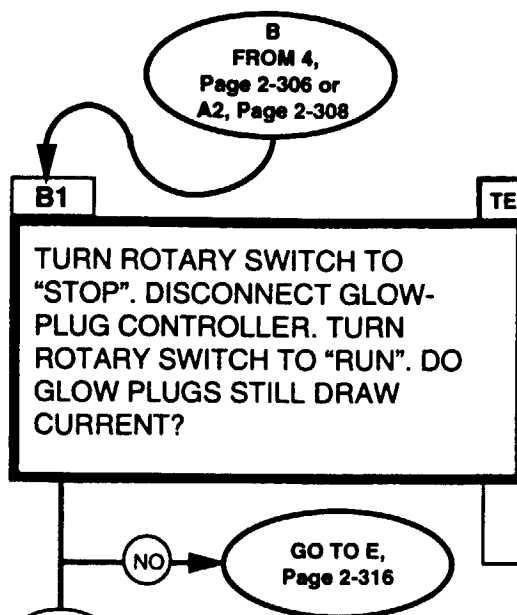
2. Disconnect the negative battery cable. Disconnect the PCB connector harness from the PCB. Reconnect the negative battery cable. Measure the resistance between pin Din the engine connector harness of the protective control box and ground. There should NOT be continuity (resistance reading off-the-scale). If there is continuity, repair or replace the harness.
3. Repeat the following for each glowplug
  - a. Reconnect the wiring harness to the glowplug while you repeat the resistance measurement described in step 2. When you reconnect the wire to the glowplug, the resistance should drop to between 1 and 2 ohms (glowplugs are typically 1.6 ohms).
  - b. If step a passed; disconnect the glowplug again, making sure the resistance goes off-scale again. Repeat step a for the next glowplug.
  - c. If step a failed; then either the glowplug or its wire is no good. Take the wire off the glowplug again and measure the resistance from the glowplug to the engine block. If the resistance is 1-2 ohms, then the cable is no good, otherwise replace the glowplug and check the cable for continuity, just to be sure.

4. Reconnect the PCB and all wires.

# GLOWPLUGS

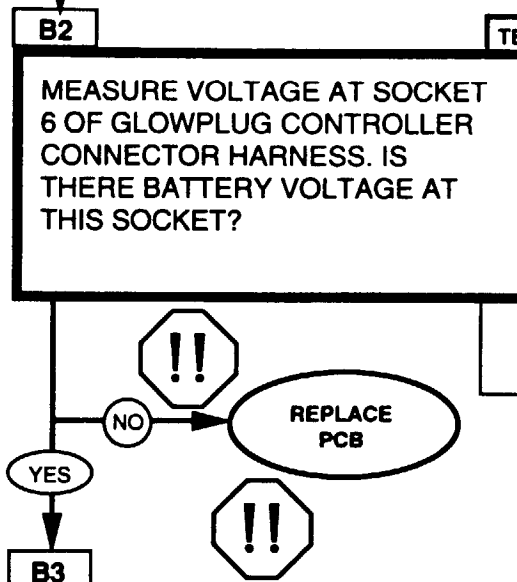
## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUG CURRENT OK NOT CYCLING PROPERLY
POSSIBLE PROBLEMS
PCB

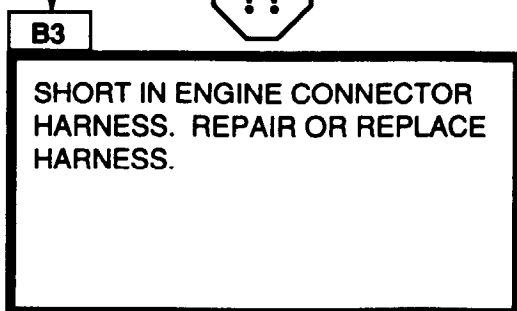


TEST OPTIONS
1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER
REASON FOR QUESTION
If the glowplug controller is shorted, the glowplug power relay in the protective control box will always be closed.

KNOWN INFO
GLOWPLUG CURRENT OK GLOWPLUGS NOT CYCLING GLOWPLUGS DRAW CURRENT WITH CONTROLLER DISCONNECTED.
POSSIBLE PROBLEMS
WIRING SHORT PCB (GLOWPLUG POWER RELAY)



TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER
REASON FOR QUESTION
If there is a short in the harness, this wire will have battery voltage.



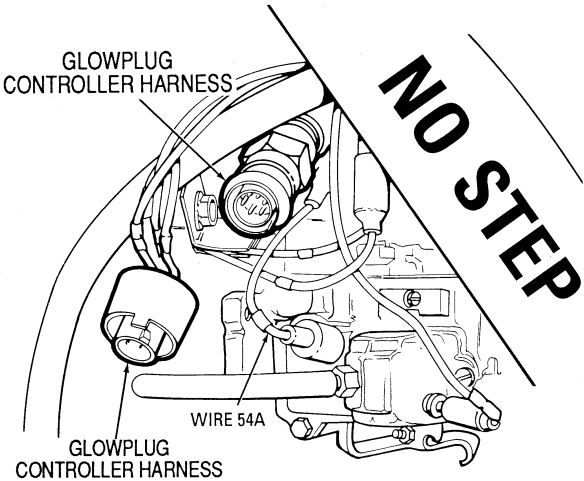
REFERENCE INFORMATION

GLOWPLUGS

NOTE

Ensure that alternator "AC" tap is functioning correctly by measuring DC volts at wire 2A. Reading should be between 9-16 Vdc. If this voltage is not present, glowplug system will never stop cycling.

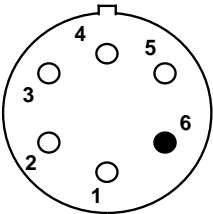
Refer to the functional flow schematic. If the glowplug controller is shorted (continuity from pin 6 to pin 3), the glowplug power relay will always be energized and the glowplugs will always be drawing current.



BATTERY CURRENT  
STE/ICE-R TEST 80

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

Since the glowplugs draw current without the glowplug controller connected, there must be a short in the harness or a stuck relay in the protective control box (PCB). If there were a short in the harness directly to the glowplugs, the glowplugs would have burned out long ago and you wouldn't be here. The only other short in the harness that would make the glowplugs turn on without the glowplug controller installed would show up as battery voltage at pin 6 of the controller's connector.



Glowplug Controller  
Harness Schematic

Replace PCB, refer to (para. 4-5).

Check the end of the harness at the protective control box, glowplugs, etc. for shorts. Repair whatever you can. If you don't see anything wrong, the short must be in the main body of the harness, which means that you have to replace the harness.



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

For repair or replacement of wiring, refer to (para. 4-85).

BATTERY CURRENT  
MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

0-45 DC VOLTS  
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

VOLTAGE  
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



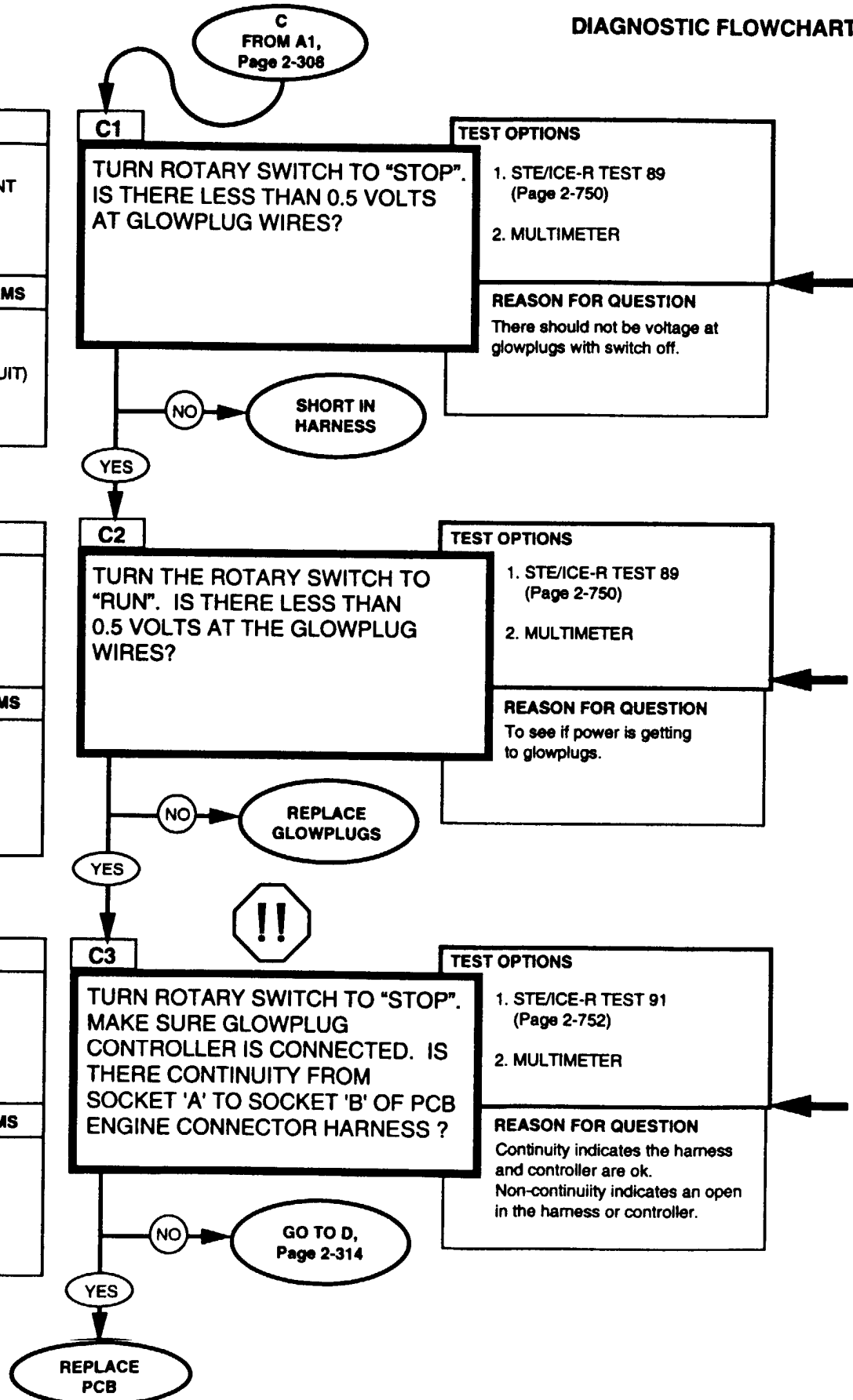
# GLOWPLUGS

## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUGS DON'T DRAW ANY CURRENT
POSSIBLE PROBLEMS
GLOWPLUG CONTROLLER WIRING (OPEN CIRCUIT) 8 BAD GLOWPLUGS PCB

KNOWN INFO
NO SHORTS GLOWPLUGS DRAW ZERO AMPS
POSSIBLE PROBLEMS
GLOWPLUG CONTROLLER BAD GLOWPLUGS PCB

KNOWN INFO
NO SHORTS GLOWPLUGS DRAW NO CURRENT NO VOLTAGE AT GLOWPLUGS
POSSIBLE PROBLEMS
OPEN IN PCB OPEN IN GLOWPLUG CONTROLLER OPEN IN WIRING



# REFERENCE INFORMATION

# GLOWPLUGS



Replace harness. Notify DS Maintenance.



Replace glowplugs, refer to (para 3-38).

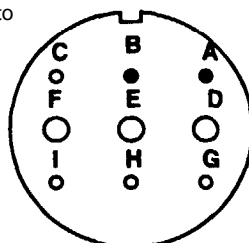


## WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace PCB, refer to (para 4-5).



Engine Connector with pins 'A' & 'B' highlighted.

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

## 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

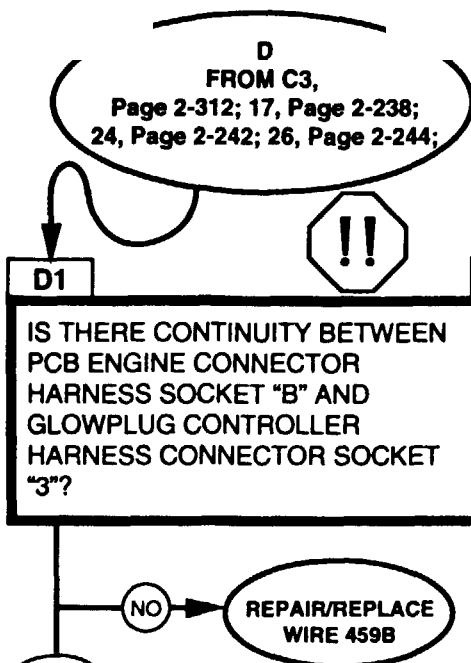
## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# GLOWPLUGS

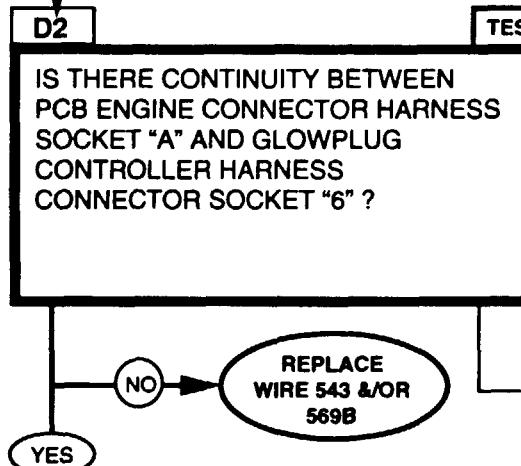
## DIAGNOSTIC FLOWCHART

KNOWN INFO
OPEN CIRCUIT IN GLOW-PLUG CONTROLLER OR WIRING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER

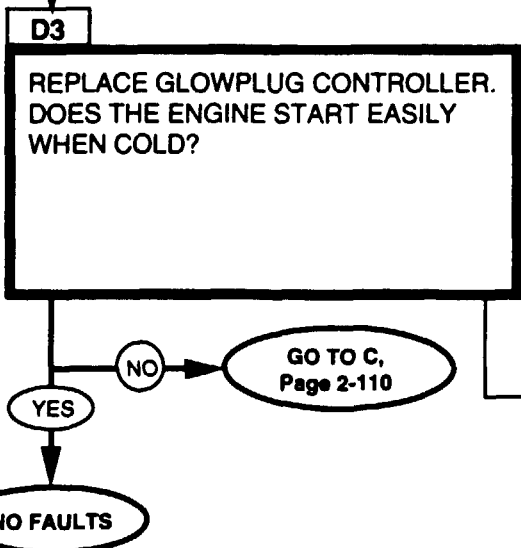


TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
This checks the return wire from the glowplug controller to the protective control box.

KNOWN INFO
OPEN CIRCUIT IN GLOW-PLUG CONTROLLER OR WIRING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER



TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
This checks the main power wire from the protective control box to the glowplug controller.



REASON FOR TESTS
You verified that the wiring is OK so the controller must be bad.

REFERENCE INFORMATION

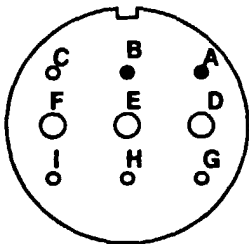
GLOWPLUGS



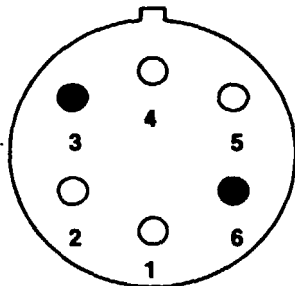
**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.



Engine Connector Harness  
with sockets "A" & "B"  
highlighted.

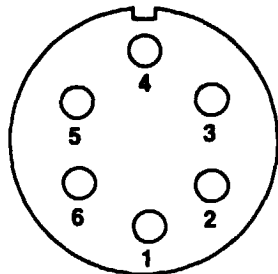


Glowplug Controller Harness  
with sockets 3 & 6 highlighted

**NOTE**

You will not be able to check the solid-state controller using the pin-to-pin resistance check. The solid-state controller is identified by a green finish and a larger case.

Replace glowplug controller, refer to (para 4-29).



Glowplug Controller

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

**CONTINUITY (RESISTANCE)  
MULTIMETER**

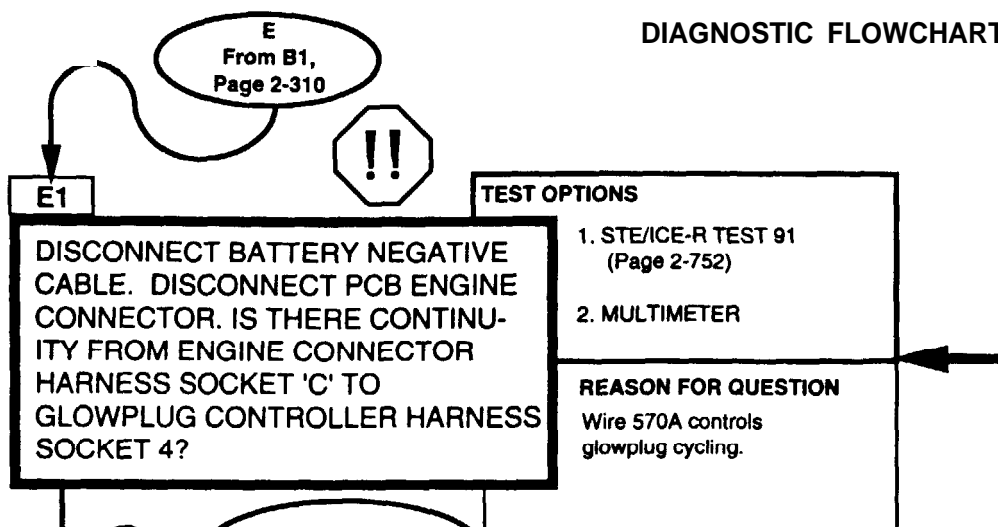
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

PIN-TO-PIN		RESISTANCE
1	5	130 $\Omega$ $\pm$ $\Omega$
2	3	0.40 $\Omega$ TO 0.75 $\Omega$
4	5	27 $\Omega$ $\pm$ 3 $\Omega$
2	6	.45 $\Omega$ MAXIMUM

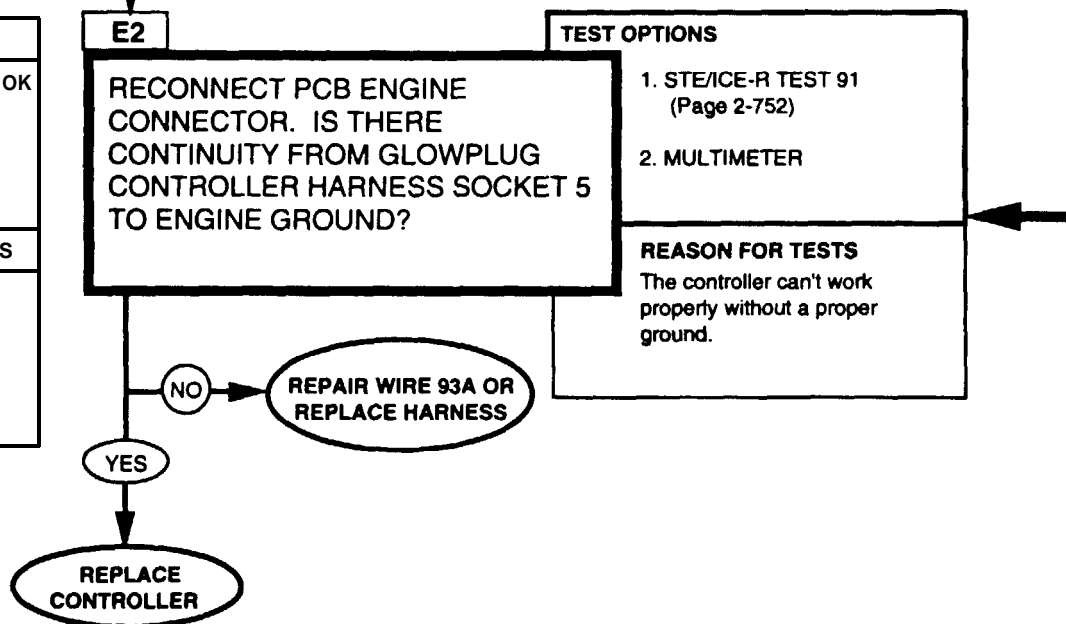
# GLOWPLUGS CIRCUIT

## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUG CURRENT OK PCB OK GLOWPLUGS NOT CYCLING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER



KNOWN INFO
GLOWPLUG CURRENT OK PCB OK GLOWPLUGS NOT CYCLING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER



## REFERENCE INFORMATION

## GLOWPLUGS CIRCUIT



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Repair wiring or replace harness, refer to (para 4-34).

### **0-4500 OHMS STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair wiring or replace harness, refer to (para 4-85).

Replace glowplug controller, refer to (para 4-29).

### **CONTINUITY (RESISTANCE) Multimeter**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

### 2-31.1. GLOWPLUGS CIRCUIT TESTS (DISTRIBUTION BOX)

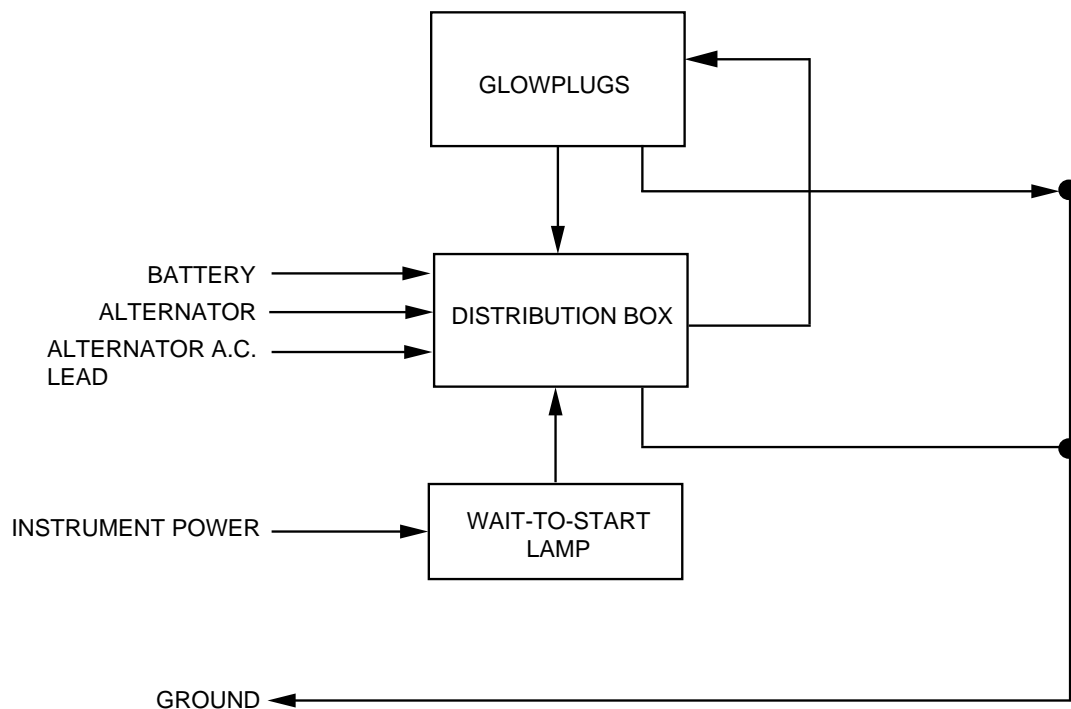
These tests of the Glowplugs Circuit can be run anytime you think there may be a problem with the glowplugs, or if you were sent here from another test.

If you were sent from another test, be sure to mark where you came from so you will be able to return.

If you are running this test because the engine is hard to start when cold, remember that there is also a cold start advance circuit (part of the fuel system) which is not checked here.

For any starting problem, we recommend running the "STARTABILITY" test chain just to be sure you don't miss anything.

At the bottom of this page is a simplified block diagram which shows how the different parts of the glowplug circuit depend on each other and on other engine circuits.

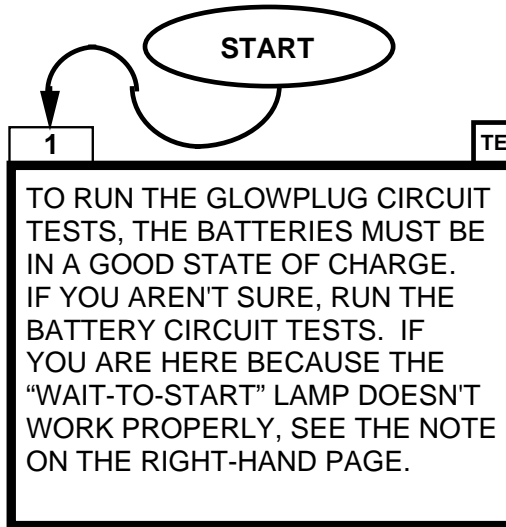


**GLOWPLUGS CIRCUIT SIMPLIFIED BLOCK DIAGRAM  
FOR DISTRIBUTION BOX**

# GLOWPLUGS

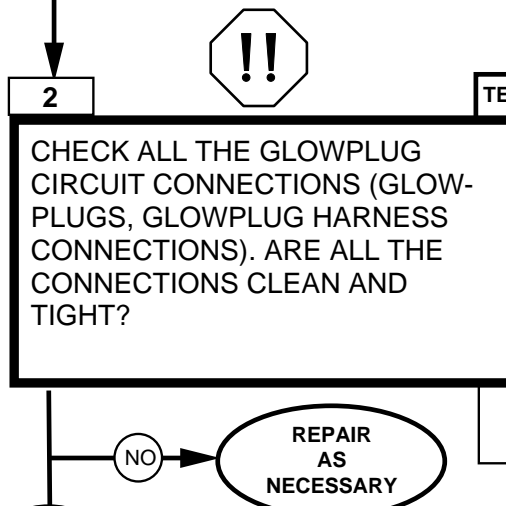
## DIAGNOSTIC FLOWCHART

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
GLOWPLUGS DISTRIBUTION BOX CABLES



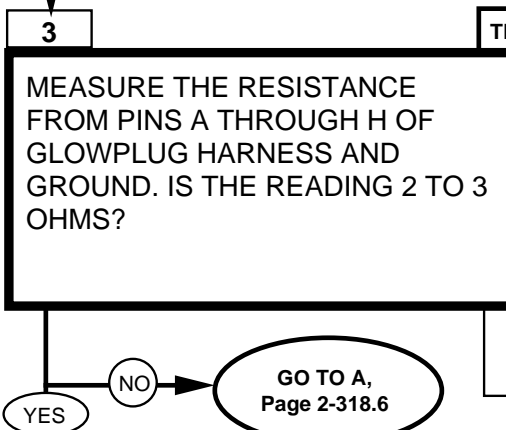
TEST OPTIONS
BATTERY TESTS (Page 2-251)
REASON FOR QUESTION
The glowplugs and their control circuits require battery power to work.

KNOWN INFO
BATTERIES OK
POSSIBLE PROBLEMS
GLOWPLUGS DISTRIBUTION BOX CABLES



TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
Loose or dirty connections can hinder current flow or cause mixups in the control signals.

KNOWN INFO
BATTERIES OK CABLES/CONNECTIONS SEEM OK
POSSIBLE PROBLEMS
GLOWPLUGS DISTRIBUTION BOX CABLES



TEST OPTIONS
1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER
REASON FOR QUESTION
If the resistance is OK, then the glowplugs and harness are OK.



## REFERENCE INFORMATION

## GLOWPLUGS

If the engine cranks ok (or starts), then the batteries are good enough for testing the glowplugs. If the engine starts, shut it off.

You can use STE/ICE Test 10 to measure cranking speed. The engine should crank at least 100 RPM in cold weather and at least 180 RPM in warm weather.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

**BAD CONNECTIONS ARE THE MOST COMMON PROBLEM !**

Sometimes, just disconnecting, cleaning and reconnecting will solve a problem. BE THOROUGH ! The time you save may be your own. Refer to the functional flow schematic and check the following;

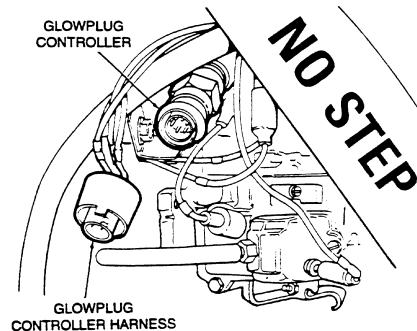
1. BATTERY - make sure all connections are clean and tight, including the shunt and power stud.
2. DISTRIBUTION BOX - unscrew the three connectors and look for bent or broken pins, pins pushed out of their socket, or dirt and corrosion in the connections.
3. GLOWPLUGS - Check that all the glowplug wires are snug. Don't just look with your eyes. Many problems are solved by looking with your fingers to be sure a connection is snug.

**NORMAL GLOWPLUG OPERATION**

The glowplugs are heated quickly for 5 to 20 seconds. This cycle is active while the "Wait-to-Start" light is on. The length of "on" time is dependent on battery voltage, the weaker the batteries the longer the "on" time. This cycle will only repeat if the run start switch has been off for more than 2 1/2 minutes. After the initial 5 to 20 seconds preglow, the system goes to afterglow. Afterglow provides lower voltage to the glowplugs to keep them at operating temperature for approximately 60 seconds.

**NOTE**

The "WAIT-TO-START" lamp is NOT diagnosed in this section. If the lamp does not work properly, the glowplug circuit may be affecting its operation. Run these tests to check out the glowplug circuit. If the lamp still does not work properly, go to the INSTRUMENTS section for a full diagnosis of the lamp's problem.

**BATTERY CURRENT MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

**BATTERY CURRENT STE/ICE-R TEST 80**

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

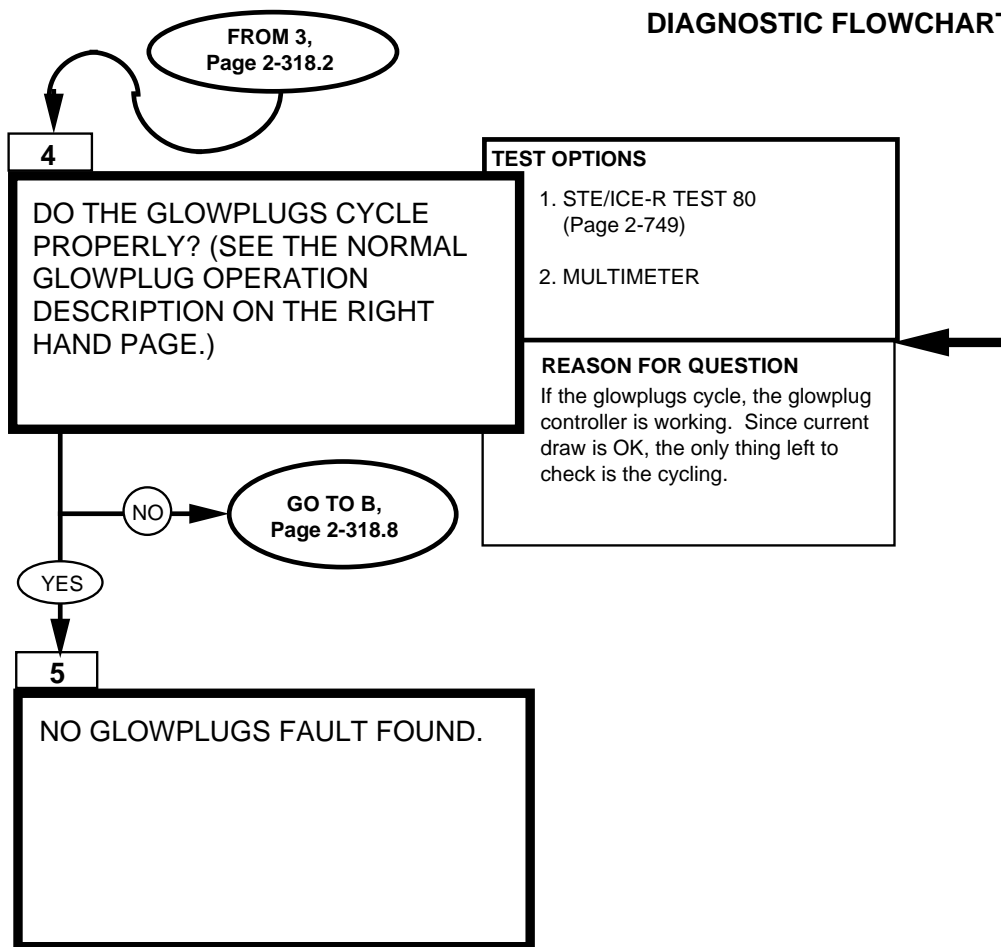
**NOTE**

To check for glowplug current draw, start STE/ICE-R Test 80, battery current. Turn off all accessories (lights, heater, wipers etc). STE/ICE-R should immediately measure at least 74 amps. Take note, however, that if all your glowplugs are working, the current draw should be close to or more than 100 amps, especially if it's cold. If it's near freezing and the glowplugs only draw 75-80 amps, you probably have a few bad glowplugs.

## GLOWPLUGS

## DIAGNOSTIC FLOWCHART

KNOWN INFO
BATTERIES OK GLOWPLUGS OK DISTRIBUTION BOX OK
POSSIBLE PROBLEMS
CABLES GLOWPLUG CONTROL CIRCUIT



## REFERENCE INFORMATION

## GLOWPLUGS

**NORMAL GLOWPLUG OPERATION**

The glowplugs first come ON when the engine temperature is below 120 °F (49 °C) and the rotary switch is turned to RUN. They stay ON for up to 9 seconds and then go OFF. They will stay OFF for about 7-15 seconds then come ON again for about 1 second, then go OFF again. If you don't start the engine, the glowplugs should keep cycling like this, due to the glowplug cycle timer in the glowplugs controller. If you start the engine, they will cycle until the engine is warm, due to the afterglow cycle timer in the glowplug controller. When the engine gets up to 120 °F (49 °C), the glowplugs should stop cycling completely.

**ENGINE NOT RUNNING.  
ROTARY SWITCH IN RUN.**

If the glowplugs are cycling properly, you should hear a click from the distribution box when the glowplugs turn on and when they turn off. This is the glowplug cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, the STE/ICE-R will measure 3-8 amps.

**ENGINE RUNNING.  
ROTARY SWITCH IN RUN**

If the glowplugs are cycling properly, you can hear a click from the distribution box when the glowplugs turn on and when they turn off (you may have to duck your head under the dash). This is the afterglow cycle timer, a thermal circuit breaker. A good way to check for cycling is STE/ICE-R test 80, battery current. When the glowplugs turn on, STE/ICE-R will measure 74-125 amps. When the glowplugs turn off, STE/ICE-R will measure 3-8 amps. As the engine gets warmer, the glowplugs turn on less frequently and for less time.

**NOTE**

If you don't have a STE/ICE-R or a multimeter for measuring current, you can watch the vehicle volts gauge for indication of glowplug operation. The glowplugs draw so much current that the volts gage should jump about half-an-inch to the left when the glowplugs come on. Before starting the engine, you should hear the glowplug power relay click open and closed as the glowplugs cycle. (You can hear the relay after the engine has started by leaning your head under the dash near the distribution box.) This method won't tell you if all the glowplugs are working properly, but it at least shows that the glowplugs are trying to work and that the glowplug power relay is working.

**EXPECTED GLOWPLUG CURRENT**

ROTARY SWITCH IN RUN POSITION;

GLOWPLUGS ON : 74 - 125 AMPS 74 is only for weak batteries. You should get at least 100 amps when glowplugs are working properly.

GLOWPLUGS OFF : AT or NEAR ZERO With the rotary switch in the RUN position, other parts of the vehicle are drawing current. You might measure up to 8 amps.

**BATTERY CURRENT  
STE/ICE-R TEST 80**

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

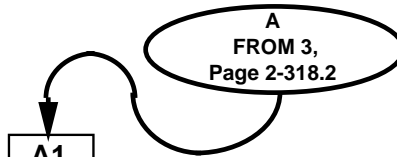
**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

## GLOWPLUGS

## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUGS DO NOT DRAW ENOUGH CURRENT
POSSIBLE PROBLEMS
GLOWPLUGS GLOWPLUG CONTROLLER CABLES



TURN THE ROTARY SWITCH TO "RUN". DO THE GLOWPLUGS DRAW AT LEAST 15 AMPS?

TEST OPTIONS
1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER
REASON FOR QUESTION
A working glowplug draws 12-15 amps. If at least one glowplug is working, the distribution box is OK.

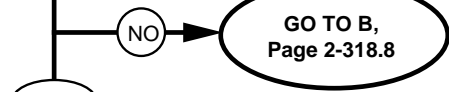


KNOWN INFO
GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT DISTRIBUTION BOX OK
POSSIBLE PROBLEMS
GLOWPLUGS GLOWPLUG CONTROLLER CABLES

A2

DO THE GLOWPLUGS CYCLE PROPERLY?

TEST OPTIONS
1. STE/ICE-R TEST 80 (Page 2-749)
2. MULTIMETER
REASON FOR QUESTION
If the glowplugs cycle properly, the glowplug controller is OK.



KNOWN INFO
GLOWPLUGS DRAW SOME BUT NOT ENOUGH CURRENT DISTRIBUTION BOX OK GLOWPLUG CONTROLLER OK
POSSIBLE PROBLEMS
GLOWPLUGS CABLES

A3

CHECK THE GLOWPLUGS AND WIRES USING THE PROCEDURE ON THE RIGHT-HAND PAGE. REPAIR OR REPLACE PARTS AS REQUIRED. RERUN THE MAIN TEST CHAIN.

TEST OPTIONS
SEE THE PROCEDURE ON THE RIGHT HAND PAGE AND USE:
1. STE/ICE-R TEST #91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
Since the glowplugs draw some current and cycle properly, the only reason they wouldn't draw enough current is that the glowplugs themselves are bad or the wires are no good.

## REFERENCE INFORMATION

Dead glowplugs draw virtually no current, but other parts of the vehicle are drawing some current, up to 8 amps. If any glowplugs are drawing any current, then the distribution box and glowplug circuit is probably OK.

For a good description of how glowplugs cycle and how to check for proper cycling, refer to page 2-307.

**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

If most or all of the glowplugs are bad, you may also have a problem with the distribution box or the glowplug controller which caused them to go bad (usually they burn out from being on too long or not turning off at all). After replacing the bad glowplugs, rerun the glowplugs test chain paying special attention to the glowplugs cycling, especially that they turn OFF when they should.

Replace glowplugs, wires, or harness, refer to (para. 3-38).

## GLOWPLUGS

**BATTERY CURRENT  
STE/ICE-R TEST 80**

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

**BATTERY CURRENT  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

CHECKING GLOWPLUGS & THEIR WIRES

1. Disconnect ALL the glowplugs.



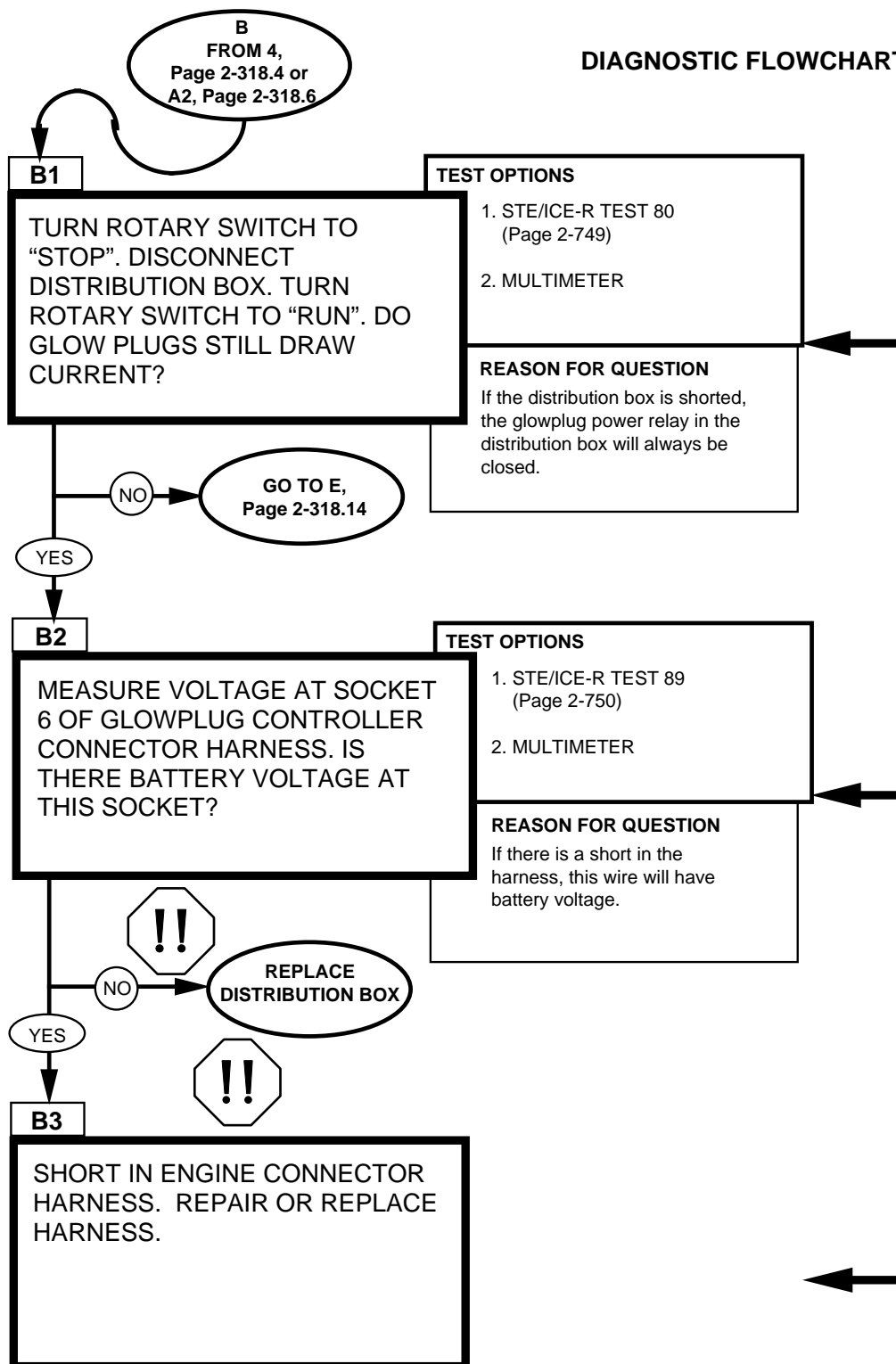
2. Disconnect the negative battery cable. Disconnect the distribution box connector harness from the distribution box. Reconnect the negative battery cable. Measure the resistance between pin D in the engine connector harness of the distribution box and ground. There should NOT be continuity (resistance reading off-the-scale). If there is continuity, repair or replace the harness.
3. Repeat the following for each glowplug:
  - a. Reconnect the wiring harness to the glowplug while you repeat the resistance measurement described in step 2. When you reconnect the wire to the glowplug, the resistance should drop to between 1 and 2 ohms (glowplugs are typically 1.6 ohms).
  - b. If step a passed; disconnect the glowplug again, making sure the resistance goes off-scale again. Repeat step a for the next glowplug.
  - c. If step a failed; then either the glowplug or its wire is no good. Take the wire off the glowplug again and measure the resistance from the glowplug to the engine block. If the resistance is 1 - 2 ohms, then the cable is no good, otherwise replace the glowplug and check the cable for continuity, just to be sure.

4. Reconnect the distribution box and all wires.

**GLOWPLUGS****DIAGNOSTIC FLOWCHART**

KNOWN INFO
GLOWPLUG CURRENT OK NOT CYCLING PROPERLY
POSSIBLE PROBLEMS
DISTRIBUTION BOX

KNOWN INFO
GLOWPLUG CURRENT OK GLOWPLUGS NOT CYCLING GLOWPLUGS DRAW CURRENT WITH DISTRIBUTION BOX DISCONNECTED.
POSSIBLE PROBLEMS
WIRING SHORT DISTRIBUTION BOX (GLOWPLUG POWER RELAY)



REFERENCE INFORMATION

GLOWPLUGS

NOTE

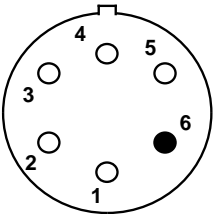
Ensure that alternator "AC" tap is functioning correctly by measuring DC volts at wire 2A. Reading should be between 9-16 Vdc. If this voltage is not present, glowplug system will never stop cycling.

Refer to the functional flow schematic. If the distribution box is shorted (continuity from pin 6 to pin 3), the glowplug power relay will always be energized and the glowplugs will always be drawing current.

BATTERY CURRENT  
STE/ICE-R TEST 80

1. Start Test 80, battery current.
2. Displayed reading is in amps. The reading will be greater than 30 amps, depending on how many accessories you have on.

Since the glowplugs draw current without the distribution box connected, there must be a short in the harness or a stuck relay in the distribution box. If there were a short in the harness directly to the glowplugs, the glowplugs would have burned out long ago and you wouldn't be here. The only other short in the harness that would make the glowplugs turn on without the distribution box installed would show up as battery voltage at pin 6 of the controller's connector.



Glowplug Controller  
Harness Schematic

Replace distribution box, refer to (para. 4-5.1).

Check the end of the harness at the distribution box, glowplugs, etc. for shorts. Repair whatever you can. If you don't see anything wrong, the short must be in the main body of the harness, which means that you have to replace the harness.

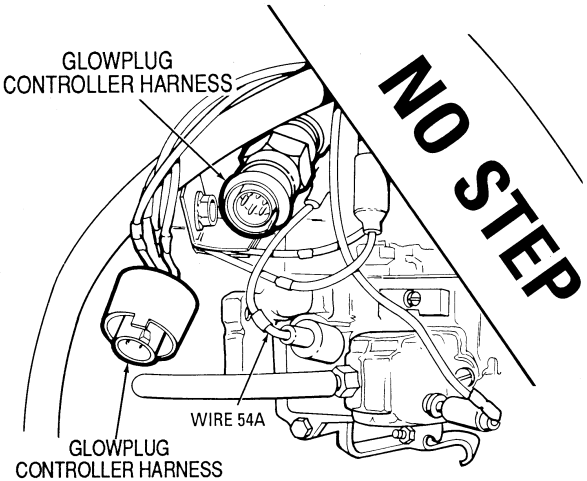


**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

For repair or replacement of wiring, refer to (para. 4-85).



BATTERY CURRENT  
MULTIMETER

1. Set the voltmeter to a DC volts scale of about 1 volt.
2. Connect the BLACK lead to the battery side of the current shunt and the RED lead to the other end of the current shunt.
3. Current shunt voltage is proportional to battery current, 100 millivolts = 1000 amps. To get current, multiply millivolts x 10.

0-45 DC VOLTS  
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

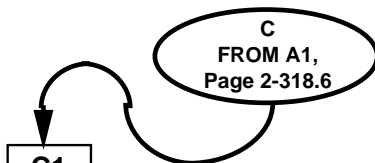
VOLTAGE  
MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

# GLOWPLUGS

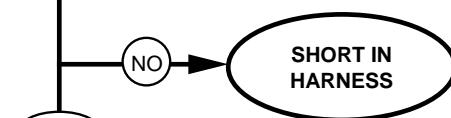
## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUGS DON'T DRAW ANY CURRENT
POSSIBLE PROBLEMS
GLOWPLUG CONTROLLER WIRING (OPEN CIRCUIT) BAD GLOWPLUGS DISTRIBUTION BOX

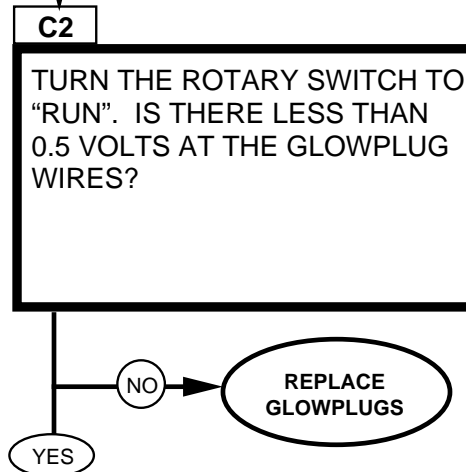


TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
REASON FOR QUESTION
There should not be voltage at glowplugs with switch off.

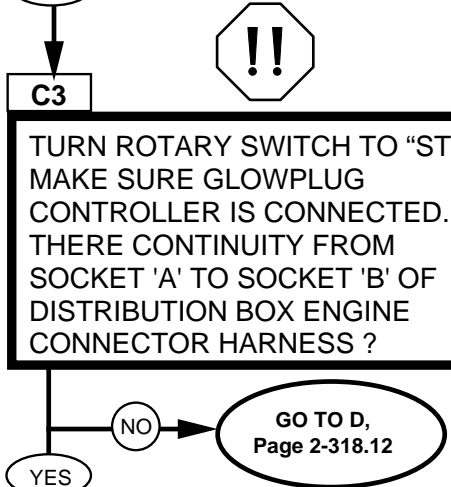
KNOWN INFO
NO SHORTS GLOWPLUGS DRAW ZERO AMPS
POSSIBLE PROBLEMS
GLOWPLUG CONTROLLER BAD GLOWPLUGS DISTRIBUTION BOX



TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER
REASON FOR QUESTION
To see if power is getting to glowplugs.



KNOWN INFO
NO SHORTS GLOWPLUGS DRAW NO CURRENT NO VOLTAGE AT GLOWPLUGS
POSSIBLE PROBLEMS
OPEN IN DISTRIBUTION BOX OPEN IN WIRING



TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
Continuity indicates the harness and controller are ok. Non-continuity indicates an open in the harness or distribution box.



REFERENCE INFORMATION

GLOWPLUGS

Replace harness. Notify DS Maintenance.

Replace glowplugs, refer to (para. 3-38).

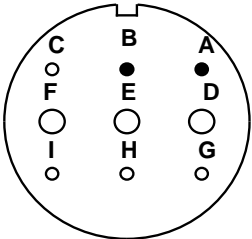


**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace distribution box, refer to (para. 4-5.1).



Engine Connector with pins 'A' & 'B' highlighted.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

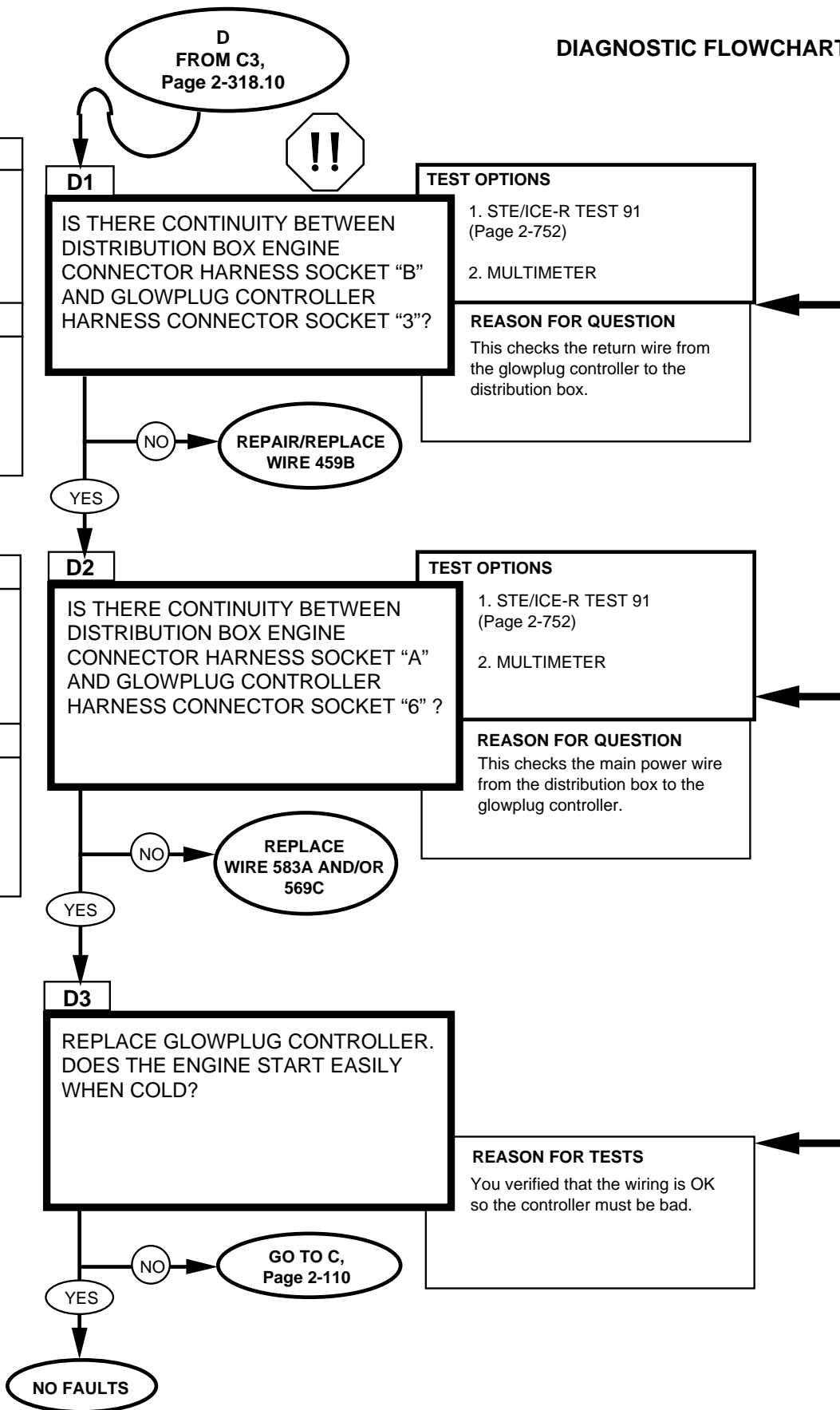
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# GLOWPLUGS

## DIAGNOSTIC FLOWCHART

KNOWN INFO
OPEN CIRCUIT IN GLOW-PLUG CONTROLLER OR WIRING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER

KNOWN INFO
OPEN CIRCUIT IN GLOW-PLUG CONTROLLER OR WIRING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER



## REFERENCE INFORMATION

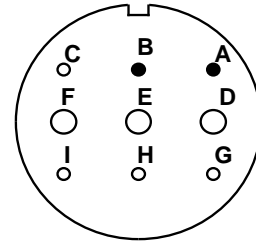
## GLOWPLUGS



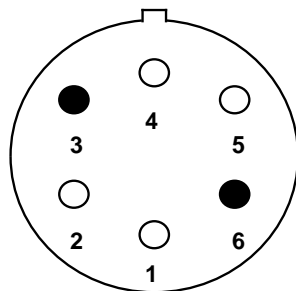
### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

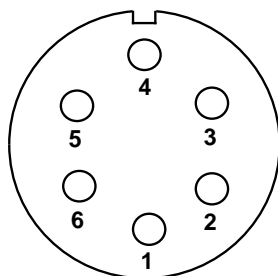
There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.



Engine Connector Harness with sockets "A" & "B" highlighted.



Glowplug Controller Harness with sockets 3 & 6 highlighted



Glowplug Controller

### **0-4500 OHMS STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

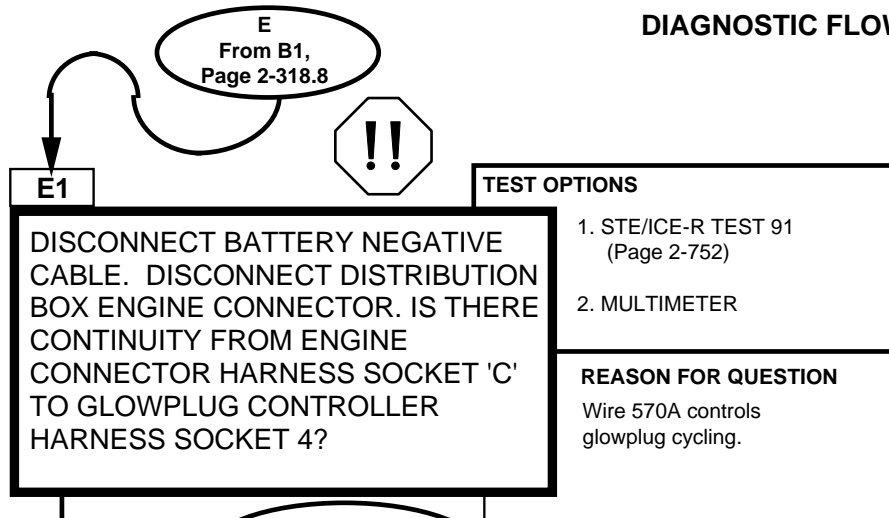
### **CONTINUITY (RESISTANCE) MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

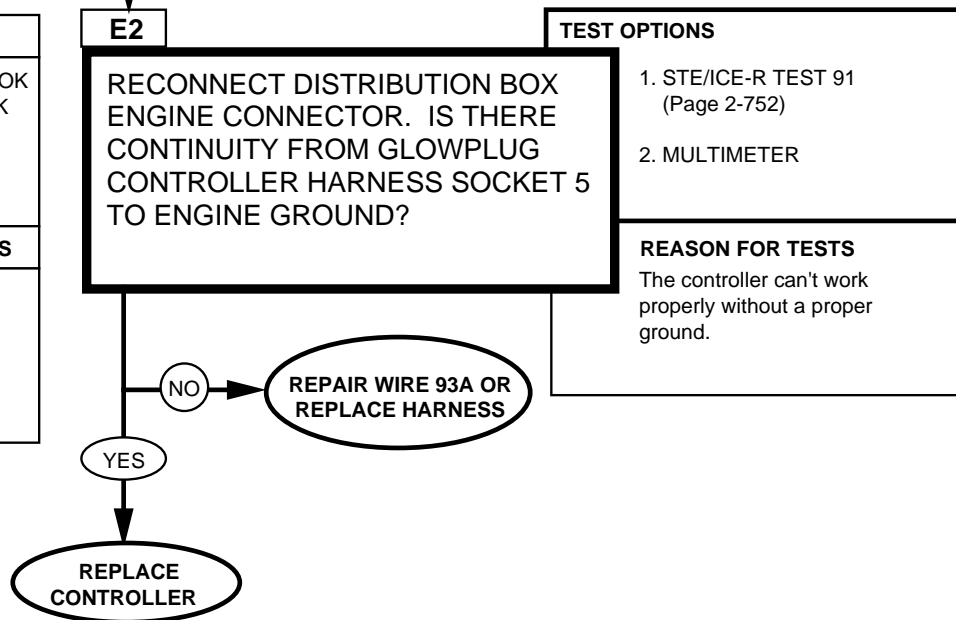
# GLOWPLUGS CIRCUIT

## DIAGNOSTIC FLOWCHART

KNOWN INFO
GLOWPLUG CURRENT OK DISTRIBUTION BOX OK GLOWPLUGS NOT CYCLING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER



KNOWN INFO
GLOWPLUG CURRENT OK DISTRIBUTION BOX OK GLOWPLUGS NOT CYCLING
POSSIBLE PROBLEMS
WIRING GLOWPLUG CONTROLLER



## REFERENCE INFORMATION



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting distribution box harness.

There is battery voltage at the distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Repair wiring or replace harness, refer to (para. 4-84).

Repair wiring or replace harness, refer to (para. 4-85).

Replace glowplug controller, refer to (para. 4-29).

## GLOWPLUGS CIRCUIT

### **0-4500 OHMS STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

### **CONTINUITY (RESISTANCE) MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

## **2-32. INSTRUMENT TESTS**

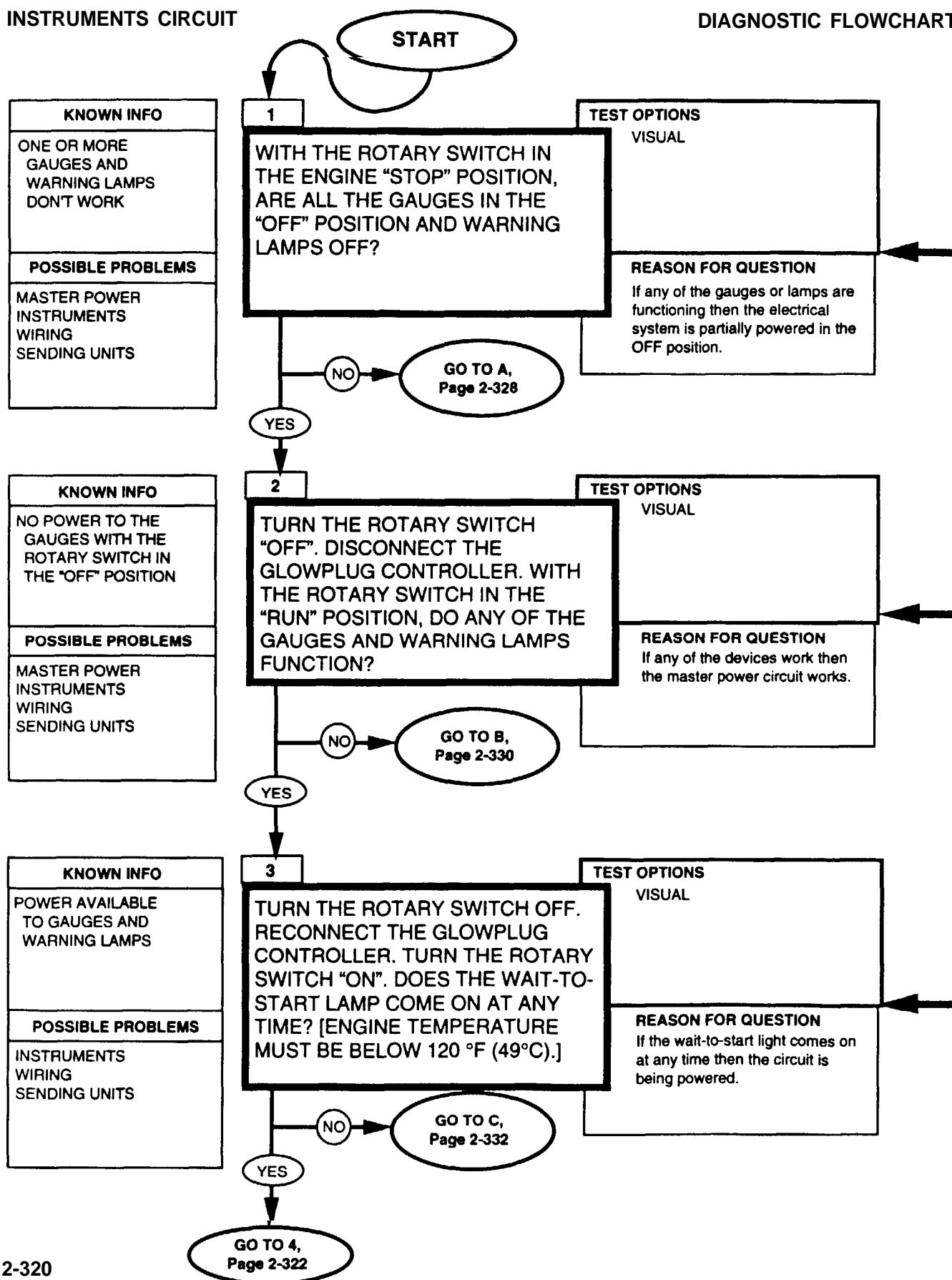
These Instrument Tests can be run any time you think there is a problem with the instruments or if you were sent here from another test.

If you get an unusual gauge reading it is a good idea to check out the system that the gauge monitors to be sure that it is a gauge problem and not a real problem in the engine or electrical system.

Refer to fold-out page FO-10 and leave fold-out open for reference during testing. Diagrams of the individual gauge circuits will be found on the page that deals with that circuit.

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART



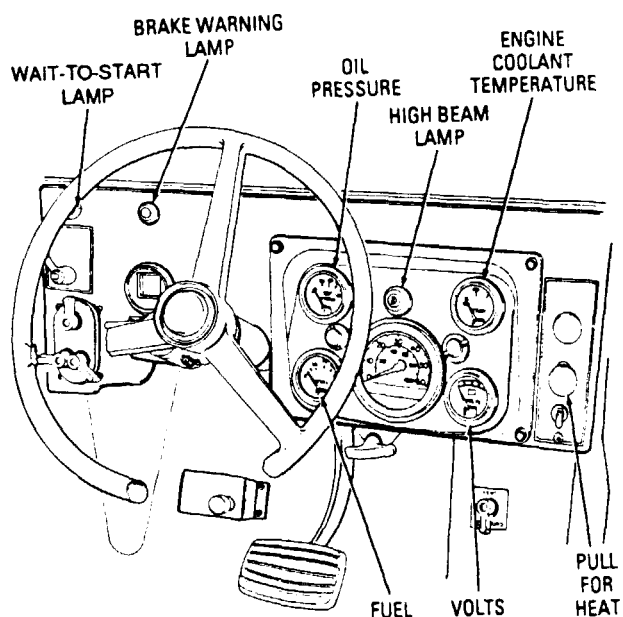
## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT

None of the following instruments and accessories should work when the rotary switch is in the STOP position:

Volts gauge  
Wait-to-start lamp  
Temperature gauge  
oil pressure gauge  
Fuel gauge  
Windshield wiper/washer  
Brake warning lamp

If any of the instruments and accessories work when the rotary switch is in the RUN position, then power is available and the circuit breaker is OK.



## NOTE

The wait-to-start lamp is not an accurate indication of glowplug operation. Make sure the glowplugs are operating properly BEFORE you check out the light. Go to the Glowplug Tests, page 2-303. Return here if the light still doesn't operate properly.

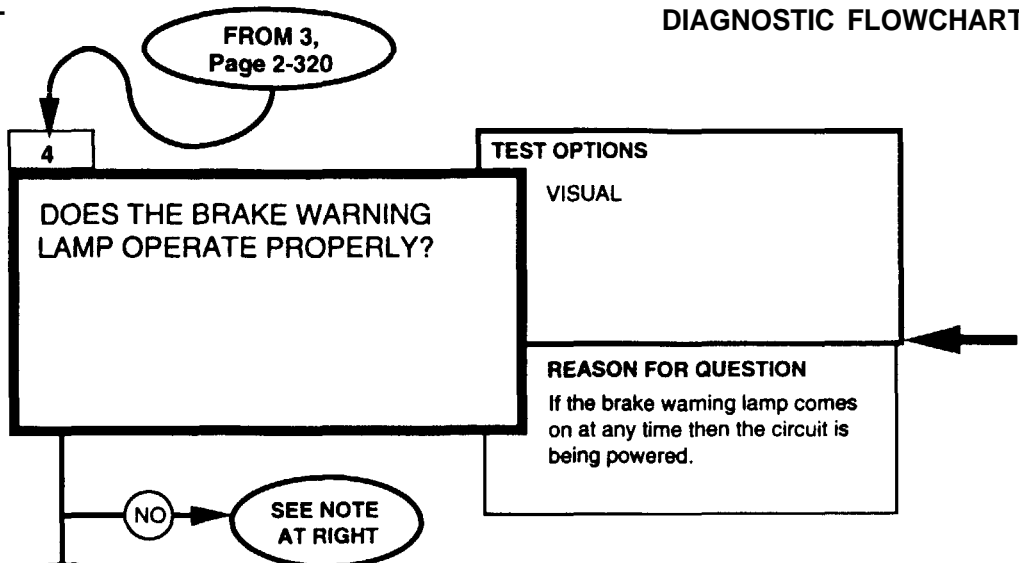
The wait-to-start lamp should come on when the engine is below 120°F (49° C) and the rotary switch is first turned to the RUN position.



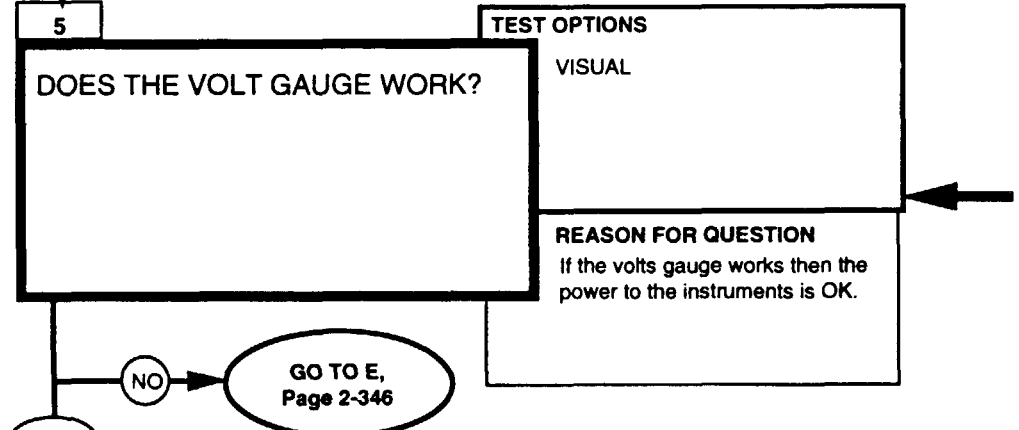
INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

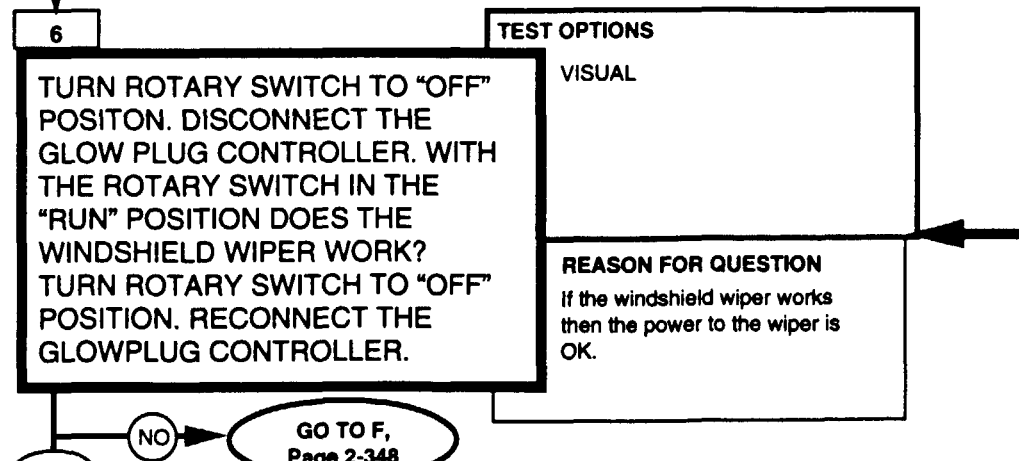
KNOWN INFO
WAIT-TO-START LAMP OK
POSSIBLE PROBLEMS
INSTRUMENTS WIRING SENDING UNITS



KNOWN INFO
BRAKE LAMP OK
POSSIBLE PROBLEMS
INSTRUMENTS WIRING SENDING UNITS



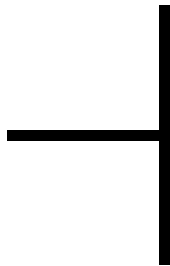
KNOWN INFO
VOLT GAUGE OK
POSSIBLE PROBLEMS
INSTRUMENTS WIRING SENDING UNITS



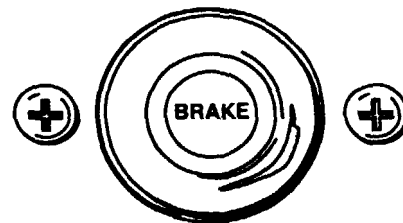
GO TO 7,  
Page 2-324

## REFERENCE INFORMATION

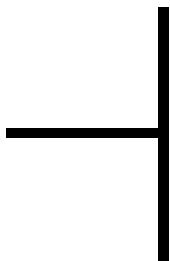
## INSTRUMENTS CIRCUIT



The brake warning lamp should come on when the engine is cranking, when the parking brake is set, or When there is a failure in the brake system. If brake warning lamp stays on, go to 1, page 2-342. If the warning lamp does not come on, go to D, page 2-338.



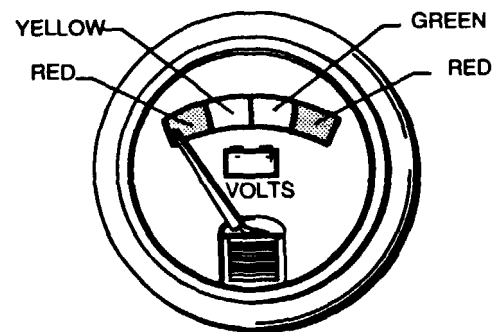
**BRAKE WARNING LAMP**



The volt gauge may be checked by running STE/ICE-R Test 67 with the engine running. The position in the center of the green area of the volt gauge marked GEN is approximately 26 volts.

The volt gauge is a gatvanometer type gauge. It is conceivable that the coil in the gauge may have a broken wire that only opens when the gauge is heated up. If you are having an intermittent gauge problem, leave the vehicle running for awhile and watch the gauge.

If the charging system is ok, but the gauge is reading full scale one way or the other, then you may have this type of problem.



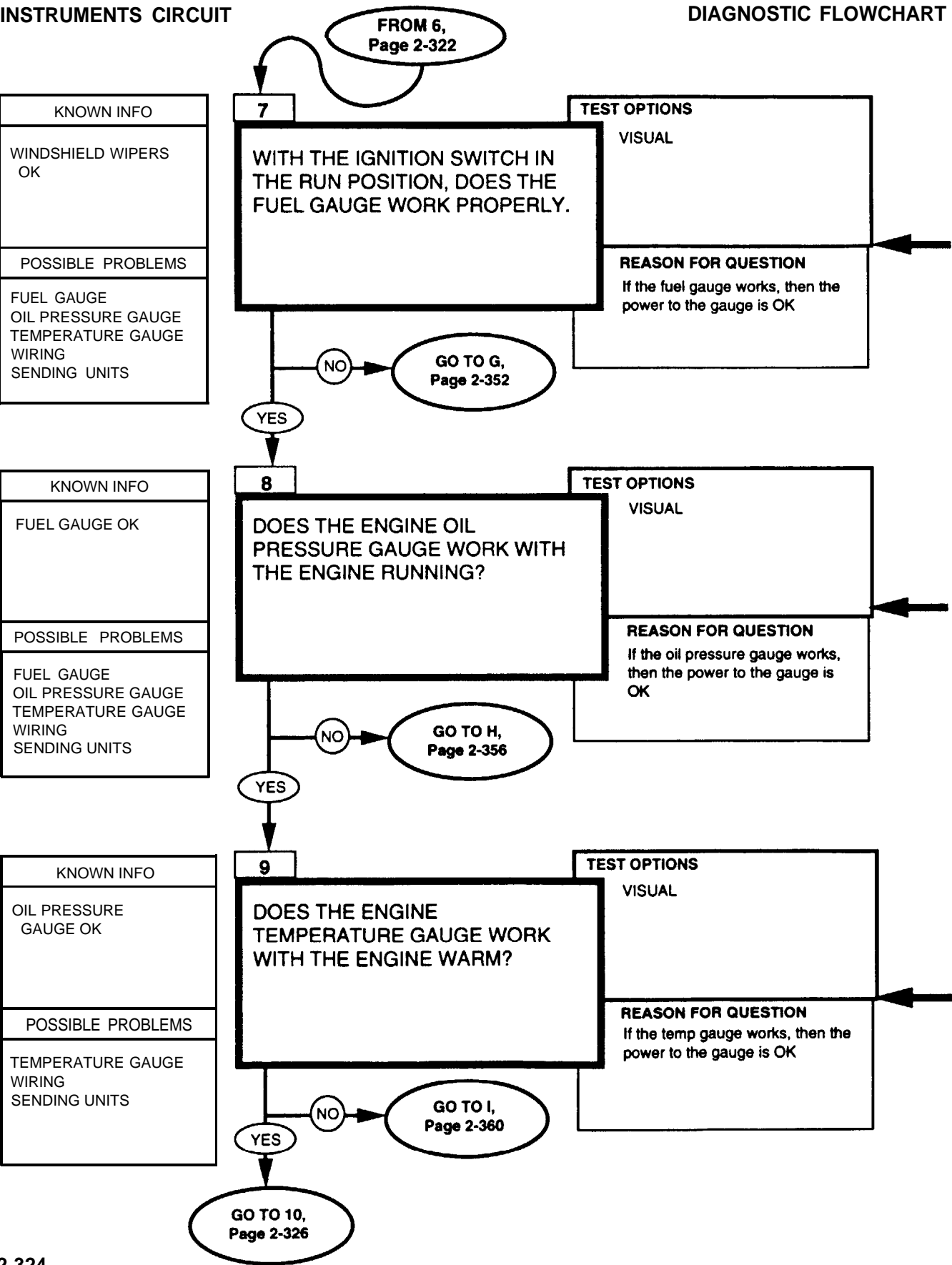
**VOLT  
GAUGE**



Rotary switch has to be in the RUN position for the windshield wiper or washer to operate.

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## NOTE

These gauges are galvanometer type gauges. It is conceivable that the coil in the gauge may have a broken wire that only opens when the gauge is warmed up. If you are having an intermittent gauge problem, leave the vehicle running for a while and watch the gauge. If the system the gauge monitors is OK, but the gauge is reading full scale one way or the other, then you may have this type of problem.

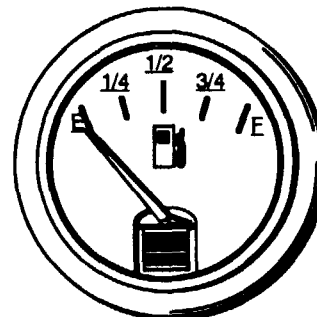
Fill the fuel tank if necessary to obtain a reading greater than empty.

With the engine running, the oil pressure should be approximately 10 PSI at idle, 40-45 PSI at 2000 RPM, and it should be 0 when stopped.

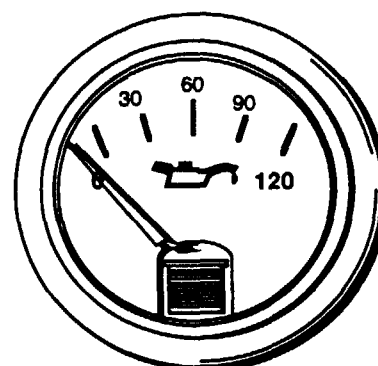
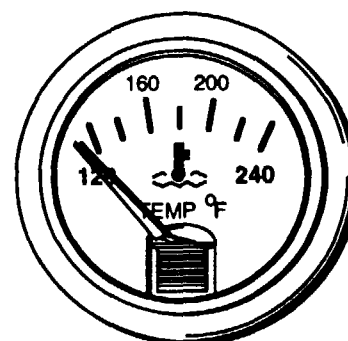
Make sure shift lever is in neutral before running this test.

With the engine cold the gauge should read off scale to the left and when warm the reading should be 190°- 230°F (88° - 110° C).

## INSTRUMENTS CIRCUIT

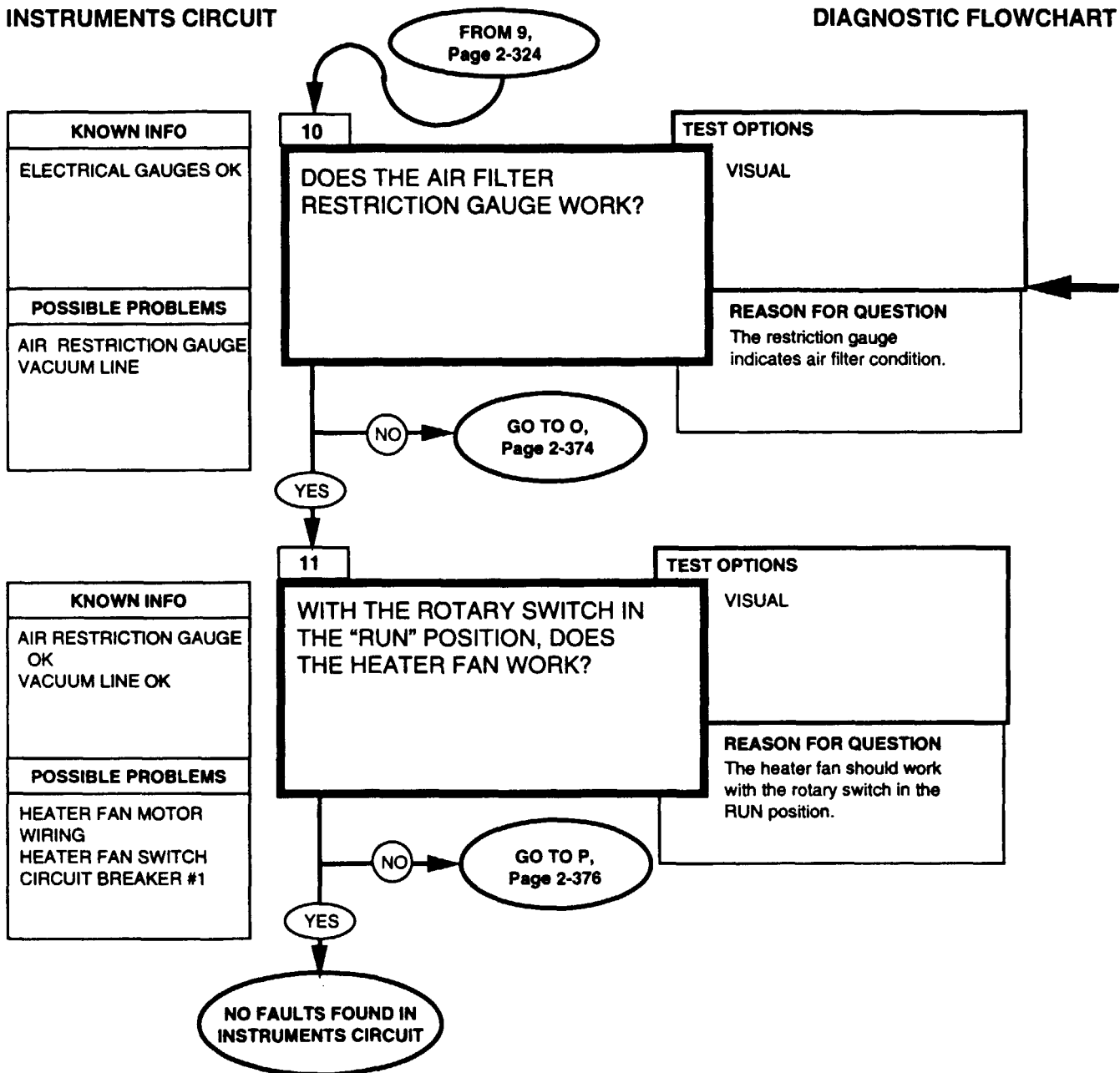


FUEL GAUGE

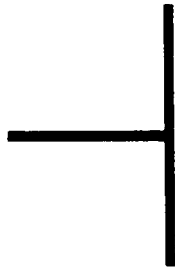
OIL PRESSURE  
GAUGETEMPERATURE  
GAUGE

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

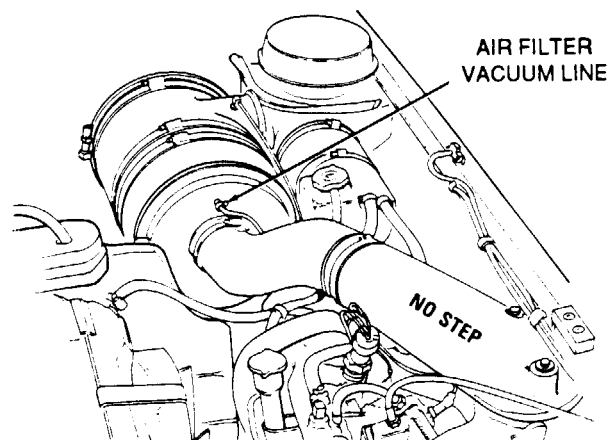
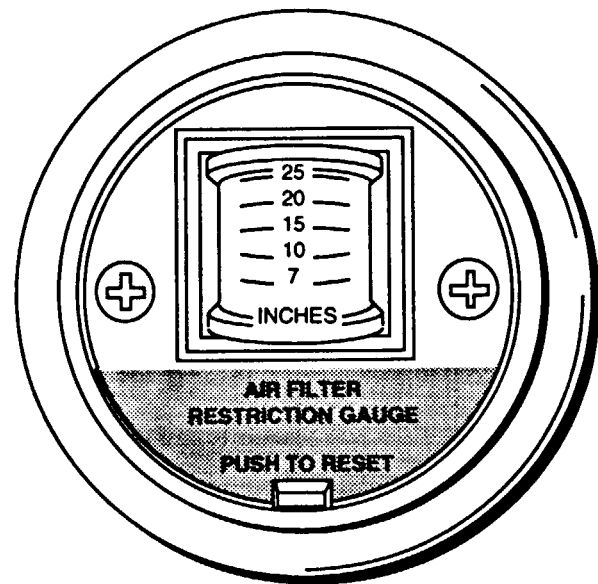


## REFERENCE INFORMATION



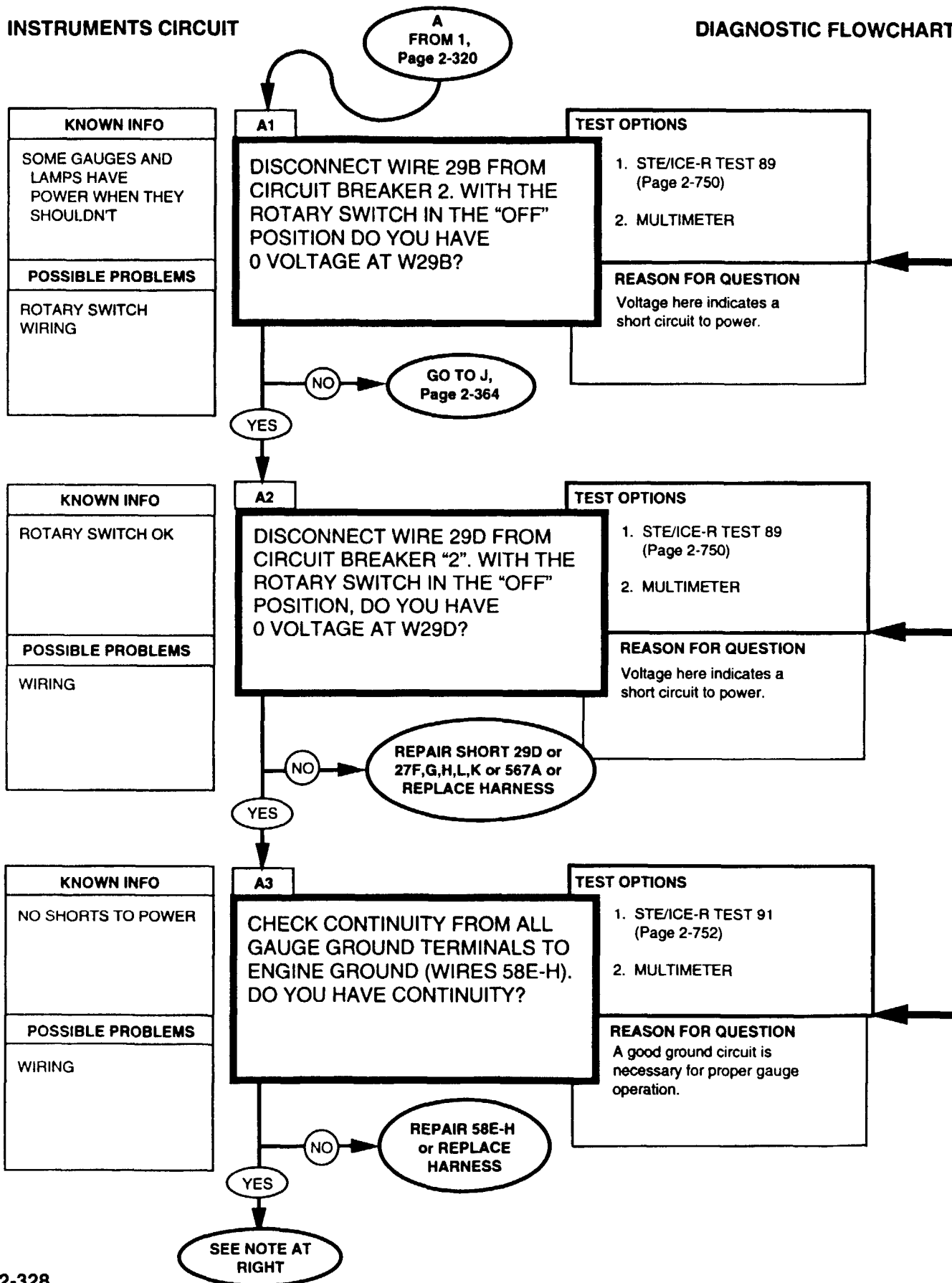
When vacuum is applied to the line at the air filter, the gauge should read yellow and hold the reading until it is released by pressing the reset button on the gauge.

## INSTRUMENTS CIRCUIT



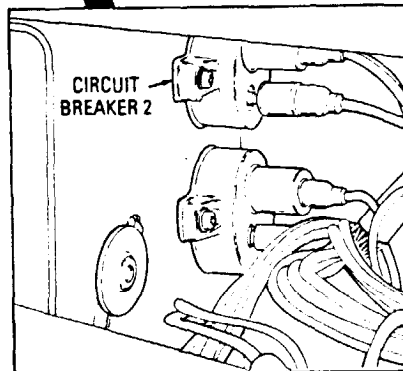
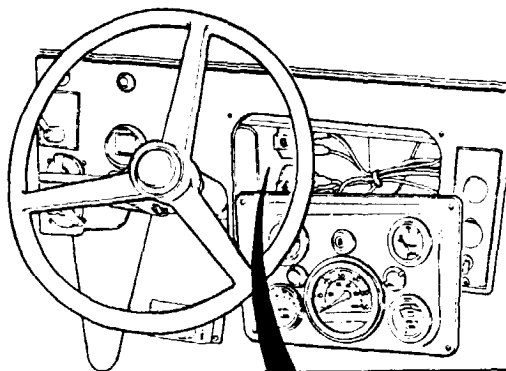
# INSTRUMENTS CIRCUIT

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

The easiest way to reach the circuit breaker and gauge wiring is to remove the gauge panel screws and pull the panel out far enough to work with the wiring.



Replace harness/or repair wiring, refer to (para 4-85).

Connect the Black test lead to a good engine ground and connect the Red test lead to each gauge ground terminal (the uninsulated screw) one at a time and note each reading.

**NOTE**

You have checked all the wiring that is common to all the gauges and warning lamps. Reconnect wires and return to step 2 of the go-chain, page 2-320, and continue testing.

## INSTRUMENTS CIRCUIT

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

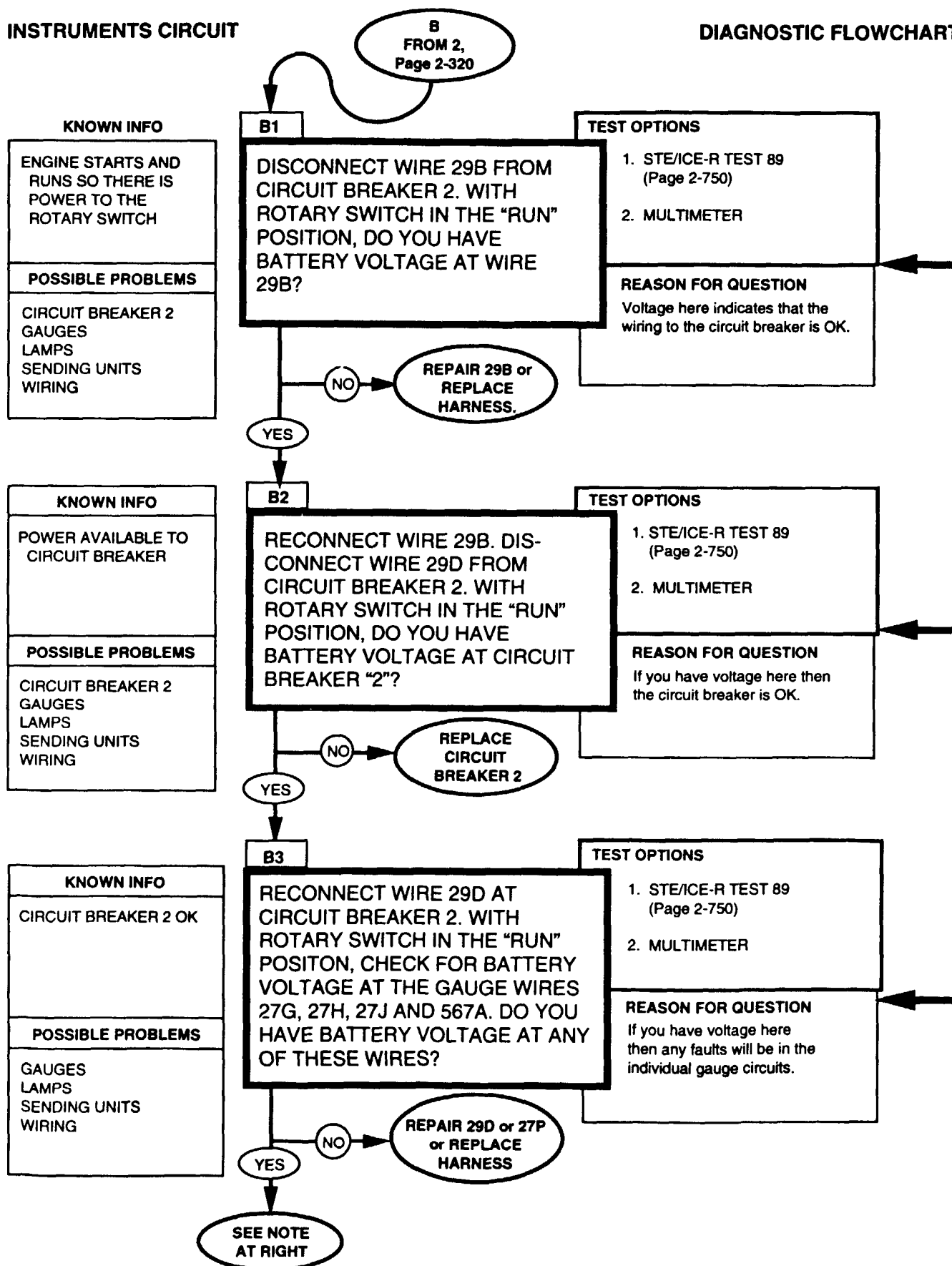
**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



# INSTRUMENTS CIRCUIT

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT

The easiest way to reach the circuit breaker and gauge wiring is to remove the gauge panel screws and pull the panel out far enough to work with the wiring.

Replace harness/or repair wiring, refer to (para 4-85).

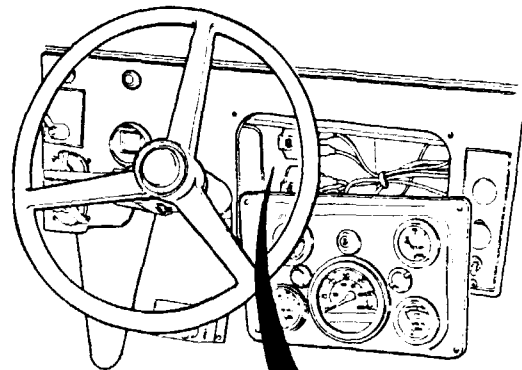
**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

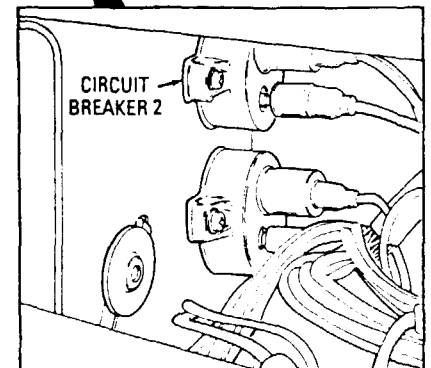
Replace circuit breaker, refer to (para 4-9).



Replace harness/or repair wiring, refer to (para 4-85).

**NOTE**

You have checked all the common power wiring to all the gauges and warning lamps. Reconnect wires and return to step 3 of the go-chain, page 2-320, and continue testing.



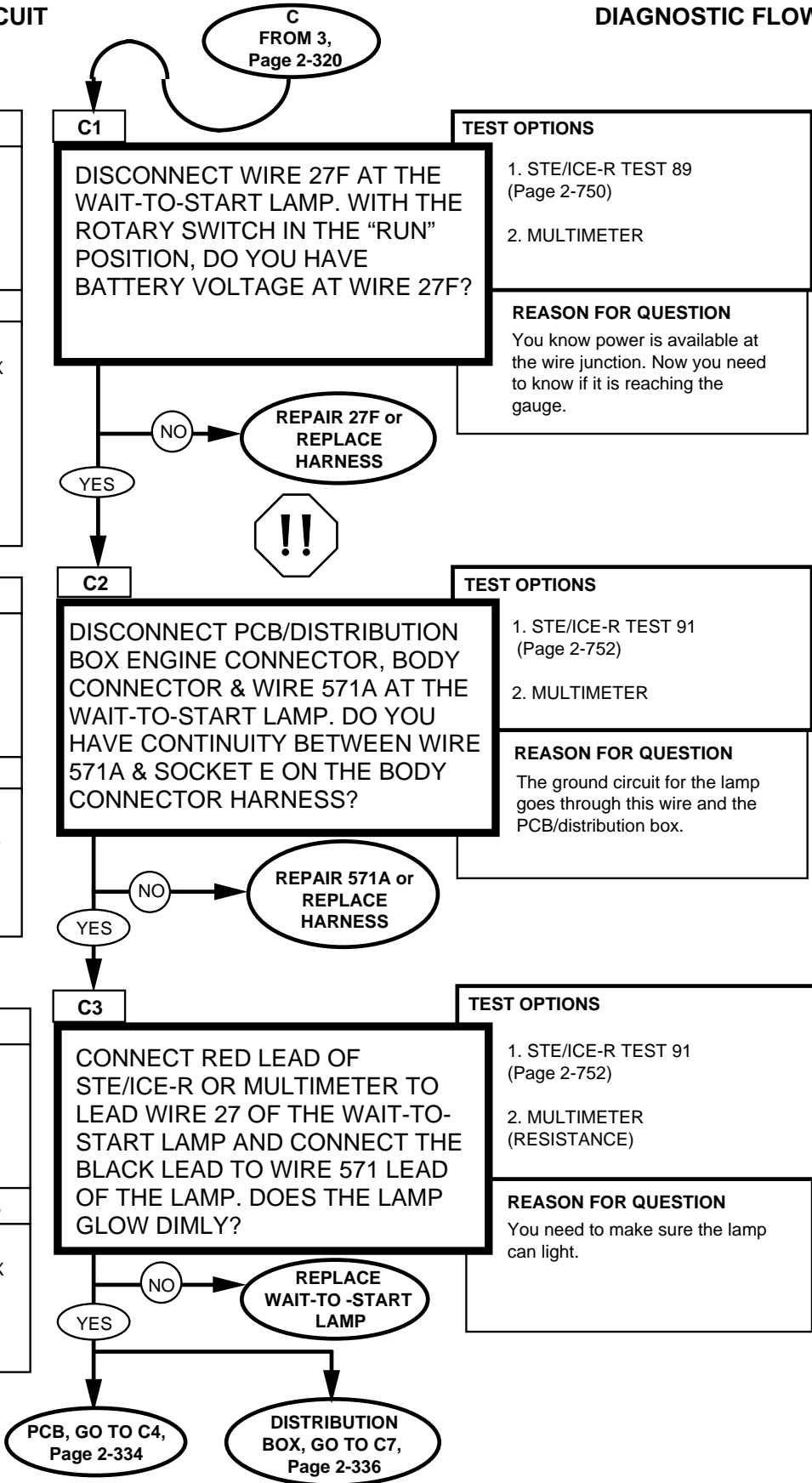
INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
POWER AVAILABLE TO GAUGES WAIT-TO-START LAMP DOESN'T COME ON
<b>POSSIBLE PROBLEMS</b>
WAIT-TO-START LAMP PCB/DISTRIBUTION BOX GLOWPLUG CONTROLLER WIRING NOTE: NO GLOWPLUG CONTROLLER WITH DISTRIBUTION BOX

<b>KNOWN INFO</b>
POWER AVAILABLE TO LAMP
<b>POSSIBLE PROBLEMS</b>
WAIT-TO-START LAMP PCB/DISTRIBUTION BOX GLOWPLUG CONTROLLER WIRING

<b>KNOWN INFO</b>
LAMP HAS GROUND
<b>POSSIBLE PROBLEMS</b>
WAIT-TO-START LAMP PCB/DISTRIBUTION BOX GLOWPLUG CONTROLLER WIRING



**REFERENCE INFORMATION**



**WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

It is important to connect the leads as indicated because you are checking continuity across a diode. The lamp will glow dimly because you are supplying a small amount of power thru STE/ICE-R. You may have to shade the lamp with your hand to see if it glows.

**NOTE**

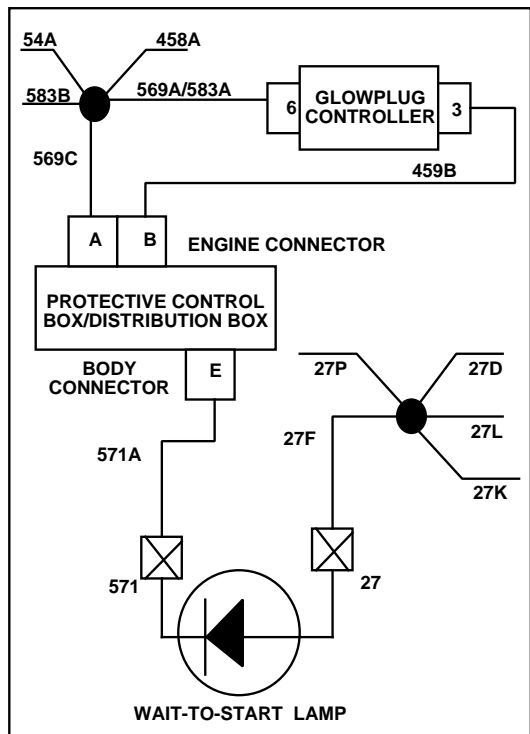
A multimeter may not supply enough power to light the lamp. In this case look for a much greater resistance when measuring with the leads connected in one direction than when they are connected in reverse.

Replace harness or lamp, refer to (para. 4-17).

**INSTRUMENTS CIRCUIT**

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
LAMP OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX GLOWPLUG CONTROLLER WIRING

FROM C3,  
Page 2-332

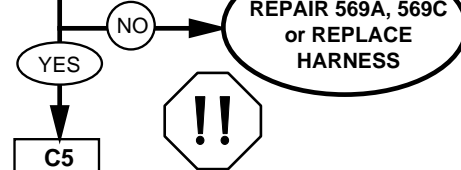
**C4**

**NOTE: FOR DISTRIBUTION BOX SKIP STEPS C4, C5, AND C6. DISCONNECT GLOWPLUG CONTROLLER. DO YOU HAVE CONTINUITY BETWEEN SOCKET "6" IN THE CONTROLLER HARNESS & SOCKET A IN THE ENGINE CONNECTOR HARNESS?**

**TEST OPTIONS**

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

**REASON FOR QUESTION**  
This wire provides power to the controller.



KNOWN INFO
LAMP OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX GLOWPLUG CONTROLLER WIRING

**C5**

**DO YOU HAVE CONTINUITY BETWEEN SOCKET "3" IN THE CONTROLLER HARNESS & SOCKET "B" IN THE ENGINE CONNECTOR HARNESS?**

**TEST OPTIONS**

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

**REASON FOR QUESTION**  
This wire returns power for the lamp.



KNOWN INFO
WIRING TO & FROM CONTROLLER OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX GLOWPLUG CONTROLLER

**C6**

**RECONNECT GLOWPLUG CONTROLLER. DO YOU HAVE CONTINUITY BETWEEN SOCKET "A" & SOCKET "B" IN THE ENGINE CONNECTOR HARNESS?**

**TEST OPTIONS**

1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER

**REASON FOR QUESTION**  
If you don't have continuity here then you know that the controller is bad.



REFERENCE INFORMATION



WARNING

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

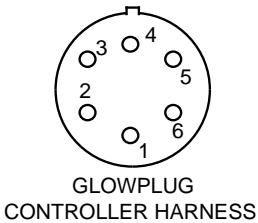
There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

<b>0-4500 OHMS STE/ICE-R TEST 91</b>
1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

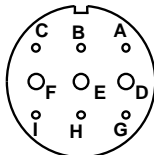
<b>CONTINUITY (RESISTANCE) MULTIMETER</b>
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Engine temperature must be below 120°F (49°C) in order to make this test, otherwise normal operation of the glowplug controller will cause the circuit to be open.

Replace harness and glowplug controller, refer to (para. 4-29).

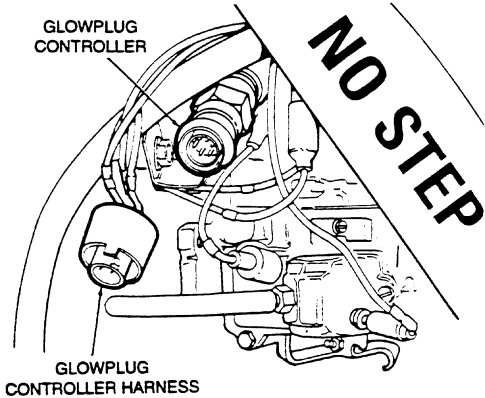
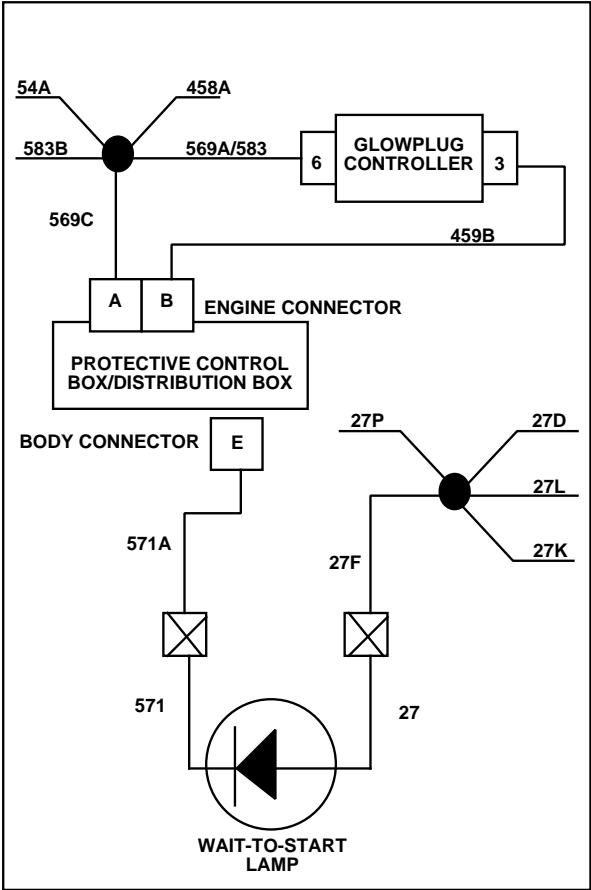


GLOWPLUG  
CONTROLLER HARNESS



PCB ENGINE CONNECTOR

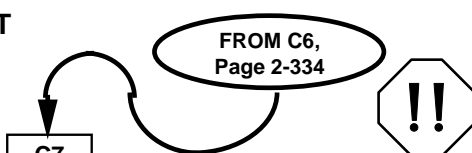
INSTRUMENTS CIRCUIT



# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

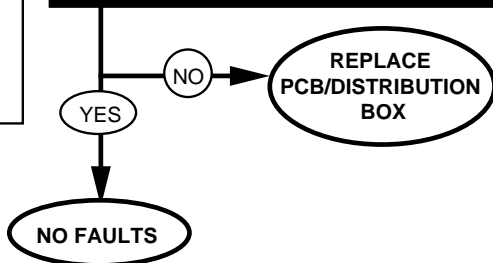
KNOWN INFO
GLOWPLUG CONTROLLER OK
POSSIBLE PROBLEMS
PCB/DISTRIBUTION BOX



**C7**

RECONNECT ALL WIRING (RECONNECT ENGINE CONNECTOR LAST) AND RECHECK WAIT-TO-START LAMP OPERATION. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DOES THE WAIT-TO-START LAMP COME ON ?

TEST OPTIONS
CONNECT THE WIRES
REASON FOR QUESTION
You may have fixed a loose or dirty connection without knowing it.



## REFERENCE INFORMATION



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box/distribution box harness.

There is battery voltage at the PCB/distribution box at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Engine temperature must be below 120°F (49° C) or the lamp may not come on.

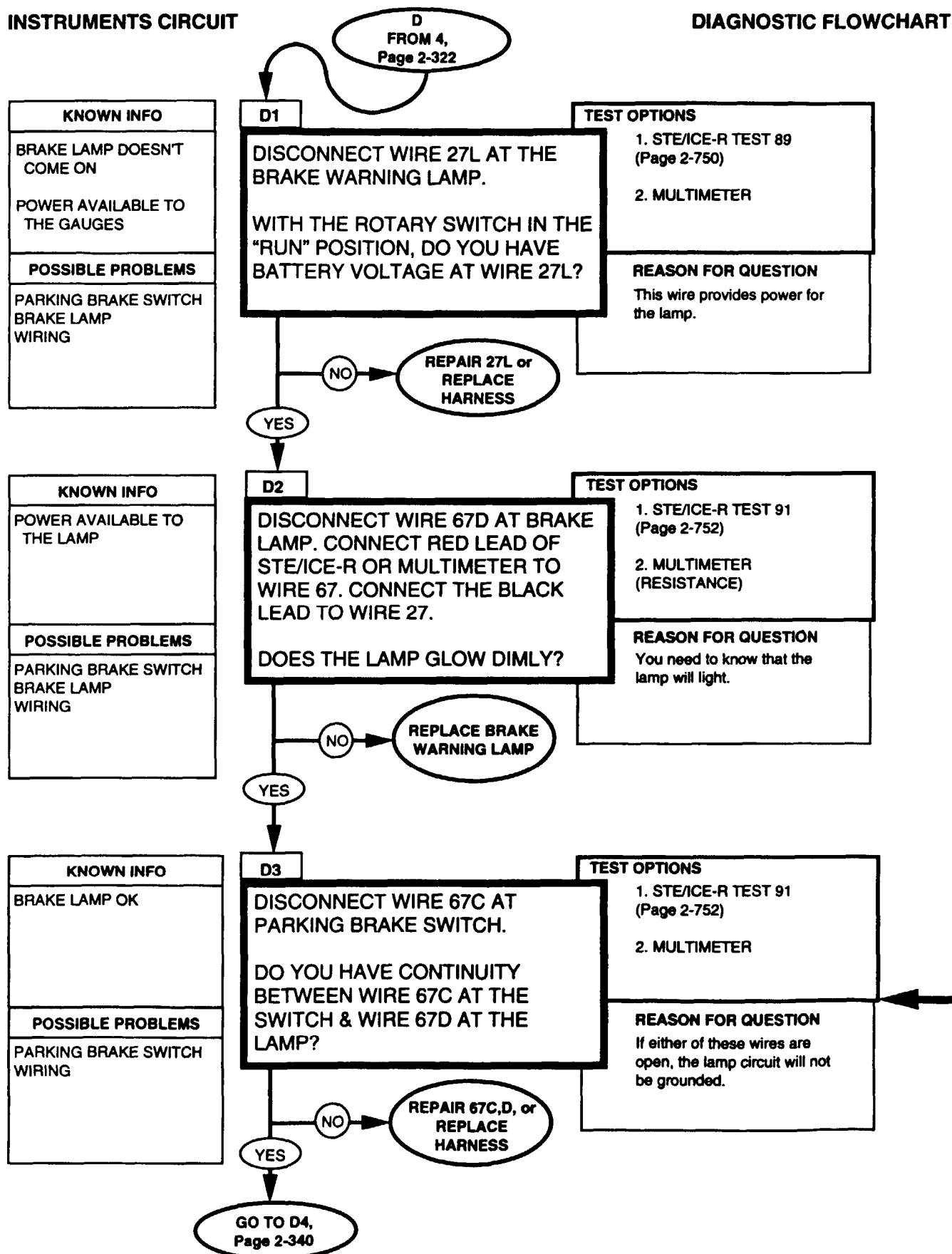
Replace PCB, refer to (para. 4-5).  
Replace distribution box (para. 4-5.1).

## INSTRUMENTS CIRCUIT



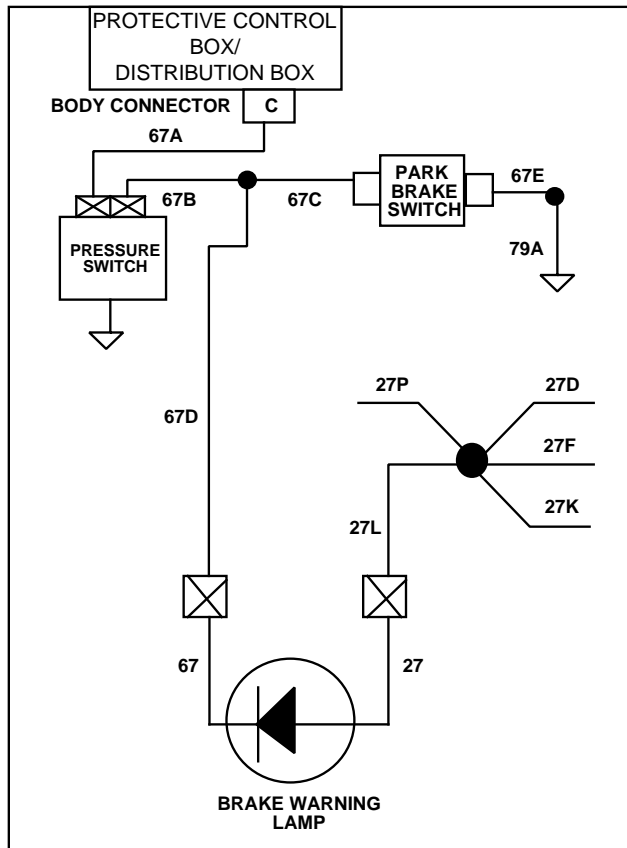
# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT



It is important to connect the leads as indicated because you are checking continuity across a diode. The lamp will glow dimly because you are supplying a small amount of power thru STE/ICE-R. You may have to shade the lamp with your hand to see if it glows.

**NOTE**

A multimeter may not supply enough power to light the lamp. In this case look for a much greater resistance when measuring with the leads connected in one direction than when they are connected in reverse.

Replace harness/or repair wiring, refer to (para. 4-85).

Replace brake warning lamp, refer to (para. 4-17).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

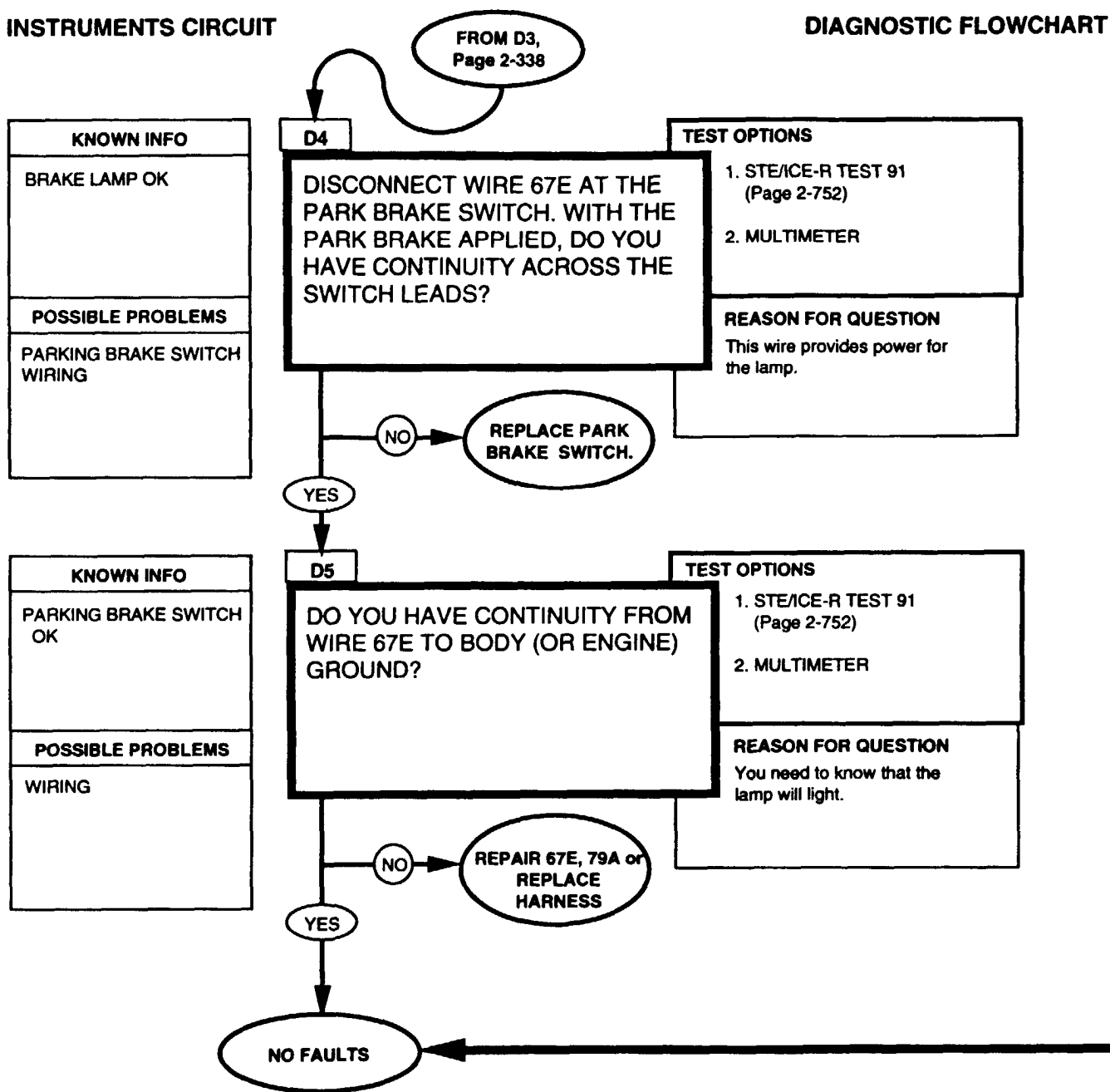
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

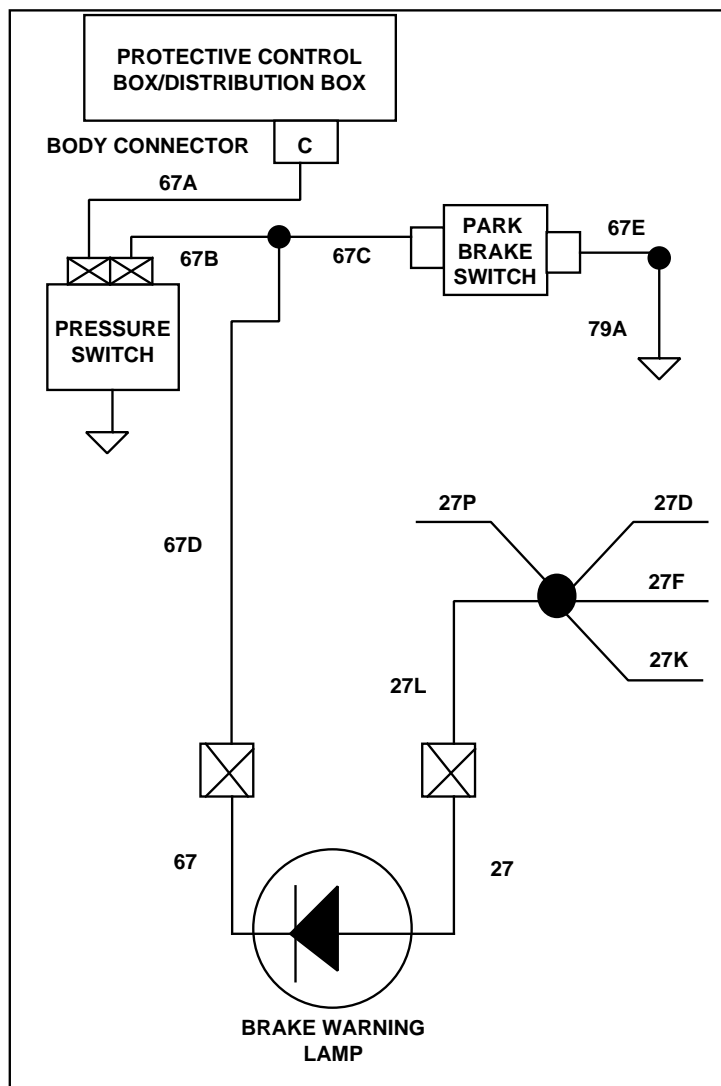
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION



## INSTRUMENTS CIRCUIT

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

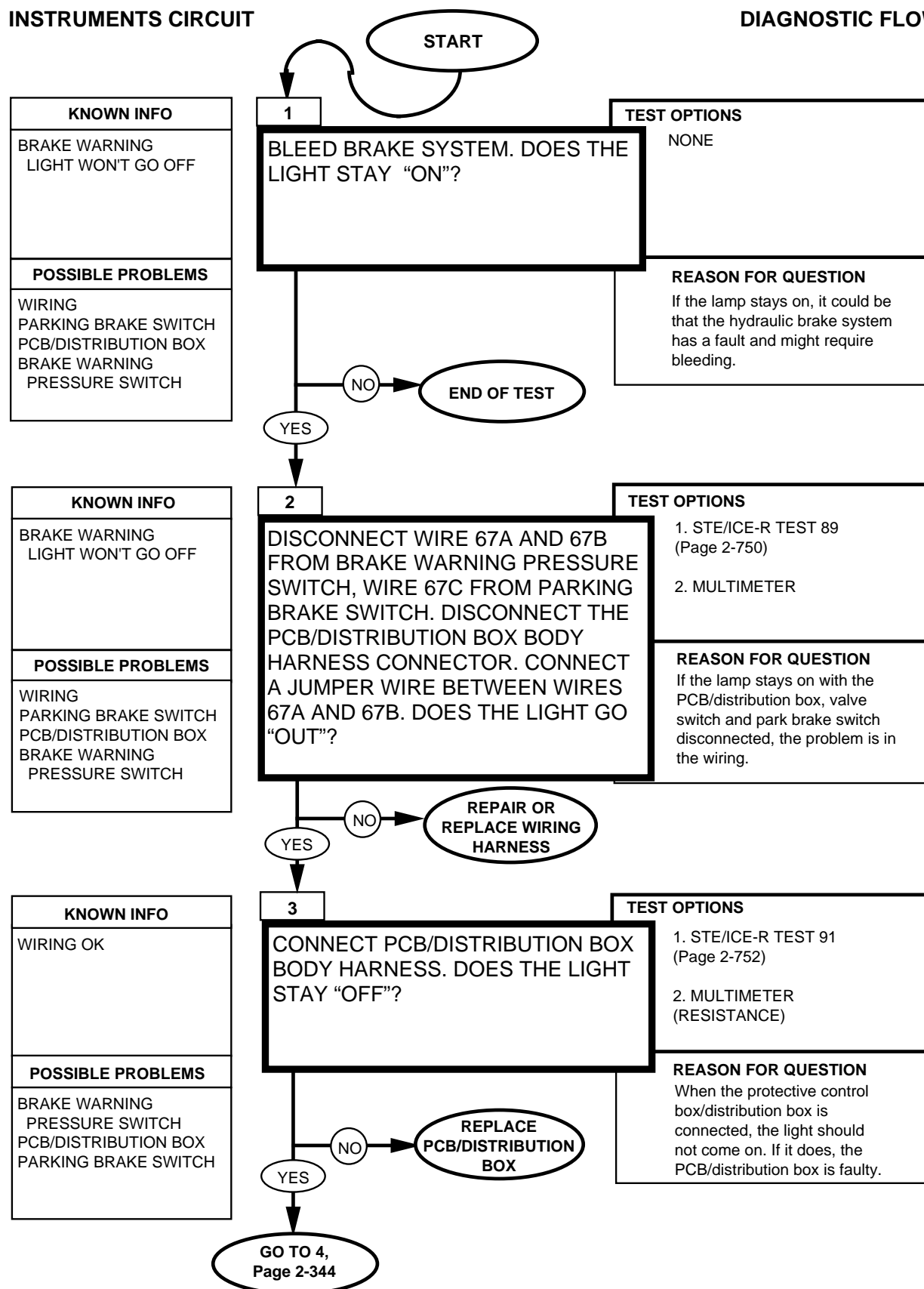
Reconnect all wiring. Connect the glowplug controller last.

Replace parking brake switch. Refer to (para. 4-19).

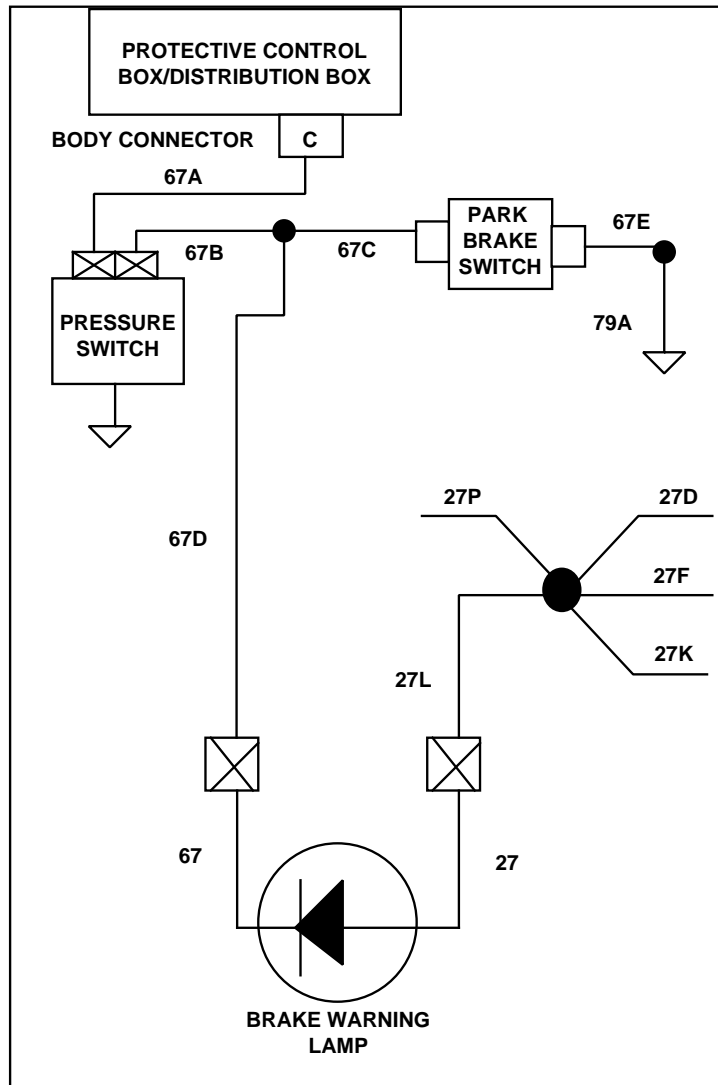
Replace harness/or repair wiring. Refer to (para. 4-85).

## INSTRUMENTS CIRCUIT

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION



Bleed brake system. Refer to (para. 7-10).

Replace parking brake switch. Refer to (para. 4-19).

Replace harness/or repair wiring. Refer to (para. 4-85).

Replace PCB. Refer to (para. 4-5).

Replace distribution box (para. 4-5.1).

## INSTRUMENTS CIRCUIT

### 0-45 OHMS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to the negative.
3. Be sure to read the correct scale.

### 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays '9.9.9.9.'

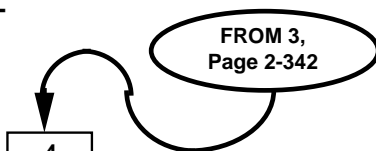
### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# INSTRUMENTS CIRCUIT

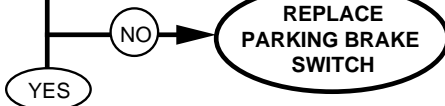
# DIAGNOSTIC FLOWCHART

KNOWN INFO
WIRING OK PCB/DISTRIBUTION BOX OK BRAKE WARNING VALVE SWITCH OK
POSSIBLE PROBLEMS
PARKING BRAKE SWITCH



CONNECT PARKING BRAKE SWITCH. MAKE SURE THE PARKING BRAKE IS DISENGAGED. DOES THE LIGHT STAY OFF?

TEST OPTIONS
VISUAL
REASON FOR QUESTION
The light will only come on when the parking brake switch is connected. If the parking brake switch has a problem.

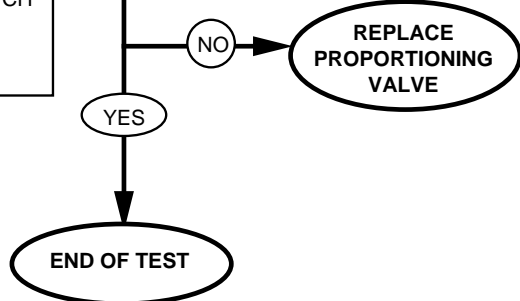


KNOWN INFO
PCB/DISTRIBUTION BOX OK WIRING OK
POSSIBLE PROBLEMS
BRAKE WARNING PRESSURE SWITCH PARKING BRAKE SWITCH

5

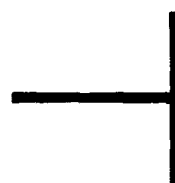
REMOVE JUMPER WIRE. CONNECT BRAKE WARNING PRESSURE SWITCH. DOES LIGHT STAY OFF?

TEST OPTIONS
1. STE/ICE-R TEST 91 (PAGE 2-752) 2. MULTIMETER
REASON FOR QUESTION
If the light comes on when brake warning pressure switch is connected, the brake warning pressure switch is the problem.



**REFERENCE INFORMATION**

Replace parking brake switch, refer to (para. 4-19).



When the brake warning pressure switch is defective, the proportioning valve must be replaced. Refer to (para. 7-18).

**INSTRUMENTS CIRCUIT**
**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the terminations indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

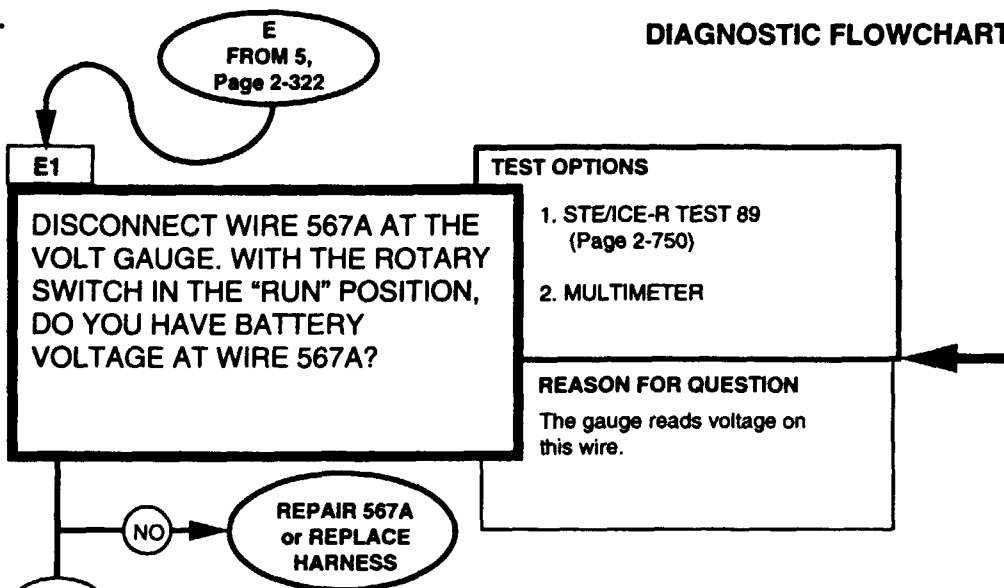
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



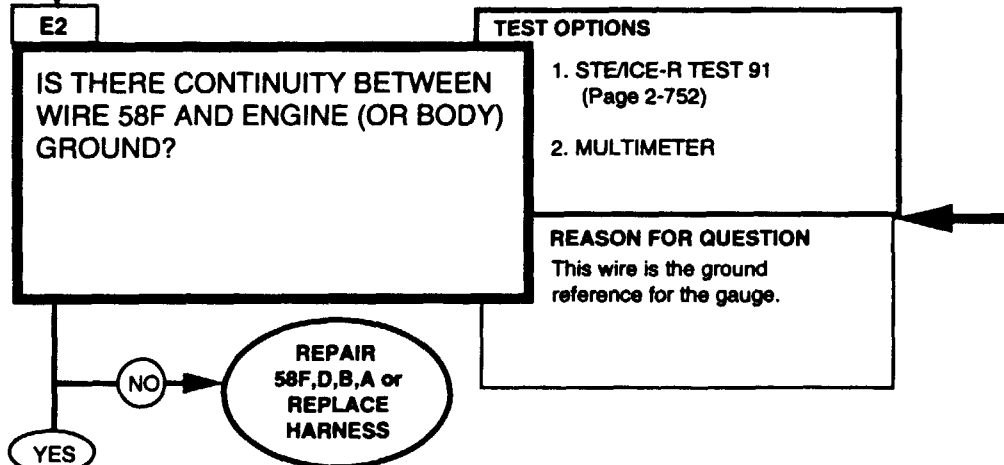
# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
POWER AVAILABLE TO GAUGES VOLT GAUGE DOESN'T WORK
POSSIBLE PROBLEMS
VOLT GAUGE WIRING

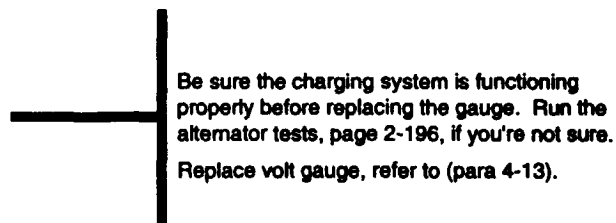
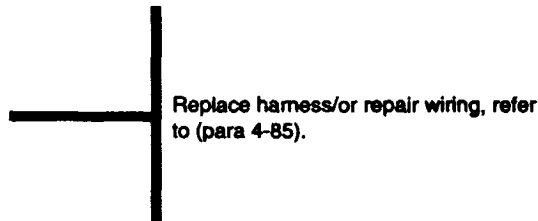
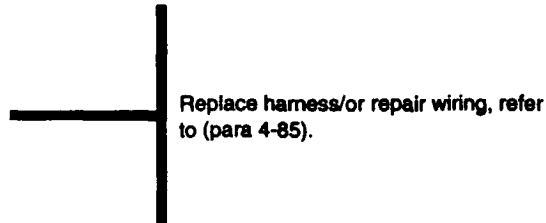


KNOWN INFO
POWER AVAILABLE AT VOLT GAUGE
POSSIBLE PROBLEMS
VOLT GAUGE WIRING



## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT


**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

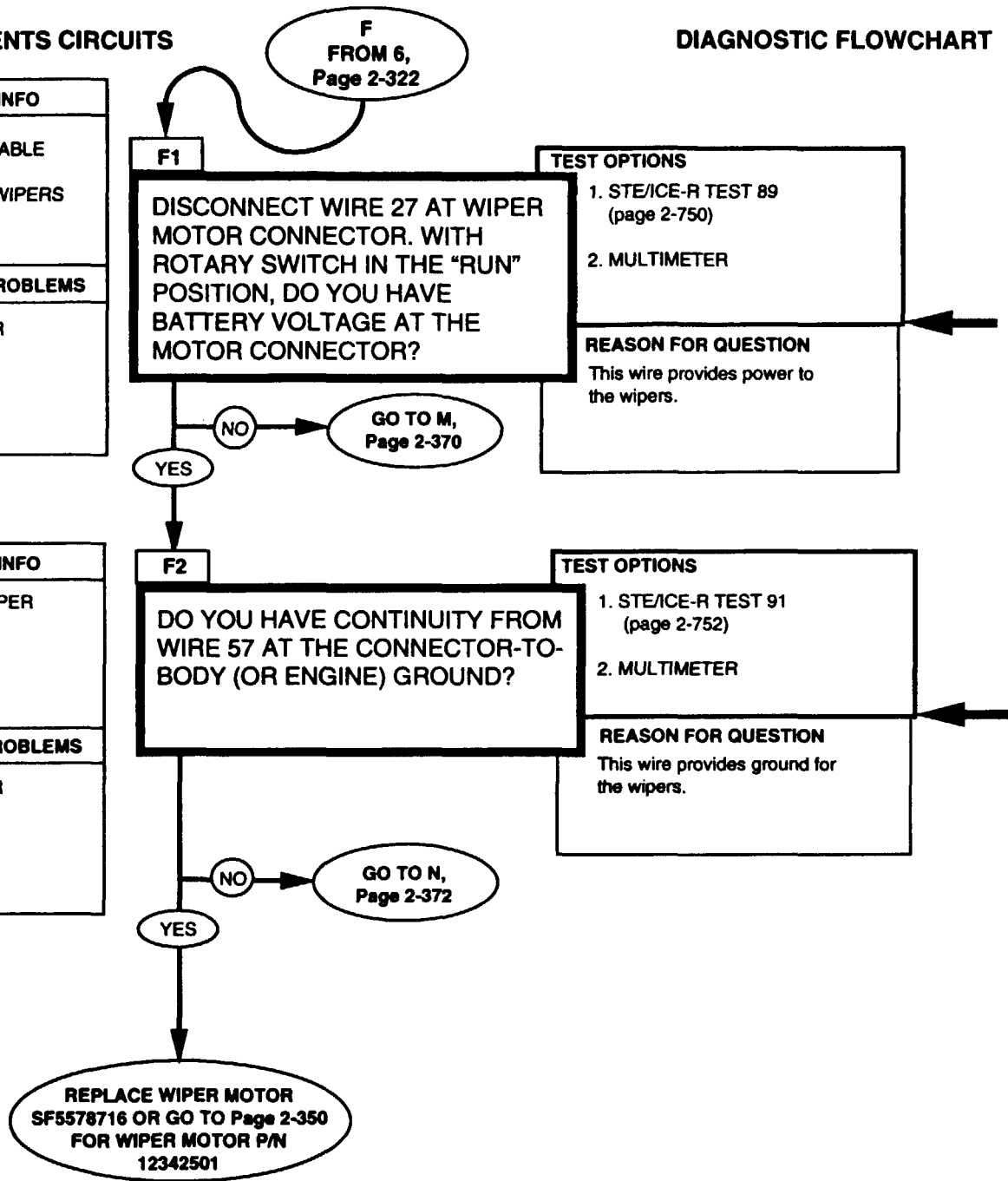
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# INSTRUMENTS CIRCUITS

KNOWN INFO
POWER AVAILABLE TO GAUGES WINDSHIELD WIPERS DON'T WORK
POSSIBLE PROBLEMS
WIPER MOTOR WIRING

KNOWN INFO
POWER TO WIPER MOTOR
POSSIBLE PROBLEMS
WIPER MOTOR WIRING

# DIAGNOSTIC FLOWCHART



# REFERENCE INFORMATION

# INSTRUMENTS CIRCUIT



Replace wiper motor SF5578716.  
Refer to (para. 10-71.)

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE-R displays "9.9.9.9."

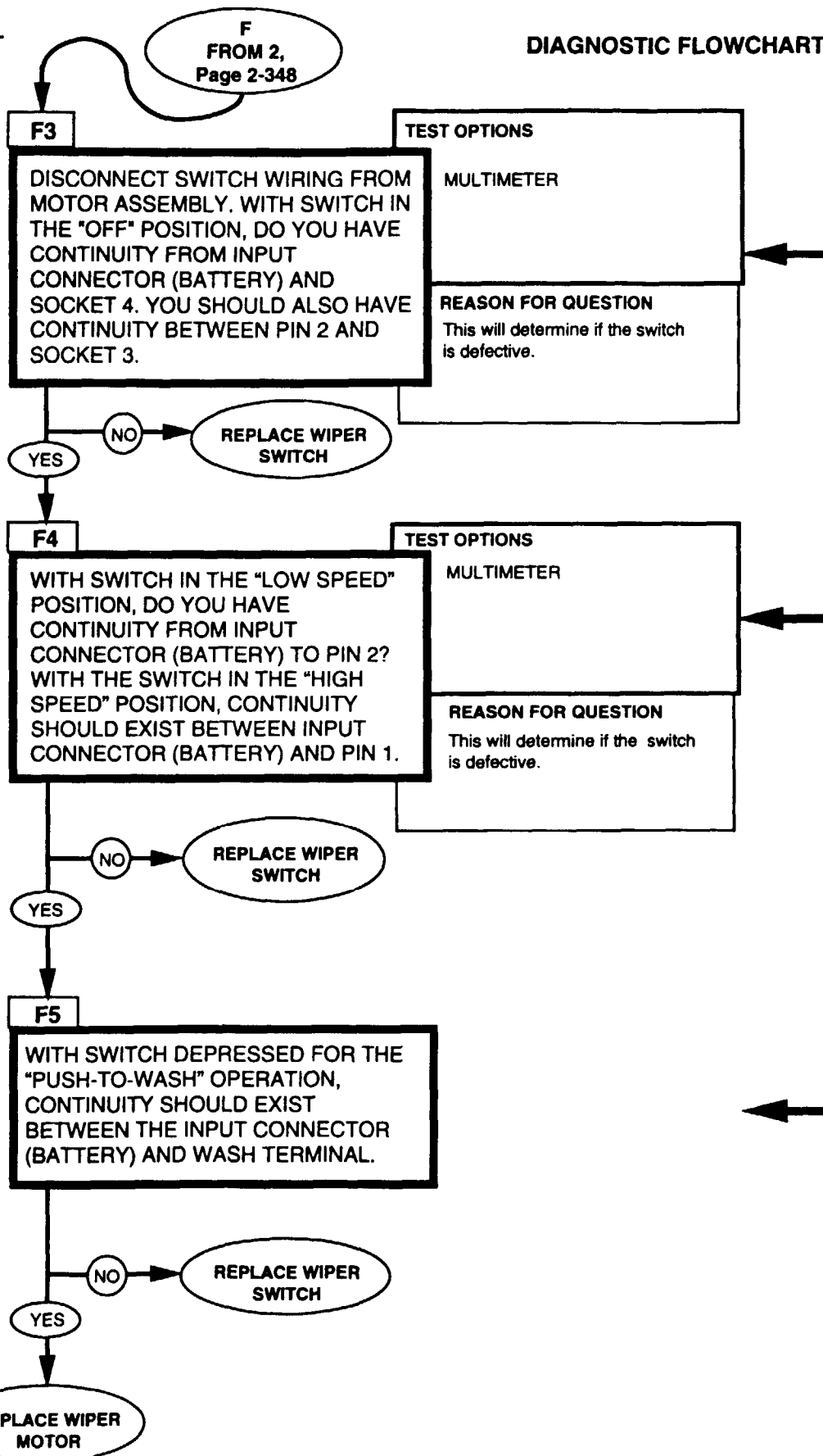
CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

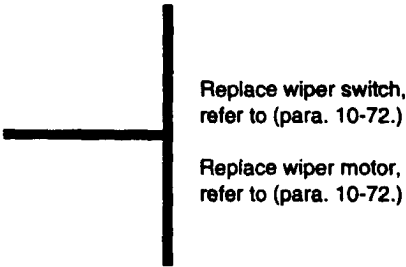
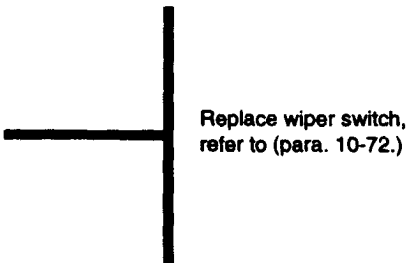
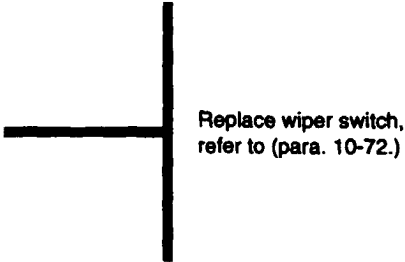
KNOWN INFO
POWER TO WIPER MOTOR
POSSIBLE PROBLEMS
WIPER MOTOR WIRING

KNOWN INFO
POWER TO WIPER MOTOR
POSSIBLE PROBLEMS
WIPER MOTOR WIRING

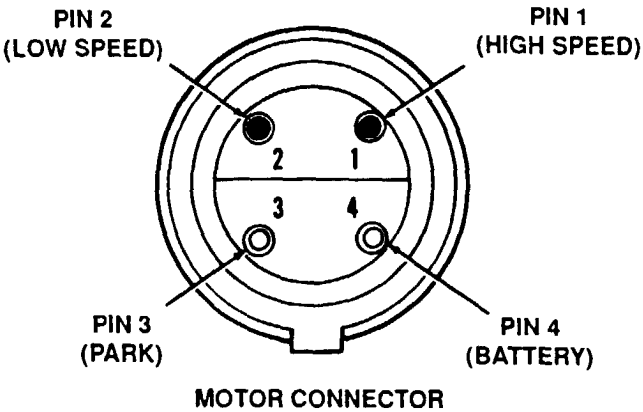
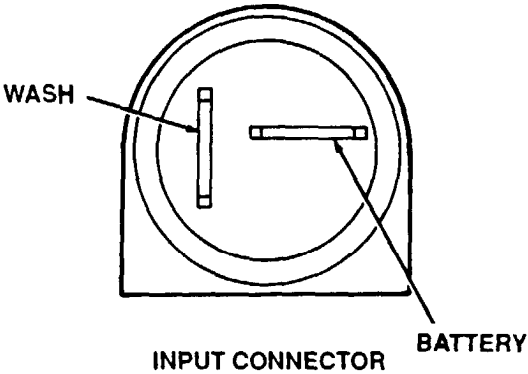


REFERENCE INFORMATION

INSTRUMENTS CIRCUITS



CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
FUEL GAUGE DOESN'T WORK
<b>POSSIBLE PROBLEMS</b>
GAUGE WIRING SENDING UNIT

**G1**

DISCONNECT WIRE 27J FROM FUEL GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27J?

**TEST OPTIONS**

1. STE/ICE-R TESTS 89 (PAGE 2-750)
2. MULTIMETER

**REASON FOR QUESTION**  
This wire provides power for the gauge.

YES

NO

REPAIR 27J or REPLACE HARNESS

<b>KNOWN INFO</b>
POWER AVAILABLE TO THE GAUGE
<b>POSSIBLE PROBLEMS</b>
GAUGE WIRING SENDING UNIT

**G2**

IS THERE CONTINUITY BETWEEN WIRE 58H AT THE FUEL GAUGE AND GROUND?

**TEST OPTIONS**

1. STE/ICE-R TESTS 91 (PAGE 2-752)
2. MULTIMETER

**REASON FOR QUESTION**  
If there is continuity then the ground is OK.

YES

NO

REPAIR 58H or REPLACE HARNESS

<b>KNOWN INFO</b>
GAUGE GROUND OK
<b>POSSIBLE PROBLEMS</b>
GAUGE WIRING SENDING UNIT

**G3**

RECONNECT WIRE 27J & DISCONNECT WIRE 28A AT THE GAUGE. IS THE RESISTANCE BETWEEN WIRE 28A AT FUEL GAUGE AND CHASSIS GROUND WITHIN 0 TO 35 OHMS?

**TEST OPTIONS**

1. STE/ICE-R TESTS 91 (PAGE 2-752)
2. MULTIMETER

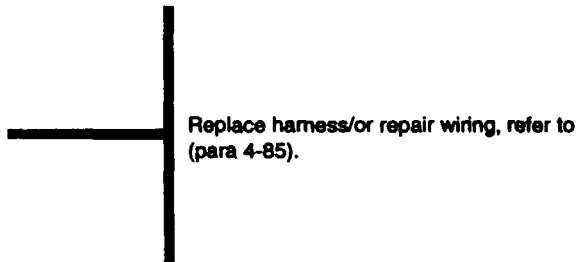
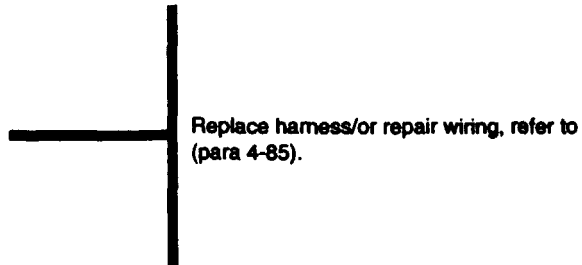
**REASON FOR QUESTION**  
If the resistance is OK then the sense line is OK.

YES

NO

GO TO L, Page 2-366

GO TO G4, Page 2-354

**REFERENCE INFORMATION****INSTRUMENTS CIRCUIT**
**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

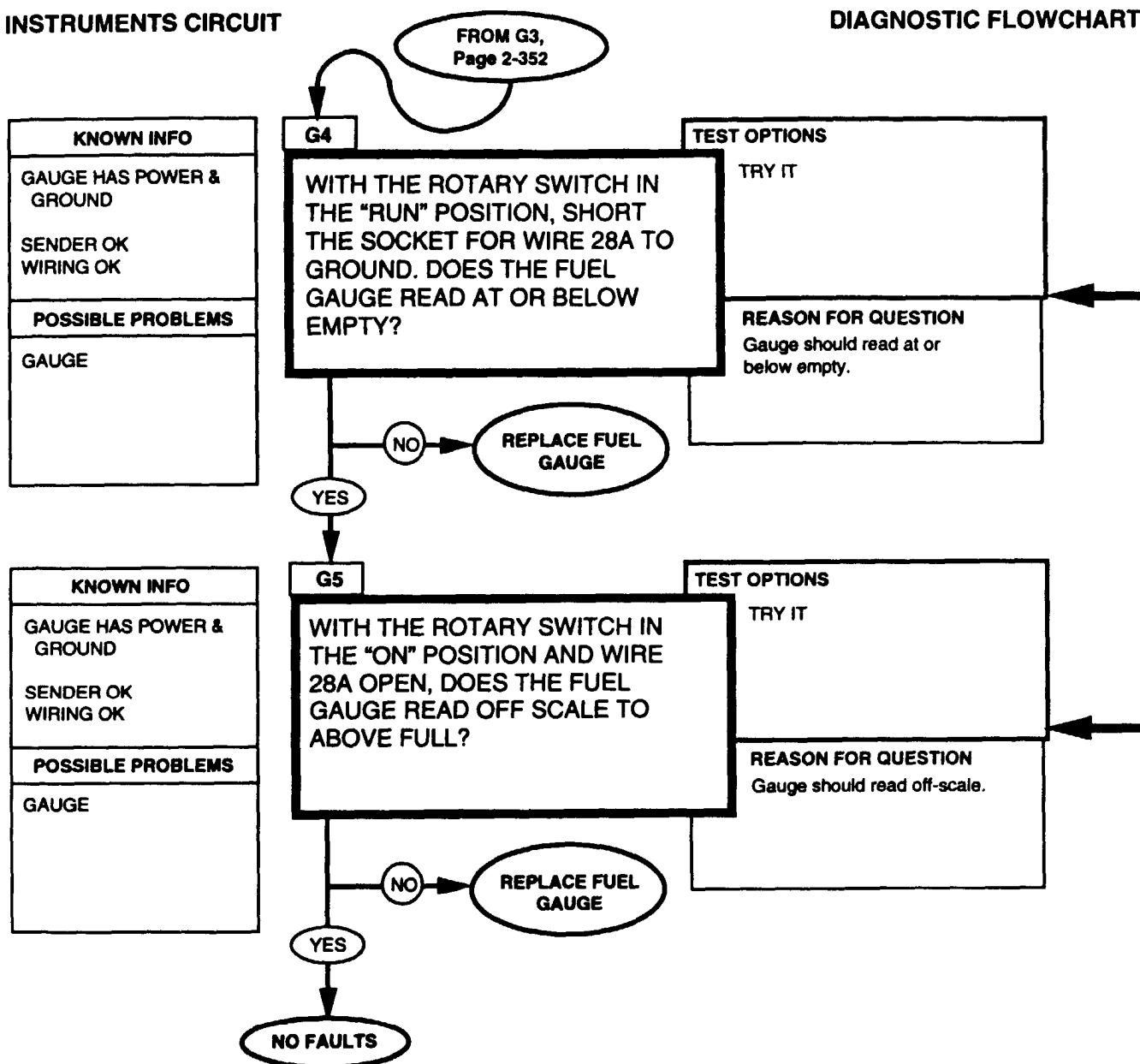
**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



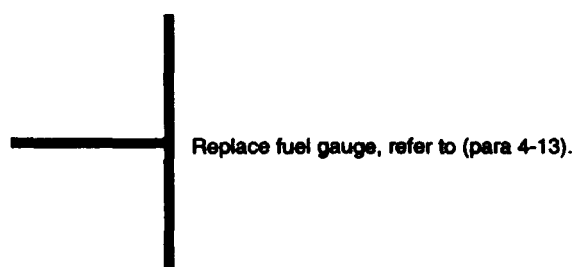
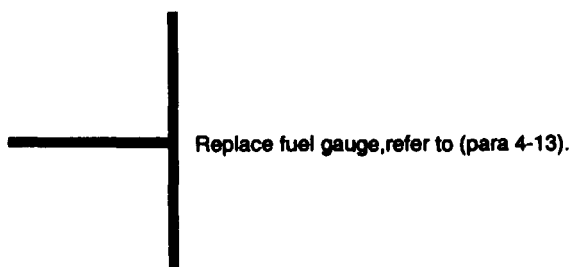
# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT



INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

KNOWN INFO

POWER AVAILABLE TO THE GAUGES  
OIL PRESSURE GAUGE DOESN'T WORK.

POSSIBLE PROBLEMS

GAUGE SENDING UNIT WIRING

H1

DISCONNECT WIRE 27H AT THE OIL PRESSURE GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27H?

TEST OPTIONS

1. STE/ICE-R TEST 89 (PAGE 2-750)

2. MULTIMETER

REASON FOR QUESTION

This is the power wire for the gauge.

NO

REPAIR 27H or REPLACE HARNESS

YES

KNOWN INFO

OIL PRESSURE GAUGE HAS POWER.

POSSIBLE PROBLEMS

GAUGE SENDING UNIT WIRING

H2

WITH THE ROTARY SWITCH IN THE "OFF" POSITION, DO YOU HAVE CONTINUITY BETWEEN WIRE 58G AT THE GAUGE AND ENGINE (OR BODY) GROUND?

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)

2. MULTIMETER

REASON FOR QUESTION

This is the ground wire for the gauge.

NO

REPAIR 58G or REPLACE HARNESS

YES

KNOWN INFO

GAUGE GROUND OK

POSSIBLE PROBLEMS

OIL PRESSURE GAUGE SENDING UNIT WIRING

H3

DISCONNECT WIRE 36A AT THE GAUGE AND AT THE OIL PRESSURE SENDING UNIT. DO YOU HAVE CONTINUITY THRU WIRE 36A? RECONNECT WIRE 36A AFTER MAKING THE MEASUREMENT.

TEST OPTIONS

1. STE/ICE-R TEST 91 (PAGE 2-752)

2. MULTIMETER

REASON FOR QUESTION

If this wire is open then the gauge will always read offscale to the left.

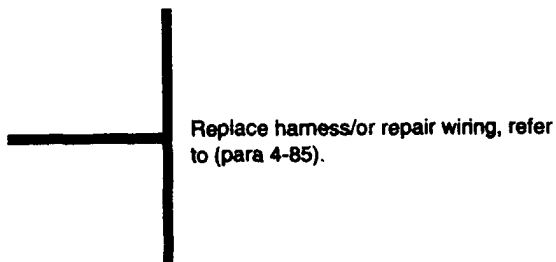
NO

REPAIR 36A or REPLACE HARNESS

YES

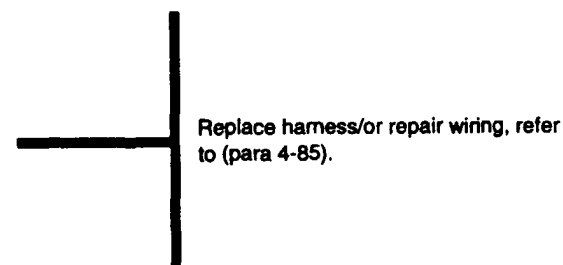
GO TO H4, Page 2-358

## REFERENCE INFORMATION



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Replace harness/or repair wiring, refer to (para 4-85).

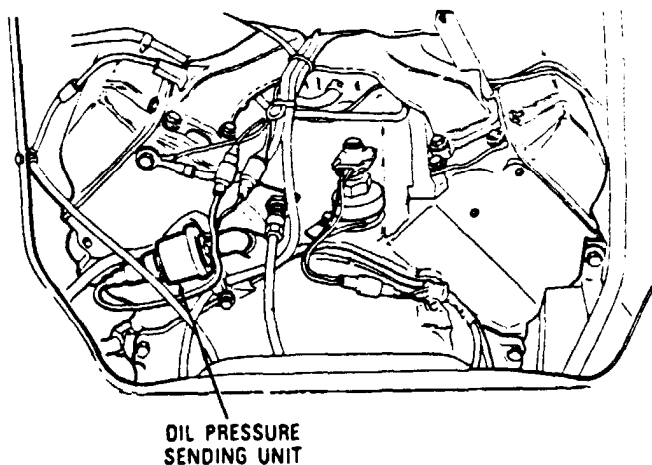


## INSTRUMENTS CIRCUIT

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

BATTERY VOLTAGE MULTIMETER
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

CONTINUITY (RESISTANCE) MULTIMETER
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

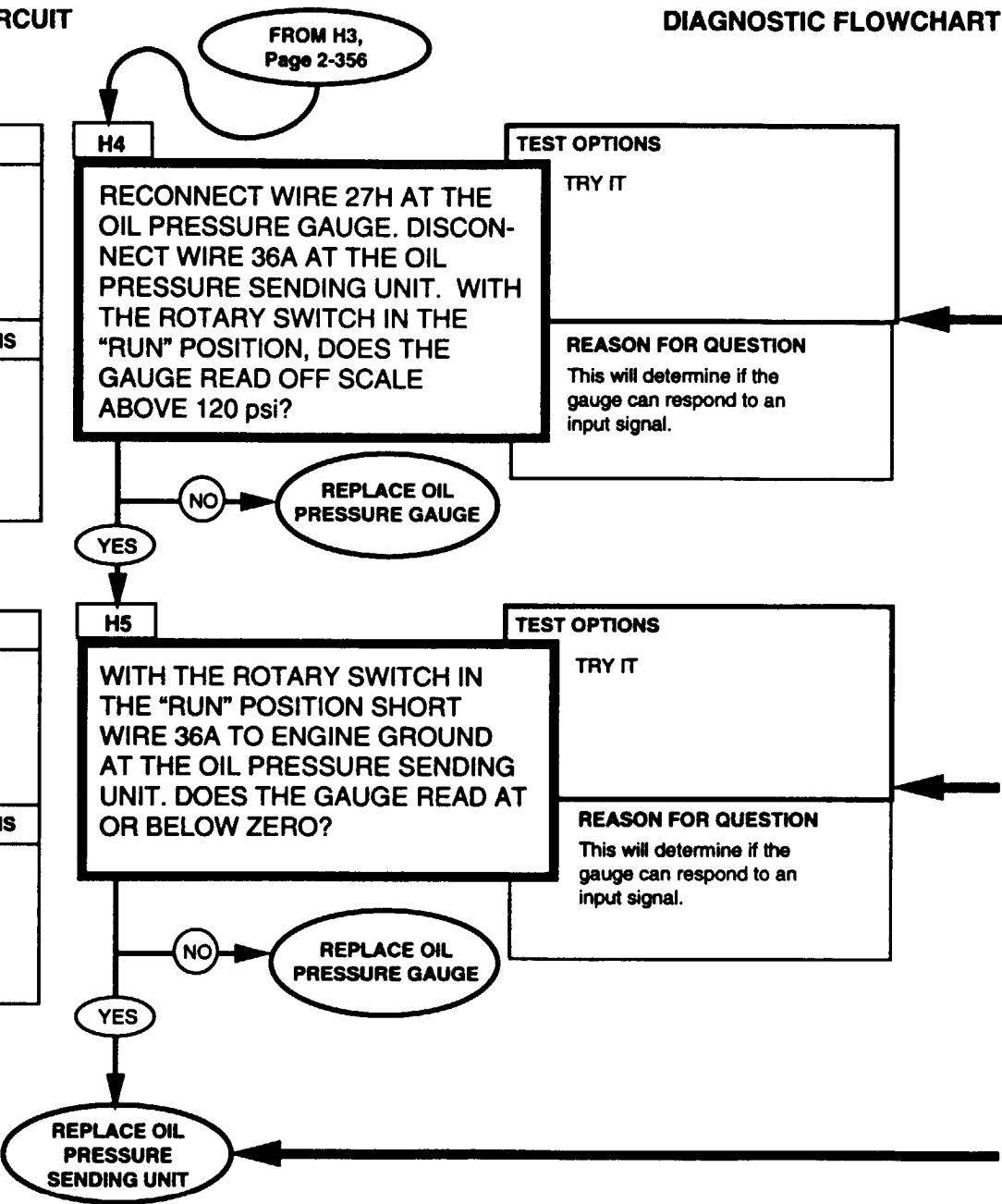


INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART

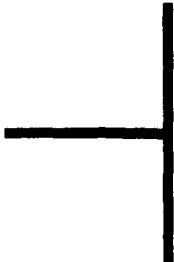
KNOWN INFO
WIRING OK
POSSIBLE PROBLEMS
GAUGE SENDING UNIT

KNOWN INFO
WIRING OK
POSSIBLE PROBLEMS
GAUGE SENDING UNIT



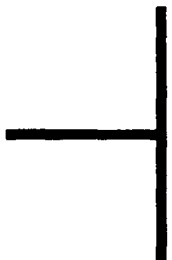
## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT



Make sure wire 36A is not connected to the sending unit and is not touching anything metal that could cause the wire to be grounded.

Replace oil pressure gauge, refer to (para 4-13).



Wire 36A must be connected at the gauge. Short the wire at the sending unit to ground.

Replace oil pressure gauge, refer to (para 4-13).



Replace oil pressure sending unit, refer to (para 4-25).

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
POWER AVAILABLE TO THE GAUGES TEMPERATURE GAUGE DOESN'T WORK.
<b>POSSIBLE PROBLEMS</b>
GAUGE SENDING UNIT WIRING

I  
FROM 9,  
Page 2-324

**I1**

DISCONNECT WIRE 27G AT THE TEMPERATURE GAUGE. WITH THE ROTARY SWITCH IN THE "RUN" POSITION, DO YOU HAVE BATTERY VOLTAGE AT WIRE 27G?

**TEST OPTIONS**

1. STE/ICE-R TEST 89 (PAGE 2-750)
2. MULTIMETER

**REASON FOR QUESTION**  
This is the power wire for the gauge.

NO → REPAIR 27G or REPLACE HARNESS

YES →

<b>KNOWN INFO</b>
TEMPERATURE GAUGE HAS POWER.
<b>POSSIBLE PROBLEMS</b>
GAUGE SENDING UNIT WIRING

**I2**

WITH THE ROTARY SWITCH IN THE "OFF" POSITION, DO YOU HAVE CONTINUITY BETWEEN WIRE 58E AT THE GAUGE AND ENGINE (OR BODY) GROUND?

**TEST OPTIONS**

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

**REASON FOR QUESTION**  
This is the ground wire for the gauge.

NO → REPAIR 58E or REPLACE HARNESS

YES →

<b>KNOWN INFO</b>
GAUGE GROUND OK
<b>POSSIBLE PROBLEMS</b>
TEMPERATURE GAUGE SENDING UNIT WIRING

**I3**

DISCONNECT WIRE 33A AT THE GAUGE AND AT THE WIRE 33B AT THE TEMPERATURE SENDING UNIT. DO YOU HAVE CONTINUITY FROM WIRE 33A TO WIRE 33B?

**TEST OPTIONS**

1. STE/ICE-R TEST 91 (PAGE 2-752)
2. MULTIMETER

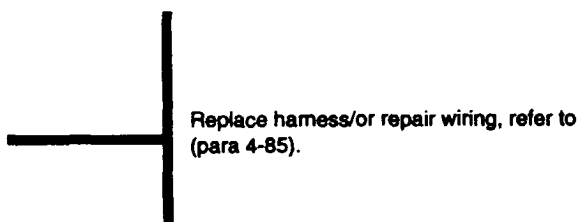
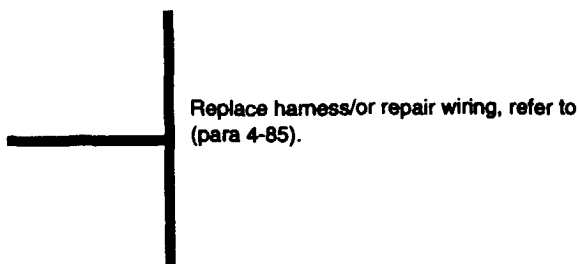
**REASON FOR QUESTION**  
If either of these wires are open then the gauge will always read off scale to the left.

NO → REPAIR 33A, 33B or REPLACE HARNESS

YES →

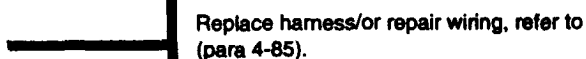
GO TO I4,  
Page 2-362

## REFERENCE INFORMATION



**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

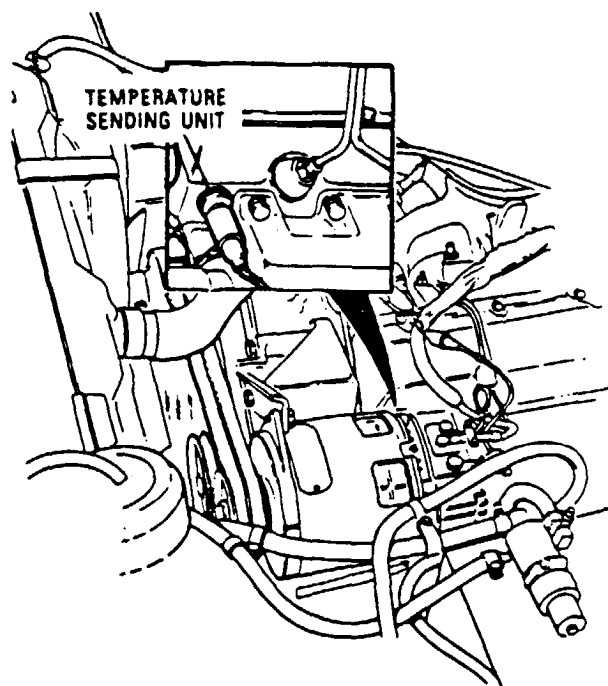
## INSTRUMENTS CIRCUIT

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

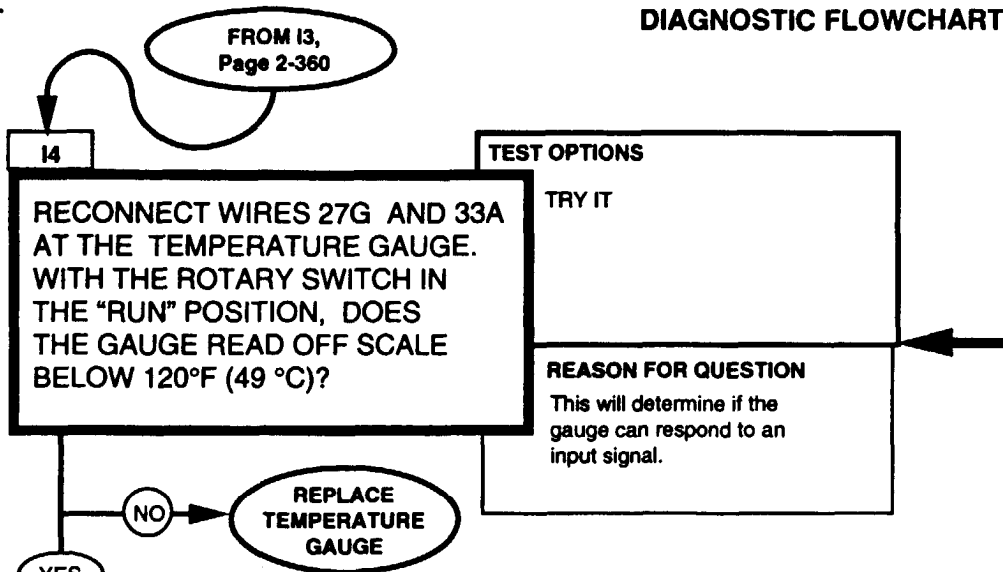




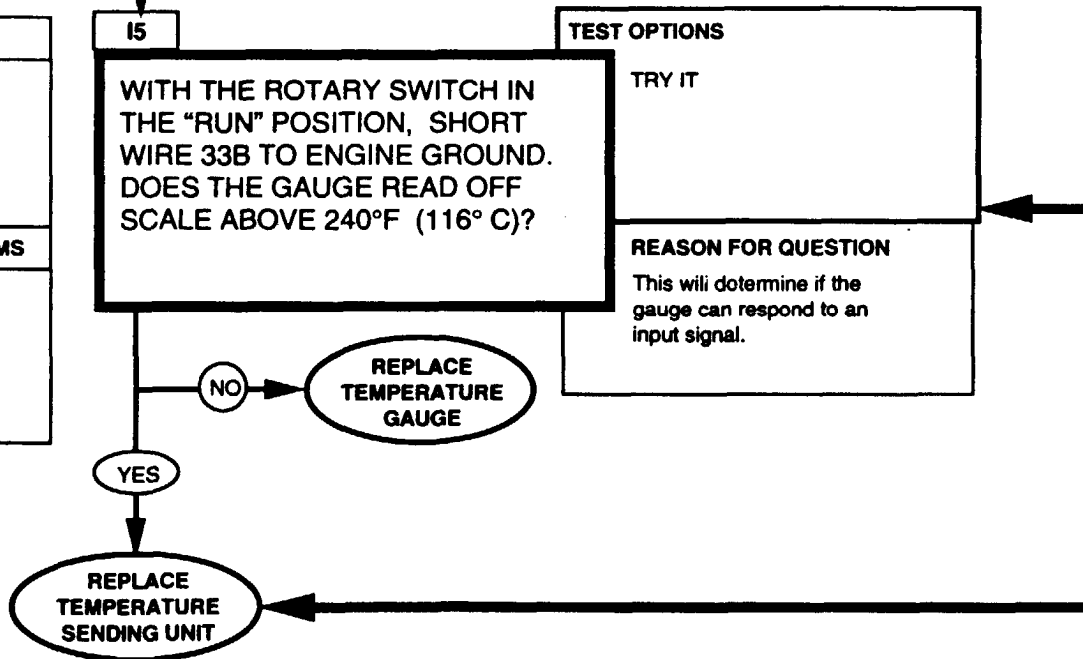
# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

<b>KNOWN INFO</b>
WIRING OK
<b>POSSIBLE PROBLEMS</b>
GAUGE SENDING UNIT

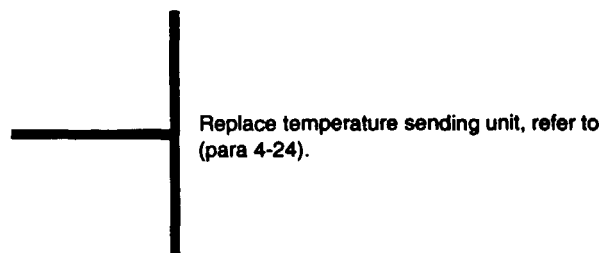
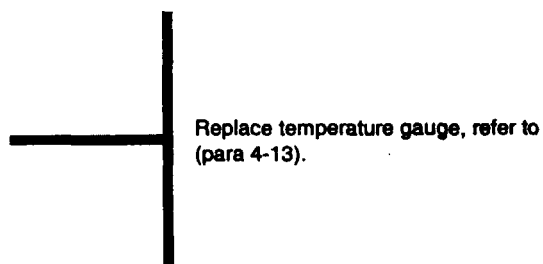
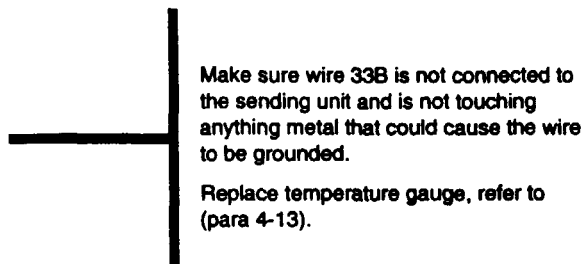


<b>KNOWN INFO</b>
WIRING OK
<b>POSSIBLE PROBLEMS</b>
GAUGE SENDING UNIT



## REFERENCE INFORMATION

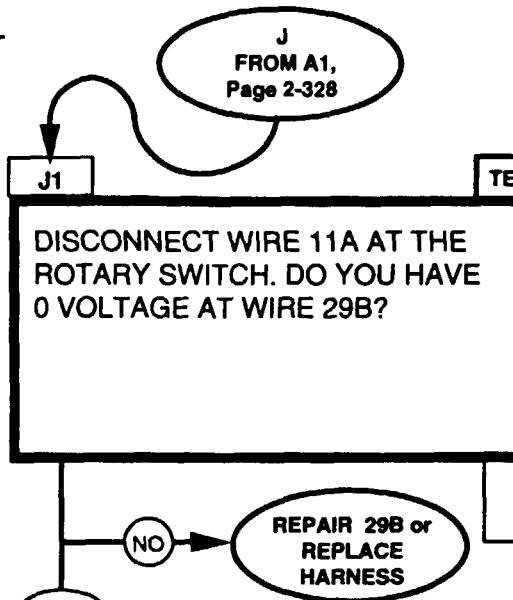
## INSTRUMENTS CIRCUIT



# INSTRUMENTS CIRCUIT

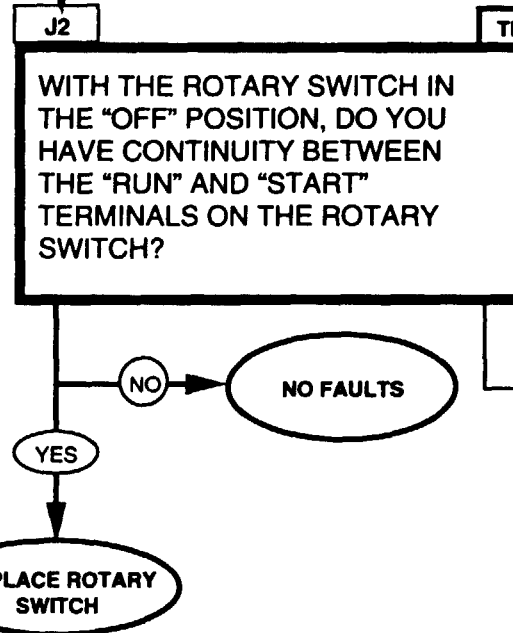
# DIAGNOSTIC FLOWCHART

KNOWN INFO
POWER TO GAUGES WITH ROTARY SWITCH OFF
POSSIBLE PROBLEMS
ROTARY SWITCH WIRING



TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750)
2. MULTIMETER
REASON FOR QUESTION
If you disconnect the switch and still have power then the wiring is shorted.

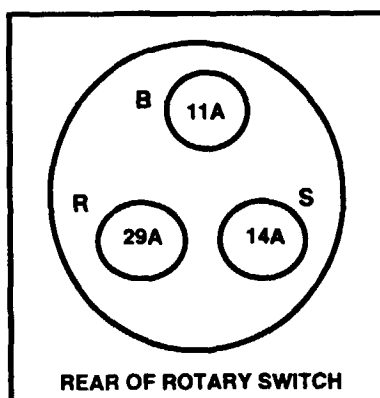
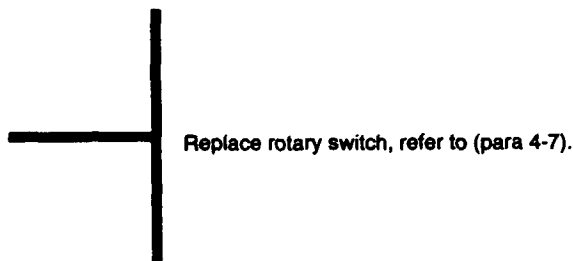
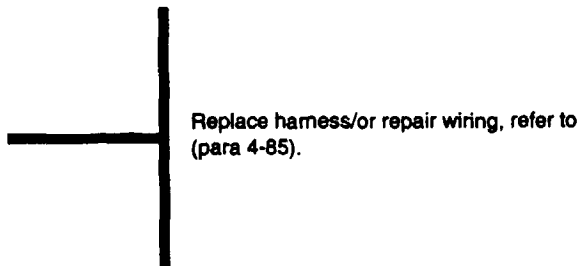
KNOWN INFO
WIRING OK
POSSIBLE PROBLEMS
ROTARY SWITCH



TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752)
2. MULTIMETER
REASON FOR QUESTION
Continuity with the switch off indicates a shorted switch.

# REFERENCE INFORMATION

# INSTRUMENTS CIRCUIT



## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

## 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT

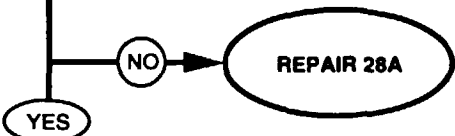
DIAGNOSTIC FLOWCHART

KNOWN INFO
WINDSHIELD WIPERS OK
POSSIBLE PROBLEMS
FUEL GAUGE OIL PRESSURE GAUGE TEMPERATURE GAUGE

**L1**

DISCONNECT WIRE 28A AT THE FUEL SENDING UNIT HARNESS. IS THERE CONTINUITY BETWEEN THE ENDS OF WIRE 28A AT THE FUEL GAUGE AND AT THE FUEL SENDING UNIT HARNESS?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
If the wire is OK then the sense line from the sending unit to the gauge is OK.

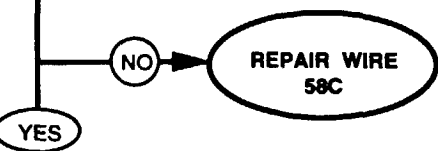


KNOWN INFO
WINDSHIELD WIPERS OK
POSSIBLE PROBLEMS
FUEL GAUGE OIL PRESSURE GAUGE TEMPERATURE GAUGE

**L2**

IS THERE CONTINUITY BETWEEN WIRE 58C AT THE FUEL SENDING UNIT HARNESS AND BODY (OR ENGINE) GROUND?

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
If the wire is OK then the sending unit ground is OK.

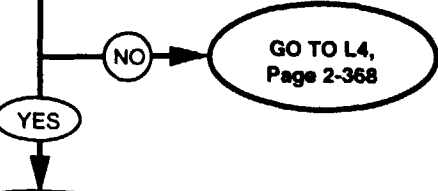


KNOWN INFO
WINDSHIELD WIPERS OK
POSSIBLE PROBLEMS
FUEL GAUGE OIL PRESSURE GAUGE TEMPERATURE GAUGE

**L3**

CHECK RESISTANCE ACROSS WIRE 28B & WIRE 58J AT THE FUEL SENDING UNIT HARNESS. IS THE RESISTANCE LESS THAN 50 OHMS?

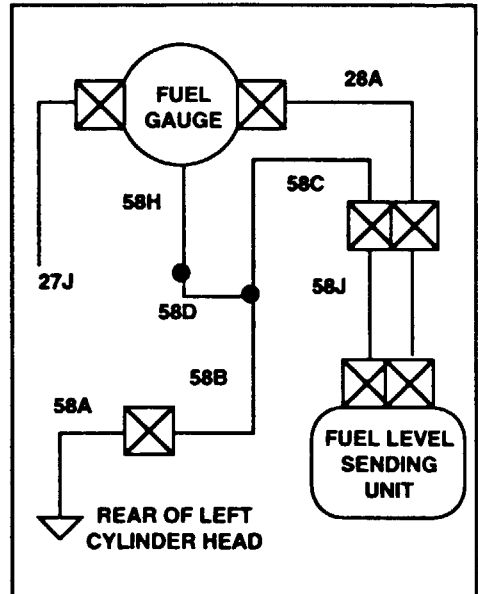
TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER
REASON FOR QUESTION
If the fuel sending unit is OK then it could have been bad connections.



# REFERENCE INFORMATION

# INSTRUMENTS CIRCUIT

The connector is located above the driveshaft toward the rear of the vehicle.



GAUGE READING	OHMS
FULL	35
HALF	16
EMPTY	0

**0-4500 OHMS  
STE/ICE-R TEST 91**

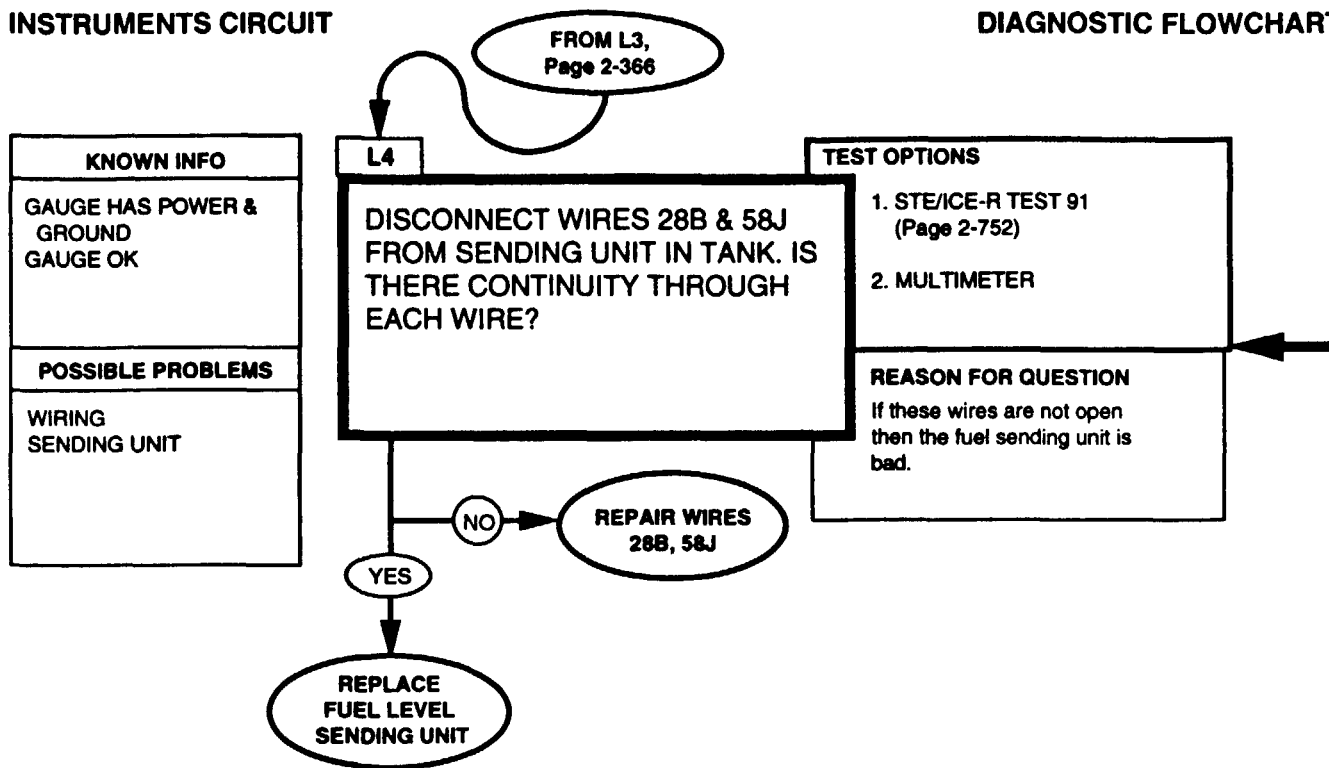
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

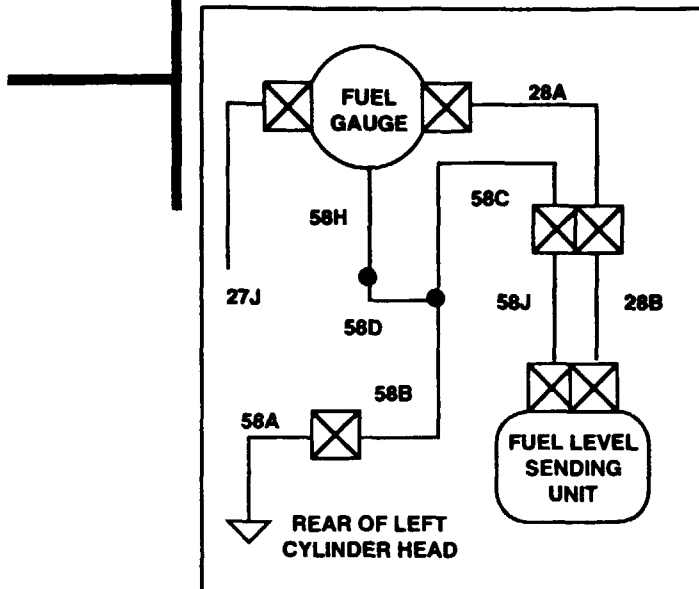


# REFERENCE INFORMATION

# INSTRUMENTS CIRCUIT

In order to reach these wires and the sending unit you have to remove the fuel tank. You may want to recheck the previous steps to be sure you didn't miss anything before you proceed with this step.

Replace fuel level sending unit and repair wiring, refer to (para 4-28 and 4-85).

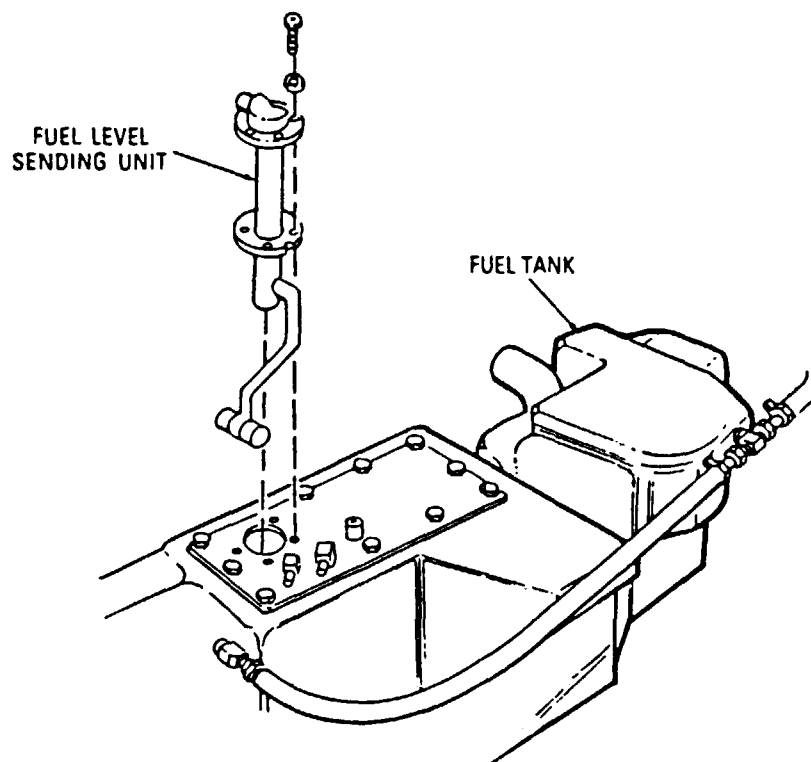


## 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



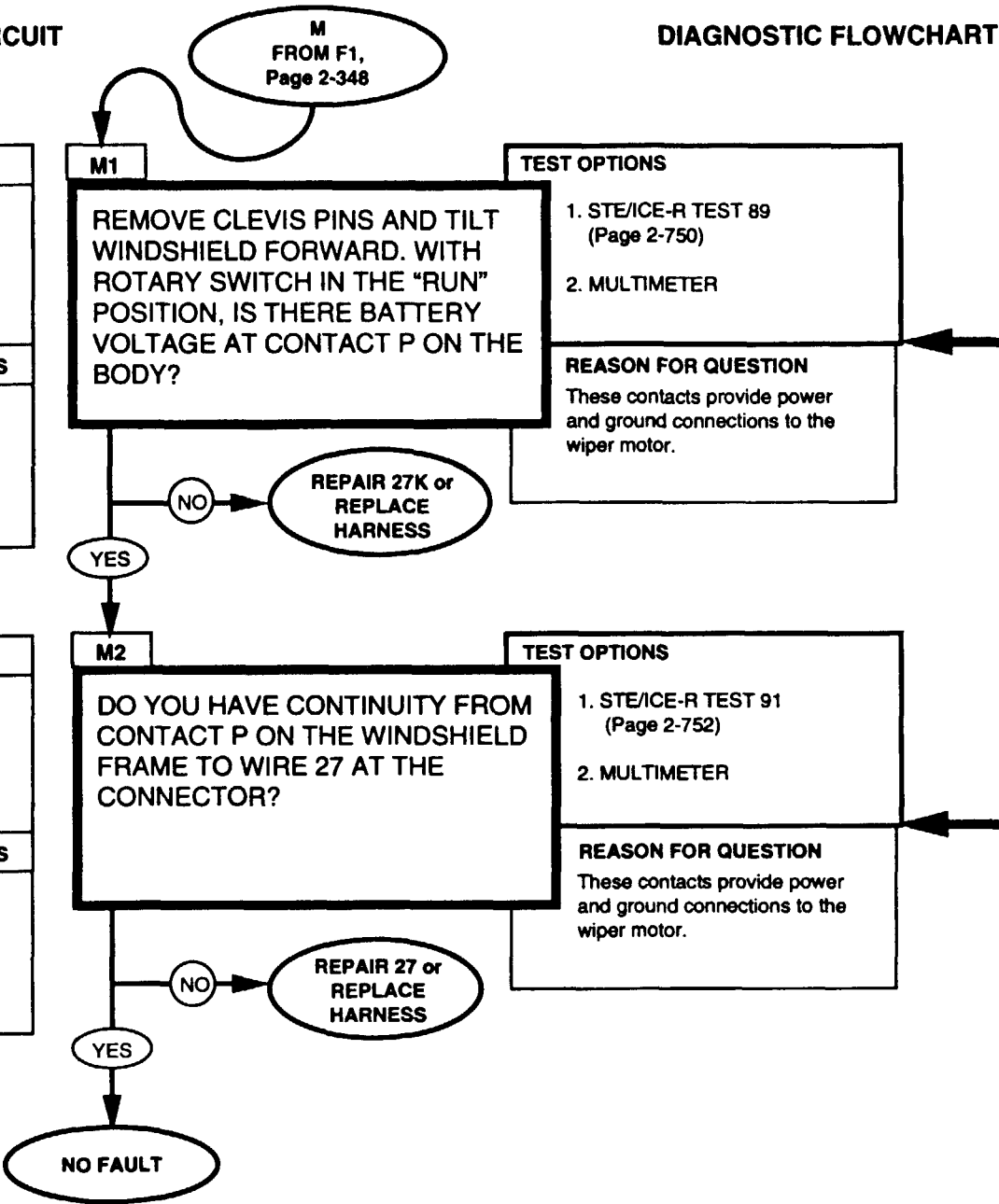


INSTRUMENTS CIRCUIT

KNOWN INFO
POWER AVAILABLE TO GAUGES NO POWER AT WIPER MOTOR
POSSIBLE PROBLEMS
WIRING

KNOWN INFO
POWER TO CONTACT
POSSIBLE PROBLEMS
WIRING

DIAGNOSTIC FLOWCHART

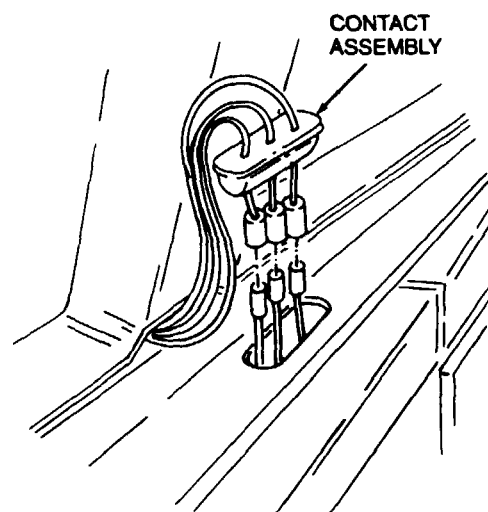


## REFERENCE INFORMATION

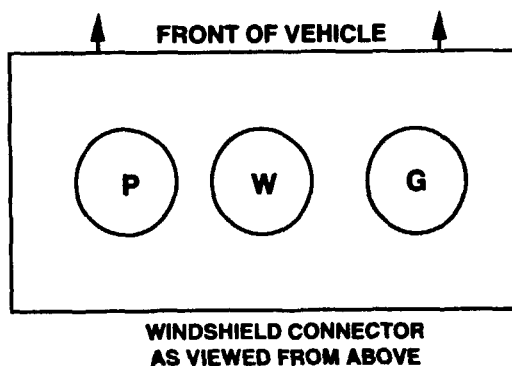
Make sure these contacts are clean otherwise the wiper motor may not have power or ground.

If you experience intermittent problems with the wiper motor on your vehicle, inspect the terminals and the rubber grommet of the contact assembly. If the terminals are dirty or corroded, clean or replace as required. If the grommet shows signs of damage or deformity, replace the contact assembly (TM 9-2320-280-24P).

Replace harness or repair wiring, refer to (para 4-85).



Replace harness/or repair wiring, refer to (para 4-85).



### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

## INSTRUMENTS CIRCUIT

### 0-45 DC VOLTS STE/ICE-R TEST 89

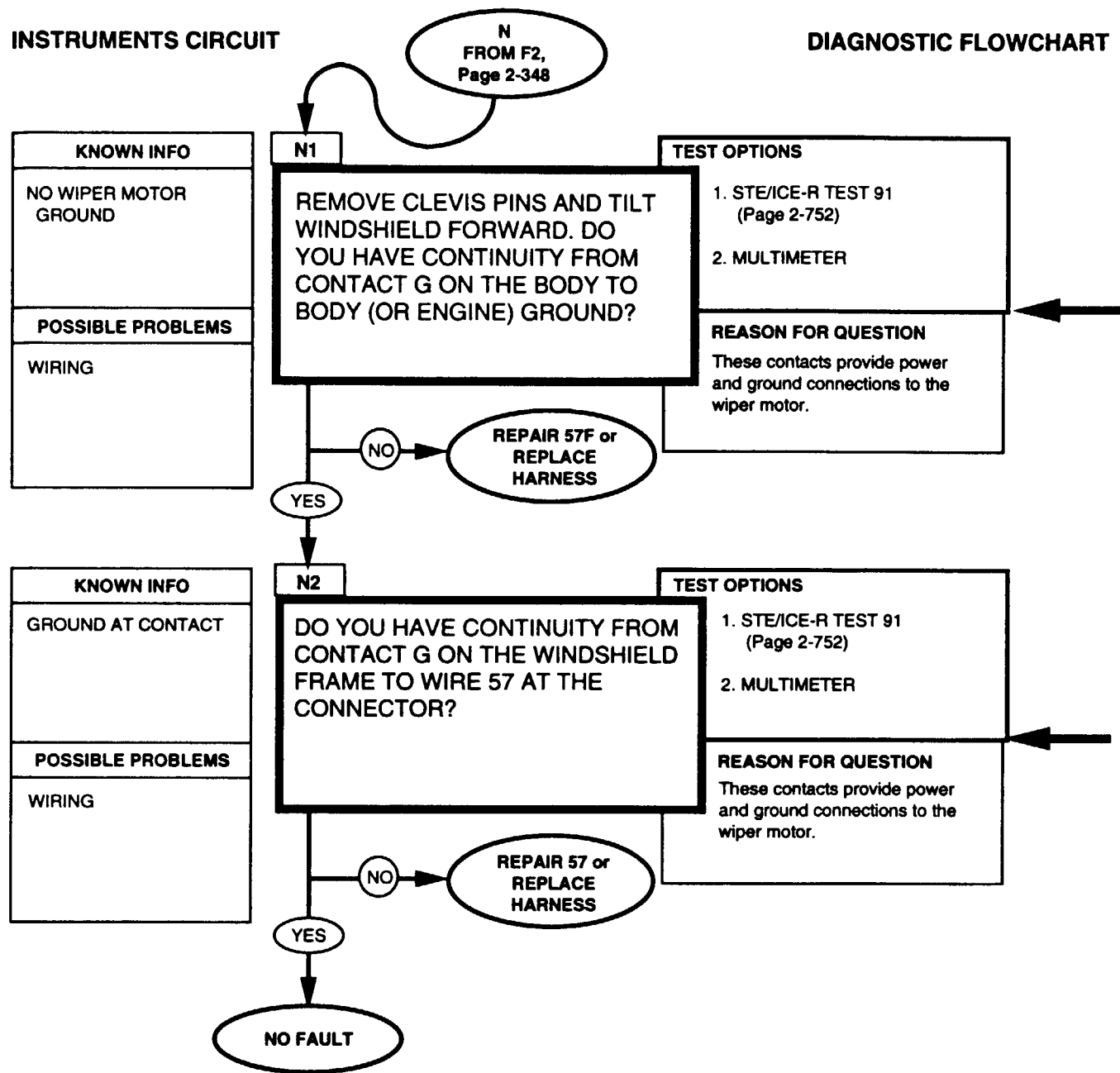
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

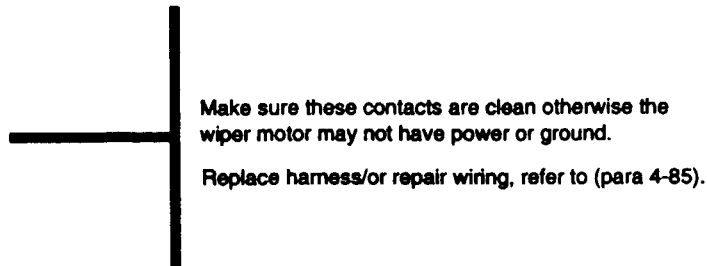
### 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

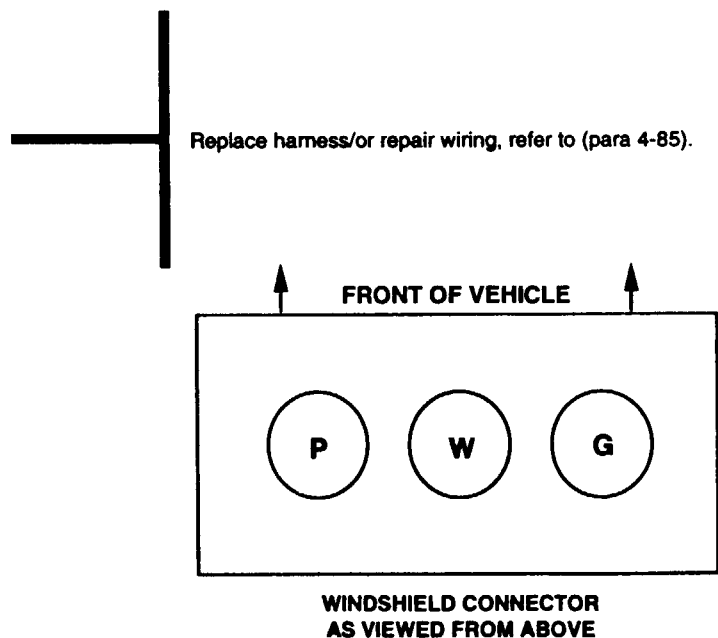


## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT



0-4500 OHMS STE/ICE-R TEST 91
<ol style="list-style-type: none"> <li>1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.</li> <li>2. Start Test 91, 0-4500 ohms.</li> <li>3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."</li> </ol>



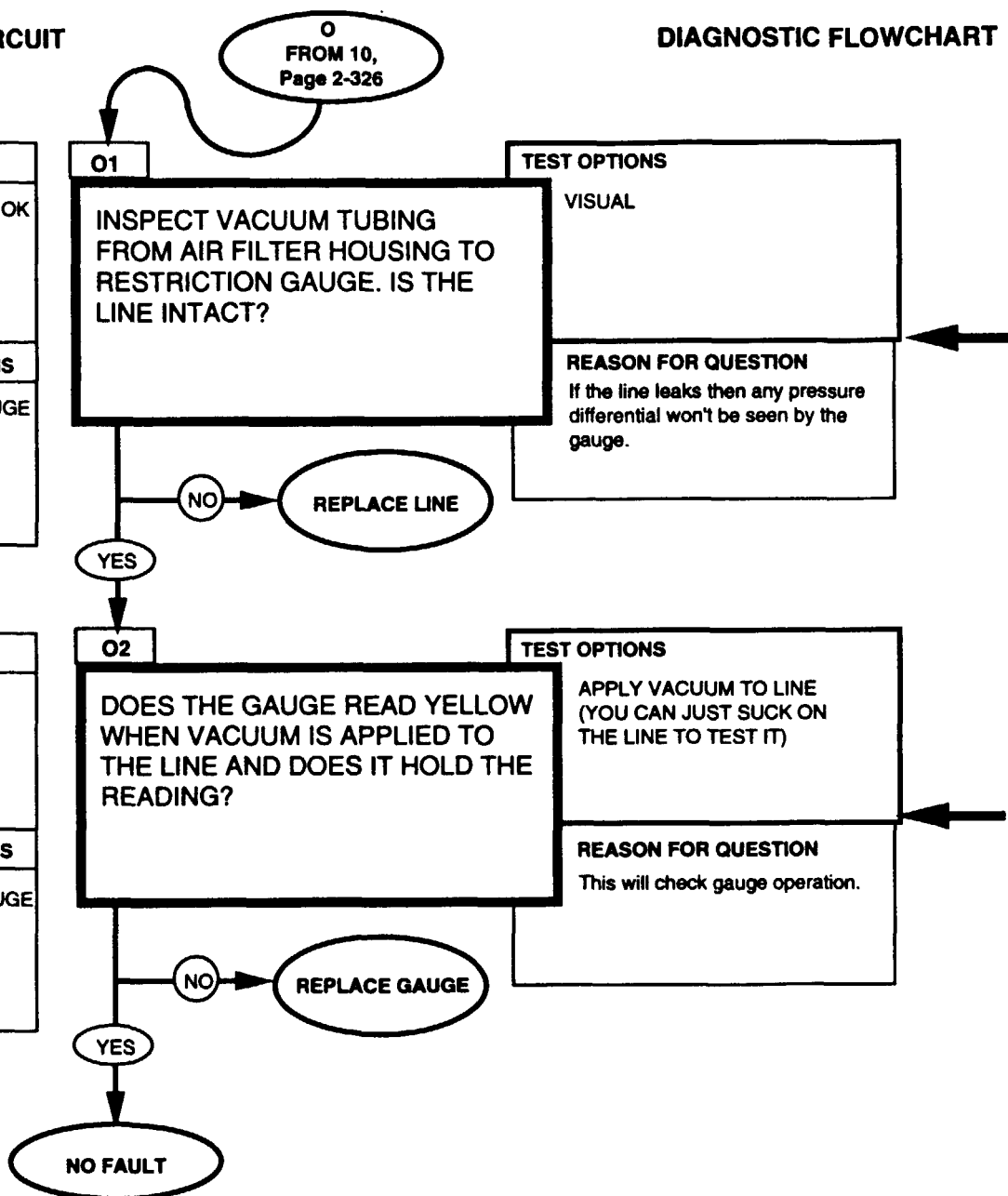
CONTINUITY (RESISTANCE) MULTIMETER
<ol style="list-style-type: none"> <li>1. Set the voltmeter to an ohms scale of about 1000 ohms.</li> <li>2. Connect the RED and BLACK leads to the connections stated in the question.</li> <li>3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).</li> </ol>

# INSTRUMENTS CIRCUIT

# DIAGNOSTIC FLOWCHART

KNOWN INFO
ELECTRICAL GAUGES OK
POSSIBLE PROBLEMS
AIR RESTRICTION GAUGE VACUUM LINE

KNOWN INFO
VACUUM LINE OK
POSSIBLE PROBLEMS
AIR RESTRICTION GAUGE



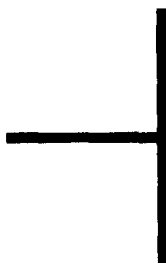
## REFERENCE INFORMATION

## INSTRUMENTS CIRCUIT

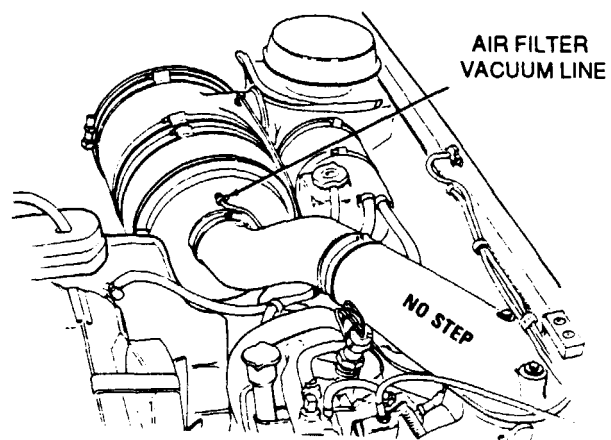


You can provide enough vacuum to operate the gauge by sucking on the line.

Replace vacuum line, refer to (para 3-19).

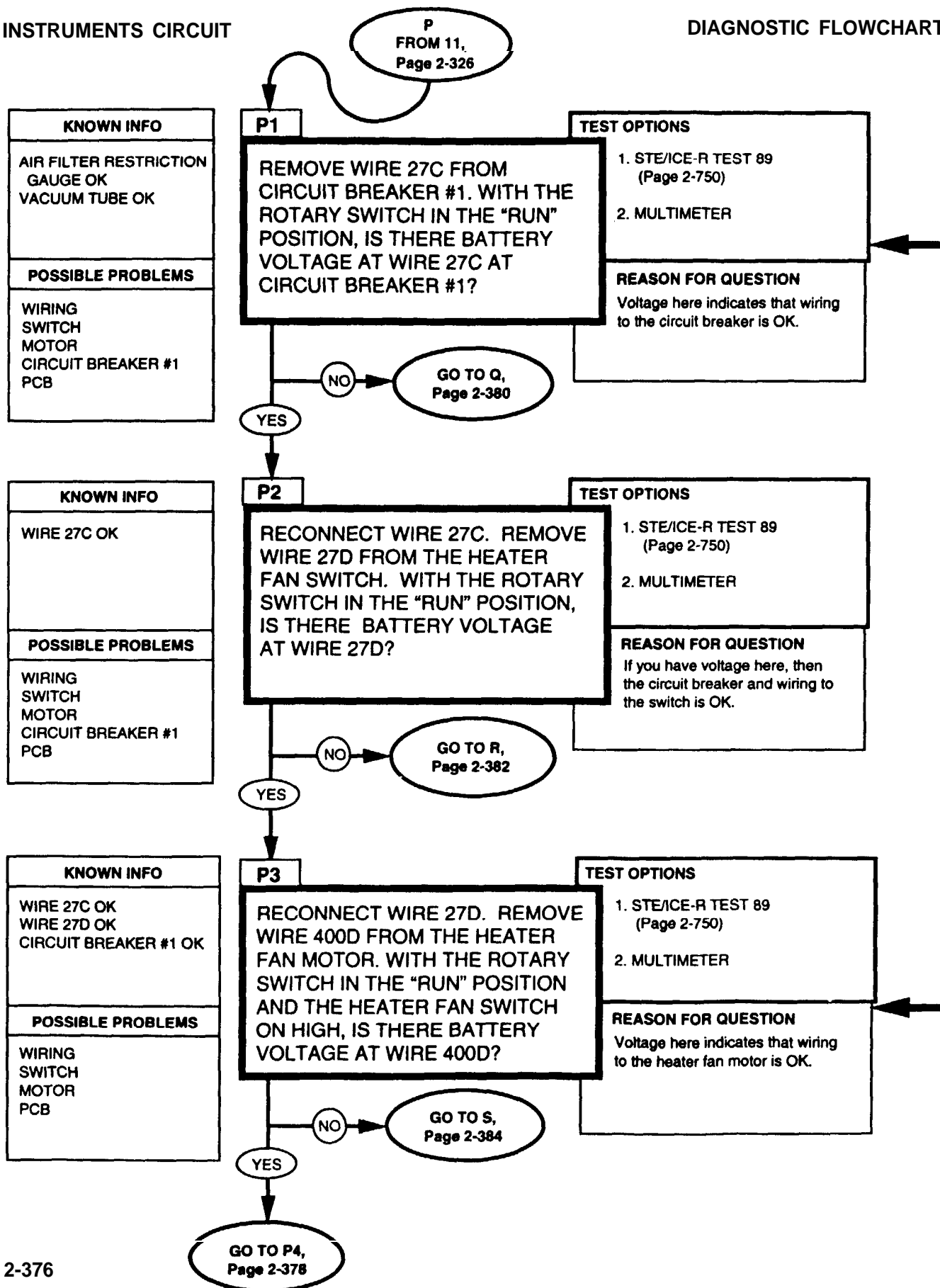


Replace gauge, refer to (para 3-17).



INSTRUMENTS CIRCUIT

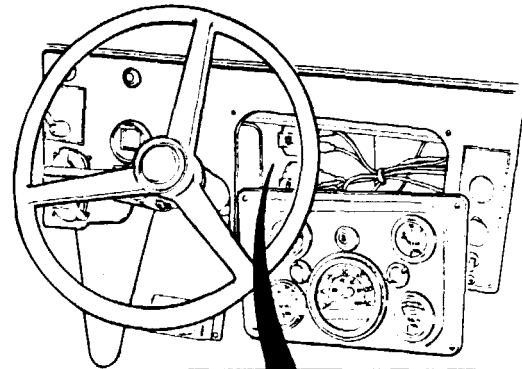
DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

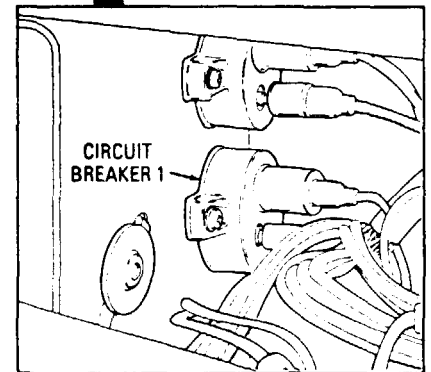
## INSTRUMENTS CIRCUIT

The easiest way to reach the circuit breaker is to remove the gauge panel screws and pull the panel out far enough to work with the wiring.



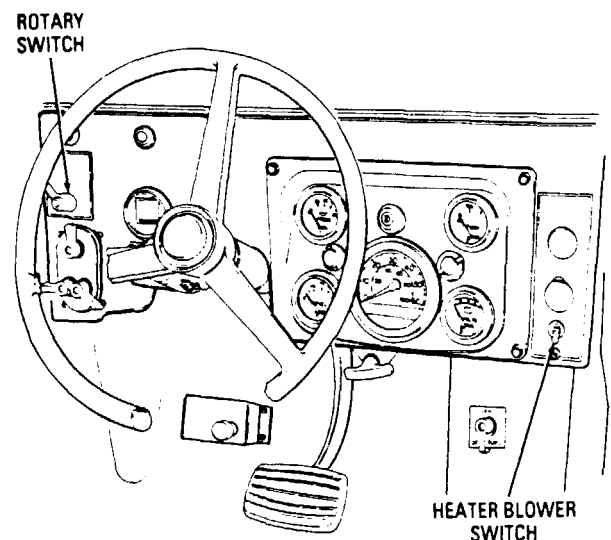
### 0-45 DC VOLTS STEICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

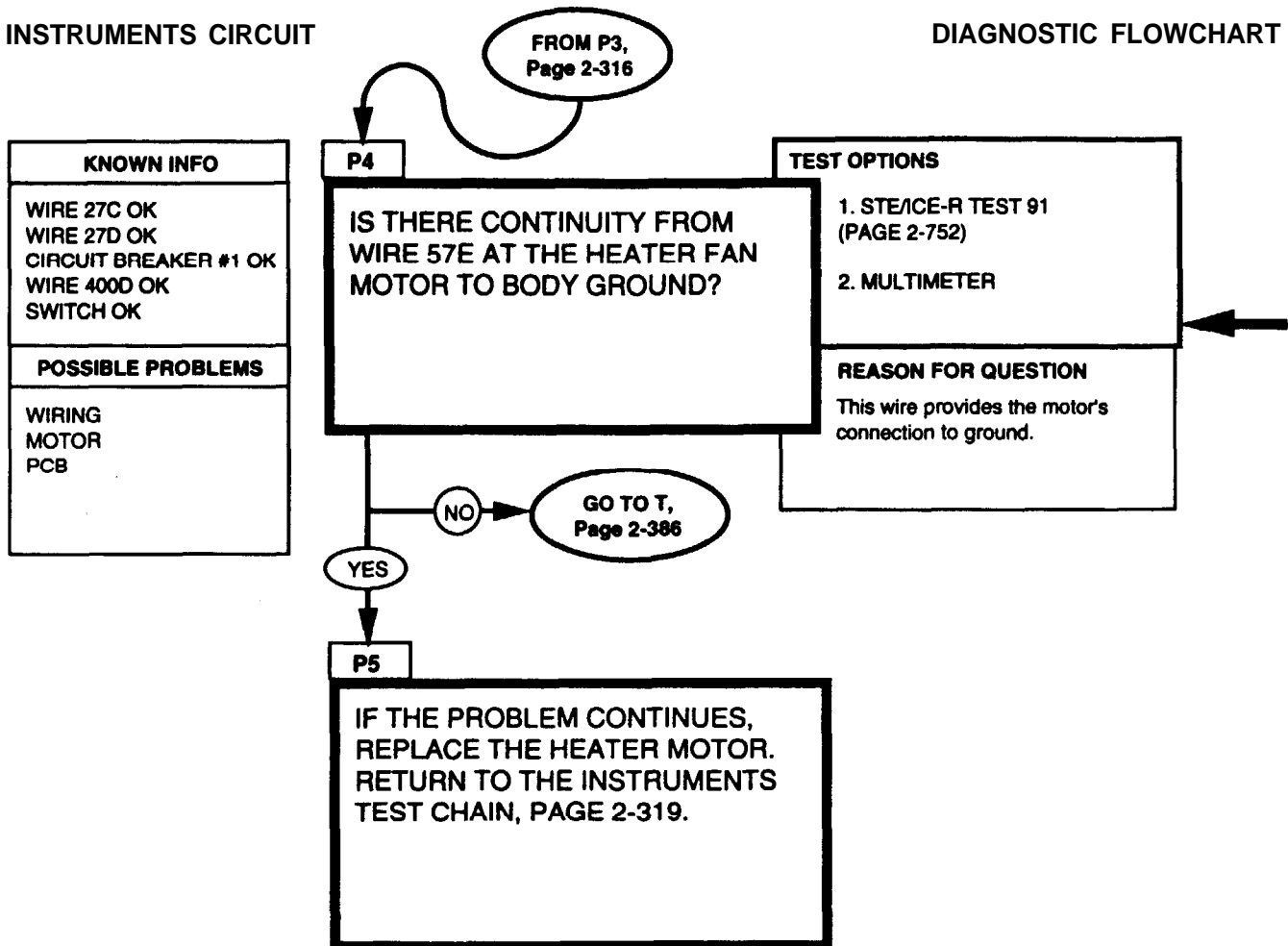


The heater motor is located directly in front of the passenger seat under the dashboard, connected to the heating ducts.

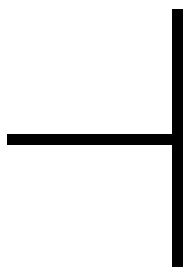


INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION



## INSTRUMENTS CIRCUIT

**0-4500 OHMS  
STE/ICE-R TEST 91**

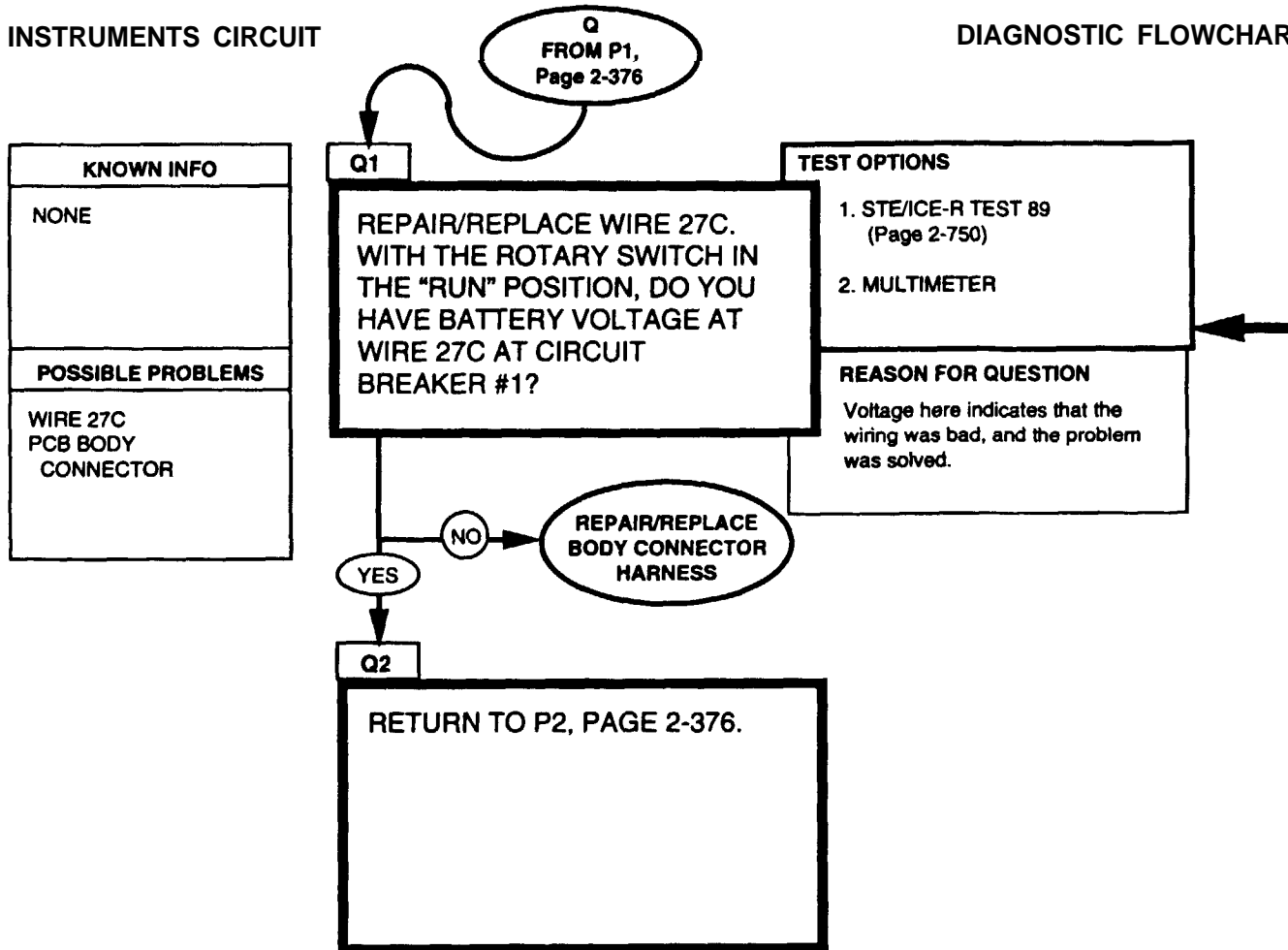
1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

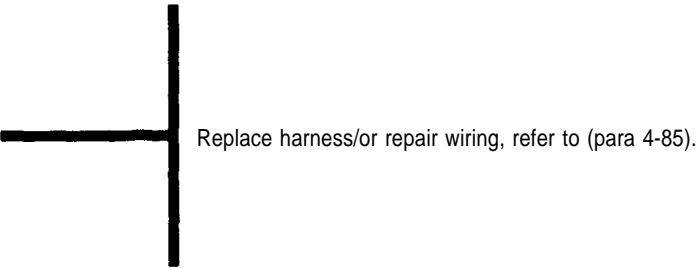
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION

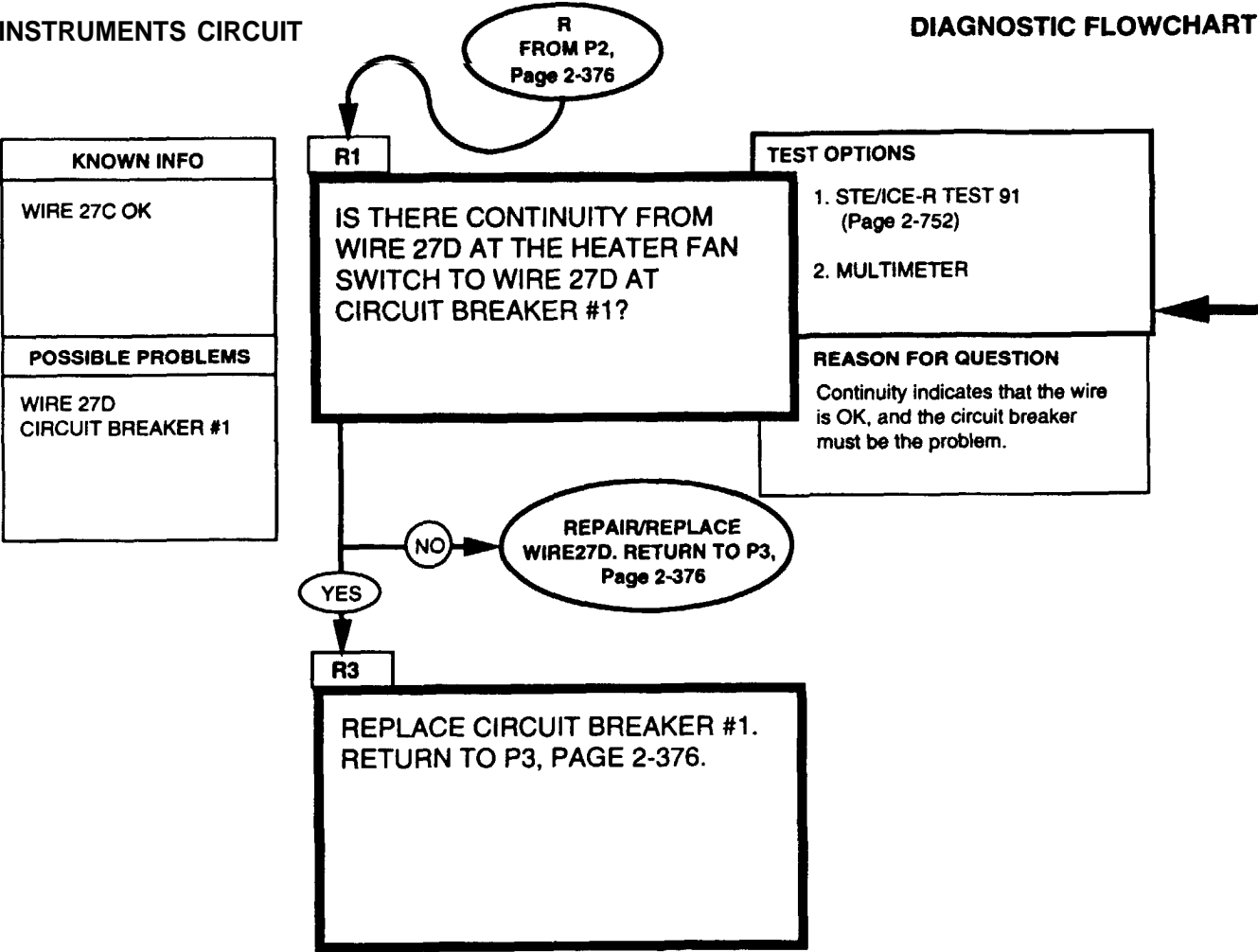


INSTRUMENTS CIRCUIT

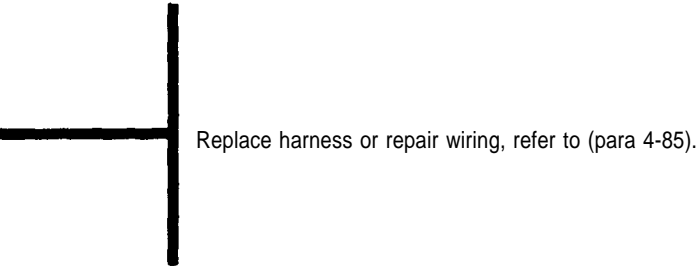
<b>0-45 DC VOLTS STE/ICE-R TEST 89</b>
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.  2. Start Test 89, DC volts.  3. Displayed reading is in volts.
<b>BATTERY VOLTAGE MULTIMETER</b>
1. Set the voltmeter to a DC volts scale of at least 40 volts.  2. Connect the RED lead to positive and the BLACK lead to negative.  3. Be sure to read the correct scale.

INSTRUMENTS CIRCUIT

DIAGNOSTIC FLOWCHART



REFERENCE INFORMATION



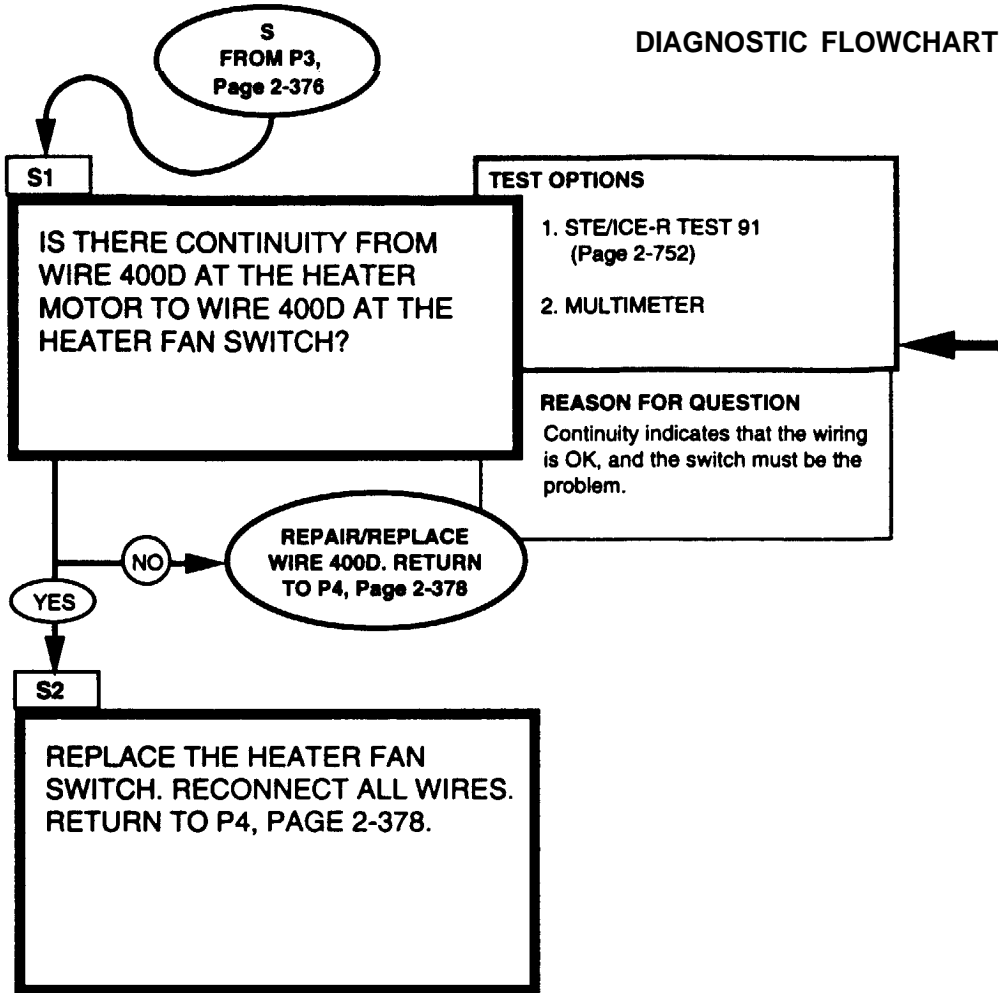
INSTRUMENTS CIRCUIT

<b>0-4500 OHMS STE/CE-R TEST 91</b>
<p>1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.</p> <p>2. Start Test 91, 0-4500 ohms.</p> <p>3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/CE displays "9.9.9.9."</p>
<b>CONTINUITY (RESISTANCE) MULTIMETER</b>
<p>1. Set the voltmeter to an ohms scale of about 1000 ohms.</p> <p>2. Connect the RED and BLACK leads to the connections stated in the question.</p> <p>3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).</p>

INSTRUMENTS CIRCUIT

KNOWN INFO
WIRE 27C OK WIRE 27D OK CIRCUIT BREAKER #1 OK
POSSIBLE PROBLEMS
WIRE 400D SWITCH

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION



Repair wire or replace harness, refer to (para 4-85).

## INSTRUMENTS CIRCUIT

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated test points in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

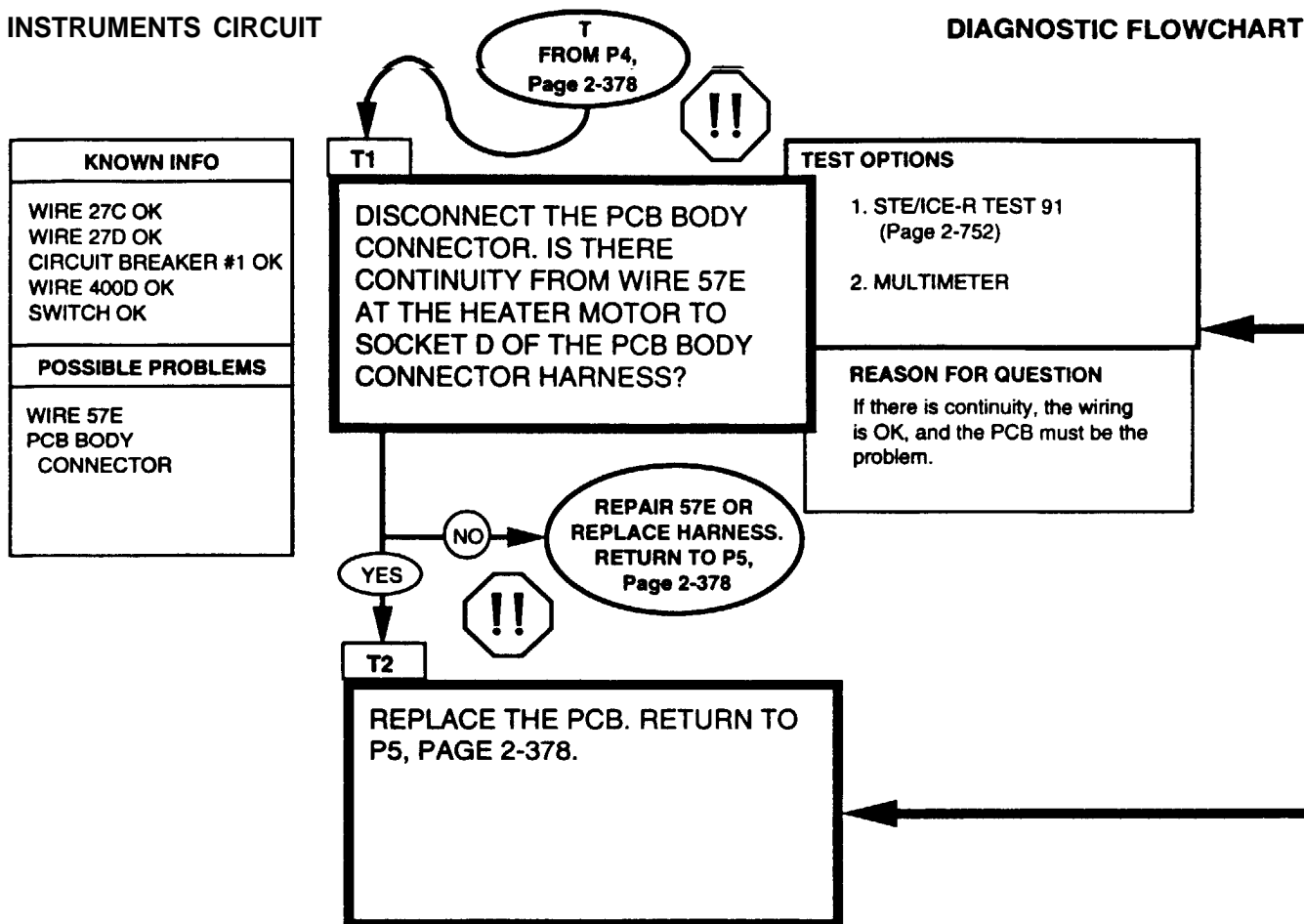
**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



## INSTRUMENTS CIRCUIT

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace harness or repair wiring, refer to (para 4-85).



### **WARNING**

Disconnect negative battery cable before disconnecting and reconnecting protective control box harness.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.

Replace the PCB, refer to (para 4-5).

## INSTRUMENTS CIRCUIT

### **0-4500 OHMS STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

### **CONTINUITY (RESISTANCE) MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

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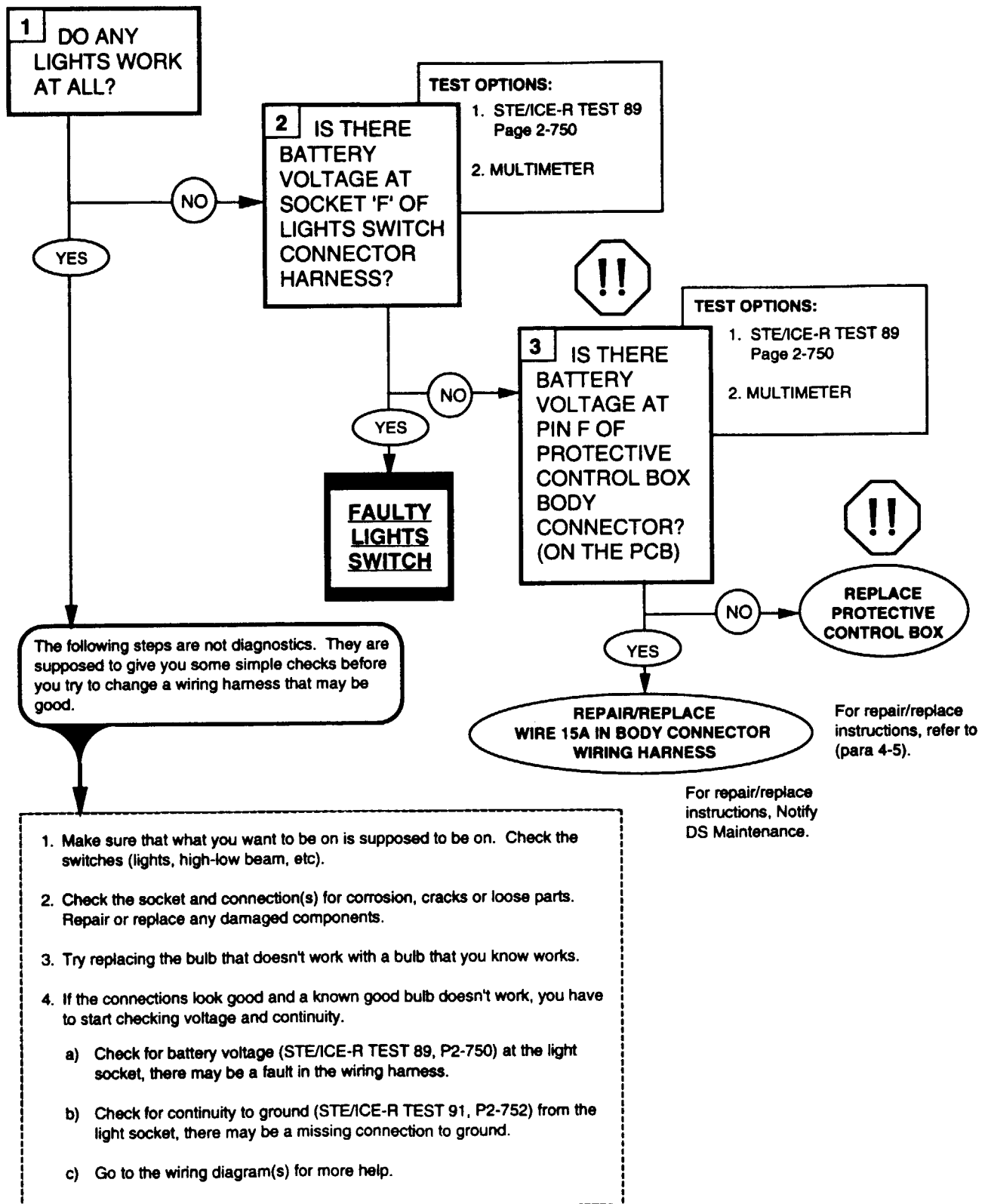
## **2-33. LIGHT TESTS**

---

The Lights paragraph has almost no flow chart to guide you through a problem. This is because there aren't very many problems that can occur. The most common problems are burned-out bulbs and loose or corroded connections. Aside from bulbs and wiring, the only components are the PCB and the lights switch. If either of these is found to be faulty, you just replace the bad unit. On the following pages you will find diagrams of the major portions of the Lights Circuit. These are designed to help you isolate a problem without wasting too much time.

# LIGHTS

## DIAGNOSTIC FLOWCHART



# REFERENCE INFORMATION

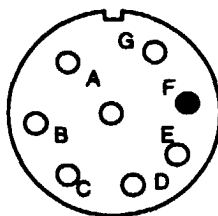
# LIGHTS



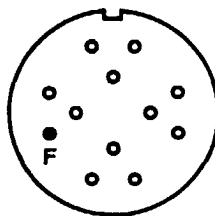
## WARNING

DISCONNECT NEGATIVE BATTERY CABLE BEFORE DISCONNECTING AND RECONNECTING PROTECTIVE CONTROL BOX HARNESS.

There is battery voltage at the PCB at all times. Failure to disconnect battery cable will result in damage to equipment or injury to personnel.



PCB BODY  
CONNECTOR



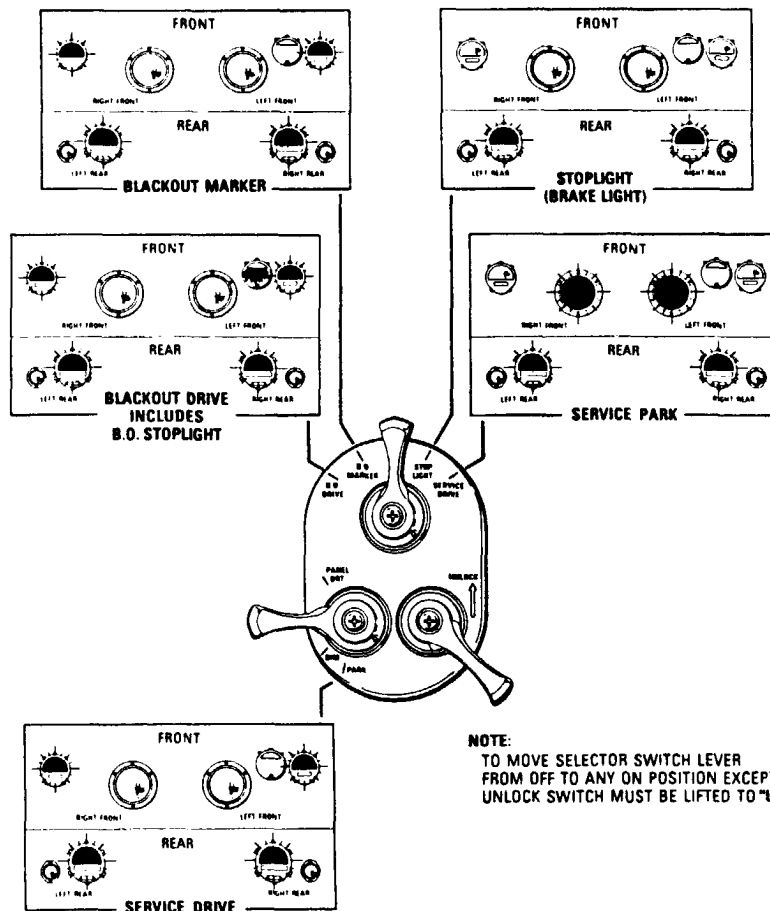
LIGHT SWITCH  
CONNECTOR HARNESS

## 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in the question.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

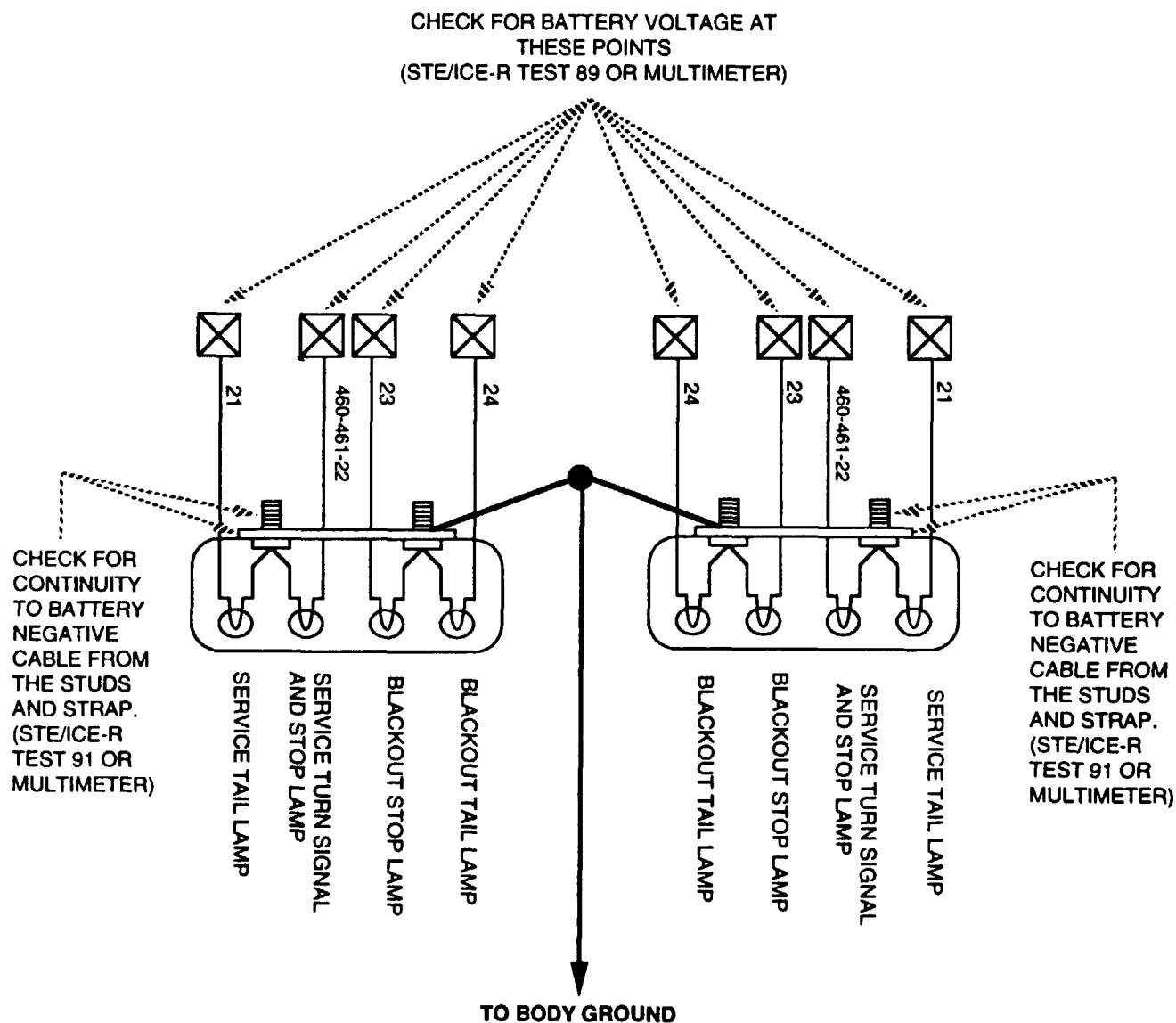
## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to positive, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



## LIGHTS

## REAR LIGHTS (NOT INCLUDING BACKUP LAMPS AND SIDE MARKERS)



1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

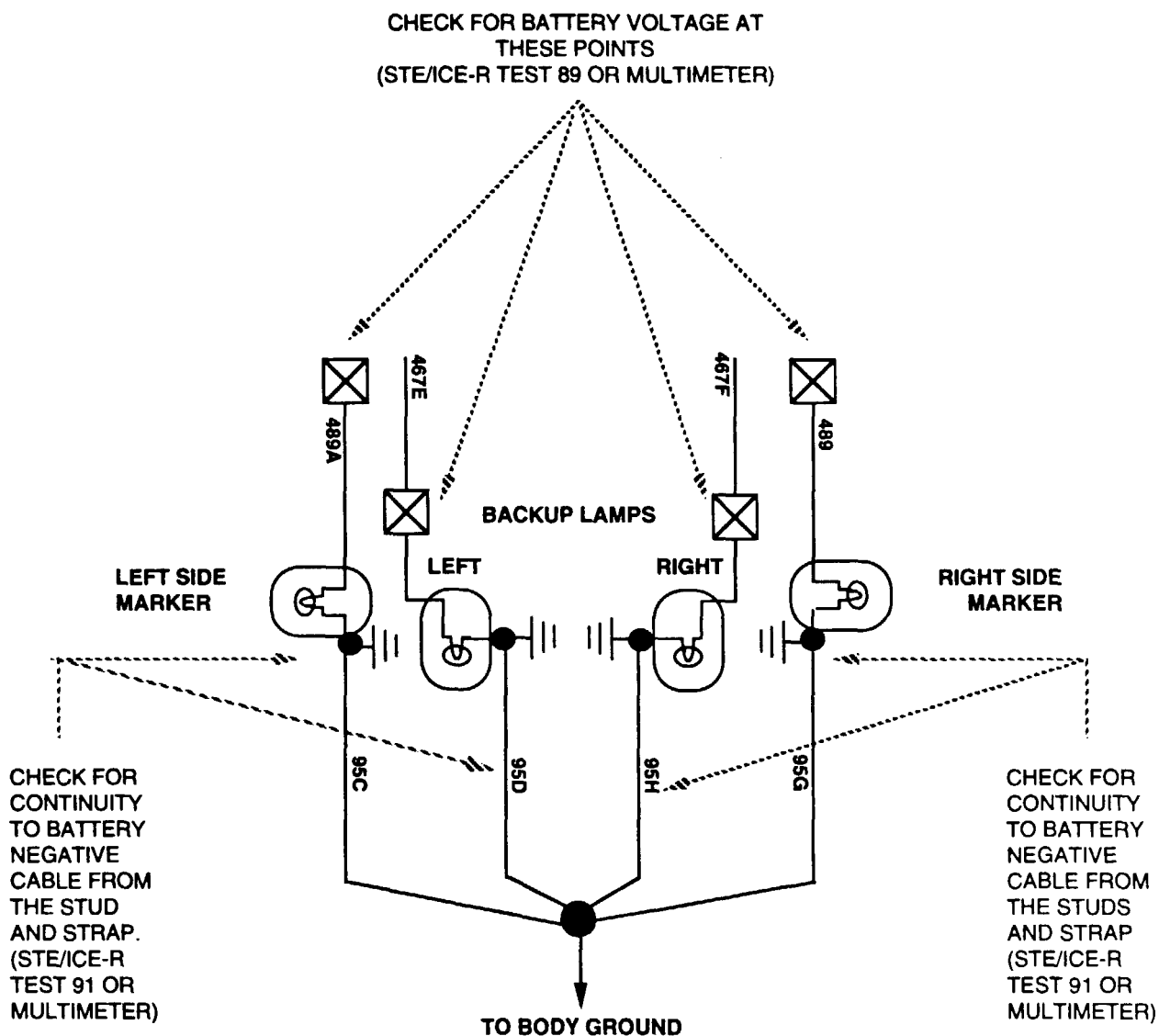
### CAUTION

DISCONNECT NEGATIVE BATTERY CABLE PRIOR  
TO MAKING CONTINUITY MEASUREMENTS

2. CHECK CONTINUITY TO BODY GROUND.

# BACKUP LAMPS AND REAR SIDE MARKERS

# LIGHTS



1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

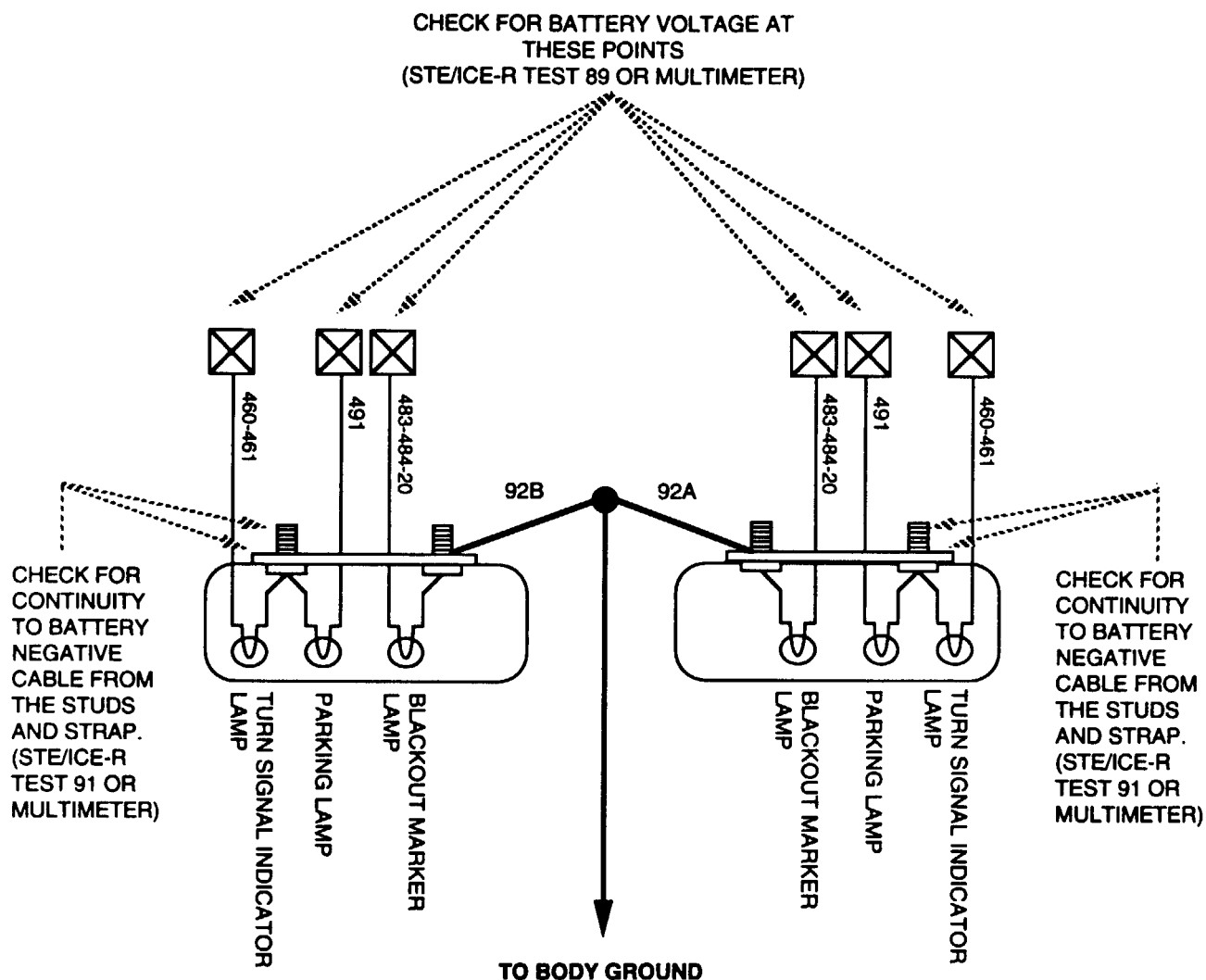
## CAUTION

DISCONNECT NEGATIVE BATTERY CABLE PRIOR  
TO MAKING CONTINUITY MEASUREMENTS

2. CHECK CONTINUITY TO BODY GROUND.

# LIGHTS

## FRONT LIGHTS (PARK LIGHTS, TURN SIGNAL LAMPS, BLACKOUT MARKERS)



1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

### CAUTION

DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO MAKING CONTINUITY MEASUREMENTS.

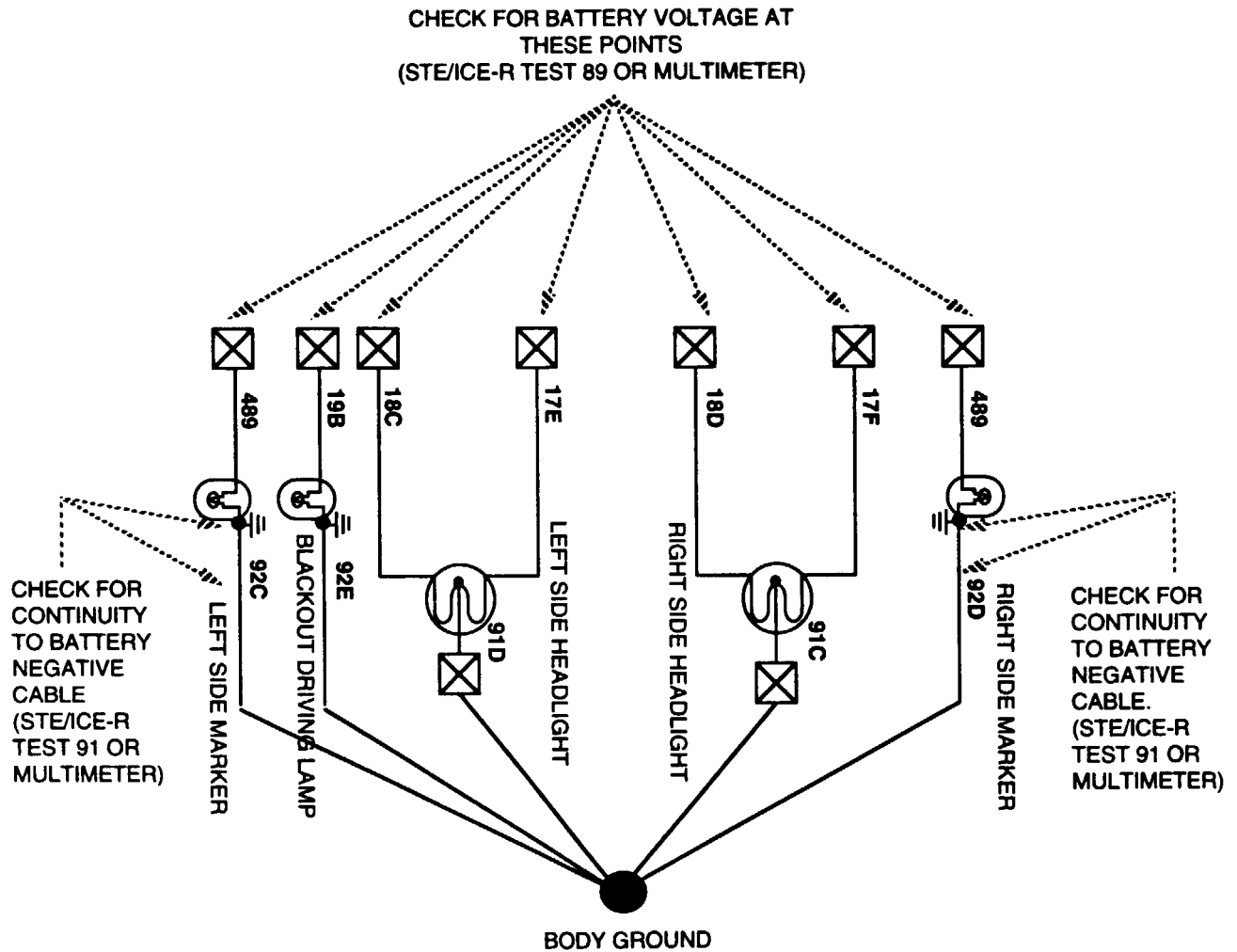
2. CHECK CONTINUITY TO BODY GROUND.



## FRONT LIGHTS

HEADLAMPS,  
BLACKOUT DRIVING  
LAMP, SIDE  
MARKERS

## LIGHTS



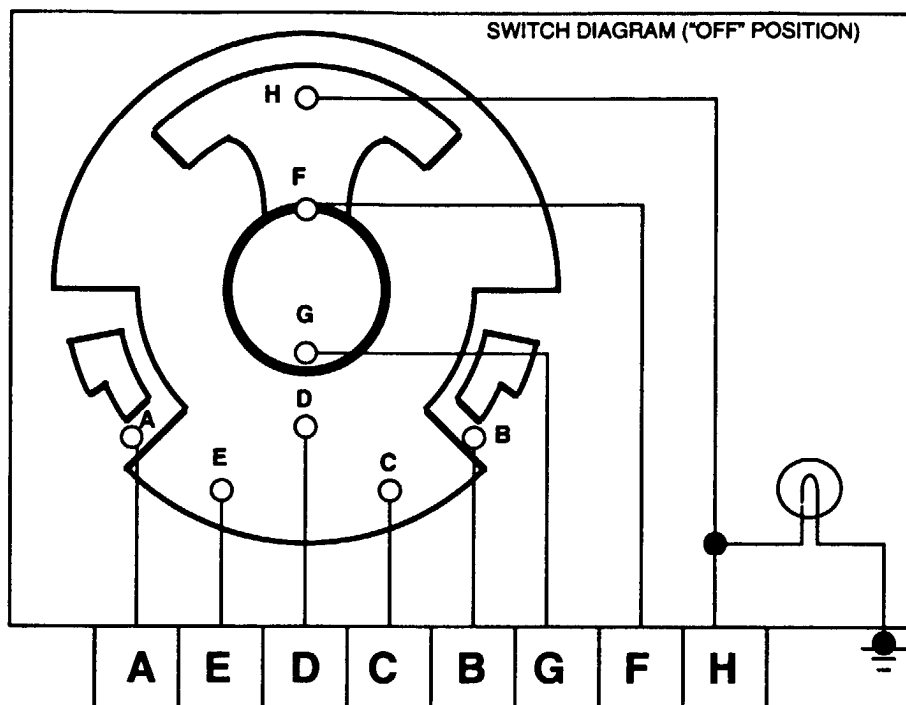
1. WHEN CHECKING FOR VOLTAGE, MAKE SURE THAT THE LAMP YOU ARE CHECKING IS SUPPOSED TO BE ON (CHECK THE LIGHTS SWITCH, TURN SIGNAL SWITCH, TRANSMISSION, ETC.).

**CAUTION**  
DISCONNECT NEGATIVE BATTERY CABLE PRIOR  
TO MAKING CONTINUITY MEASUREMENTS.

2. CHECK CONTINUITY TO BODY GROUND.

## LIGHTS

## TURN SIGNAL SWITCH



## SUMMARY OF CONNECTIONS:

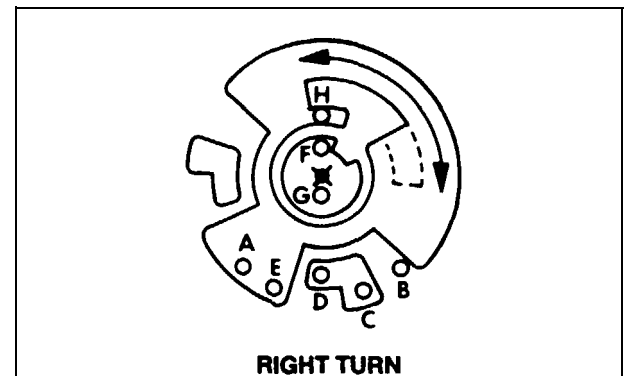
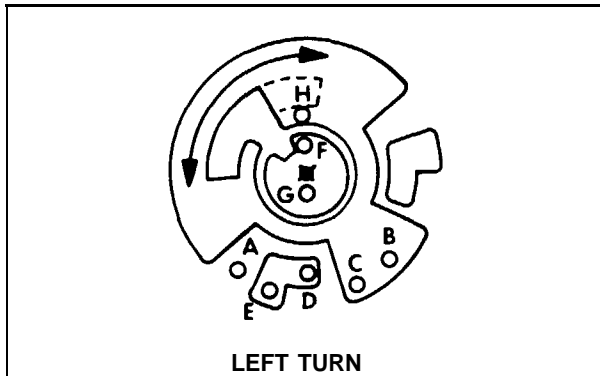
TERMINAL	CONNECTION	WIRE NUMBER
A	RIGHT FRONT TURN SIGNAL	460A
B	LEFT FRONT TURN SIGNAL	461A
C	LEFT REAR TURN SIGNAL/STOP LAMP	22-461A
D	LIGHT SWITCH TERMINAL "C"	22A
E	RIGHT REAR TURN SIGNAL	22-460A
F	HAZARD/TURN SIGNAL FLASHER TERM. "B"	325B
G	LIGHT SWITCH TERMINAL "J" (24 VOLTS)	467B
H	HAZARD/TURN SIGNAL FLASHER TERM. "A"	325A

**CAUTION**

DISCONNECT NEGATIVE BATTERY CABLE PRIOR TO  
MAKING CONTINUITY MEASUREMENTS.

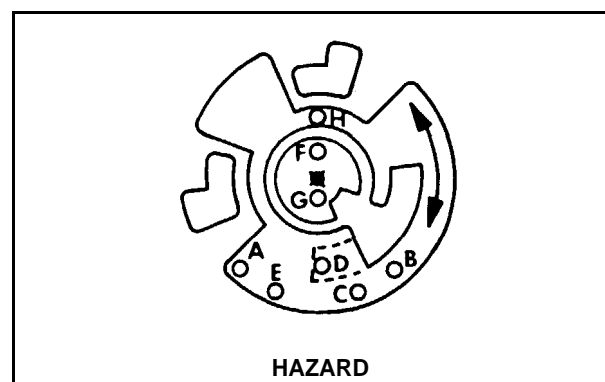
**TURN SIGNAL SWITCH****LIGHTS**

1. WITH THE SWITCH IN THE 'LEFT' POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN "H" TO PINS "B" AND "C", PIN "D" TO "E", AND PIN "F" TO "G".
2. WITH THE SWITCH IN THE "RIGHT" POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN "H" TO PINS "A" AND "E", PIN "C" TO "D", AND PIN "F" TO "G".

**NOTE**

- IF VEHICLE IS EQUIPPED WITH BRAKE LIGHT OVERRIDE DIRECTIONAL SIGNAL CONTROL ASSEMBLY (P/N12339312-1), REFER TO STEP 3.
- IF VEHICLE IS EQUIPPED WITH DIRECTIONAL SIGNAL CONTROL ASSEMBLY (P/N 12339312), REFER TO STEP 4.

3. WITH SWITCH IN HAZARD POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN H TO PINS "A", "B", "C", "D", AND "E" AND PIN "F" TO "G".
4. WITH SWITCH IN HAZARD POSITION, YOU SHOULD HAVE CONTINUITY FROM PIN H TO PINS "A", "B", "C". AND "E" AND PIN "F" TO "G".



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**2-34. TRANSMISSION SYSTEM TESTS (3L80)**

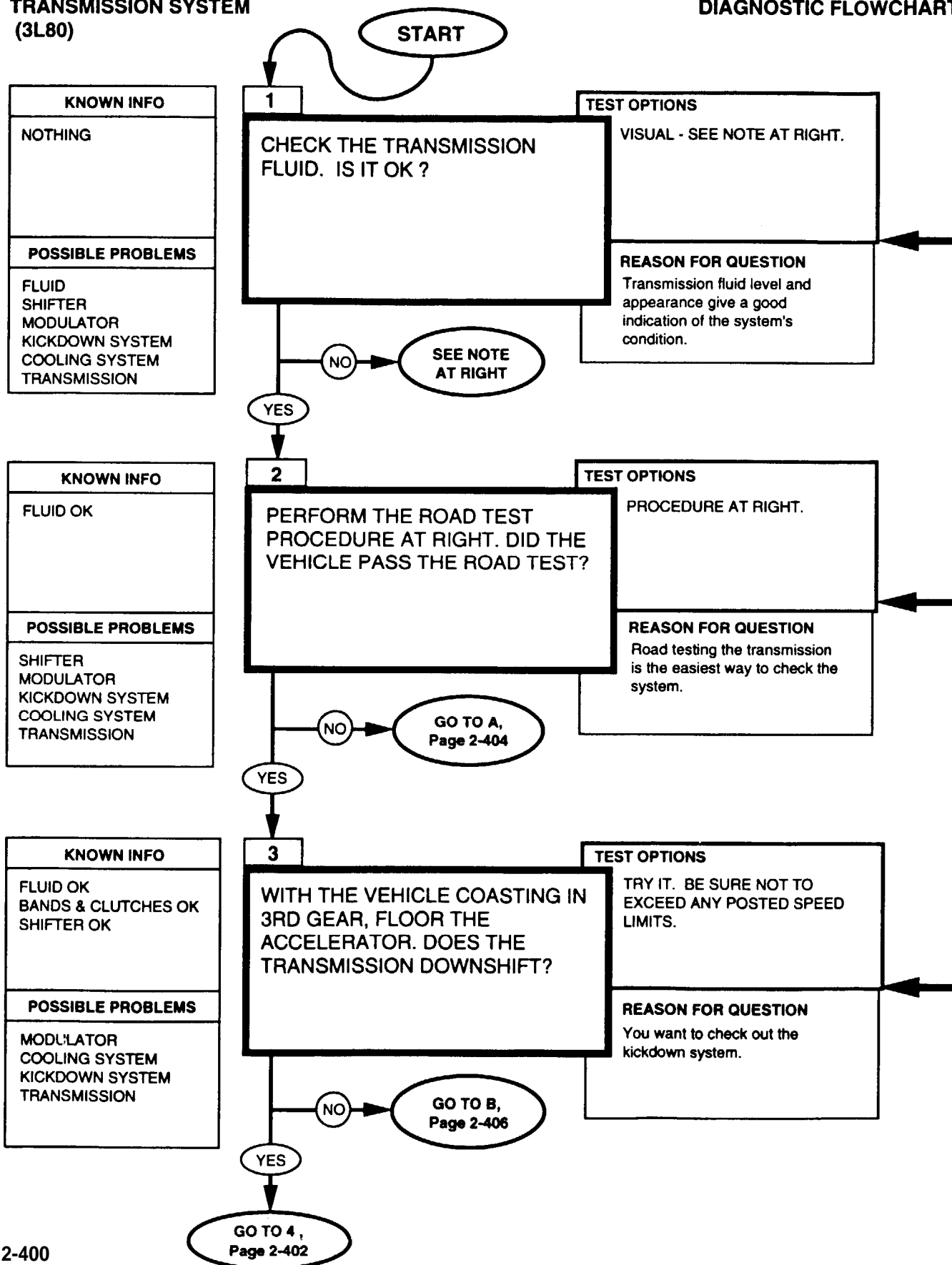
---

These Transmission System tests may be run any time you think you have a transmission problem or if you were sent hereby another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary. (4L80-E) Transmission system tests, refer to (para. 2-35).

Fold-out page FO-12 may be left open for reference while testing.

**TRANSMISSION SYSTEM  
(3L80)**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

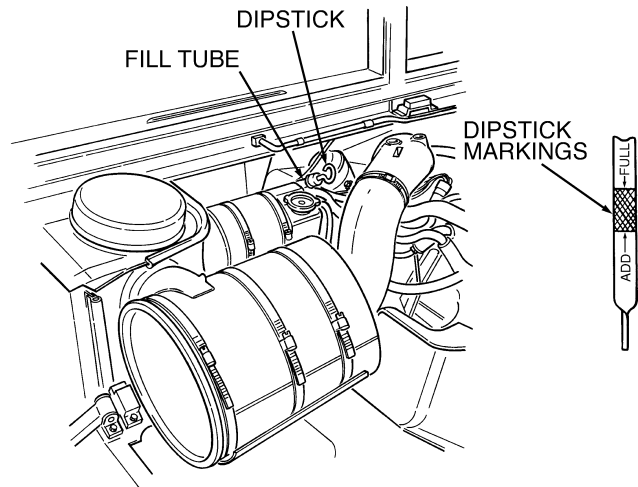
TRANSMISSION SYSTEM  
(3L80)Procedure for checking transmission fluid

1. Start engine.
2. Hold down brake pedal and move transmission shift lever through all ranges including reverse. Leave the lever in each range for 2 seconds.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between FULL and ADD marks on dipstick.

**NOTE**

Check fluid for a burnt smell, grit, discoloration, air bubbles, or a milky appearance.

- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance.
- Bubbles indicate an overfilled system or air leaks in the system. Drain the fluid and refill to proper level. Refer to (para 5-2).
- Milky appearance is due to water in the system. Change the fluid and filter.
- Check fill tube for indications of fluid being blown out. If fluid is being blown out, check vent line for obstructions, and refill transmission to proper level. Refer to (para 5-2).
- Transmission fluid coming out of dipstick filler tube indicates a restriction in the ventilation system. Check for clogged, melted, or crushed lines and/or fittings between transmission and atmosphere vent on air cleaner canister. Replace where needed. Refer to (para 5-16).

Road Test Procedure

1. Position transmission shift lever in "D" (drive) and accelerate vehicle from 0 mph. A 1-2 and 2-3 shift should occur at all throttle openings. Allow vehicle to coast down to about 0 mph and 3-2 and 2-1 shifts should occur.
2. Position transmission shift lever in "2" (low two) and accelerate vehicle from 0 mph. A 1-2 shift should occur at all throttle openings. No 2-3 shift can be obtained in this range. A 1-2 shift in 2 is somewhat firmer than in "D". This is normal.
3. Position shift lever in "1" and accelerate the vehicle from 0 mph. No upshifts should occur in this range.
4. Position shift lever in "D" and with the vehicle speed at approximately 35 mph, close throttle and move lever to "2". Transmission should downshift to 2nd gear. An increase in engine rpm and engine braking effect should be noticed.
5. Position shift lever "2" and with the vehicle speed at approximately 25 mph, close the throttle and move lever to "1". Transmission should downshift to 1st gear. An increase in engine RPM and engine braking effect should be noticed.
6. Position shift lever in "R" and check for reverse operation.
7. Hard shifting may be indicative of an underfilled or clogged system.

The kickdown system is used to shift the transmission to a lower gear under heavy acceleration. The system also disengages the engine cooling fan so as to allow maximum engine power to be used for moving the vehicle.

**TRANSMISSION SYSTEM  
(3L80)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK KICKDOWN OK
POSSIBLE PROBLEMS

MODULATOR  
COOLING

FROM 3,  
Page 2-400

**4**

SHUT THE ENGINE OFF. DOES THE MODULATOR CABLE MOVE AS YOU STEP ON THE ACCELERATOR?

TEST OPTIONS
VISUAL INSPECTION.
REASON FOR QUESTION
The modulator is needed for telling the transmission when to shift.

NO → REPLACE TRANSMISSION MODULATOR

YES →

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK KICKDOWN OK MODULATOR OK
POSSIBLE PROBLEMS

LEAKS  
COOLING

**5**

INSPECT THE TRANSMISSION SYSTEM FOR LEAKS. IS EVERYTHING OK?

TEST OPTIONS
VISUAL.
REASON FOR QUESTION
To see if anything is leaking

NO → REPAIR OR REPLACE AS NECESSARY

YES →

KNOWN INFO
EVERYTHING IS OK SO FAR
POSSIBLE PROBLEMS

INTERNAL TRANSMISSION PROBLEMS.

**6**

IF YOU STILL SUSPECT A PROBLEM, YOU CAN RUN THE PRESSURE TESTS AT THE RIGHT. DOES THE TRANSMISSION PASS THE PRESSURE TESTS?

TEST OPTIONS
1. SEE PROCEDURE AT RIGHT. USE STE/ICE-R TEST 50 AND THE BLUE TRANSDUCER. USE CONTROL FUNCTION 01 TO INTERLEAVE PRESSURE WITH RPM.
2. PRESSURE GAUGE.
REASON FOR QUESTION
There may be a problem not previously discovered in the testing.

NO → NOTIFY DS MAINTENANCE

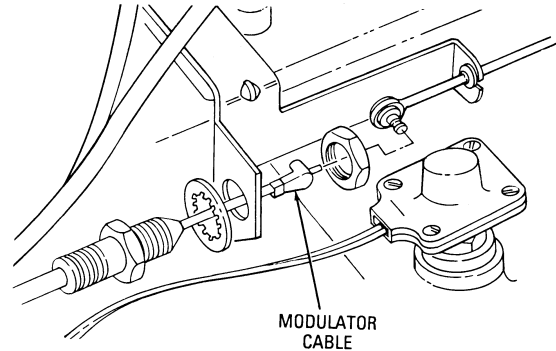
YES →

NO FAULTS

## REFERENCE INFORMATION

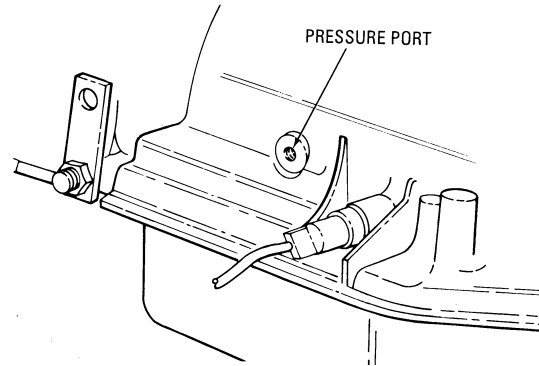
TRANSMISSION SYSTEM  
(3L80)

Replace transmission modulator, refer to (para. 5-14).



**STE/ICE-R TEST #50  
0 TO 1000 PSIG PRESSURE  
INTERLEAVED WITH RPM**

1. Connect blue pressure transducer (1000 PSI) to system under test, and other end to a W4 cable. Make sure the system under test is not pressurized.
2. Dial 01 into VTM, and then 50 when prompted.
3. Perform offset test.
4. Start engine and VTM will display pressure interleaved with RPM.



**Transmission oil pressure test**

1. Remove plug from pressure port on left side of transmission.
2. Connect transducer to port using appropriate fittings.
3. Perform offset test.
4. Start engine and check for leaks at connections.
5. Bring engine to operating temperature.
6. Place shift lever in N and bring engine to 1000 RPM (STE/ICE-R test 10). Pressure should be 55-70 psi (379-483 kPa). If not, notify DS Maintenance.
7. Apply service brakes and place shifter in D. Operate engine at 1000 RPM. Pressure should be 60-90 psi (414-621 kPa). If not, notify DS Maintenance.
8. Apply brakes and place lever in 2. With engine at 1000 RPM, pressure should be 135-160 psi (931- 1103 kPa). If not, notify DS Maintenance.
9. Apply brakes and place lever in 1. With engine at 1000 RPM, pressure should be 135-160 psi (931-1103 kPa). If not, notify DS Maintenance.
10. Apply brakes and place lever in R. With engine at 1000 RPM, pressure should be 95-150 psi (655-1034 kPa). If not, notify DS Maintenance.
11. Apply brakes and place lever in D. With engine idling, pressure should be 60-85 psi (414-586 kPa). If not, notify DS Maintenance.

**NOTE**

NEXT TEST MUST BE PERFORMED DURING A ROAD TEST OR WITH VEHICLE RAISED AND TIRES OFF THE GROUND. RECORD PRESSURE WITH THROTTLE CLOSED.

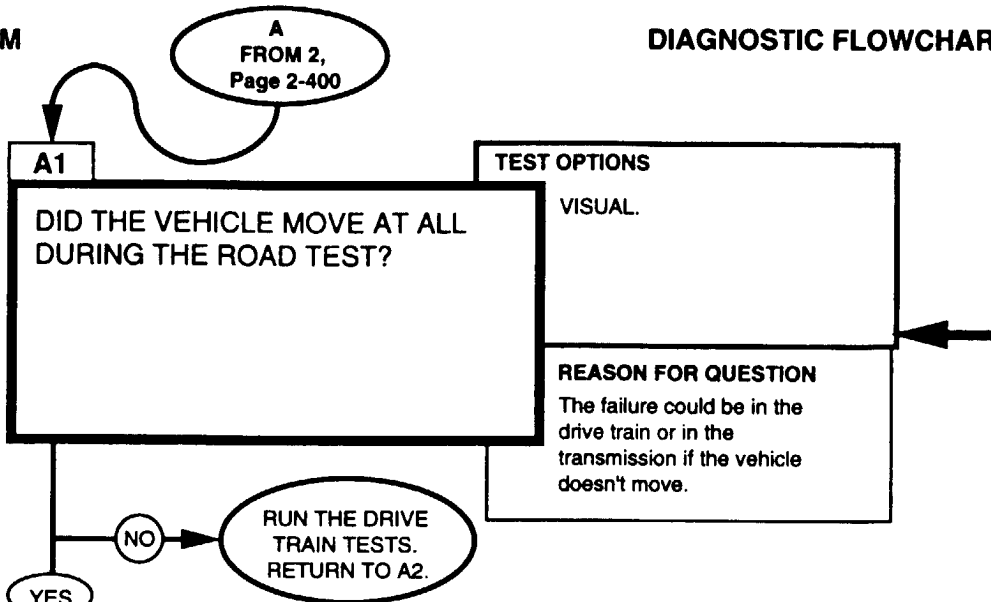
12. Place lever in D and take foot off brake. With engine at 2000 RPM, close throttle and read pressure between 1200 and 2000 RPM. Pressure should be 65-70 psi (448-485 kPa). If not, notify DS Maintenance.
13. Shut off engine, remove transducer and reinstall plug.



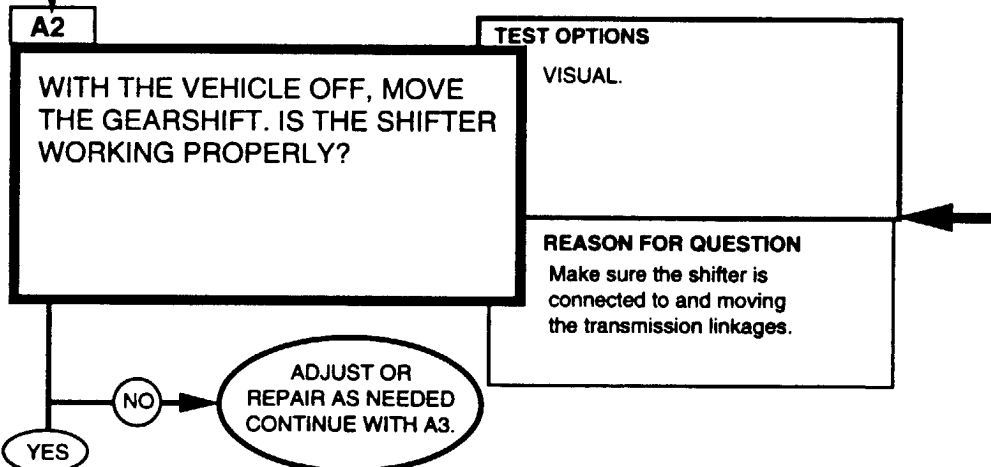
# TRANSMISSION SYSTEM (3L80)

## DIAGNOSTIC FLOWCHART

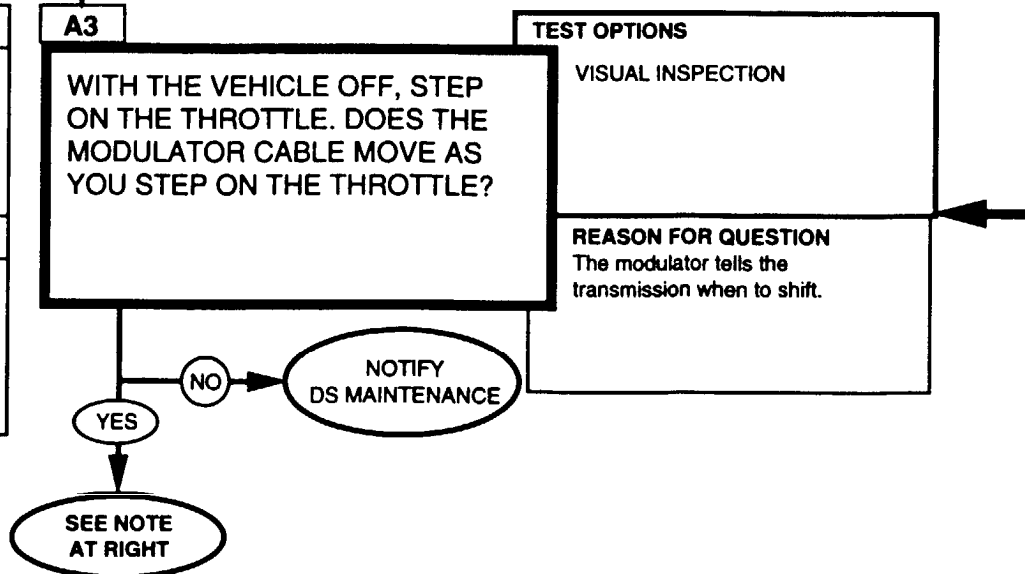
KNOWN INFO
TRANSMISSION FAILS ROAD TEST
POSSIBLE PROBLEMS
SHIFTER TRANSMISSION



KNOWN INFO
TRANSMISSION FAILS ROAD TEST VEHICLE MOVES.
POSSIBLE PROBLEMS
SHIFTER TRANSMISSION MODULATOR



KNOWN INFO
SHIFTER OK FINAL DRIVE OK TRANSMISSION FAILS ROAD TEST
POSSIBLE PROBLEMS
MODULATOR TRANSMISSION



## REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(3L80)

If the drivetrain system checks out OK, the problem is either the transmission itself, the shifter or the modulator. The DRIVETRAIN tests are located in (para. 2-38) of this manual.

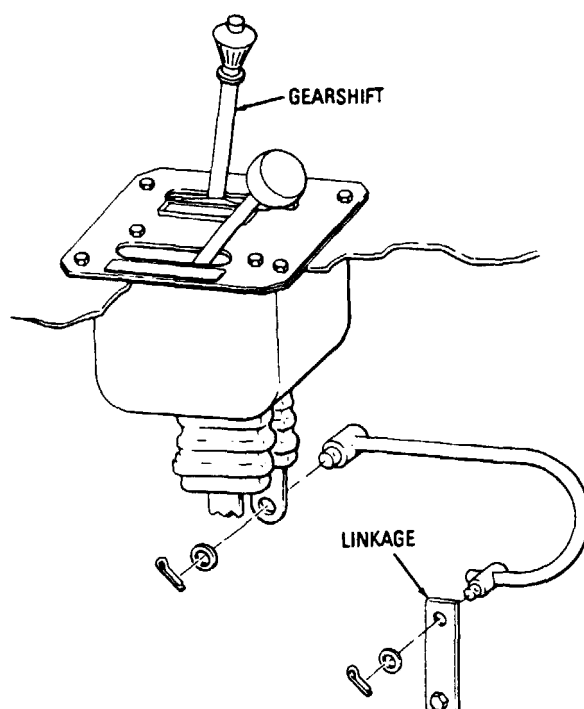
Make sure that the detents in the shifter correspond to the shift positions shown on the plate. Have an assistant move the shifter and look to see that the linkage is moving at the transmission.

Linkage repair and adjustment procedures are shown in (para. 5-12).

Look for a modulator problem if the vehicle was not shifting, or was not shifting as well as it should be.

**NOTE**

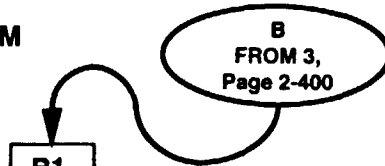
Run the BRAKES and DRIVETRAIN tests in this manual. If you don't find any faults, notify DS maintenance.



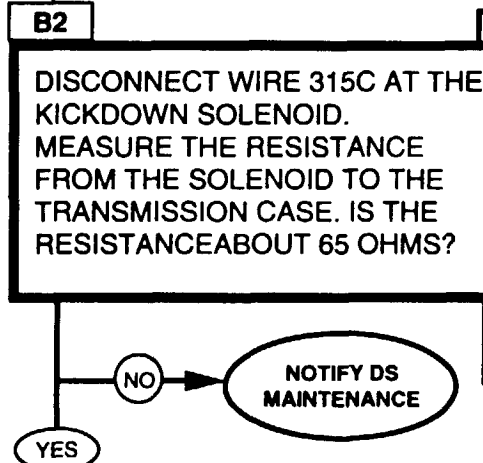
**TRANSMISSION SYSTEM  
(3L80)**

**DIAGNOSTIC FLOWCHART**

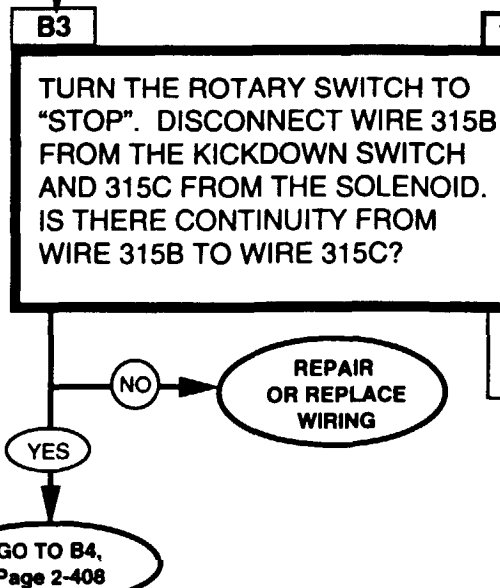
<b>KNOWN INFO</b>
KICKDOWN SYSTEM DOESN'T WORK
<b>POSSIBLE PROBLEMS</b>
TIME DELAY MODULE KICKDOWN SWITCH KICKDOWN SOLENOID WIRING TRANSMISSION



<b>KNOWN INFO</b>
KICKDOWN DOESN'T WORK TIME DELAY MODULE OK
<b>POSSIBLE PROBLEMS</b>
KICKDOWN SWITCH KICKDOWN SOLENOID WIRING TRANSMISSION

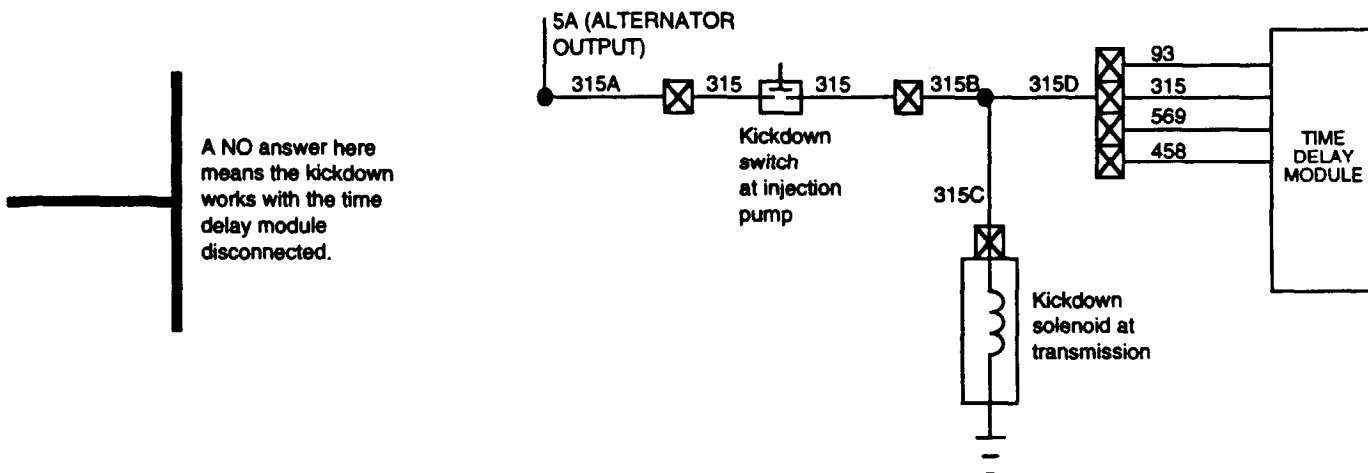


<b>KNOWN INFO</b>
SOLENOID OK TIME DELAY MODULE OK
<b>POSSIBLE PROBLEMS</b>
SWITCH WIRING TRANSMISSION



## REFERENCE INFORMATION

## TRANSMISSION SYSTEM (3L80)



### 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the test points indicated in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

A measurement of zero or infinity means the solenoid is no good.

### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**TRANSMISSION SYSTEM  
(3L80)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
SOLENOID OK WIRING AFTER SWITCH OK TIME DELAY MODULE OK
POSSIBLE PROBLEMS
SWITCH WIRING BEFORE SWITCH TRANSMISSION ALTERNATOR

**B4**

DISCONNECT WIRE 315A FROM THE KICKDOWN SWITCH. IS THERE CONTINUITY FROM WIRE 5A AT THE ALTERNATOR TO WIRE 315A AT THE KICKDOWN SWITCH?

YES

NO

REPAIR OR REPLACE WIRING AS NEEDED

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER.
REASON FOR QUESTION
Test the wiring from the alternator to the switch.

KNOWN INFO
SOLENOID OK WIRING OK TIME DELAY MODULE OK
POSSIBLE PROBLEMS
SWITCH TRANSMISSION ALTERNATOR

**B5**

IS THE KICKDOWN SWITCH FUNCTIONING PROPERLY?

YES

NO

ADJUST OR REPLACE SWITCH

TEST OPTIONS
1. STE/ICE-R TEST 91 (Page 2-752) 2. MULTIMETER.
REASON FOR QUESTION
Test out the kickdown switch.

KNOWN INFO
SOLENOID OK WIRING OK SWITCH OK TIME DELAY MODULE OK
POSSIBLE PROBLEMS
NO VOLTAGE AT ALTERNATOR OUTPUT TRANSMISSION

**B6**

RECONNECT EVERYTHING. DISCONNECT WIRE 315A FROM THE KICKDOWN SWITCH. WITH THE ROTARY SWITCH IN RUN, IS THERE BATTERY VOLTAGE AT WIRE 315A?

YES

NO

GO TO ALTERNATOR, Page 2-195

TEST OPTIONS
1. STE/ICE-R TEST 89 (Page 2-750) 2. MULTIMETER.
REASON FOR QUESTION
Check for voltage input to the circuit.

SEE NOTE AT RIGHT

REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(3L80)

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in the question. RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

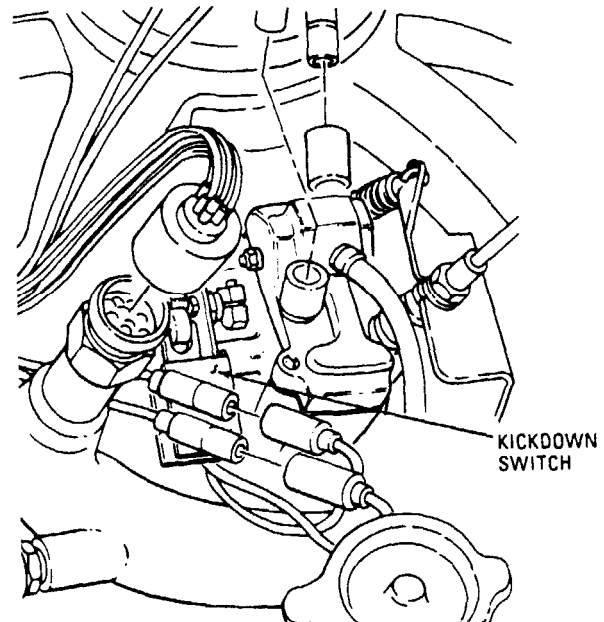
**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

Repair or replace wiring, refer to (para 4-85).

There should be continuity when the injector pump is wide open, and an open circuit when it isn't. Check out both positions.

Adjust or replace kickdown switch, refer to (para 4-43).



**NOTE**

Recheck everything in the circuit. If you don't find anything wrong, notify DS maintenance. The problem is probably in the transmission itself.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

---

## 2-35. TRANSMISSION SYSTEM TESTS (4L80-E)

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The 4L80-E Transmission system is equipped with a computer called the Transmission Control Module (TCM) (located left rear seat compartment; for M996A2 and M997A2 vehicles, located in the left exterior stowage compartment) which interprets, analyzes and records electronic signals from sensors and switches located on the engine, brake pedal, and transmission. The recorded codes stored in the TCM are known as TROUBLE CODES which are retrieved using the Diagnostic Switch Cable on the J2 connector of the TCM. The TCM can protect the transmission from damage by locking it in Second Gear, with maximum fluid pressure, until the problem has been corrected. The following procedures will detail diagnostic testing, troubleshooting and corrective action for any existing faults. These Transmission System tests may be run any time you think there is a transmission problem or if you were sent here by another test chain. This paragraph has a different kind of flow chart to guide you through testing because of the many problems that can occur. The most common problems are loose or corroded wiring connections. To troubleshoot the transmission, you will need a diagnostic switch cable, digital multimeter and a throttle position (TP) sensor test cable.

### **CAUTION**

Do not disconnect battery without recording Trouble Codes. Failure to do so will result in loss of diagnostic test codes.

The diagnostic test codes (DTC) are transmitted from the TCM to transmission lamp located next to the shift lever. When Diagnostic Switch Cable is connected to the J2 connector, the system is placed in the diagnostic mode, which causes the transmission lamp to flash. The transmission lamp will flash once, pause, flash twice (meaning code 12) pause, flash once, pause, flash twice (code 12 again), and do this one more time for a total of three times, which means the system is operational.

### **NOTE**

Diagnostic test code 63 will be set at all times.

For example if the TCM is sending the trouble code 74, the lamp will flash 12 three times, flash 63 three times, which is set all the time and is to be disregarded, flash code 7 and 4, 7 and 4, 7 and 4 for code 74, and then 12, 12, 12, which ends the diagnostic check. These codes will repeat again, if not taken out of diagnostic mode.

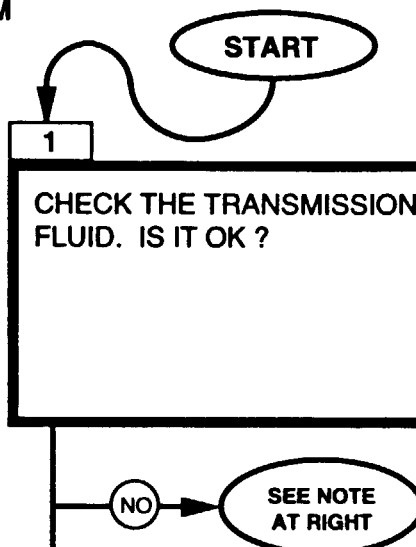
The TCM J1 connector will be used to diagnose and troubleshoot wiring, sensor connectors, pins, solenoids, and brake switch, to insure all external problems are checked and corrected prior to TCM and transmission faults.

On the following pages you will find diagrams and charts of the major portions of the transmission circuits. These are designed to help you isolate a problem and correct it.

# TRANSMISSION SYSTEM (4L80-E)

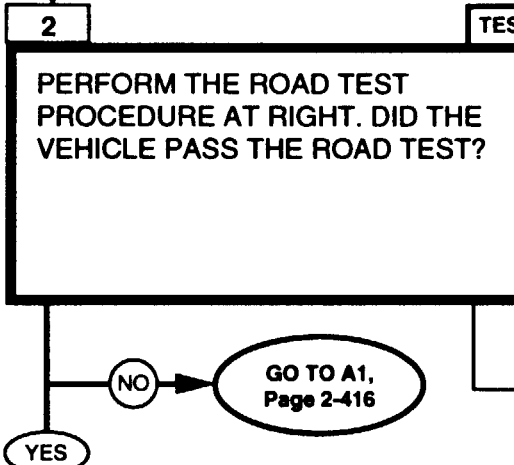
## DIAGNOSTIC FLOWCHART

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
FLUID SHIFTER FAN CUT-OFF SWITCH TP SENSOR COOLING SYSTEM TRANSMISSION



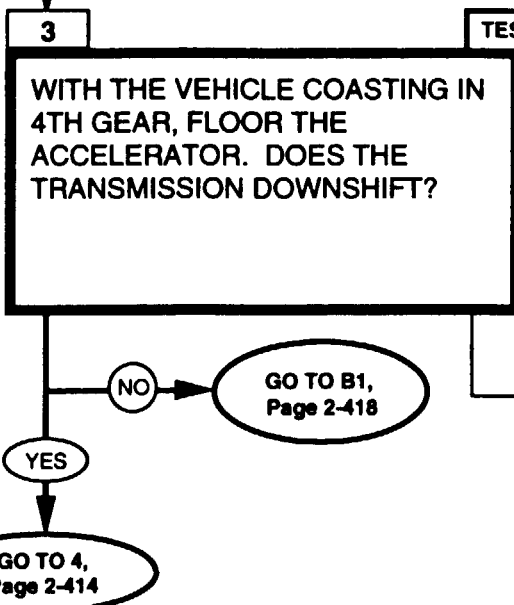
TEST OPTIONS
VISUAL - SEE NOTE AT RIGHT.
REASON FOR QUESTION
Transmission fluid level and appearance give a good indication of the system's condition.

KNOWN INFO
FLUID OK
POSSIBLE PROBLEMS
SHIFTER FAN CUT-OFF SWITCH TP SENSOR COOLING SYSTEM TRANSMISSION



TEST OPTIONS
PROCEDURE AT RIGHT.
REASON FOR QUESTION
Road testing the transmission is the easiest way to check the system.

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK
POSSIBLE PROBLEMS
FAN CUT-OFF SWITCH COOLING SYSTEM TP SENSOR TRANSMISSION



TEST OPTIONS
TRY IT. BE SURE NOT TO EXCEED ANY POSTED SPEED LIMITS.
REASON FOR QUESTION
You want to check out the fan cut-off switch.



## REFERENCE INFORMATION

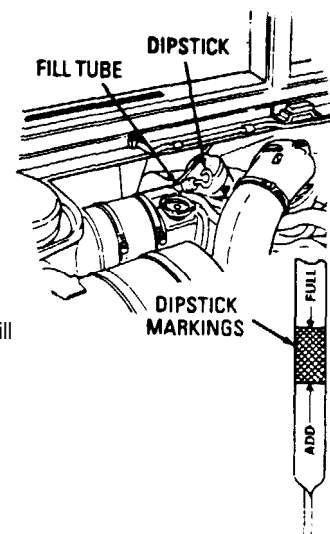
TRANSMISSION SYSTEM  
(4L80-E)Procedure for checking transmission fluid

1. Start engine
2. Hold down brake pedal and move transmission shift lever through all ranges including reverse. Leave the lever in each range for 2 seconds.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between FULL and ADD marks on dipstick.

**NOTE**

Check fluid for a burnt smell, grit, discoloration, air bubbles, or a milky appearance.

- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance
- Bubbles indicate an overfilled system or air leaks in the system. Drain the fluid and refill to proper level. Refer to (para 5-2).
- Milky appearance is due to water in the system. Change the fluid and filter.
- Check fill tube for indications of fluid being blown out. If fluid is being blown out, check vent line for obstructions, and refill transmission to proper level. Refer to (para. 5-2).

**Road Test Procedure**

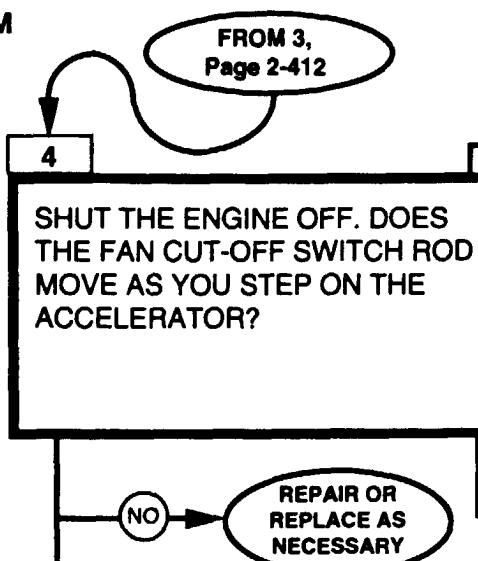
1. Position shift lever in "D" (overdrive) and accelerate vehicle from 0 mph. A 1-2, 2-3 and 3-4 shift should occur at all throttle openings. Allow vehicle to coast down to about 0 mph and 4-3, 3-2 and 2-1 shifts should occur.
2. Position transmission shift lever in "D" (drive) and accelerate vehicle from 0 mph. A 1-2 and 2-3 shift should occur at all throttle openings. Allow vehicle to coast down to about 0 mph and 3-2 and 2-1 shifts should occur.
3. Position transmission shift lever in "2" (low two) and accelerate vehicle from 0 mph. A 1-2 shift should occur at all throttle openings. No 2-3 shift can be obtained in this range. A 1-2 shift in 2 is somewhat firmer than in "D". This is normal.
4. Position shift lever in "1" and accelerate the vehicle from 0 mph. No upshifts should occur in this range.
5. Position shift lever in "D" and with the vehicle speed at approximately 45 mph, close throttle and move lever to "3". Transmission should downshift to 3rd gear. An increase in engine rpm and engine braking effect should be noticed.
6. Position shift lever in "D" and with the vehicle speed at approximately 35 mph, close throttle and move lever to "2". Transmission should downshift to 2nd gear. An increase in engine rpm and engine braking effect should be noticed.
7. Position shift lever "2" and with the vehicle speed at approximately 25 mph, close the throttle and move lever to "1". Transmission should downshift to 1st gear. An increase in engine RPM and engine braking effect should be noticed.
8. Position shift lever in "R" and check for reverse operation.
9. Hard shifting may be indicative of an underfilled or dogged system.

The fan cut off switch and TP sensor are used to shift the transmission to a lower gear under heavy acceleration. The system also disengages the engine cooling fan so as to allow maximum engine power to be used for moving the vehicle.

# TRANSMISSION SYSTEM (4L80-E)

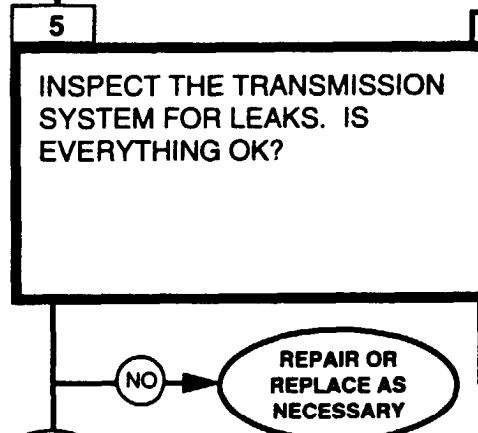
## DIAGNOSTIC FLOWCHART

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK TP SENSOR OK
POSSIBLE PROBLEMS
FAN CUT-OFF SWITCH COOLING



TEST OPTIONS
VISUAL INSPECTION.
REASON FOR QUESTION
The fan cut-off switch is needed for telling the transmission when to shift.

KNOWN INFO
FLUID OK BANDS & CLUTCHES OK SHIFTER OK TP SENSOR OK FAN CUT-OFF SWITCH OK
POSSIBLE PROBLEMS
LEAKS COOLING



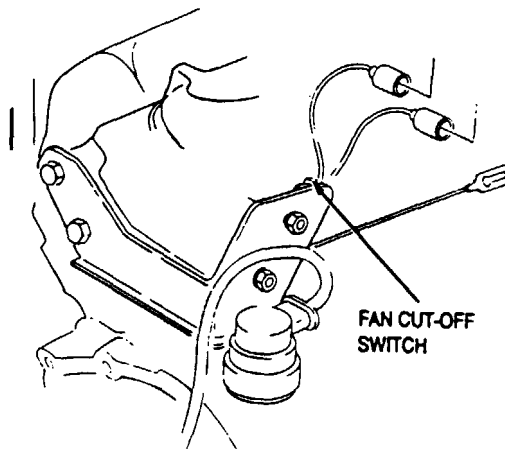
TEST OPTIONS
VISUAL.
REASON FOR QUESTION
To see if anything is leaking

REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(4L80-E)

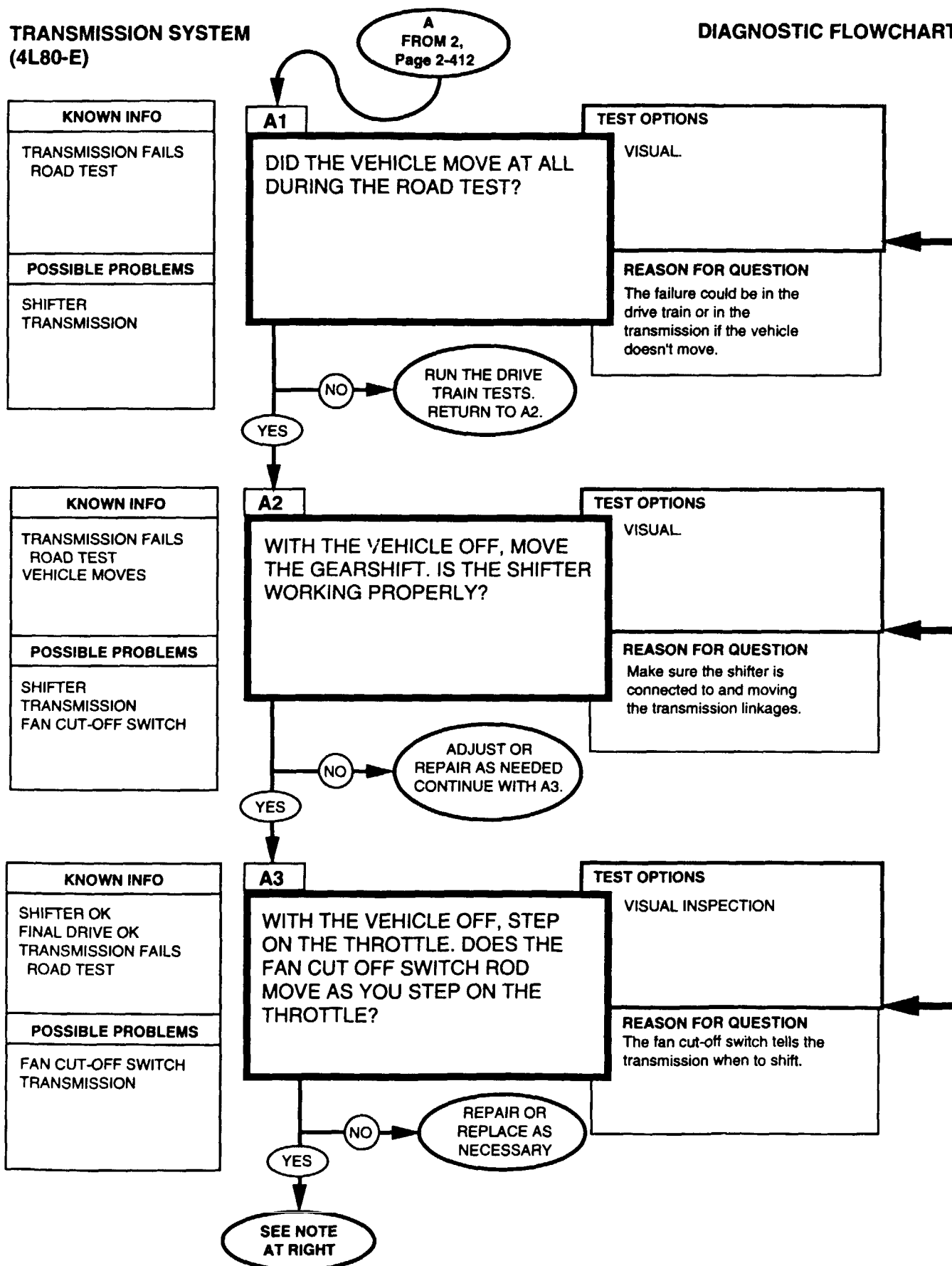


Repair or replace fan cut-off switch,  
refer to (para 4-44).



**TRANSMISSION SYSTEM  
(4L80-E)**

**DIAGNOSTIC FLOWCHART**



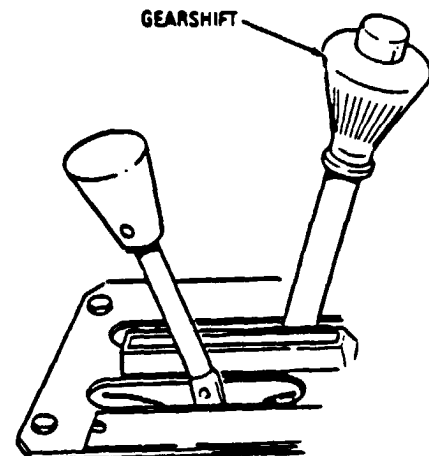
## REFERENCE INFORMATION

## TRANSMISSION SYSTEM (4L80-E)

If the drivetrain system checks out OK, the problem is either the transmission itself, the shifter or the modulator. The DRIVETRAIN tests are located in Paragraph 2-33 of this manual.

Make sure that the detents in the shifter correspond to the shift positions shown on the plate. Have an assistant move the shifter and look to see that the linkage is moving at the transmission.

Linkage repair and adjustment procedures are shown in Paragraph 5-13.



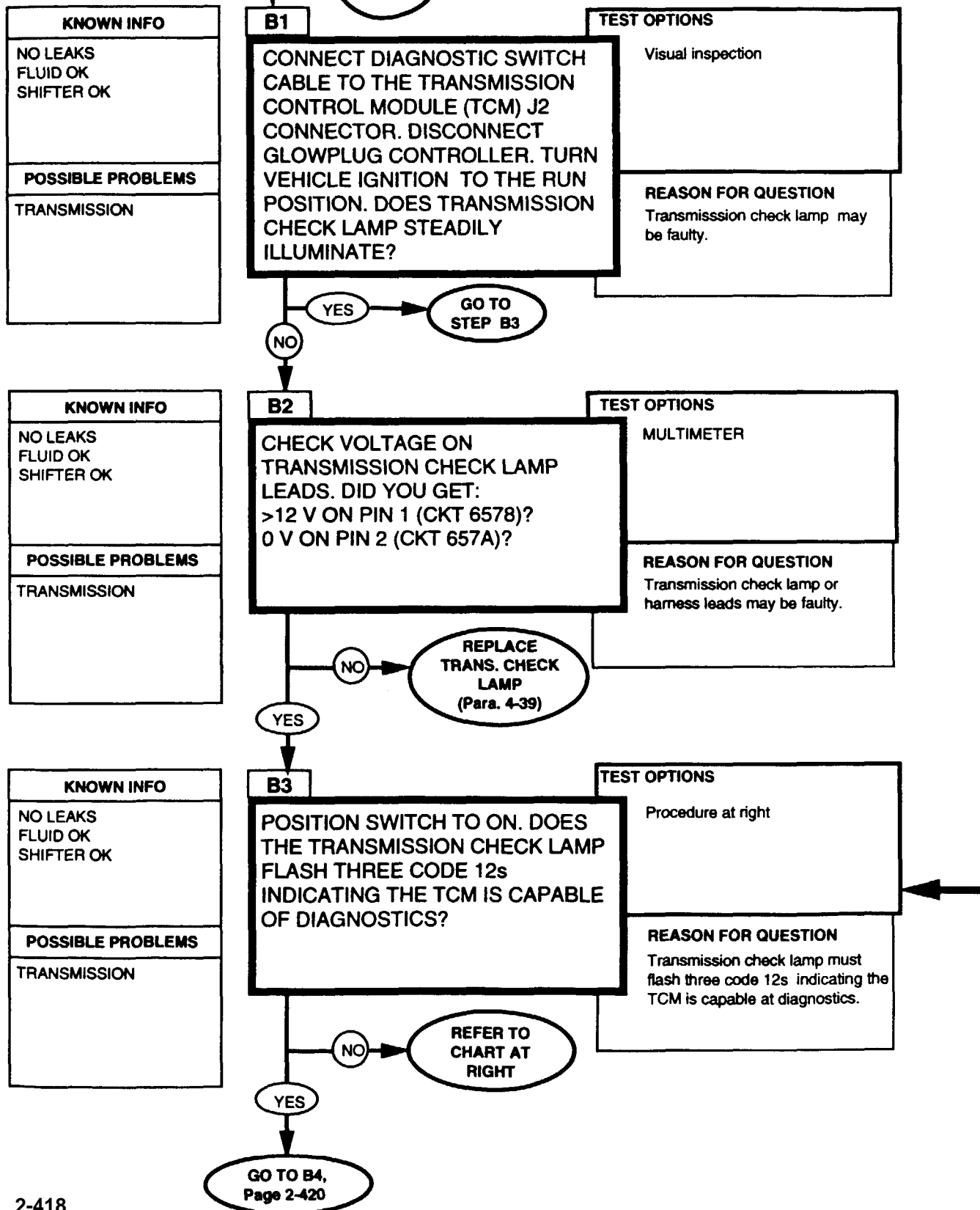
Look for a fan cut-off switch problem if the vehicle was not shifting, or was not shifting as well as it should be.

### NOTE

Run the BRAKES and DRIVETRAIN tests in this manual. If you don't find any faults, notify DS maintenance.

**TRANSMISSION SYSTEM  
(4L80-E)**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(4L80-E)**Will Not Display DTC Code 12, or Check Transmission "ON" Steady**

(NOTE: TRANSMISSION CHECK LAMP IS THE LAMP NEXT TO THE SHIFT LEVER MARKED TRANS-ONLY.)

IGNITION ON, ENGINE OFF AND GLOWPLUG  
CONTROLLER DISCONNECTED (PARA 4-29).

REMOVE DIAGNOSTIC SWITCH CABLE. INSTALL JUMPER  
CABLE BETWEEN PINS A AND E OF J2 ON TCM. ASSY.

NO DTC 12

DTC 12 FLASHES

CHECK DIAGNOSTIC CABLE  
FOR OPEN AND REPAIR.

READ CODES AND REMOVE  
JUMPER.

- IGNITION OFF.
- DISCONNECT TCM CONNECTOR.
- IGNITION ON.

TRANS CHECK LAMP OFF.

TRANS CHECK LAMP ON.

- IGNITION OFF.
- DIAGNOSTIC TERMINAL  
NOT GROUNDED.
- RECONNECT TCM  
CONNECTOR.
- IGNITION ON AND  
ENGINE OFF.
- PROBE PIN E ON J2 TO  
GROUND.

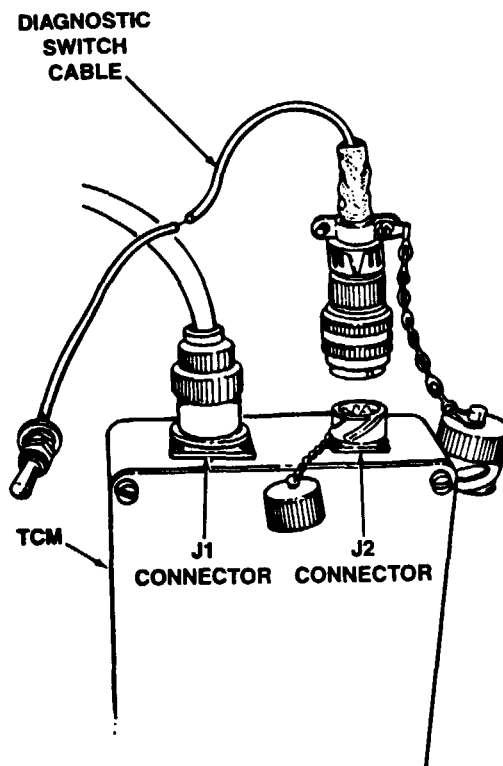
REPAIR SHORT TO  
GROUND IN CKT 657A.  
(REFER TO PARA. 4-85).

NO DTC 12

DTC 12 FLASHES

REPLACE DEFECTIVE TCM.  
(REFER TO PARA 4-42).

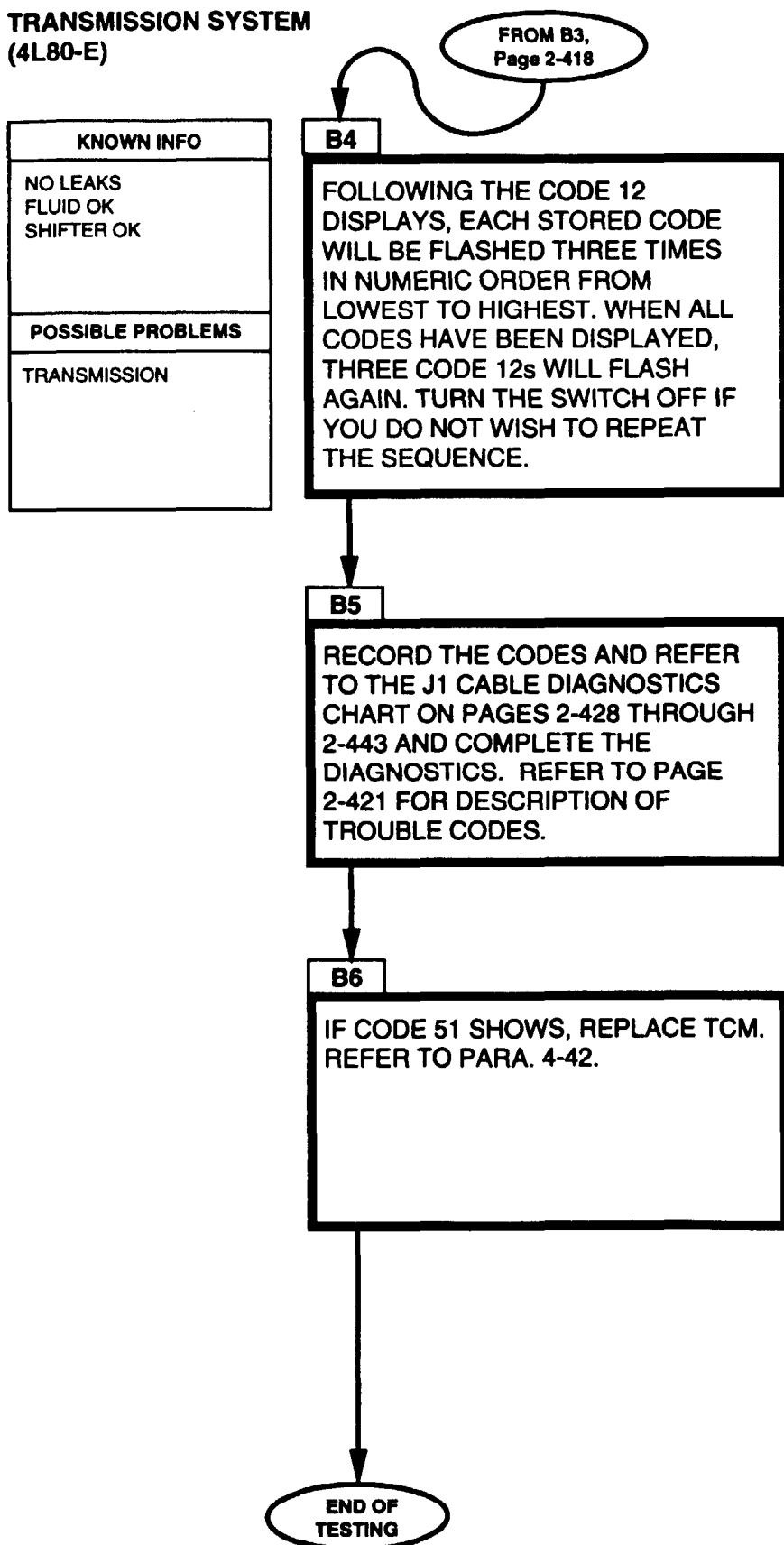
OPEN CKT PIN A J2.  
REPLACE TCM.  
(REFER TO PARA 4-42).



NOTE: AFTER TROUBLESHOOTING, RECONNECT GLOWPLUG CONTROLLER. VEHICLE WILL HAVE TO BE OPERATED IN ORDER FOR TCM TO RECEIVE TROUBLE CODES. AFTER REPAIRS, CHECK TRANS LAMP OPERATION.

TRANSMISSION SYSTEM  
(4L80-E)

DIAGNOSTIC FLOWCHART





**REFERENCE INFORMATION****TRANSMISSION SYSTEM  
(4L80-E)**

The following chart will help you find the code you need. The J1 cable diagnostics checks (page 2-428) must be performed. Always correct the lower code number first. If code 51 shows up, replace TCM (para. 4-42), operate vehicle, and recheck for trouble codes.

<b>TROUBLE CODE</b>	<b>CIRCUIT</b>	<b>PAGE NO.</b>
21	Throttle Position High	2-422
22	Throttle Position Low	2-422
24	Transmission Output Speed Sensor (TOSS)	2-422
28	Transmission Range Pressure Switch	2-422
37	Torque Converter Clutch (TCC) Brake Switch Stuck "ON"	2-422
38	TCC Brake Switch Stuck "OFF"	2-422
39	TCC Stuck "OFF"	2-423
51	Transmission Control Module (TCM) Bad	2-423
52	System Voltage High Long	2-423
53	System Voltage High	2-423
58	Transmission Temperature High	2-423
59	Transmission Temperature Low	2-423
68	Transmission Component Slipping	2-424
69	Torque Converter Clutch (TCC) Stuck "ON"	2-424
71	Engine Speed Sensor Circuit Low	2-424
73	Pressure Control Solenoid (PCS) Current	2-424
74	Transmission Input Speed Sensor (TISS) Circuit	2-425
75	System Voltage Low	2-425
79	Transmission Fluid Overtemp	2-425
81	2-3 Shift Solenoid Circuit Fault	2-425
82	1-2 Shift Solenoid Circuit Fault	2-426
83	TCC Solenoid (PWM) Circuit Fault	2-426
85	Undefined Ratio	2-426
86	Low Ratio	2-427
87	High Ratio	2-427

**TRANSMISSION SYSTEM  
(4L80-E)**

**REFERENCE INFORMATION**

**DTC 21/22**

**Throttle Position (TP) Sensor Circuit High/  
Throttle Position Sensor Circuit Low**

***Circuit Description:***

The TP sensor contains a resistor strip with one end connected to a 5-volt supply and the other to ground. The signal is connected to a movable contact within the TP sensor. As the accelerator pedal is applied, and the throttle shaft rotates, the voltage signal will increase from approximately 0.5 to 4.5 volts.

***DTC 21 Will Set When:***

- Engine is operating.
- TP sensor signal voltage is greater than 4.9 volts.
- Conditions are met for one second.

***DTC 22 Will Set When:***

- Engine is operating.
- TP sensor signal voltage is less than 0.2 volt.
- Conditions are met for one second.

**DTC 24**

**Output Speed Sensor Signal**

***Circuit Description:***

The Output Speed sensor is a magnetic induction type sensor. Gear teeth pressed onto the output shaft induce an alternating voltage into the sensor.

***DTC 24 Will Set When:***

- Not in P/N.
- CKT voltage is constant.
- Engine speed is greater than 3000 rpm.
- Output speed is less than 200 rpm.
- TP is between 10% and 100%.
- All conditions are met for 3 seconds.

**DTC 28**

**Transmission Range (TR) Pressure  
Switch Assembly (PSA) Fault**

***Circuit Description:***

The Transmission Range (TR) switch assembly consists of five normally open pressure switches mounted on the valve body. The TCM supplies battery voltage to each range signal. By grounding one or more of these circuits through various combinations of the pressure switches, the TCM assembly detects what transmission range has been selected by the vehicle operator. When the transmission electrical connector is disconnected, the ground potential for the three range signals to the TCM will be removed and D2 gear will be indicated.

***DTC 28 Will Set When:***

- Range signals "A" and "C" are both zero volts.
- Condition is met for 2 seconds.

**DTC 37/38**

**Torque Converter Clutch (TCC) Brake  
Switch Stuck "ON"/  
TCC Brake Switch Stuck "OFF"**

***Circuit Description:***

The normally closed brake switch supplies a B+ signal volt when the TCC brake switch is closed (brake pedal not applied).

***DTC 37 Will Set When:***

- CKT 810B is open.
- Then vehicle speed is between 5 mph (8 kph) and 20 mph (32 kph) for greater than 6 seconds.
- Then vehicle speed is greater than 20 mph (32 kph) for greater than 6 seconds.
- For a complete total of seven times.

***DTC 38 Will Set When:***

- TCC brake switch feed CKT 810B has constant voltage.
- Vehicle speed is greater than 20 mph (32 kph) for greater than 6 seconds.
- Then vehicle speed is between 5 mph (8 kph) and 20 mph (32 kph) for greater than 6 seconds.
- For a complete total of seven times.

## REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(4L80-E)**DTC 39**  
**TCC Stuck "OFF"****Circuit Description:**

The TCM commands the TCC PWM solenoid "ON" by modulating TCC signal fluid acting on the converter clutch shift valve. Then TCC fluid applies the torque converter clutch.

**DTC 39 Will Set When:**

- TCC is commanded "ON."
- TCC slip speed greater than 65 RPM.
- Trans range in D3 or D4.
- 2nd or 3rd gear.
- All conditions are met for two seconds.

**DTC 51**  
**Faulty or Incorrect****Circuit description:**

The transmission Control Module (TCM) , an on board computer, receives and processes input signals from sensors on the vehicle and delivers output signals to the solenoids located on the control valve assembly. These solenoids control the transmission operating pressures, upshift and downshift patterns and torque converter clutch (TCC) operation.

**DTC 51 Will Set When:**

- There is an uncorrectable computational error, or an input is in error intermittently.

**DTC 52/53**  
**System Voltage High Long/  
System Voltage High****Circuit Description:**

Ignition voltage is supplied to the control module to indicate the status of the ignition switch. Battery voltage is supplied to the control module to, in part, maintain memory of learned functions and parameters.

**DTC 52 Will Set When:**

- The ignition is "ON" and the system voltage is greater than 16 volts.
- Condition is met for 109 minutes.

**DTC 53 Will Set When:**

- The ignition is "ON" and the system voltage is greater than 19.5 volts.
- Condition is met for 2 minutes.

**DTC 58**  
**Transmission Fluid Temperature (TFT)**  
**Sensor Circuit Low**  
**(High Temperature Indicated)****Circuit Description:**

The TFT sensor is a thermistor that controls the signal voltage to the TCM. The TCM supplies a 5-volt reference signal to the sensor on TWC pin "L." When the transmission fluid is cold, the sensor resistance is high and the TCM will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts. With DTC 79 also set, check the transmission cooling system.

**DTC 58 Will Set When:**

- Signal voltage indicates TFT greater than 304°F (151°C).
- Condition is met for 1 second.

**TRANSMISSION SYSTEM  
(4L80-E)**

**DTC 59  
Transmission Fluid Temperature (TFT)  
Sensor Circuit High  
(Low Temperature Indicated)**

***Circuit Description:***

The TFT sensor is a thermistor that controls the signal voltage to the TCM. The TCM supplies a 5-volt reference signal to the sensor on TWC Pin "L." When the transmission fluid is cold, the sensor resistance is high and the TCM will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts.

***DTC 59 Will Set When:***

- Signal voltage indicates TFT less than -34°F (-37°C).
- Condition is met for 1 second.

**DTC 68  
Transmission Component Slipping  
*Circuit Description:***

The TCM monitors the difference in engine Speed and input Speed.

***DTC 68 Will Set When:***

- TCC slip speed greater than 200 RPM.
  - Fourth gear is indicated.
  - TCC is locked.
  - Not in park/neutral.
  - All conditions are met for 2 seconds.
- 
- Trans range switch indicates D3 or D4.
  - Commanded gear indicates 2nd or 3rd gear.
  - All conditions are met for 2 seconds.

**REFERENCE INFORMATION**

**DTC 69  
Torque Converter Clutch (TCC) Stuck "ON"**

***Circuit Description:***

The TCM commands the TCC PWM solenoid "ON" by modulating TCC signal fluid acting on the converter clutch shift valve. Then TCC fluid applies the torque converter clutch.

***DTC 69 Will Set When:***

- TCC slip speed RPM indicates between -5 and +10 RPM.
- TCC solenoid is commanded "OFF."
- TP sensor signal is greater than 25%.

**DTC 71  
Engine Speed, Sensor Circuit Low**

***Circuit Description:***

The camshaft position sensor (CPS) detects the rotational speed of the camshaft. As the camshaft rotates, an AC signal is generated in the circuit. This signal provides the input to determine engine speed for use in various calculations including TCC slip speed and overdrive ratio.

***DTC 71 Will Set When:***

- Engine speed less than 50 rpm
- Transmission range indicates, R, D4, D3, or D1.
- Conditions are met for 2 seconds.

## REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(4L80-E)**DTC 73**  
**Pressure Control Solenoid (PCS) Circuit**  
**Current Error (Force Motor Circuit)***Circuit Description:*

The pressure control solenoid is a TCM-controlled device used to regulate transmission line pressure. The TCM compares TP voltage, engine rpm and other inputs to determine the appropriate line pressure of a given load. The TCM will regulate the pressure by applying a varying amperage to the pressure control solenoid. The applied amperage can vary from 0.1 to 1.1 amp. The TCM then monitors the amperage at the return line.

*DTC 73 Will Set When:*

- The return amperage varies greater than 0.16 amps from the commanded amperage.
- All conditions are met for 1 second.

**DTC 74**  
**Transmission Input Speed**  
**Sensor (TISS) Circuit***Circuit Description:*

The TISS sensor consists of a permanent magnet surrounded by a coil of wire. As the forward clutch housing rotates, an AC voltage is induced in the circuit. The signal voltage and frequency vary directly with the forward clutch rotational speed.

*DTC 74 Will Set When:*

- Trans range not in park or neutral.
- Engine speed greater than 300 rpm.
- Trans output speed greater than 200 rpm.
- Trans input speed less than 50 rpm.
- All conditions are met for 2 seconds.

**DTC 75**  
**System Voltage Low***Circuit Description:*

Ignition voltage is supplied to the control module to indicate the status of the ignition switch. Battery voltage is supplied to the control module to, in part, maintain memory of learned functions and parameters.

*DTC 75 Will Set When:*

- The ignition is "ON."
- Ignition feed voltage to the control module is less than the graduated scale of:
  - -40°F (-40°C) = 7.3 volts.
  - 194°F (-90°C) = 10.3 volts.
  - 302°F (-150°C) = 11.7 volts.
- Engine speed greater than 1000 rpm.
- All conditions are met for 4 seconds.

**DTC 79**  
**Transmission Fluid Overtemp***Circuit Description:*

The Transmission Fluid Temperature (TFT) sensor is a thermistor that controls the signal voltage to the TCM. The TCM supplies a 5-volt reference signal to the sensor on CKT 923A. When the transmission fluid is cold, the sensor resistance is high and the TCM will sense high signal voltage.

As the transmission fluid temperature warms to normal transmission operating temperature 212°F (100°C), the sensor resistance becomes less and the voltage decreases to approximately 1.5 to 2.0 volts.

*DTC 79 Will Set When:*

- Trans fluid temp greater than 295°F (146°C).
- All conditions are met for 30 minutes.

**TRANSMISSION SYSTEM  
(4L80-E)****REFERENCE INFORMATION****DTC 81  
2-3 Shift Solenoid Circuit Fault*****Circuit Description:***

Ignition voltage is supplied directly to the 2-3 shift solenoid. The TCM controls the solenoid by providing the ground path through CKT 315A to TCM.

***DTC 81 Will Set When:***

- The TCM commands the solenoid “ON” and voltage remains high.
- The TCM commands the solenoid “OFF” and voltage remains low.
- All conditions are met for 2 seconds.

**DTC 82  
1-2 Shift Solenoid Fault*****Circuit Description:***

Ignition voltage is supplied directly to the 1-2 shift solenoid. The TCM controls the solenoid by providing the ground path through CKT 237A to TCM.

***DTC 82 Will Set When:***

- The TCM commands the solenoid “ON” and voltage remains high.
- The TCM commands the solenoid “OFF” and voltage remains low.
- All conditions are met for 2 seconds.

**DTC 83  
TCC Solenoid (PWM) Circuit Fault*****Circuit Description:***

The control module supplies a ground through an internal Quad-Driver Module (QDM) allowing current to flow through the solenoid coil according to the duty cycle (percentage of “ON” and “OFF” time). This current flow through the solenoid coil creates a magnetic field that magnetizes the solenoid core. The magnetized core attracts the check-ball to seat against spring pressure. This blocks the exhaust for the TCC signal fluid and allows 2-3 drive fluid to feed the TCC signal circuit. The TCC signal fluid pressure acts on the TCC regulator valve to regulate line pressure and to apply fluid pressure to the TCC shift valve. When the TCC shift valve is in the “apply” position, regulated apply fluid pressure is directed through the TCC valve to apply the torque converter clutch.

***DTC 83 Will Set When:***

- The TCM commands the solenoid “ON” and voltage remains high.
- The TCM commands the solenoid “OFF” and voltage remains low.
- AU conditions are met for 2 seconds.

## REFERENCE INFORMATION

TRANSMISSION SYSTEM  
(4L80-E)**DTC 85**  
**Undefined Ratio Error*****Circuit Description:***

The control module calculates ratio based on the transmission input speed and output speed sensor reading. The control module compares the known transmission ratio to the calculated ratio for the particular gear range selected.

***DTC 85 Will Set When:***

- TP is greater than 25%.
- Not in park neutral, or 4th gear.
- Engine speed is greater than 300 rpm.
- Vehicle speed is greater than 7 mph (11 kph).

COMMANDED GEAR	IF CALCULATED RATIO IS:	
	LESS THAN	MORE THAN
1st	2.38	2.63
2nd	1.43	1.58
3rd	0.95	1.05
REV	1.97	2.17

- All conditions are met for 2 seconds.

**DTC 86**  
**Low Ratio Error*****Circuit Description:***

The control module calculates ratio based on the transmission input speed and output speed sensor readings. The control module compares the known transmission ratio to the calculated ratio for the particular gear range selected.

***DTC 86 Will Set When:***

- Not in park, reverse, or neutral.
- Engine speed greater than 300 rpm.
- TP greater than 25%.
- Vehicle speed is greater than 7 mph (11 kph).
- Trans gear ratio is less than 1.06 in first or second gear.
- All conditions are met for 2 seconds.

**DTC 87**  
**High Ratio Error*****Circuit Description:***

The control module calculates ratio based on the transmission input speed and output speed sensor readings. The control module compares the known transmission ratio to the calculated ratio for the particular gear range selected.

***DTC 87 Will Set When:***

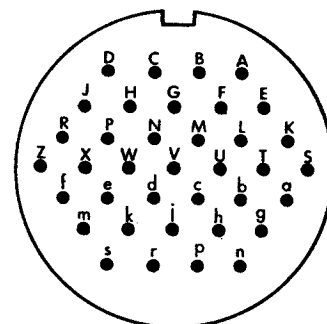
- TP greater than 25%.
- Not in park, reverse, or neutral.
- Engine speed greater than 300 rpm.
- Vehicle speed greater than 7 mph (11 kph).
- Transmission temperature is greater than 68°F (20°C).
- All conditions are met for 2 seconds.

# TRANSMISSION SYSTEM (4L80-E)

## DIAGNOSTIC FLOWCHART

### NOTE

- The following diagnostics will help isolate and repair problem circuits, wires, pins, connectors, sensors, circuit breakers, and solenoids.
- For repair of all wiring, refer to para. 4-85.
- Check connector pins before inserting probes.



J1

### J1 CABLE DIAGNOSTICS CHART

J1 Voltage Measurements With Ignition ON, Engine OFF,  
and Glow Plug Controller Disconnected. Refer to para 4-29.

CKT NOM.	CKT #	PIN	TO	PIN	EXP READ
IGN PWR	291D	j	a or b		12VDC
Battery Pos	537D	Z	a or b		12VDC
Trans Lp	657A	U*	a or b		LED Lights
Brake Sw	810B	W	a or b		12V (Brake OFF)
Brake Sw	810B	W	a or b		O (Brake ON)

\* Jumper wire from U to a or b.

Reconnect Glow Plug Controller; refer to para 4-29.  
J1 Voltage Measurement With Ignition ON, Engine ON,  
and Transmission in PARK.

CKT NOM.	CKT #	PIN	TO	PIN	EXP READ
Engine RPM	349A	h	c or p		0.3 Volts min @ idle
Press SW A	765A	A	a or b		Open wire
Press SW B	763A	B	a or b		0 to 1 ohms
Press SW C	764A	C	a or b		Open wire

No Go to pg 2-430

No Go to pg 2-431

No Go to pg 2-432

No Go to pg 2-433

No Go to pg 2-433

Go to pg 2-434

No Go to pg 2-442

No Go to pg 2-442

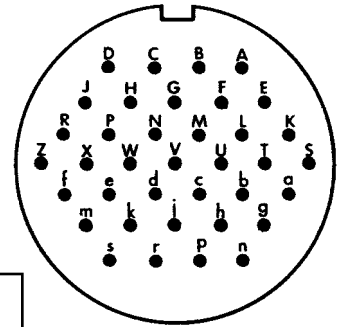
No Go to pg 2-442



## DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM  
(4L80-E)**NOTE**

Check connector pins before inserting probes.

*J1 CABLE DIAGNOSTICS CHART (Cont'd)***J1 Resistance Measurements With Ignition OFF**

CKT NOM.	CKT #	PIN	TO	PIN	EXP READ
Battery Neg	599A	a	Shunt		0 ohms
Battery Neg	599B	b	Shunt		0 ohms
TPS	355A	s	c or p		~ 1 to 2 Kohms
TPS	350A	d	c or p		4 to 6 Kohms
TISS	495A 496A	m	n		1 to 2 Kohms
TOSS	497A 498A	S	R		1 to 2 Kohms
TCC SOL	924A	X	j		~ 8 to 12 ohms
SHIFT SOL A	237A	E	j		~18 to 24 ohms
SHIFT SOL B	375A	D	j		~18 to 24 ohms
FORCE MTR	264A 265A	g	k		3.5 to 5.2 ohms
Trans Temp Sensor	923A	e	c or p		40 ohm to 5 Kohm (High Temp → Low Resist.)

No Go to pg 2-431

No Go to pg 2-431

No Go to pg 2-435

No Go to pg 2-435

No Go to pg 2-436

No Go to pg 2-437

No Go to pg 2-438

No Go to pg 2-439

No Go to pg 2-440

No Go to pg 2-441

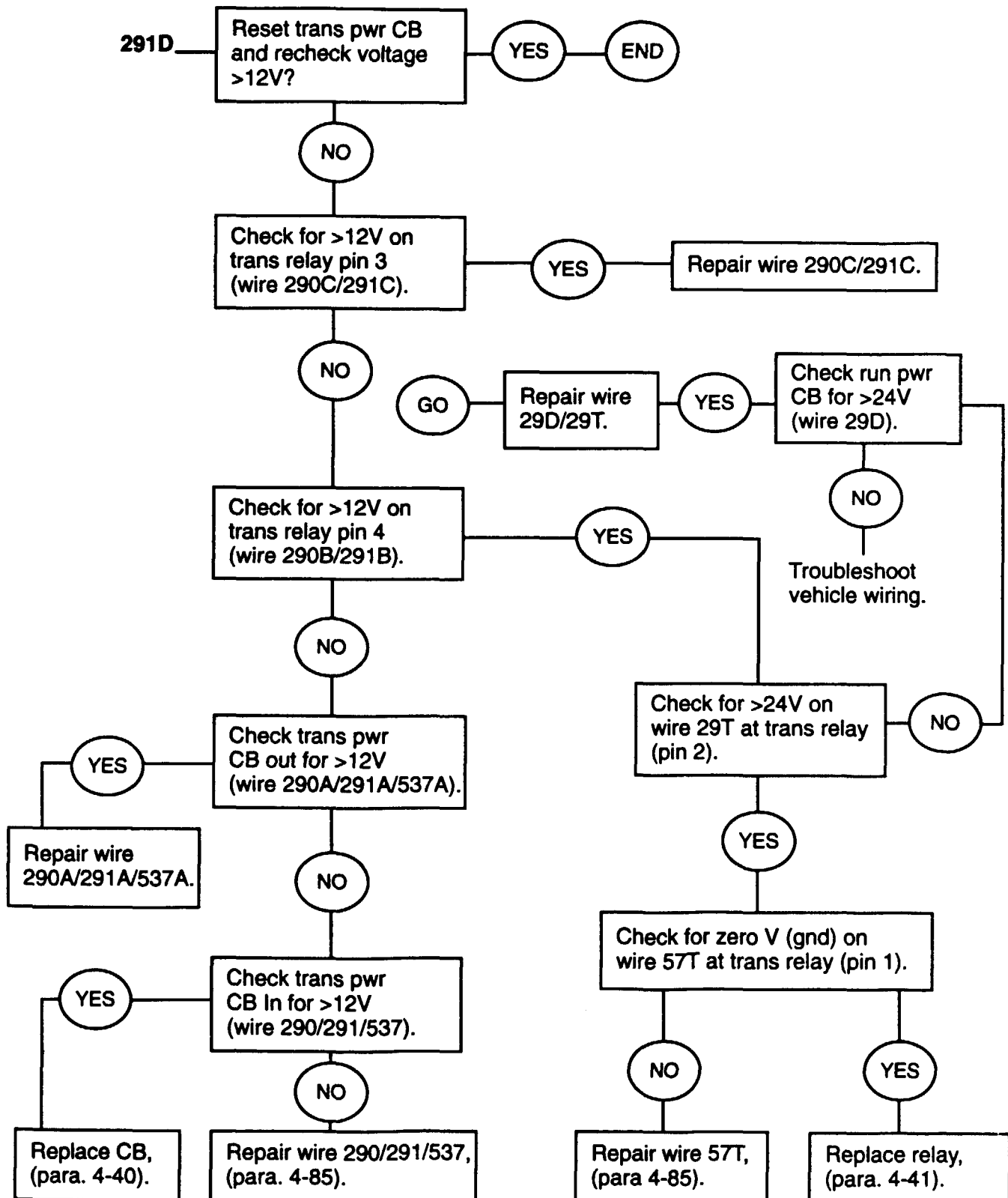
No Go to pg 2-443

Upon completion of J1 cable diagnostics, operate the vehicle and recheck for codes to insure codes have cleared. If codes have not cleared, refer to DS Maintenance.

**TRANSMISSION SYSTEM  
(4L80-E)**

**DIAGNOSTIC FLOWCHART**

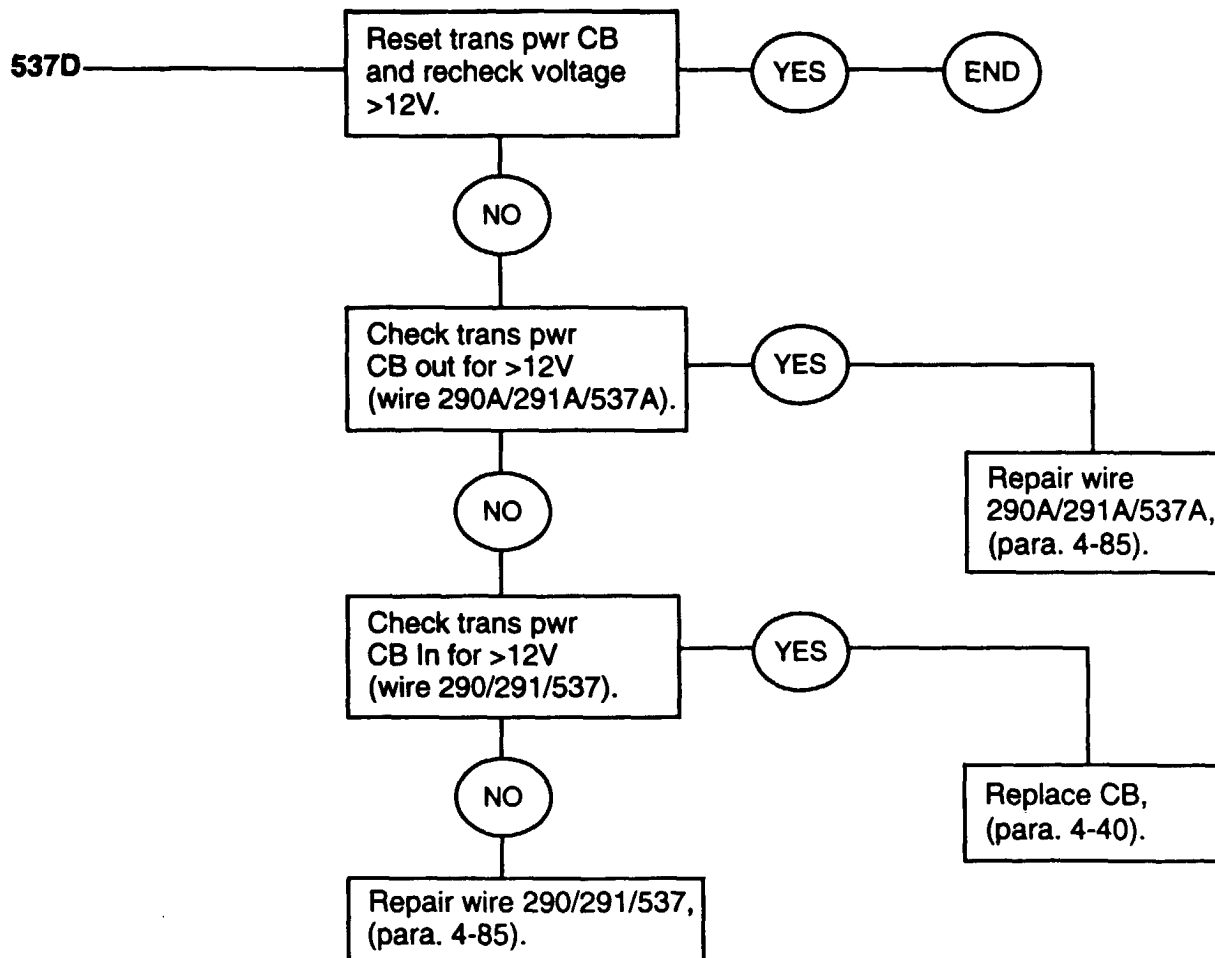
**IGN POWER CIRCUIT**



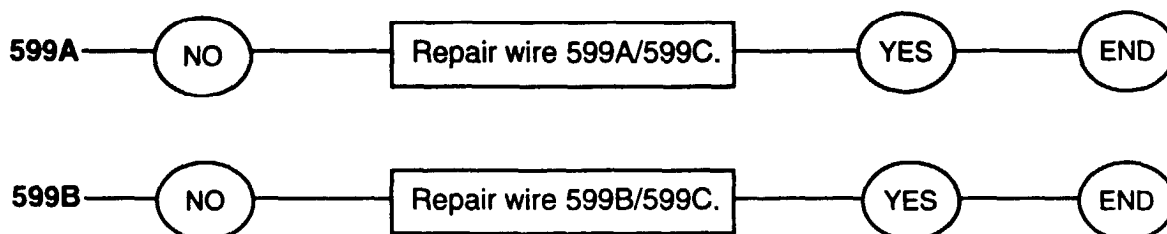
# DIAGNOSTIC FLOWCHART

## TRANSMISSION SYSTEM (4L80-E)

### BATTERY CIRCUIT



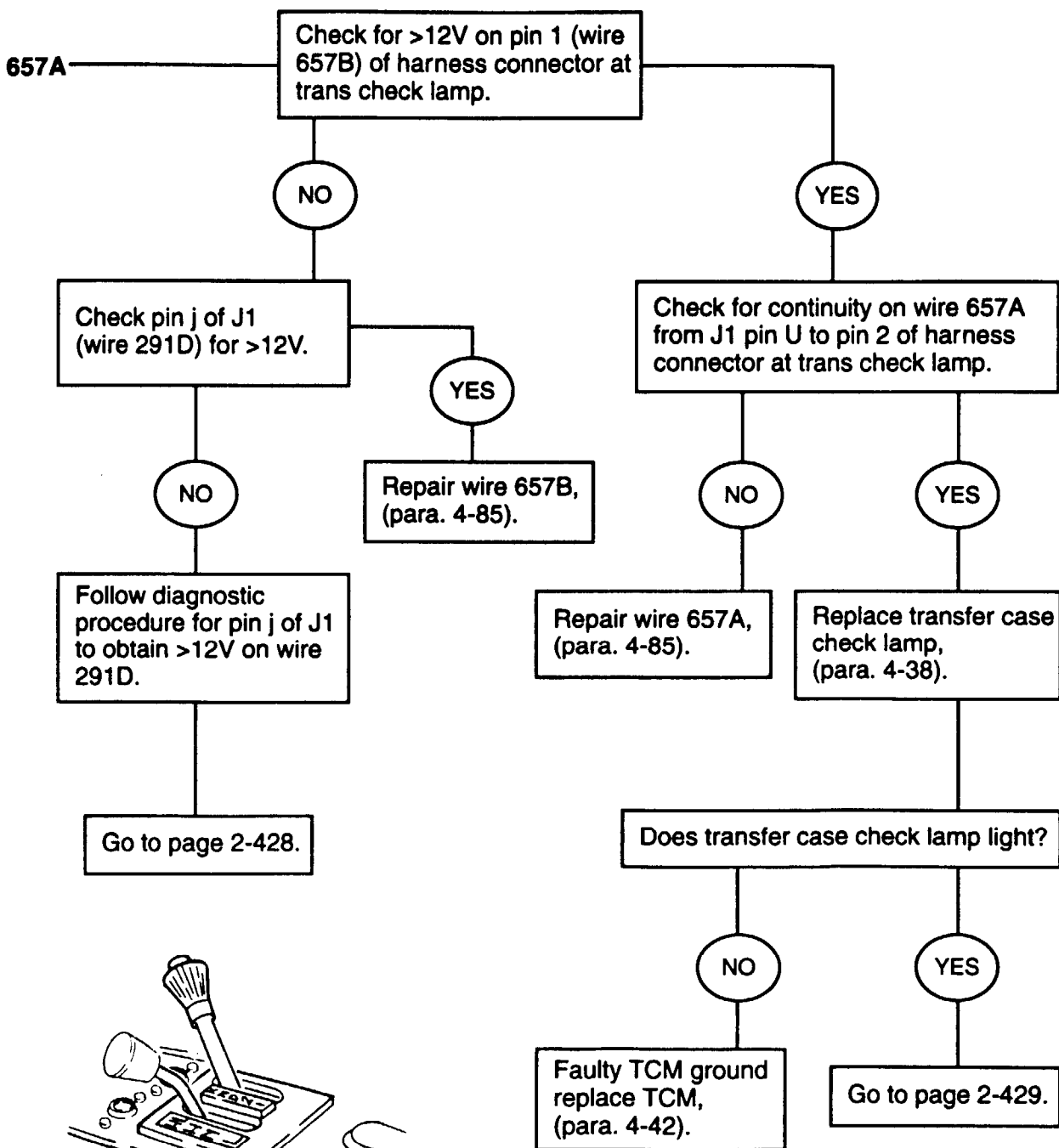
### VEHICLE GROUND CIRCUIT



# TRANSMISSION SYSTEM (4L80-E)

## DIAGNOSTIC FLOWCHART

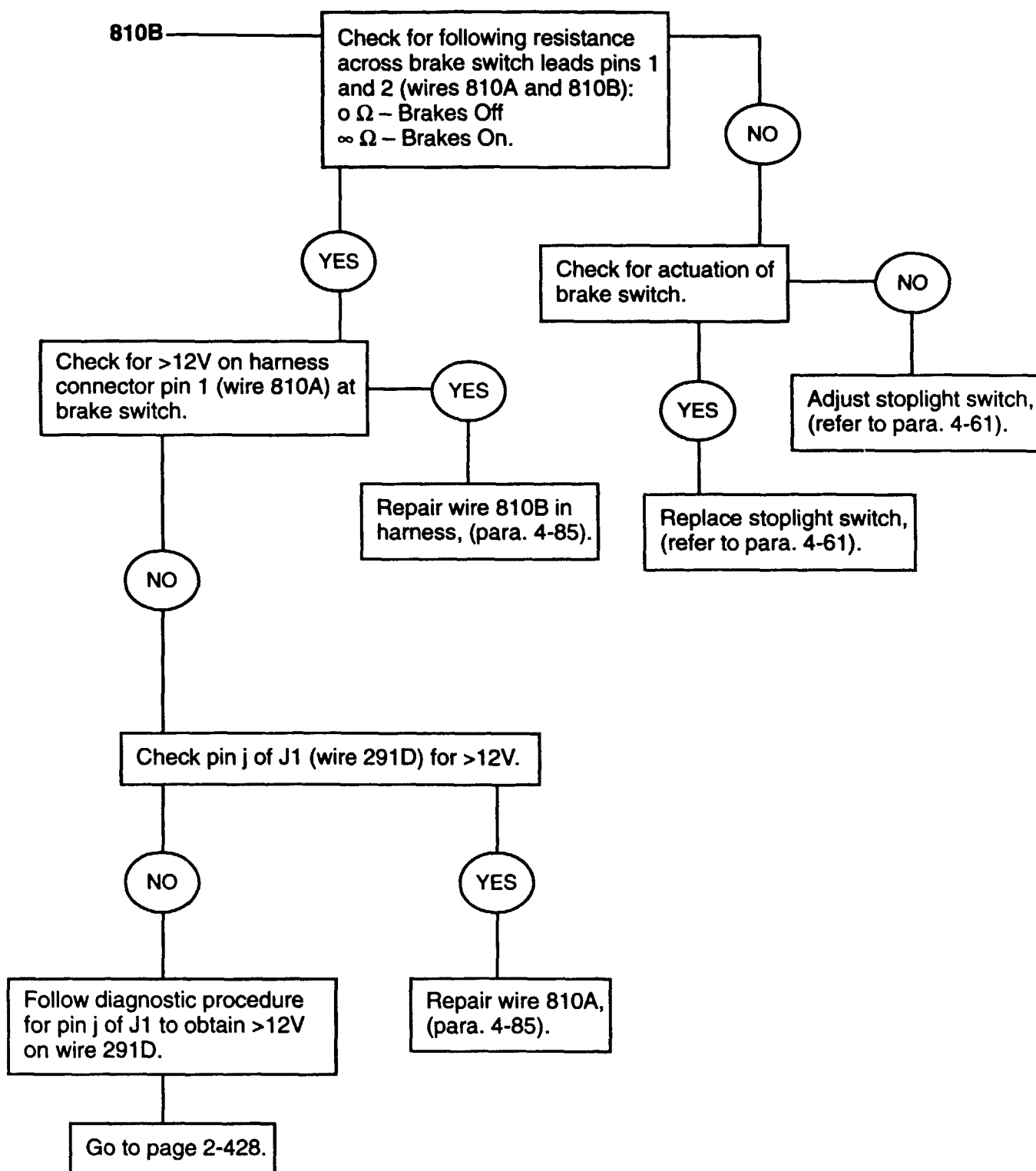
### TRANSMISSION LIGHT CIRCUIT



## DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM  
(4L80-E)

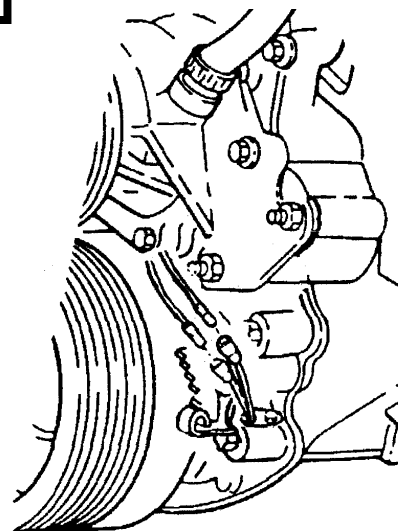
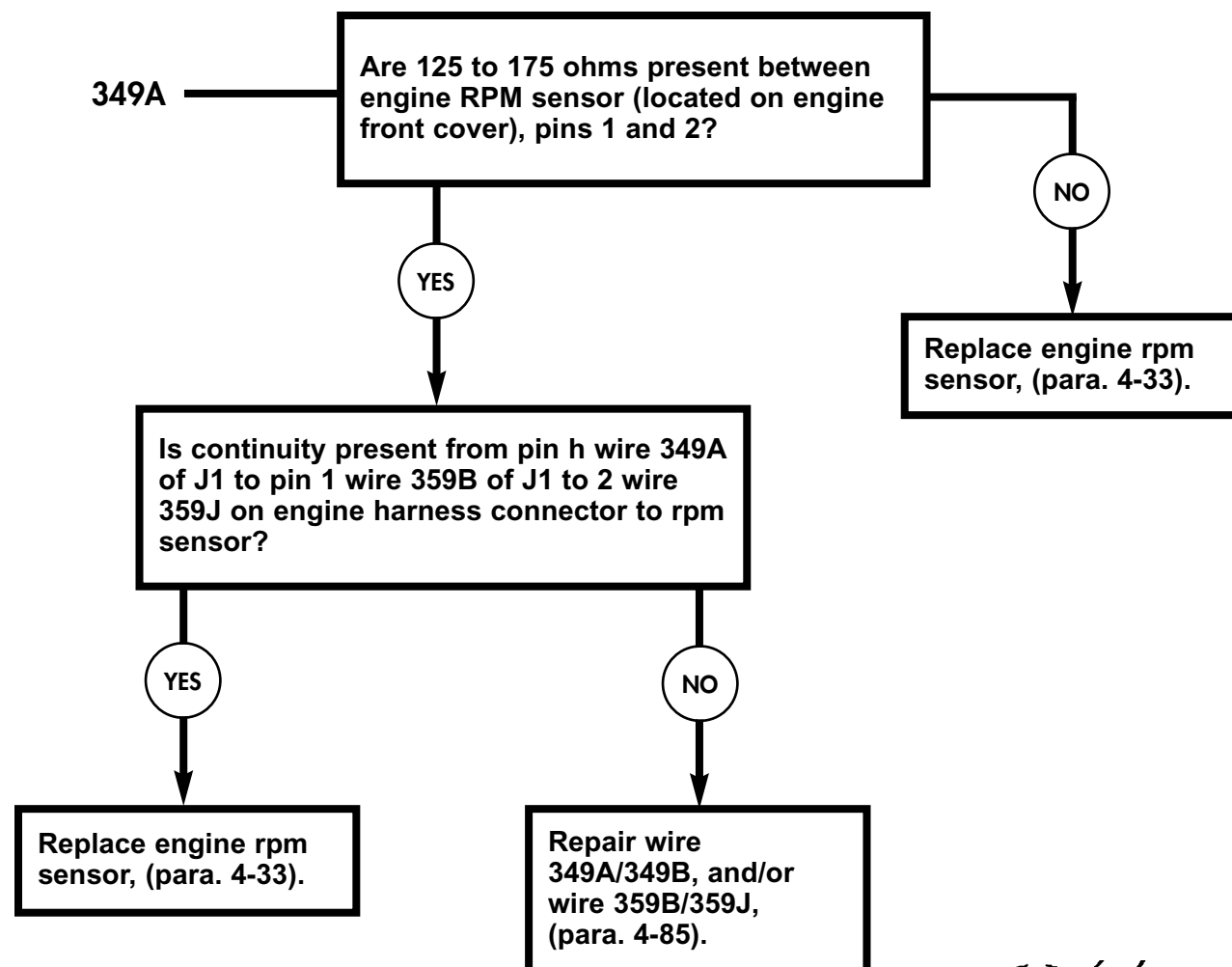
## BRAKE SWITCH CIRCUIT

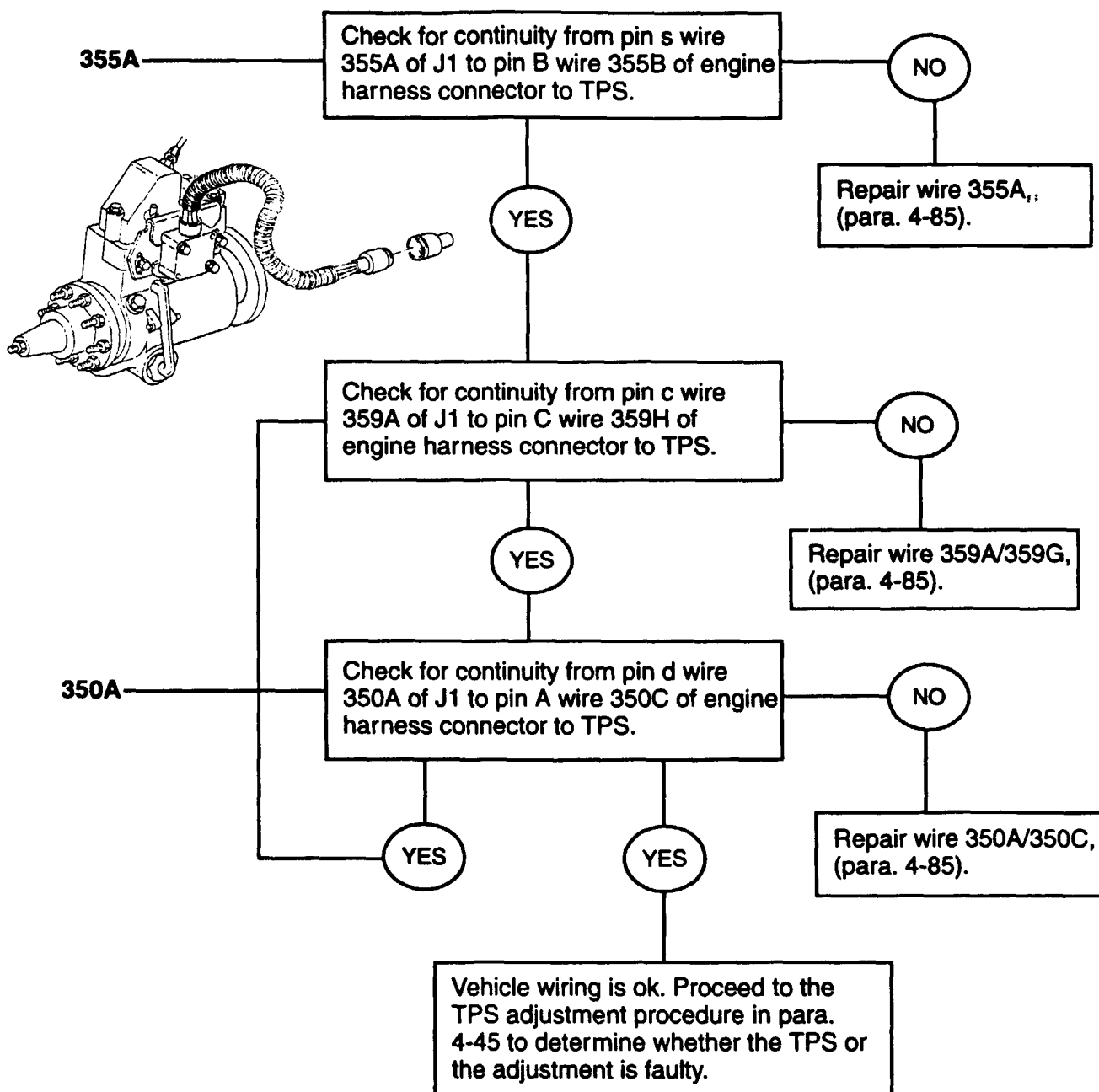


**TRANSMISSION SYSTEM  
(4L80-E)**

**ENGINE RPM SENSOR**

**DIAGNOSTIC FLOWCHART**



**DIAGNOSTIC FLOWCHART****TRANSMISSION SYSTEM  
(4L80-E)****THROTTLE POSITION SENSOR  
CIRCUIT**

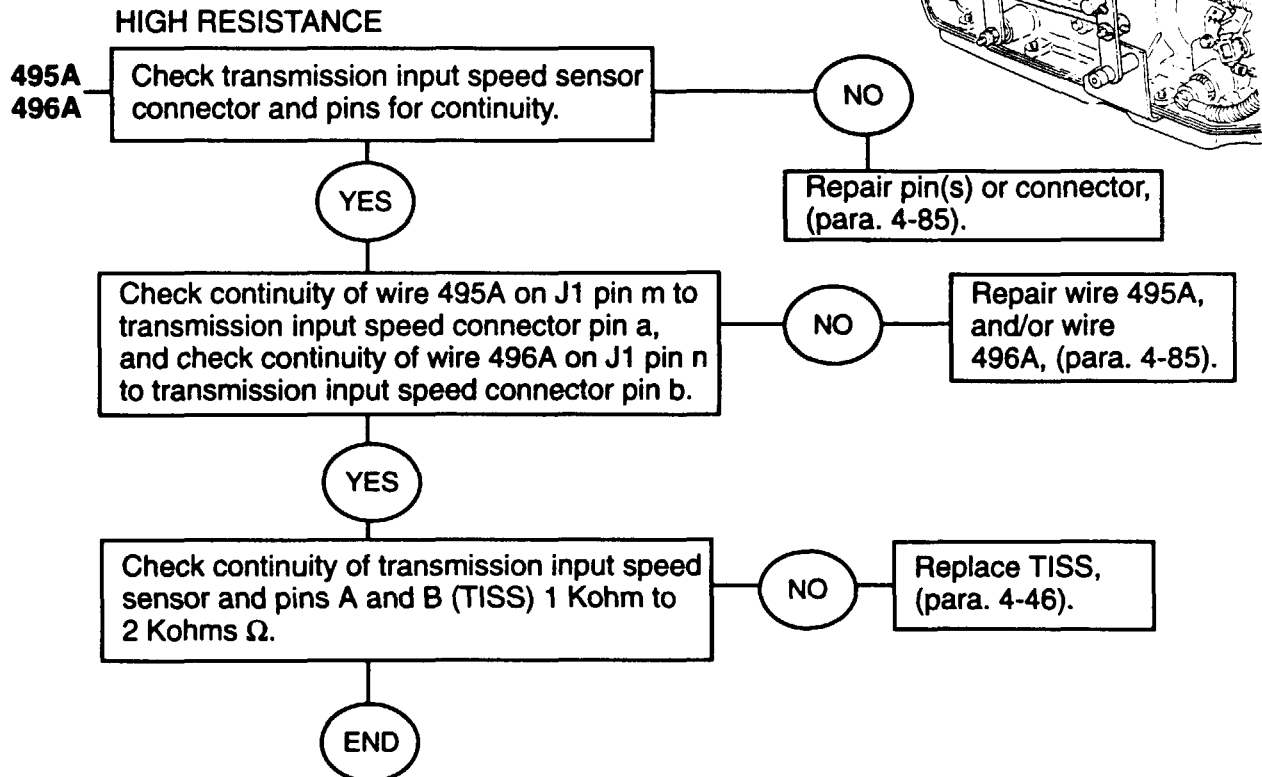
# TRANSMISSION SYSTEM (4L80-E)

## DIAGNOSTIC FLOWCHART

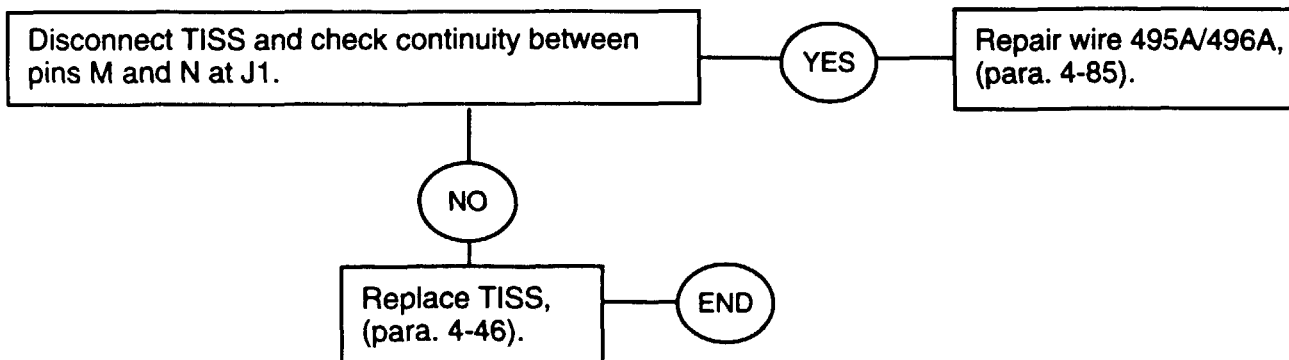
### TRANSMISSION INPUT SPEED SENSOR (TISS) CIRCUIT

#### NOTE

If reading from J1 diagnostics chart is greater than 2, perform high resistance - less than 1 perform low resistance.



### LOW RESISTANCE

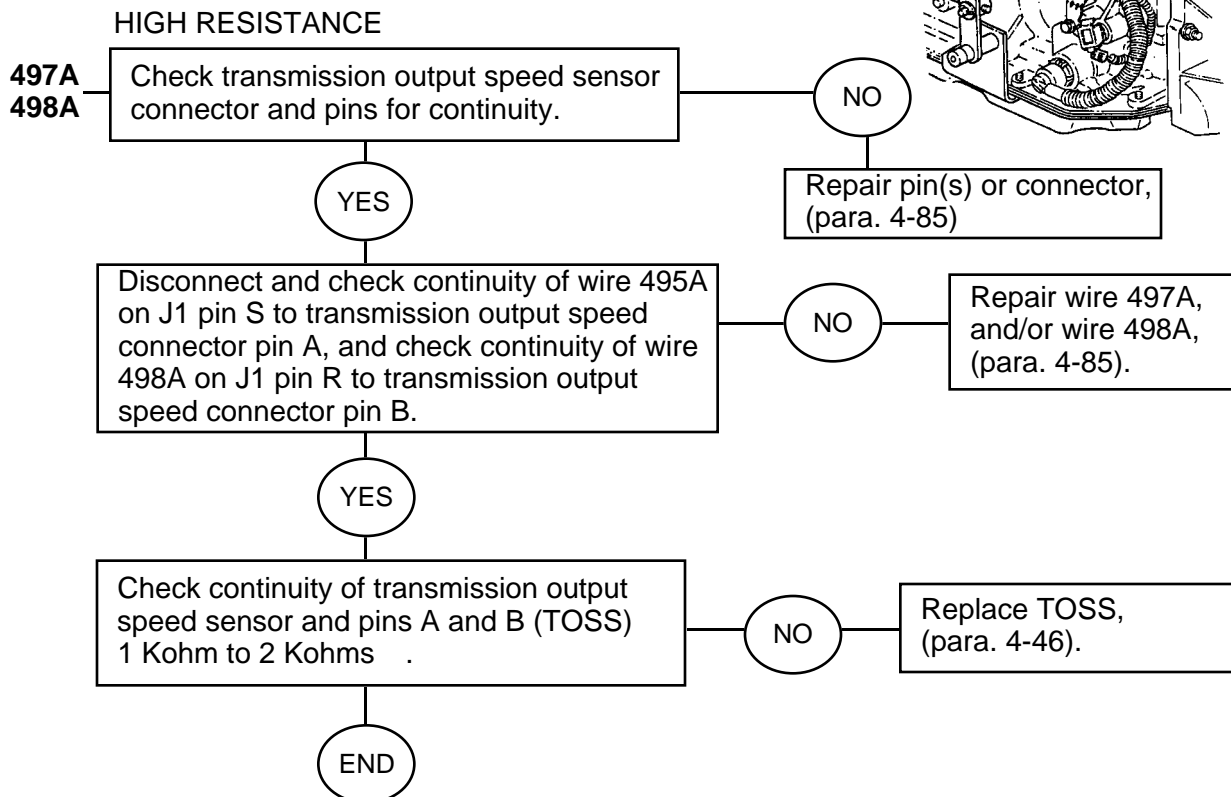
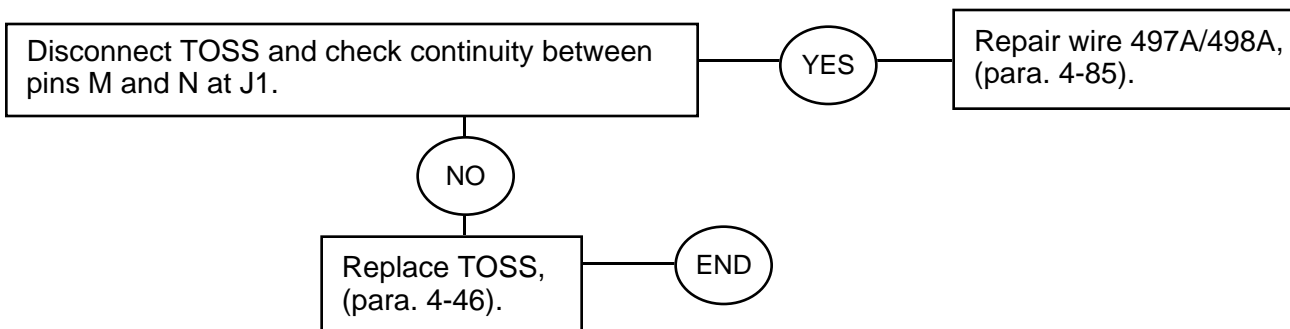




## DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM  
(4L80-E)TRANSMISSION OUTPUT SPEED  
SENSOR (TOSS) CIRCUIT**NOTE**

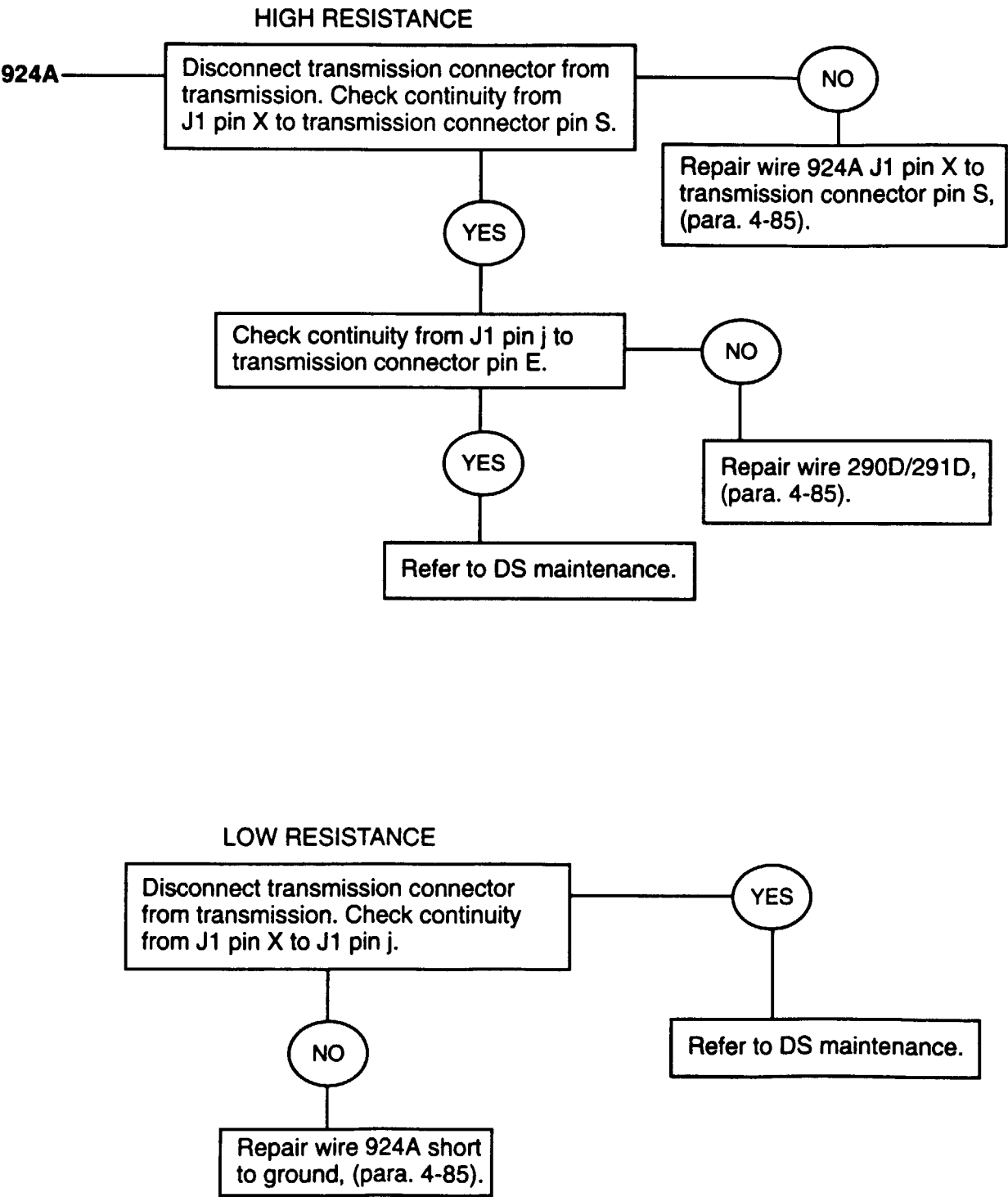
If reading from J1 diagnostics chart is greater than 2, perform high resistance - less than 1 perform low resistance.

**LOW RESISTANCE**

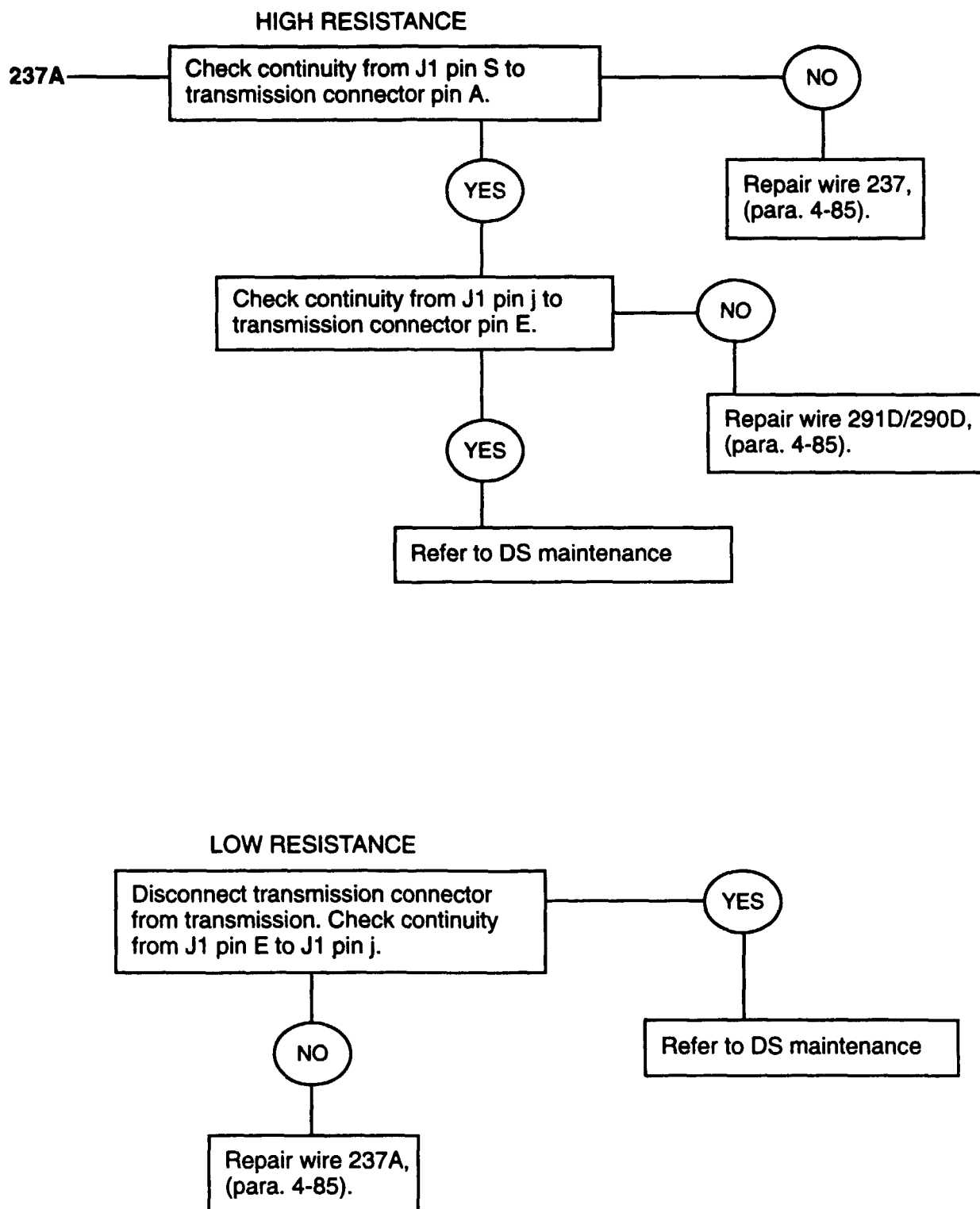
TRANSMISSION SYSTEM  
(4L80-E)

TORQUE CONVERTER CLUTCH  
SOLENOID CIRCUIT

DIAGNOSTIC FLOWCHART



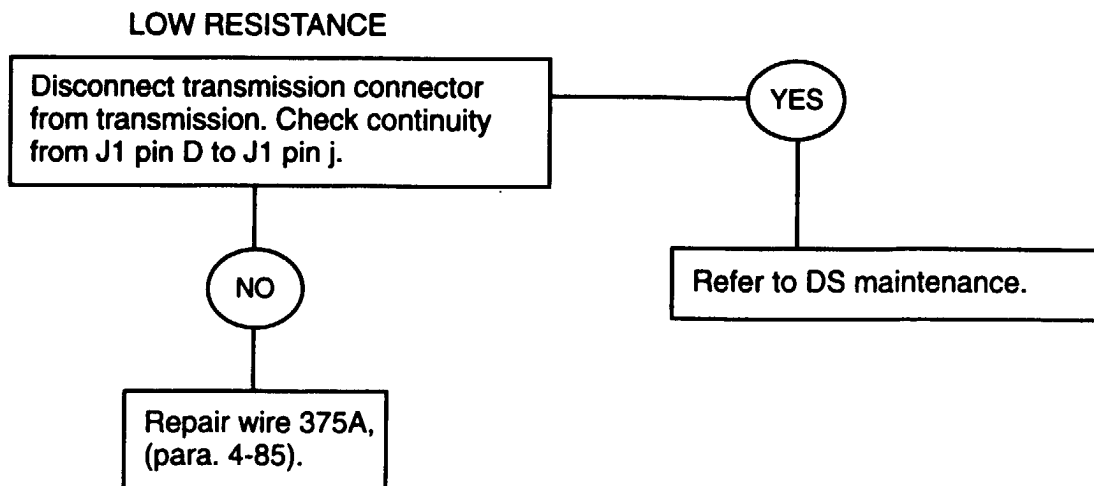
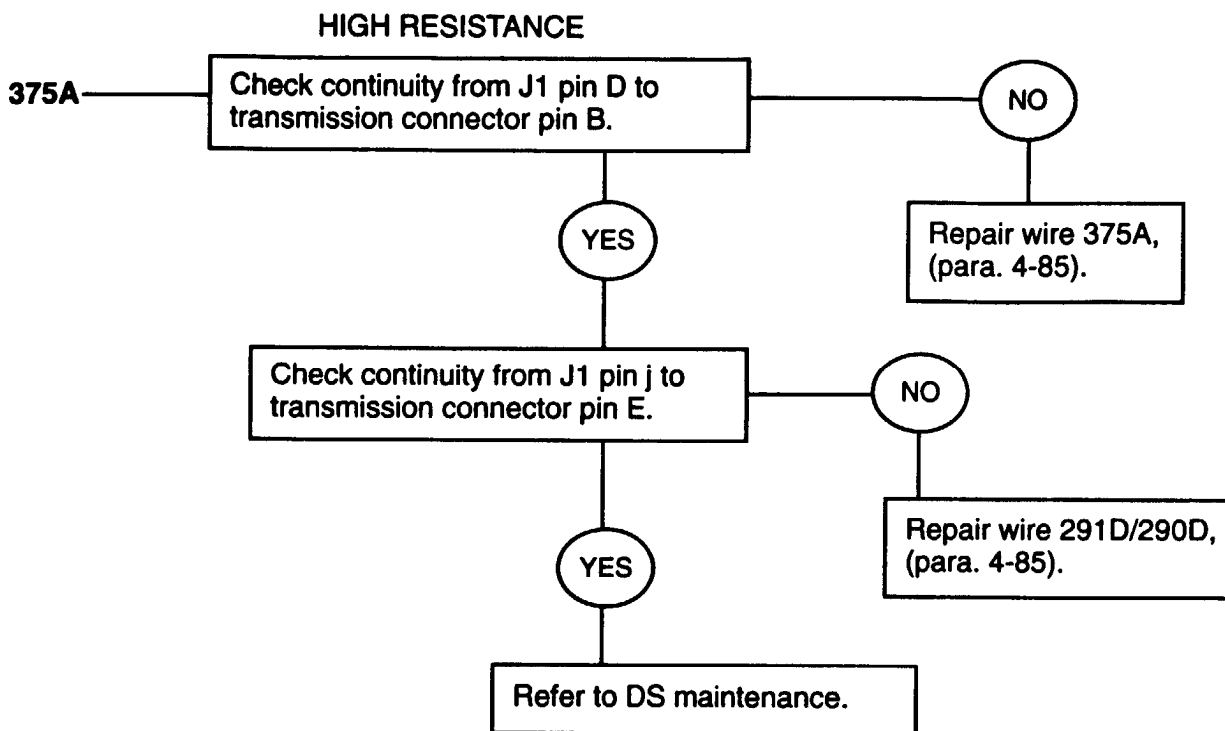
## DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM  
(4L80-E)1-2 SHIFT SOLENOID CIRCUIT SHIFT  
SOLENOID A

# TRANSMISSION SYSTEM (4L80-E)

## 2-3 SHIFT SOLENOID CIRCUIT SHIFT SOLENOID B

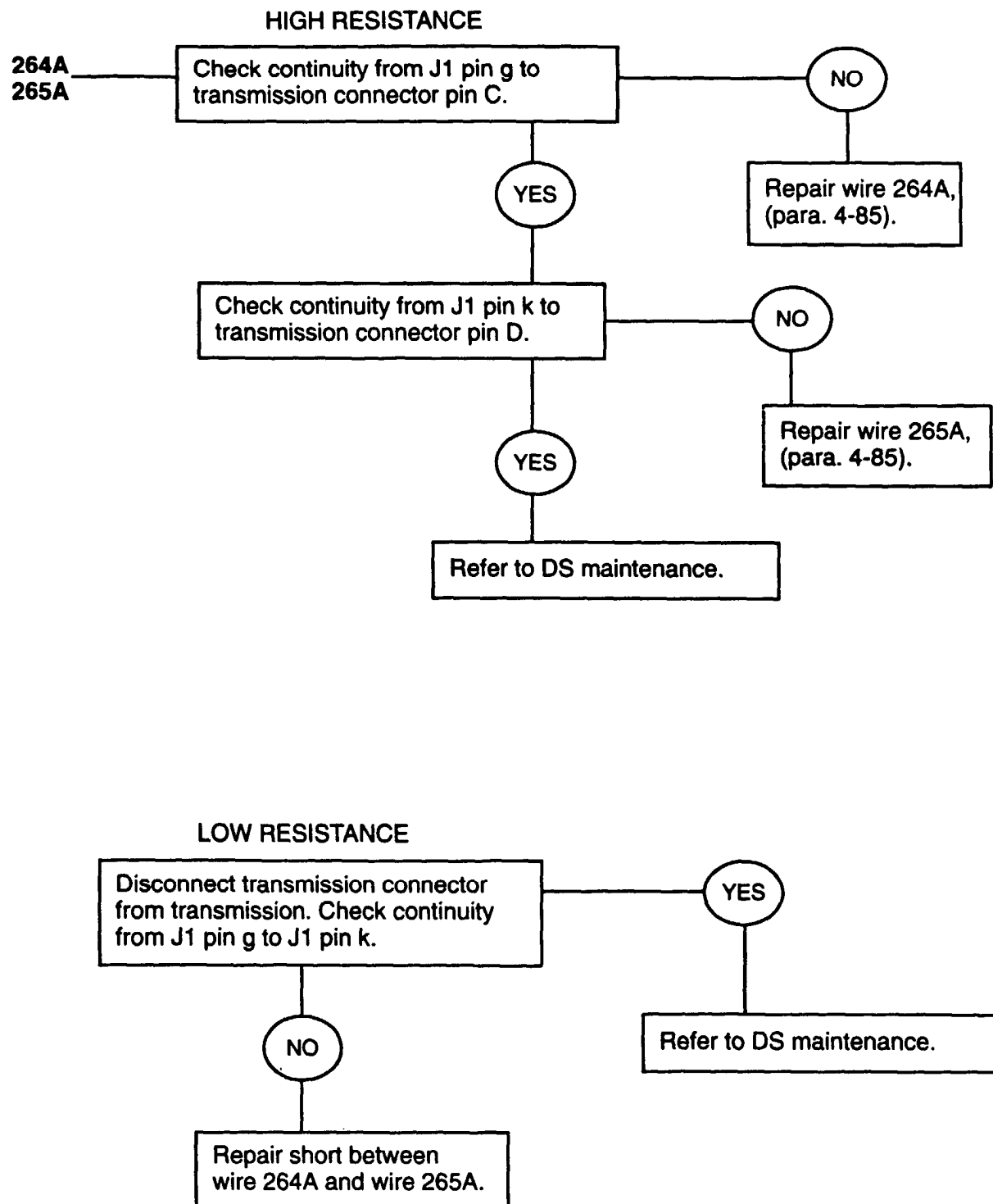
## DIAGNOSTIC FLOWCHART



# DIAGNOSTIC FLOWCHART

## TRANSMISSION SYSTEM (4L80-E)

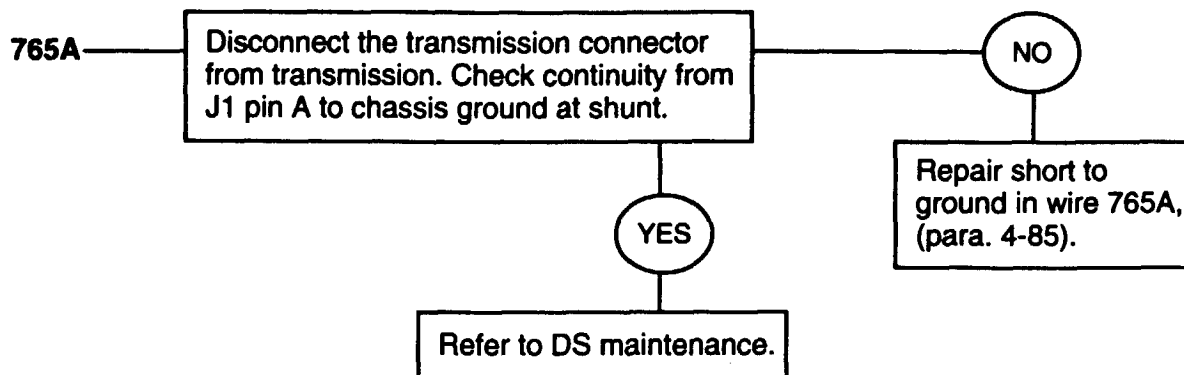
### PRESSURE CONTROL SOLENOID CIRCUIT FORCE MOTOR HIGH



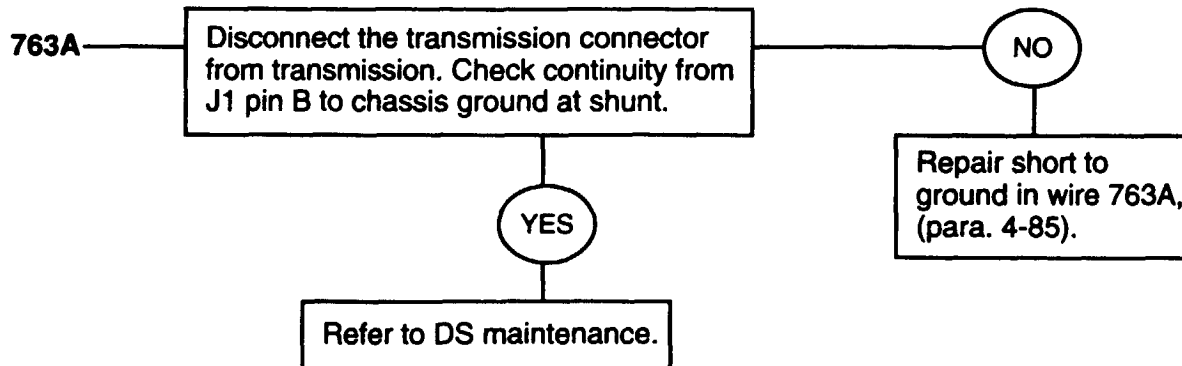
# TRANSMISSION SYSTEM (4L80-E)

## DIAGNOSTIC FLOWCHART

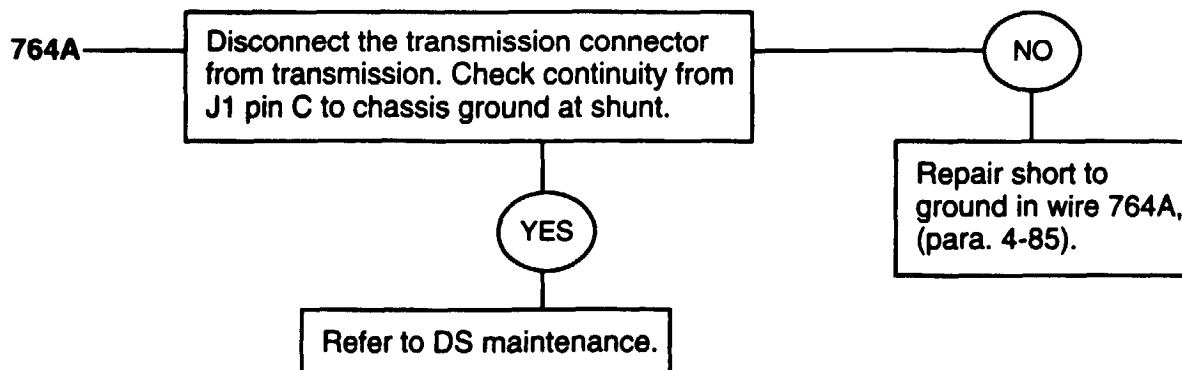
### TRANSMISSION RANGE PRESSURE SWITCH, CIRCUIT PRESSURE SWITCH A



### TRANSMISSION RANGE PRESSURE SWITCH, CIRCUIT PRESSURE SWITCH B



### TRANSMISSION RANGE PRESSURE SWITCH, CIRCUIT PRESSURE SWITCH C



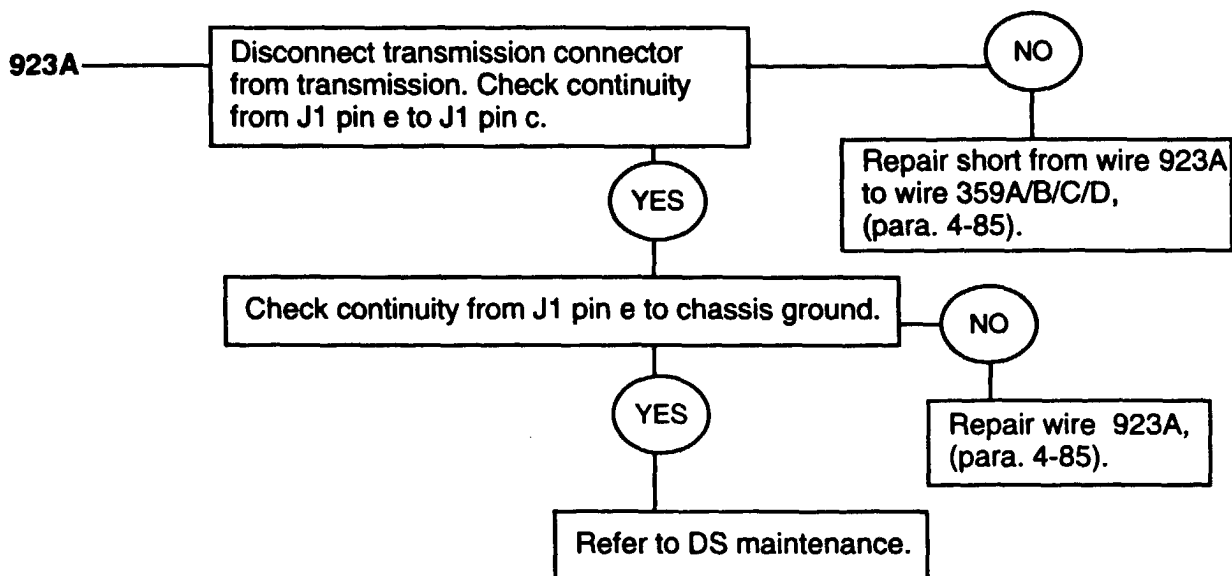
## DIAGNOSTIC FLOWCHART

TRANSMISSION SYSTEM  
(4L80-E)

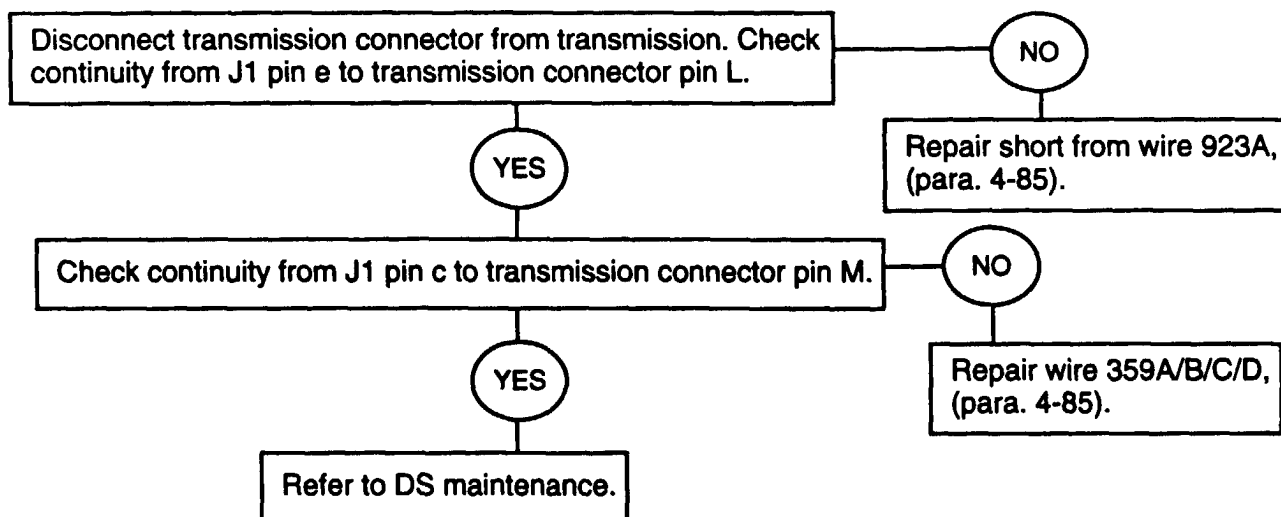
## TRANSMISSION TEMPERATURE SENSOR

The transmission temperature sensor is a thermistor. The resistance decreases as the temperature increases at 68°F (20°C) the resistance should be from 2980 to 4020 ohms, at 248°F (120°C) the resistance should be 90 to 111 ohms.

## RESISTANCE TOO LOW



## RESISTANCE TOO HIGH



**2-36. BRAKE SYSTEM TESTS**

These Brake System tests may be run any time you think you have a braking problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

Fold-out page FO-13 may be left open for reference while testing.

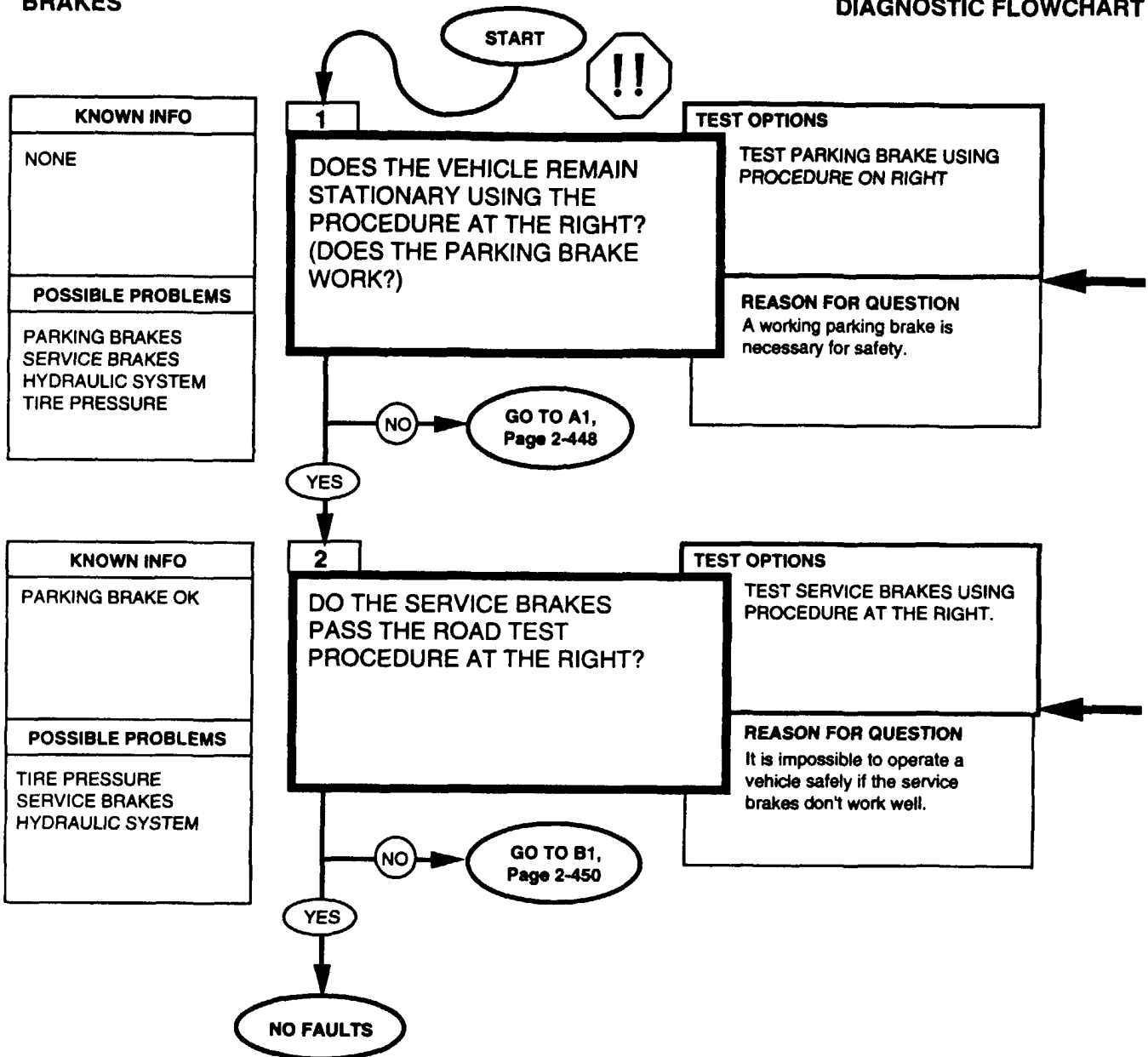
**NOTE**

- The brake lights and the parking brake warning lamp are not diagnosed here. If you are having trouble with these parts, and you are sure the brakes are OK, go to Instruments, Page 2-319, for the warning lamp, or Lights, Page 2-389, for the brake lights.
- When parking brake handle is pulled, the parking brake is applied to the left and right rear service brake rotors.



# BRAKES

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## BRAKES

**WARNING**

Make sure the area is clear of personnel and obstacles prior to performing this test. Failure to do so may result in serious injury.

**PARKING BRAKE TEST PROCEDURE:**

1. Depress service brake pedal and start engine.
2. Place transmission shift lever in D (drive) and transfer case shift lever in H (high).
3. Apply parking brake. Slowly let up on service brake pedal. Vehicle should remain stationary.

**SERVICE BRAKE ROAD TEST PROCEDURE:**

1. On an open, smooth, flat surface, accelerate to a steady, reasonable, safe speed (below posted limits).
2. Apply pressure on the brake pedal and bring the vehicle to a stop.
3. Repeat this procedure several times, applying a different brake pressure each time. Look for the following symptoms, which may indicate a problem with the service brakes:
  - 1) Spongy or pulsating brake pedal,
  - 2) Incomplete brake pedal return,
  - 3) Excessive pull to one side,
  - 4) Unusually long braking distance,
  - 5) Rear wheels lock-up before front wheels,
  - 6) Brake warning light comes on while braking, and
  - 7) A squealing, grinding, or chattering noise while braking.

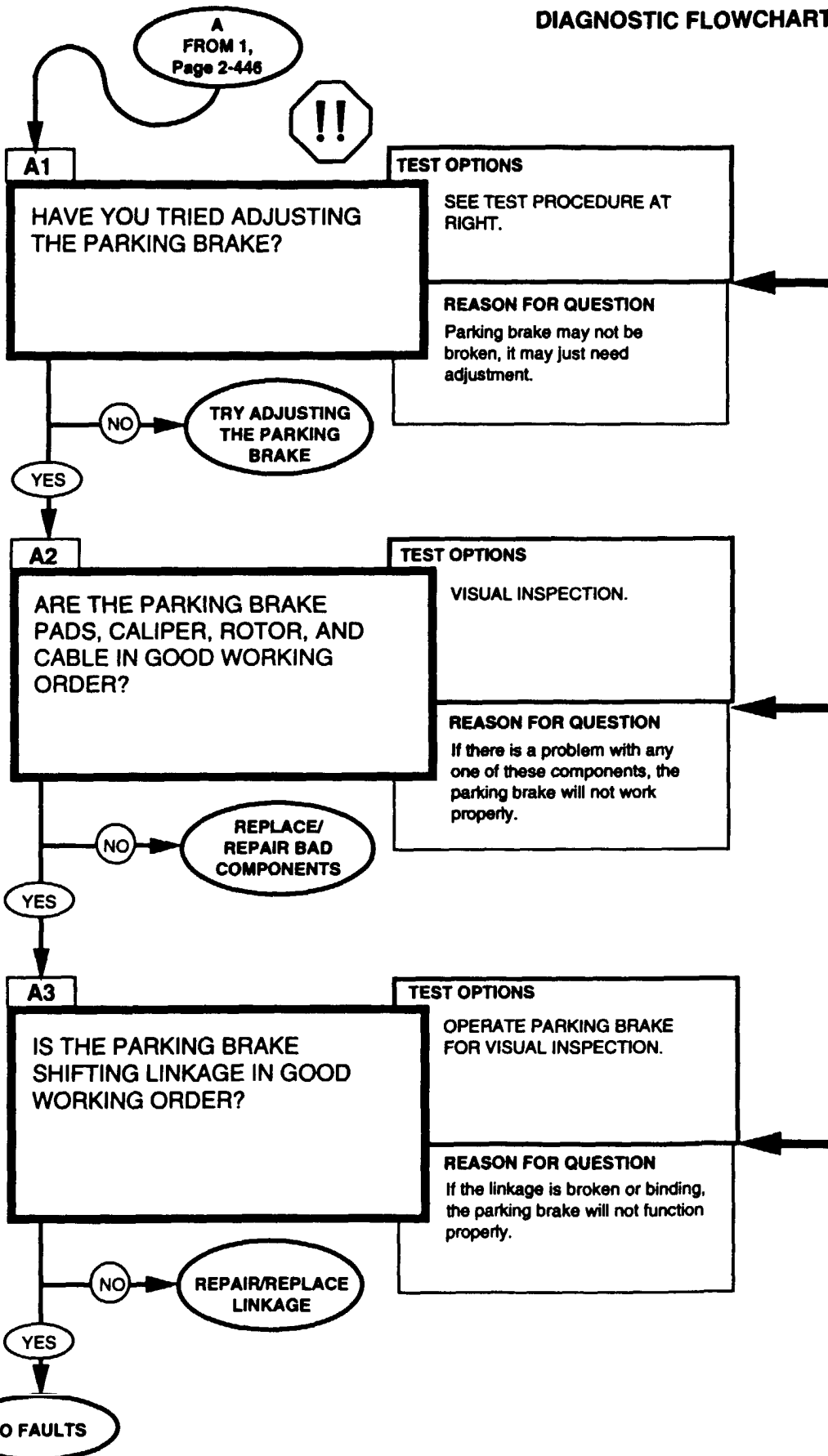
# BRAKES

## DIAGNOSTIC FLOWCHART

KNOWN INFO
PARKING BRAKE INOPERATIVE
POSSIBLE PROBLEMS
PADS CALIPER ROTOR CABLE BRAKE LEVER

KNOWN INFO
PARKING BRAKE INOPERATIVE
POSSIBLE PROBLEMS
PADS CALIPER ROTOR CABLE BRAKE LEVER

KNOWN INFO
PARKING BRAKE INOPERATIVE PADS OK CALIPER OK ROTOR OK CABLE OK
POSSIBLE PROBLEMS
PARKING BRAKE LEVER AND LINKAGE



## REFERENCE INFORMATION

## BRAKES

**PARKING BRAKE ADJUSTMENT:**

- A. Chock wheels and release parking brake handle.
- B. Turn adjusting knob at the tip of the brake handle clockwise as tight as possible by hand.
- C. Apply parking brake handle.
- D. If parking brake cannot be applied, turn adjusting knob counterclockwise until parking brake can be applied.
- E. Test parking brake.

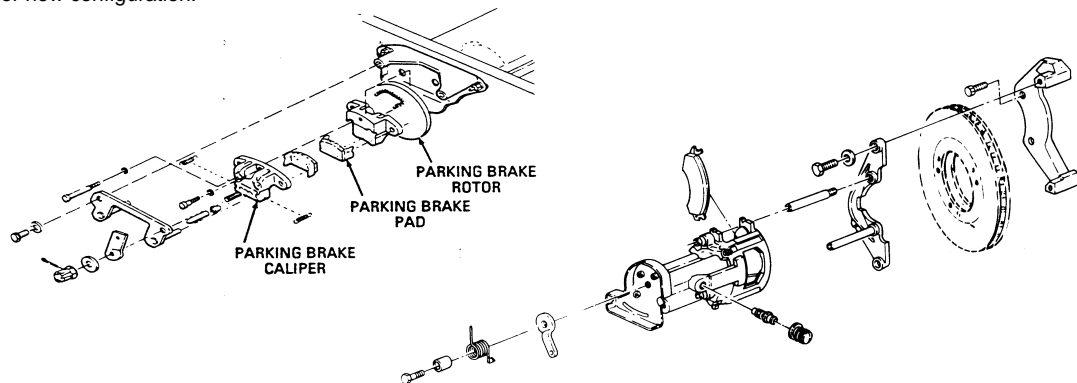
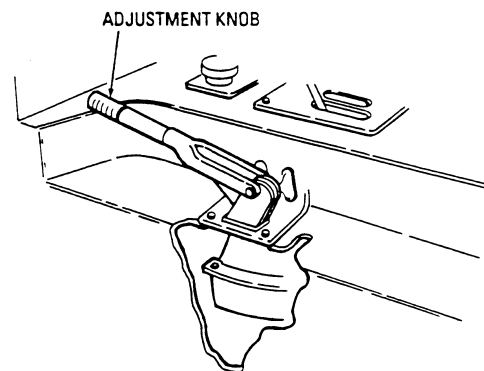
**WARNING**

Make sure the area is clear of personnel and obstacles prior to performing this test. Failure to do so may result in serious injury.

- (1) Remove chocks.
- (2) Depress service brake pedal and start engine.
- (3) Place transmission shift lever in drive and transfer case shift lever in high.
- (4) Apply parking brake and slowly let up on service brake pedal. Vehicle should remain stationary.

Replace or repair parts, refer to (para. 7-3) for old configuration.

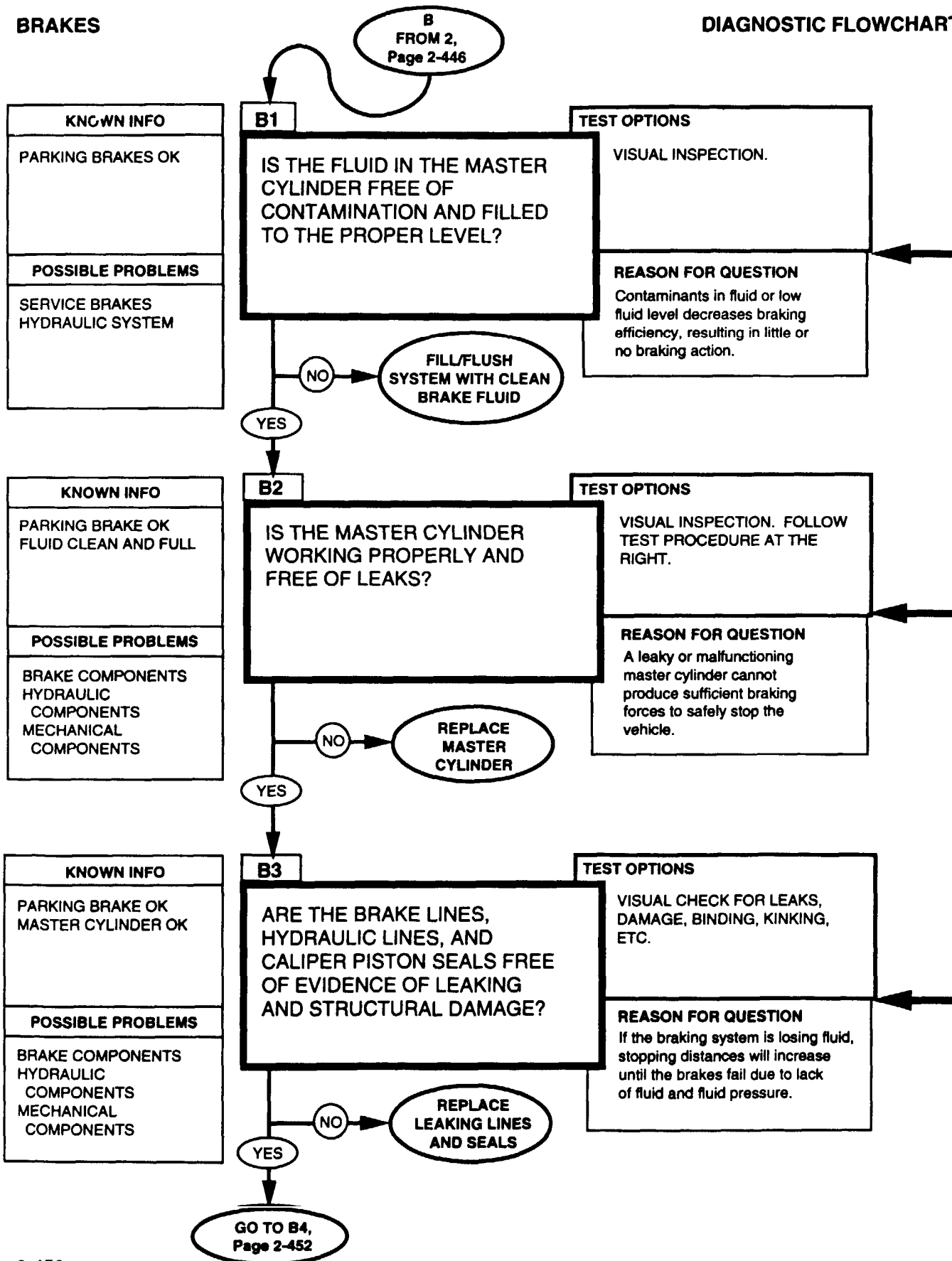
Replace or repair parts, refer to (para 7-20) for new configuration.



Repair or replace linkage, refer to (paras. 7-5, 7-23, and 7-24).

# BRAKES

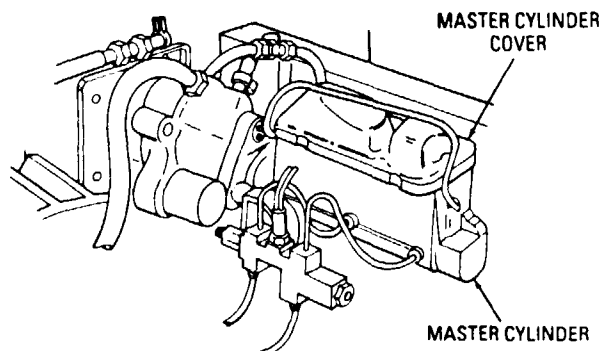
## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## BRAKES

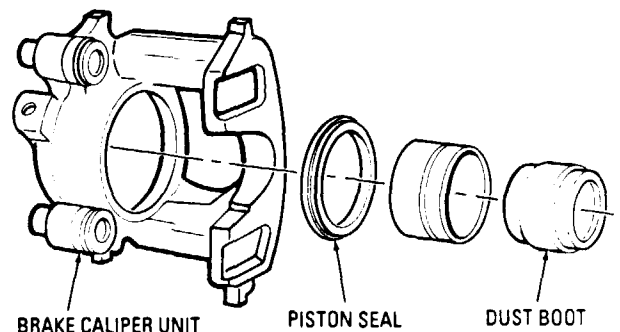
Flush and bleed the brake system, refer to (para 7-10).



Master cylinder test procedure:

1. With the engine off, pump the brake pedal six or seven times, or until the pedal becomes noticeably stiffer and harder to depress.
2. Press hard on the brake pedal. If the pedal keeps going down to the floor, either the master cylinder is bad, or there is a leak in the hydraulic system.

Replace master cylinder, refer to (para 7-13).



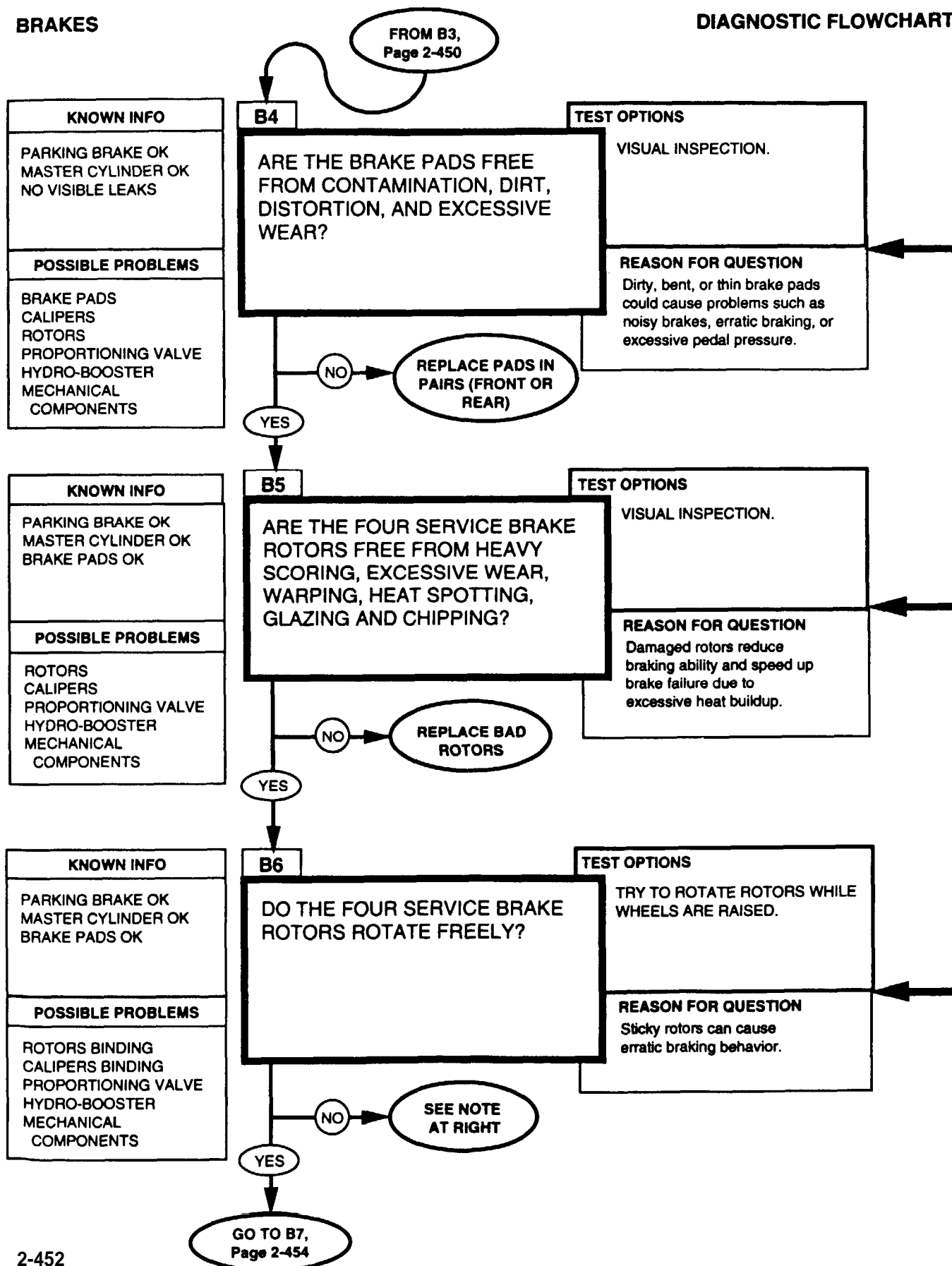
Check the individual lines going to each brake. Check the supply and return lines to the hydro-boost unit. Replace brake line, refer to (para 7-15).

**NOTE**

Brake hydraulic system must be bled of air whenever hydraulic lines are broken. Bleed service brake, refer to (para 7-10).

# BRAKES

## DIAGNOSTIC FLOWCHART



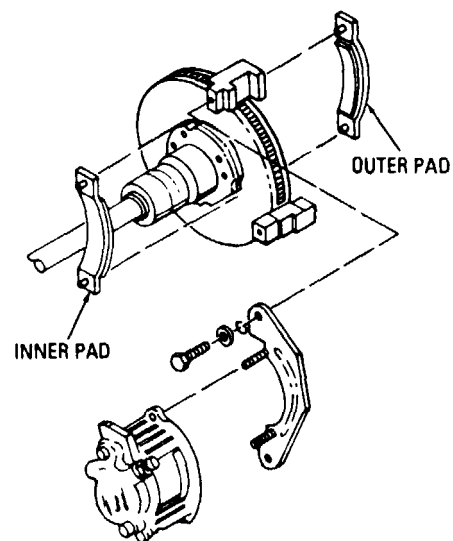
## REFERENCE INFORMATION

## BRAKES

Replace brake pad, refer to (para 7-11).

**NOTE**

The minimum brake pad thickness is 1/8 of an inch (3.2mm).



Replace service brake rotor, refer to (para 7-1 9).

**NOTE**

The only way the rotors can be sticking is if the calipers are not releasing fully.

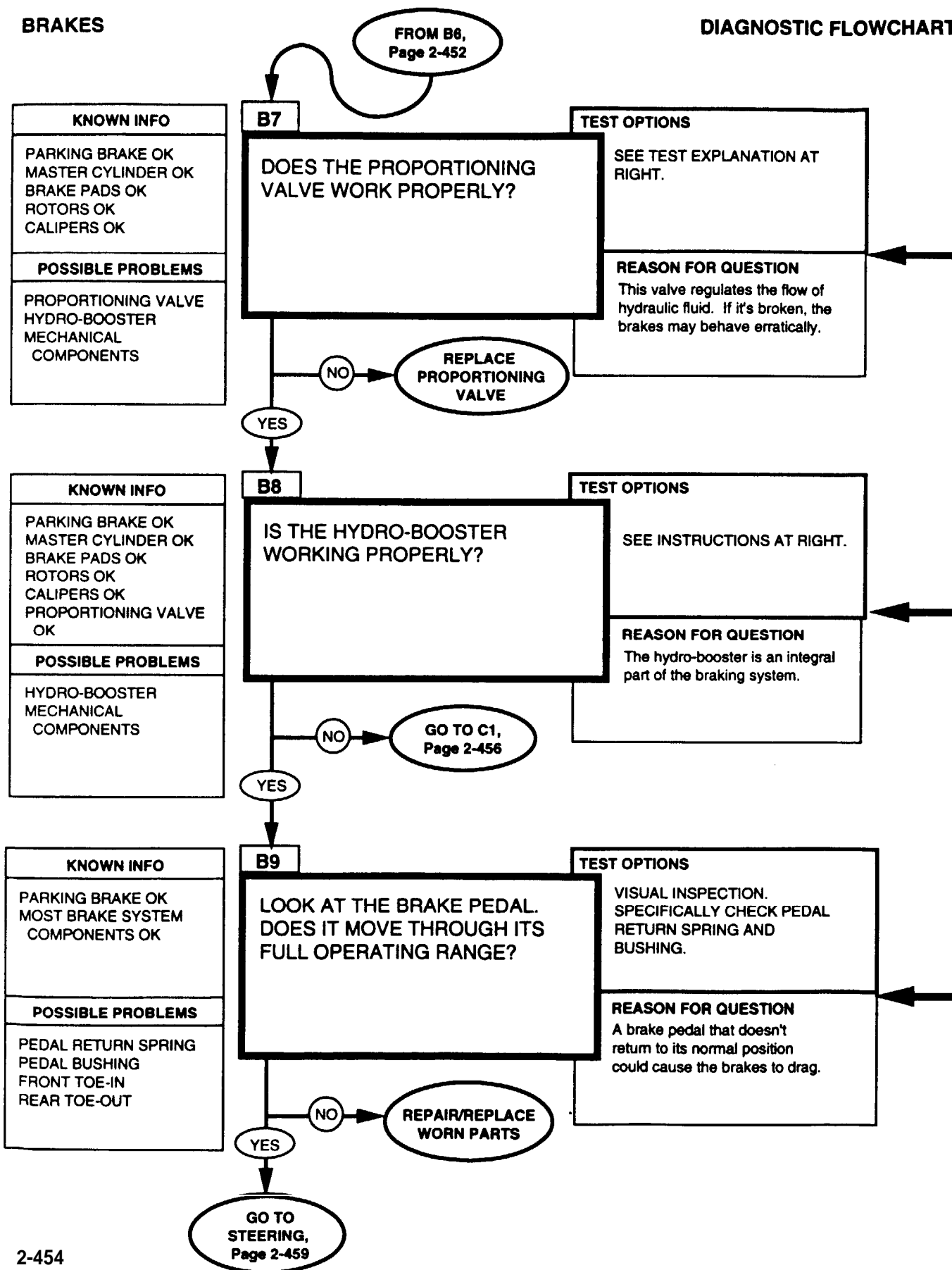
Remove calipers. clean and lubricate guide pins with grease.

Replace and clean brake caliper, refer to (para 7-12).



# BRAKES

## DIAGNOSTIC FLOWCHART



## 6"REFERENCE INFORMATION

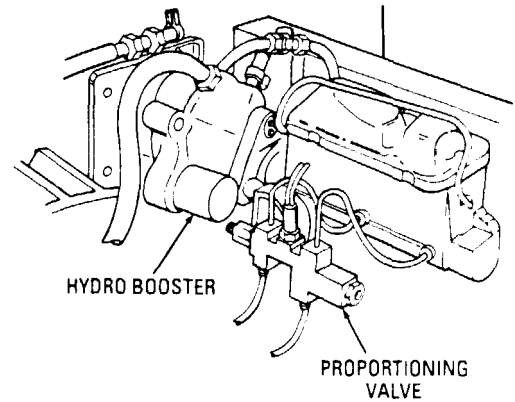
## BRAKES

Test for faulty proportioning valve:

Drive the vehicle and have an assistant observe during the performance of this test.

With vehicle at curb weight, decelerate vehicle from 46 to 40mph (72 to 69 kph) on dry concrete road and apply sufficient pressure to lockup front brakes. If rear brakes lock up before front brakes, then the proportioning valve should be replaced.

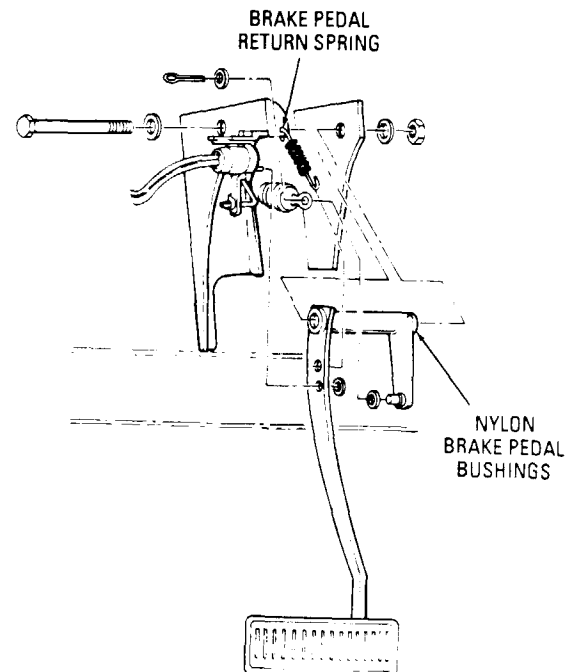
Replace proportioning valve, refer to (para 7-18).



Method for checking hydrobooster:

Depress brake pedal several times to exhaust accumulator pedal. Depress brake pedal and start engine. Brake pedal should fall, then push back against operators foot.

Replace hydro-booster, refer to (para 7-14).

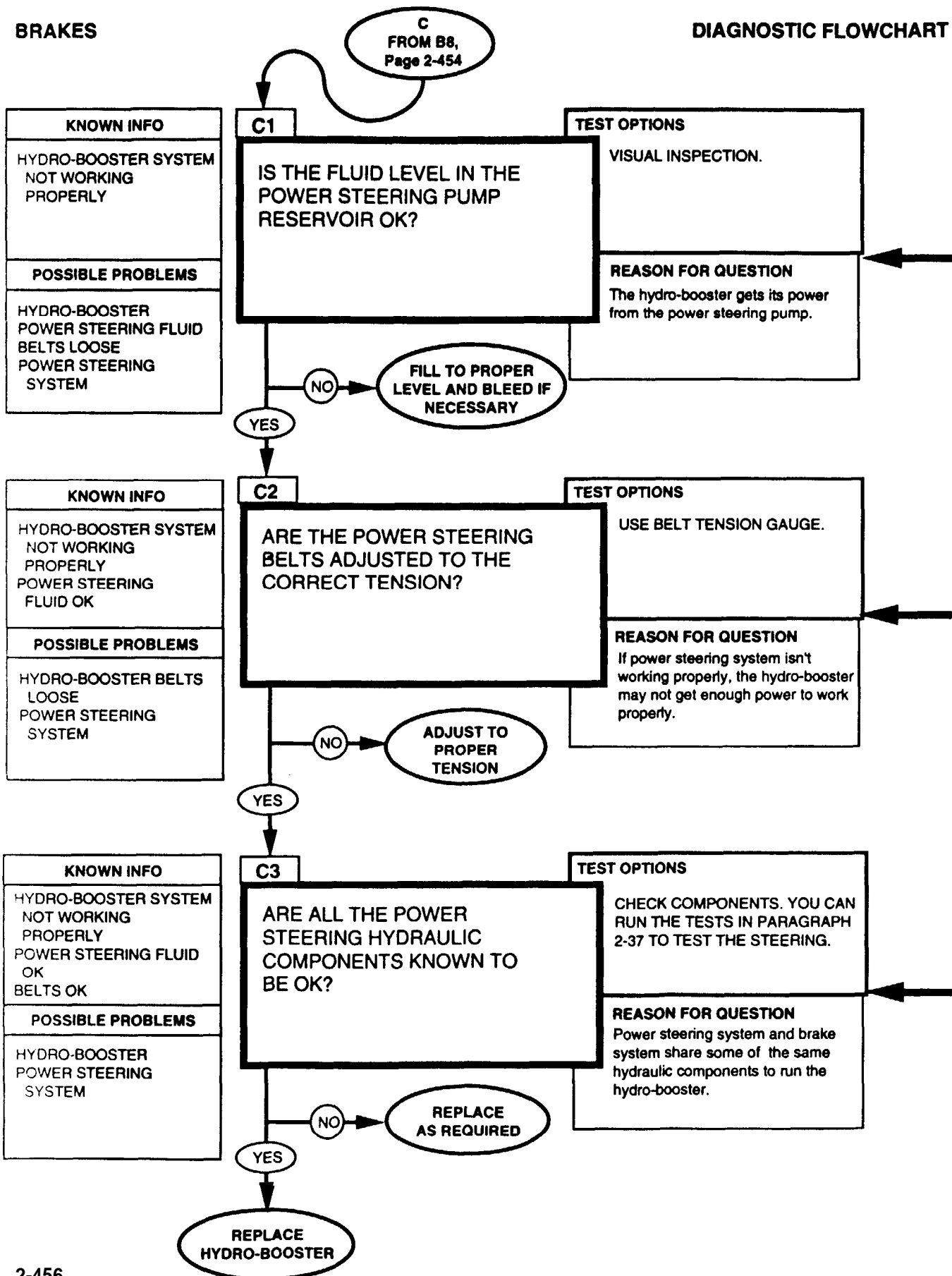


Replace service brake pedal, refer to (para 7-16).

The steering tests will check for suspension problems that will affect braking.

# BRAKES

## DIAGNOSTIC FLOWCHART



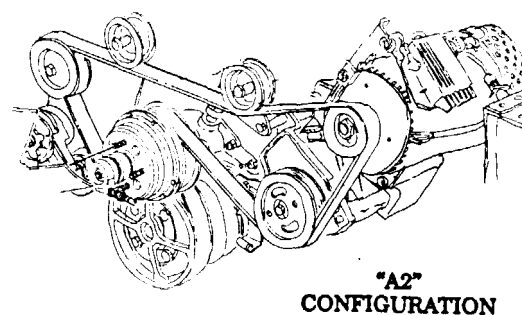
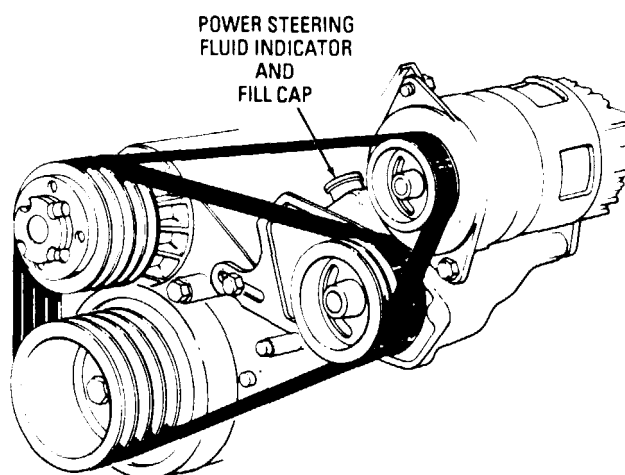
# REFERENCE INFORMATION

## BRAKES

Bleed power steering system, refer to (para 8-29).

Check belts using the belt tension gauge, refer to (pars 3-82) (All except "A2" vehicles).

A defective power steering pump, gear, hoses, or control valve could affect hydro-booster operation.



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## **2-37. STEERING SYSTEM TESTS**

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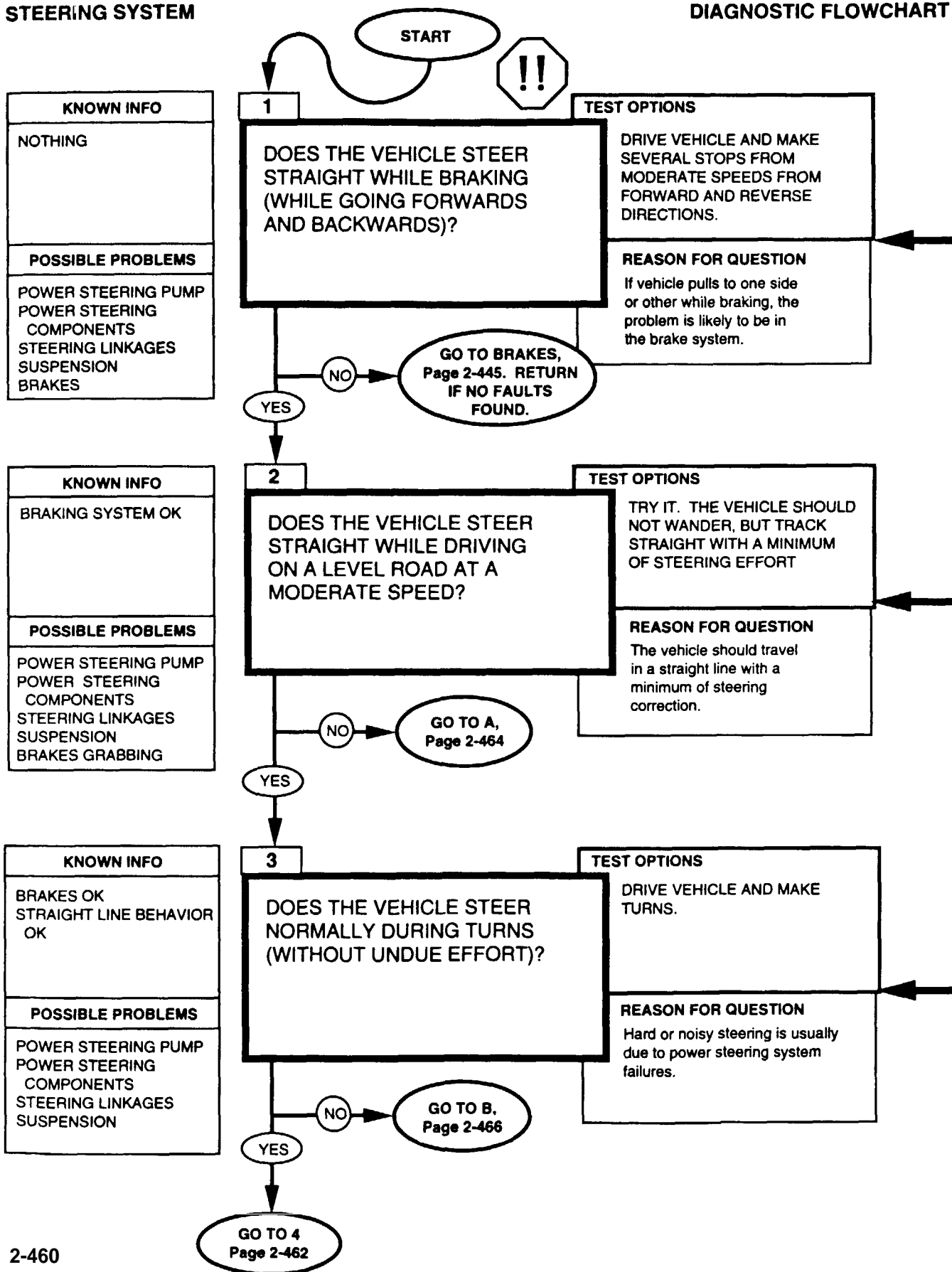
These Steering System tests may be run any time you have a steering problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The fold-out page shows the location of the major components of the steering in case you are not familiar with them. These parts are shown in a schematic manner. Illustrations of the actual components are given wherever applicable on the reference pages of the diagnostics.

Fold-out page FO-14 may be left open for reference while testing. The functional flow diagram shows the mechanical and hydraulic parts of the system and how they interact. Even if the hydraulic system fails, you will still be able to steer the vehicle, although it will require more effort.

# STEERING SYSTEM

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## STEERING SYSTEM

**WARNING**

Make sure that the area where you conduct these tests is free of natural and man-made obstructions. Failure to do so may result in serious injury.

**PRIOR TO PERFORMING THESE TESTS:**

Visually inspect steering components:

1. Check all four tires and rims for wear, inflation, damage, or warping.
  - a. Adjust tire pressure (TM 9-2320-280-10).
  - b. Replace any unserviceable rims (para 8-4).
2. Check steering linkage for damage.
  - a. Replace any damaged steering linkage components (para 3-12).
  - b. Lubricate steering linkage (TM 9-2320-280-10).
3. Check power **steering** fluid for contamination and level (TM 9-2320-280-10).
  - a. Drain and replace any fluid that appears black and smells burned.
  - b. Bleed air from system where fluid appears milky white (para 8-29).
4. Check pump drivebelts for fraying, cracks, damage, or misadjustment.
  - a. Replace unserviceable power steering drivebelts (para 3-80).
  - b. Adjust loose power steering drivebelts (para 3-82).

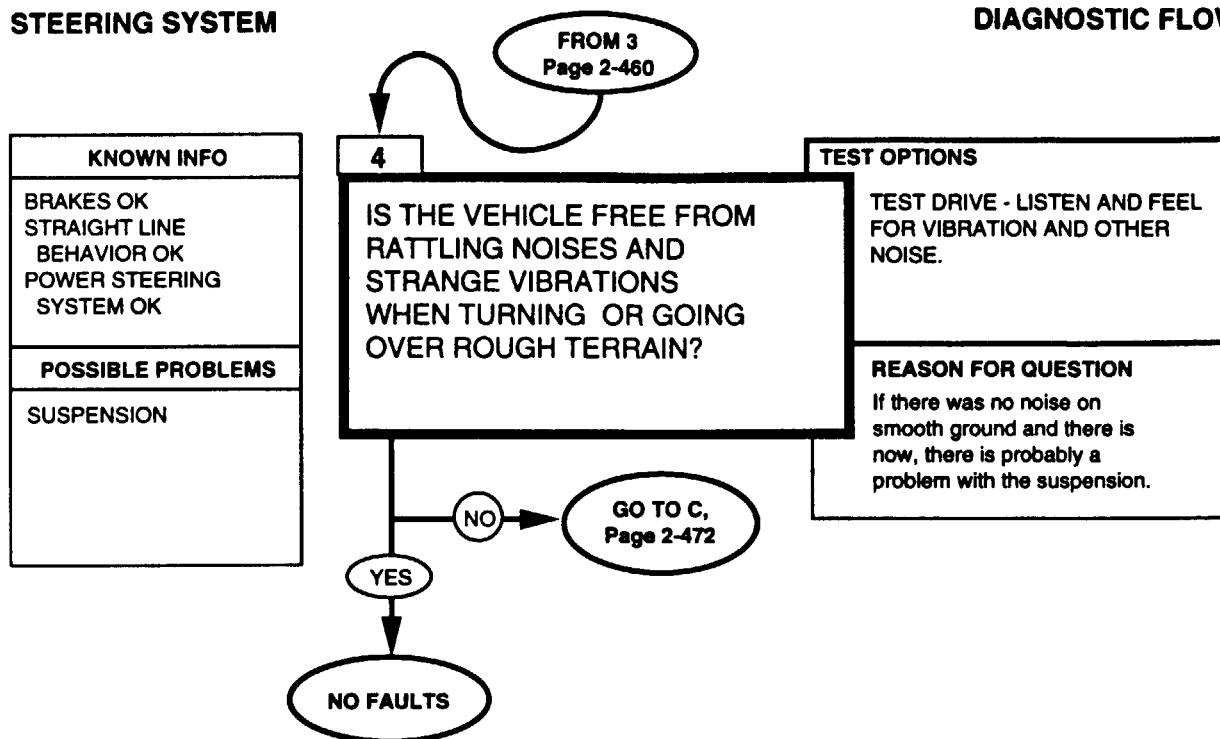
While travelling at a moderate speed (20mph) (32 kmph), apply the brakes while applying minimal pressure to the steering wheel. If pull to one side or the other occurs, make a note of the speed at which it occurs and on what side of the vehicle it occurs. Repeat this procedure for different speeds and braking forces. If the vehicle seems to steer straight while braking, then there probably isn't a problem with the brakes (at least not one that affects the steering). If the braking action feels strange in anyway, then the brake diagnostics should be run to assure vehicle safety. TM test will usually reveal problems with frozen brake calipers.

If the wheels are out of alignment or if the tires are worn unevenly, vehicle may wander.

Symptoms of bad steering characteristics include hard steering, excessive play in steering, a momentary increase in steering effort when turning wheel quickly, and jerking of the steering wheel when turning.

# STEERING SYSTEM

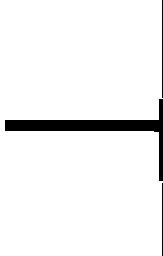
## DIAGNOSTIC FLOWCHART





## REFERENCE INFORMATION

## STEERING SYSTEM

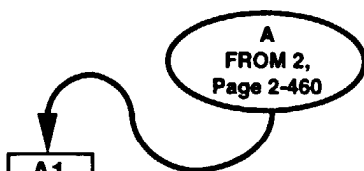


Drive the vehicle until the fires warm up. If the condition goes away it was probably caused by a burst lube pack or a flat spot on a tire. Both of these conditions are OK since the vehicle will operate normally after the fires warm up.

# STEERING SYSTEM

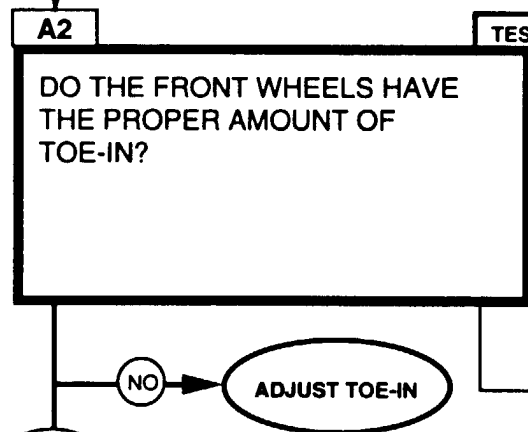
## DIAGNOSTIC FLOWCHART

KNOWN INFO
VEHICLE EXHIBITS POOR STRAIGHT LINE STEERING
POSSIBLE PROBLEMS
TIRES ALIGNMENT SUSPENSION



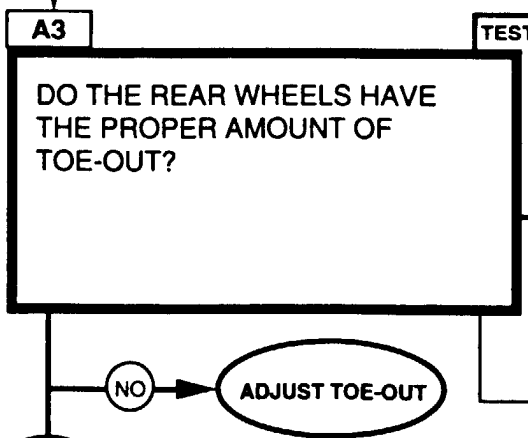
TEST OPTIONS
CHECK THE TIRES FOR PROPER INFLATION AND FOR UNEVEN OR EXCESSIVE WEAR. CHECK THE WHEELS FOR LARGE DENTS OR WARPAGE.
REASON FOR QUESTION
You can't expect the vehicle to steer OK if the tires are not good.

KNOWN INFO
WHEELS AND TIRES OK
POSSIBLE PROBLEMS
FRONT AND REAR WHEEL ALIGNMENT SUSPENSION



TEST OPTIONS
MEASURE TOE.
REASON FOR QUESTION
Poorly adjusted toe-in could have an effect on directional stability.

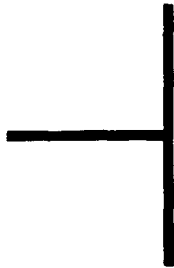
KNOWN INFO
WHEELS AND TIRES OK FRONT ALIGNMENT OK
POSSIBLE PROBLEMS
SUSPENSION REAR ALIGNMENT



TEST OPTIONS
MEASURE TOE.
REASON FOR QUESTION
Poorly adjusted toe-out could have an effect on directional stability.

## REFERENCE INFORMATION

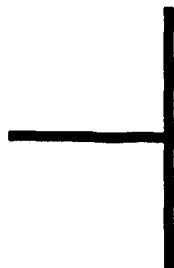
## STEERING SYSTEM



Uneven tire wear can be caused by improper inflation, suspension misalignment or damage, hard service, or wheel imbalance. For wheel and tire replacement and maintenance procedures, refer to (para 8-3).



For instructions on adjusting front wheel toe-in, refer to (para 8-10).



For instructions on adjusting rear wheel toe-out, refer to (para 8-11). Part C will test out the suspension parts to see if they are OK.

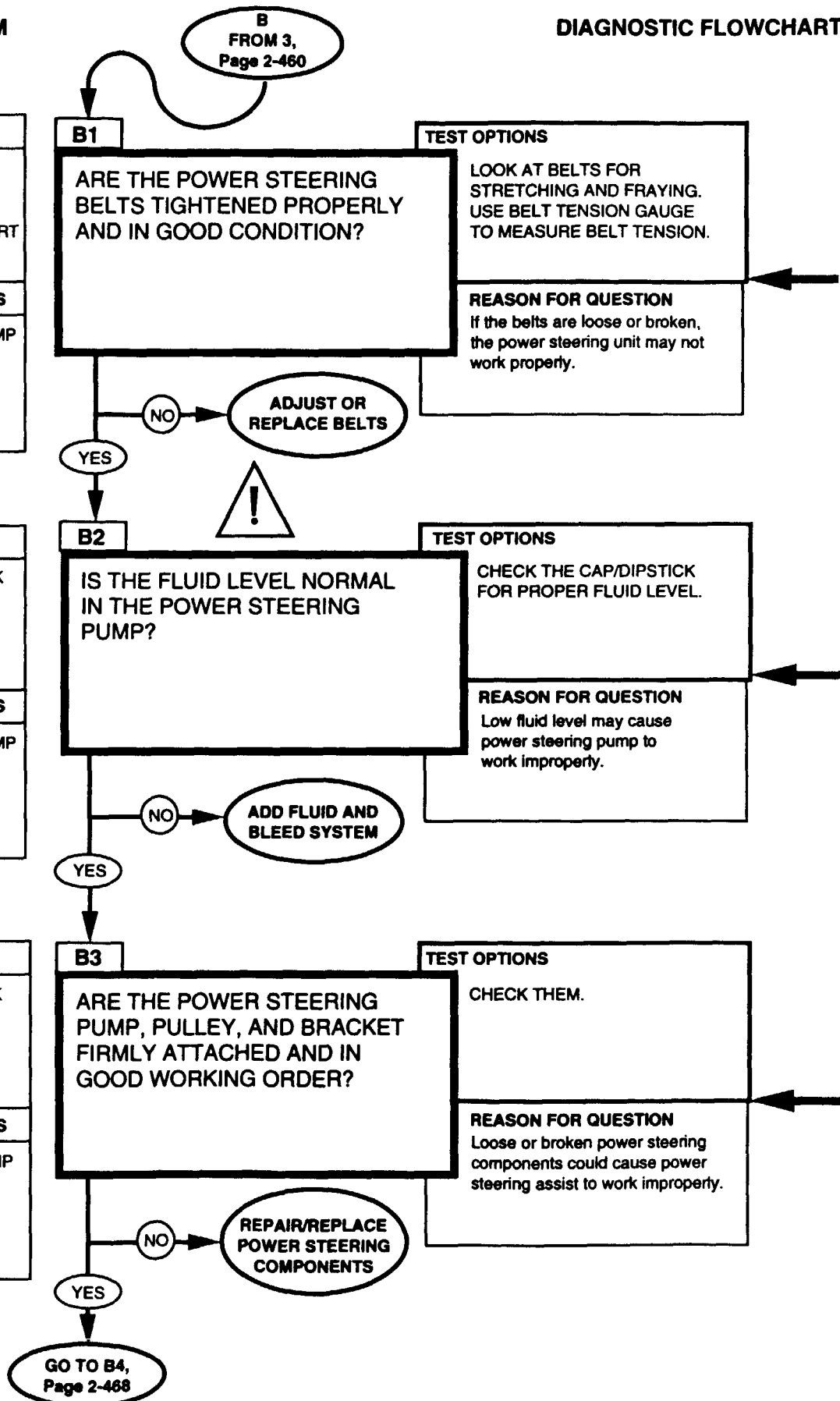
# STEERING SYSTEM

## DIAGNOSTIC FLOWCHART

KNOWN INFO
STRAIGHT LINE BEHAVIOR OK BRAKES OK HARD STEERING EFFORT
POSSIBLE PROBLEMS
POWER STEERING PUMP POWER STEERING COMPONENTS SUSPENSION

KNOWN INFO
WHEELS AND TIRES OK BRAKES OK HARD STEERING BELTS OK
POSSIBLE PROBLEMS
POWER STEERING PUMP POWER STEERING COMPONENTS SUSPENSION

KNOWN INFO
WHEELS AND TIRES OK BRAKES OK HARD STEERING BELTS OK FLUID LEVEL OK
POSSIBLE PROBLEMS
POWER STEERING PUMP POWER STEERING COMPONENTS SUSPENSION



## REFERENCE INFORMATION

## STEERING SYSTEM

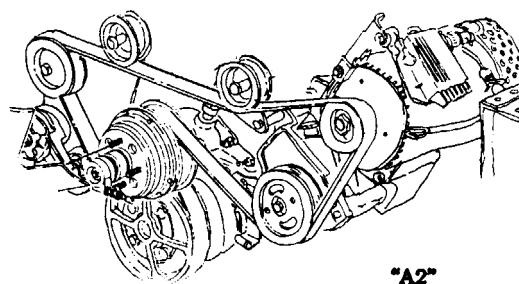
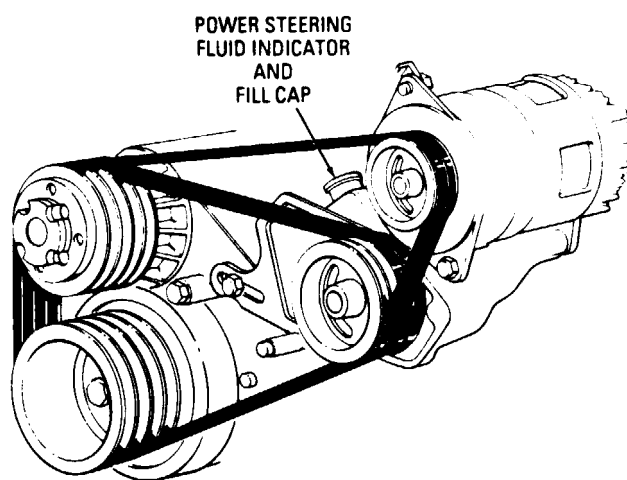
Check belts using the belt tension gauge, refer to (para 3-82) (All except "A2" Vehicles).

**CAUTION**

Do not overfill hydraulic fluid.

See TM 9-2320-280-10 for fluid replacement procedure. For bleeding procedure, refer to (para 8-29).

Low fluid level could indicate a problem elsewhere in the system, either leaking hydraulic lines or a leaking or damaged power steering pump. If adding fluid seems to cure the problem, you should probably run the rest of the tests to make sure there aren't any other problem.



**"A2"  
CONFIGURATION**

A loose pump, pulley, or bracket could cause excess noise, slipping belts, or other malfunctions. For appropriate repair or replacement procedures, refer to (para 8-24).



## REFERENCE INFORMATION

## STEERING SYSTEM

Check hydraulic hoses, power steering pump, power steering cooler, hydraulic control valve, hydro-boost unit, steering gear, fan shroud, and fan clutch. See hose replacement procedures (refer to para 8-25). Check power steering cooler for bent fins or any other airflow restrictions. Straighten fins or replace power steering cooler (para. 8-28) if damaged beyond repair.

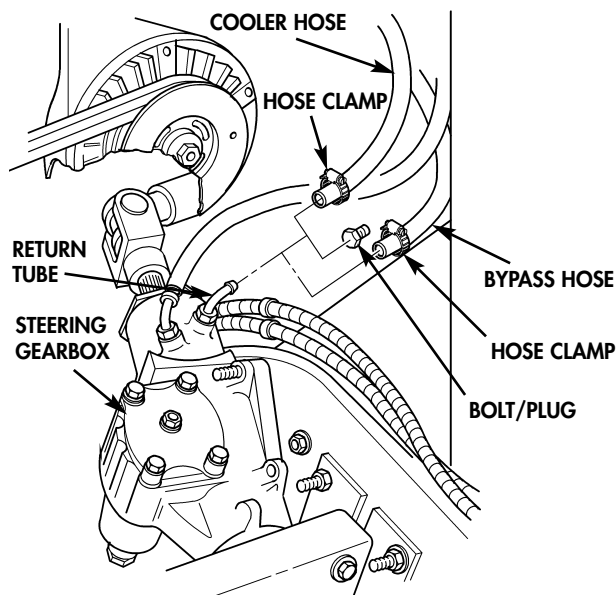
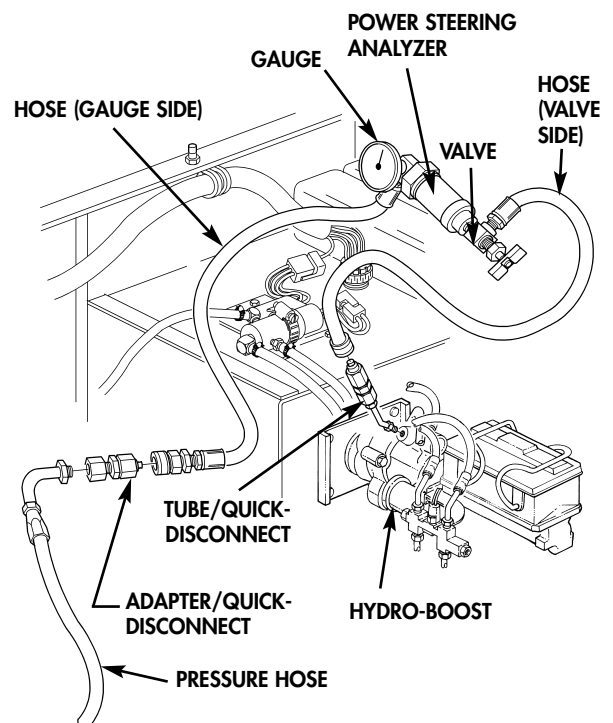
1. With engine off, disconnect pressure hose from hydro-boost and connect tube and quick-disconnect to hydro-boost.

**NOTE**

Have drainage container ready to catch fluid.

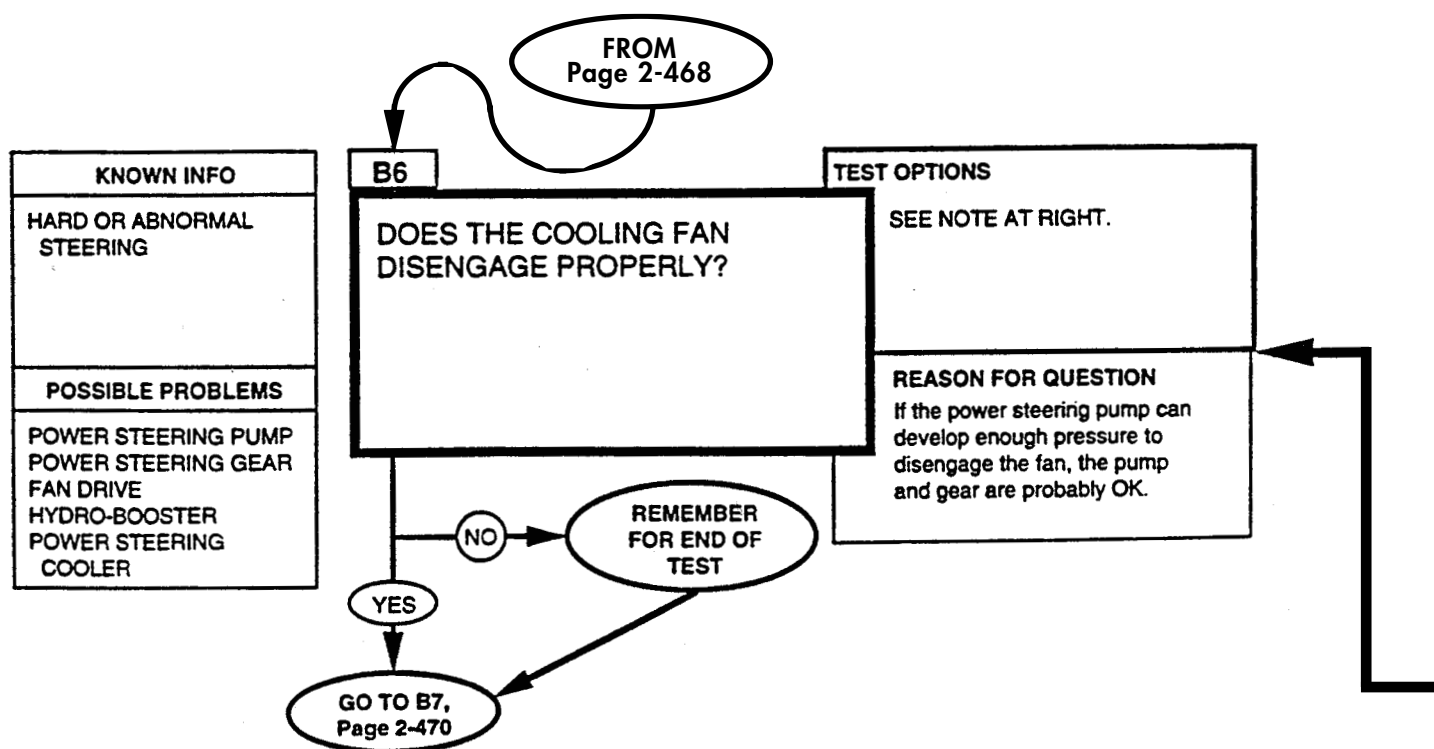
2. Connect adapter and quick-disconnect to pressure hose.
3. Connect hose from valve on power steering analyzer to tube and quick-disconnect on hydro-boost.
4. Connect hose from gauge side of power steering analyzer to adapter and quick-disconnect on pressure hose.
5. Loosen hose clamp and remove cooler hose from return tube on steering gearbox.
6. Plug hose with plug or bolt (3/8 in. or 10 mm dia.) and secure with hose clamp.
7. Connect bypass hose to tube on steering gearbox and secure with hose clamp.

(continued on page 2-469)



## STEERING SYSTEM

## DIAGNOSTIC FLOWCHART



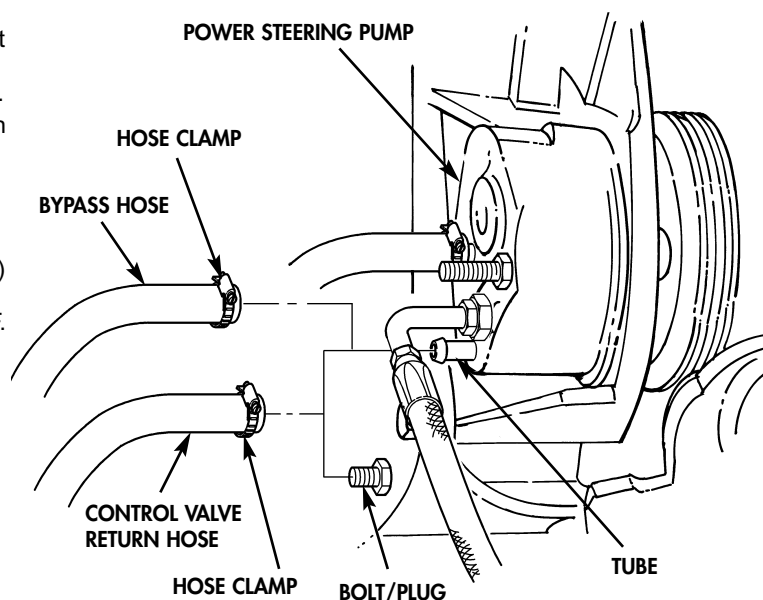


## REFERENCE INFORMATION

## STEERING SYSTEM

8. Loosen hose clamp and remove control valve return hose from tube on power steering pump.
9. Plug return hose with plug or bolt (3/8 in. or 10 mm dia.) and secure with hose clamp.
10. Connect other end of bypass hose to tube on power steering pump and secure with hose clamp.
11. Connect STE/ICE-R to vehicle diagnostic connector and set for measuring RPM (para. 2-43).
12. Open analyzer valve to full open position.
13. Start engine (Refer to TM 9-2320-280-10).
14. Remove power steering reservoir cap and turn steering wheel all the way left, hold in place for 5 seconds, then repeat process with steering wheel all the way right. This releases air from the system.
15. Return steering wheel to center position and shut engine off (para. 3-44).
16. Check and add power steering fluid to reach FULL COLD level in reservoir (Refer to TM 9-2320-280-10).
17. Start engine (Refer to TM 9-2320-280-10) and allow engine to idle and reach operating temperature of 190° F to 230° F.
18. Check for proper engine idle speeds and adjust if necessary (para. 3-44).
 

6.2L engine	650±25 RPM
6.5L engine	700±25 RPM
6.5L detuned engine	700±25 RPM
19. Ensure analyzer valve is in full open position and engine is at proper idle speed.
20. Initial pressure should be 150-250 psi and a flow of 2.50-3.50 gpm. If these specifications aren't present, check installation of analyzer and check power steering system (Refer to TM 9-2320-280-10).
21. With power steering system working properly, partially close analyzer valve until pressure reaches 700 psi. If flow rate varies more than 1 gpm from the initial reading, replace power steering pump (para. 8-24).

**CAUTION**

Do not leave analyzer valve fully closed for more than 5 seconds. Severe damage may occur to power steering pump.

22. With engine at idle, close and open analyzer valve three times, recording pressure each time. All readings should be 1300 psi or higher, if pressure is lower, replace power steering pump (para. 8-24).
23. With analyzer valve in the open position, increase engine rpm to 1500 and record fluid flow. If fluid flow varies more than 1 gpm from initial reading, replace power steering pump (para. 8-24).
24. With engine at idle, turn steering wheel all the way left, hold in place for 5 seconds, then repeat process with steering wheel all the way right and record flow rates. If flow rate does not drop to 1 gpm or less, replace steering gearbox (para. 8-21).
25. With engine at idle, turn wheels slightly left and right and release quickly. If pressure does not increase and snap back within 2 seconds, check steering shaft and column for binding and repeat step 15. If pressure still does not increase and snap back, replace steering gearbox (para. 8-21).
26. With engine at idle, push brake pedal down and hold. Record pressure. If pressure varies more than 50 psi from step 22, replace hydro-boost (para. 7-14).
27. With engine at idle, push brake pedal down and release quickly. If pressure does not increase and snap back within 2 seconds, replace hydro-boost (para. 7-14).
28. Shut off engine. Remove power steering analyzer and restore power steering system to original configuration.
29. Bleed power steering system (para. 8-29).

**NOTE**

You must be certain that the engine cooling system is working ok, or this test won't tell you anything. If the engine is cold, and everything is working ok, the fan should be disengaged. You can tell by gently revving the engine in neutral with the hood open. If the fan is engaged you will feel a breeze outside the driver's door. If it's disengaged, you won't feel it. If you aren't sure if it's working ok, run the tests in Paragraph 2-25.

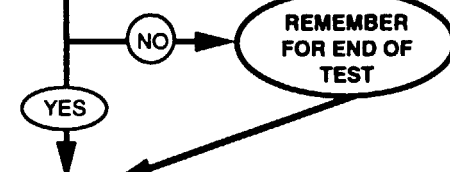
# STEERING SYSTEM

## DIAGNOSTIC FLOWCHART

KNOWN INFO
HARD OR ABNORMAL STEERING
POSSIBLE PROBLEMS
POWER STEERING PUMP POWER STEERING GEAR FAN DRIVE HYDRO-BOOSTER

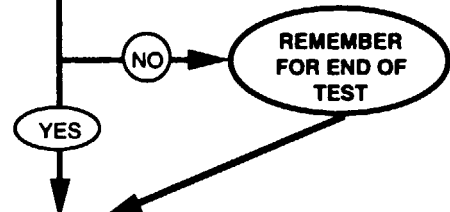
FROM B6, Page 2-468

<b>B7</b>	<p>IS THE HYDRO-BOOSTER WORKING PROPERLY?</p>	<p><b>TEST OPTIONS</b></p> <p>SEE INSTRUCTIONS AT RIGHT.</p> <p><b>REASON FOR QUESTION</b></p> <p>The hydro-booster will affect the operation of the steering system.</p>
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KNOWN INFO
HARD OR ABNORMAL STEERING
POSSIBLE PROBLEMS
POWER STEERING PUMP POWER STEERING GEAR FAN DRIVE HYDRO-BOOSTER

<b>B8</b>	<p>TURN STEERING WHEEL SLIGHTLY TO LEFT OR RIGHT AND RELEASE WHEEL QUICKLY. THE STEERING WHEEL SHOULD CENTER ITSELF. DOES THIS HAPPEN?</p>	<p><b>TEST OPTIONS</b></p> <p>TRY IT</p> <p><b>REASON FOR QUESTION</b></p> <p>The steering gear is working properly if this happens.</p>
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KNOWN INFO
HARD OR ABNORMAL STEERING
POSSIBLE PROBLEMS
POWER STEERING PUMP POWER STEERING GEAR FAN DRIVE HYDRO-BOOSTER

<b>B9</b>	<p>LOOK AT THE CHART TO THE RIGHT TO DETERMINE WHAT IS WRONG AND REPAIR IT AS DIRECTED.</p>	<p><b>TEST OPTIONS</b></p> <p>N/A</p> <p><b>REASON FOR TESTS</b></p> <p>N/A</p>
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## REFERENCE INFORMATION

## STEERING SYSTEM

Method for checking hydro-booster. Depress brake pedal several times to exhaust accumulator. Depress brake pedal and start engine. Brake pedal should fall, then push back against operator's foot.

ANSWERS TO QUESTION: B6      B7      B8			COMPONENT TO REPLACE
NO	NO	NO	POWER STEERING PUMP
NO	NO	YES	SEE NOTE BELOW
NO	YES	NO	SEE NOTE BELOW
NO	YES	YES	RUN ENGINE COOLING TEST (PARA 2-19)
YES	NO	NO	POWER STEERING PUMP
YES	NO	YES	HYDRO-BOOSTER
YES	YES	NO	DS LEVEL STEERING GEAR
YES	YES	YES	NO FAULTS

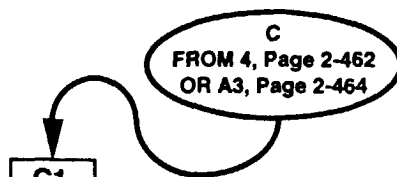
## NOTE

To diagnose the second and third cases to one item, it is necessary to have a power steering analyzer. Additionally, for all cases, check the hoses for the particular part to make sure they are OK.

# STEERING SYSTEM

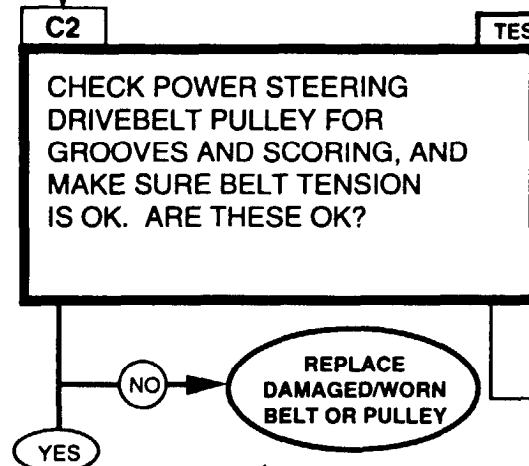
## DIAGNOSTIC FLOWCHART

KNOWN INFO
WHEELS AND TIRES OK BRAKES OK ALIGNMENT OK
POSSIBLE PROBLEMS
STEERING COMPONENTS SUSPENSION COMPONENTS



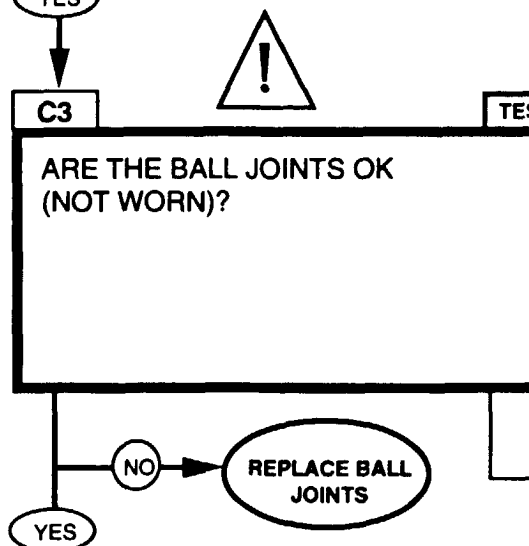
TEST OPTIONS
VISUAL INSPECTION - LOOK FOR BENT PARTS, LOOSE MOUNTINGS AND BAD BUSHINGS.
REASON FOR QUESTION
These are the parts that turn the front wheels in response to the steering wheel movements.

KNOWN INFO
WHEELS AND TIRES OK BRAKES OK STEERING LINKAGES OK
POSSIBLE PROBLEMS
DRIVEBELT & PULLEY CAPSCREWS SUSPENSION COMPONENTS



TEST OPTIONS
1. VISUAL INSPECTION. 2. BELT TENSION GAUGE.
REASON FOR QUESTION
A damaged pulley will ruin the drivebelt. A loose belt will slip, causing the power steering to loose power or fail.

KNOWN INFO
WHEELS AND TIRES OK BRAKES OK POWER STEERING BELTS OK STEERING LINKAGES OK
POSSIBLE PROBLEMS
BALL JOINTS OTHER SUSPENSION COMPONENTS OTHER STEERING COMPONENTS



TEST OPTIONS
PROCEDURE AT RIGHT
REASON FOR QUESTION
Worn ball joints can result in difficult or noisy steering.

## REFERENCE INFORMATION

Check for looseness in idler arm and pitman arm, refer to (para. 8-18 and 8-14). For replacing center link refer to (para. 8-15). For replacing tie rods refer to (para. 8-17).

For adjusting the drivebelt tension, refer to (para. 3-82, all except M1123 and "A2" vehicles), and replacing the pulley, refer to (para 8-24).



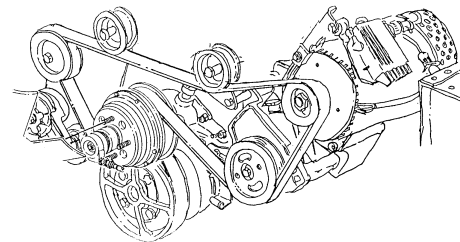
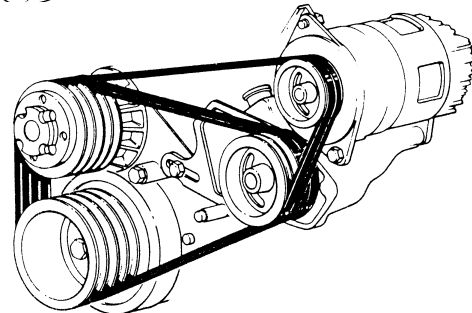
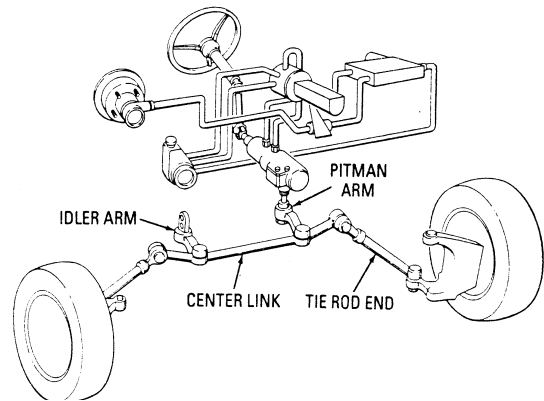
### CAUTION

Do not loosen slotted nut to install cotter pin. Loosening the nut may result in damage to the equipment.

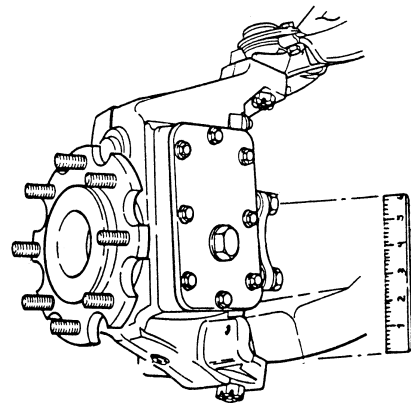
To check for proper operation of ball joints:

- (i) Chock rear wheels front and back.
- (ii) Raise front wheels about two inches off the ground and support on a jack stand.
  - (a) Lower ball joints.
- (iii) Mark a line across the head of the top bolt holding the steering arm cover. Make sure the mark is parallel to the lower control arm.
- (iv) Put a prybar between the cover control arm and geared hub.
- (v) Set a 6-inch ruler upright between the lower control arm and the marked screw.
- (vi) Push down the prybar to try to move the hub.
- (vii) Measure movement in the hub assembly. If movement is more than 1/8 inch (3 mm), replace lower ball joint (refer to para. 6-27).
  - (b) Upper ball joints.
- (viii) Grasp top of tire and attempt to move it in and out.
- (ix) Measure any movement at top outer edge of tire. Replace upper ball joints if tire movement is 3/8 inch (10 mm) or more (refer to para. 6-26).

## STEERING SYSTEM

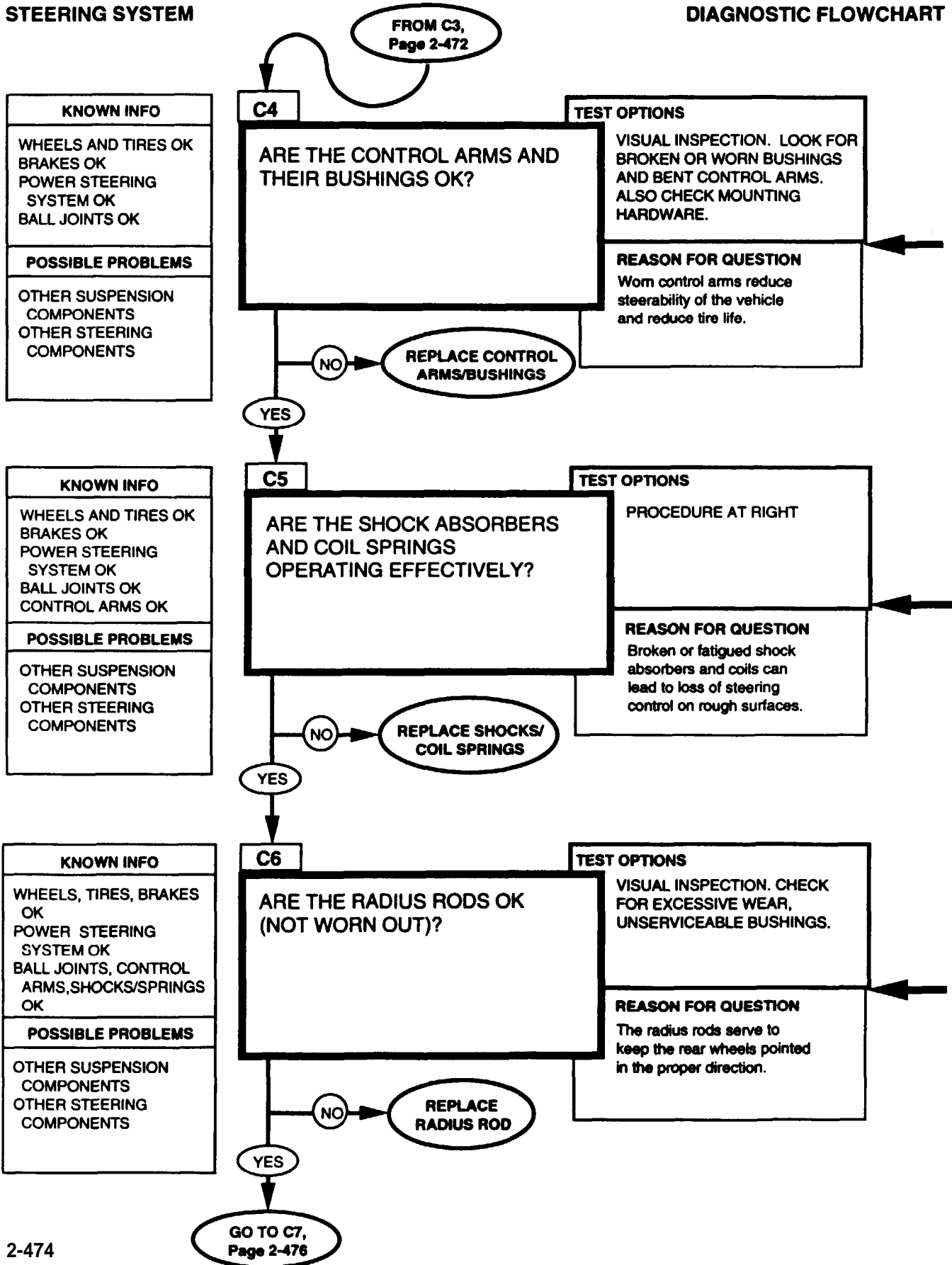


### M1123 and "A2" CONFIGURATION



STEERING SYSTEM

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

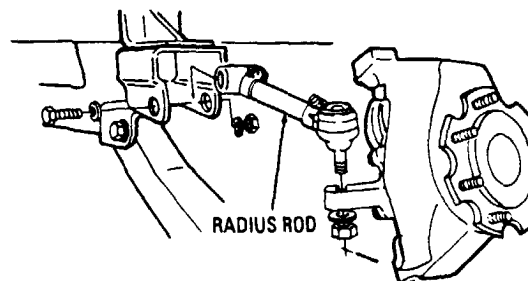
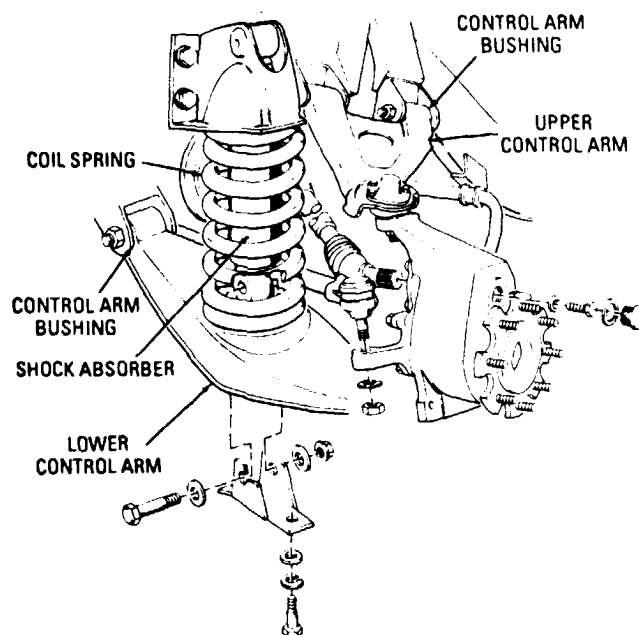
## STEERING SYSTEM

For upper and lower control arm and bushing replacement instructions, refer to (para 6-28 and 6-29).

To test the shocks and springs, drive the vehicle over a variety of terrain. If the vehicle continues to bounce after hitting a bump, the shocks may be worn. If the vehicle bottoms out on the suspension, the shocks may be worn. If the vehicle sags when loaded, the springs may be worn. If the shock absorber bodies are not warm after driving the vehicle, the shocks are no good.

For coil spring and shock absorber replacement instructions, refer to (para 6-30 and 6-31).

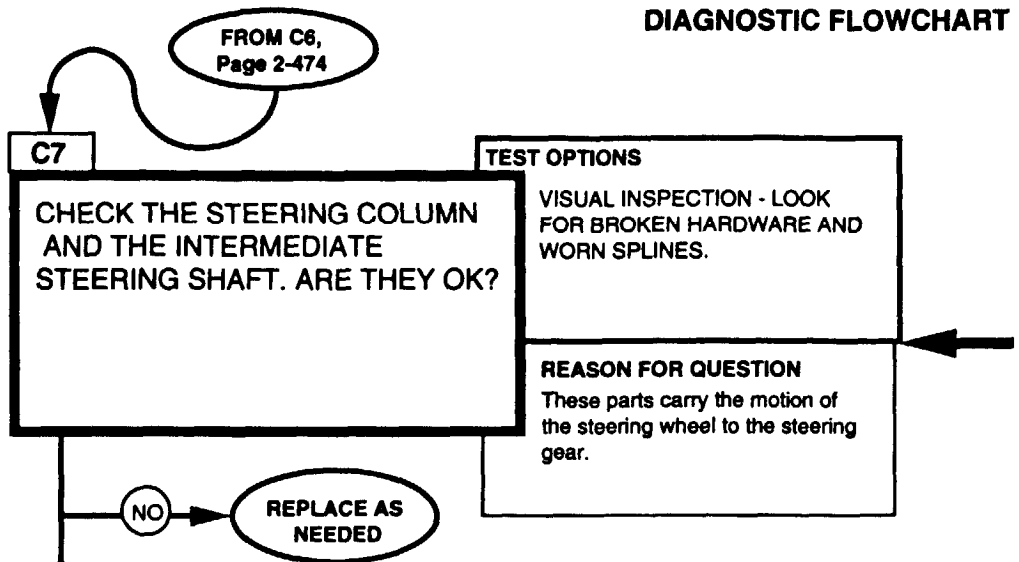
For instructions on replacing the radius rod, refer to (para 6-25).



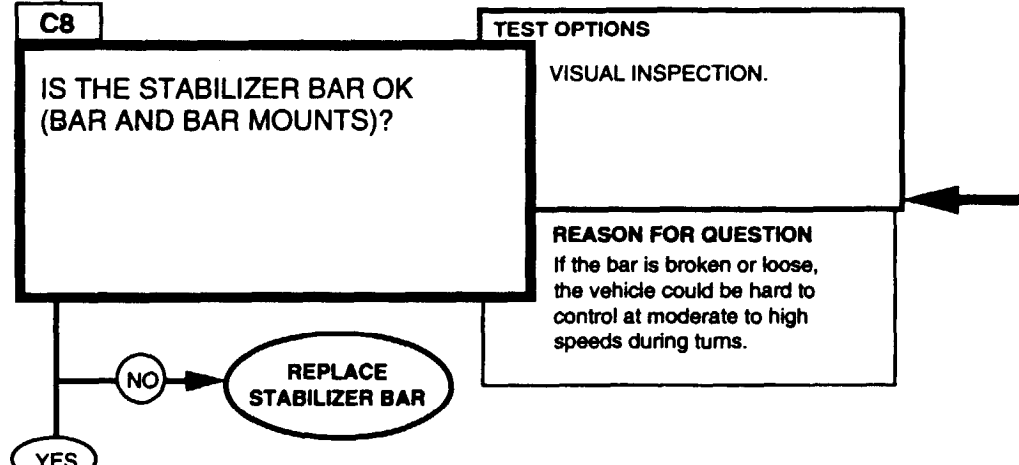
# STEERING SYSTEM

## DIAGNOSTIC FLOWCHART

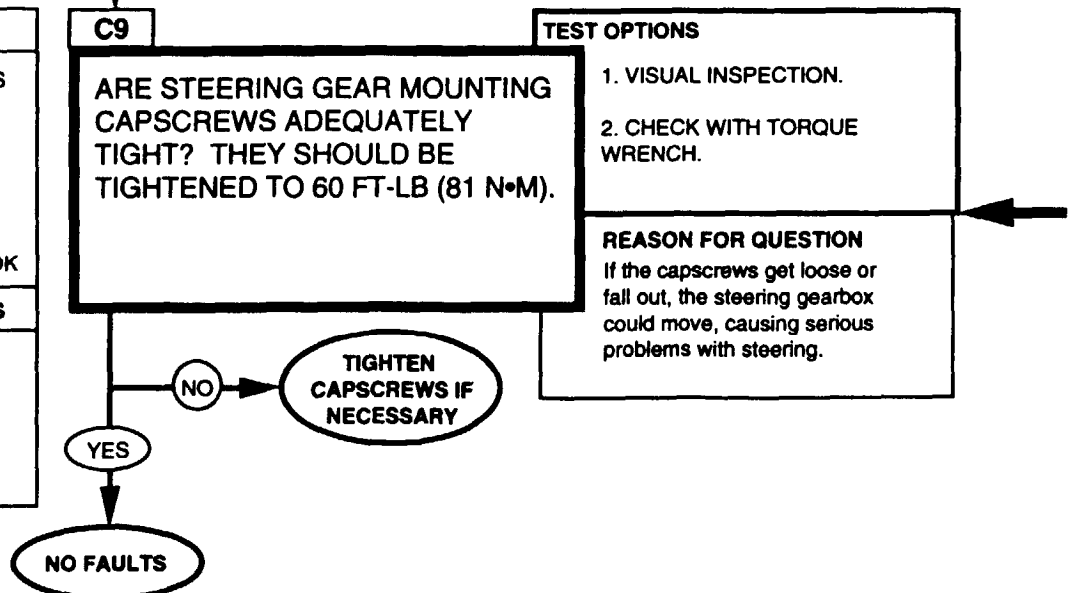
KNOWN INFO
MOST STEERING AND SUSPENSION PARTS ARE OK
POSSIBLE PROBLEMS
STEERING SHAFTS CAPSCREWS STABILIZER BAR



KNOWN INFO
WHEELS, TIRES, BRAKES OK POWER STEERING SYSTEM OK SUSPENSION OK MOST STEERING COMPONENTS OK
POSSIBLE PROBLEMS
STABILIZER BAR CAPSCREWS



KNOWN INFO
WHEELS, TIRES, BRAKES OK POWER STEERING SYSTEM OK BALL JOINTS OK CONTROL ARMS OK SHOCKS/SPRINGS OK DRIVEBELT & PULLEY OK
POSSIBLE PROBLEMS
CAPSCREWS





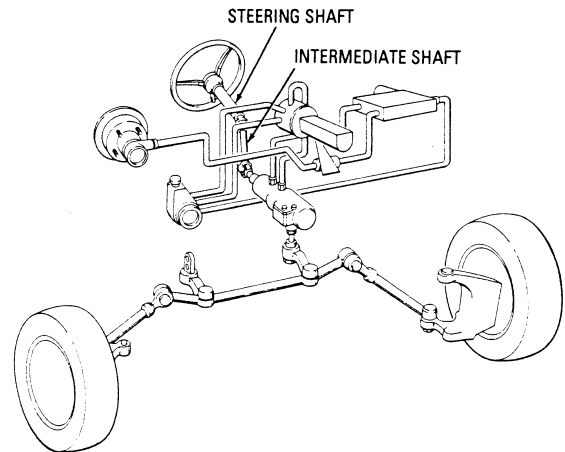
## REFERENCE INFORMATION

## STEERING SYSTEM

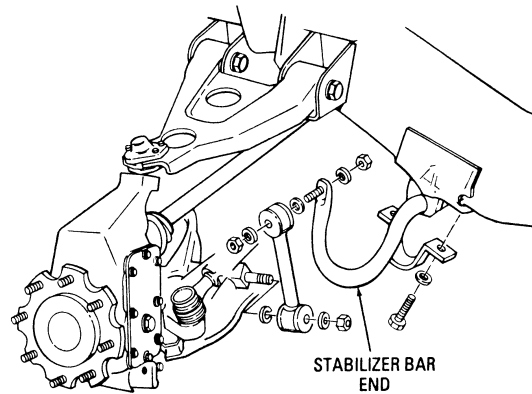
### NOTE

Inspect intermediate shaft U-joints for wear, binding, or missing/damaged grease fittings. Replace or lubricate as necessary. Refer to (para. 8-22) for replacement and TM 9-2320-280-10, Appendix G, for lubrication instructions.

Replace the steering column and intermediate shaft, refer to (paras 8-19 and 8-20).



Replace the stabilizer bar, refer to (para 6-23).



If you still have a problem, rerun the test chain to make sure you didn't miss anything. If you didn't go down the "A" chain, you may want to run those tests in order to check out the hydraulic parts of the steering system.

---

## 2-38. DRIVETRAIN TESTS

---

These Drivetrain tests maybe run anytime you think you have a drivetrain problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

The fold-out page shows the location of the major components of the drivetrain system in case you are not familiar with them.

Fold-out page FO-15 may be left open for reference while testing. Also, due to the design of the functional flow diagram, it is not necessary to have a location of parts diagram, so it has been omitted.

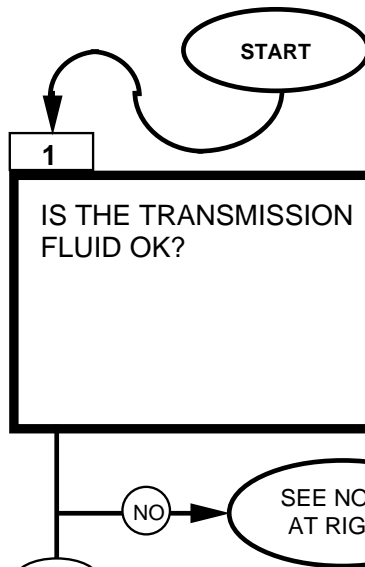
### NOTE

Problems with the transmission and drivetrain cooling system are dealt with in Paragraph 2-34 or 2-35.

# DRIVETRAIN

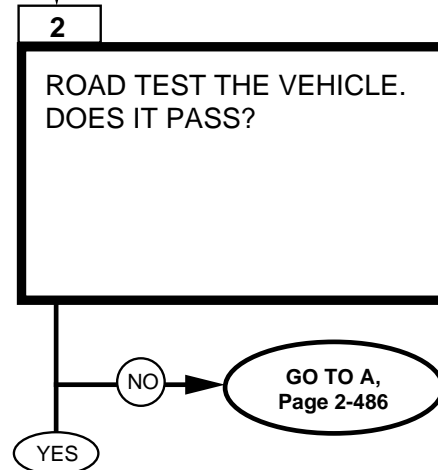
## DIAGNOSTIC FLOWCHART

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
TRANSFER CASE DIFFERENTIALS HALF AND PROPELLER SHAFTS CV & U-JOINTS GEARED HUBS



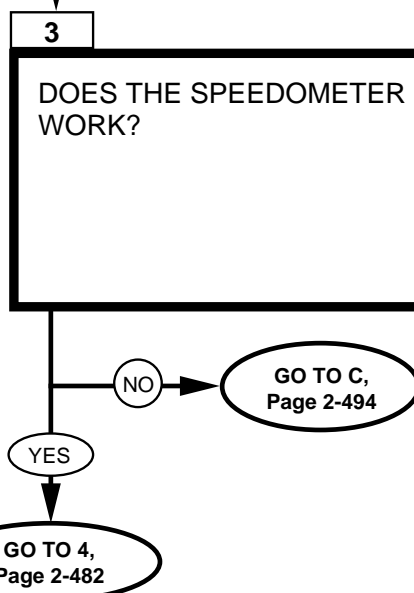
TEST OPTIONS
VISUAL - SEE NOTE AT RIGHT.
REASON FOR QUESTION
Transmission fluid passes through the transfer oil cooler located inside the transfer case.

KNOWN INFO
FLUID OK
POSSIBLE PROBLEMS
TRANSFER CASE DIFFERENTIALS HALF AND PROPELLER SHAFTS CV & U-JOINTS GEARED HUBS



TEST OPTIONS
TRY ALL TRANSFER CASE OPTIONS AND NOTE UNUSUAL BEHAVIOR.
REASON FOR QUESTION
A road test is the best way to test the drivetrain.

KNOWN INFO
SHIFTER OK FLUID OK VEHICLE PASSES ROAD TEST
POSSIBLE PROBLEMS
TRANSFER CASE DIFFERENTIALS HALF AND PROPELLER SHAFTS CV & U-JOINTS GEARED HUBS



TEST OPTIONS
VISUAL INSPECTION.
REASON FOR QUESTION
The speedometer is driven by the rear output shaft of the transfer case.

## REFERENCE INFORMATION

## DRIVETRAIN

**Procedure for checking transmission fluid**

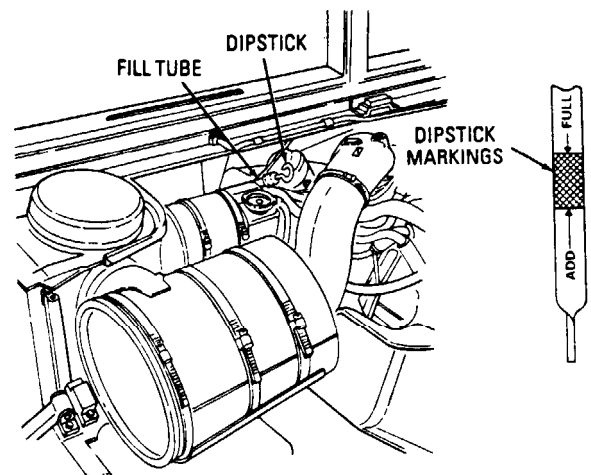
1. Start engine
2. Hold down brake pedal and move transmission shift lever through all ranges including reverse.
3. Engage parking brake and place shift lever in neutral. Check fluid level on dipstick.
4. Proper level is between FULL and ADD marks on dipstick

**NOTE**

Check fluid for a burnt smell, grit, discoloration, air bubbles, or a milky appearance.

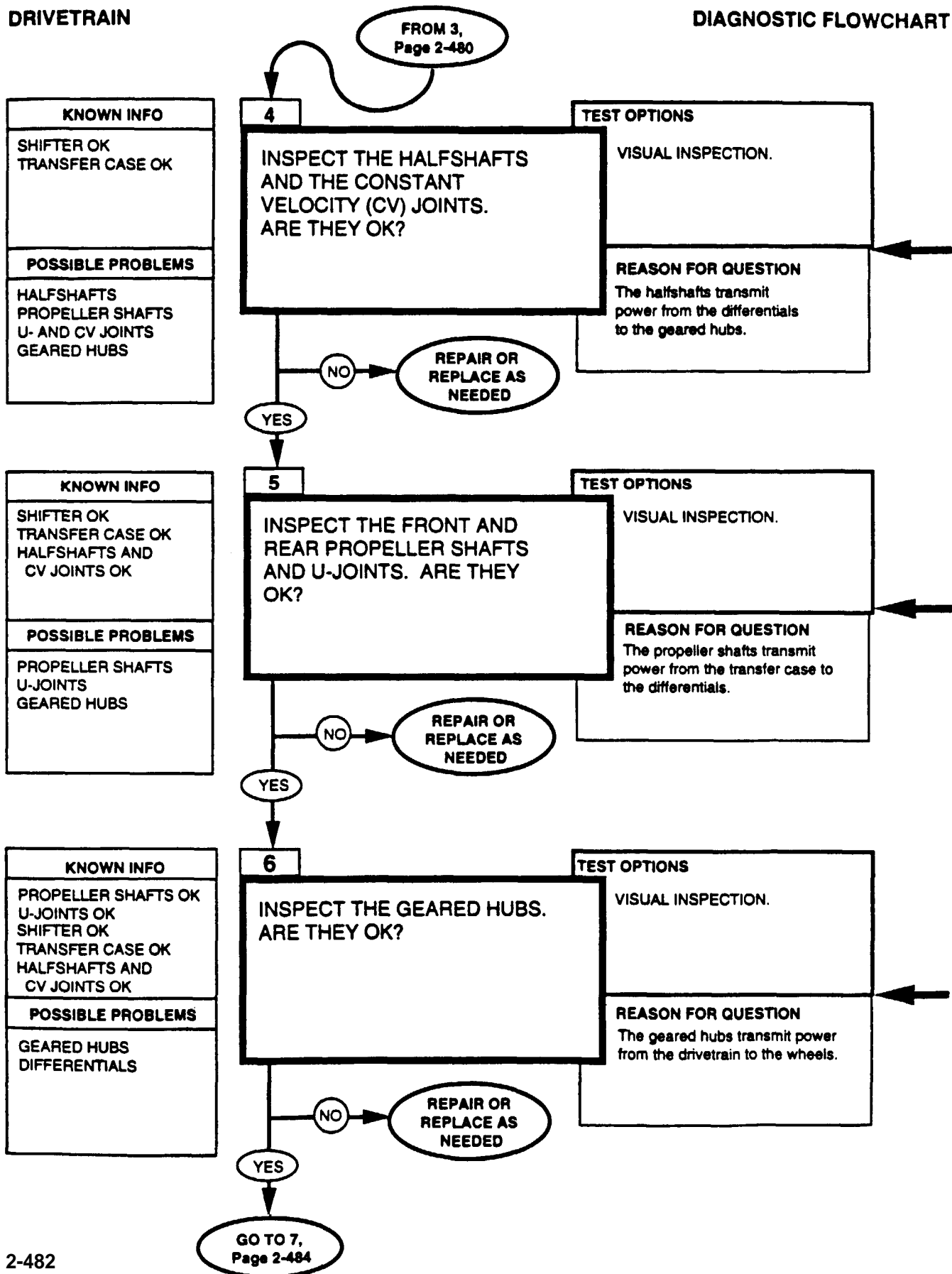
- Burnt smell, discoloration, or grit indicates worn or damaged internal components. Notify DS maintenance.
- Bubbles indicate of an overfilled system or air leaks in the system. Drain the fluid and refill to proper level, refer to (para 5-2).
- Milky appearance is due to water in the system. Replace fluid, and replace filter.

If the speedometer works, but the vehicle doesn't move, the transmission is OK and the problem is in the final drive. Most likely the fault is in the splined output shafts of the transfer case. Listen for unusual noise.



# DRIVETRAIN

## DIAGNOSTIC FLOWCHART



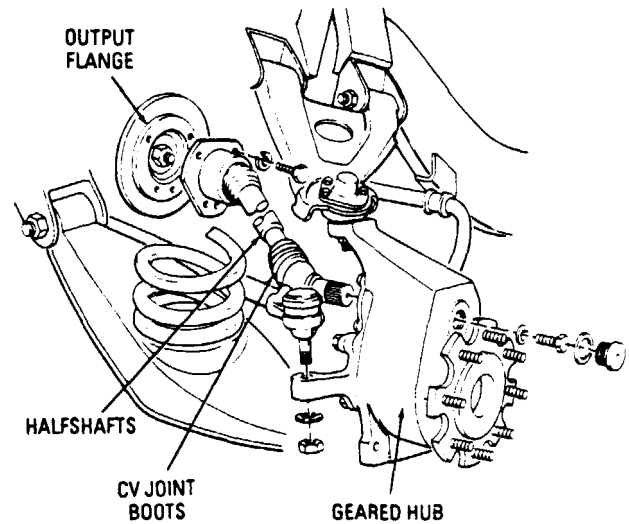
## REFERENCE INFORMATION

## DRIVETRAIN

Check for torn boots on the CV joints, stripped splines, smooth joint operation, and proper mounting torques.

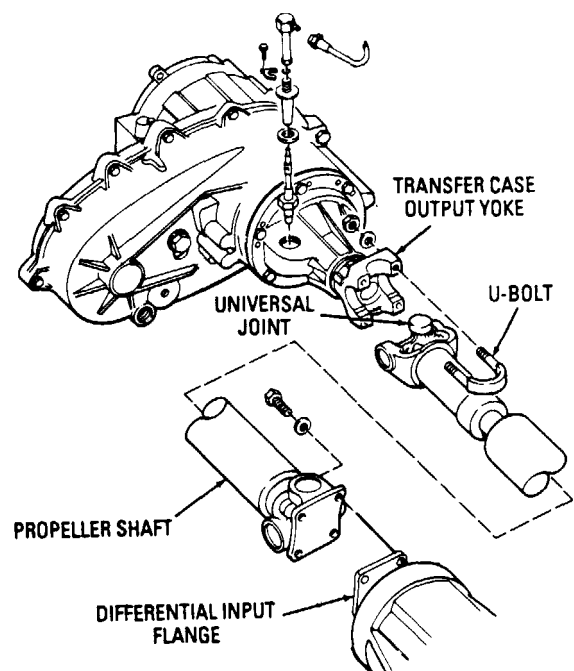
Replace halfshafts and CV joints, refer to (para 6-9).

**Lube in accordance with TM 9-2320-280-10.**



Check for smooth operation of U-joints, stripped splines, bent yokes, or other problems. Also check to see if the shaft itself is bent. Replace propeller shafts or U-joints, refer to (para 6-2 through 6-7).

**Lube in accordance with TM 9-2320-280-10.**



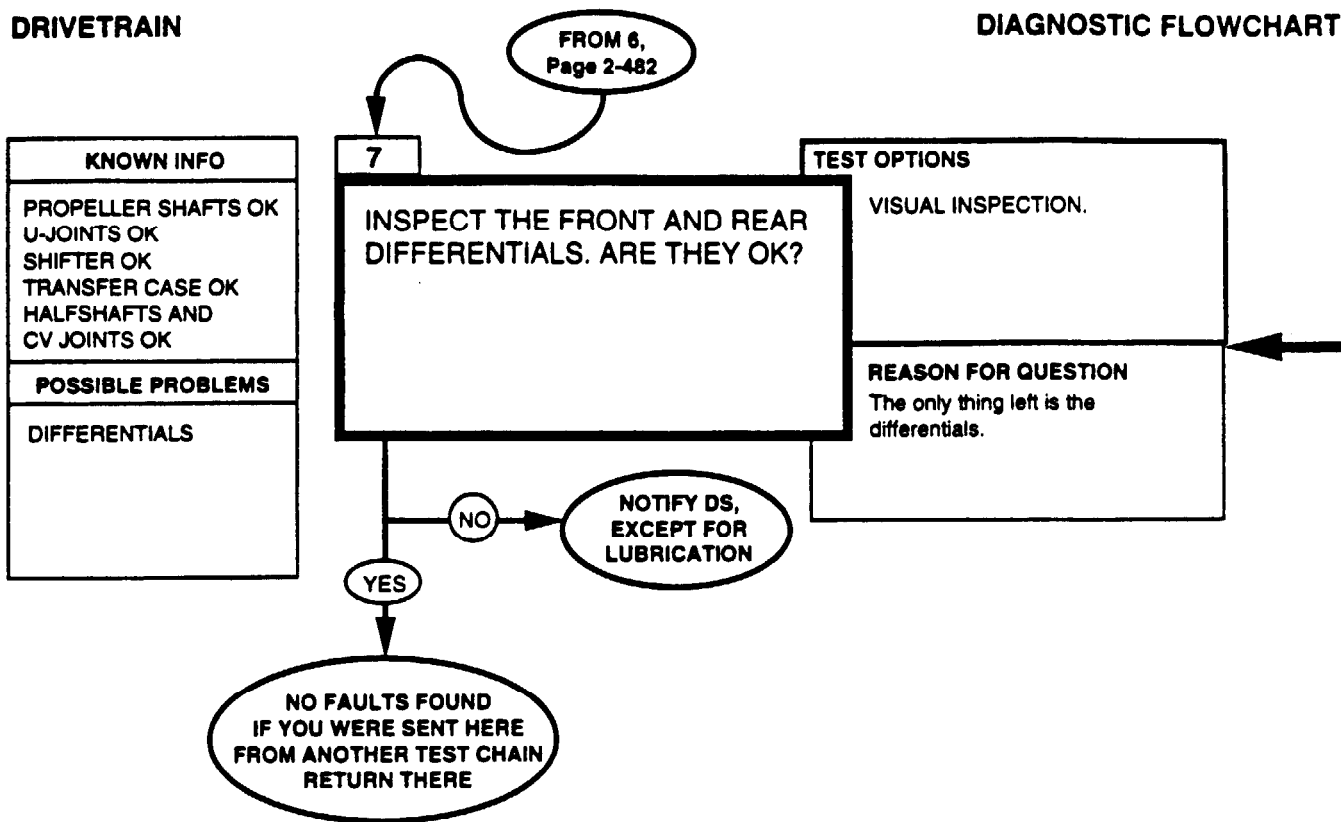
Make sure the geared hubs turn freely. Check mounting hardware for proper installation

**Lube in accordance with TM 9-2320-280-10.**

Replace geared hubs, refer to (para 6-11).

# DRIVETRAIN

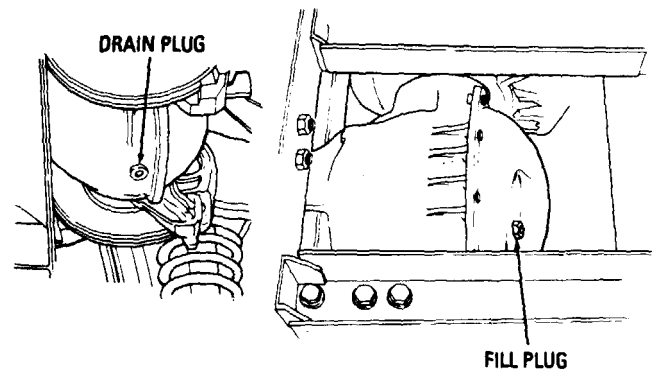
## DIAGNOSTIC FLOWCHART



# REFERENCE INFORMATION

## DRIVETRAIN

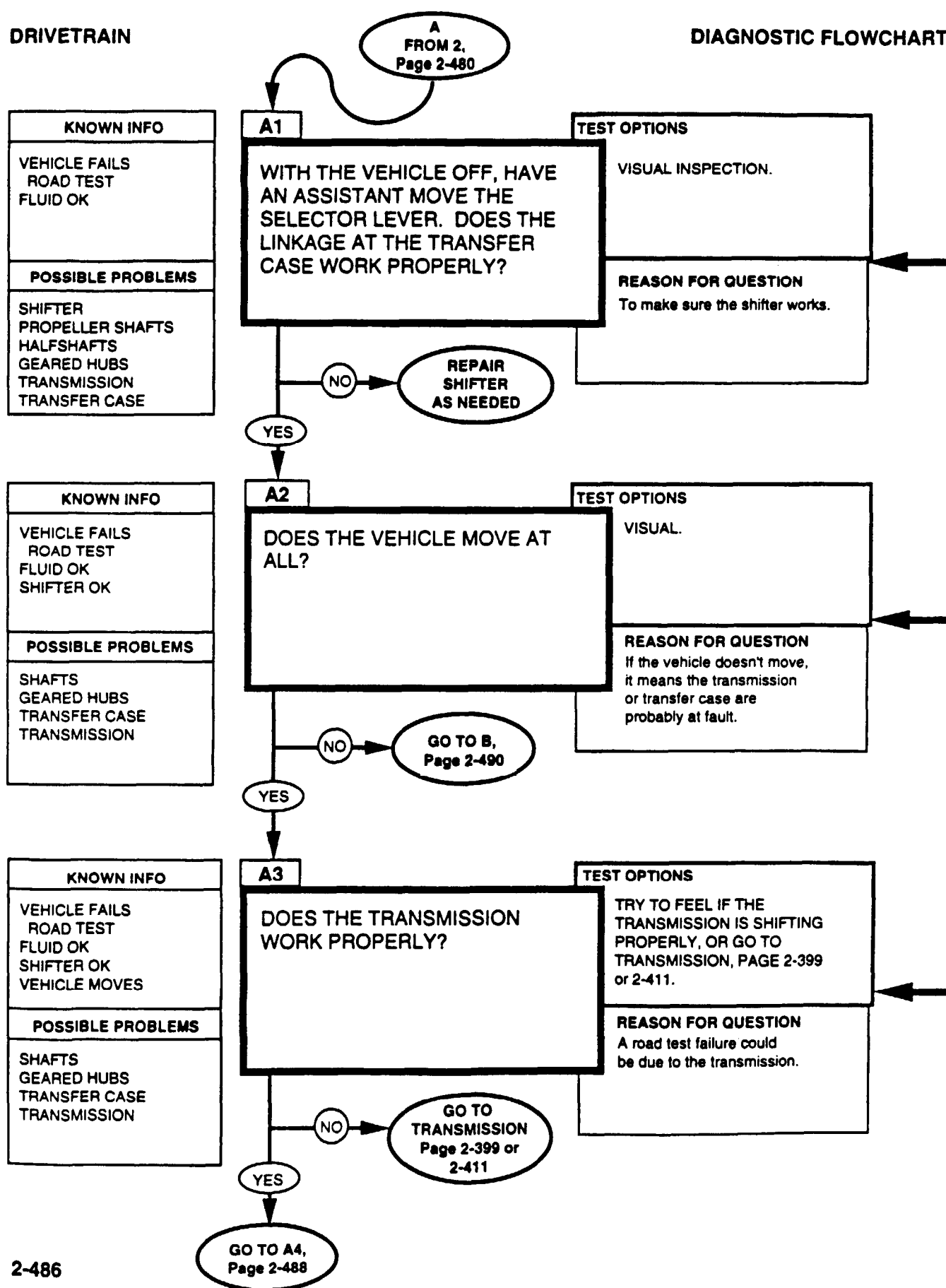
- Check for loose mounting and broken parts.
- Check fluid in accordance with TM 9-2320-280-10.
- Notify DS maintenance for other faults.





# DRIVETRAIN

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

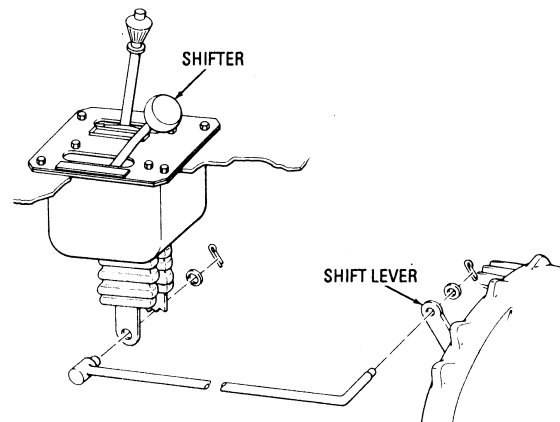
## DRIVETRAIN

Lube in accordance with table 2-1.

Adjust and repair linkage, refer to (para 5-8 or 5-11). Make sure the detents in the shifter correspond with the positions on the name plate.

If difficulty occurs when shifting transfer range with engine running, perform Engine Idle Speed Adjustment prior to troubleshooting drivetrain.

If engine was turned OFF in order to shift transfer to desired range, notify DS maintenance.



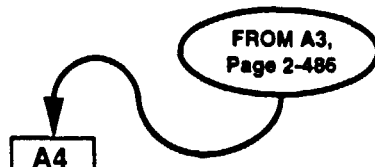
For the vehicle not to move, there must be a major problem in the drivetrain.

If you've already run the transmission tests, and you still can't find the problem, continue down this test chain.

# DRIVETRAIN

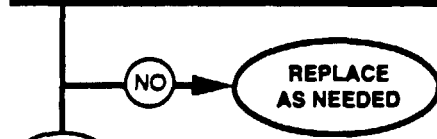
## DIAGNOSTIC FLOWCHART

KNOWN INFO
VEHICLE FAILS ROAD TEST FLUID OK SHIFTER OK VEHICLE MOVES
POSSIBLE PROBLEMS
DIFFERENTIALS SHAFTS GEARED HUBS TRANSFER CASE



ARE BOTH PROPELLER  
SHAFTS AND U-JOINTS OK?

TEST OPTIONS
VISUAL INSPECTION.
REASON FOR QUESTION
The propeller shafts transmit power to the differentials.



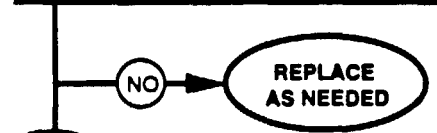
YES

KNOWN INFO
VEHICLE FAILS ROAD TEST FLUID OK SHIFTER OK VEHICLE MOVES PROPELLER SHAFTS OK
POSSIBLE PROBLEMS
DIFFERENTIALS HALFSHAFTS GEARED HUBS TRANSFER CASE

A5

ARE ALL 4 HALFSHAFTS AND  
CONSTANT VELOCITY JOINTS  
OK?

TEST OPTIONS
VISUAL.
REASON FOR QUESTION
Halfshafts transmit power from the differentials to the geared hubs.



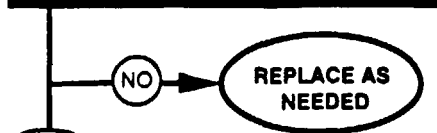
YES

KNOWN INFO
VEHICLE FAILS ROAD TEST FLUID OK SHIFTER OK VEHICLE MOVES PROPELLER SHAFTS OK HALFSHAFTS OK
POSSIBLE PROBLEMS
DIFFERENTIALS GEARED HUBS TRANSFER CASE

A6

INSPECT THE GEARED HUBS.  
ARE THEY OK?

TEST OPTIONS
VISUAL INSPECTION.
REASON FOR QUESTION
The geared hubs transmit power from the drive train to the wheels.



YES

SEE NOTE  
AT RIGHT

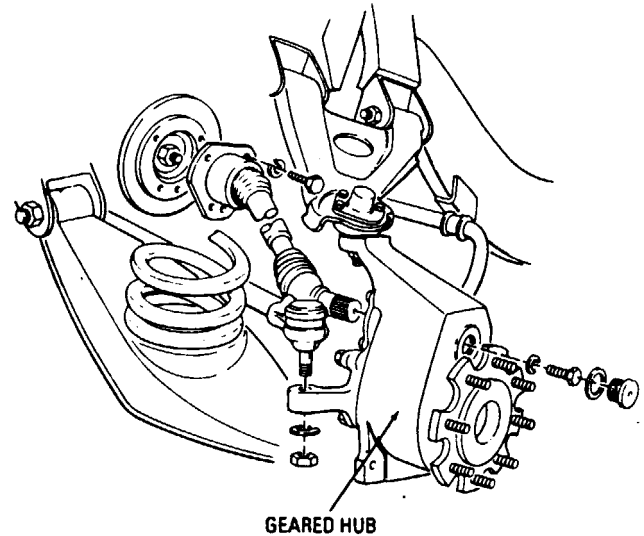
## REFERENCE INFORMATION

## DRIVETRAIN

Lube in accordance with  
TM 9-2320-280-10.

Check for smooth operation  
of U-Joints, stripped splines,  
bent yokes, or other problems.  
Also check to see if the shaft  
itself is bent.

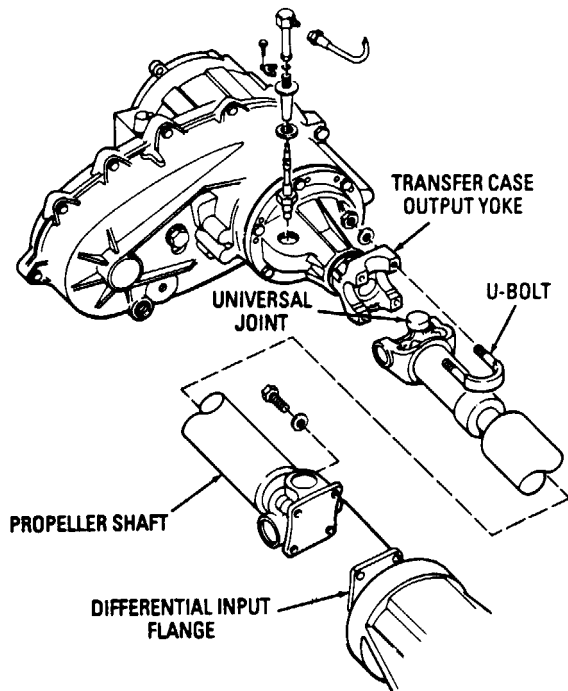
Repair and replace propeller  
shafts and U-joints, refer to  
(para 6-4 thru 6-7).



Check for torn boots on the  
CV joints, stripped splines,  
smooth joint operation, and  
proper mounting torques.

For halfshaft maintenance  
procedures, refer to (para 6-9).

Lube in accordance with  
TM 9-2320-280-10.



Make sure the geared hubs turn  
freely. Check mounting hardware  
for proper installation.

**Lube in accordance with**  
TM 9-2320-280-10.

**NOTE**

If you haven't found any faults,  
check the differential fluid in  
accordance with TM 9-2320-280-10.  
Otherwise notify DS maintenance.

DRIVETRAIN

DIAGNOSTIC FLOWCHART

KNOWN INFO
VEHICLE DOESNT MOVE SHIFTER OK FLUID OK
POSSIBLE PROBLEMS
TRANSFER CASE TRANSMISSION HALF AND PROPELLER SHAFTS GEARED HUBS

**B1**

THE PROBLEM IS MOST LIKELY IN THE TRANSFER CASE OR TRANSMISSION. IF YOU FIND NO FAULTS IN THIS TEST CHAIN, AND YOU CAME FROM TRANSMISSION, NOTIFY DS MAINTENANCE.

KNOWN INFO
SHIFTER OK TRANSFER CASE OK TRANSMISSION OK SPEEDOMETER WORKS
POSSIBLE PROBLEMS
PROPELLER SHAFTS U-JOINTS GEARED HUBS HALFSHAFTS AND CV JOINTS OK

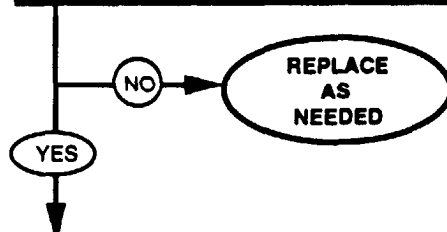
**B2**

INSPECT THE FRONT AND REAR PROPELLER SHAFTS AND U-JOINTS. ARE THEY OK?

**TEST OPTIONS**

VISUAL INSPECTION.

**REASON FOR QUESTION**  
The propeller shafts transmit power from the transfer case to the differentials.



KNOWN INFO
SHIFTER OK TRANSFER CASE OK TRANSMISSION OK SPEEDOMETER WORKS PROPELLER SHAFTS U-JOINTS
POSSIBLE PROBLEMS
GEARED HUBS HALFSHAFTS AND CV JOINTS OK

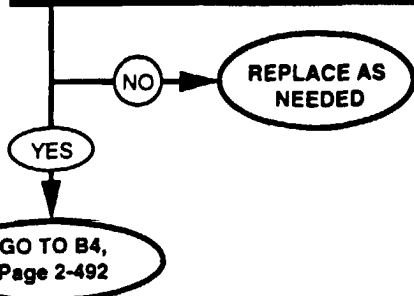
**B3**

INSPECT THE HALFSHAFTS AND THE CONSTANT VELOCITY JOINTS. ARE THEY O.K.?

**TEST OPTIONS**

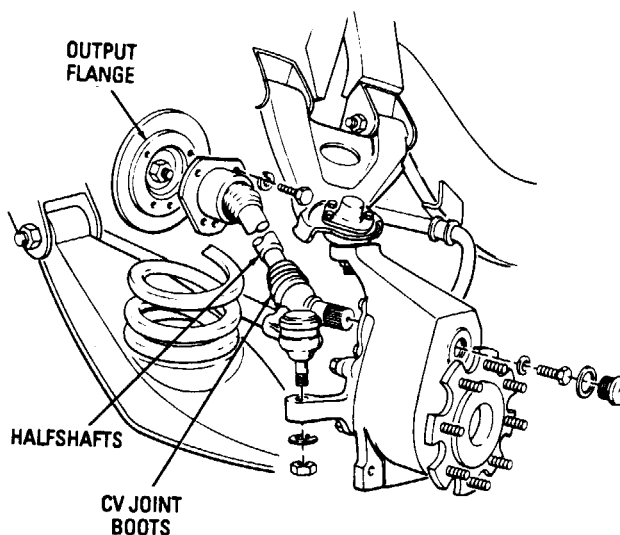
VISUAL INSPECTION.

**REASON FOR QUESTION**  
The halfshafts transmit power from the differentials to the geared hubs.



## REFERENCE INFORMATION

## DRIVETRAIN



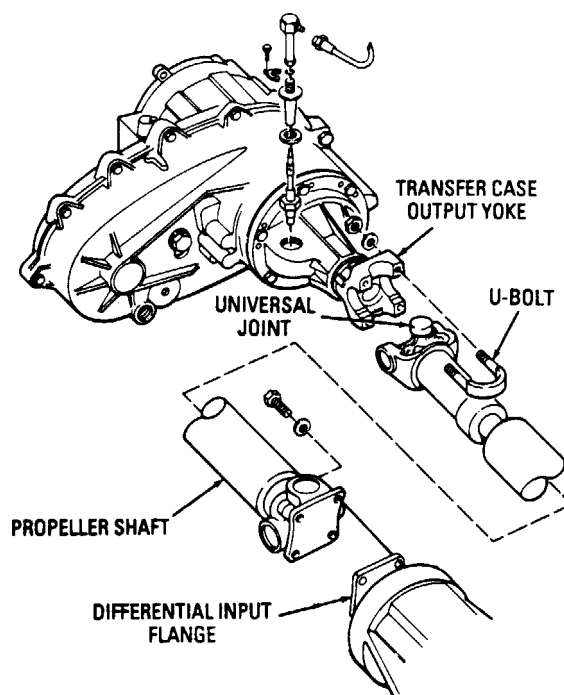
If the vehicle doesn't work, then both shafts would have to be broken.

Check for smooth operation of U-joints, stripped splines, bent yokes, or other problems.

Also check to see if the shaft itself is bent.

Replace propeller shafts, refer to (para 6-2 thru 6-6).

Lube in accordance with TM 9-2320-280-10.



If the vehicle doesn't move, all four shafts maybe broken. Check for tom boots on the CV joints, stripped splines, smooth joint operation, and proper mounting torques.

For halfshaft maintenance procedures, refer to (para 6-9).

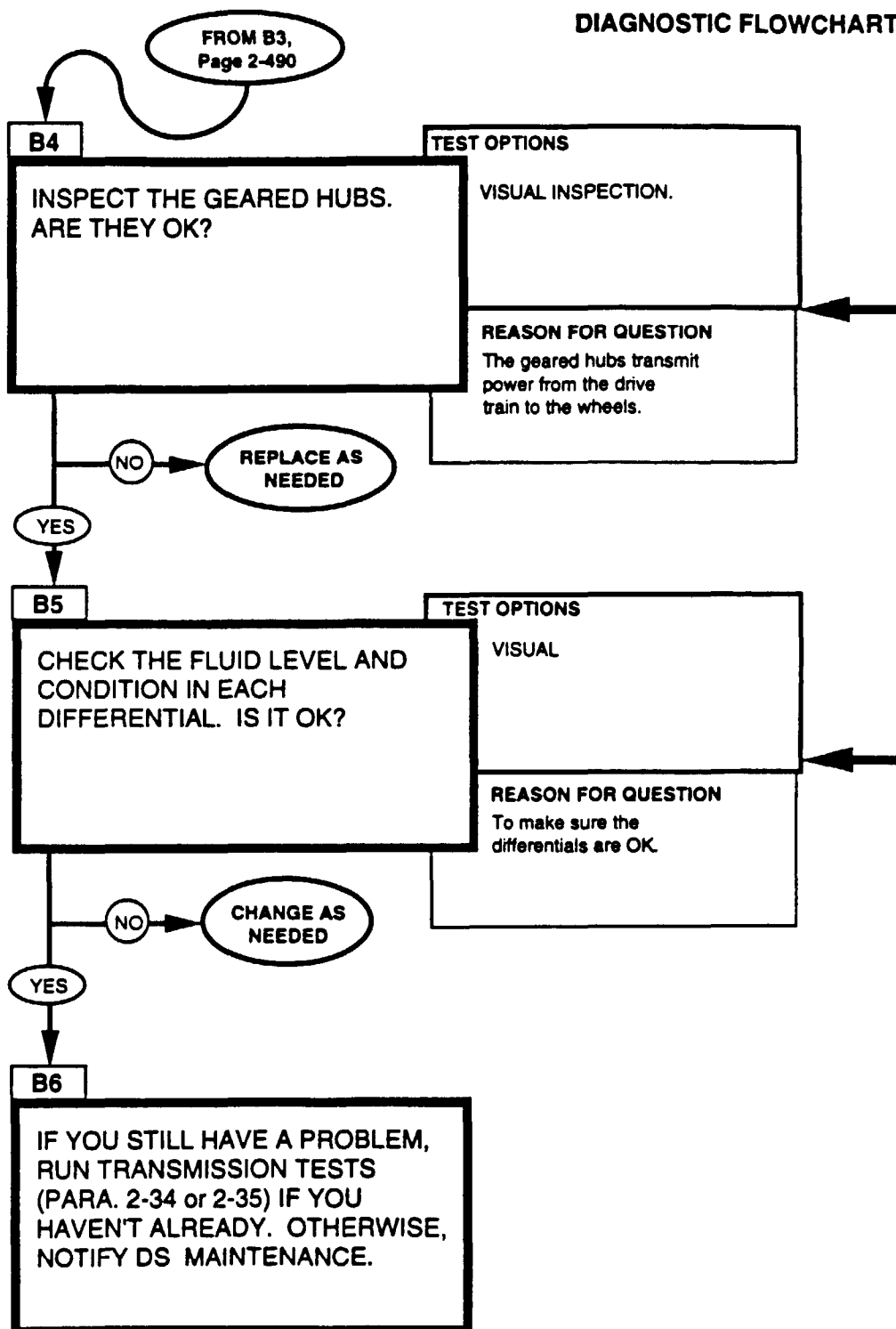
Lube in accordance with TM 9-2320-280-10.

# DRIVETRAIN

KNOWN INFO
<p>SHIFTER OK TRANSFER CASE OK TRANSMISSION OK PROPELLER SHAFTS U-JOINTS HALF SHAFTS AND CV JOINTS OK</p>
POSSIBLE PROBLEMS
<p>GEARED HUBS DIFFERENTIALS</p>

KNOWN INFO
<p>SHIFTER OK TRANSFER CASE OK TRANSMISSION OK SHAFTS AND JOINTS OK GEARED HUBS OK</p>
POSSIBLE PROBLEMS
<p>DIFFERENTIALS</p>

## DIAGNOSTIC FLOWCHART

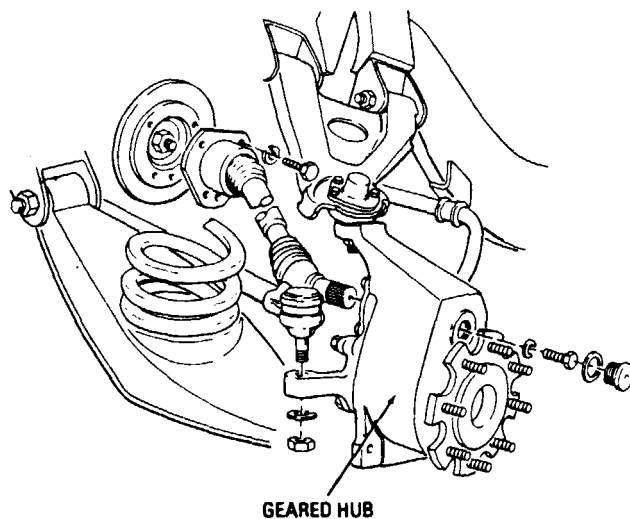


## REFERENCE INFORMATION

## DRIVETRAIN

Make sure the geared hubs turn freely.  
For geared hub replacement procedure,  
refer to (para 6-11). Check mounting  
hardware for proper installation.

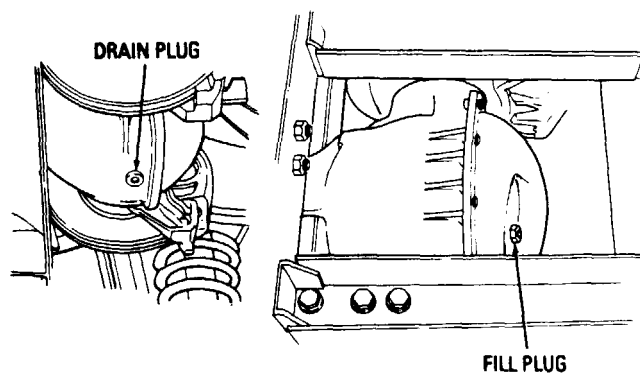
Lube in accordance with  
TM 9-2320-280-10.



Check for loose mounting and broken  
parts. Notify DS maintenance.

Check fluid level in accordance with  
TM 9-2320-280-10.

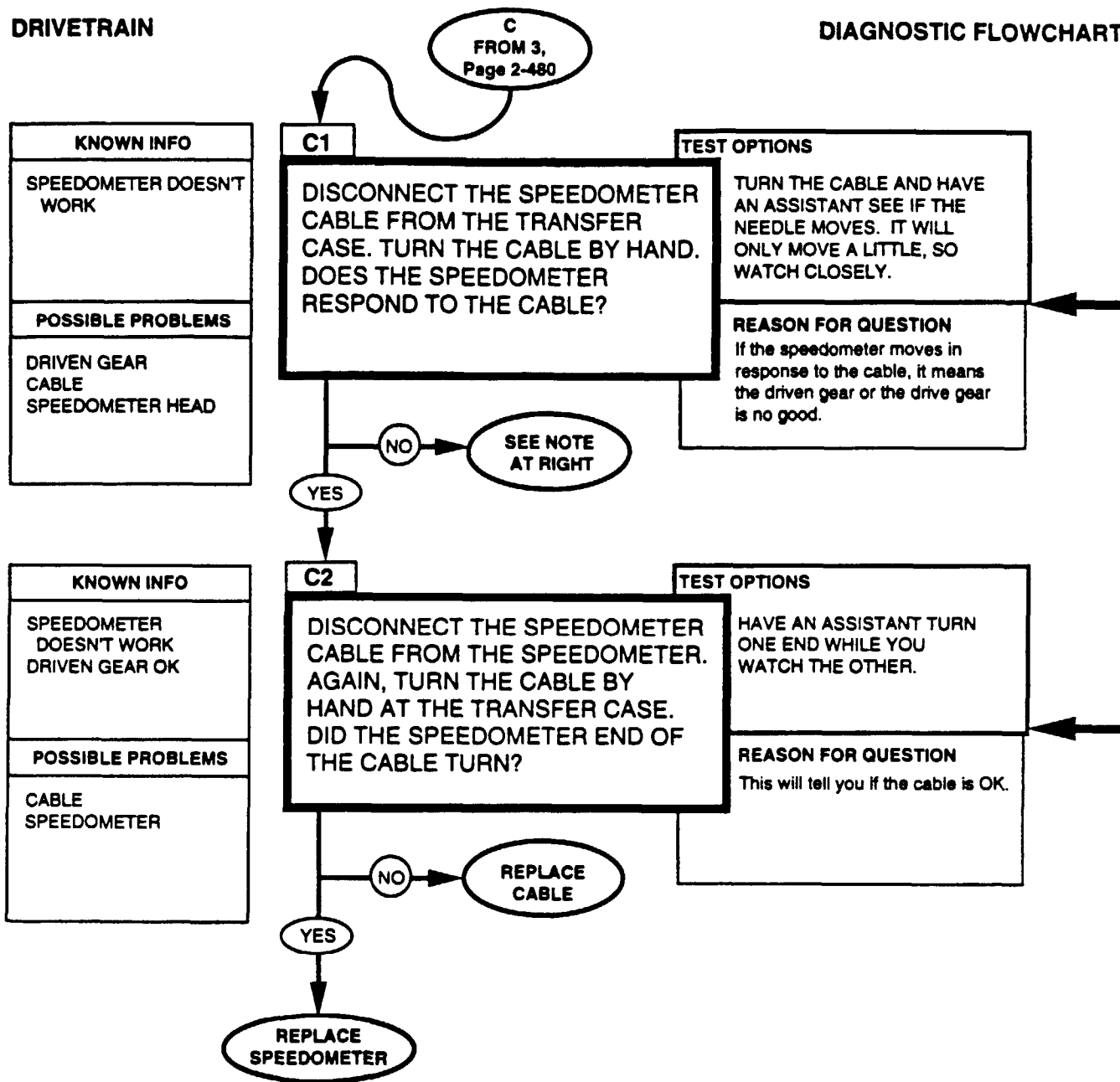
Notify DS maintenance for other faults.





# DRIVETRAIN

## DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

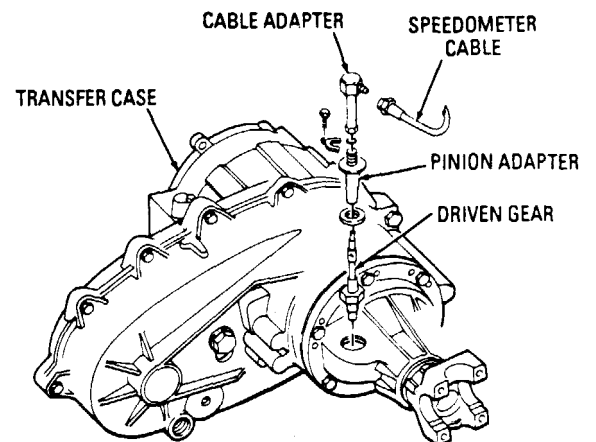
## DRIVETRAIN

A no answer means the speedometer did move.

### NOTE

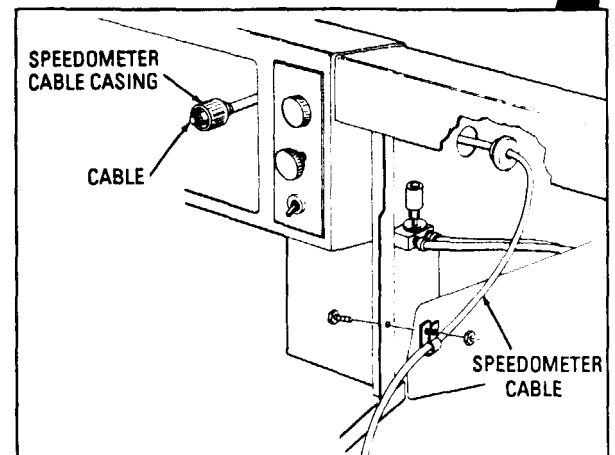
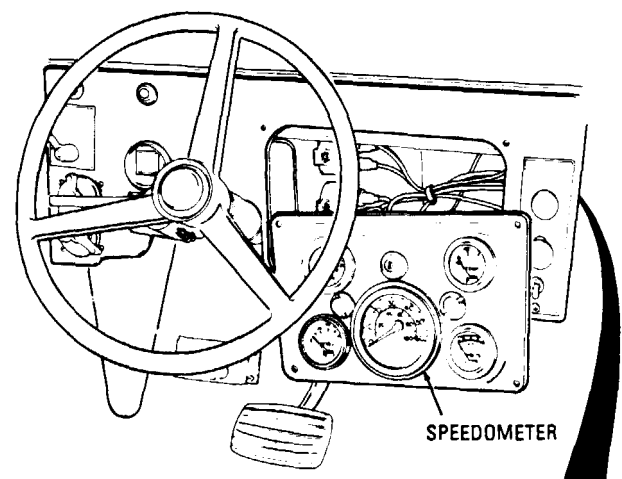
If you answer NO, check the driven gear in the transfer case. if it's OK, the problem is the drive gear. Notify DS maintenance.

Replace the driven gear, refer to (para 5-24).



Replace the cable, refer to (para 4-15).

Replace speedometer, refer to (para 4-14).



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## **2-39. AMBULANCE ELECTRICAL SYSTEM TESTS**

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This section provides information to diagnose and correct malfunctions of the ambulance electrical system.

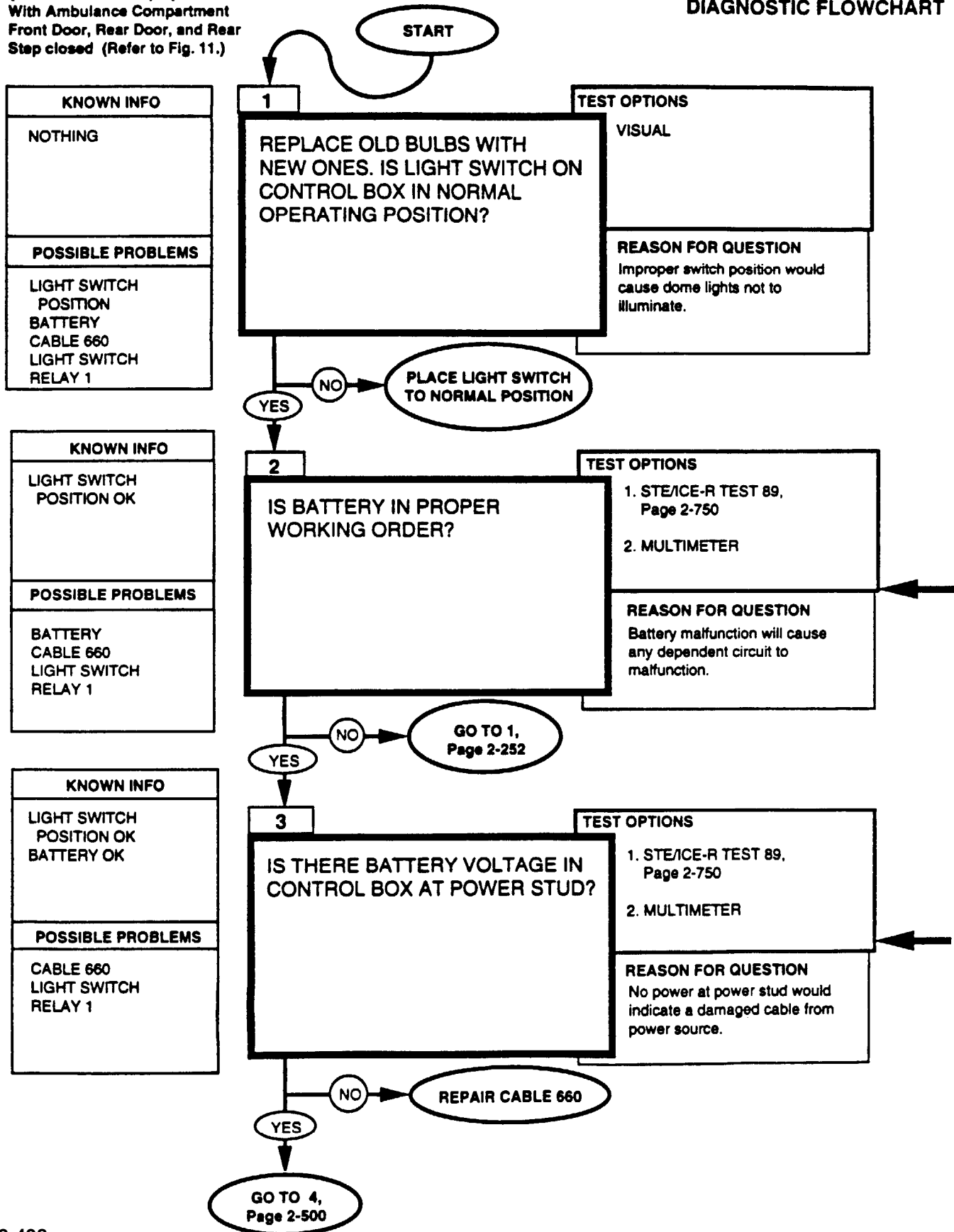
Each malfunction symptom given for an individual component or system is followed by step(s) that you should take to determine the cause and corrective action necessary to remedy the problem.

Before taking any action to correct a possible malfunction, the following rules should be followed:

- (1) Question the operator to obtain any information that might help you determine the cause of the problem.
- (2) Never overlook the chance that the problem could be of simple origin because it could be corrected with minor adjustment.
- (3) Use all senses to observe and locate trouble spots.
- (4) Use test instruments or gauges to help you determine and isolate problem.
- (5) Always isolate the system where the malfunction occurs and then locate the defective component.
- (6) Use standard automotive theories and principles when troubleshooting the vehicles covered in this manual.
- (7) Functional Schematics for ambulance electrical systems are located on pages 2-685 thru 2-691.

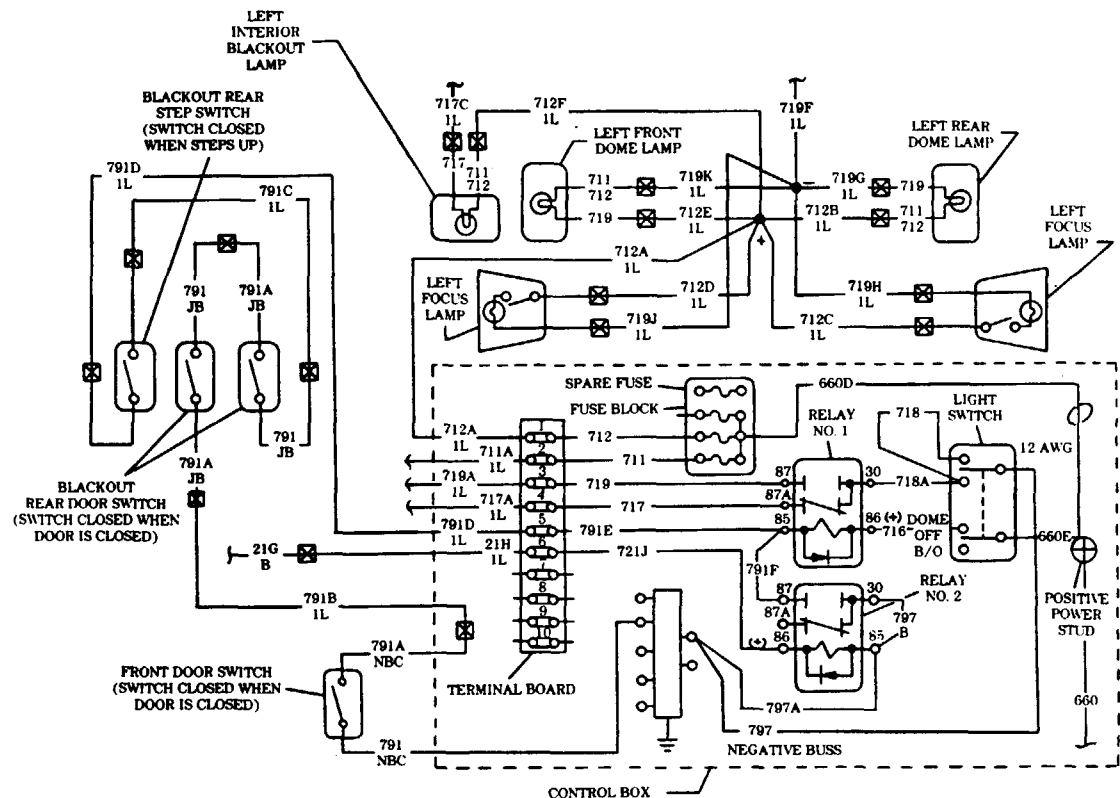
**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance Compartment  
 Front Door, Rear Door, and Rear  
 Step closed (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

**AMBULANCE**



**Repair cable, refer to DS Maintenance.**

**0-45 DC VOLTS**  
**STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

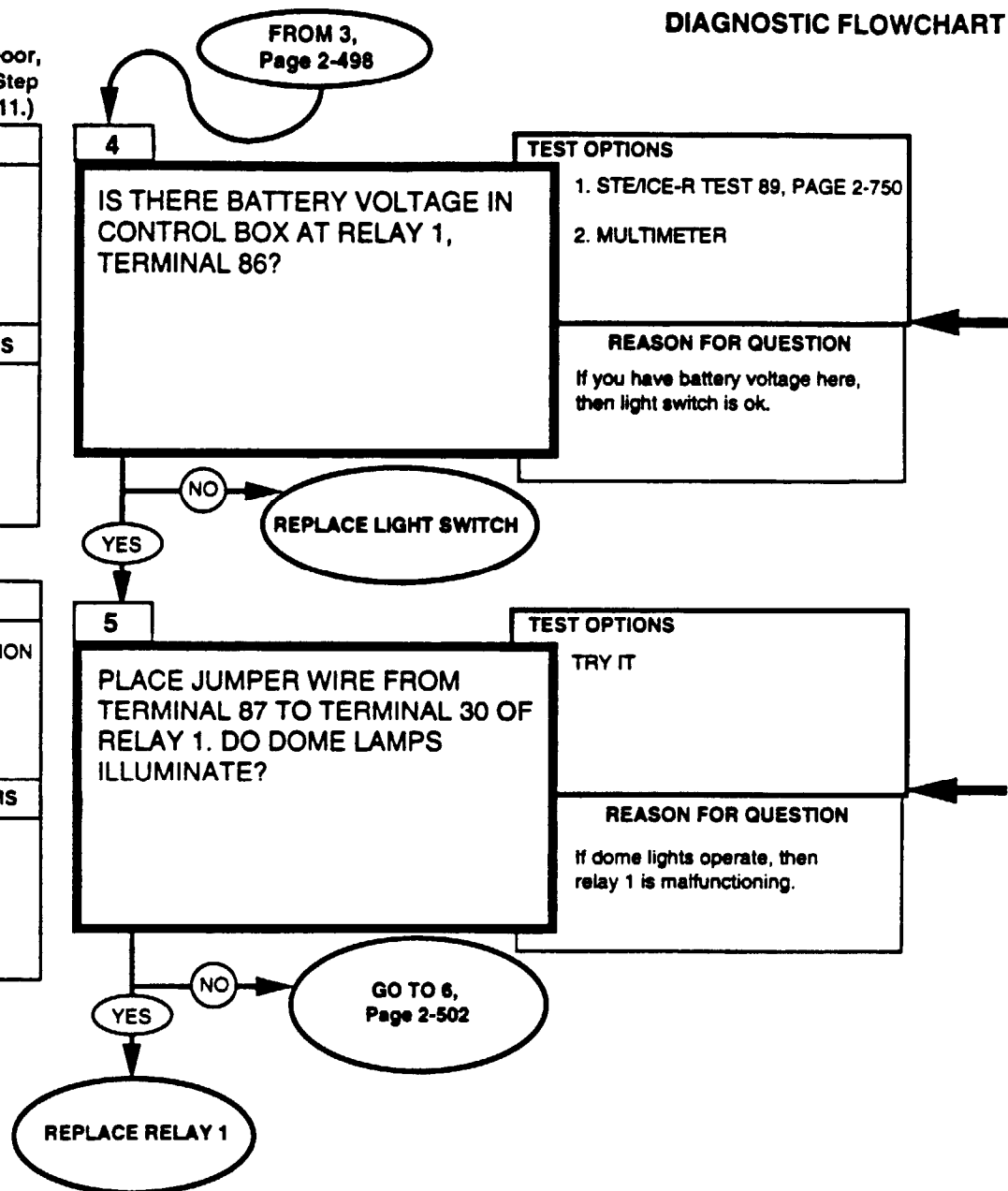
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 closed (Refer to Fig. 11.)

# DIAGNOSTIC FLOWCHART

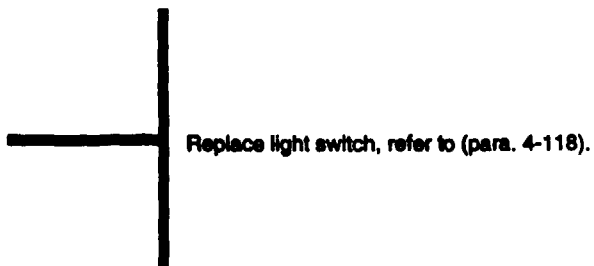
KNOWN INFO
LIGHT SWITCH POSITION OK BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
LIGHT SWITCH RELAY 1

KNOWN INFO
LIGHT SWITCH POSITION OK BATTERY OK CABLE 660 OK LIGHT SWITCH OK
POSSIBLE PROBLEMS
RELAY 1



## REFERENCE INFORMATION

## AMBULANCE

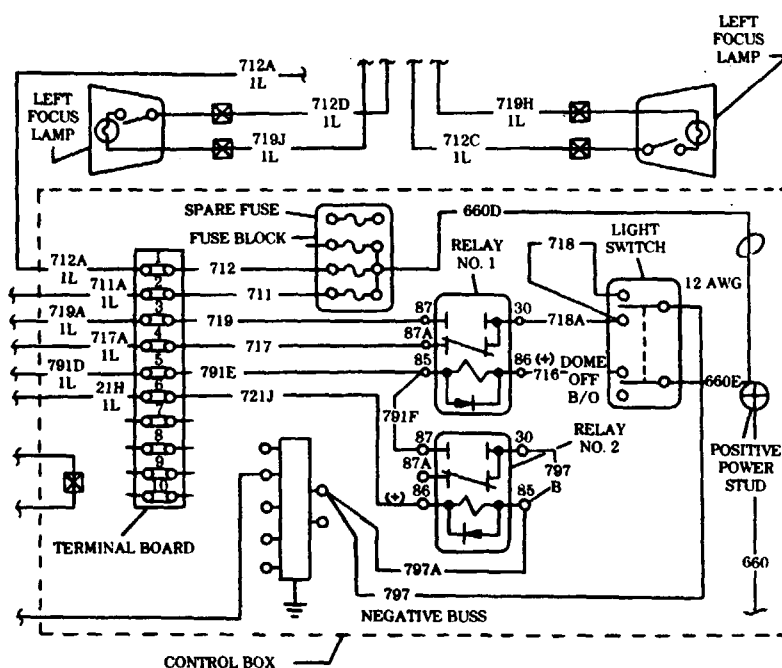
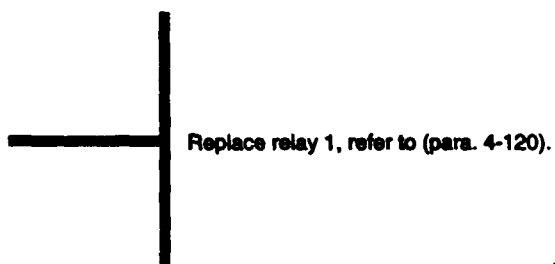


### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



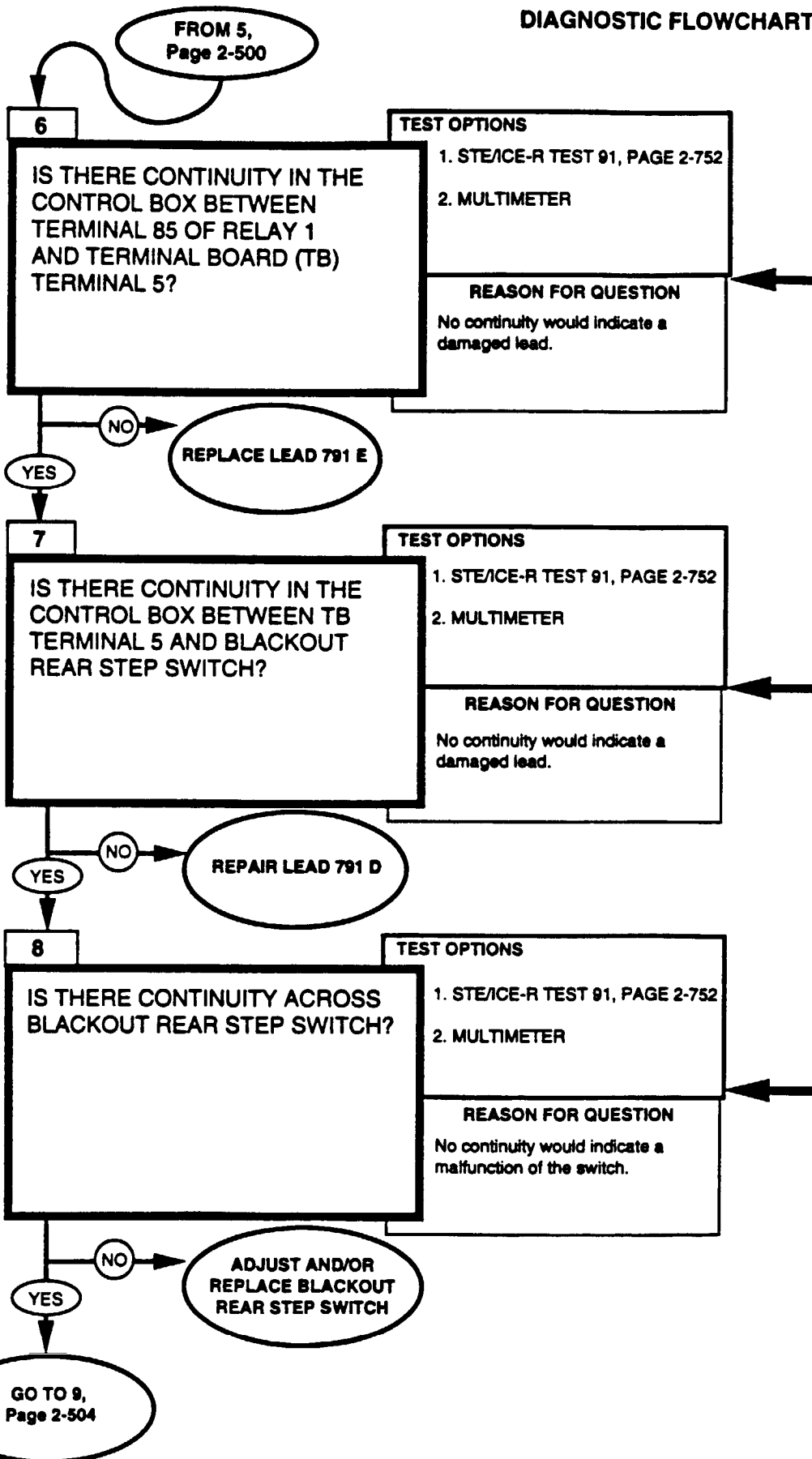
**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 closed (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 791 E LEAD 791 D BLACKOUT REAR STEP SWITCH LEAD 791 A BLACKOUT REAR DOOR SWITCH LEAD 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791

KNOWN INFO
POSSIBLE PROBLEMS
LEAD 791 D BLACKOUT REAR STEP SWITCH LEAD 791 C BLACKOUT REAR DOOR SWITCH LEAD 791 A BLACKOUT REAR DOOR SWITCH LEAD 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK
POSSIBLE PROBLEMS
BLACKOUT REAR STEP SWITCH LEAD 791 C BLACKOUT REAR DOOR SWITCH LEAD 791 A BLACKOUT REAR DOOR SWITCH LEAD 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791





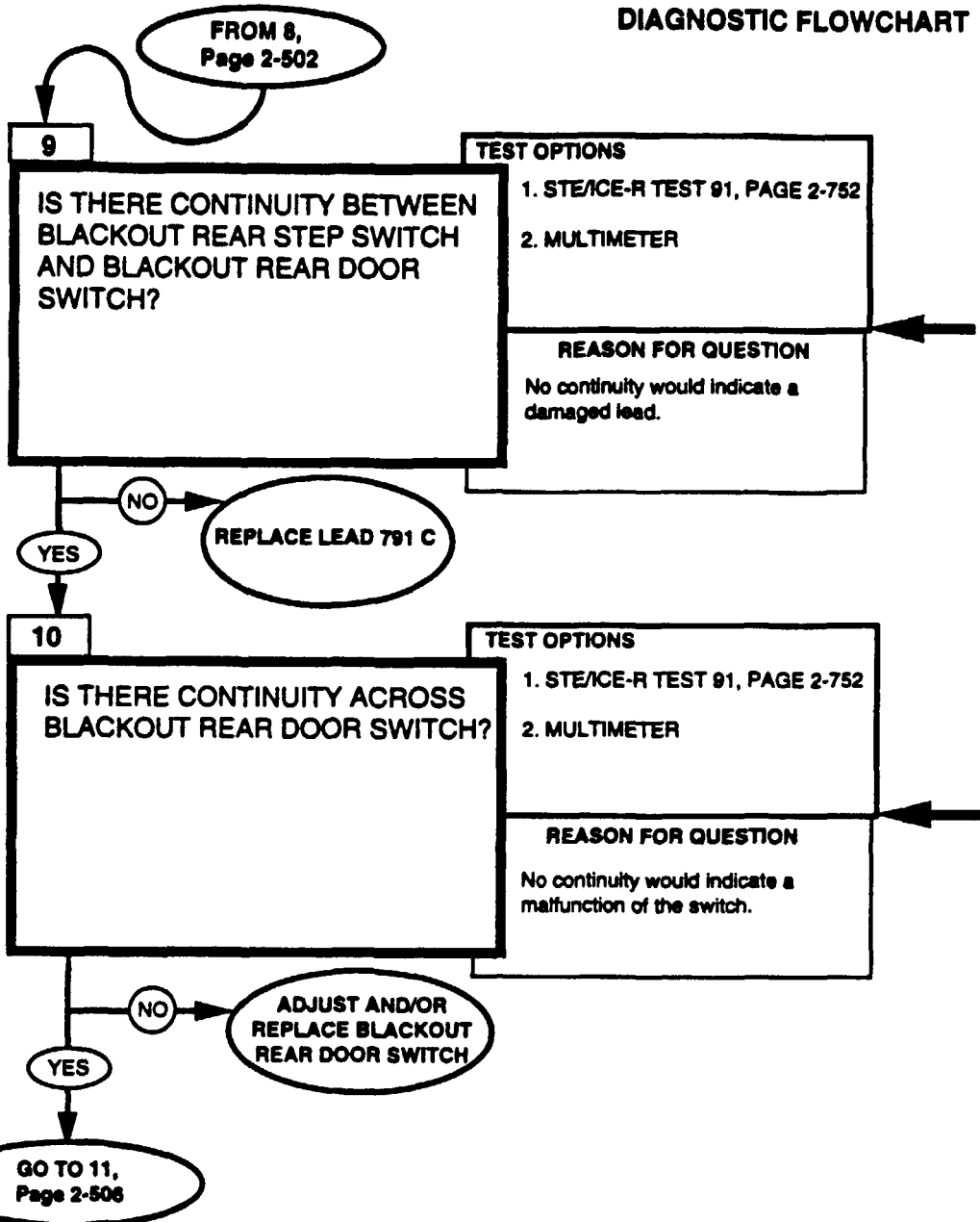


**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 closed (Refer to Fig. 11.)

# DIAGNOSTIC FLOWCHART

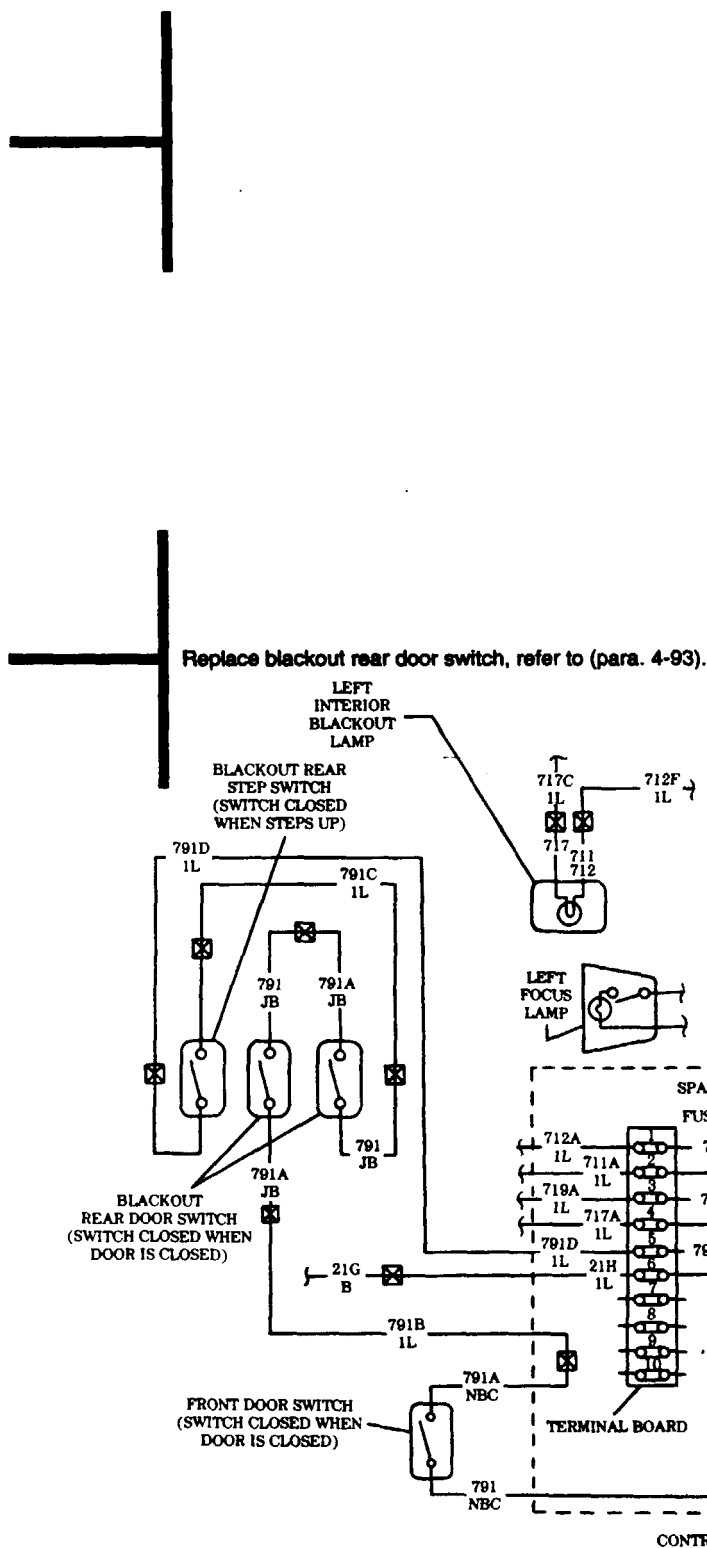
KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK
POSSIBLE PROBLEMS
LEAD 791 C BLACKOUT REAR DOOR SWITCH LEAD 791 A BLACKOUT REAR DOOR SWITCH 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791

KNOWN INFO
LEAD 791 C OK LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK
POSSIBLE PROBLEMS
BLACKOUT REAR STEP SWITCH LEAD 791 A BLACKOUT REAR DOOR SWITCH LEAD 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791



REFERENCE INFORMATION

AMBULANCE



**0-4500 DC OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

**CONTINUITY (RESISTANCE)  
MULTIMETER**

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

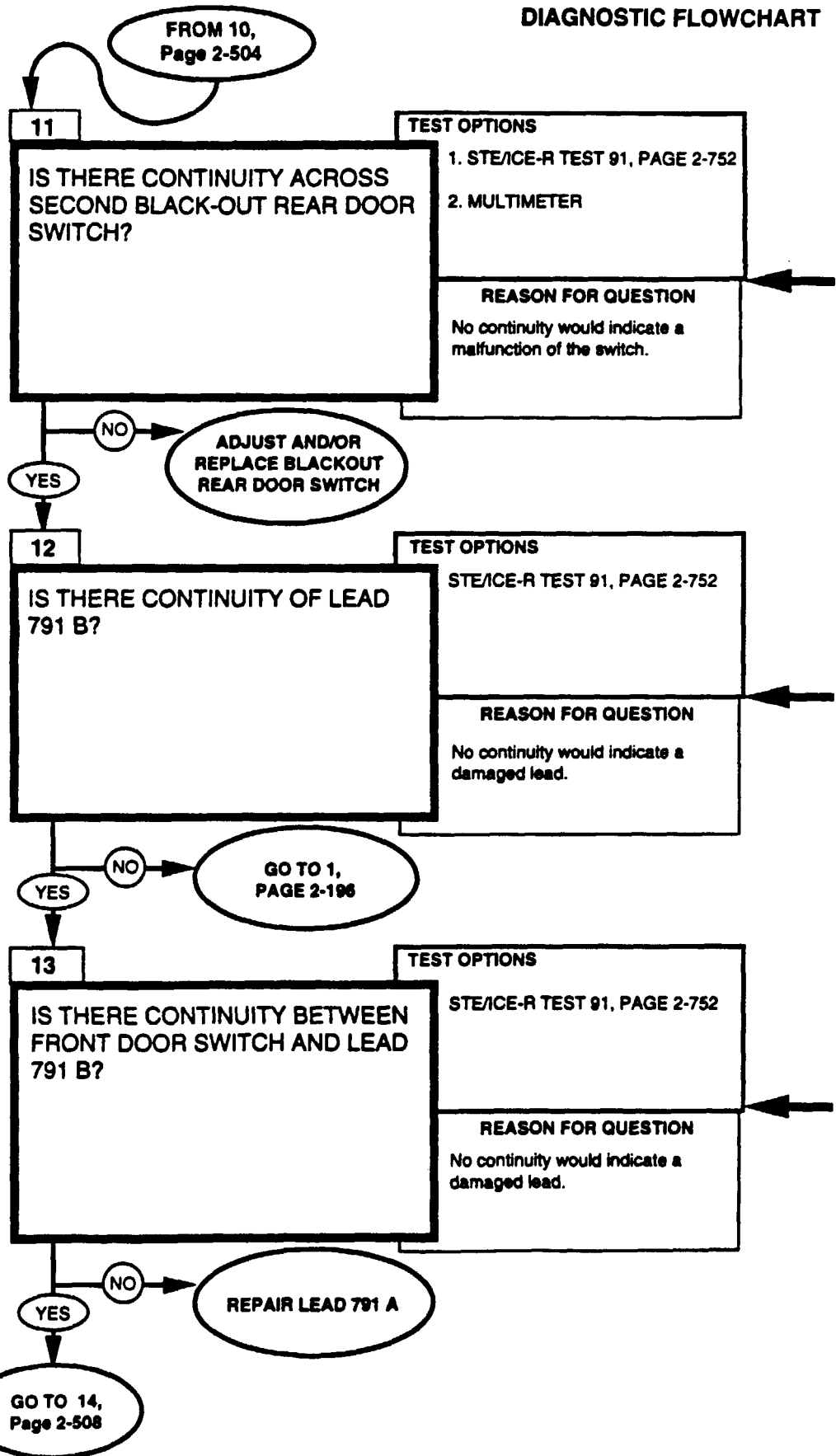
**AMBULANCE**  
(All Dome Lamps)  
With Ambulance  
Compartment Front Door,  
Rear Door, and Rear Step  
Closed (Refer to Fig. 11.)

# DIAGNOSTIC FLOWCHART

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK BLACKOUT REAR DOOR SWITCH OK
POSSIBLE PROBLEMS
BLACKOUT REAR DOOR SWITCH LEAD 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK LEAD 791 C OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK
POSSIBLE PROBLEMS
LEAD 791 B LEAD 791 A FRONT DOOR SWITCH LEAD 791

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK LEAD 791 C OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK
POSSIBLE PROBLEMS
LEAD 791 A FRONT DOOR SWITCH LEAD 791



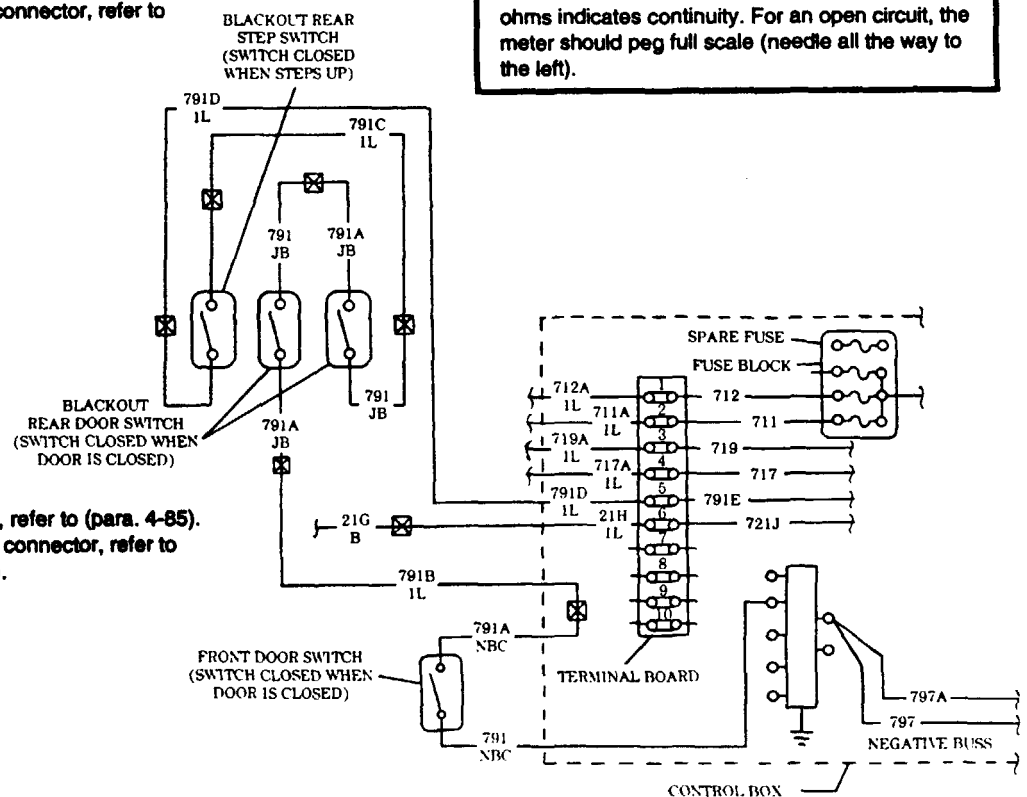
# REFERENCE INFORMATION

# AMBULANCE

Replace blackout rear door switch, refer to (para. 4-83).

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).



## 0-4500 DC OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start test 91, 0-4500 ohms.

3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

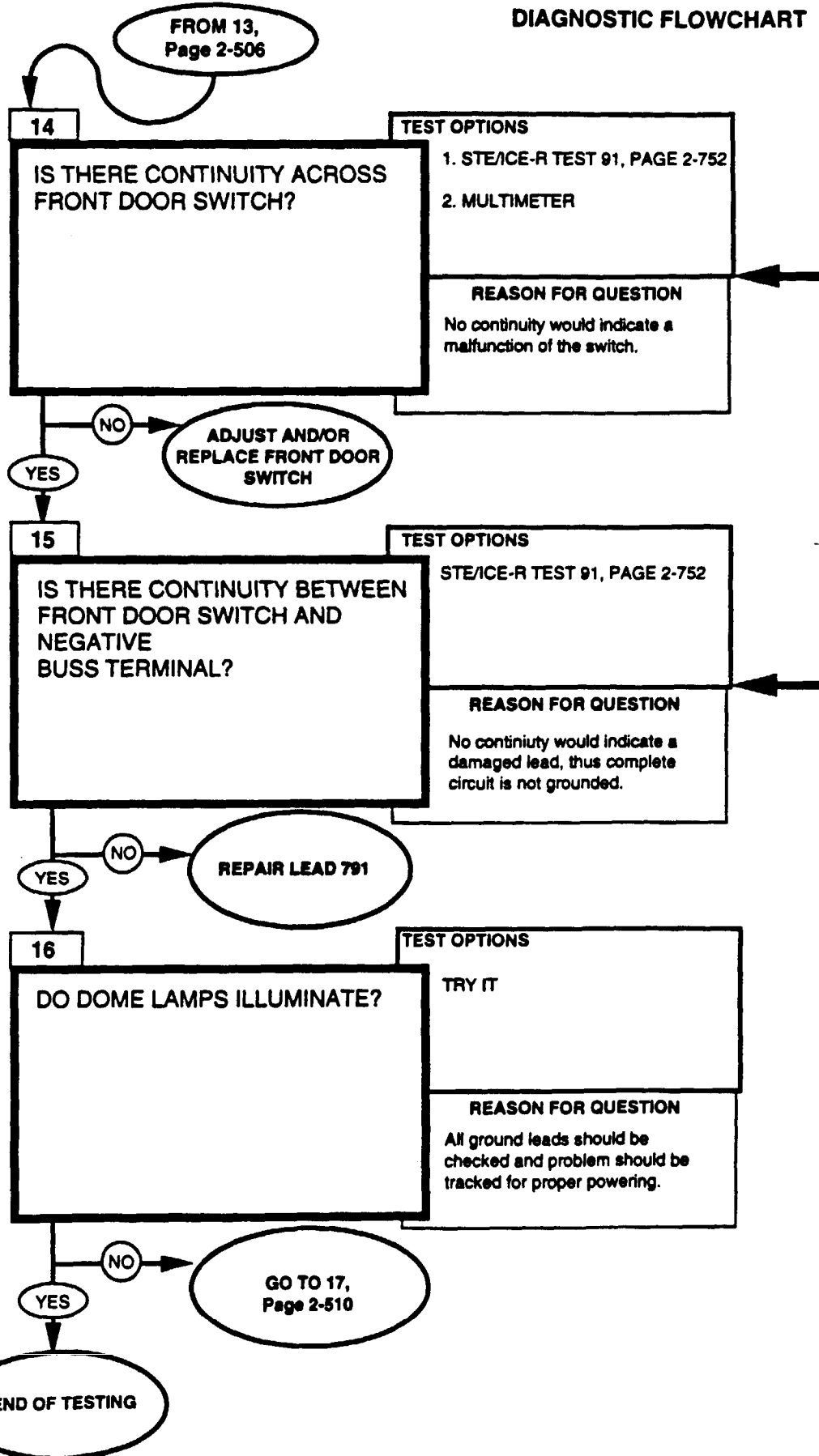
**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 Closed (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK LEAD 791 A OK
POSSIBLE PROBLEMS
FRONT DOOR SWITCH LEAD 791

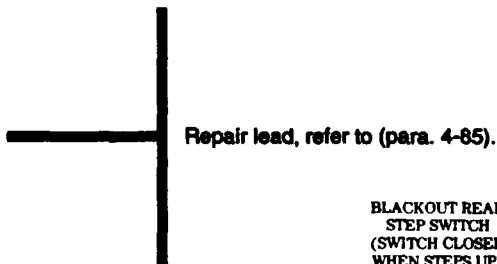
KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK LEAD 791 C OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK LEAD 791 A OK FRONT DOOR SWITCH OK
POSSIBLE PROBLEMS
LEAD 791

KNOWN INFO
LEAD 791 E OK LEAD 791 D OK BLACKOUT REAR STEP SWITCH OK LEAD 791 C OK BLACKOUT REAR DOOR SWITCH OK BLACKOUT REAR DOOR SWITCH OK LEAD 791 B OK LEAD 791 A OK FRONT DOOR SWITCH OK LEAD 791 OK
POSSIBLE PROBLEMS



# REFERENCE INFORMATION

# AMBULANCE

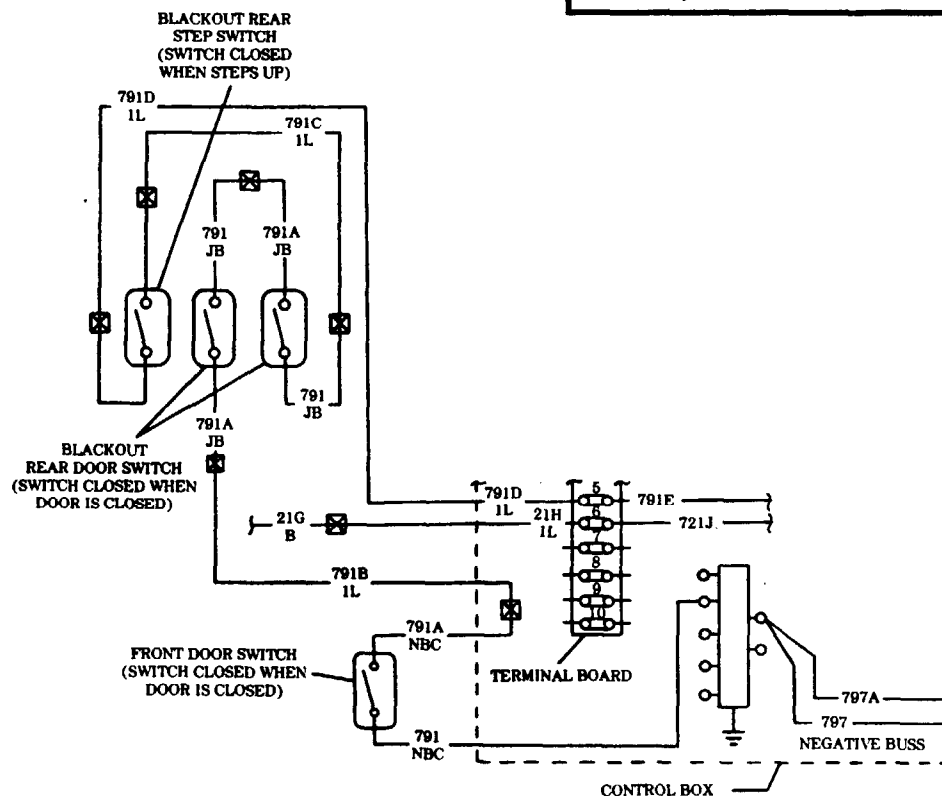


## 0-4500 DC OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question. RED to the first, BLACK to the second.
2. Start test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms. STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

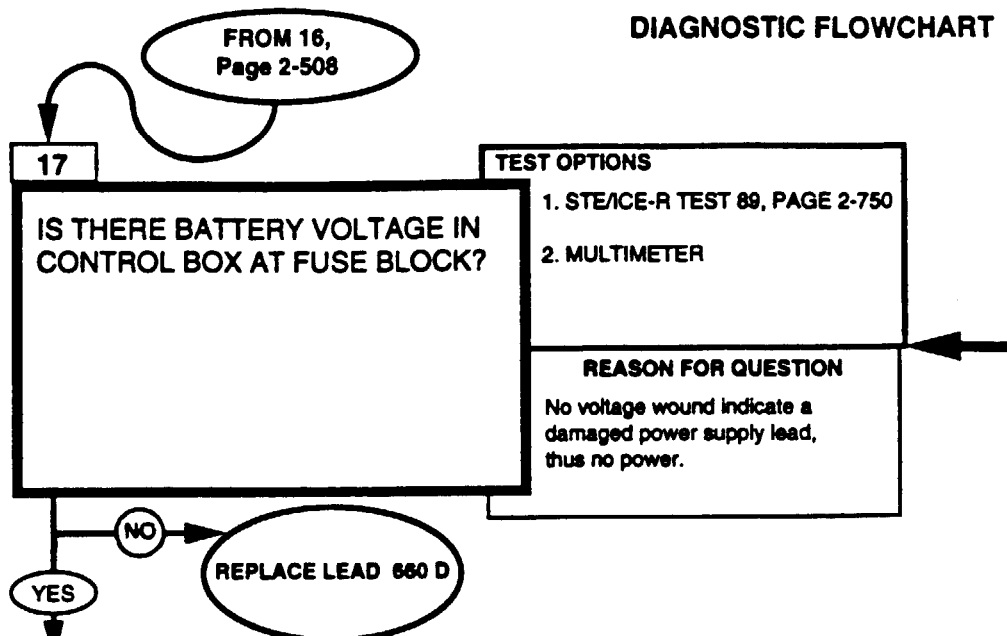
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



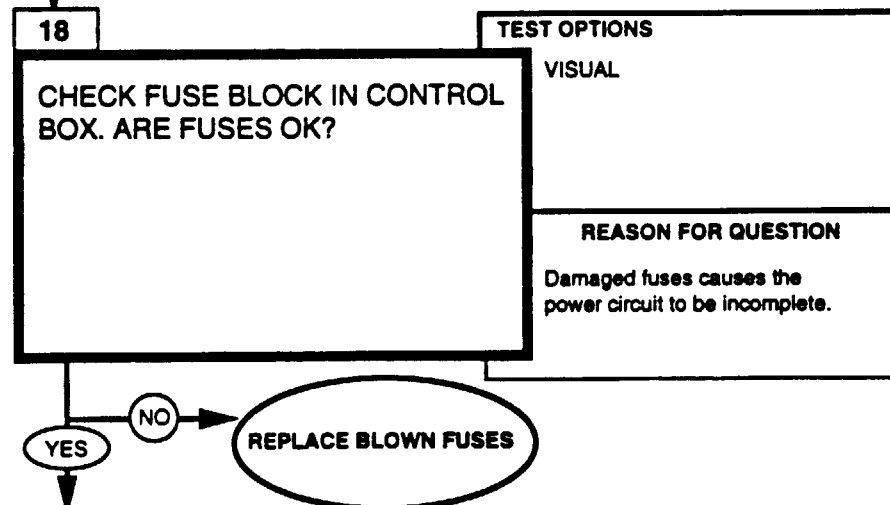
**AMBULANCE**  
 (All Dome Lamps)  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 Closed (Refer to Fig. 11.)

# DIAGNOSTIC FLOWCHART

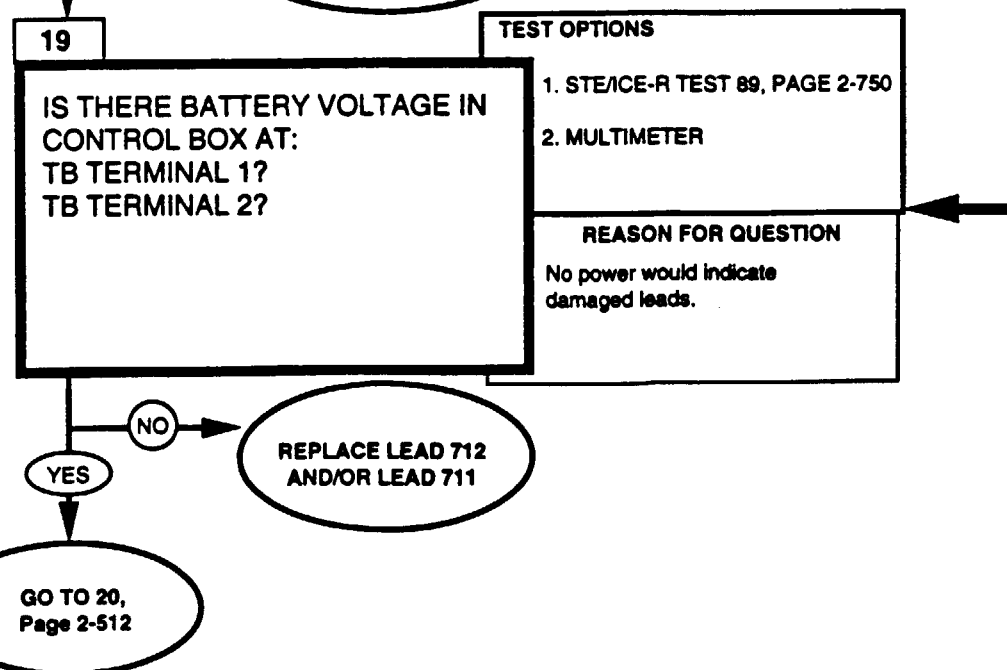
KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 660 D BLOWN FUSES LEAD 712 LEAD 711 DAMAGED LEADS



KNOWN INFO
LEAD 660 D OK
POSSIBLE PROBLEMS
BLOWN FUSES LEAD 712 LEAD 711 DAMAGED LEADS



KNOWN INFO
LEAD 660 D OK FUSES OK
POSSIBLE PROBLEMS
LEAD 712 LEAD 711 DAMAGED LEADS





## REFERENCE INFORMATION

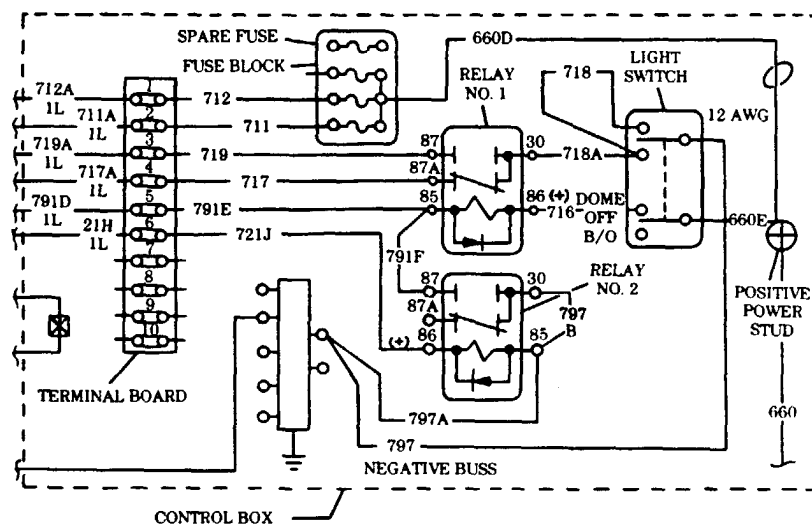
## AMBULANCE

**0-45 DC VOLTS**  
**STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

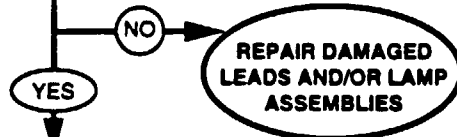
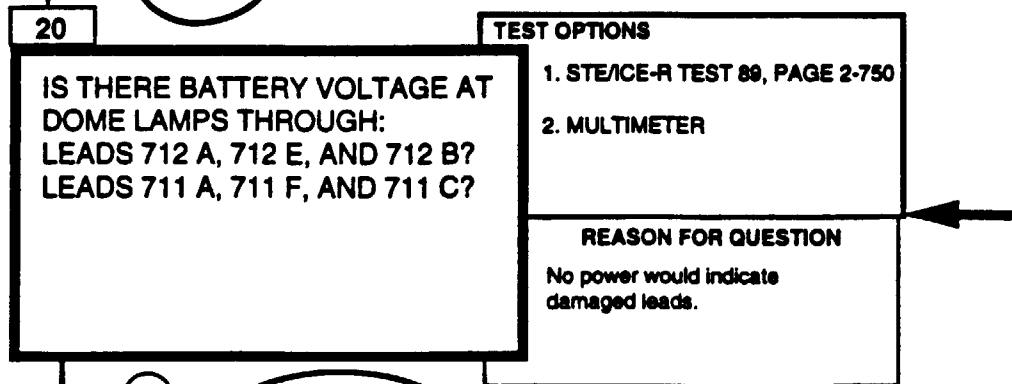
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



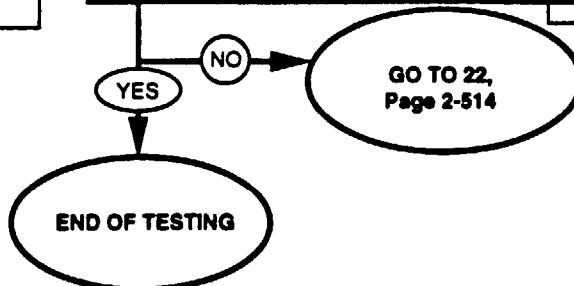
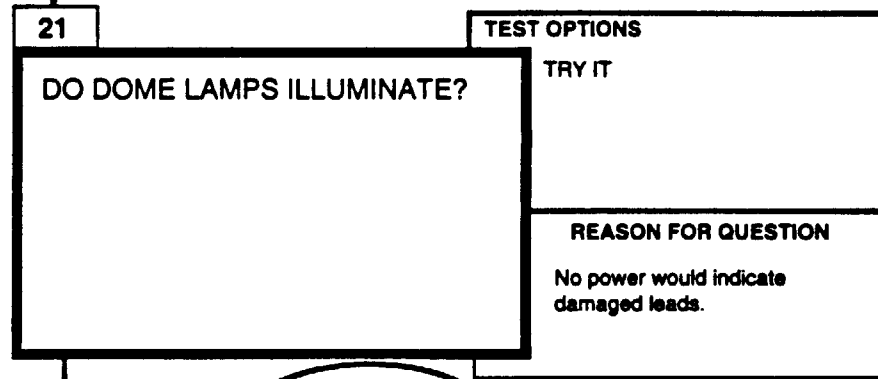
**AMBULANCE**  
 (All Dome Lamps)  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 Closed (Refer to Fig. 11.)

# DIAGNOSTIC FLOWCHART

KNOWN INFO
LEAD 660 D OK FUSES OK LEAD 712 OK LEAD 711 OK
POSSIBLE PROBLEMS
DAMAGED LAMPS



KNOWN INFO
LEAD 660 D OK FUSES OK LEAD 712 OK LEAD 711 OK LEADS OK
POSSIBLE PROBLEMS



REFERENCE INFORMATION

AMBULANCE

Replace dome lamp assembly, refer to (para. 4-87).

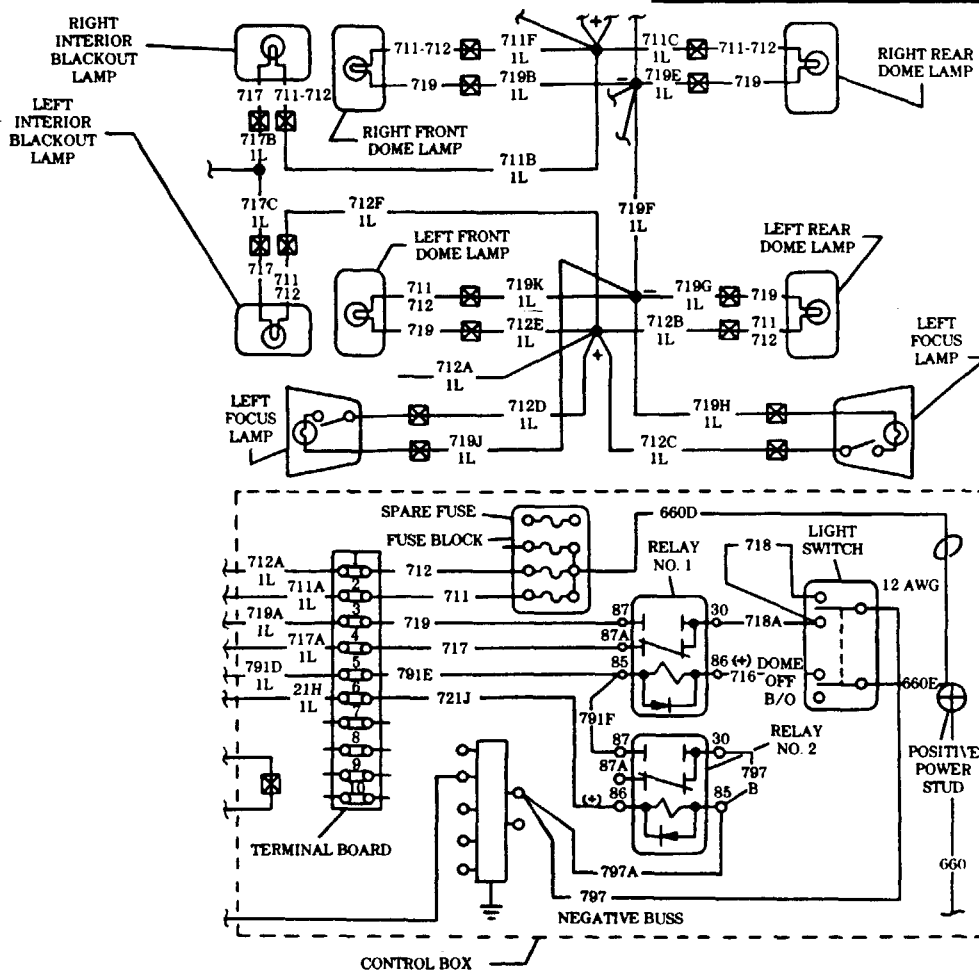
Repair lead connector, refer to (para. 4-85).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

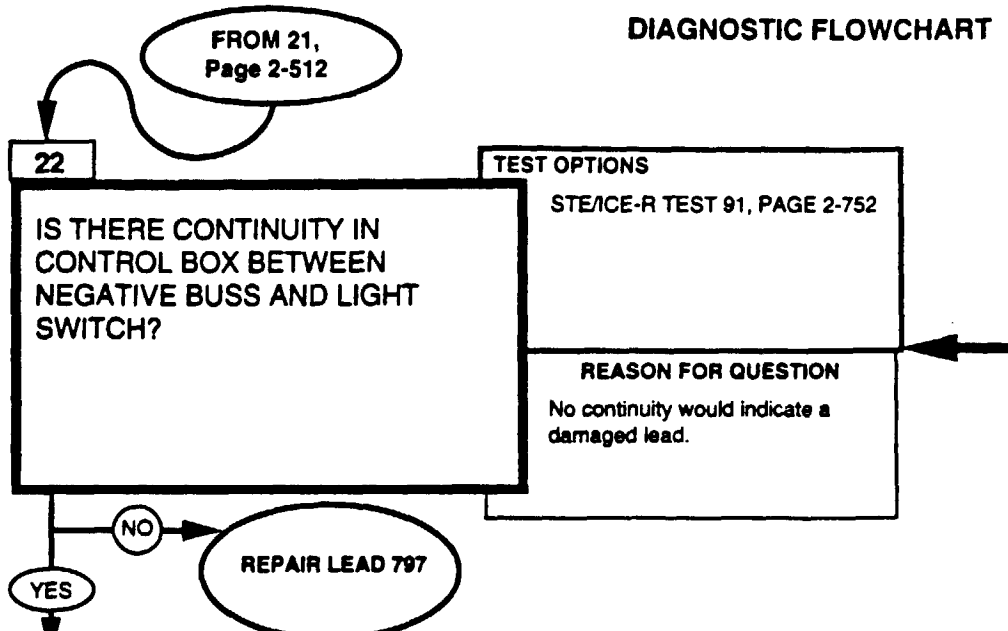
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



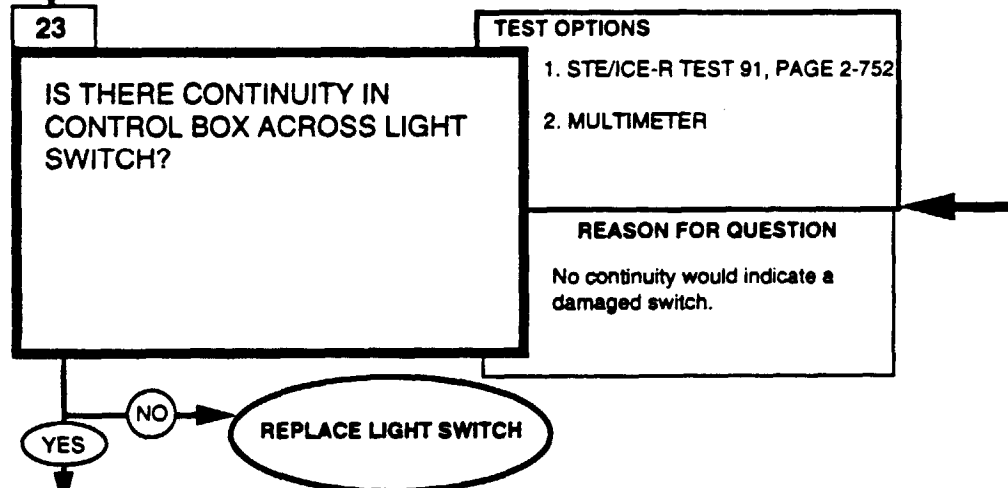
**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 Closed (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

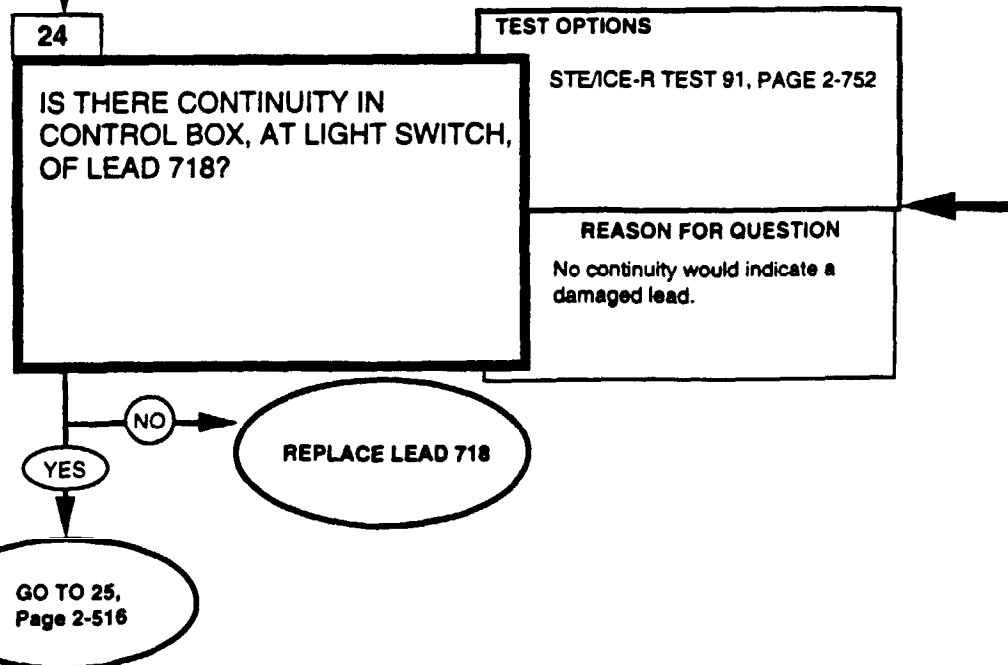
KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 797 LIGHT SWITCH LEAD 718 LEAD 718 A LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS



KNOWN INFO
LEAD 797 OK
POSSIBLE PROBLEMS
LIGHT SWITCH LEAD 718 LEAD 718 A LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS



KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK
POSSIBLE PROBLEMS
LEAD 718 LEAD 718 A LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS



REFERENCE INFORMATION

AMBULANCE

Repair lead, refer to (para. 4-85).

Replace light switch, refer to (para. 4-118).

0-4500 DC OHMS  
STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

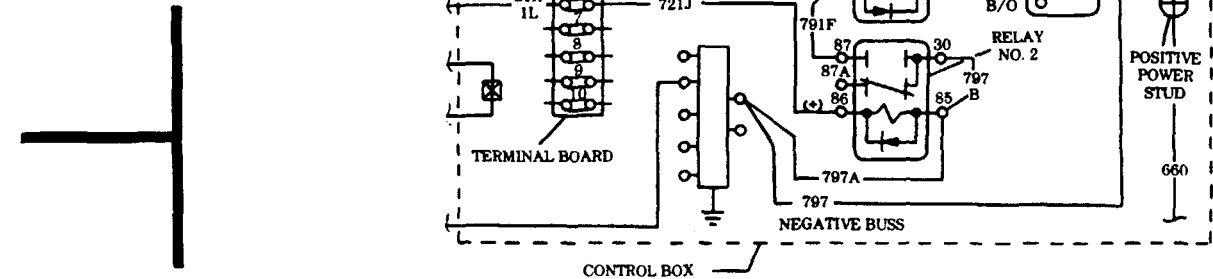
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

CONTINUITY (RESISTANCE)  
MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.

2. Connect the RED and BLACK leads to the connections stated in the question.

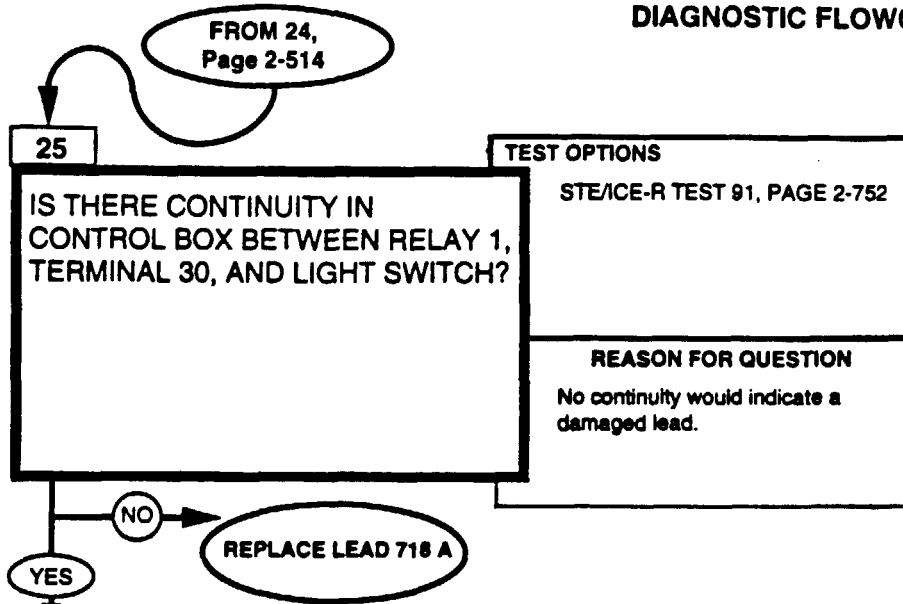
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



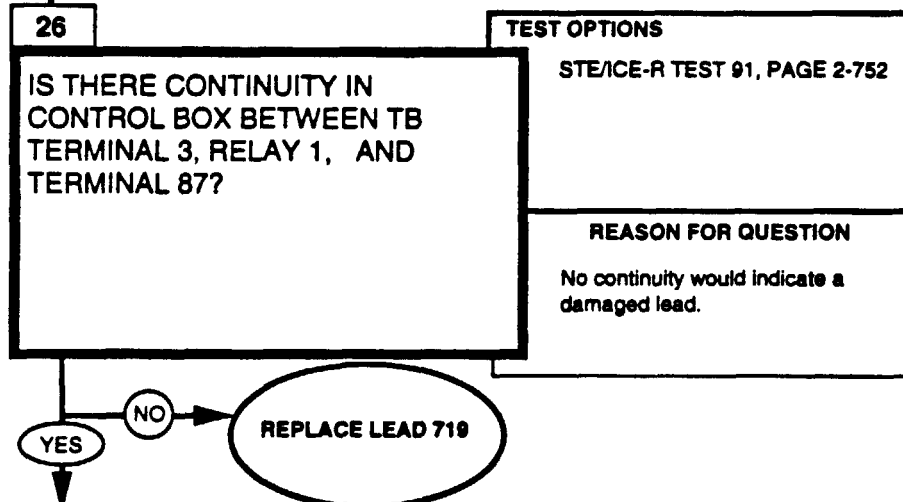
**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 Closed (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

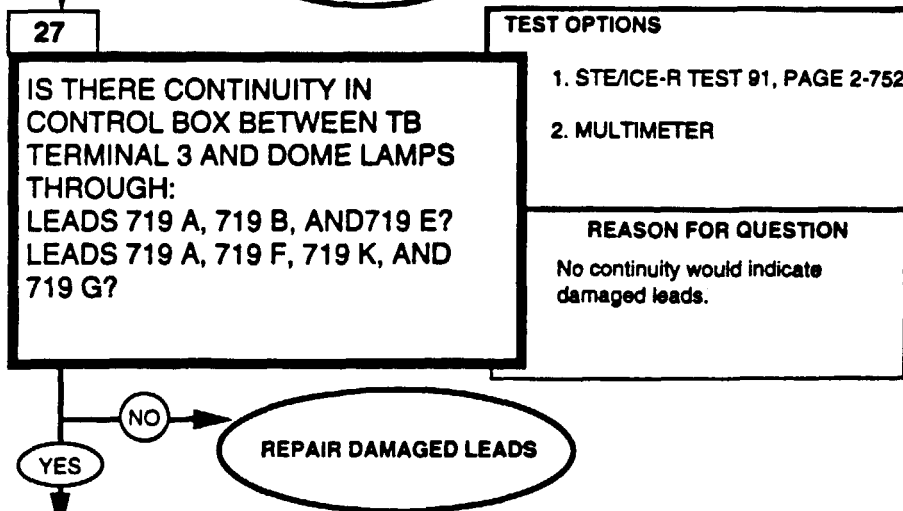
KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK
POSSIBLE PROBLEMS
LEAD 718 A LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS



KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK LEAD 718A OK
POSSIBLE PROBLEMS
LEAD 719 DAMAGED LEADS DOME LAMP SOCKETS



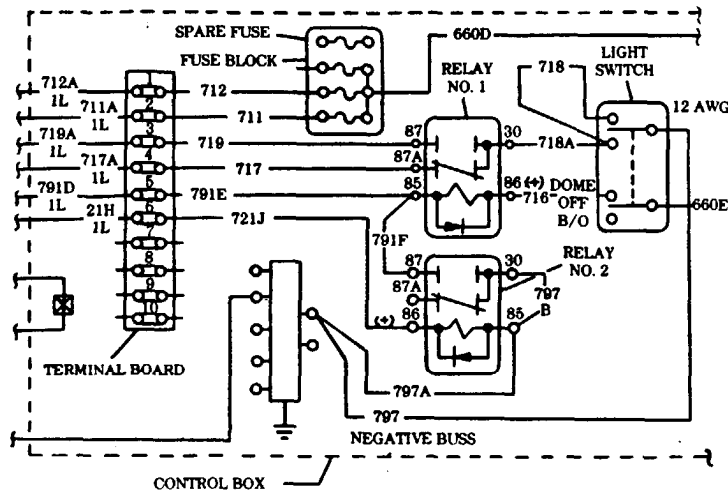
KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK LEAD 718 A OK LEAD 719 OK
POSSIBLE PROBLEMS
DAMAGED LEADS DOME LAMP SOCKETS



GO TO 28,  
Page 2-518

# REFERENCE INFORMATION

# AMBULANCE

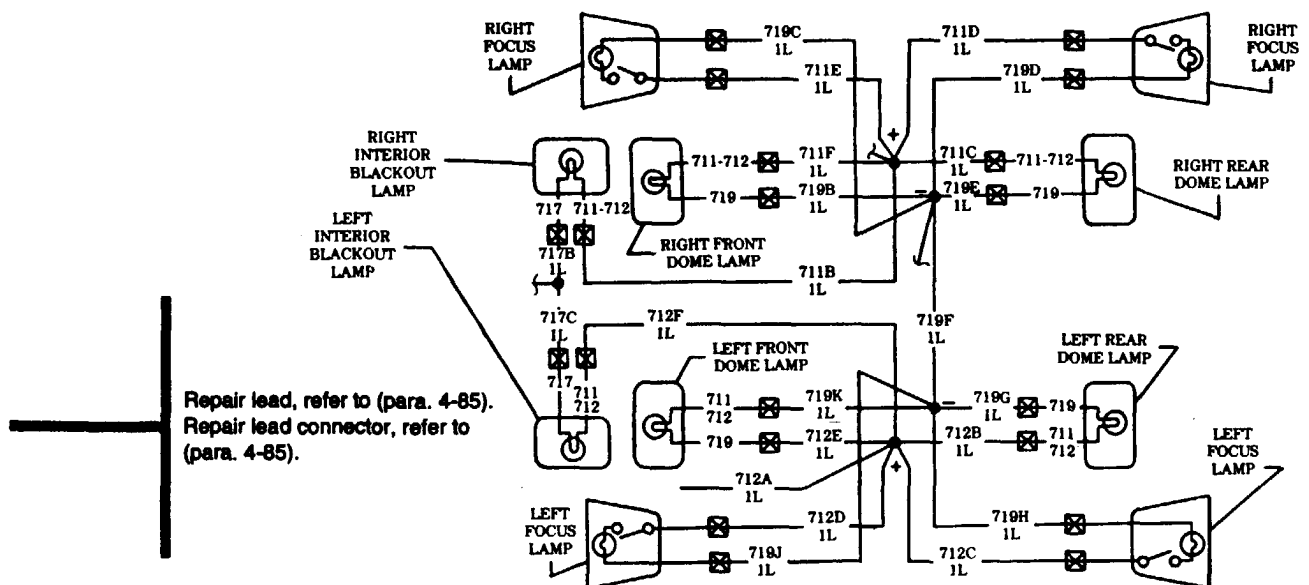


## 0-4500 DC OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

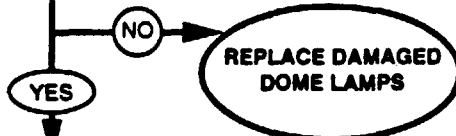
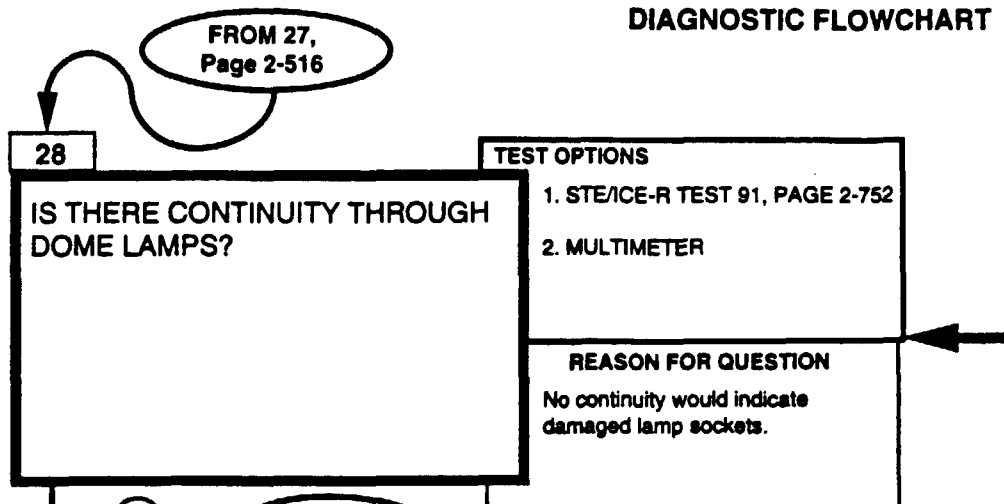
1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).



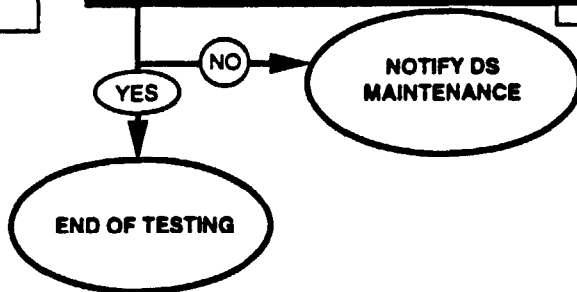
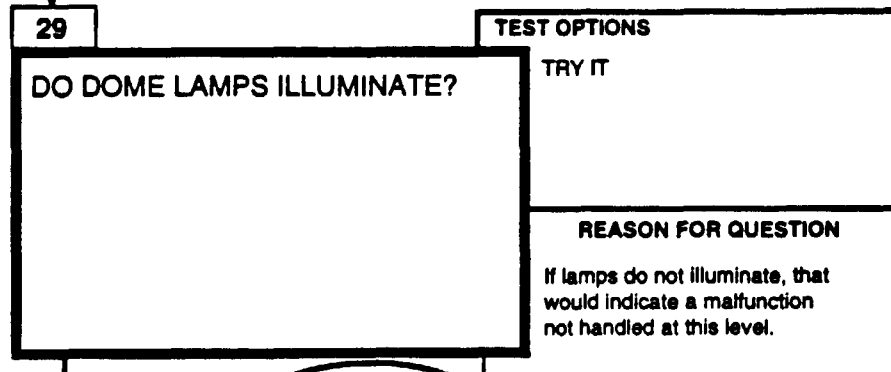
**AMBULANCE**  
**(All Dome Lamps)**  
 With Ambulance  
 Compartment Front Door,  
 Rear Door, and Rear Step  
 Closed (Refer to Fig. 11.)

# DIAGNOSTIC FLOWCHART

KNOWN INFO
LEAD 797 OK LIGHT SWITCH OK LEAD 718 OK LEAD 718 A OK LEAD 719 OK DAMAGED LEADS OK
POSSIBLE PROBLEMS
DAMAGED LAMPS



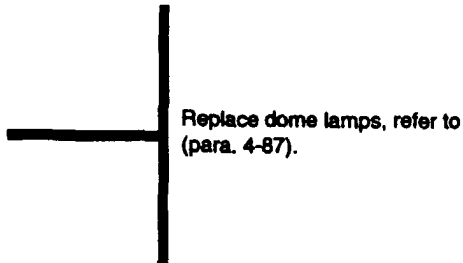
KNOWN INFO
LEAD 660 D OK FUSES OK LEAD 712 OK LEAD 711 OK LEADS OK
POSSIBLE PROBLEMS



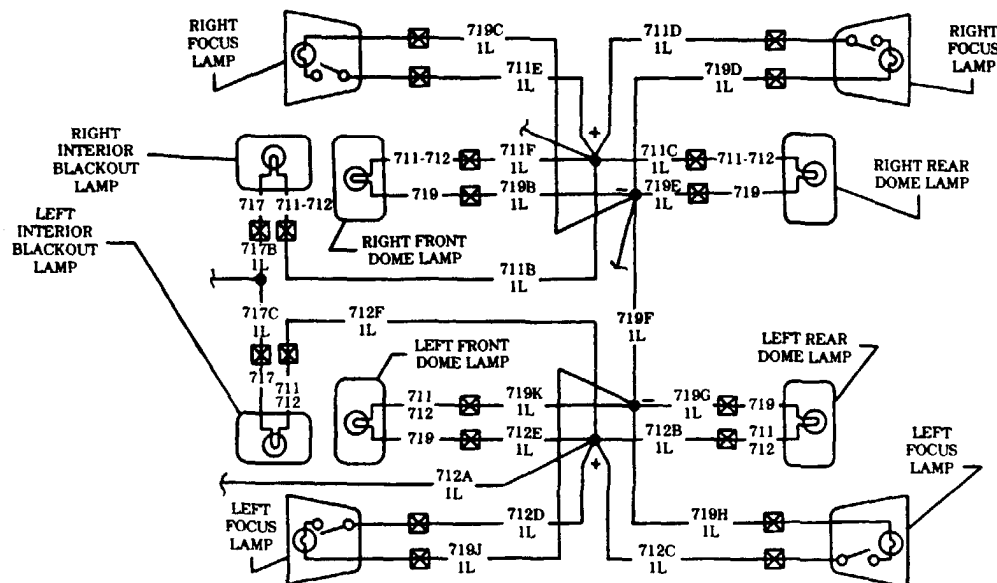


# REFERENCE INFORMATION

# AMBULANCE



0-4500 DC OHMS STE/ICE-R TEST 91
<p>1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.</p> <p>2. Start Test 91, 0-4500 ohms.</p> <p>3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."</p>
CONTINUITY (RESISTANCE) MULTIMETER
<p>1. Set the voltmeter to an ohms scale of about 1000 ohms.</p> <p>2. Connect the RED and BLACK leads to the connections stated in the question.</p> <p>3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).</p>

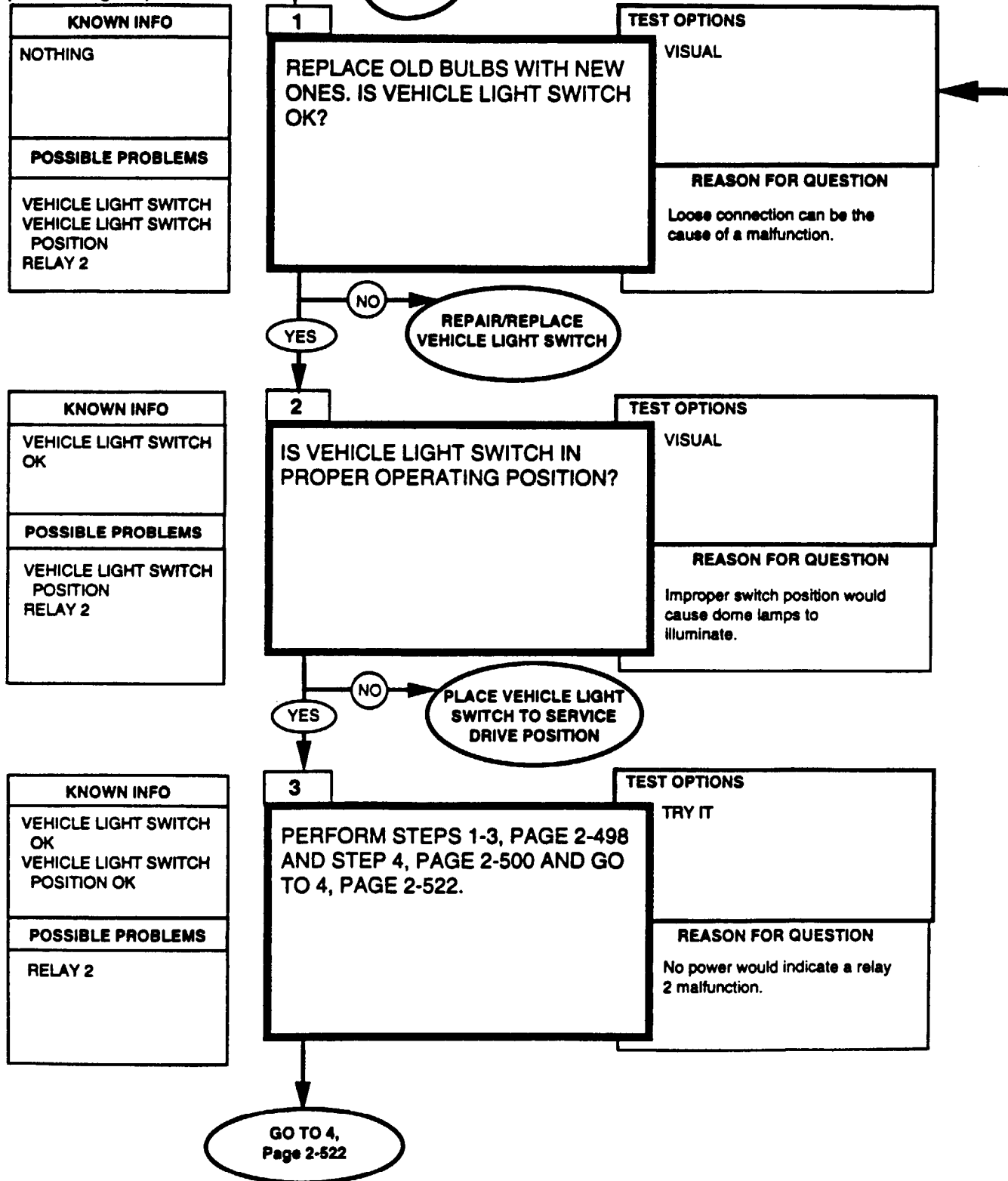


# **AMBULANCE**

## **(All Dome Lamps)**

With Ambulance compartment front door, rear door, and rear step open and vehicle light switch in service position. (Refer to Fig. 11.)

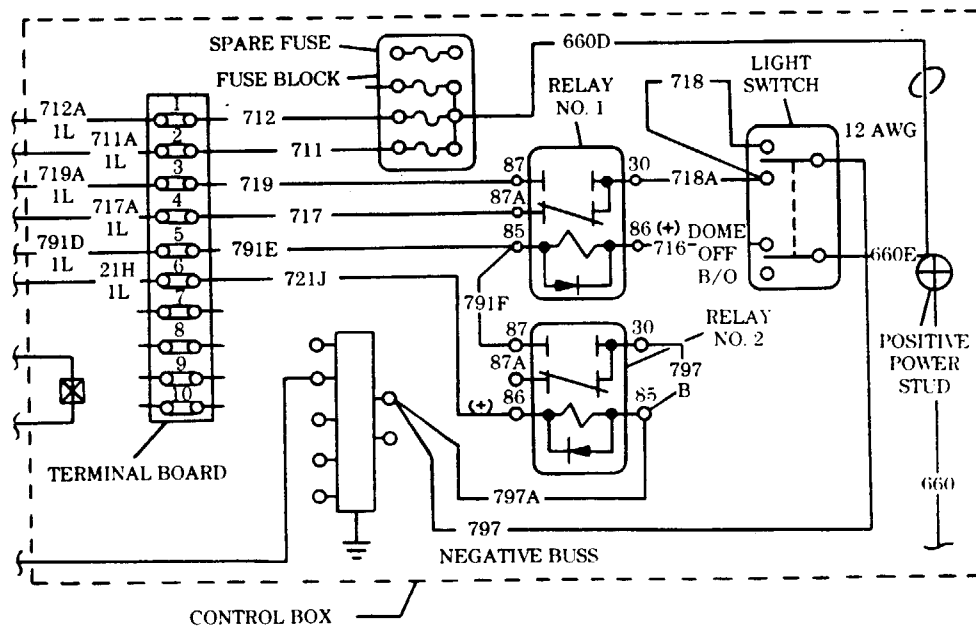
## **DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

AMBULANCE

Replace main light switch,  
refer to (para. 4-59).

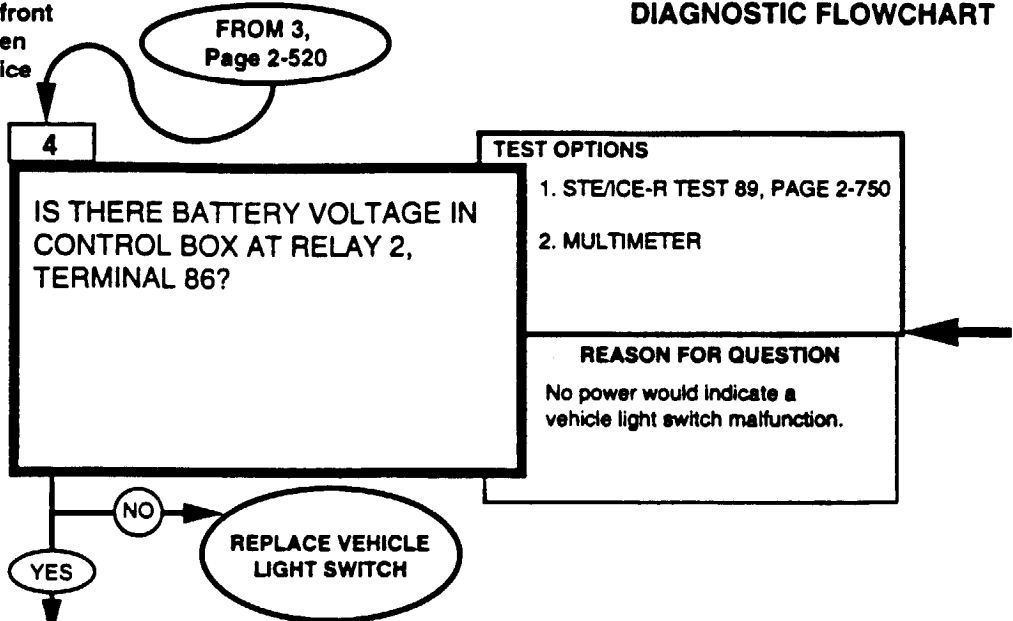


**AMBULANCE**  
**(All Dome Lamps)**

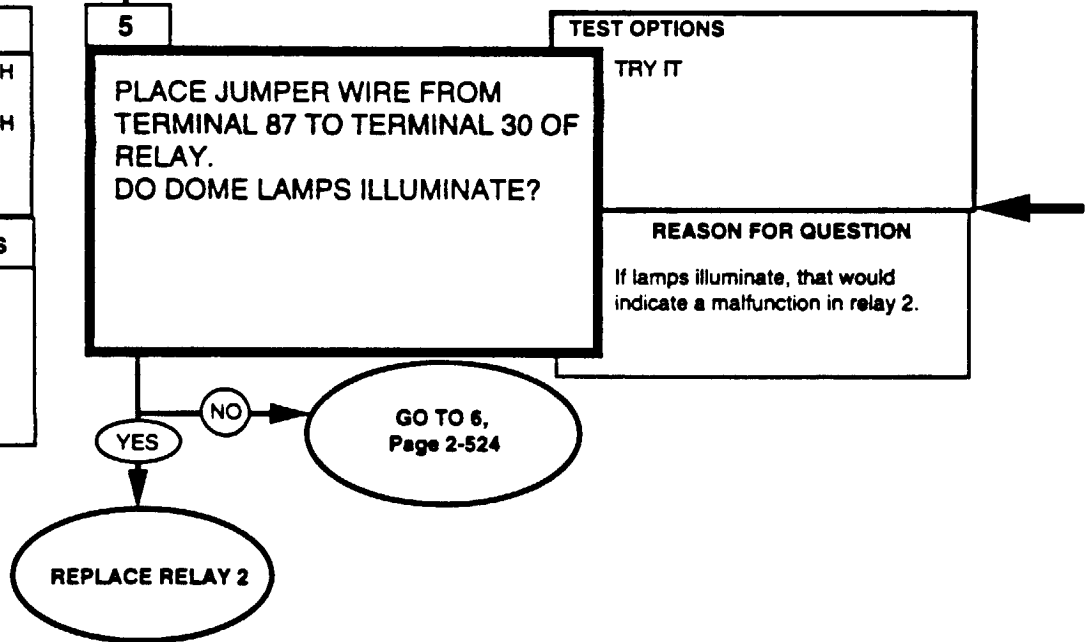
With Ambulance compartment front door, rear door, or rear step open and vehicle light switch in service position (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
VEHICLE LIGHT SWITCH OK
VEHICLE LIGHT SWITCH POSITION OK
BATTERY OK
CABLE 660 OK
POSSIBLE PROBLEMS
RELAY 2



KNOWN INFO
VEHICLE LIGHT SWITCH OK
VEHICLE LIGHT SWITCH POSITION OK
BATTERY OK
CABLE 660 OK
POSSIBLE PROBLEMS
RELAY 2



REFERENCE INFORMATION

AMBULANCE

Replace main light switch,  
refer to (para. 4-59).

Replace relay 2, refer to (para. 4-120).

**0-45DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point,  
BLACK clip to negative or ground.

2. Start Test 89, DC volts.

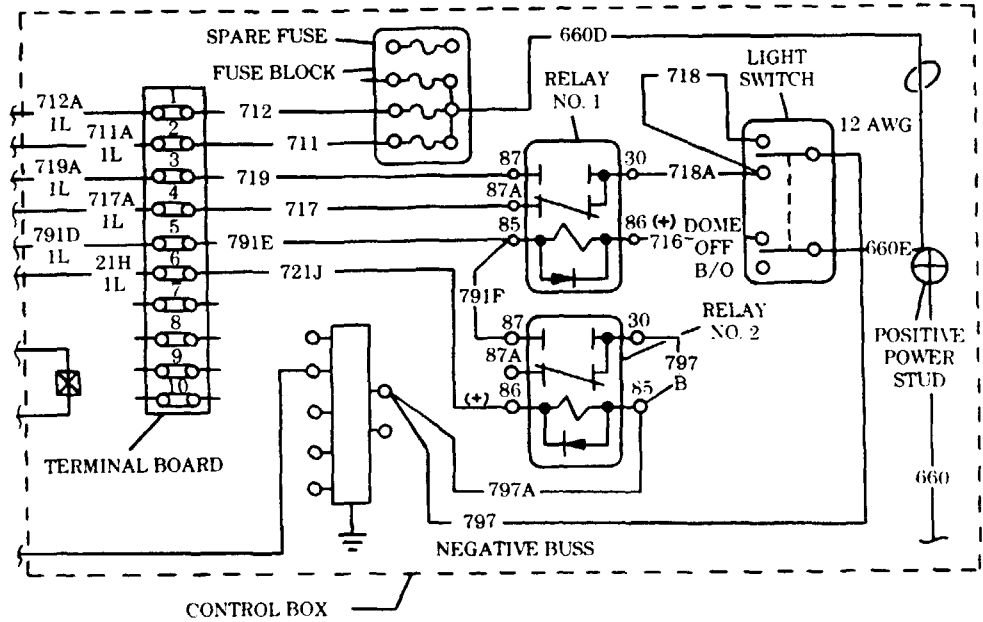
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to volts scale of at least 40  
volts.

2. Connect the RED lead to positive and the black  
lead to negative.

3. Be sure to read the correct scale.



**(All Dome Lamps)**

With Ambulance compartment front door, rear door, or rear step open and vehicle light switch in service position (Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
LEAD 797 A LEAD 797 B LEAD 791 F

6

FROM 5,  
Page 2-522

**PERFORM STEPS 18-22 ON PAGES 2-510 THROUGH 2-514. GO TO 7 BELOW IF THE ANSWER TO 21, PAGE 2-512, IS NO.**

**TEST OPTIONS**

TRY IT

**REASON FOR QUESTION**

No power would indicate damaged leads.

<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
LEAD 797 A LEAD 797 B LEAD 791 F

7

**IS THERE CONTINUITY IN CONTROL BOX BETWEEN NEGATIVE BUSS AND TERMINAL 85 OF RELAY 2?**

**TEST OPTIONS**

STE/ICE-R TEST 91, PAGE 2-752

**REASON FOR QUESTION**

No continuity would indicate a damaged lead.



<b>KNOWN INFO</b>
LEAD 797 A OK
<b>POSSIBLE PROBLEMS</b>
LEAD 797 B LEAD 791 F

8

**IS THERE CONTINUITY BETWEEN TERMINALS 85 AND 30 OF RELAY 2?**

**TEST OPTIONS**

STE-ICE-R TEST 91, PAGE 2-752

**REASON FOR QUESTION**

No continuity would indicate a damaged lead.

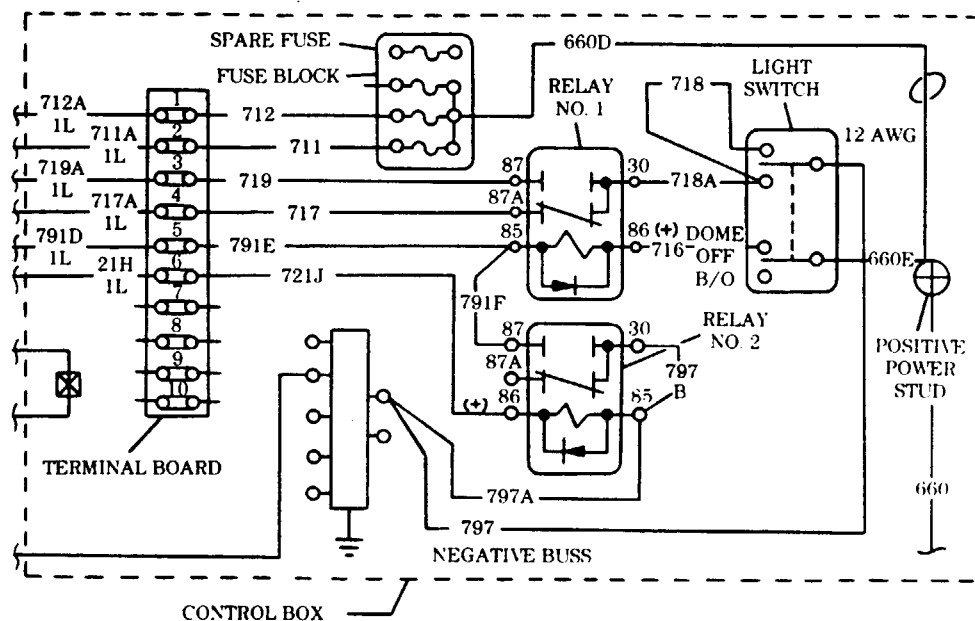


## REFERENCE INFORMATION

## AMBULANCE

### 0-4500 DC OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



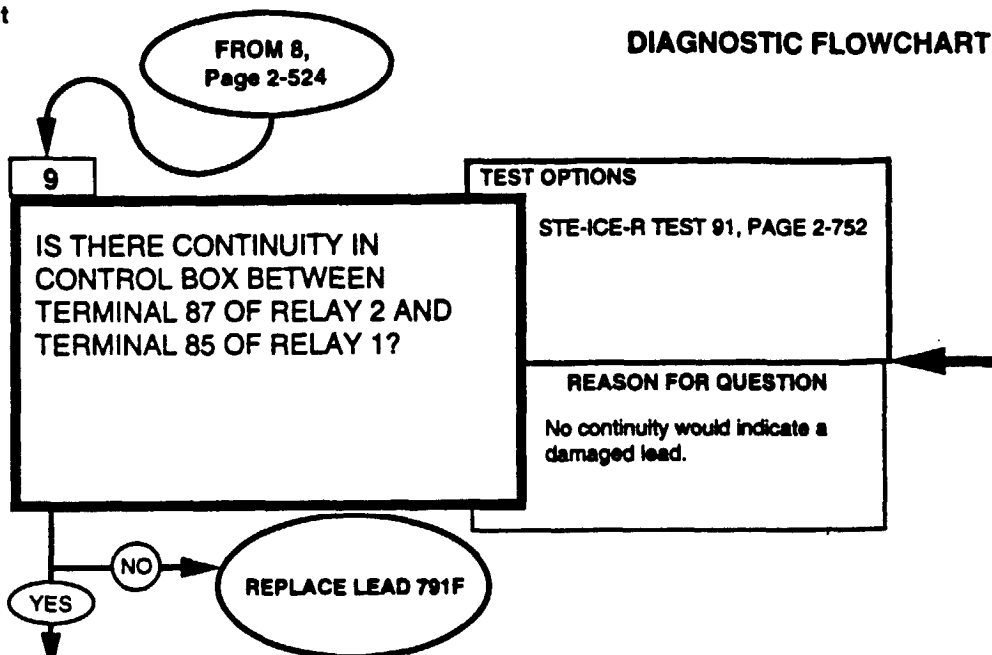
# **AMBULANCE**

(All Dome Lamps)

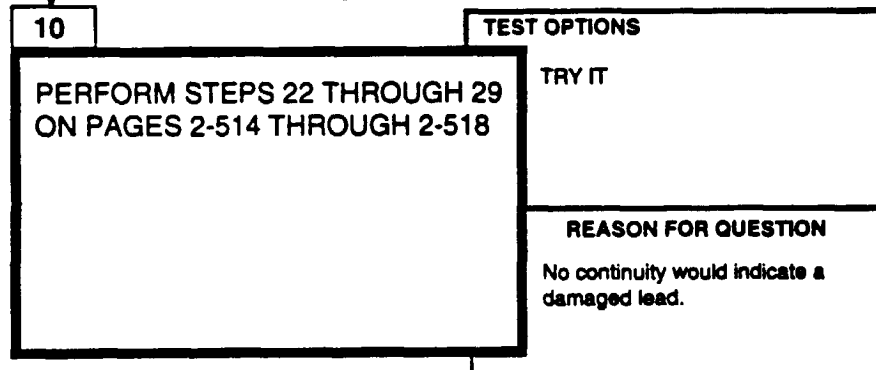
With Ambulance compartment front door, rear door, or rear step open and vehicle light switch in service position. (Refer to Fig. 11.)

## **DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 797 A OK LEAD 797 B OK
POSSIBLE PROBLEMS
LEAD 791 F



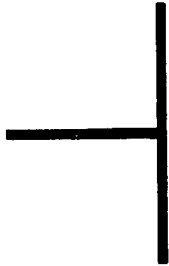
KNOWN INFO
LEAD 797 A OK LEAD 797 B OK LEAD 791 F OK
POSSIBLE PROBLEMS





## REFERENCE INFORMATION

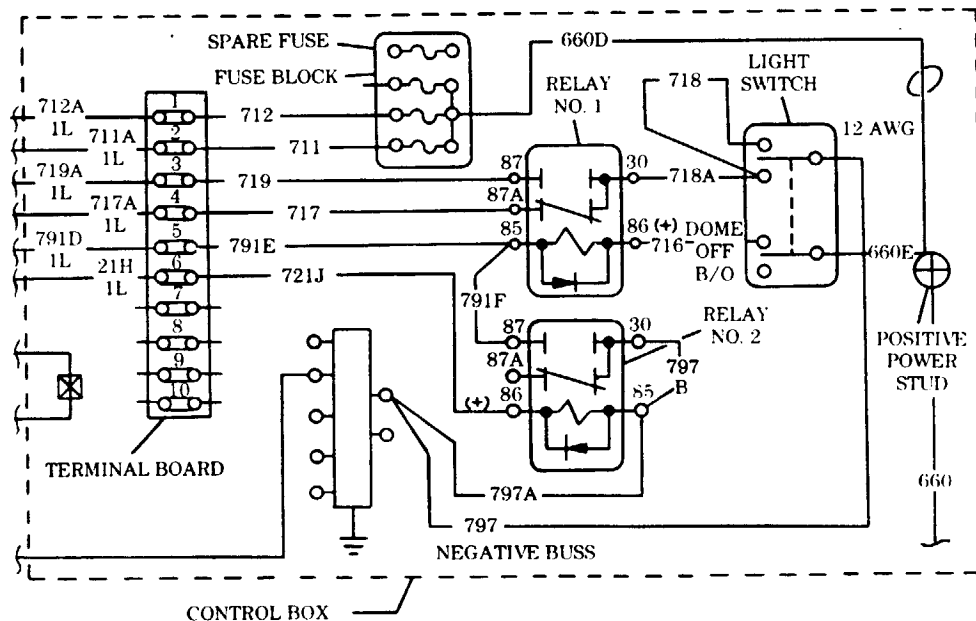
## AMBULANCE


**0-4500 DC OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start test 91, 0-4500 ohms.

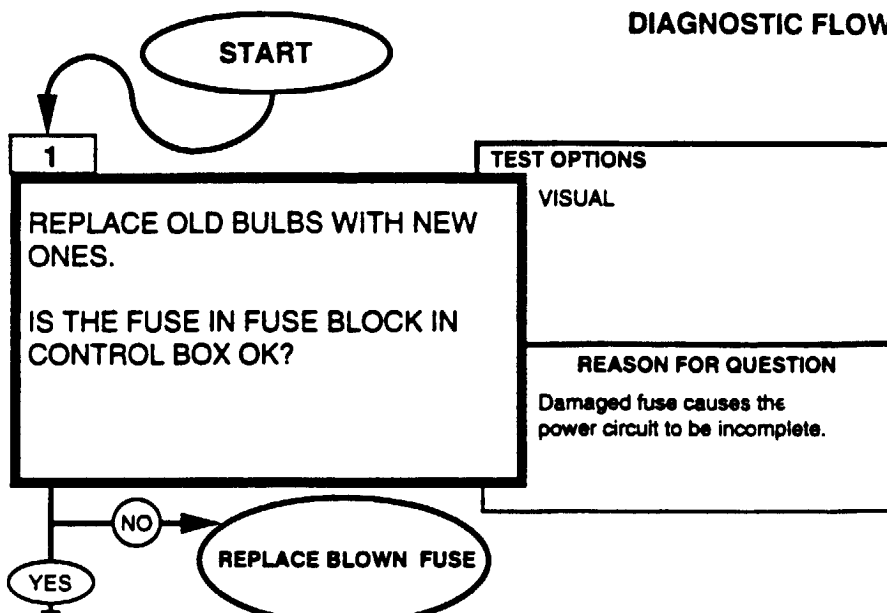
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



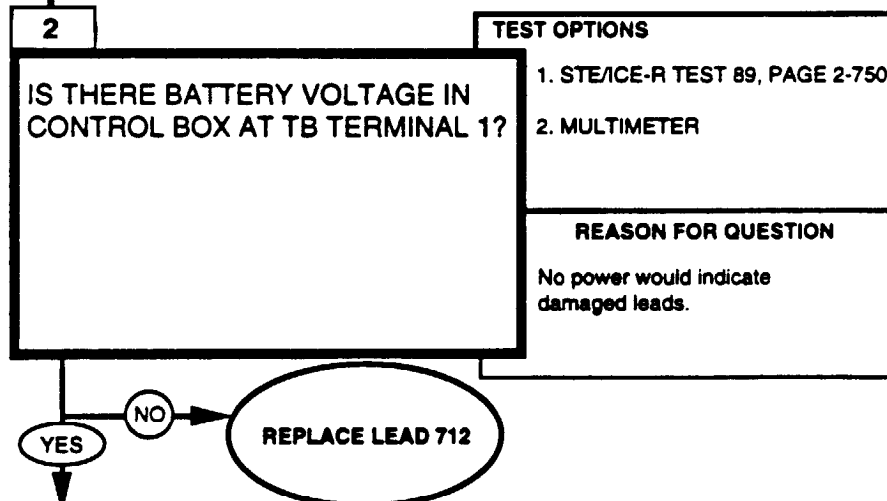
**AMBULANCE**  
**(Left Side Dome Lamps)**  
**(Refer to Fig. 11.)**

**DIAGNOSTIC FLOWCHART**

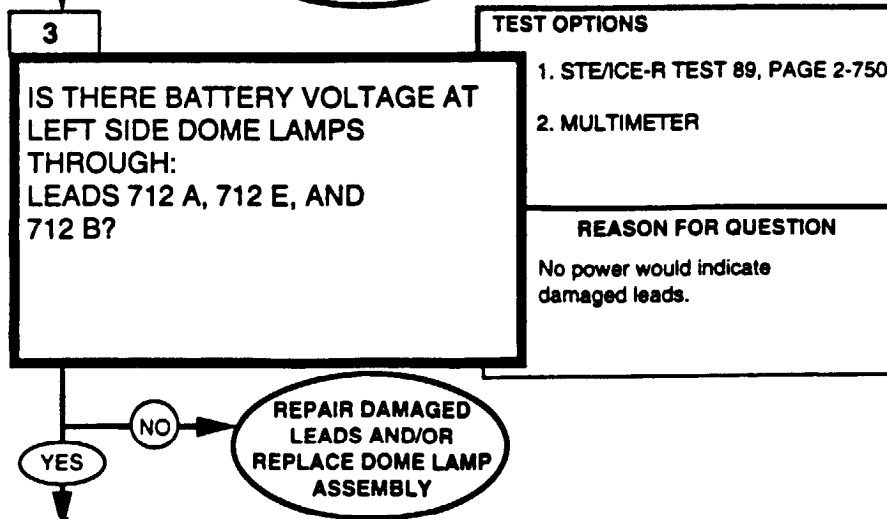
KNOWN INFO
RIGHT SIDE DOME LAMPS AND RELATED CIRCUITS OK
POSSIBLE PROBLEMS
BLOWN FUSE LEAD 712 LEAD 712 A LEAD 712 E LEAD 712 B DOME LAMPS



KNOWN INFO
RIGHT SIDE DOME LAMPS AND RELATED CIRCUITS OK FUSE OK
POSSIBLE PROBLEMS
LEAD 712 LEAS 712 A LEAD 712 E LEAD 712 B DOME LAMPS

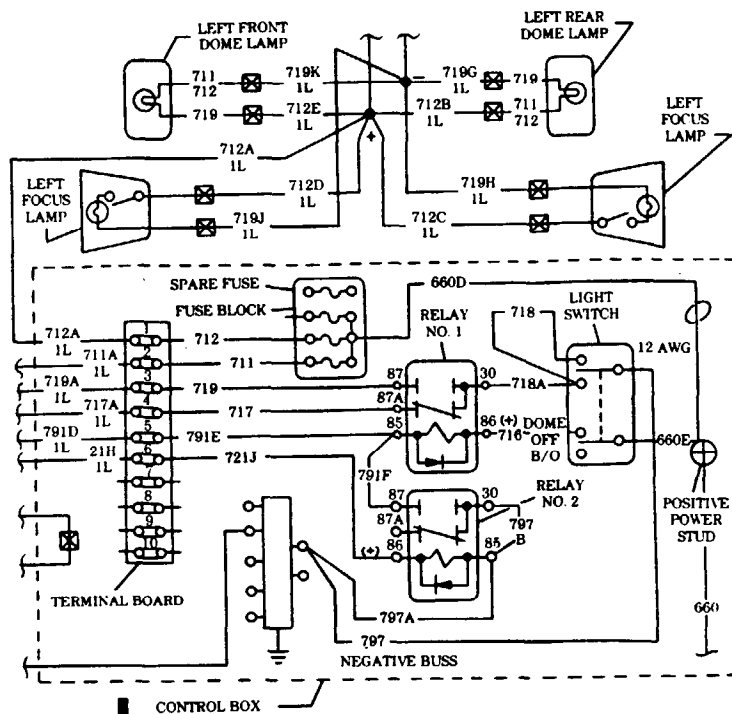


KNOWN INFO
RIGHT SIDE DOME LAMPS AND RELATED CIRCUITS OK FUSE OK LEAD 712 OK
POSSIBLE PROBLEMS
LEAD 712 A LEAD 712 E LEAD 712 B DOME LAMPS



## REFERENCE INFORMATION

## AMBULANCE



### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

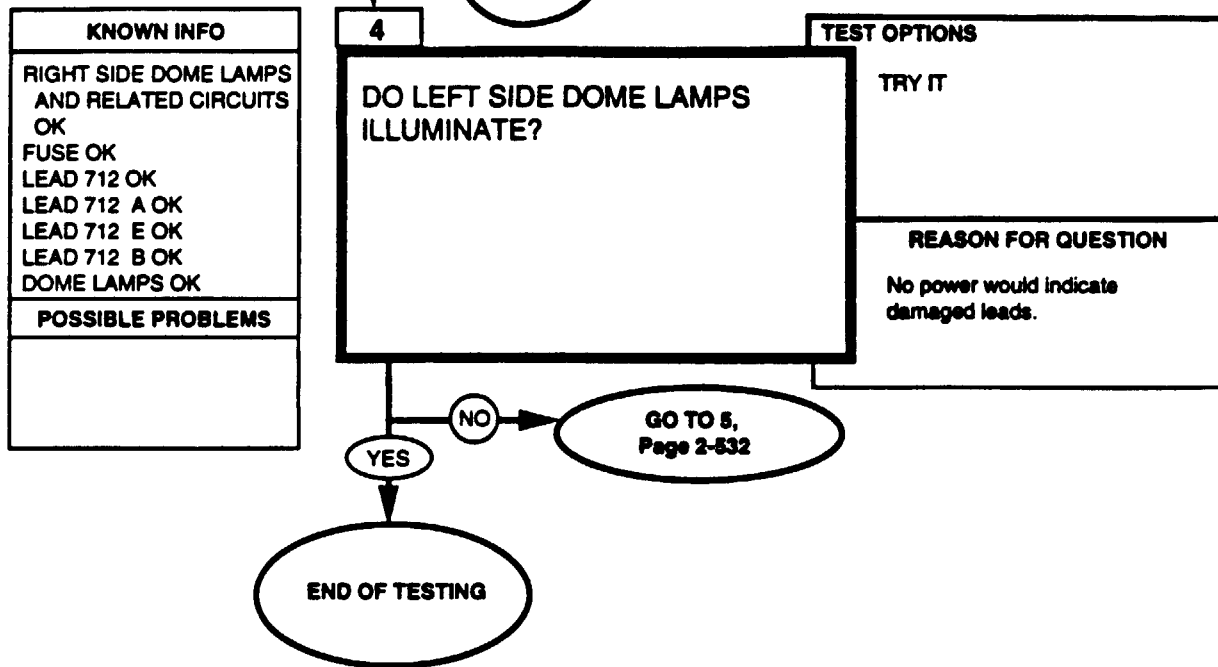
### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.

Replace dome lamp assembly,  
refer to (para. 4-87).  
Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to  
(para. 4-85).

**AMBULANCE**  
**(Left Side Dome Lamps)**  
**(Refer to Fig. 11.)**

**DIAGNOSTIC FLOWCHART**



**REFERENCE INFORMATION**

**AMBULANCE**

**AMBULANCE**  
(Left Side Dome Lamps)  
(Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 719 F LEAD 719 K LEAD 719 G DOME LAMPS

**5**

IS THERE CONTINUITY AT LEAD 719 F?

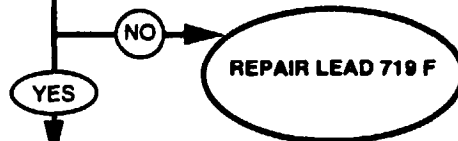
**TEST OPTIONS**

STE/ICE-R TEST 91, PAGE 2-752

---

**REASON FOR QUESTION**

No continuity would indicate a damaged lead.



KNOWN INFO
LEAD 719 F OK
POSSIBLE PROBLEMS
LEAD 719 K LEAD 719 G DOME LAMPS

**6**

IS THERE CONTINUITY OF LEADS 719 K AND 719 G THROUGH TO LEFT SIDE DOME LAMPS LEADS?

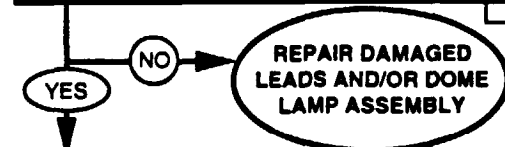
**TEST OPTIONS**

STE/ICE-R TEST 91, PAGE 2-752

---

**REASON FOR QUESTION**

No continuity would indicate damaged leads.



KNOWN INFO
LEAD 719 F OK LEAD 719 K OK LEAD 719 G OK DOME LAMPS OK
POSSIBLE PROBLEMS

**7**

DO LEFT SIDE DOME LAMPS ILLUMINATE?

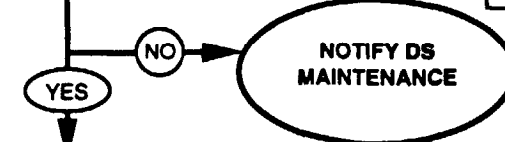
**TEST OPTIONS**

TRY IT

---

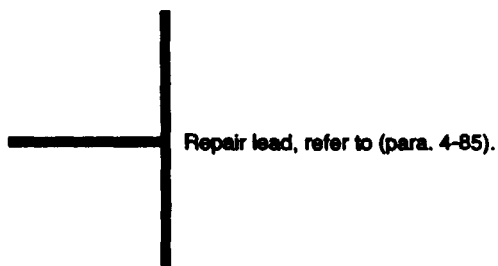
**REASON FOR QUESTION**

If left side dome lamps do not illuminate, that would indicate a malfunction not handled at this level.

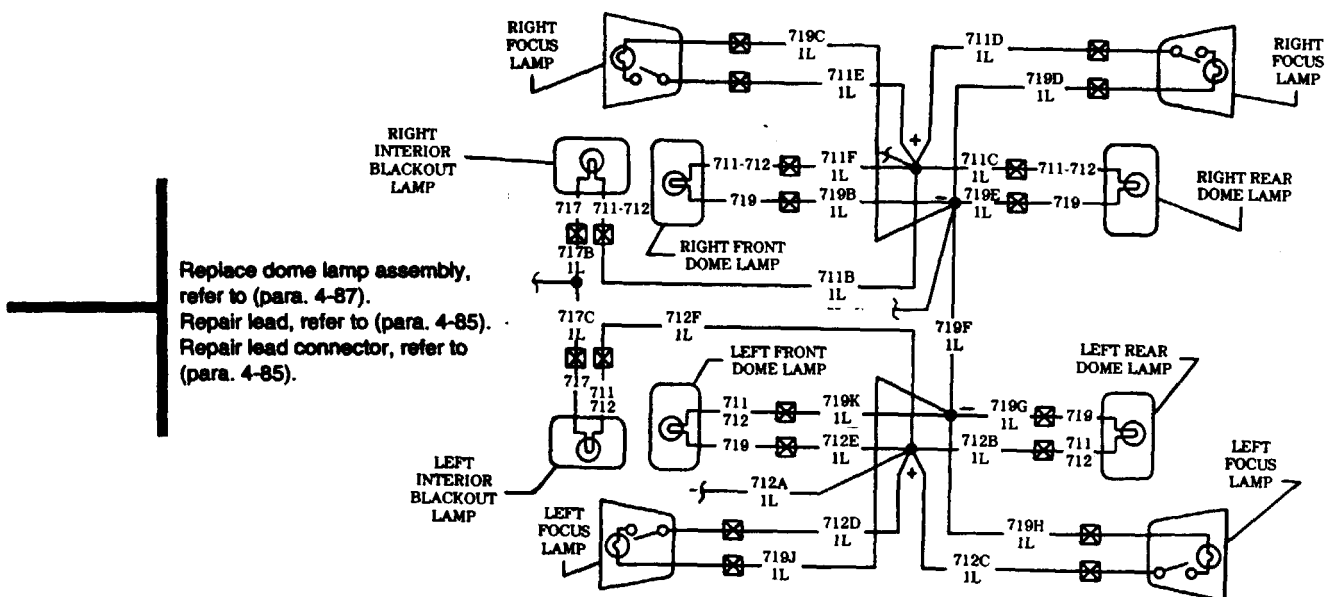


## REFERENCE INFORMATION

## AMBULANCE



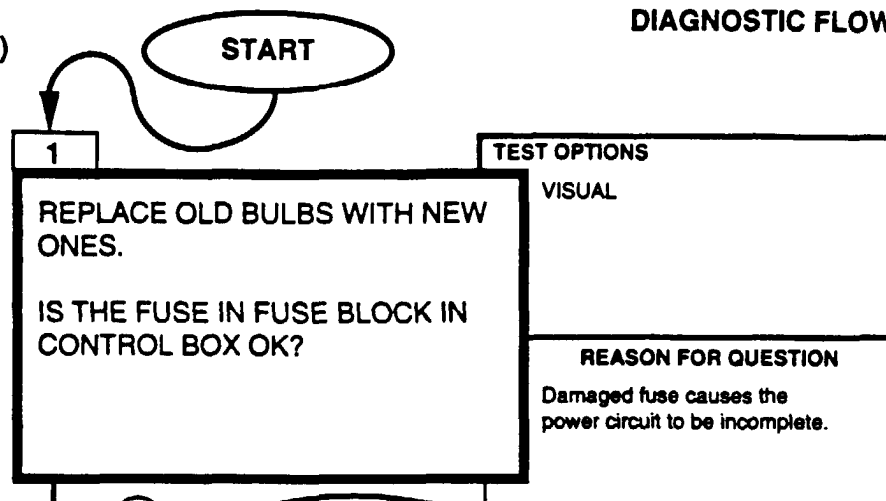
0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



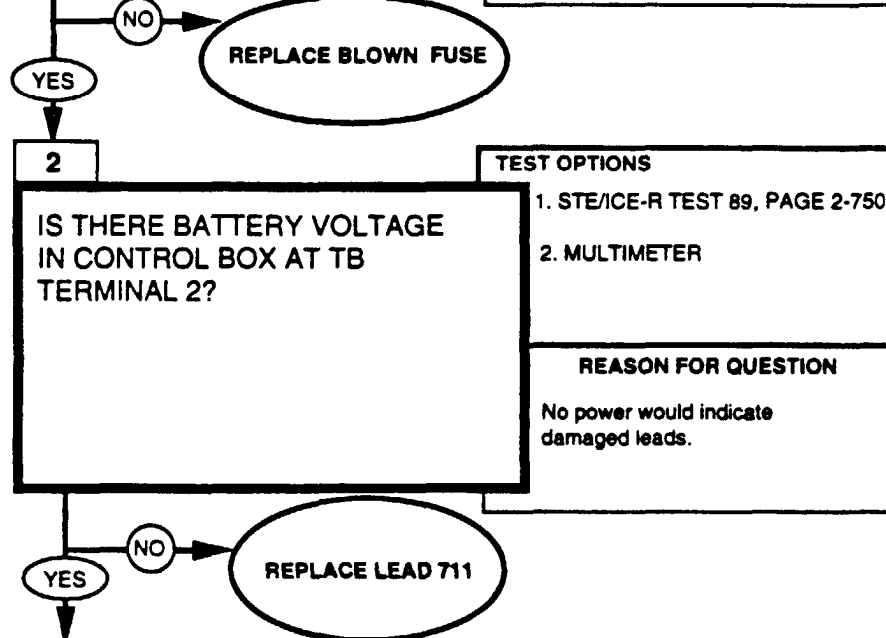
**AMBULANCE**  
(Right Side Dome Lamps)  
(Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

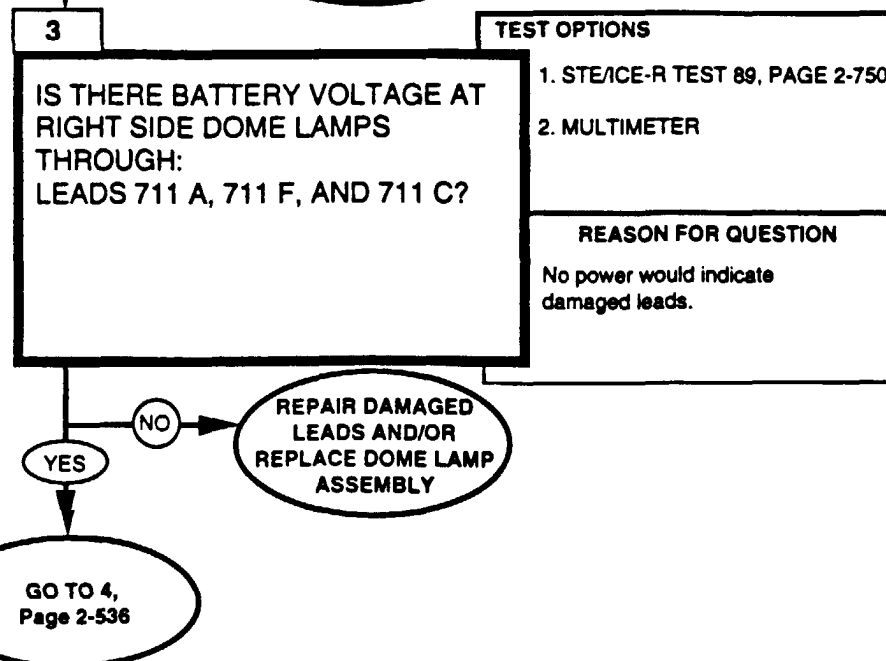
KNOWN INFO
LEFT SIDE DOME LAMPS AND RELATED CIRCUITS OK
POSSIBLE PROBLEMS
BLOWN FUSE LEAD 711 LEAD 711 A LEAD 711 F LEAD 711 C DOME LAMPS



KNOWN INFO
LEFT SIDE DOME LAMPS AND RELATED CIRCUITS OK FUSE OK
POSSIBLE PROBLEMS
LEAD 711 LEAS 711 A LEAD 711 F LEAD 711 C DOME LAMPS



KNOWN INFO
LEFT SIDE DOME LAMPS AND RELATED CIRCUITS OK FUSE OK LEAD 711 OK
POSSIBLE PROBLEMS
LEAD 711 A LEAD 711 F LEAD 711 C DOME LAMPS





# REFERENCE INFORMATION

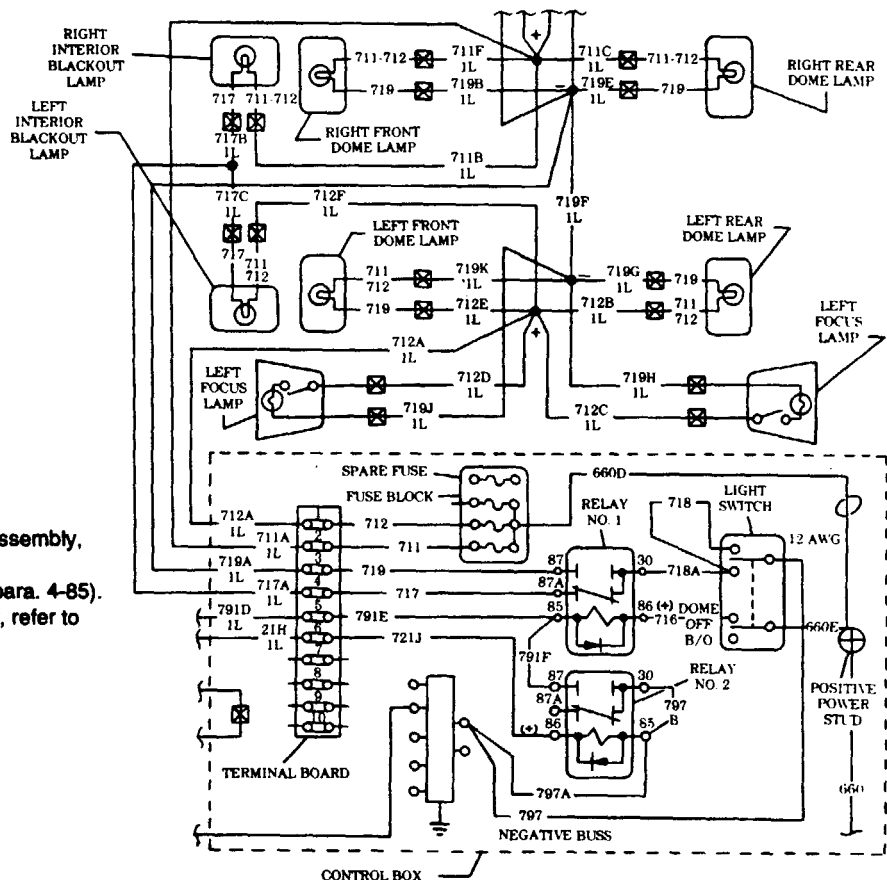
# AMBULANCE

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

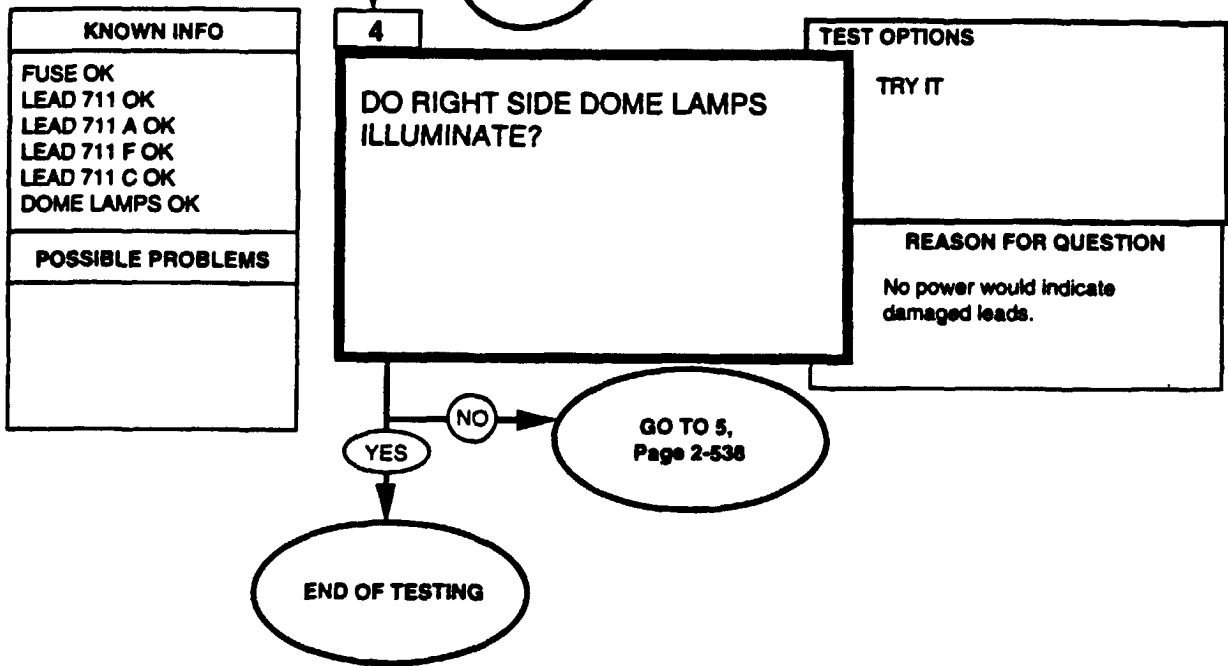
1. Set the voltmeter to volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.



Replace dome lamp assembly, refer to (para. 4-87).  
Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

**AMBULANCE**  
**(Right Side Dome Lamps)**  
**(Refer to Fig. 11.)**

**DIAGNOSTIC FLOWCHART**



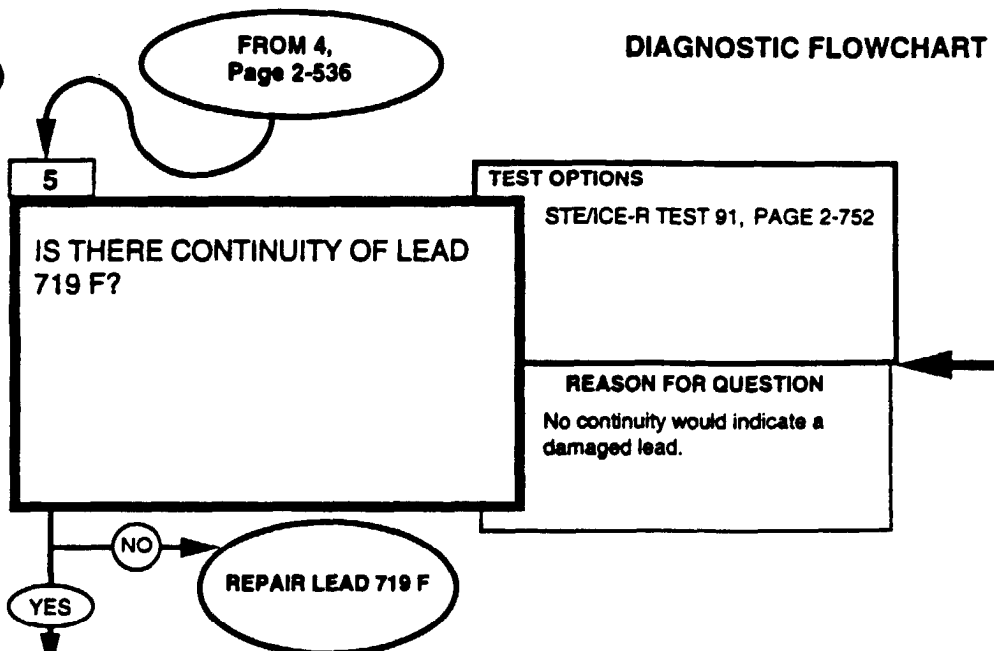
**REFERENCE INFORMATION**

**AMBULANCE**

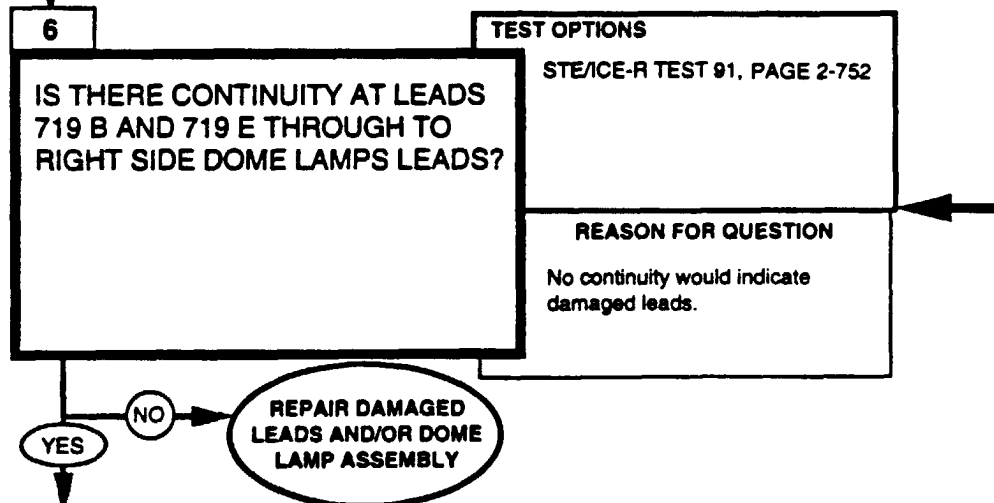
**AMBULANCE**  
(Right Side Dome Lamps)  
(Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

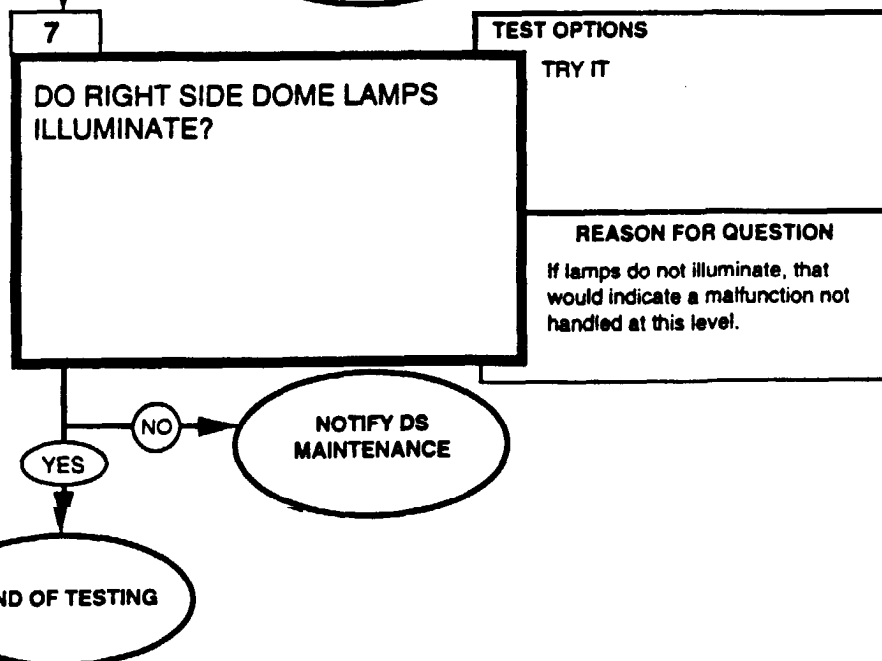
<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
LEAD 719 F LEAD 719 B LEAD 719 E DOME LAMPS



<b>KNOWN INFO</b>
LEAD 719 F OK
<b>POSSIBLE PROBLEMS</b>
LEAD 719 E LEAD 719 B DOME LAMPS

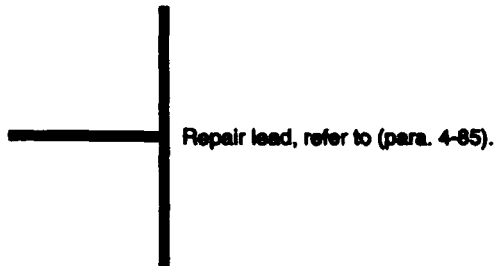


<b>KNOWN INFO</b>
LEAD 719 F OK LEAD 719 E OK LEAD 719 B OK DOME LAMPS OK
<b>POSSIBLE PROBLEMS</b>

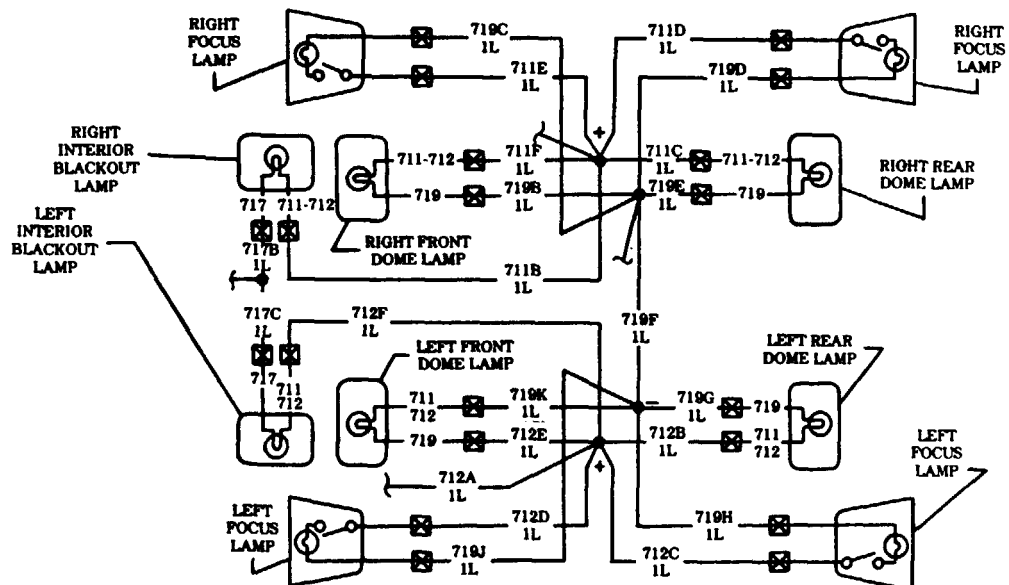
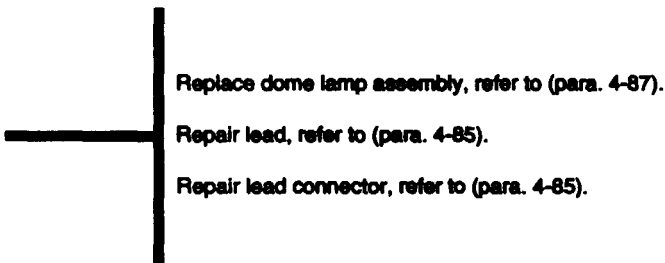


# REFERENCE INFORMATION

# AMBULANCE



0-4500 DC OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

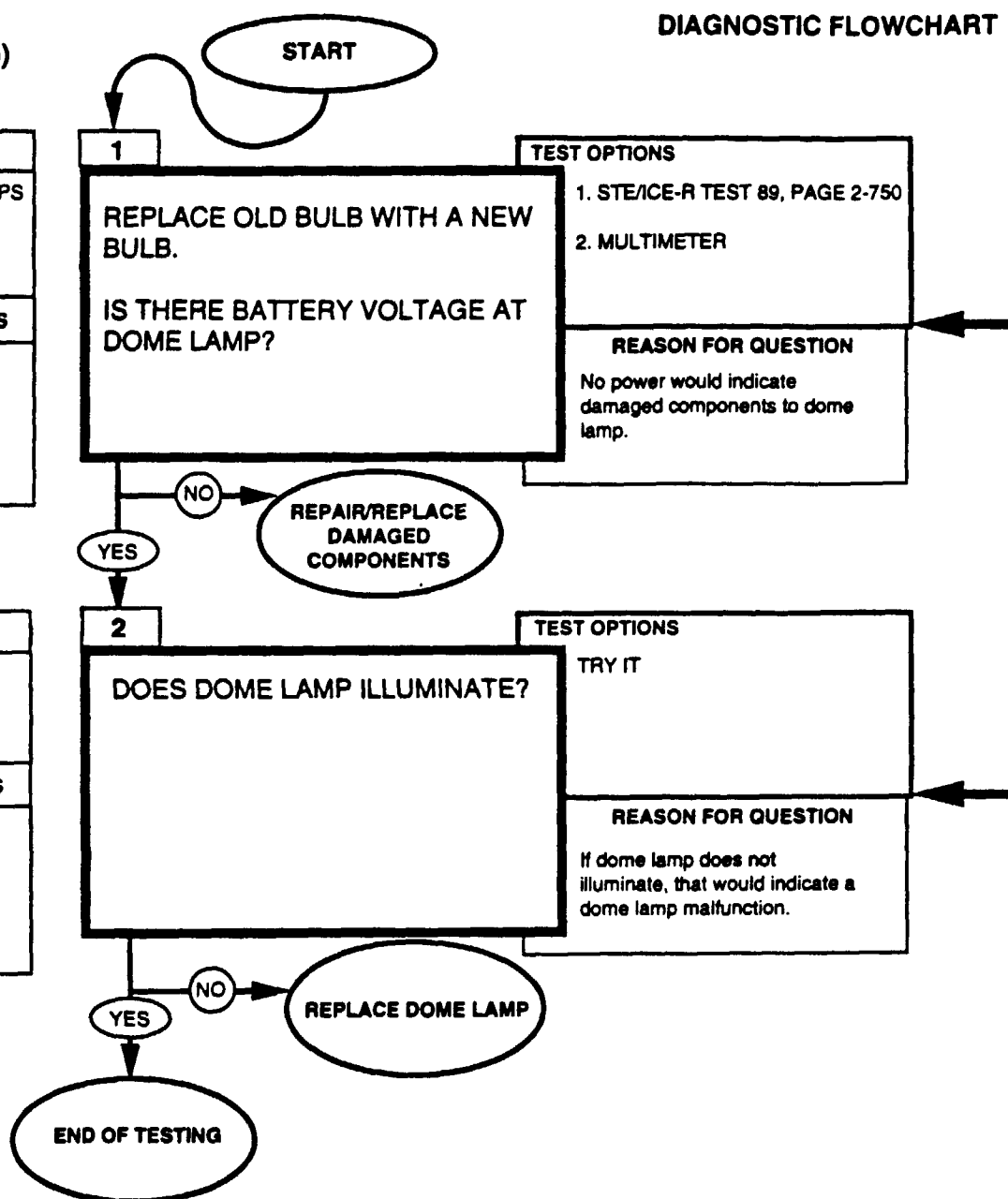


**AMBULANCE**  
(Single Dome Lamp)  
(Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
ALL OTHER DOME LAMPS ILLUMINATE
POSSIBLE PROBLEMS
CORRODED CONNECTIONS LOOSE LAMP SOCKET DAMAGED WIRE TERMINALS DOME LAMP

KNOWN INFO
CONNECTIONS OK LAMP SOCKET OK WIRE TERMINALS OK
POSSIBLE PROBLEMS
DOME LAMP



# REFERENCE INFORMATION

## AMBULANCE

Repair leads, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

Replace dome lamp assembly, refer to (para. 4-87).

<p><b>0-45 DC VOLTS STE/CE-R TEST 89</b></p> <ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC volts.</li> <li>3. Displayed reading is in volts.</li> </ol>
<p><b>BATTERY VOLTAGE MULTIMETER</b></p> <ol style="list-style-type: none"> <li>1. Set the voltmeter to DC volts scale of at least 40 volts.</li> <li>2. Connect the RED lead to positive and the black lead to negative.</li> <li>3. Be sure to read the correct scale.</li> </ol>

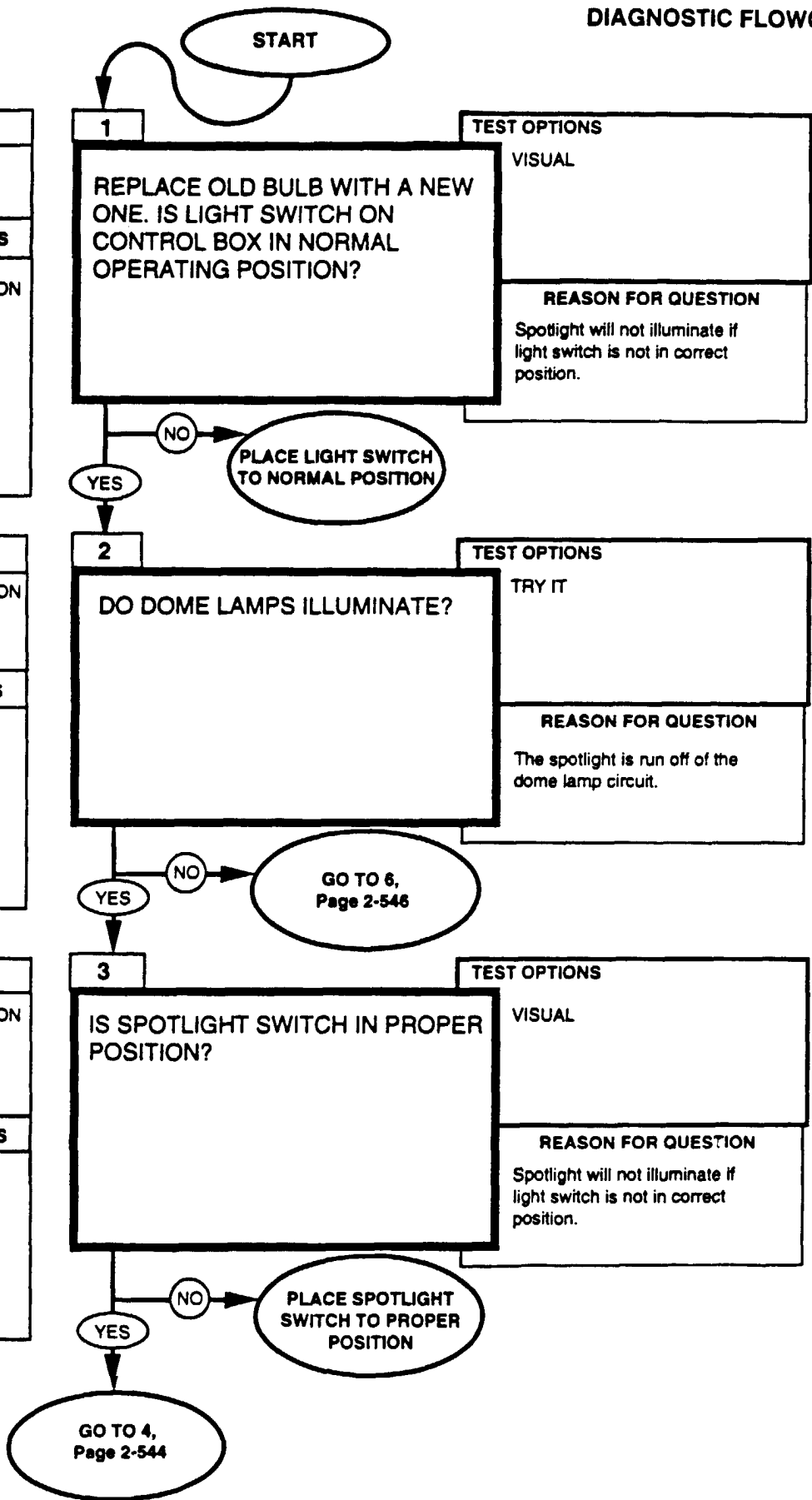
**AMBULANCE  
(SPOTLIGHT)  
(Refer to Fig. 11.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
LIGHT SWITCH POSITION SPOTLIGHT SWITCH POSITION CORRODED CONNECTIONS LOOSE LAMP SOCKET DAMAGED WIRE TERMINALS DOME LAMPS SPOTLIGHT

KNOWN INFO
LIGHT SWITCH POSITION OK
POSSIBLE PROBLEMS
SPOTLIGHT SWITCH POSITION CORRODED CONNECTIONS LOOSE LAMP SOCKET DAMAGED WIRE TERMINALS DOME LAMPS SPOTLIGHT

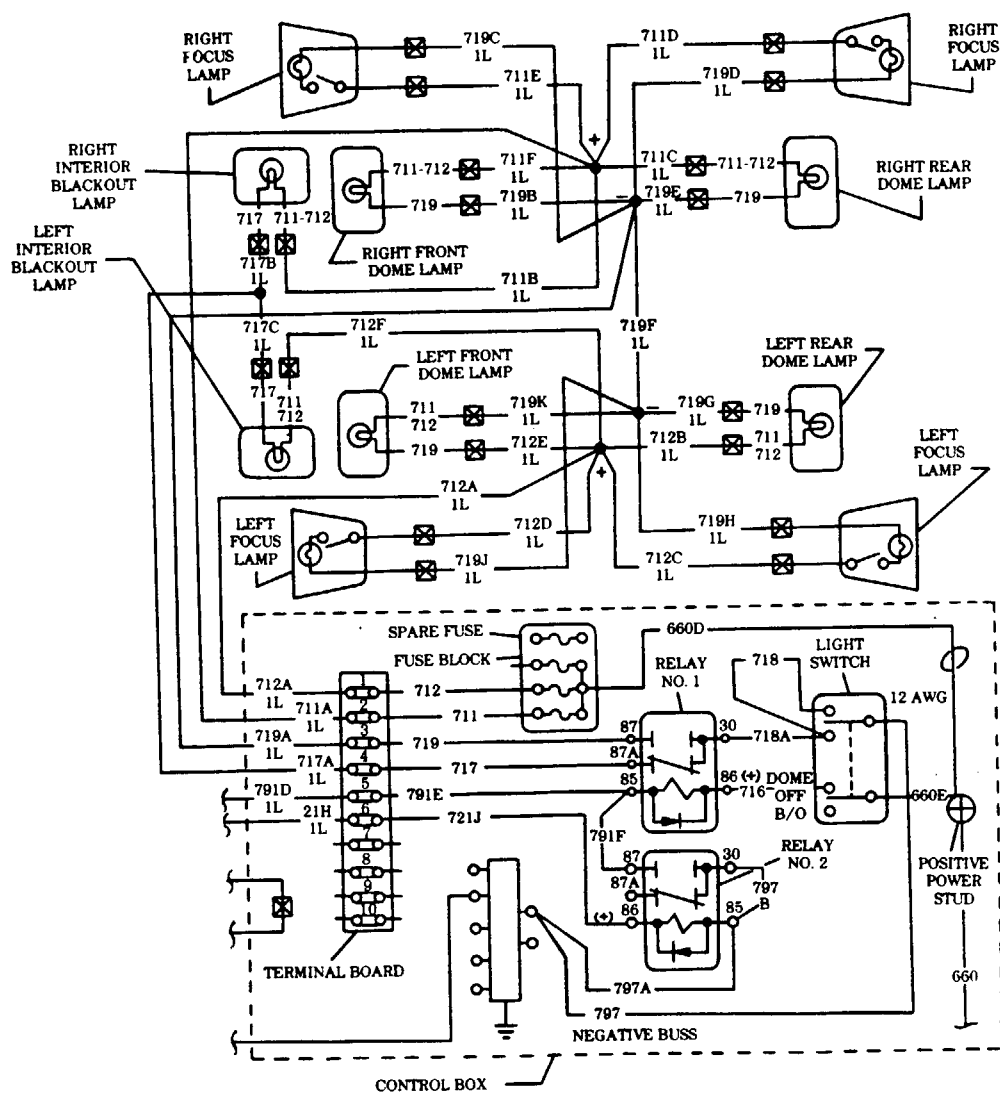
KNOWN INFO
LIGHT SWITCH POSITION OK DOME LAMPS OK
POSSIBLE PROBLEMS
SPOTLIGHT SWITCH POSITION CORRODED CONNECTIONS LOOSE LAMP SOCKET DAMAGED WIRE TERMINALS SPOTLIGHT





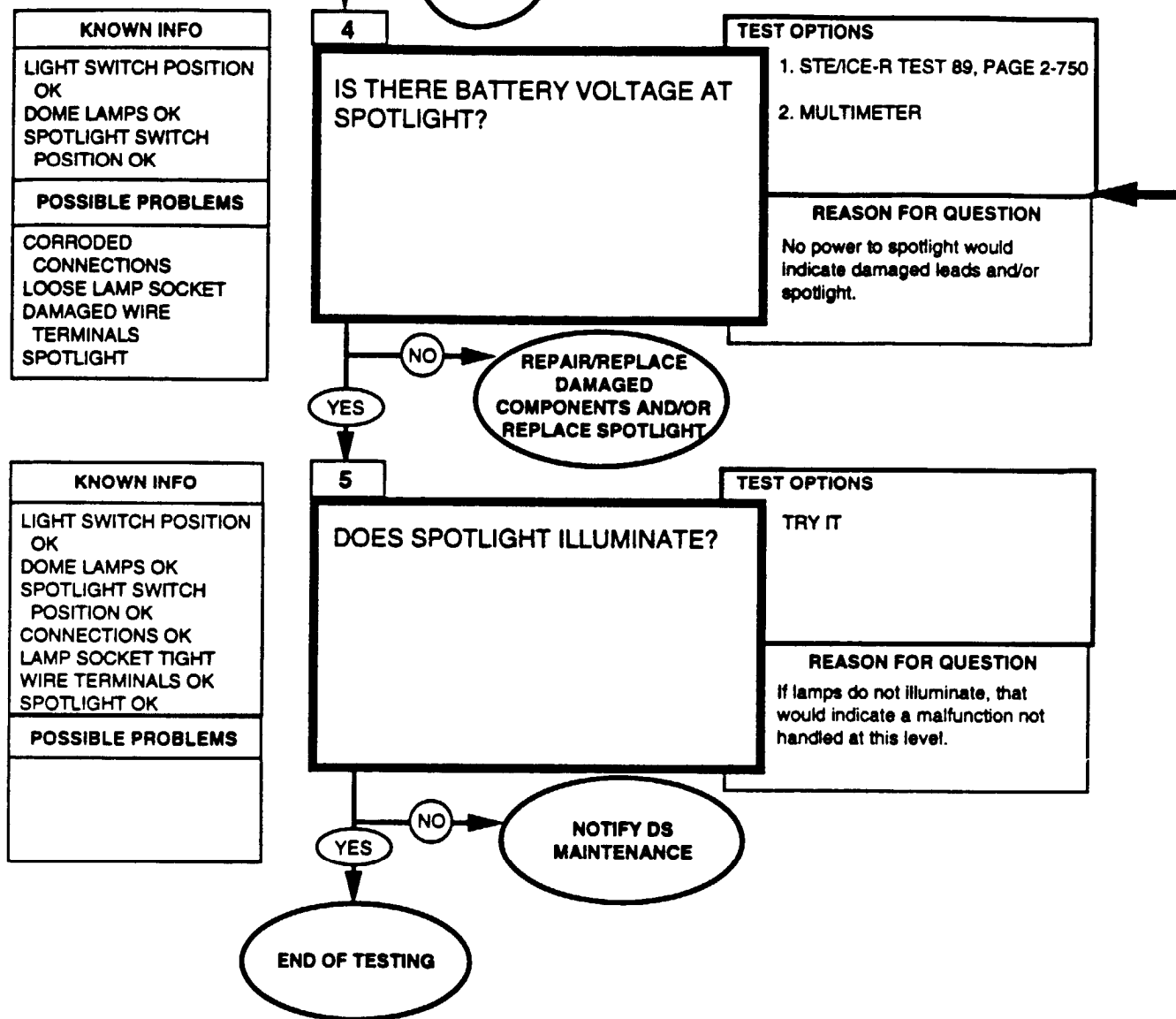
## REFERENCE INFORMATION

## AMBULANCE



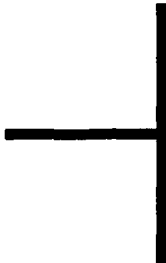
**AMBULANCE  
(Spotlight)**  
(Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

## AMBULANCE



Replace spotlight assembly,  
refer to (para. 4-88).  
Repair leads, refer to (para. 4-85).  
Repair lead connector, refer to  
(para. 4-85).

**0-45 DC VOLTS  
STE/CE-R TEST 89**

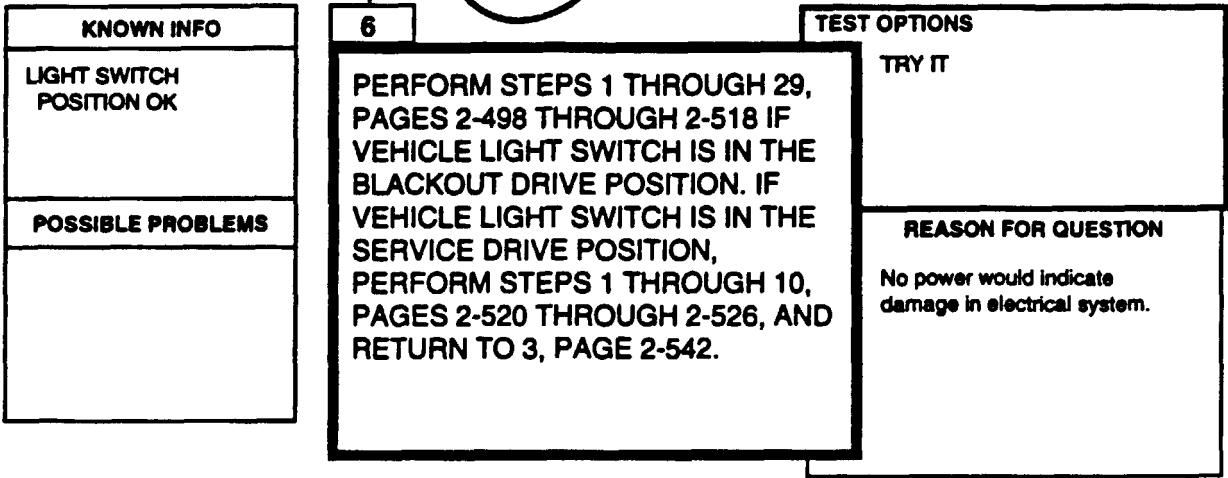
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

**AMBULANCE**  
**(Spotlight)**  
**(Refer to Fig. 11.)**

**DIAGNOSTIC FLOWCHART**



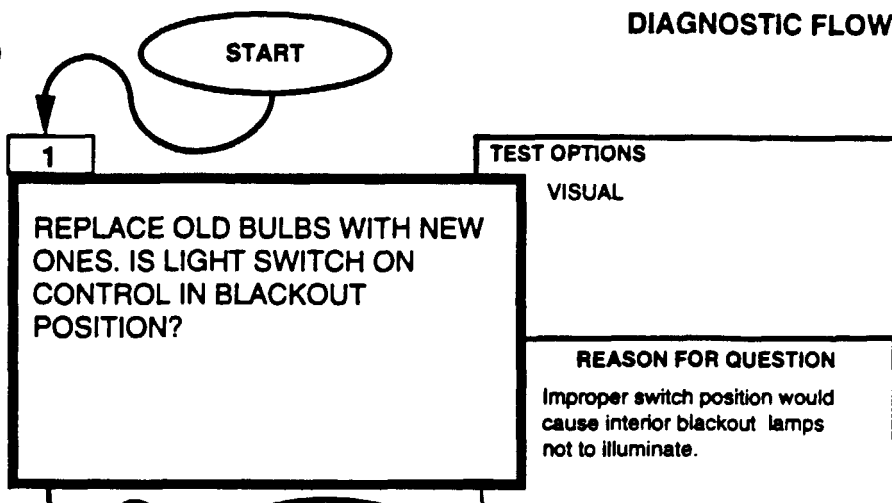
**REFERENCE INFORMATION**

**AMBULANCE**

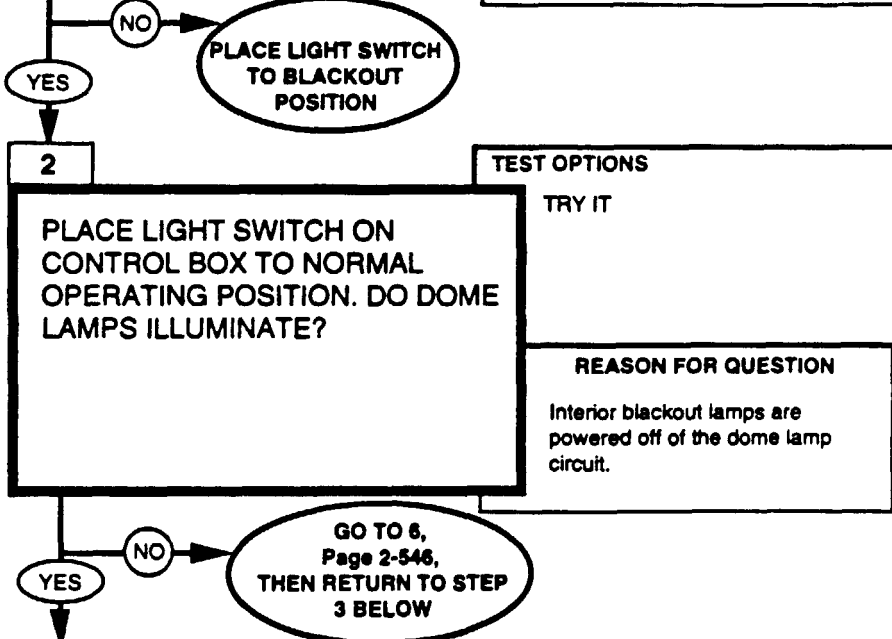
**AMBULANCE**  
(Interior Blackout Lamps)  
(Refer to Fig. 11.)

**DIAGNOSTIC FLOWCHART**

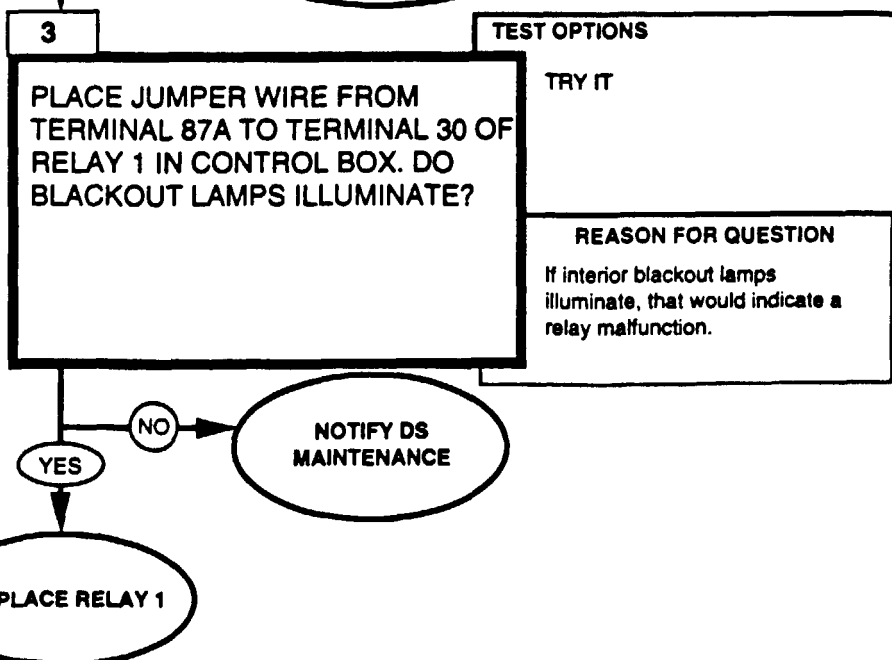
<b>KNOWN INFO</b>
NOTHING
<b>POSSIBLE PROBLEMS</b>
LIGHT SWITCH POSITION DOME LAMPS



<b>KNOWN INFO</b>
LIGHT SWITCH POSITION OK
<b>POSSIBLE PROBLEMS</b>
DOME LAMPS



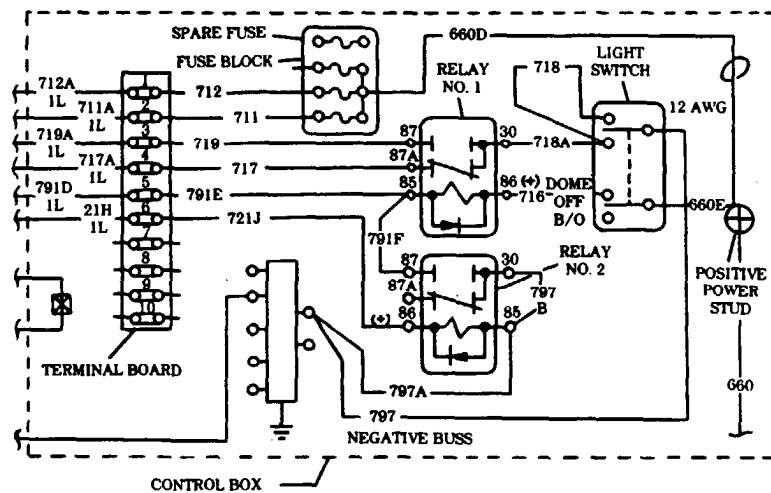
<b>KNOWN INFO</b>
LIGHT SWITCH POSITION OK DOME LAMPS OK
<b>POSSIBLE PROBLEMS</b>



REFERENCE INFORMATION

AMBULANCE

Replace relay,  
refer to (para. 4-120).

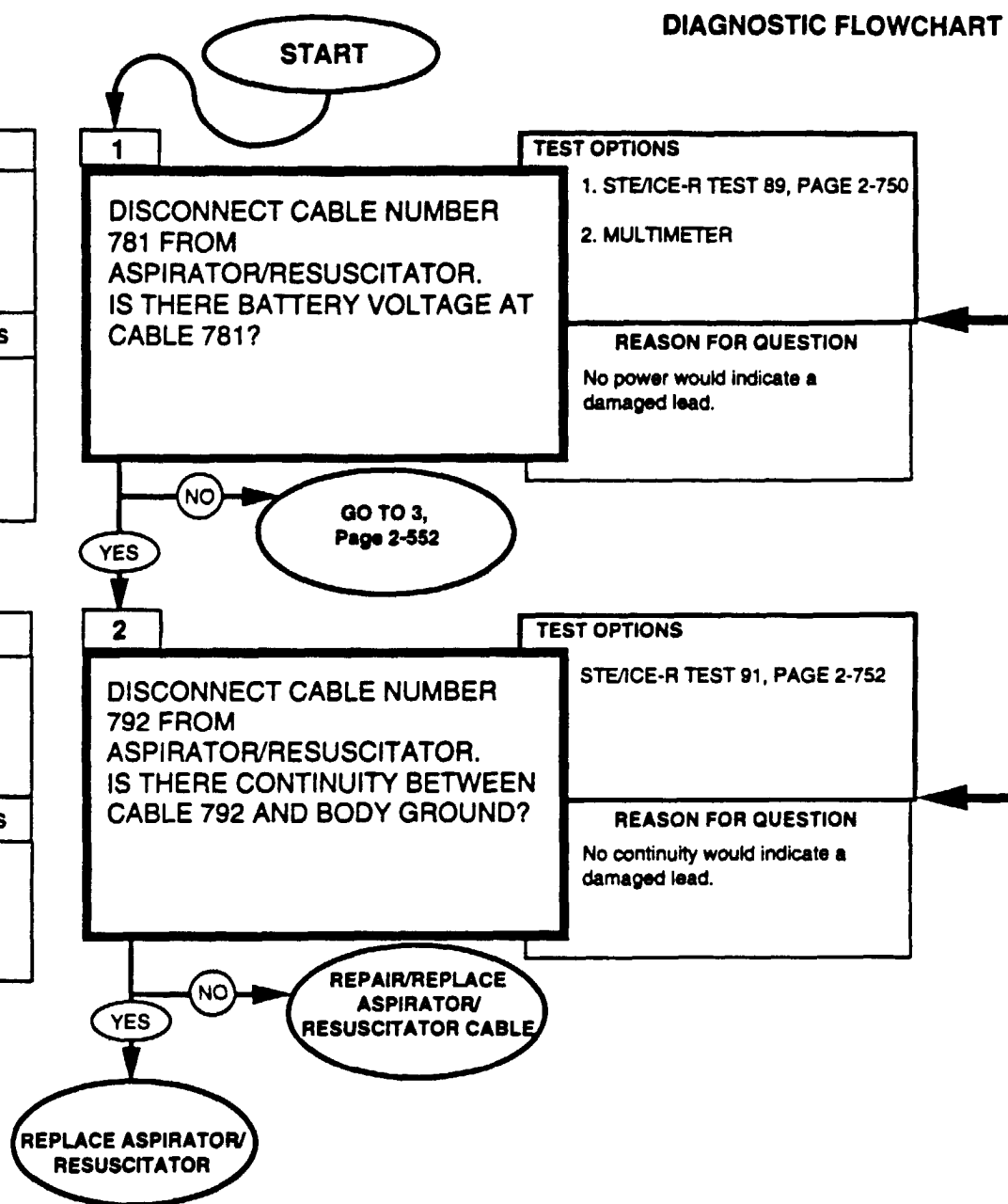


**AMBULANCE  
(Aspirator)  
(Refer to Fig. 12.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
ASPIRATOR CABLES ASPIRATOR BATTERY

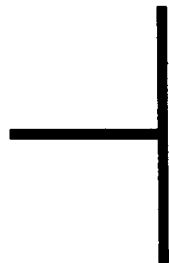
KNOWN INFO
BATTERY OK
POSSIBLE PROBLEMS
ASPIRATOR CABLES ASPIRATOR



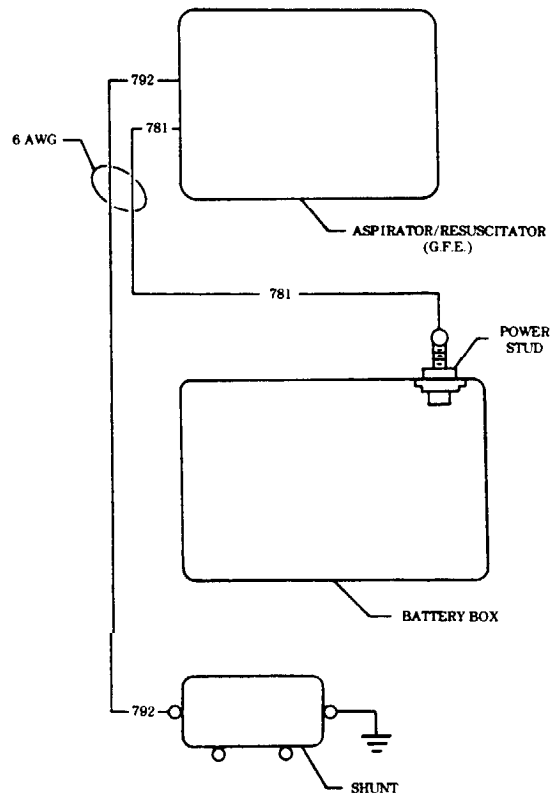


# REFERENCE INFORMATION

## AMBULANCE



Replace Aspirator/Resuscitator cable,  
refer to (para. 4-104).  
Repair cable, refer to DS Maintenance.



### 0-45 DC VOLTS STE/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

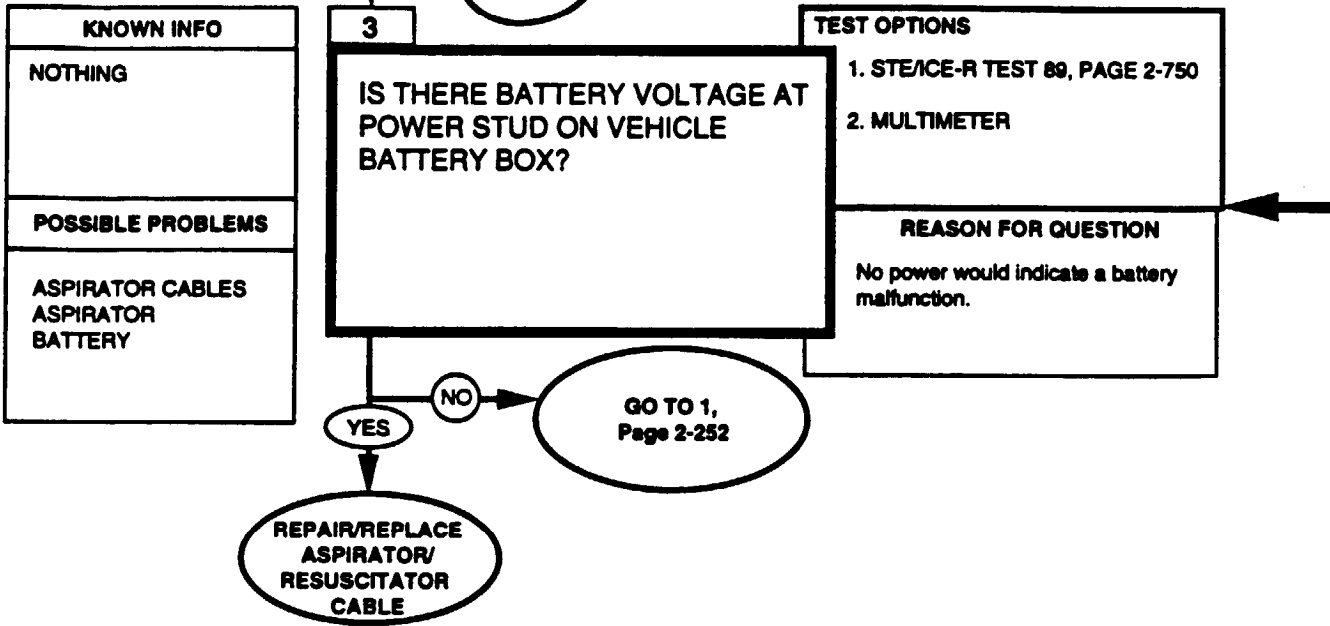
1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

### 0-4500 DC OHMS STE/CE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/CE displays "9.9.9.9."

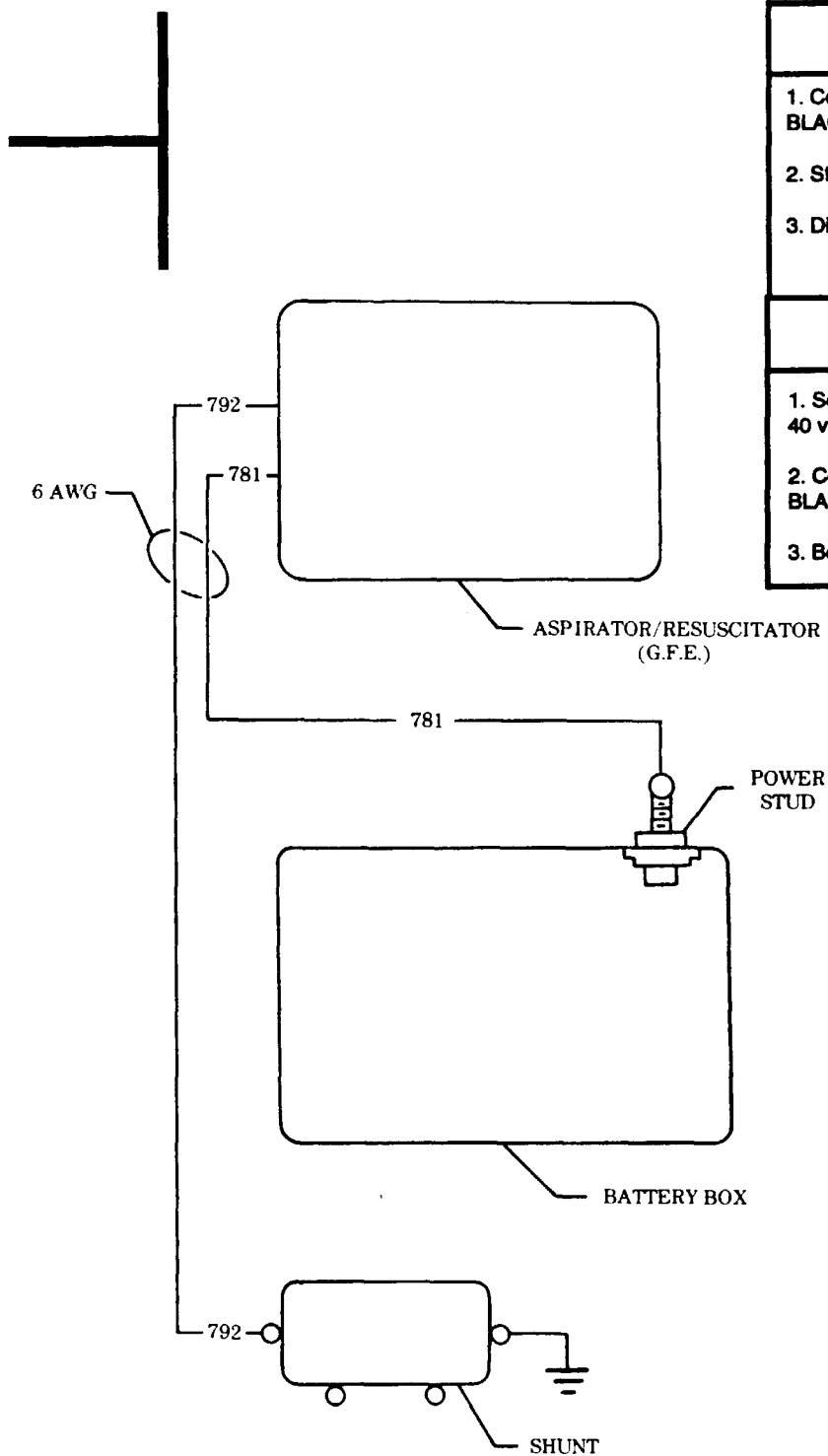
**AMBULANCE**  
**(Aspirator)**  
**(Refer to Fig. 12.)**

**DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

AMBULANCE

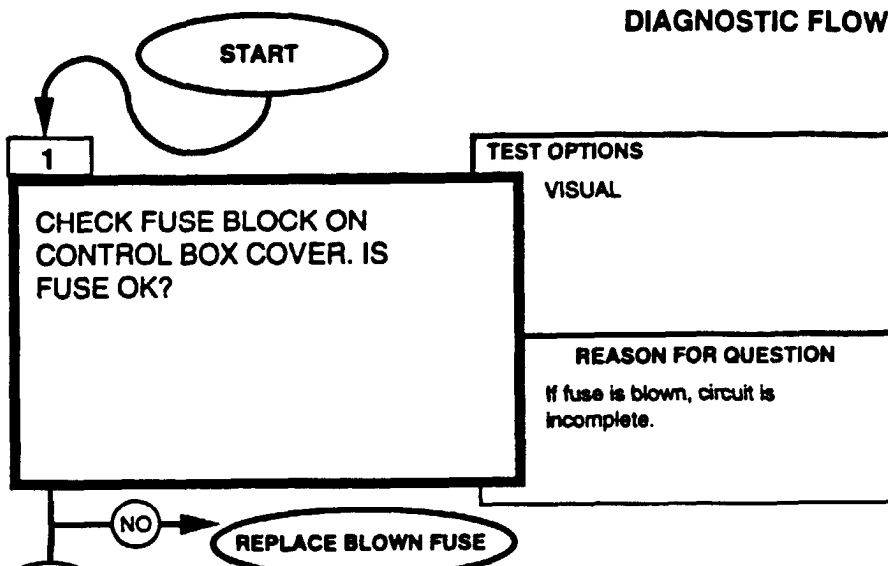


0-45 DC VOLTS STE/CE-R TEST 89
<ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC volts.</li> <li>3. Displayed reading is in volts.</li> </ol>
BATTERY VOLTAGE MULTIMETER
<ol style="list-style-type: none"> <li>1. Set the voltmeter to a DC volts scale of at least 40 volts.</li> <li>2. Connect the RED lead to positive and the BLACK lead to negative.</li> <li>3. Be sure to read the correct scale.</li> </ol>

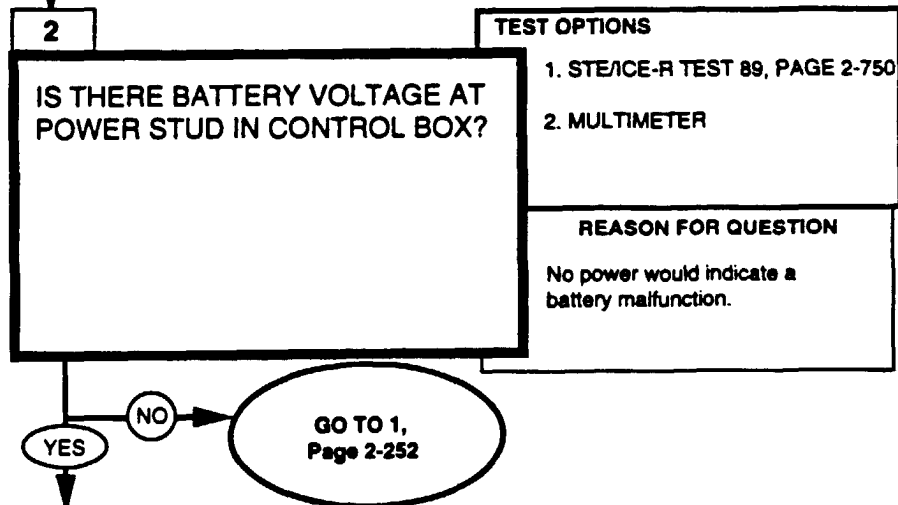
**AMBULANCE**  
(Front DC Outlet)  
(Refer to Fig. 13.)

**DIAGNOSTIC FLOWCHART**

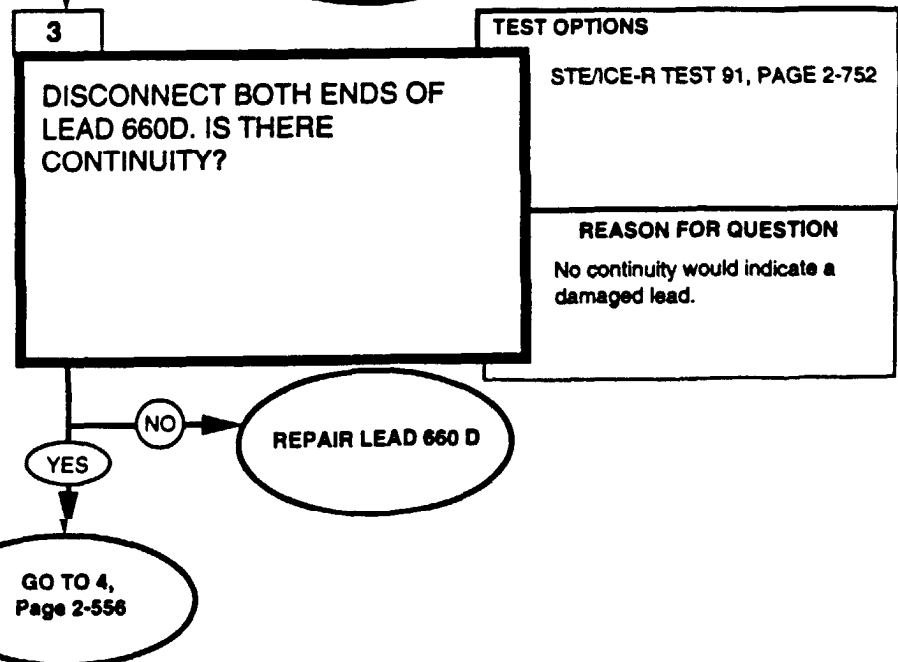
<b>KNOWN INFO</b>
NOTHING
<b>POSSIBLE PROBLEMS</b>
FUSE BATTERY LEAD 660 D LEAD 714 LEAD 790



<b>KNOWN INFO</b>
FUSE OK
<b>POSSIBLE PROBLEMS</b>
BATTERY LEAD 660 D LEAD 714 LEAD 790

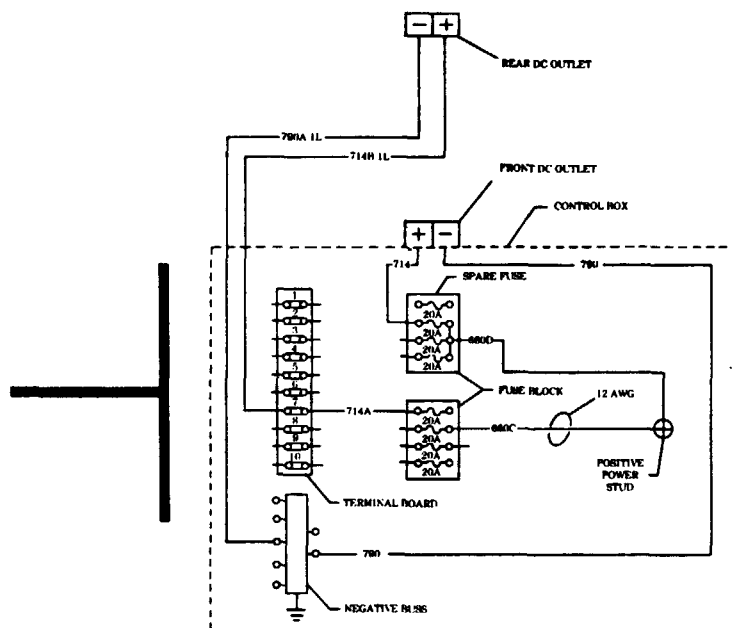


<b>KNOWN INFO</b>
FUSE OK BATTERY OK
<b>POSSIBLE PROBLEMS</b>
LEAD 660 D LEAD 714 LEAD 790



# REFERENCE INFORMATION

# AMBULANCE



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

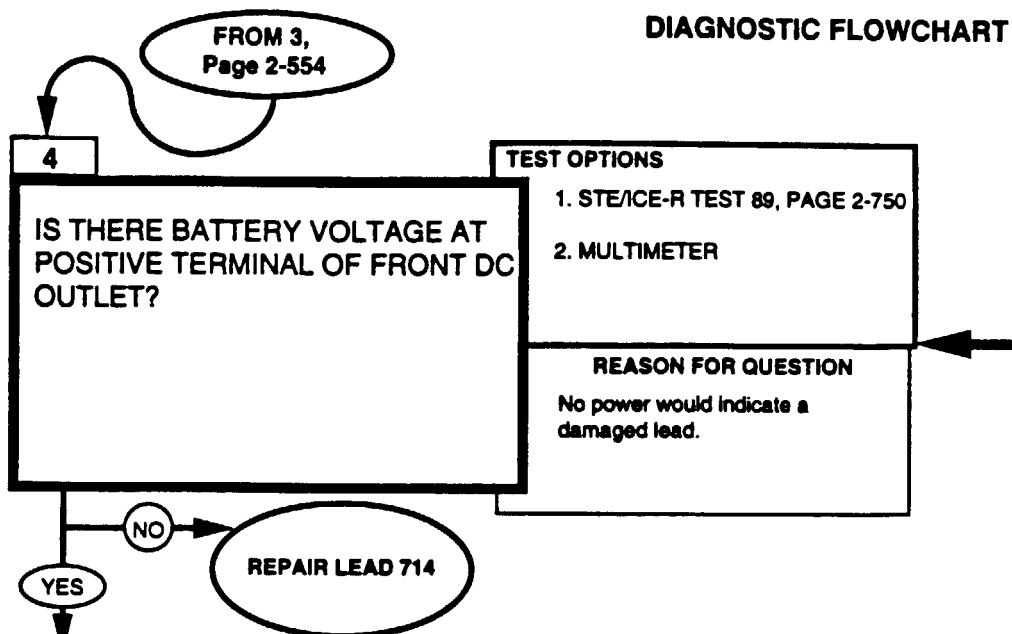
## 0-4500 DC OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

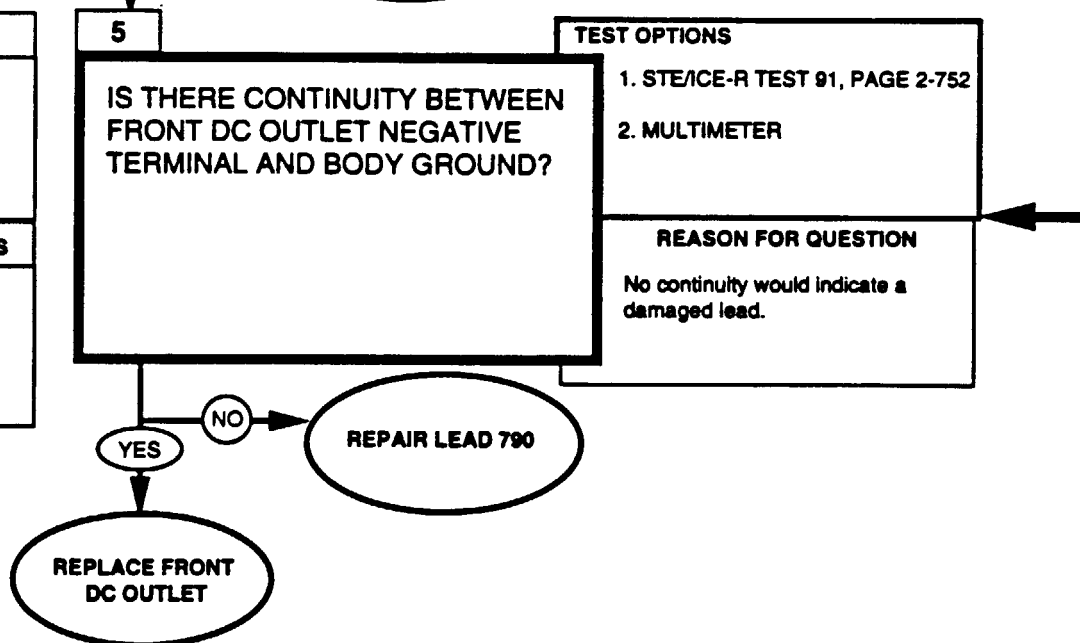
**AMBULANCE**  
(Front DC Outlet)  
(Refer to Fig. 13.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
FUSE OK BATTERY OK LEAD 660 D OK
POSSIBLE PROBLEMS
LEAD 714 LEAD 790



KNOWN INFO
FUSE OK BATTERY OK LEAD 660 D OK LEAD 714 OK
POSSIBLE PROBLEMS
LEAD 790 DC OUTLET

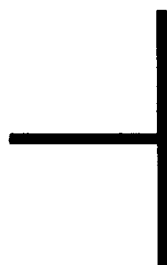


## REFERENCE INFORMATION

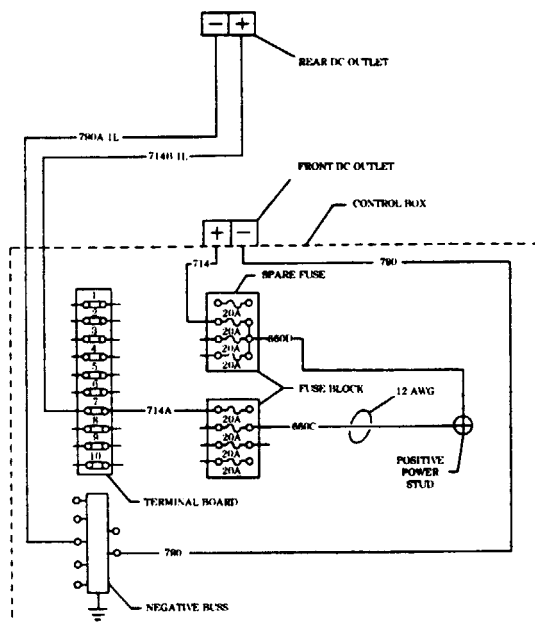
## AMBULANCE



Repair lead, refer to (para. 4-85).  
Repair lead connector,  
refer to (para. 4-85).



Repair lead connectors,  
refer to (para. 4-85).  
Repair lead, refer to (para. 4-85).  
Replace front DC outlet,  
refer to (para. 4-90).



### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

### 0-4500 DC OHMS STE/ICE-R TEST 91

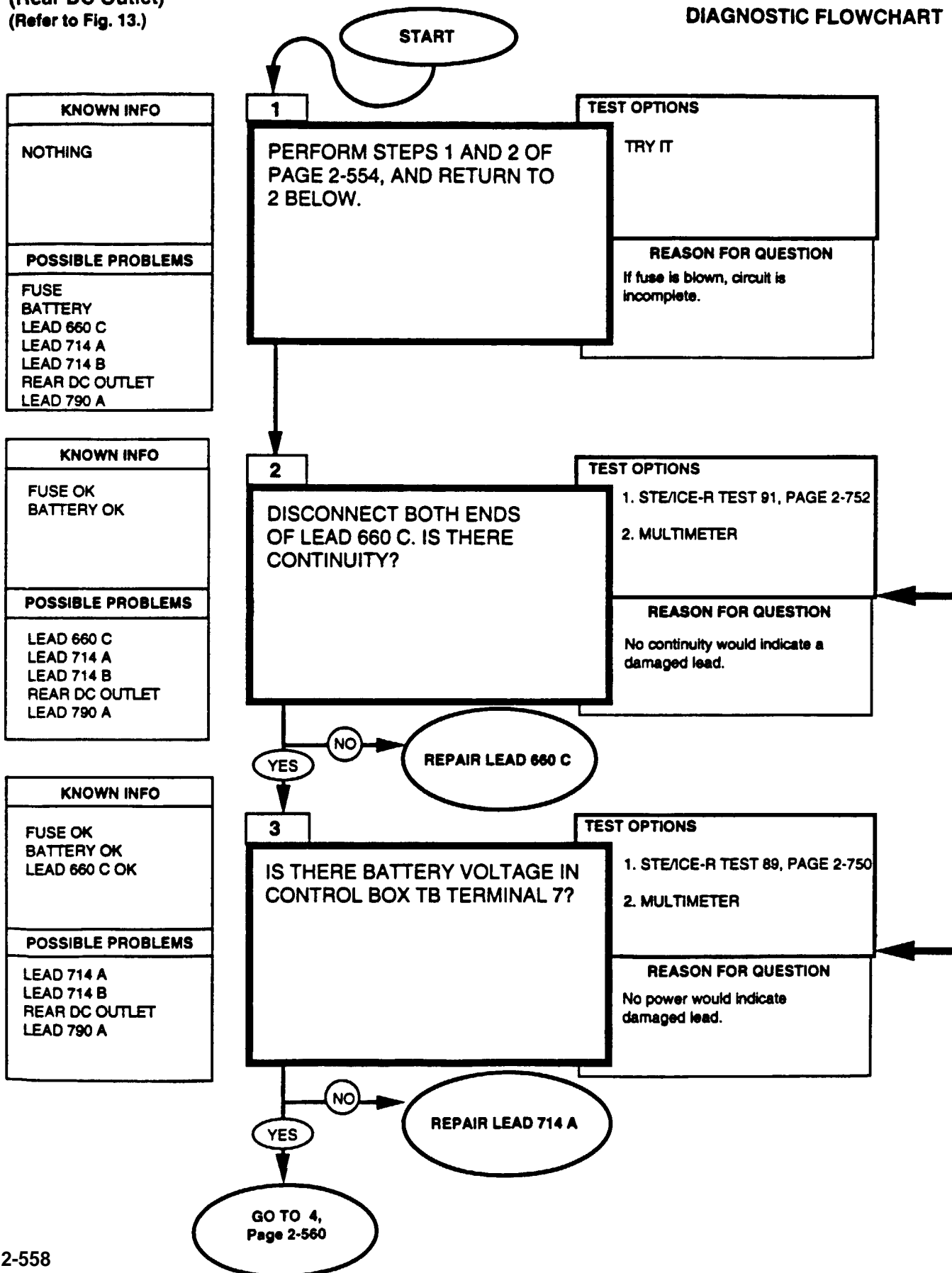
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**AMBULANCE**  
(Rear DC Outlet)  
(Refer to Fig. 13.)

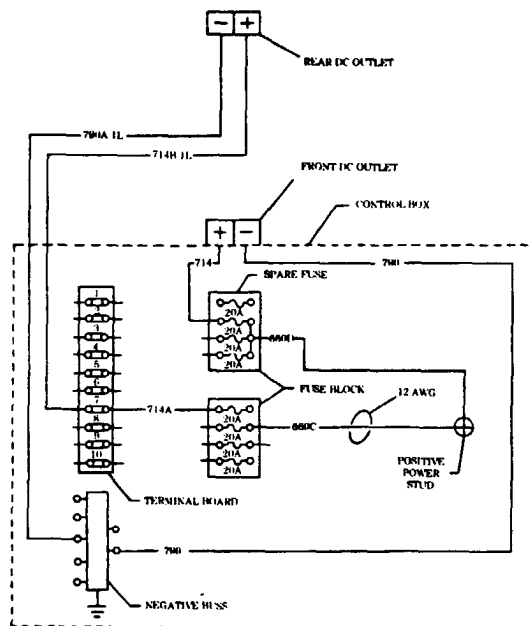
**DIAGNOSTIC FLOWCHART**





## REFERENCE INFORMATION

## AMBULANCE



**Repair lead, refer to (para. 4-85).**  
**Repair lead connector, refer to**  
**(para. 4-85).**

**Repair lead, refer to (para. 4-85).**  
**Repair lead connector, refer to**  
**(para. 4-85).**

**0-4500 OHMS**  
**STE/CE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

**0-45 DC VOLTS**  
**STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

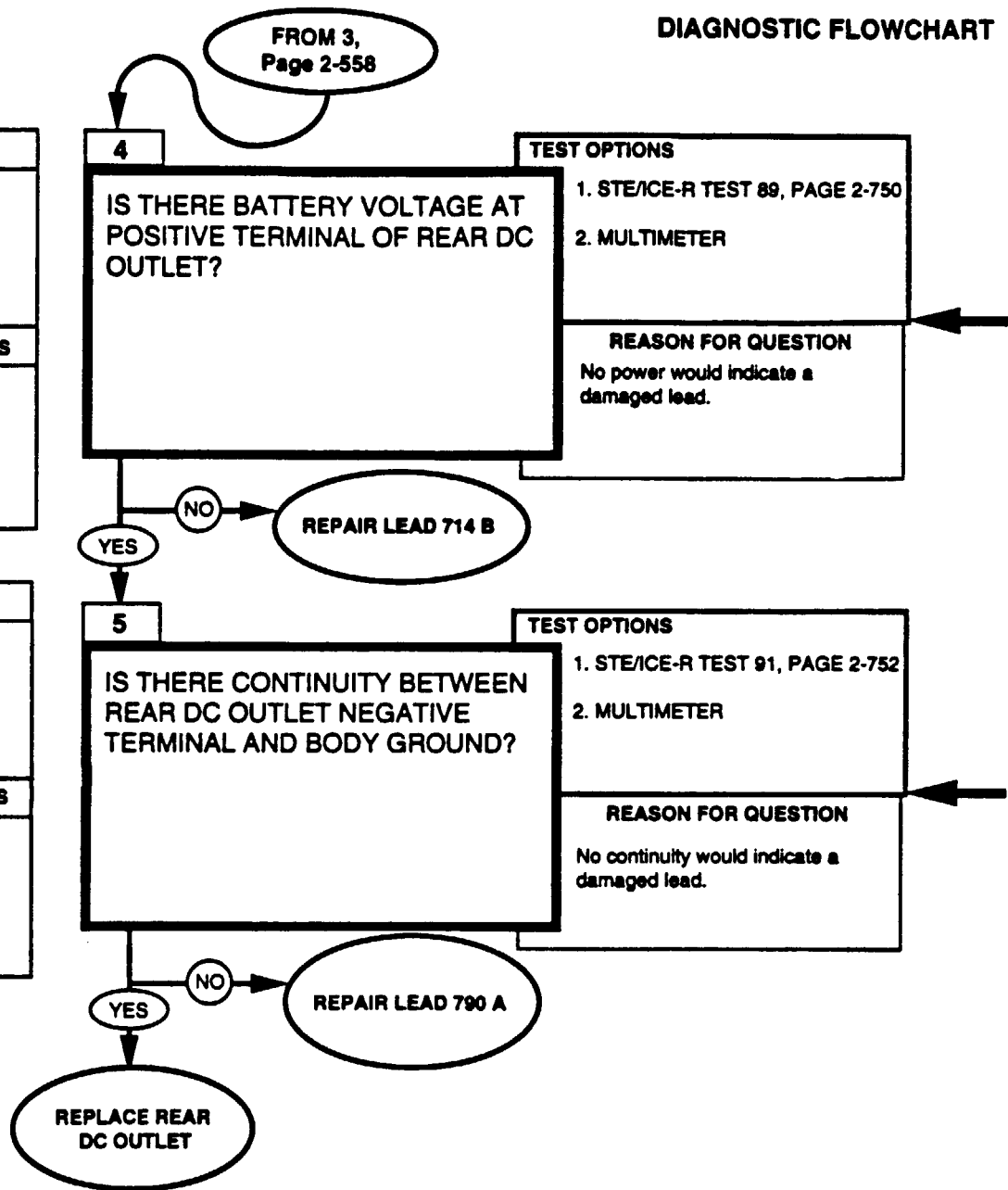
# **AMBULANCE** **(Rear DC Outlet)**

(Refer to Fig. 13.)

## **DIAGNOSTIC FLOWCHART**

KNOWN INFO
FUSE OK BATTERY OK LEAD 660 C OK LEAD 714 A OK
POSSIBLE PROBLEMS
LEAD 714 B REAR DC OUTLET

KNOWN INFO
FUSE OK BATTERY OK LEAD 660 C OK LEAD 714 A OK LEAD 714 B OK
POSSIBLE PROBLEMS
LEAD 790 A REAR DC OUTLET

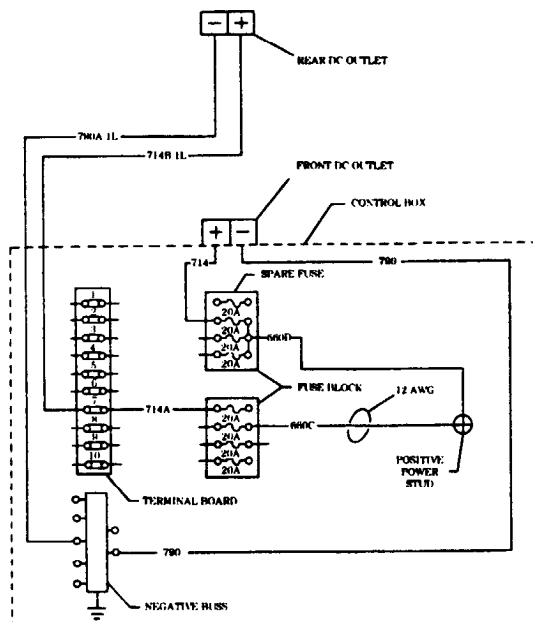


# REFERENCE INFORMATION

# AMBULANCE

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).  
Replace rear DC outlet, refer to (para. 4-90).



## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

## 0-4500 DC OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

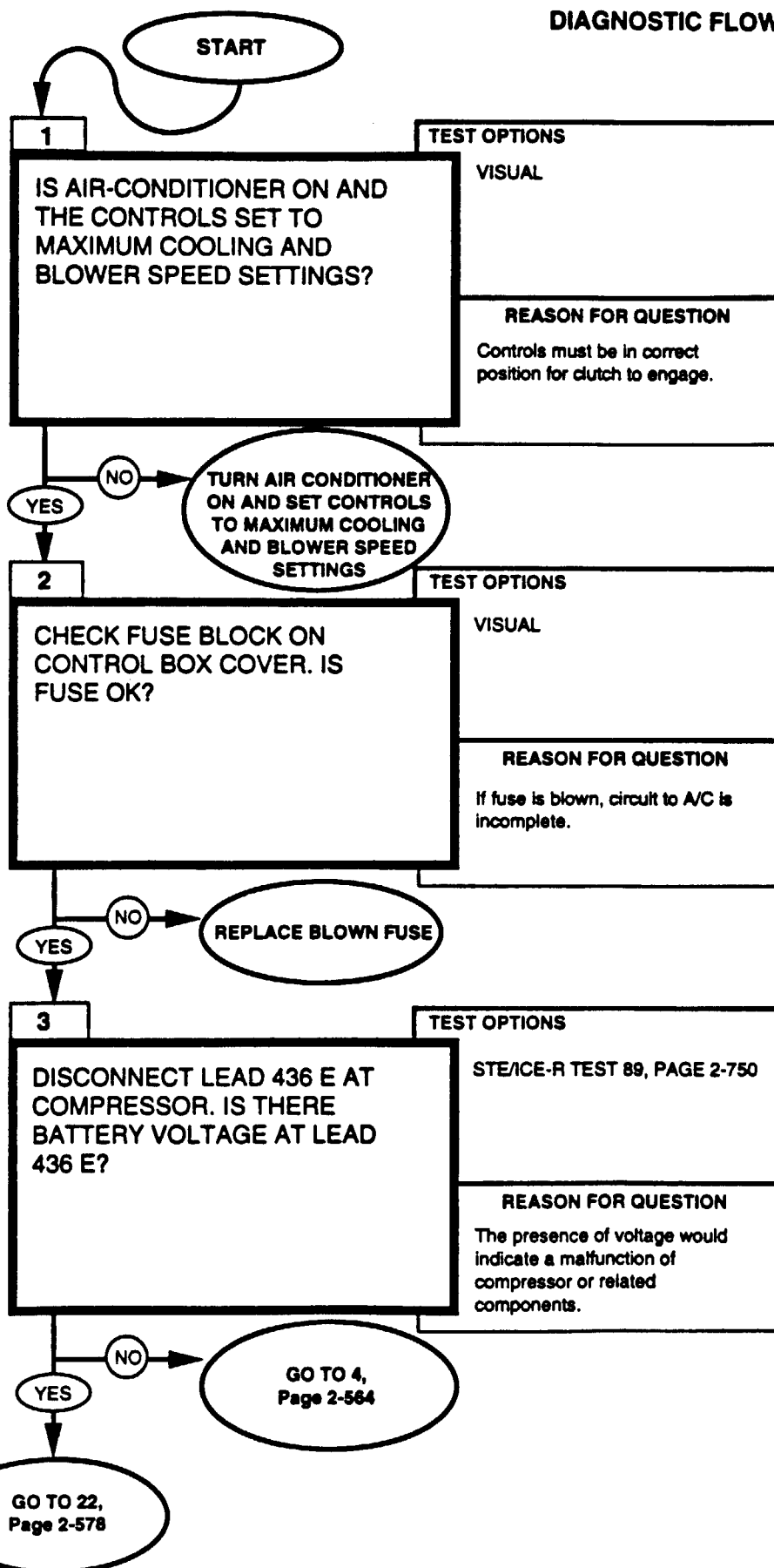
**AMBULANCE**  
**(Compressor Clutch)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
A/C CONTROL SETTING FUSE CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

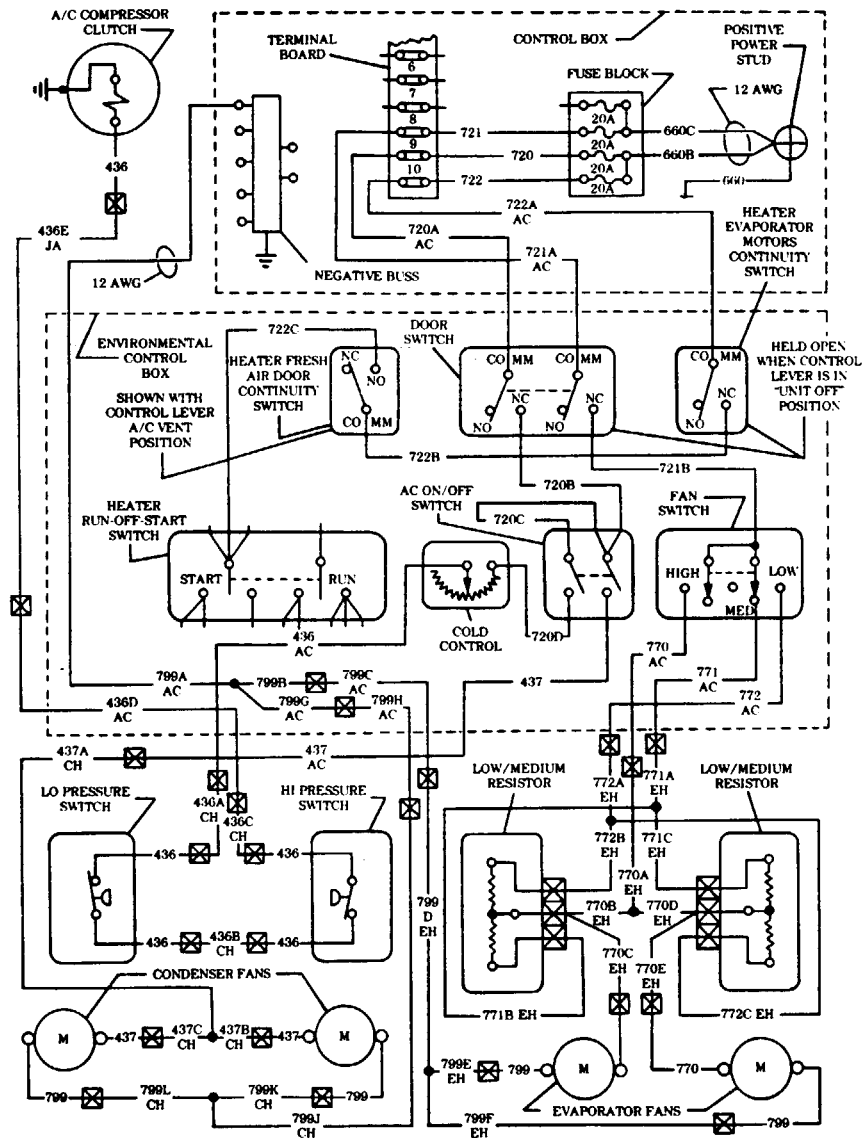
KNOWN INFO
A/C CONTROL SETTINGS OK
POSSIBLE PROBLEMS
FUSE CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH



## REFERENCE INFORMATION

## AMBULANCE



### 0-45 DC VOLTS STE/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

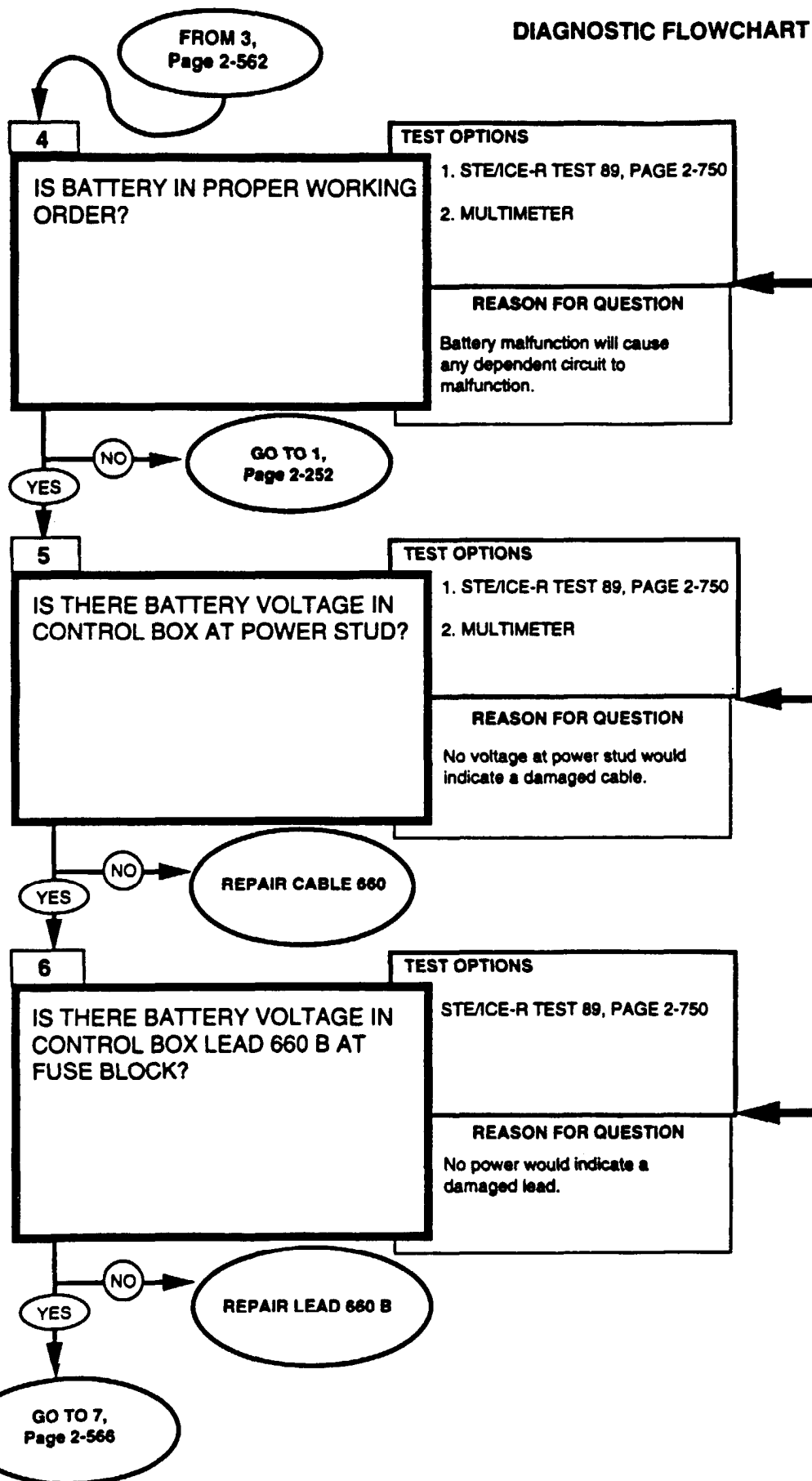
**AMBULANCE  
(Compressor Clutch)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 660 B LEAD 720 LEAD 720 A DOOR SWITCH



# REFERENCE INFORMATION

## AMBULANCE

### 0-45 DC VOLTS STE/CE-R TEST 89

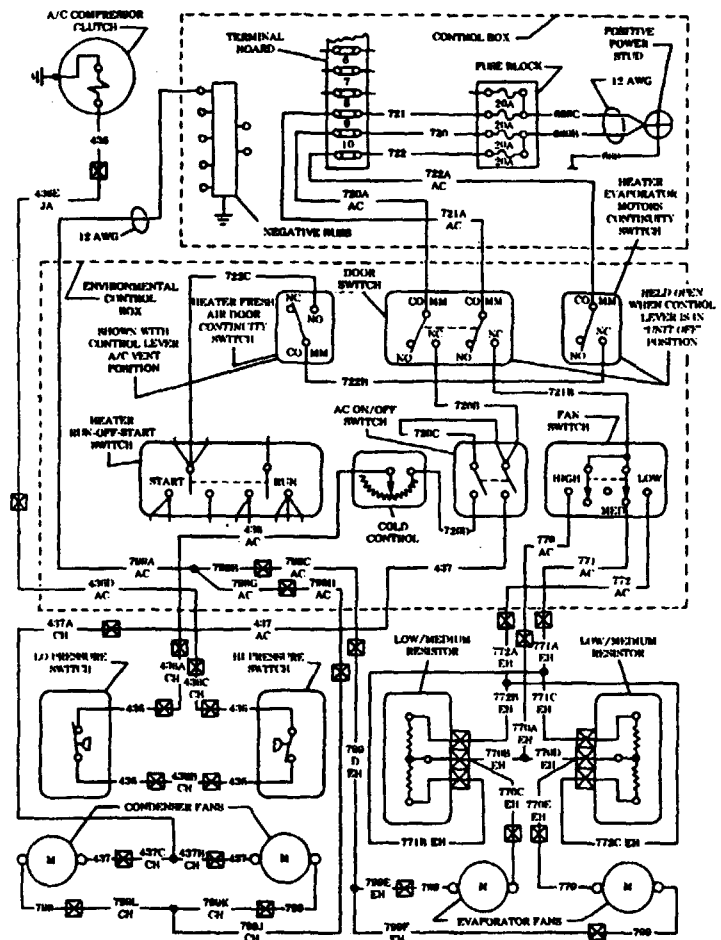
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

Repair cable, refer to DS  
Maintenance.

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to  
(para. 4-85).



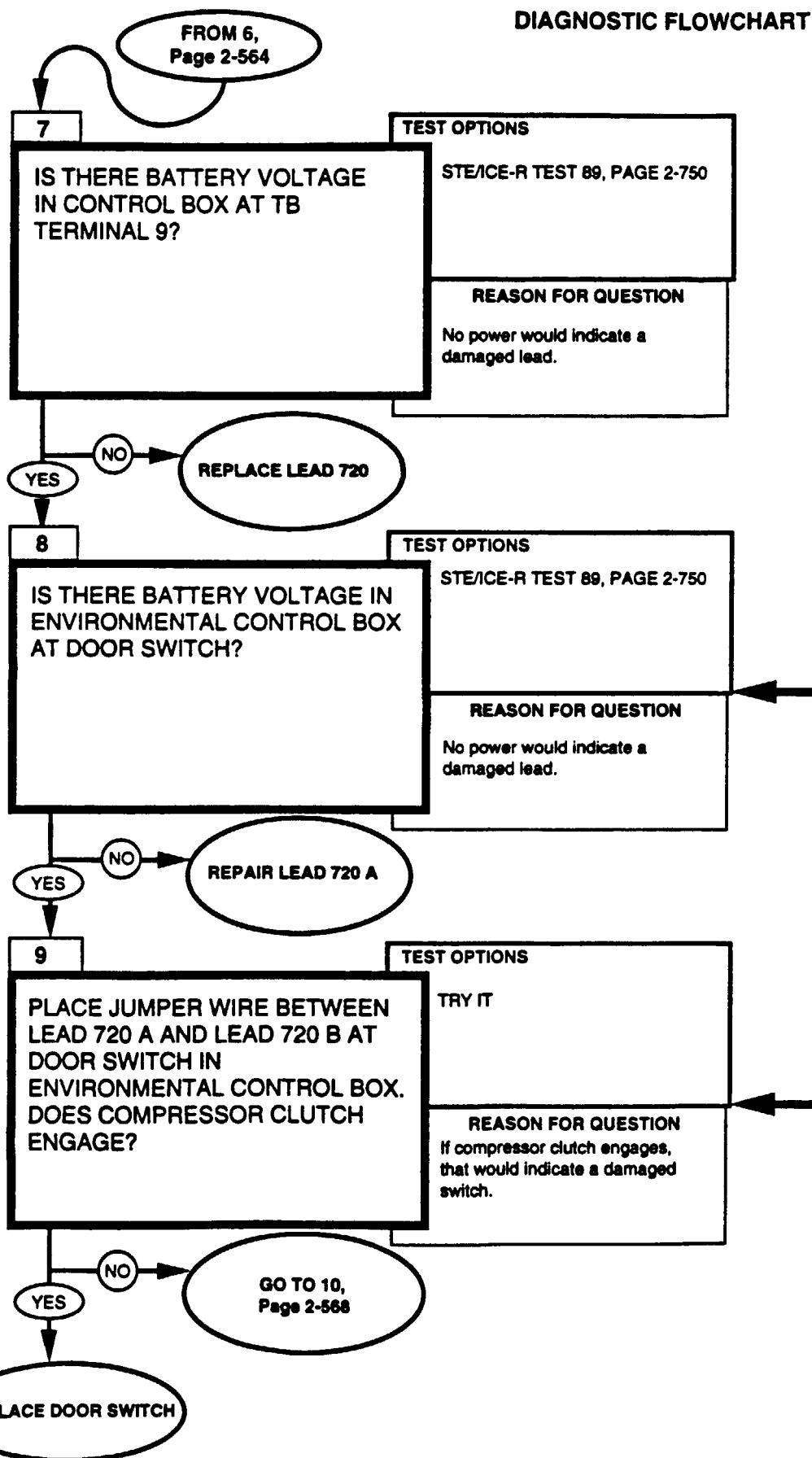
**AMBULANCE**  
**(Compressor Clutch)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK
POSSIBLE PROBLEMS
LEAD 720 LEAD 720 A DOOR SWITCH

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660B OK LEAD 720 OK
POSSIBLE PROBLEMS
LEAD 720 A DOOR SWITCH

KNOWN INFO
A/C CONTROL SETTINGS OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 720 OK LEAD 720 A OK
POSSIBLE PROBLEMS
DOOR SWITCH





# REFERENCE INFORMATION

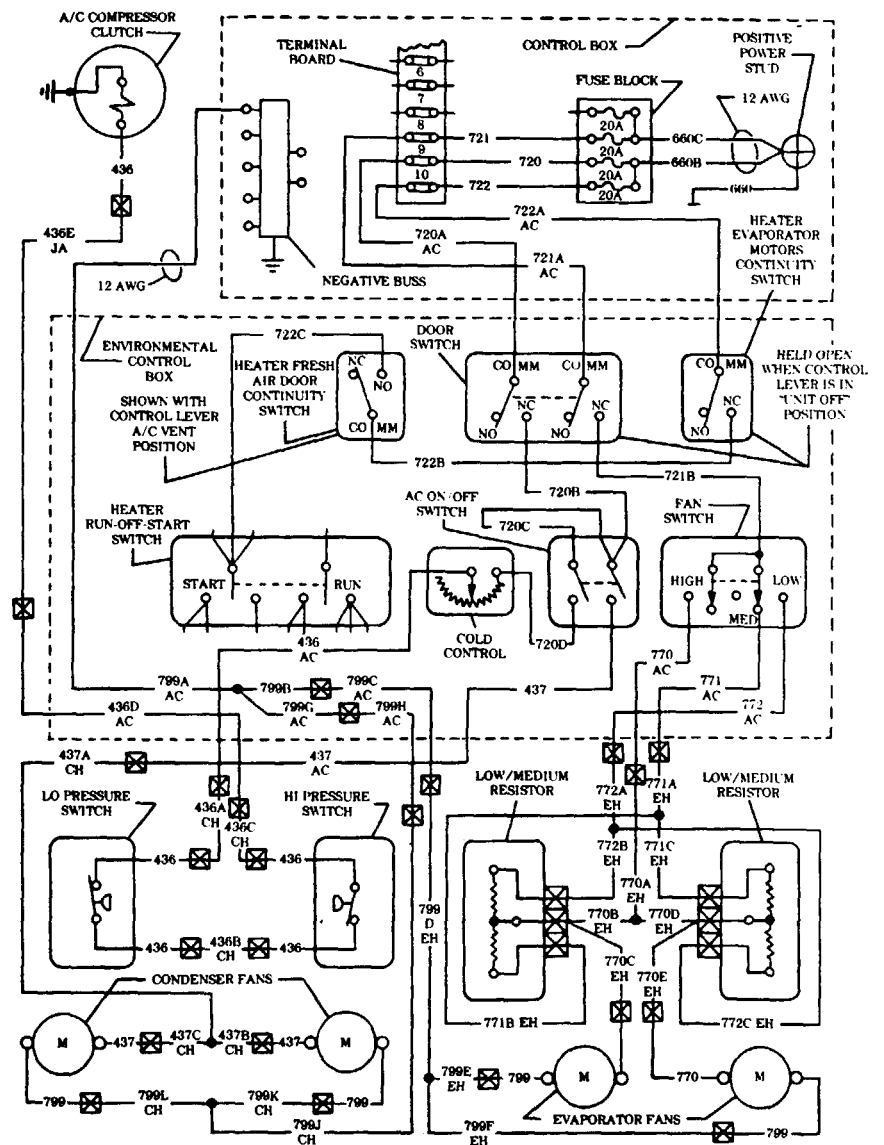
# AMBULANCE

## 0-45 DC VOLTS STE/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts..

Repair lead,  
refer to (para. 4-85).  
Repair lead connector,  
refer to (para. 4-85).

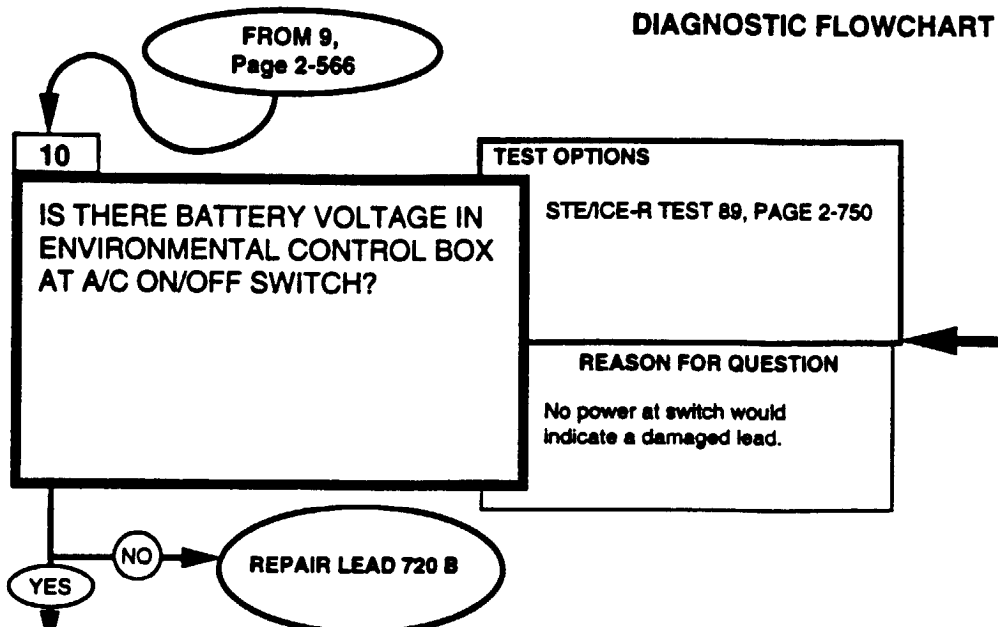
Replace door switch,  
refer to DS Maintenance.



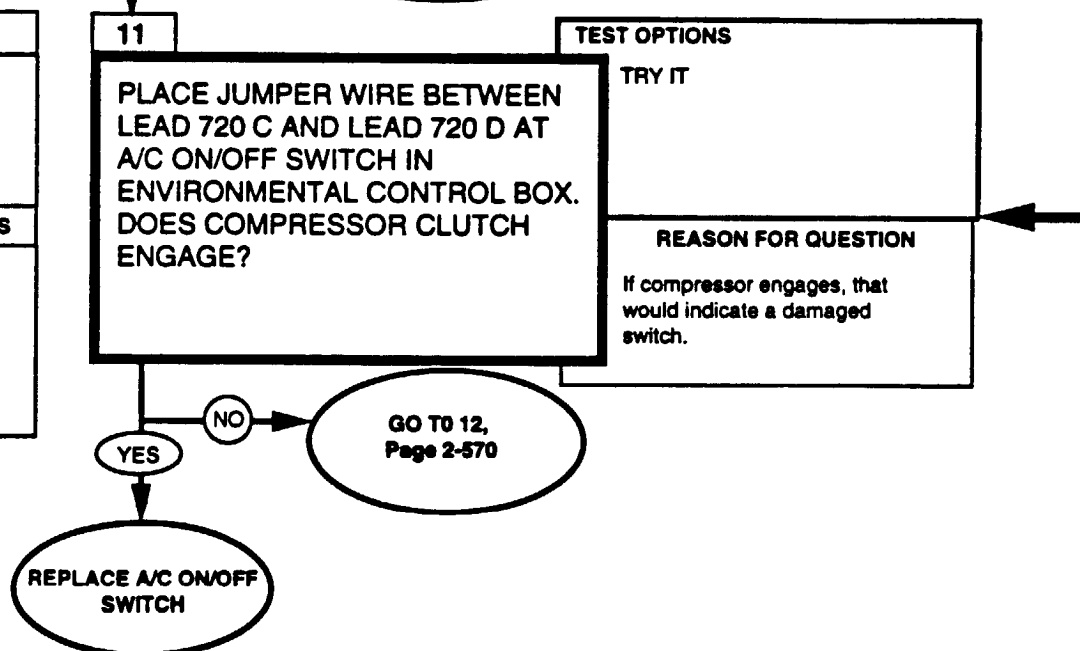
**AMBULANCE**  
(Compressor Clutch)  
(M997 Only)  
(Refer to Fig. 14.)

**DIAGNOSTIC FLOWCHART**

<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
LEAD 720 B A/C ON/OFF SWITCH



<b>KNOWN INFO</b>
LEAD 720 B OK
<b>POSSIBLE PROBLEMS</b>
A/C ON/OFF SWITCH



REFERENCE INFORMATION

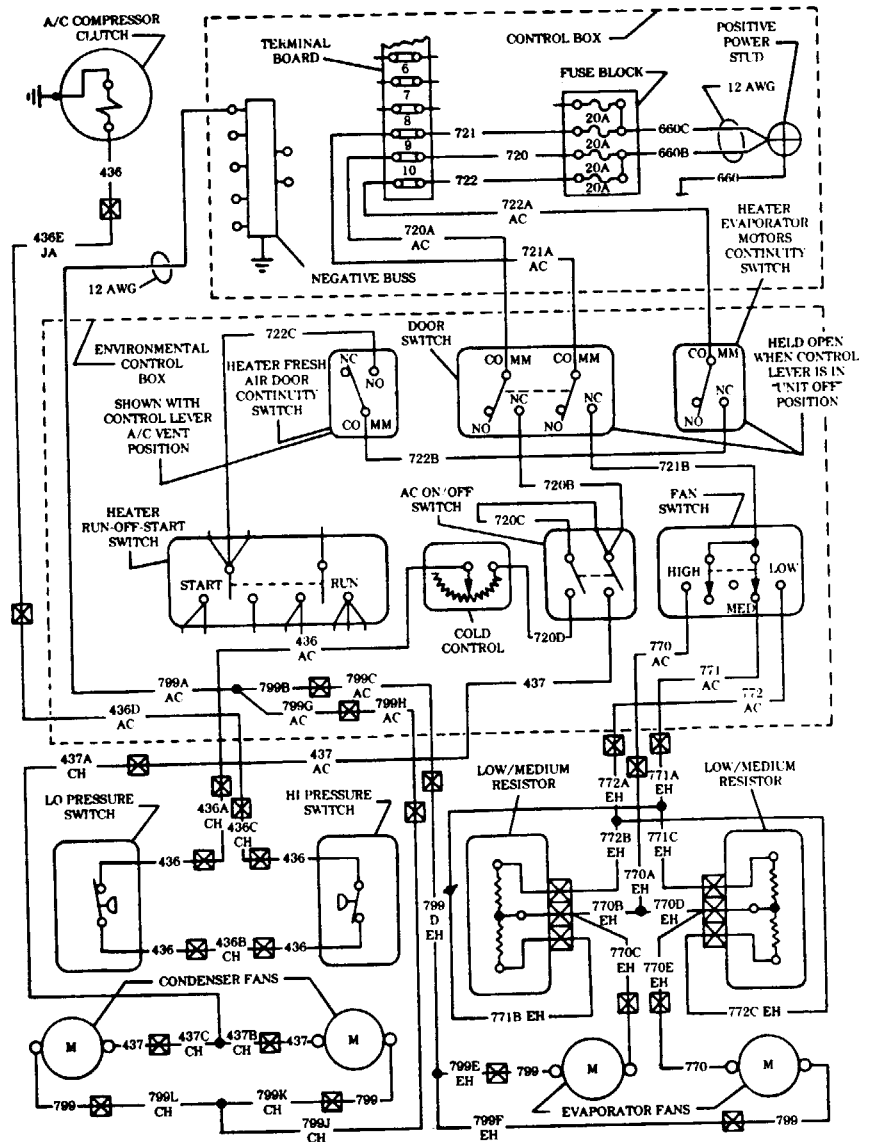
AMBULANCE

Repair lead, refer to (para. 4-85).

Replace A/C ON/OFF switch, refer to (para. 4-127).

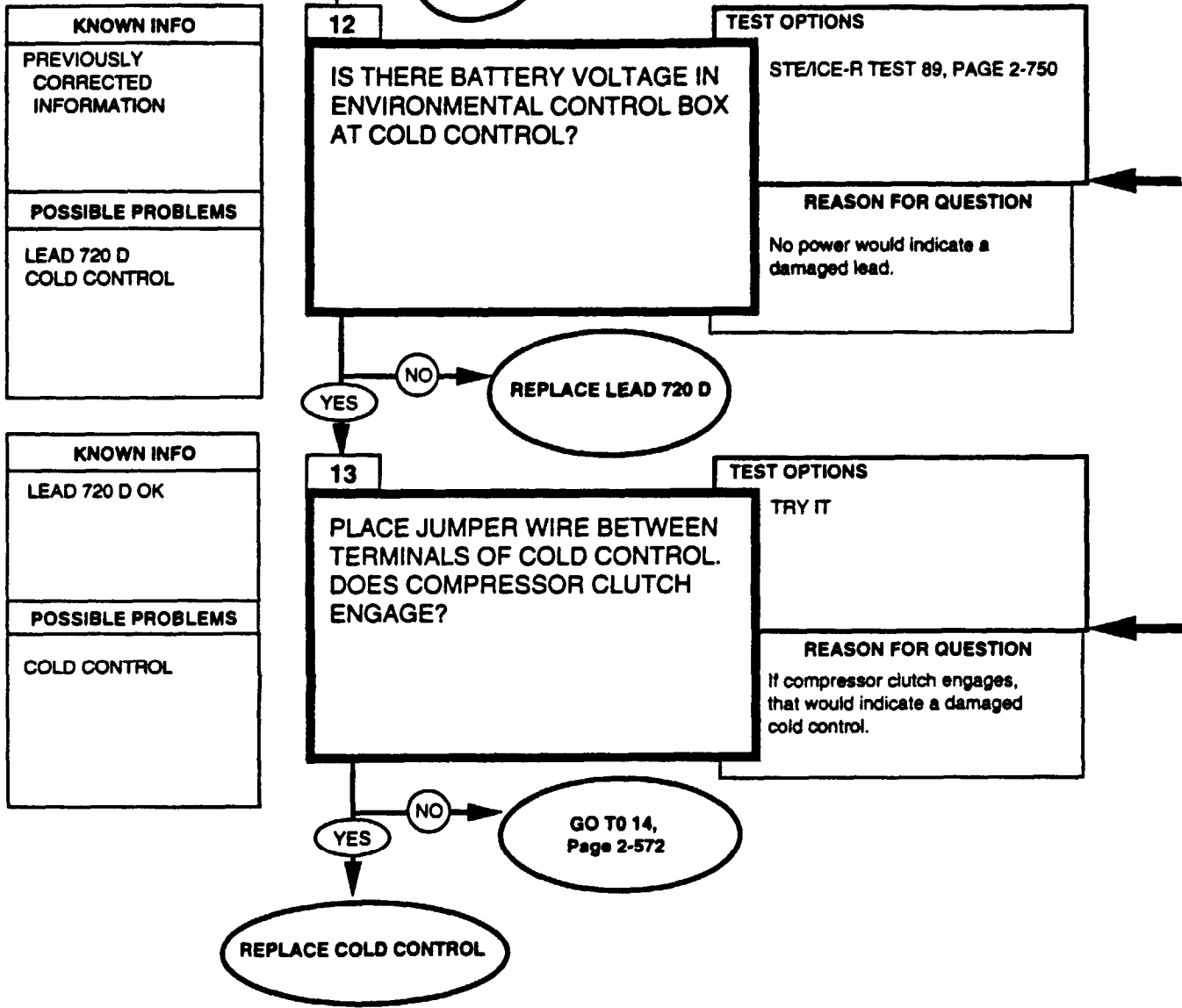
0-45 DC VOLTS  
STE/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



**AMBULANCE**  
**(Compressor Clutch)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**



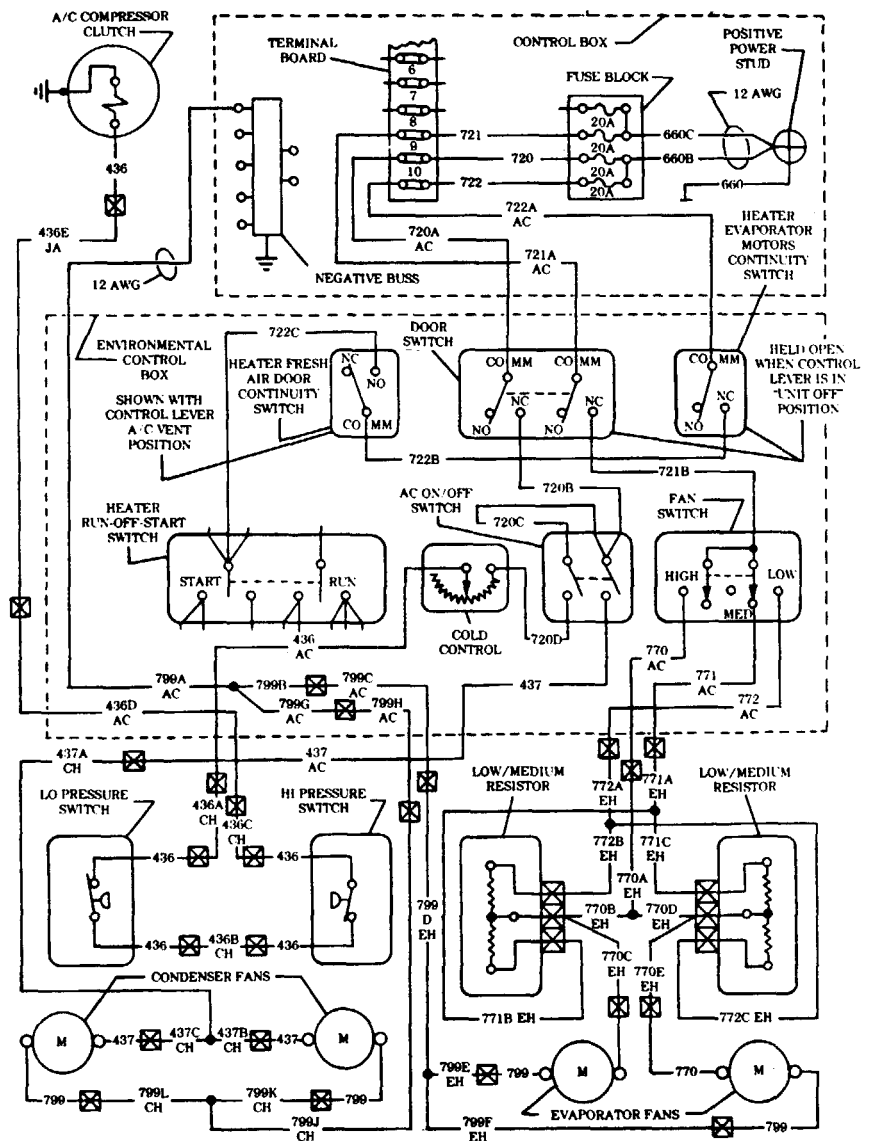
REFERENCE INFORMATION

AMBULANCE

**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace cold control, refer to  
DS Maintenance.



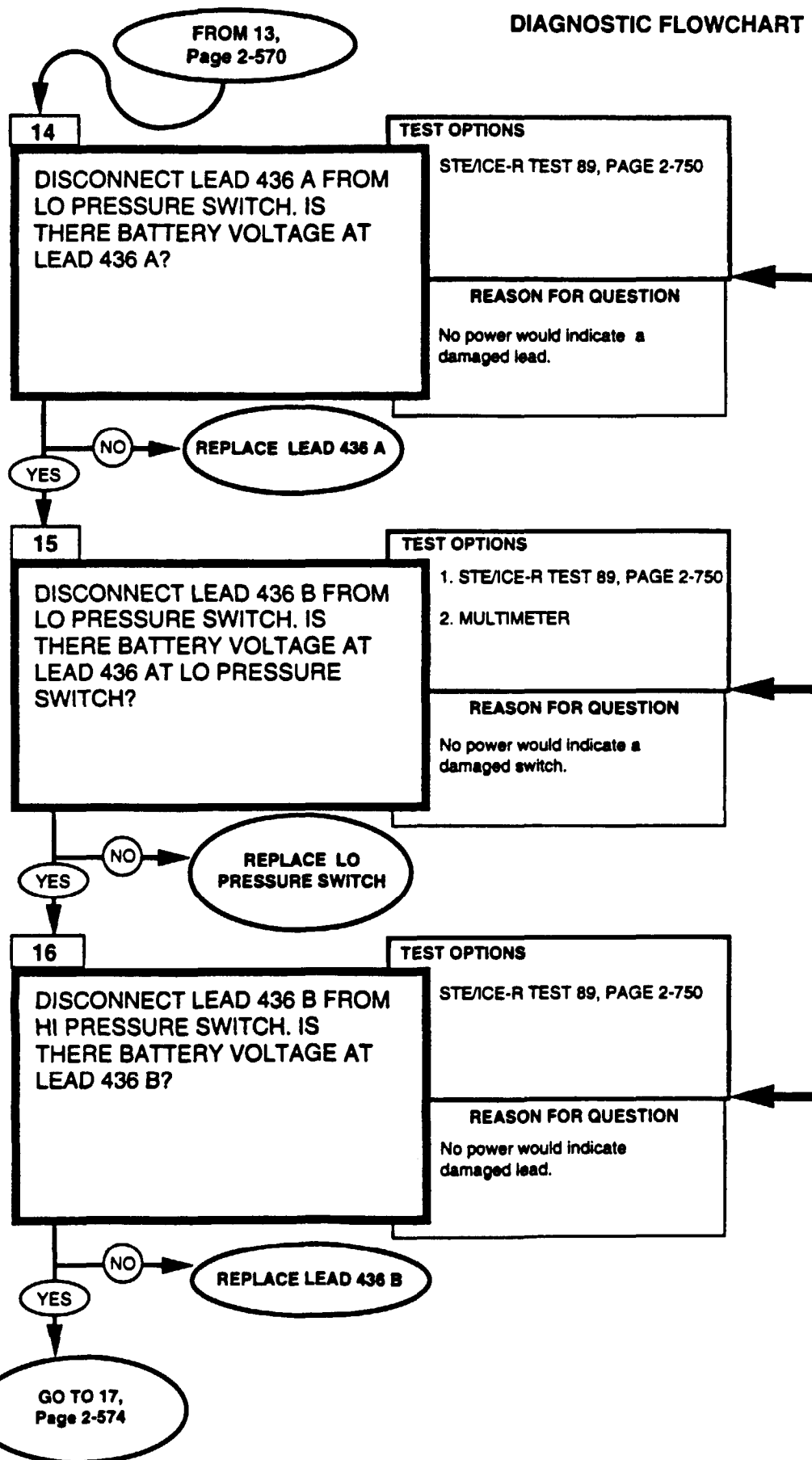
**AMBULANCE**  
(Compressor Clutch)  
(M997 Only)  
(Refer to Fig. 14.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 436 A LO PRESSURE SWITCH LEAD 436 B HI PRESSURE SWITCH LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR

KNOWN INFO
LEAD 436 A OK
POSSIBLE PROBLEMS
LO PRESSURE SWITCH LEAD 436 B HI PRESSURE SWITCH LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR

KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK
POSSIBLE PROBLEMS
LEAD 436 B HI PRESSURE SWITCH LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR

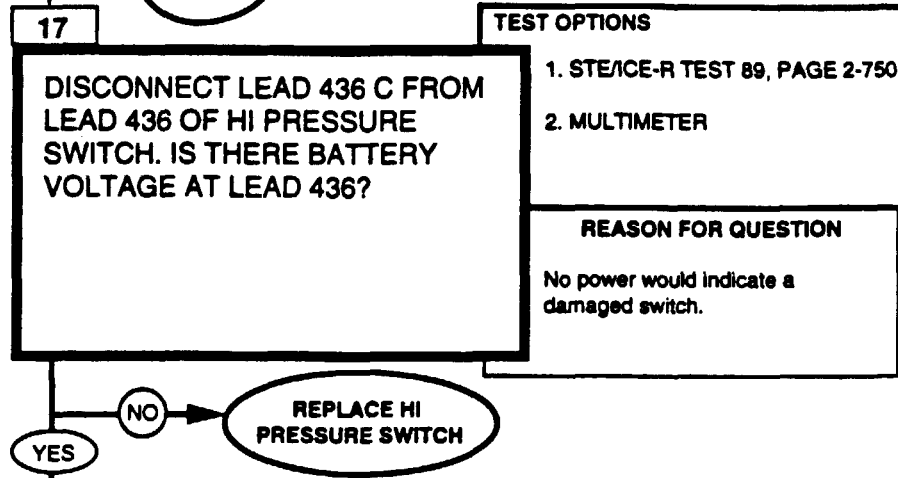




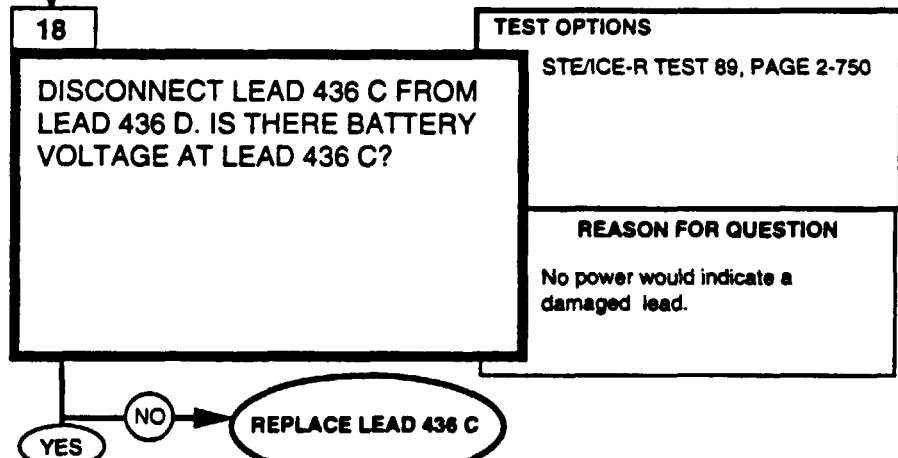
**AMBULANCE**  
(Compressor Clutch)  
(M997 Only)  
(Refer to Fig. 14.)

**DIAGNOSTIC FLOWCHART**

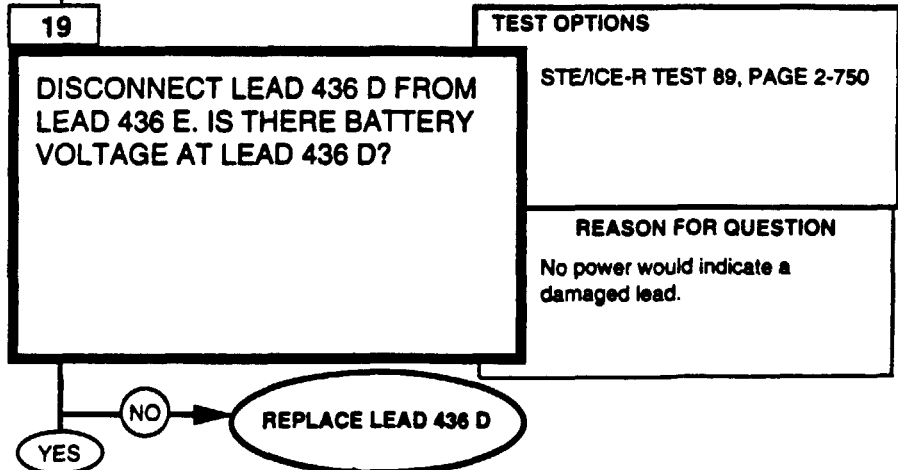
KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK LEAD 436 B OK
POSSIBLE PROBLEMS
HI PRESSURE SWITCH LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR



KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK LEAD 436 B OK HI PRESSURE SWITCH OK
POSSIBLE PROBLEMS
LEAD 436 C LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR



KNOWN INFO
LEAD 436 A OK LO PRESSURE SWITCH OK LEAD 436 B OK HI PRESSURE SWITCH OK LEAD 436 C OK
POSSIBLE PROBLEMS
LEAD 436 D LEAD 436 E COMPRESSOR WIRING HARNESS LEAD 798 A COMPRESSOR



GO TO 20,  
Page 2-576



# REFERENCE INFORMATION

# AMBULANCE

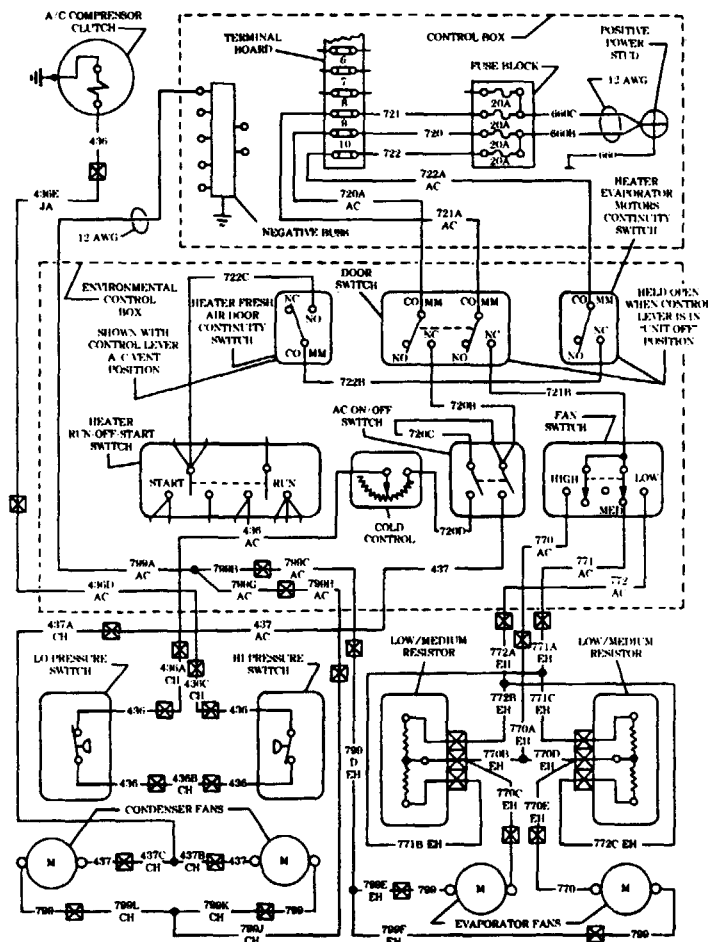
Replace high pressure switch,  
refer to DS Maintenance.

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

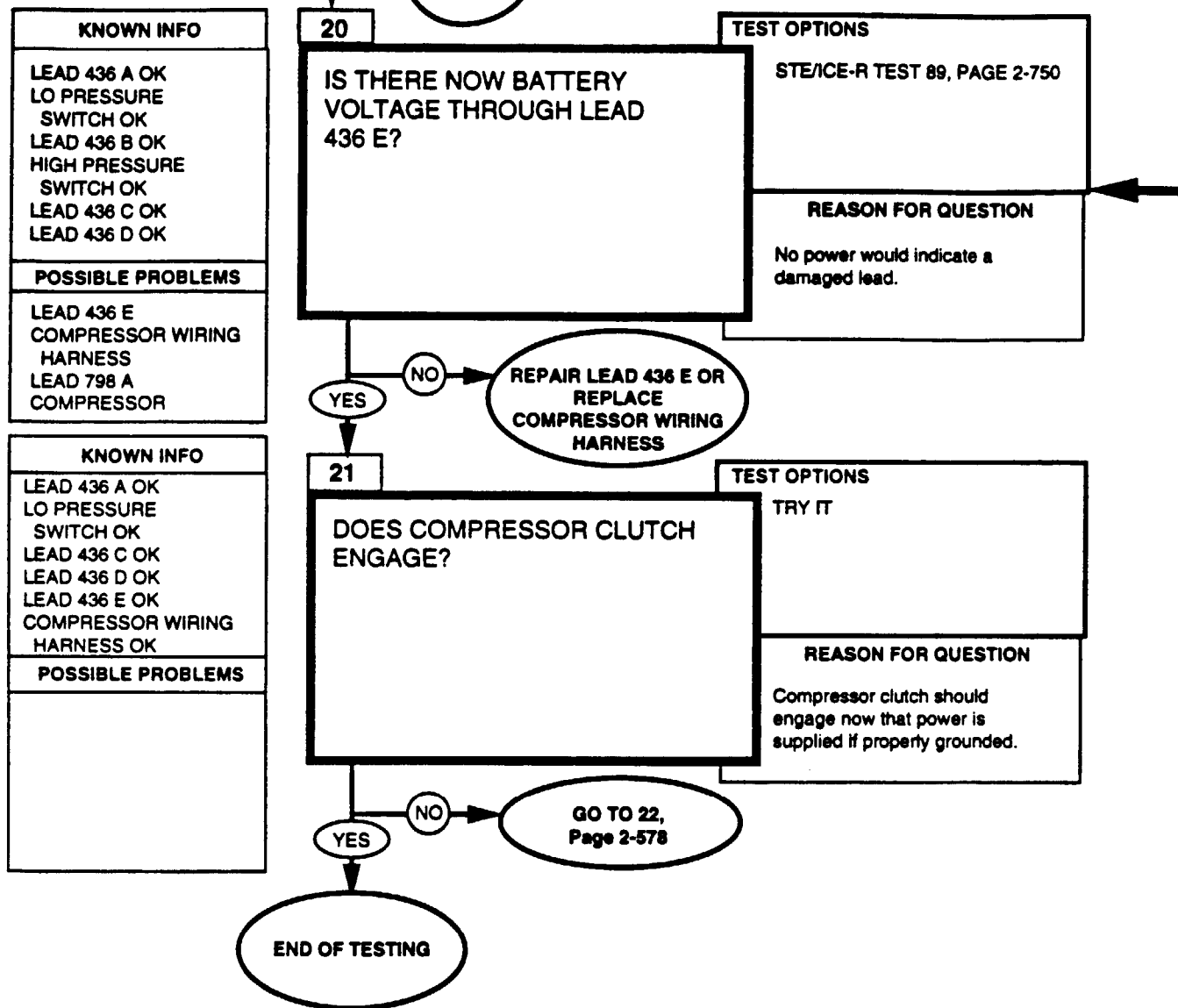
## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.



**AMBULANCE  
(Compressor Clutch)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

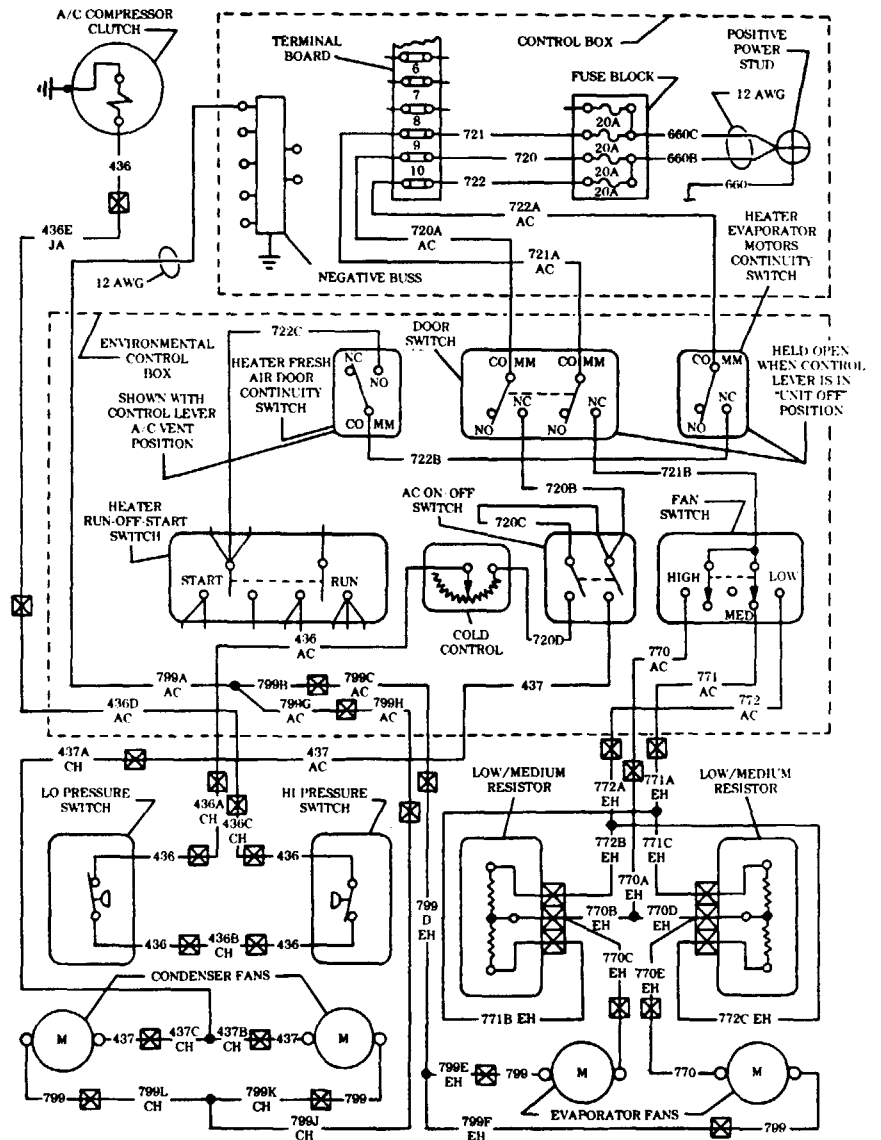
## AMBULANCE

**Replace compressor wiring harness, refer to (para. 4-122).**

**Repair lead, refer to (para. 4-85).**  
**Repair lead connector, refer to**  
**(para. 4-85).**

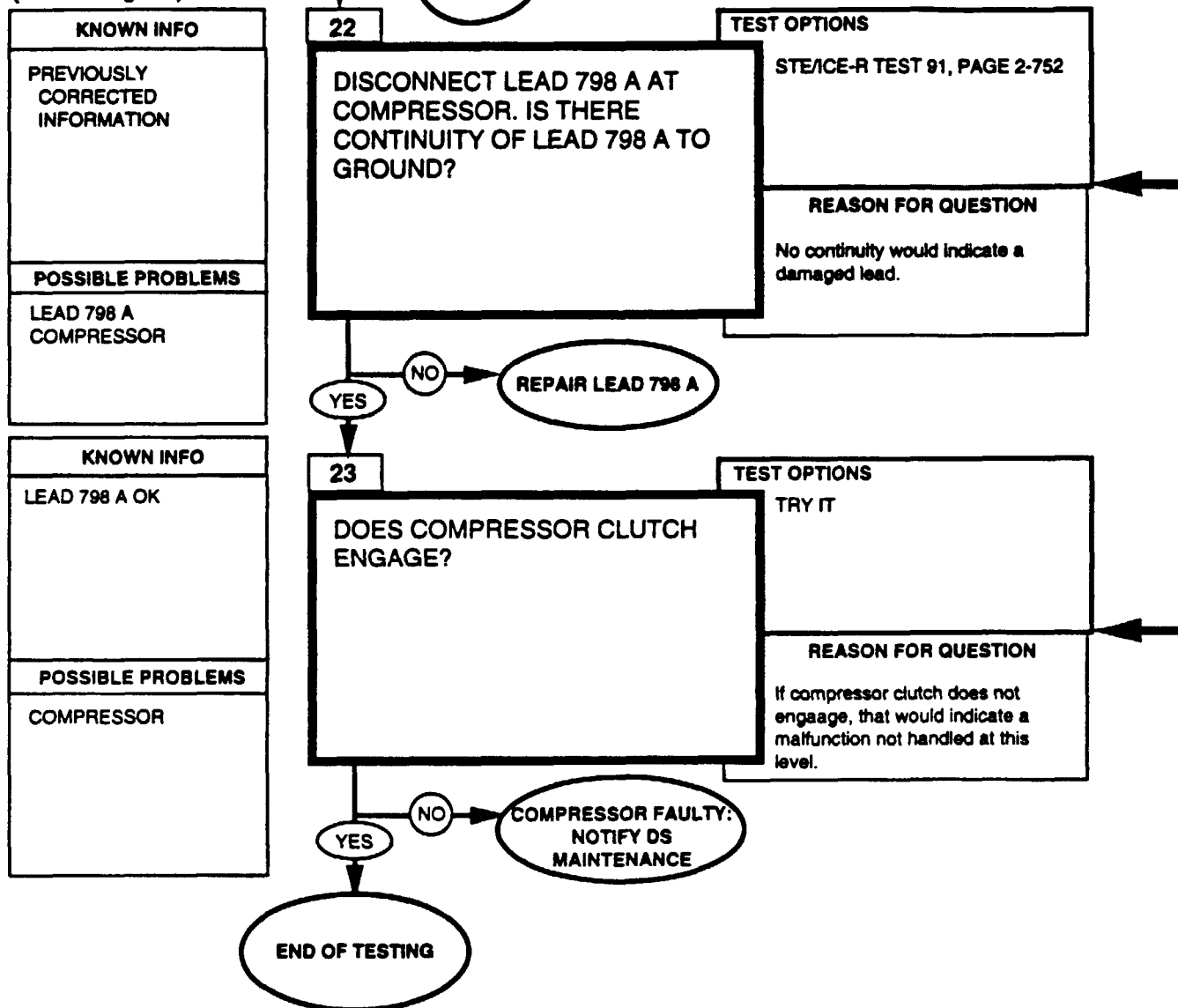
**0-45 DC VOLTS**  
**STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



**AMBULANCE  
(Compressor Clutch)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

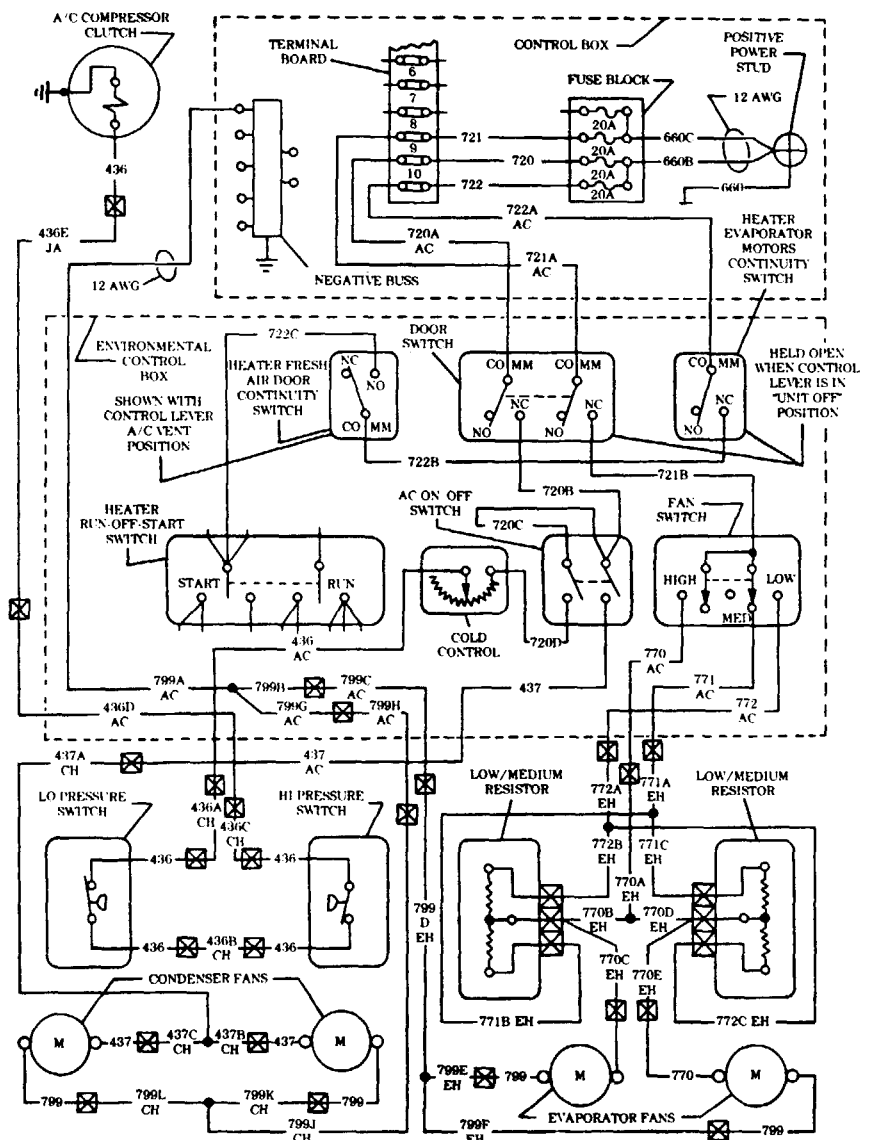
## AMBULANCE

**Repair lead, refer to (para. 4-85).**

**Repair lead connector,  
refer to (para. 4-85).**

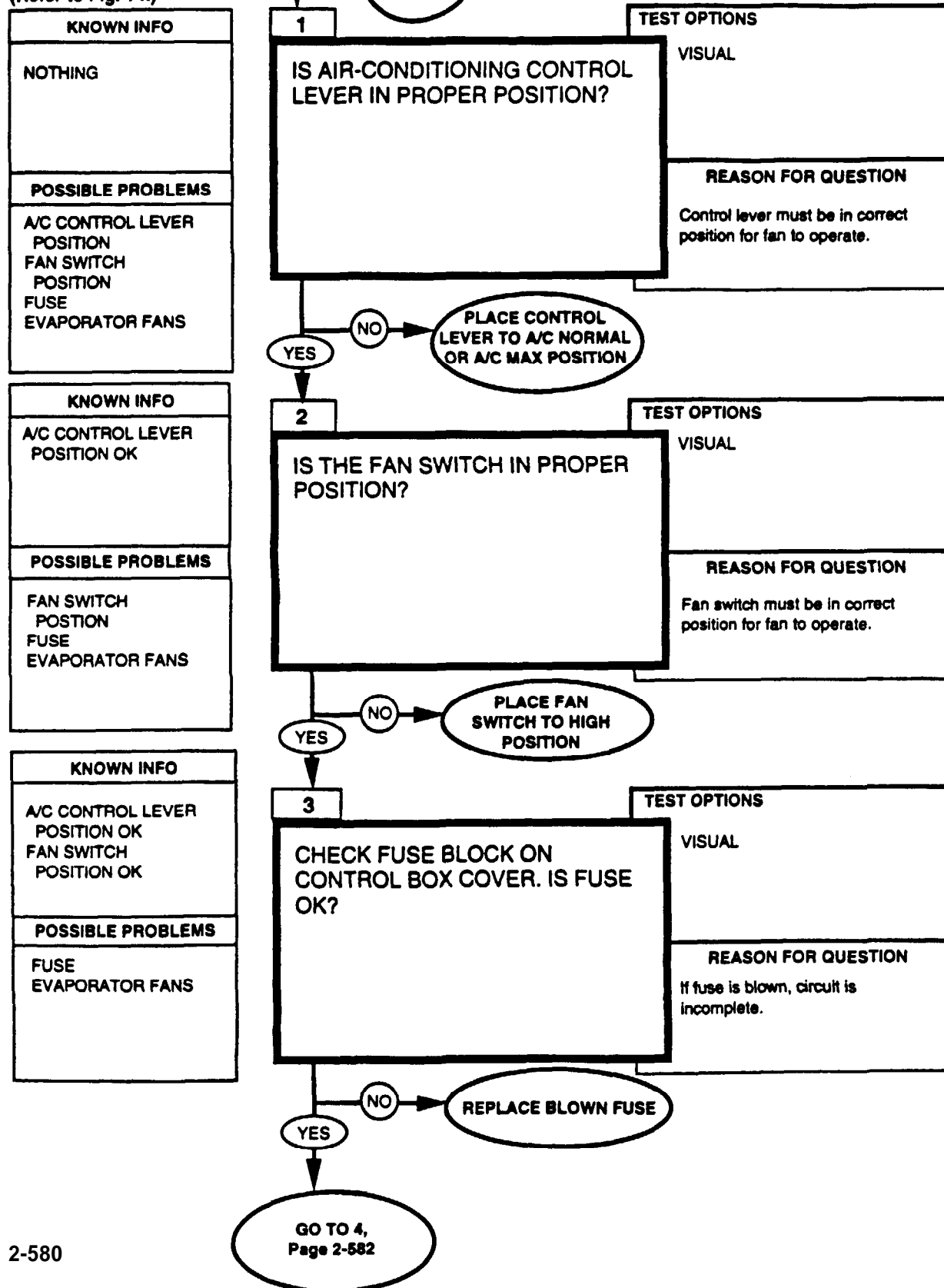
**0-4500 DC OHMS  
STE/CE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



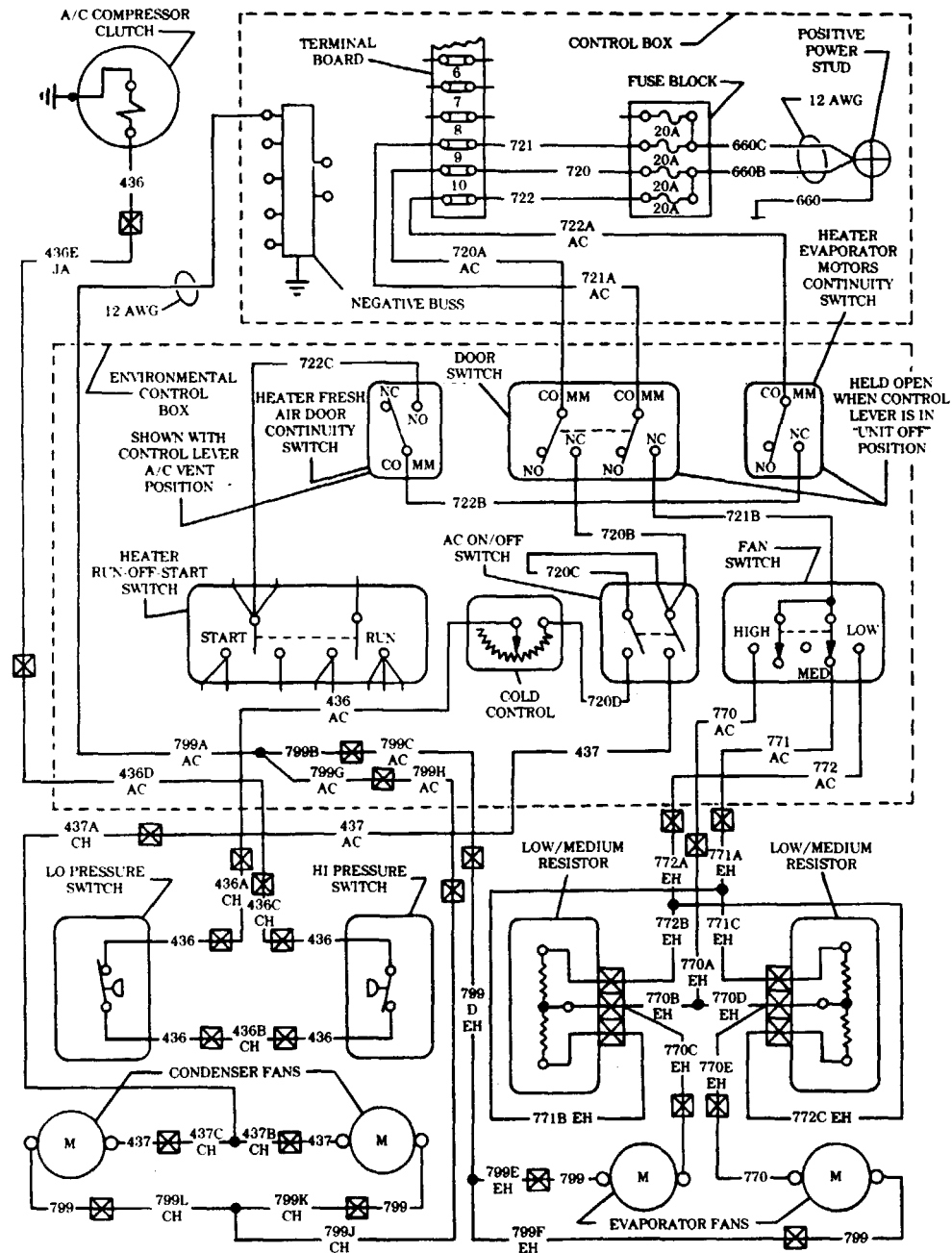
**AMBULANCE  
(Evaporator Fans)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

AMBULANCE

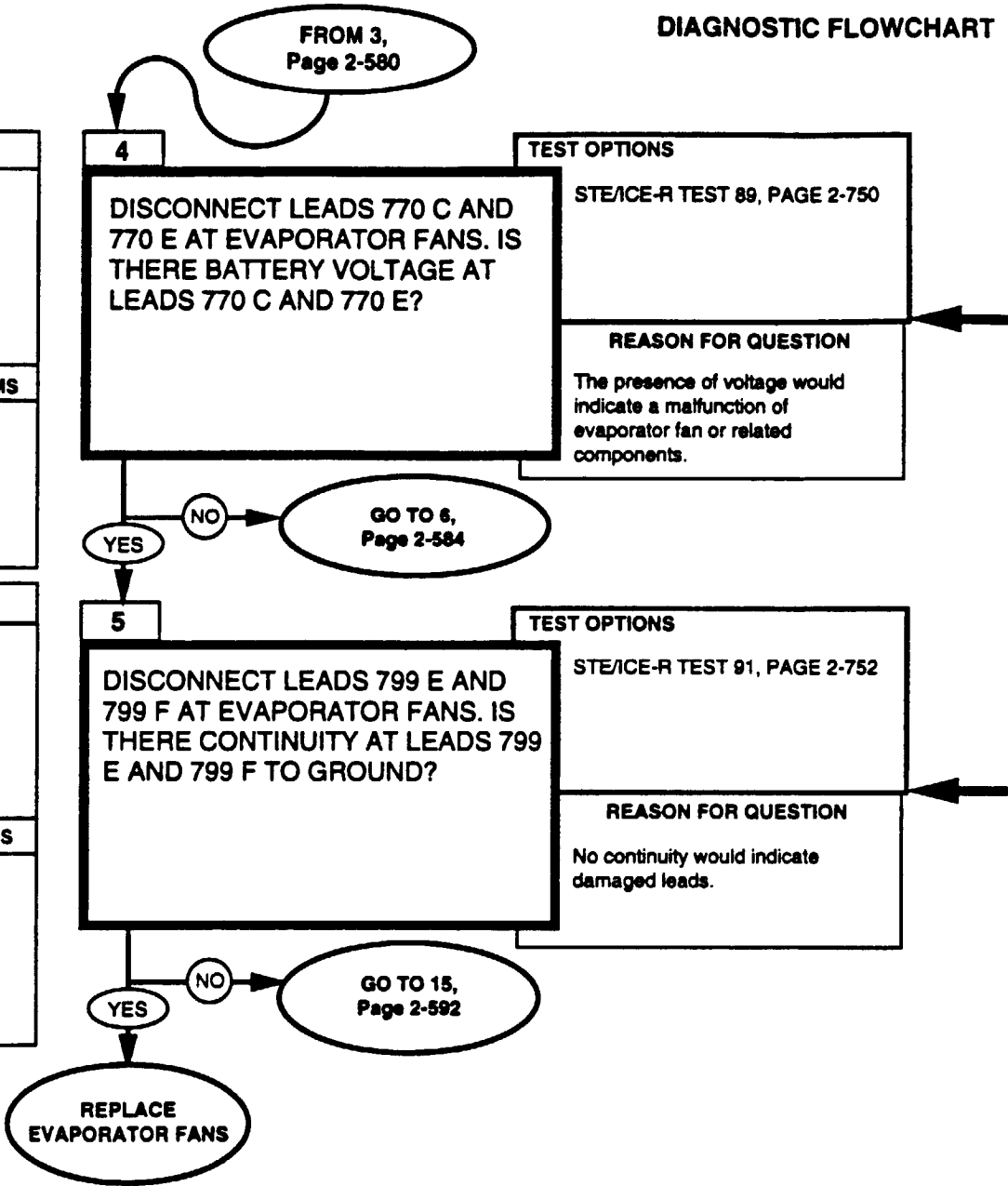


**AMBULANCE**  
**(Evaporator Fans)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

KNOWN INFO
A/C CONTROL LEVER POSITION OK FAN SWITCH POSITION OK FUSE OK
POSSIBLE PROBLEMS
EVAPORATOR FANS

KNOWN INFO
A/C CONTROL LEVER POSITION OK FAN SWITCH POSITION OK FUSE OK
POSSIBLE PROBLEMS
EVAPORATOR FANS

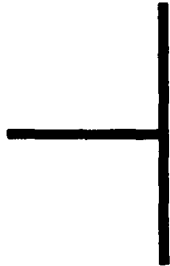
**DIAGNOSTIC FLOWCHART**





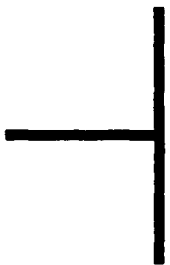
# REFERENCE INFORMATION

## AMBULANCE



### 0-45 DC VOLTS STE/ICE-R TEST 89

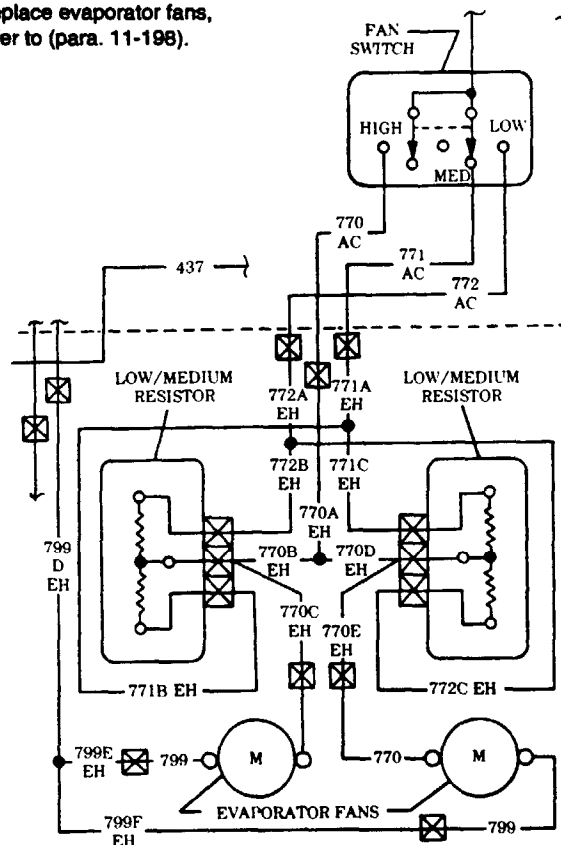
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



Replace evaporator fans,  
refer to (para. 11-198).

### 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



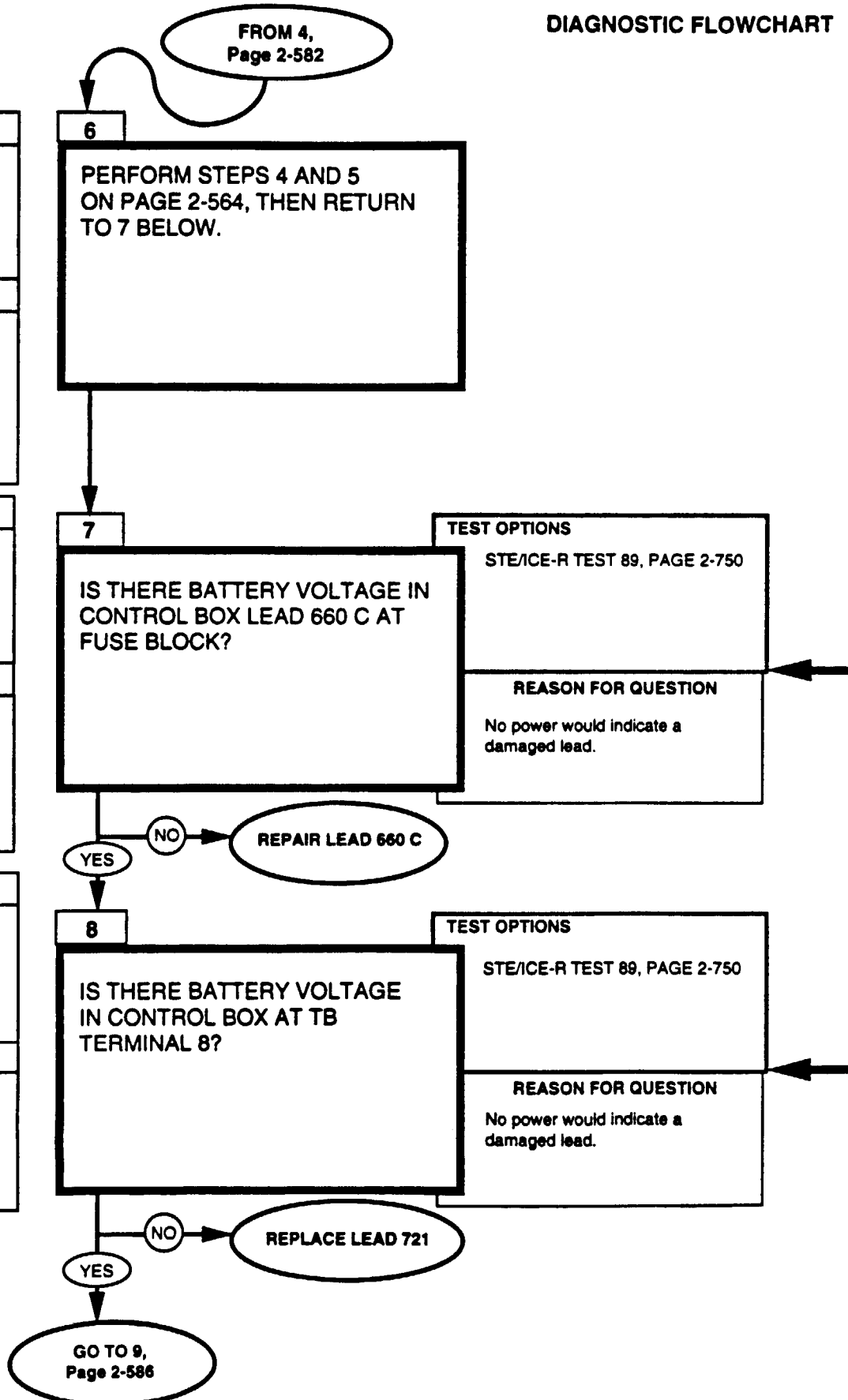
**AMBULANCE  
(Evaporator Fans)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
BATTERY CABLE 660 LEAD 660 C LEAD 721 LEAD 721 A DOOR SWITCH

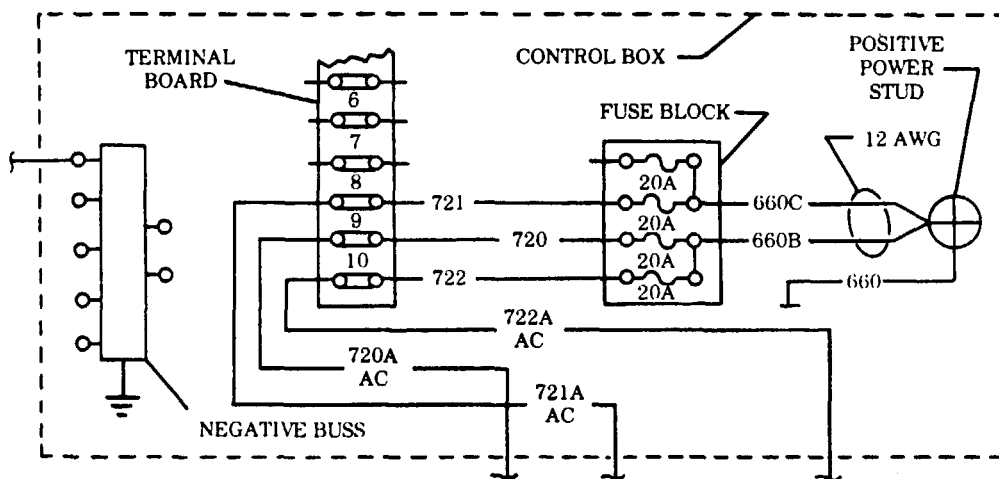
<b>KNOWN INFO</b>
BATTERY OK CABLE 660 OK
<b>POSSIBLE PROBLEMS</b>
LEAD 660 C LEAD 721 LEAD 721 A DOOR SWITCH

<b>KNOWN INFO</b>
BATTERY OK CABLE 660 OK LEAD 660 C OK
<b>POSSIBLE PROBLEMS</b>
LEAD 721 LEAD 721 A DOOR SWITCH



REFERENCE INFORMATION

AMBULANCE



Repair lead,  
refer to (para. 4-85).

Repair lead connector,  
refer to (para. 4-85).

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

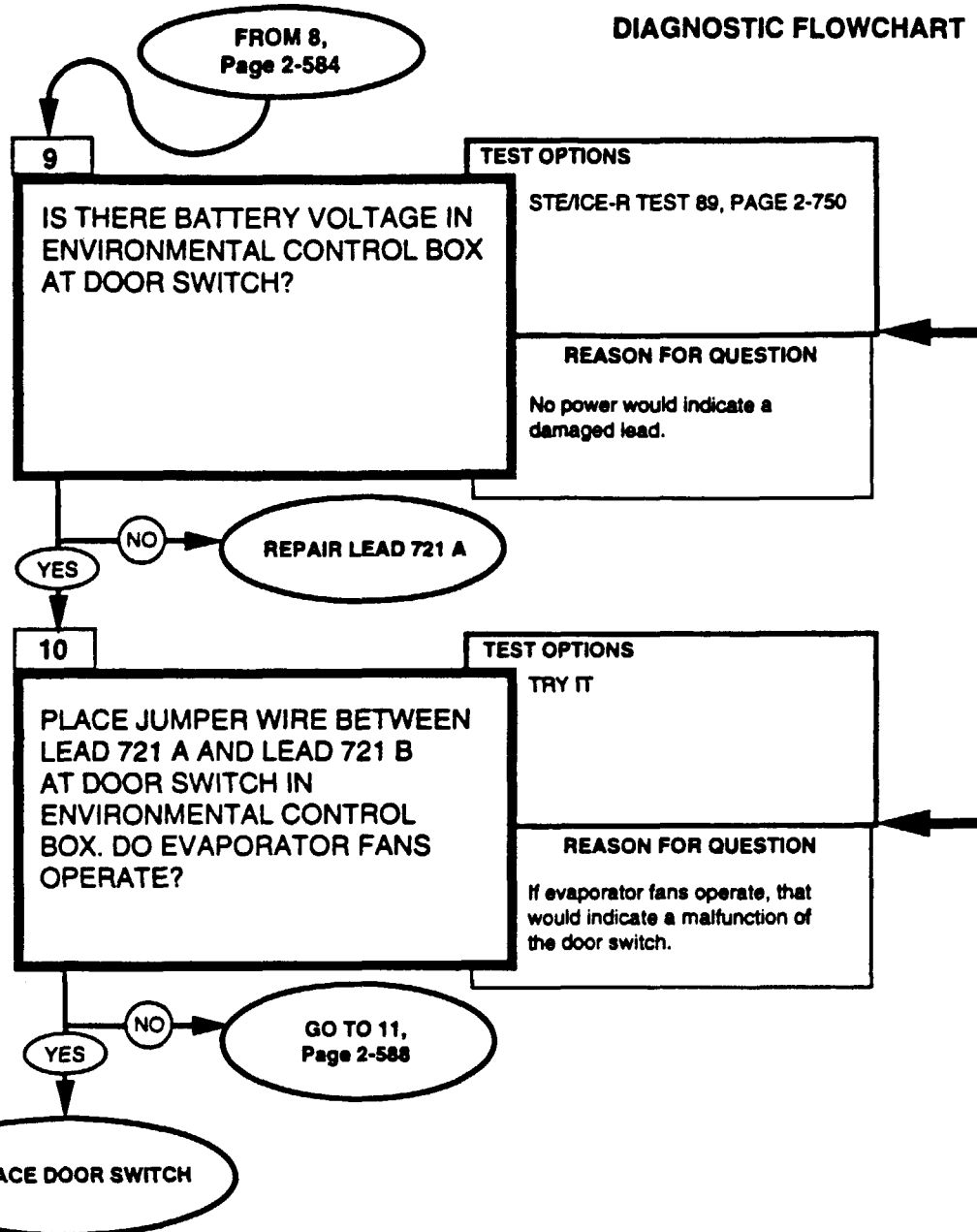
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**AMBULANCE  
(Evaporator Fans)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 660C OK LEAD 721 OK
POSSIBLE PROBLEMS
LEAD 721 A DOOR SWITCH

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 660 C OK LEAD 721 OK LEAD 721 A OK
POSSIBLE PROBLEMS
DOOR SWITCH



REFERENCE INFORMATION

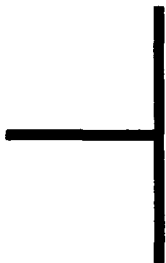
AMBULANCE



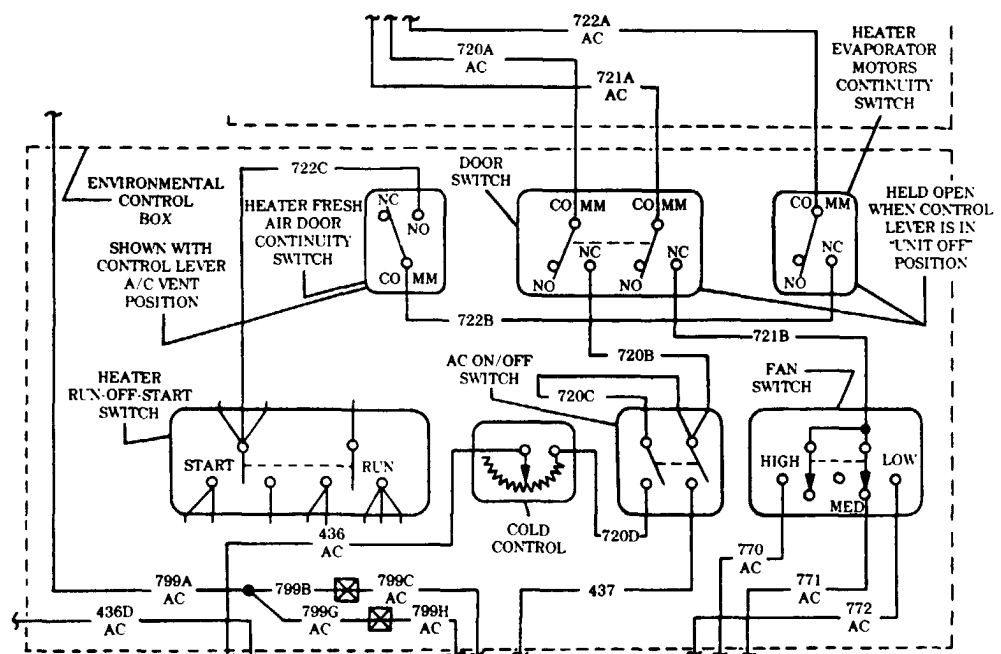
Repair lead,  
refer to (para. 4-85).

Repair lead connector,  
refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



Replace door switch,  
refer to DS Maintenance.



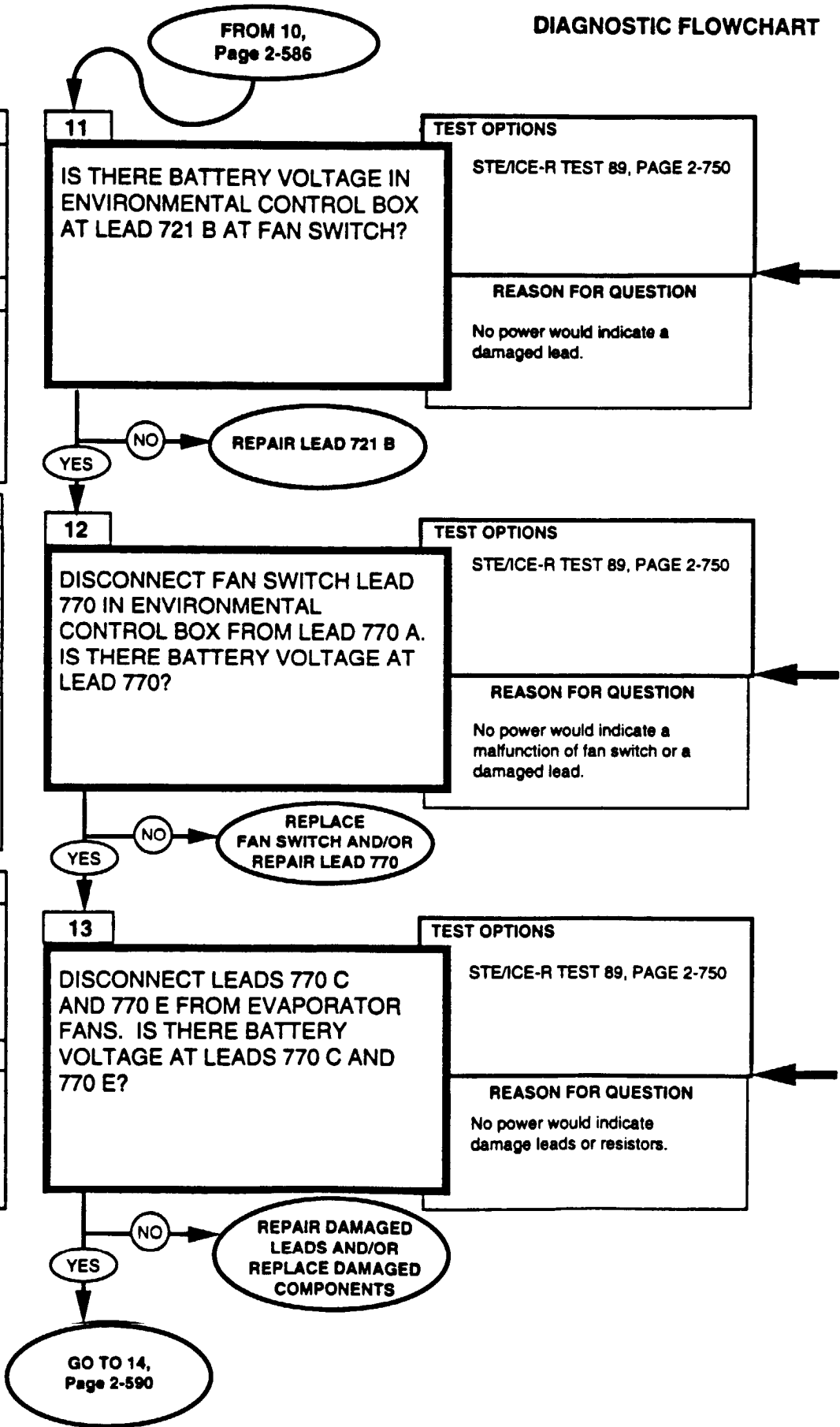
**AMBULANCE  
(Evaporator Fans)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 721 B FAN SWITCH LEAD 770 DAMAGED LEADS DAMAGED COMPONENTS

KNOWN INFO
LEAD 721 B OK
POSSIBLE PROBLEMS
FAN SWITCH LEAD 770 DAMAGED LEADS DAMAGED COMPONENTS

KNOWN INFO
LEAD 721 B OK FAN SWITCH OK LEAD 770 OK
POSSIBLE PROBLEMS
DAMAGED LEADS DAMAGED COMPONENTS



REFERENCE INFORMATION

AMBULANCE

Repair lead, refer to (para. 4-85).

**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

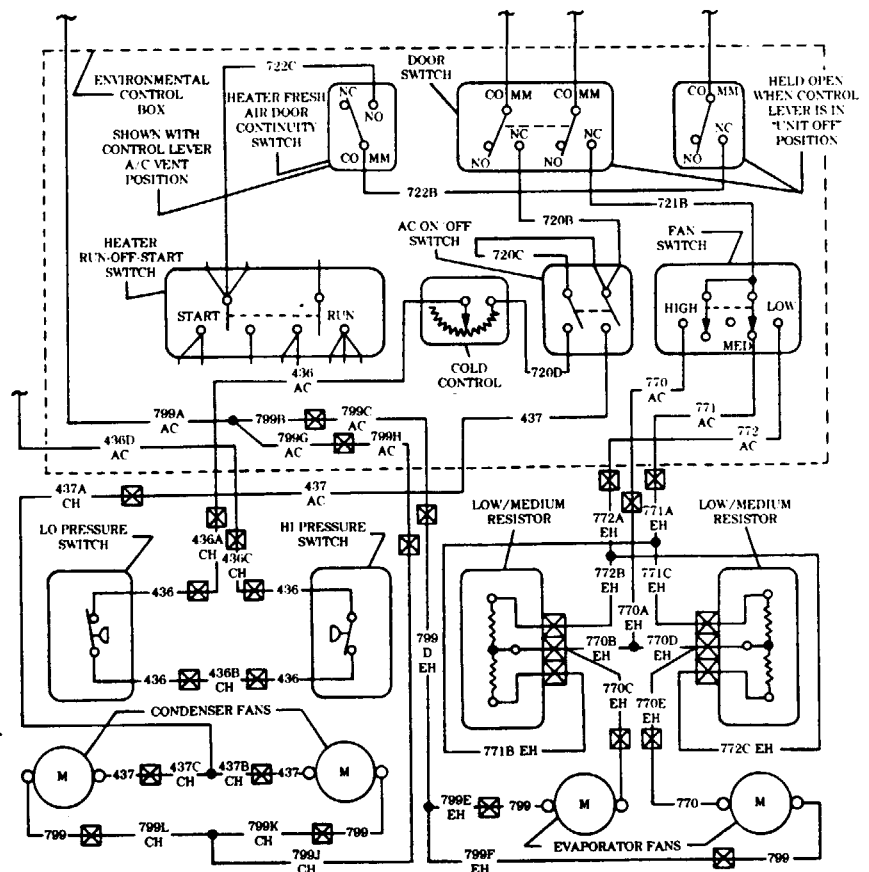
Replace fan switch, refer to (para. 4-127).

Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

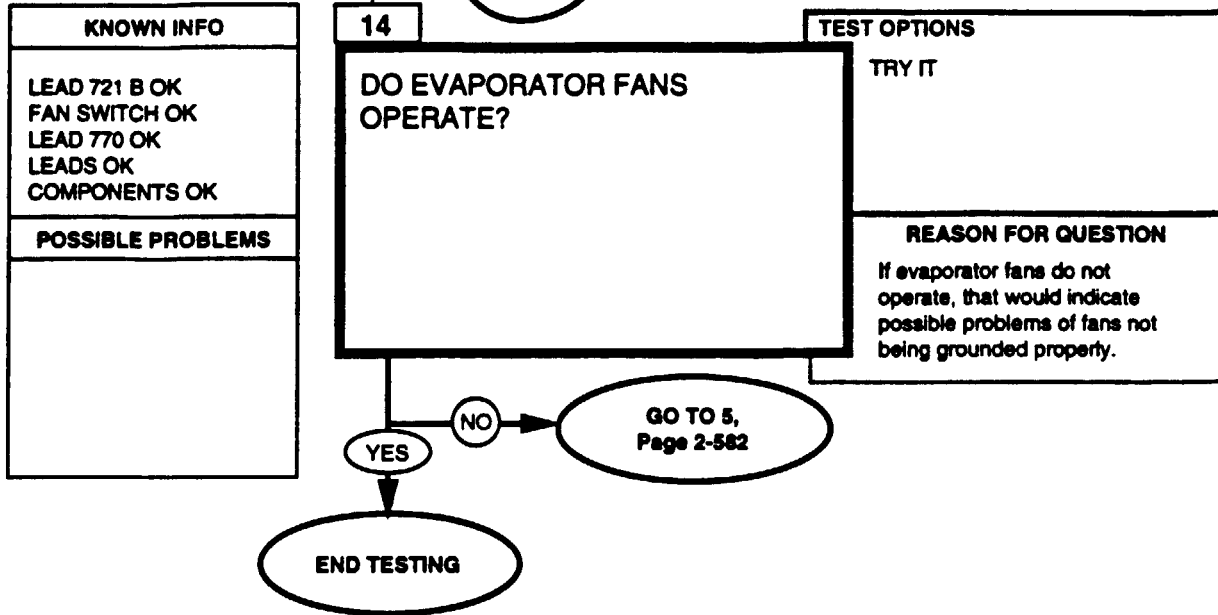
Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).



**AMBULANCE  
(Evaporator Fans)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**



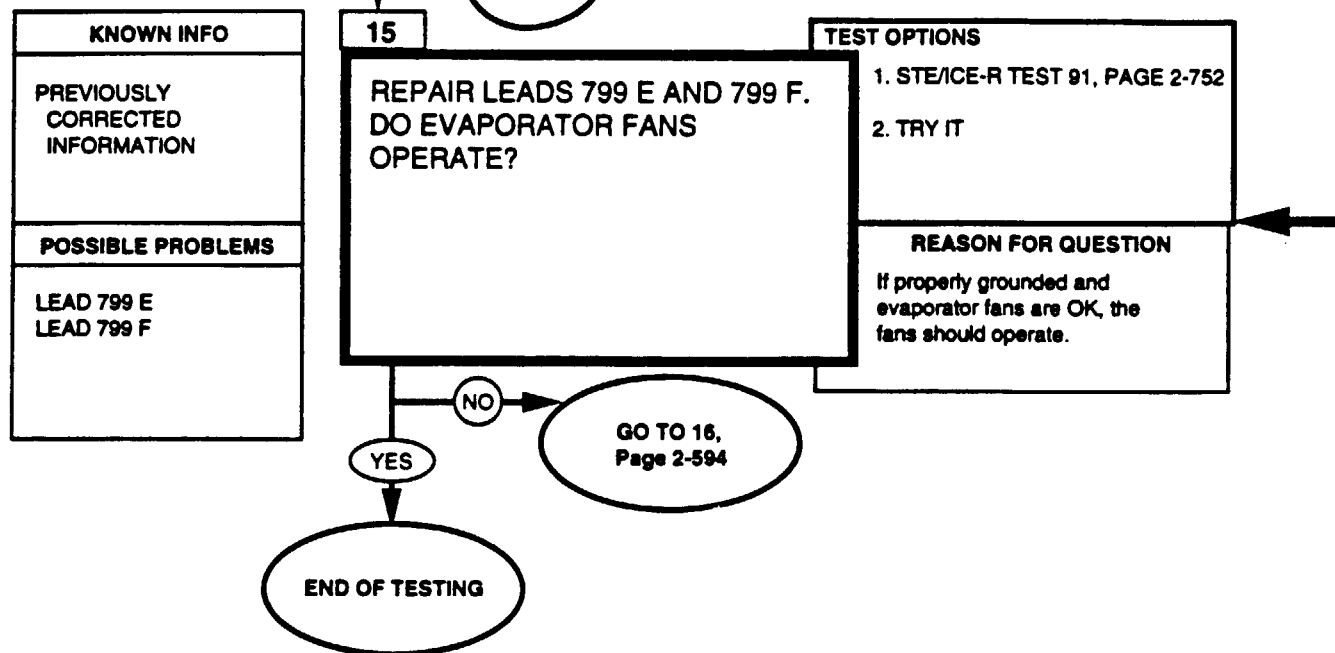


REFERENCE INFORMATION

AMBULANCE

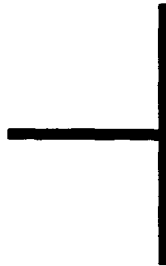
**AMBULANCE**  
**(Evaporator Fans)**  
 (M997 Only)  
 (Refer to Fig. 14.)

**DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

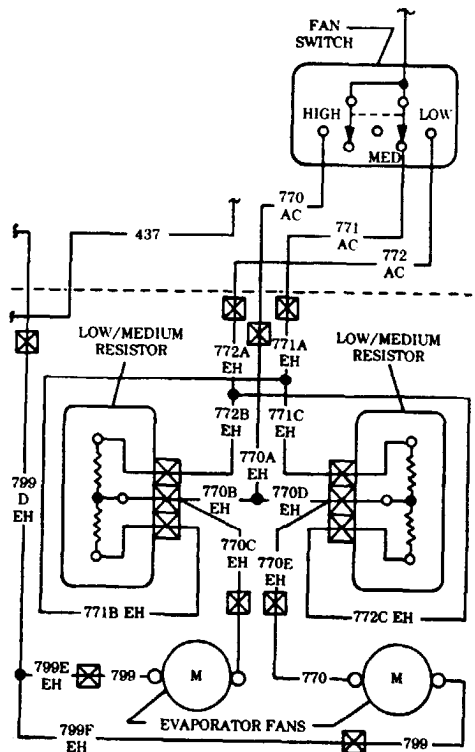
AMBULANCE



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

**0-4500 OHMS  
STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



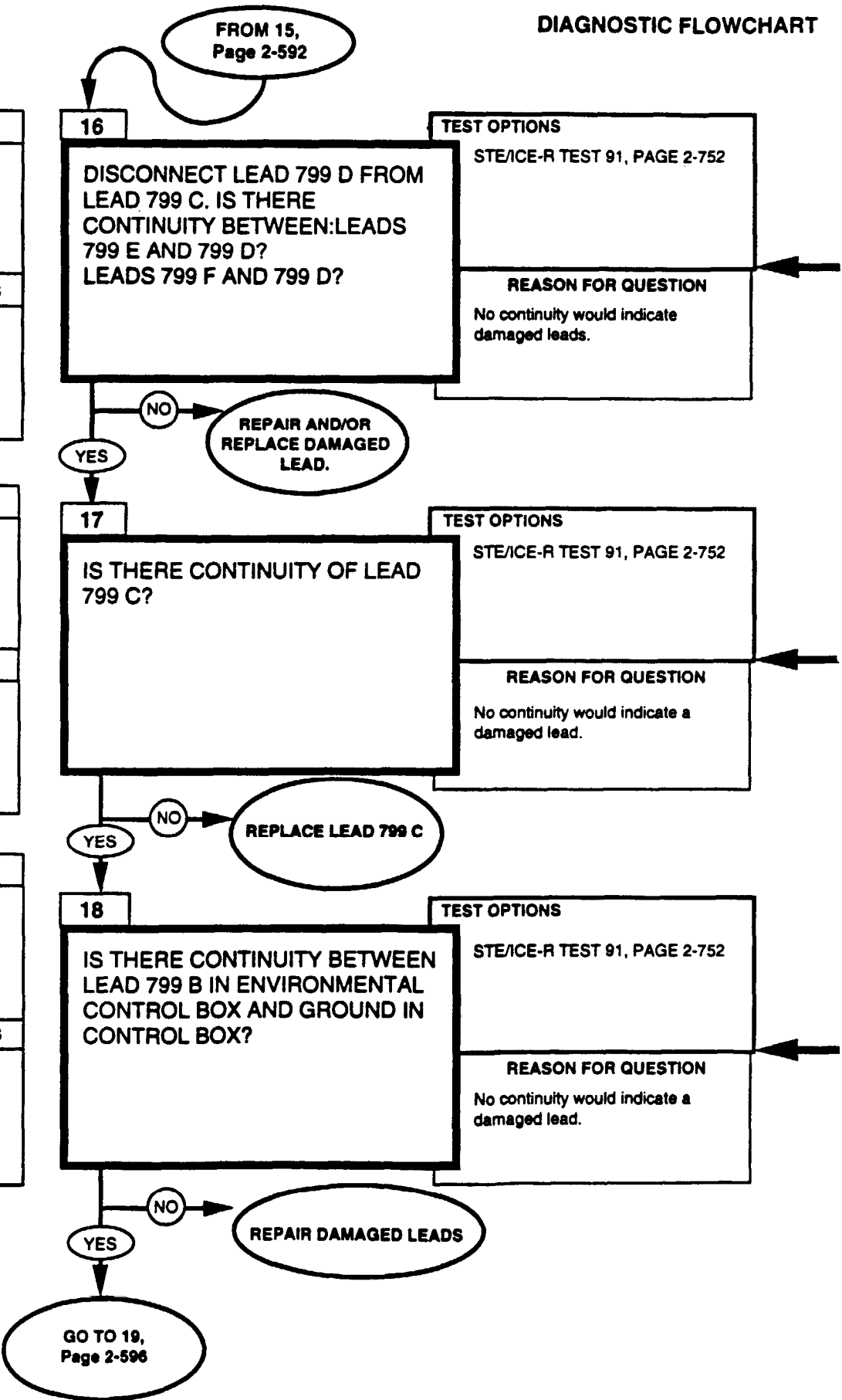
**AMBULANCE**  
**(Evaporator Fans)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 799 D LEAD 799 C LEAD 799 B LEAD 799 A EVAPORATOR FANS

KNOWN INFO
LEAD 799 D OK
POSSIBLE PROBLEMS
LEAD 799 C LEAD 799 B LEAD 799 A EVAPORATOR FANS

KNOWN INFO
LEAD 799 D OK LEAD 799 C OK
POSSIBLE PROBLEMS
LEAD 799 B LEAD 799 A EVAPORATOR FANS



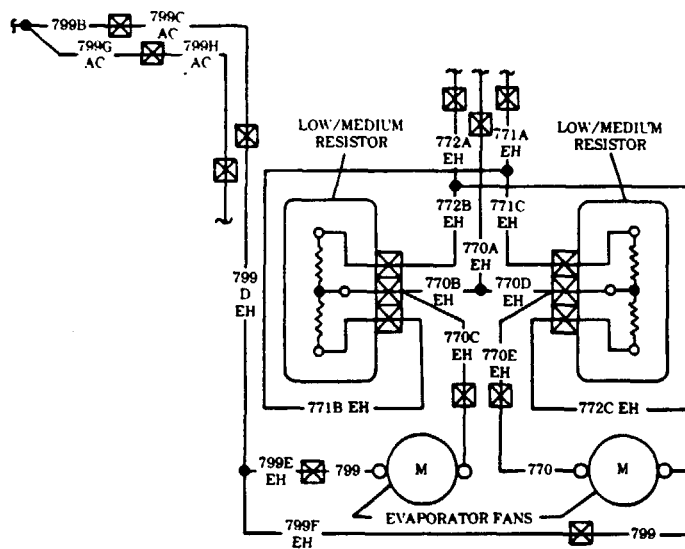
REFERENCE INFORMATION

AMBULANCE

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

**0-4500 OHMS  
STE/ICE-R TEST 91**

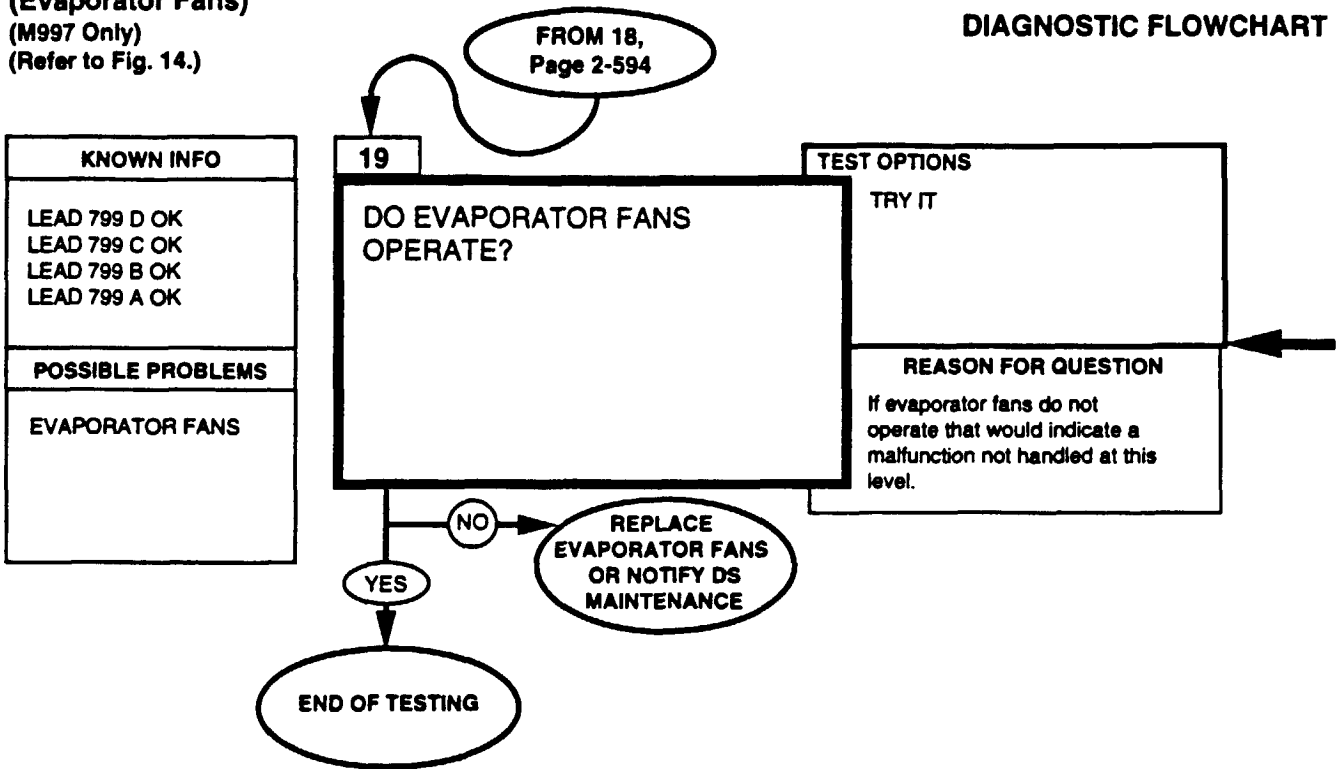
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

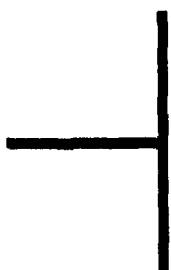
**AMBULANCE**  
**(Evaporator Fans)**  
(M997 Only)  
(Refer to Fig. 14.)

**DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

AMBULANCE



Replace evaporator fans, refer to (para.11-198).

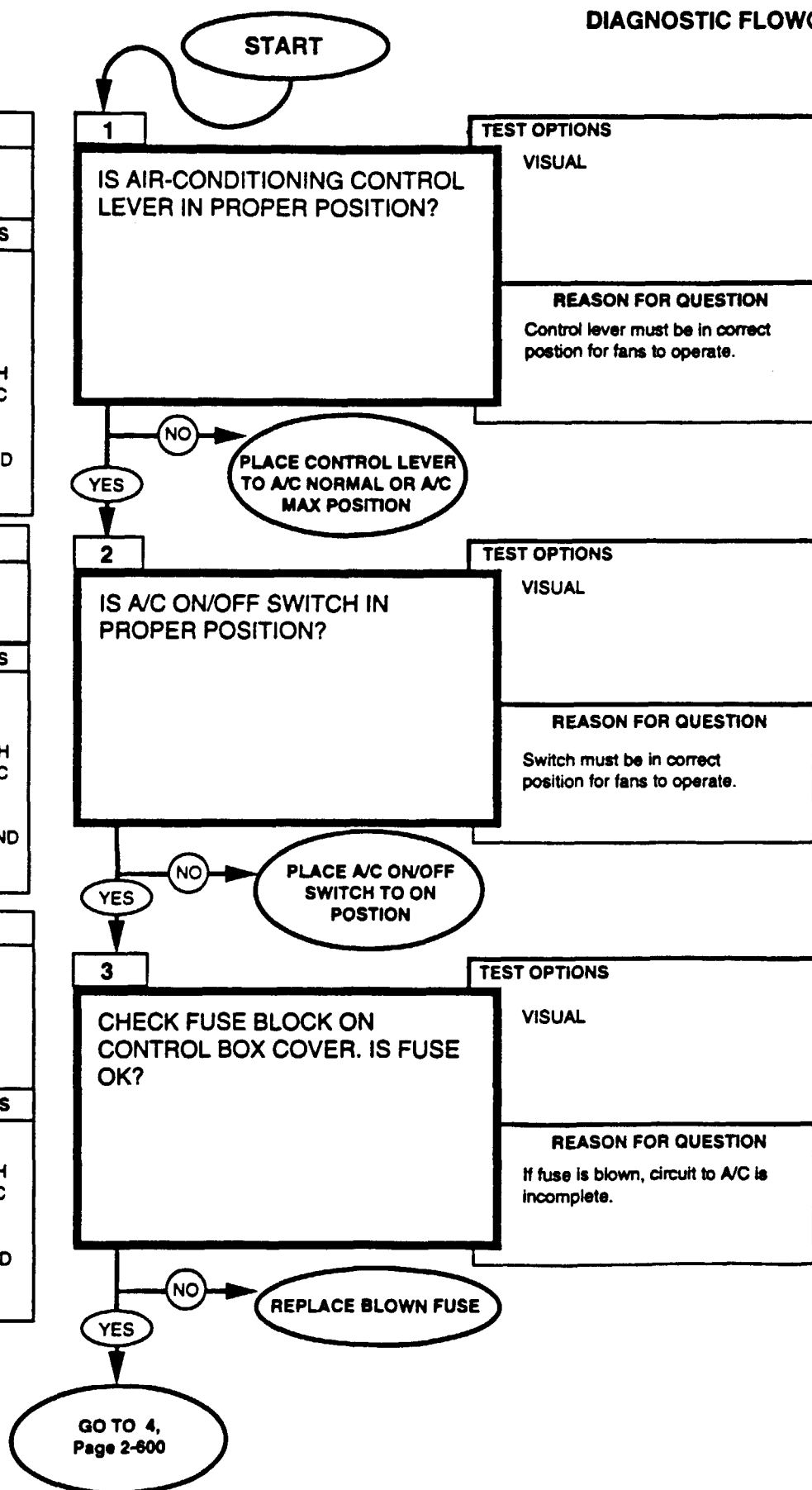
**AMBULANCE  
(Condenser Fans)  
(M997 Only)  
(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 C LEAD G LEAD H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

KNOWN INFO
A/C CONTROL LEVER POSITION OK
POSSIBLE PROBLEMS
A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

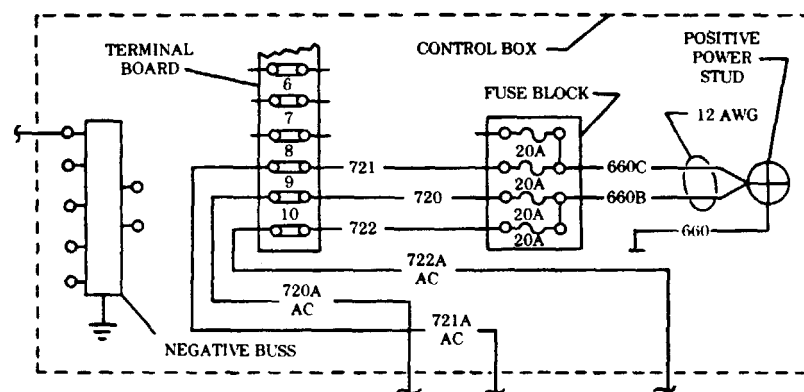
KNOWN INFO
A/C CONTROL LEVER POSITION OK A/C ON/OFF SWITCH POSITION OK
POSSIBLE PROBLEMS
FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS





REFERENCE INFORMATION

AMBULANCE



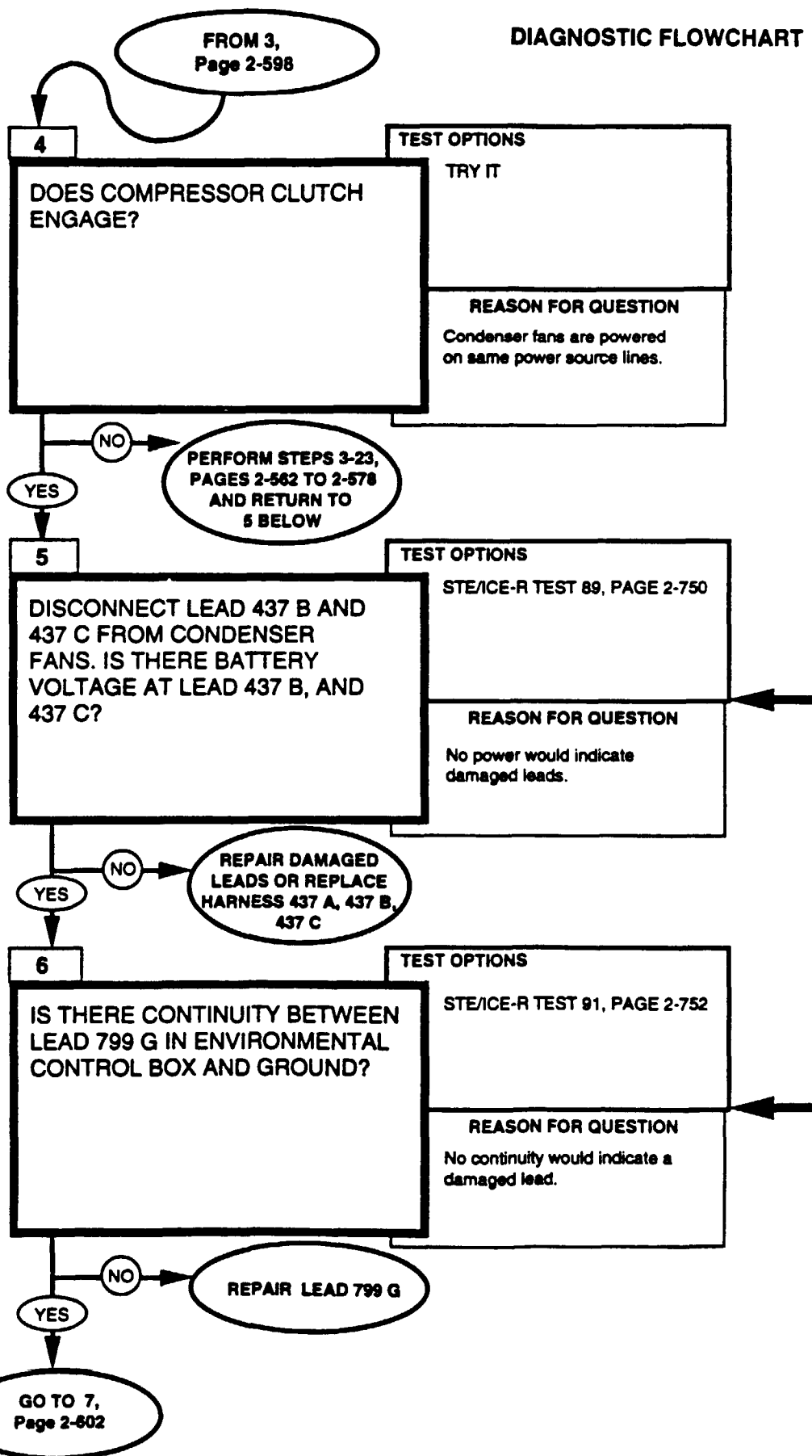
**AMBULANCE**  
**(Condenser Fans)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE
POSSIBLE PROBLEMS
COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

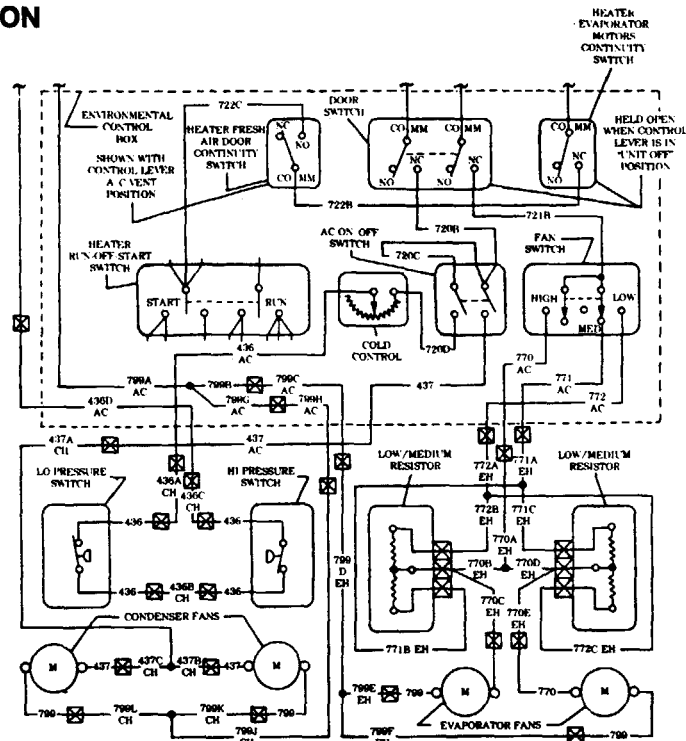
KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH
POSSIBLE PROBLEMS
LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C
POSSIBLE PROBLEMS
LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS



# REFERENCE INFORMATION

# AMBULANCE



Repair leads, refer to (para. 4-85).  
Repair lead connectors, refer to (para. 4-85).

## 0-45 DC VOLTS STE/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## 0-4500 OHMS STE/CE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/CE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

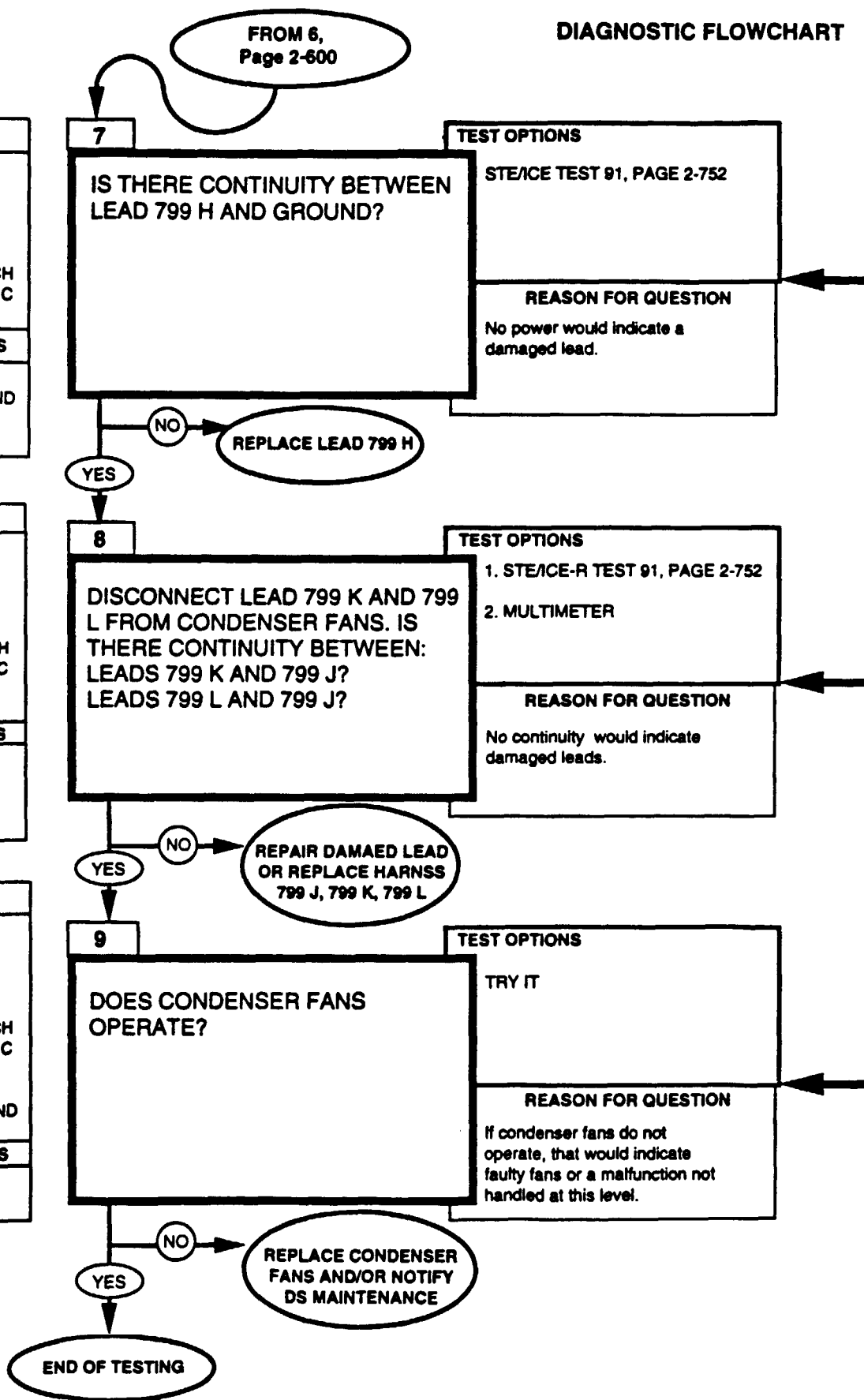
**AMBULANCE**  
**(Condenser Fans)**  
**(M997 Only)**  
**(Refer to Fig.14.)**

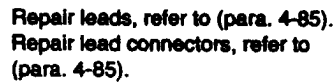
**DIAGNOSTIC FLOWCHART**

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G
POSSIBLE PROBLEMS
LEAD 799 H LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H
POSSIBLE PROBLEMS
LEADS 799 J, 799 K, AND 799 L CONDENSER FANS

KNOWN INFO
A/C CONTROL LEVER POSITION A/C ON/OFF SWITCH POSITION FUSE COMPRESSOR CLUTCH LEADS 437 B AND 437 C LEAD 799 G LEAD 799 H LEADS 799 J, 799 K, AND 799 L
POSSIBLE PROBLEMS
CONDENSER FANS

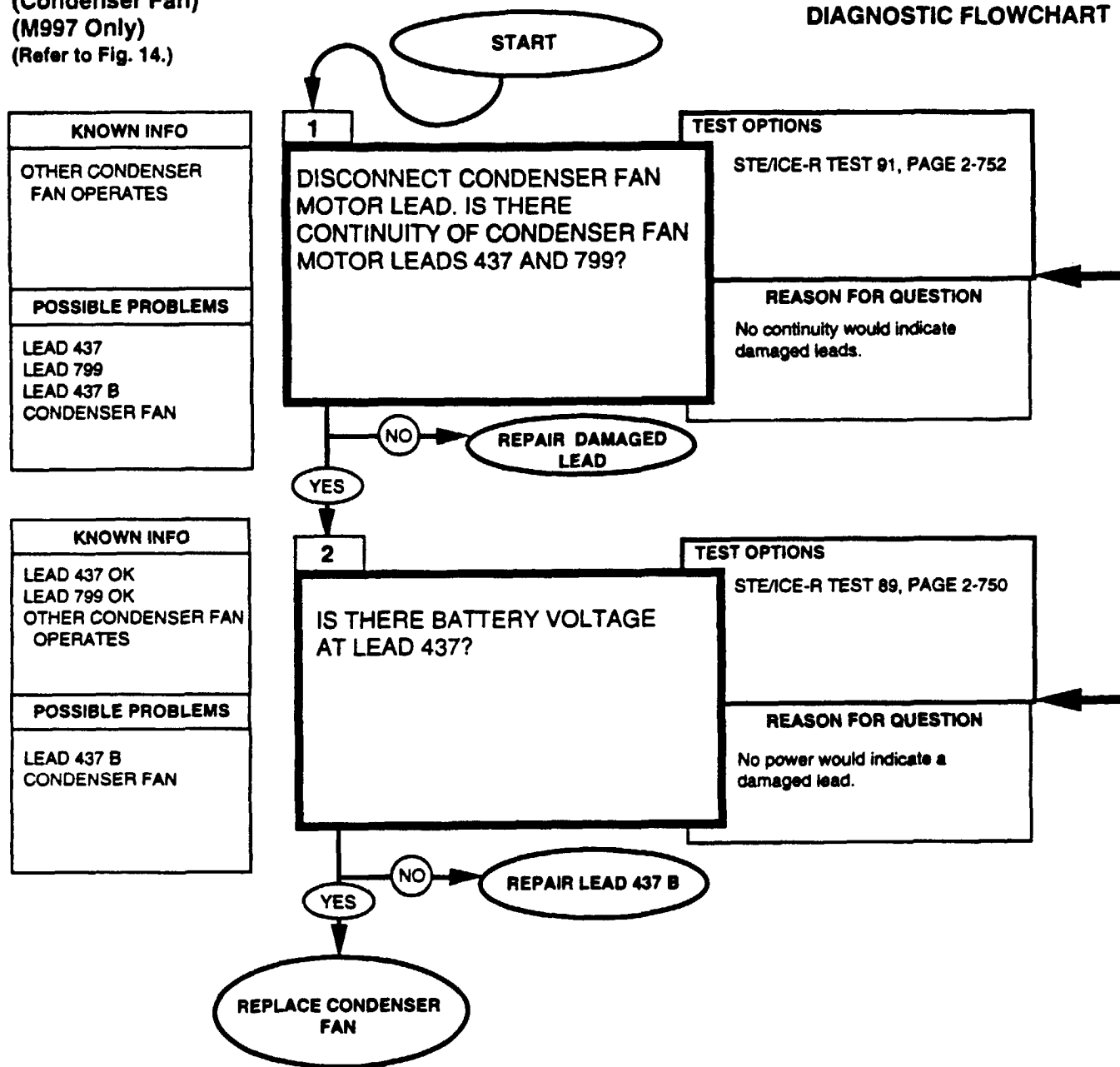




**3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).**

**AMBULANCE**  
**(Condenser Fan)**  
**(M997 Only)**  
**(Refer to Fig. 14.)**

**DIAGNOSTIC FLOWCHART**



# REFERENCE INFORMATION

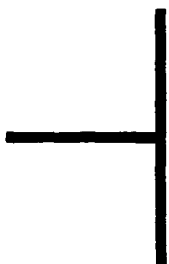
# AMBULANCE



Repair leads, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

## 0-4500 OHMS STE/ICE -R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

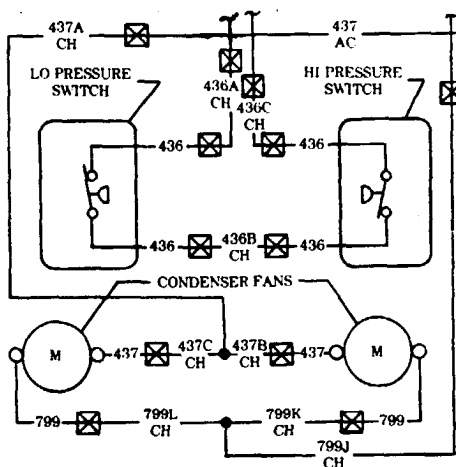


Repair lead, (refer to 4-85).  
Repair lead connector, refer to (para. 4-85).

Replace condenser fan, refer to (para. 11-201).

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



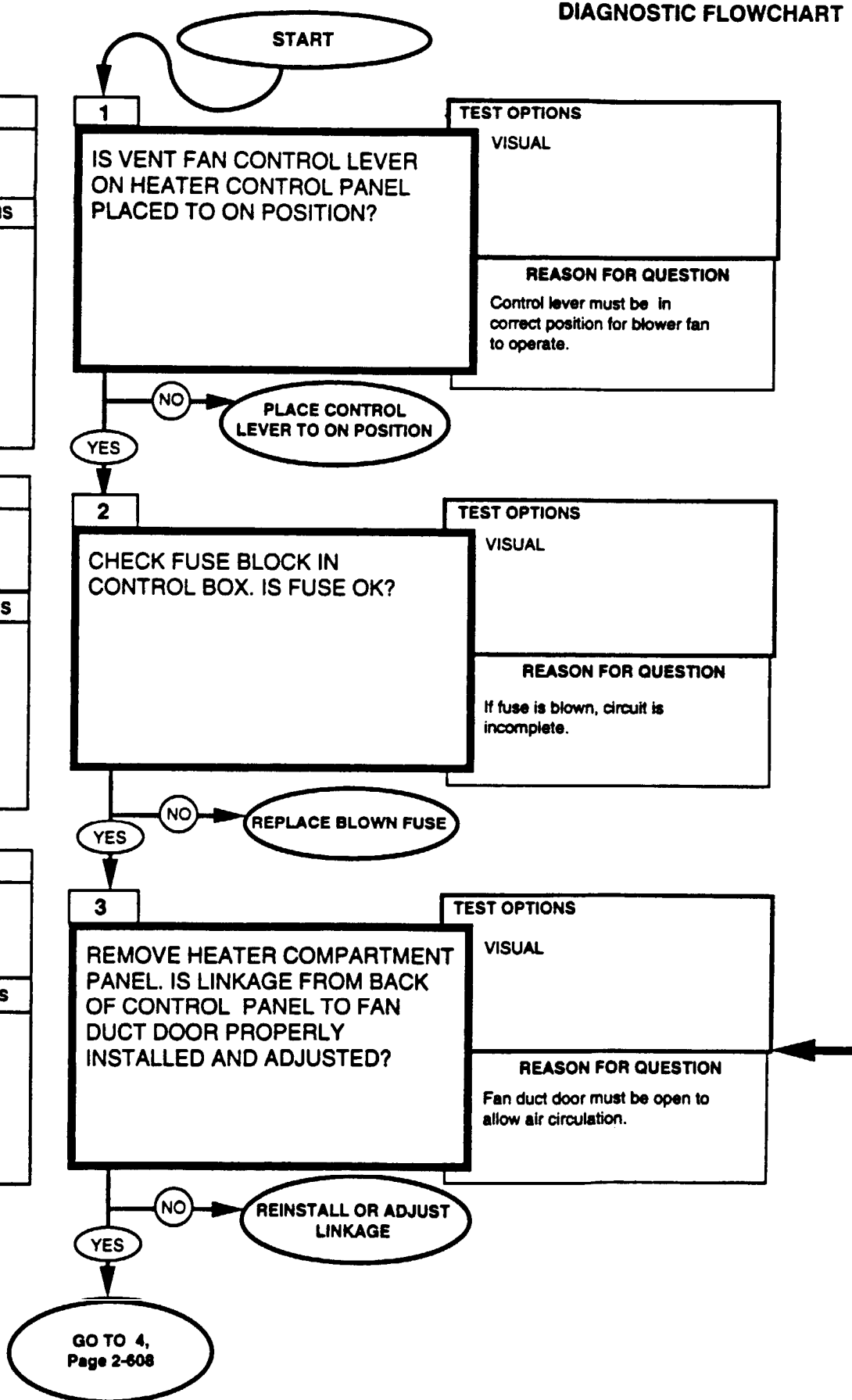
**AMBULANCE**  
**(Blower Fan)**  
**(M997 Only)**  
**(Refer to Fig. 15.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
CONTROL LEVER POSITION FUSE LINKAGE BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

KNOWN INFO
CONTROL LEVER POSITION OK
POSSIBLE PROBLEMS
FUSE LINKAGE BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

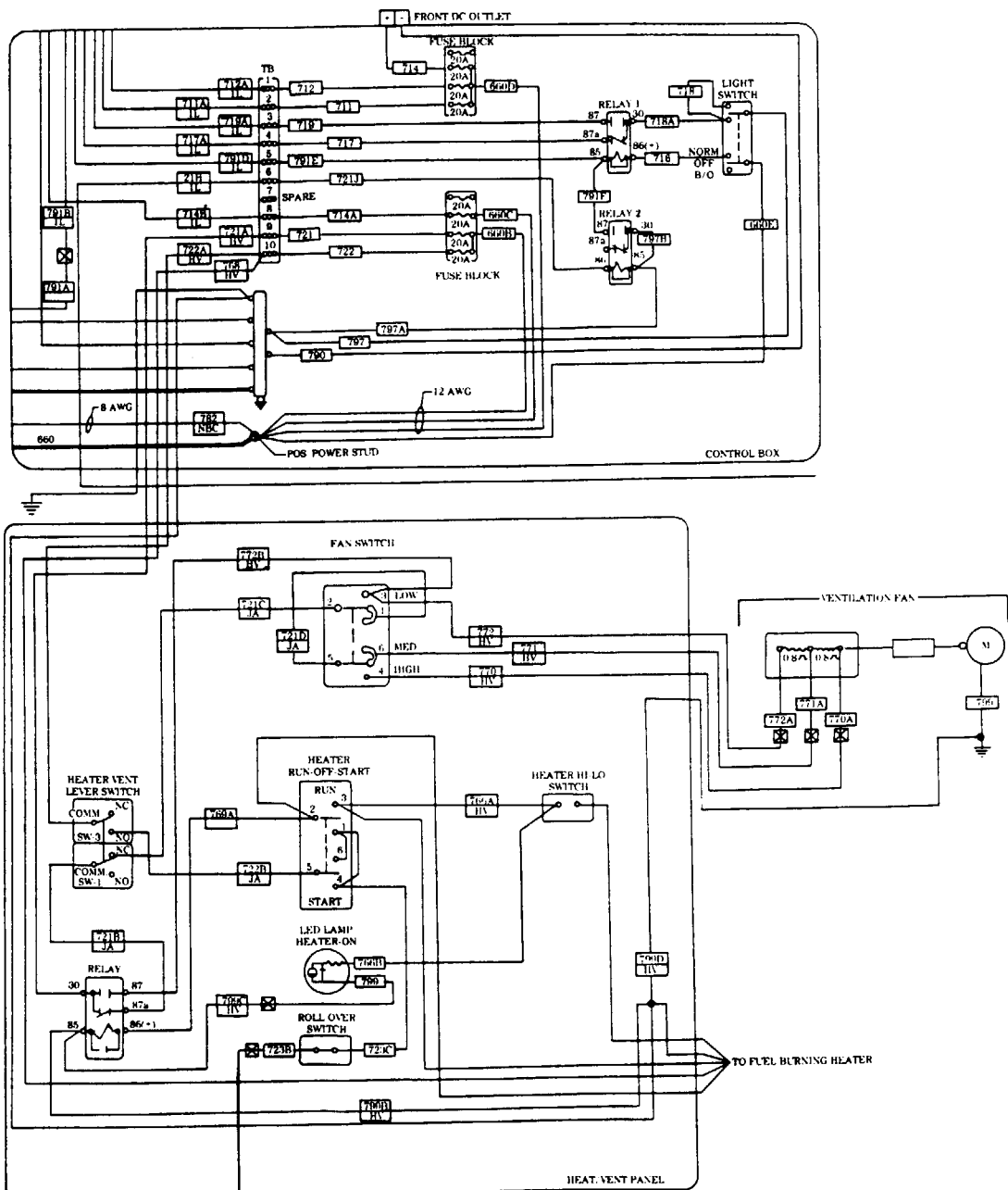
KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK
POSSIBLE PROBLEMS
LINKAGE BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY





## REFERENCE INFORMATION

## AMBULANCE



Remove heater compartment panel,  
refer to (para. 11-214).

Installation/adjustment of fan duct  
door linkage, refer to (para. 11-211).

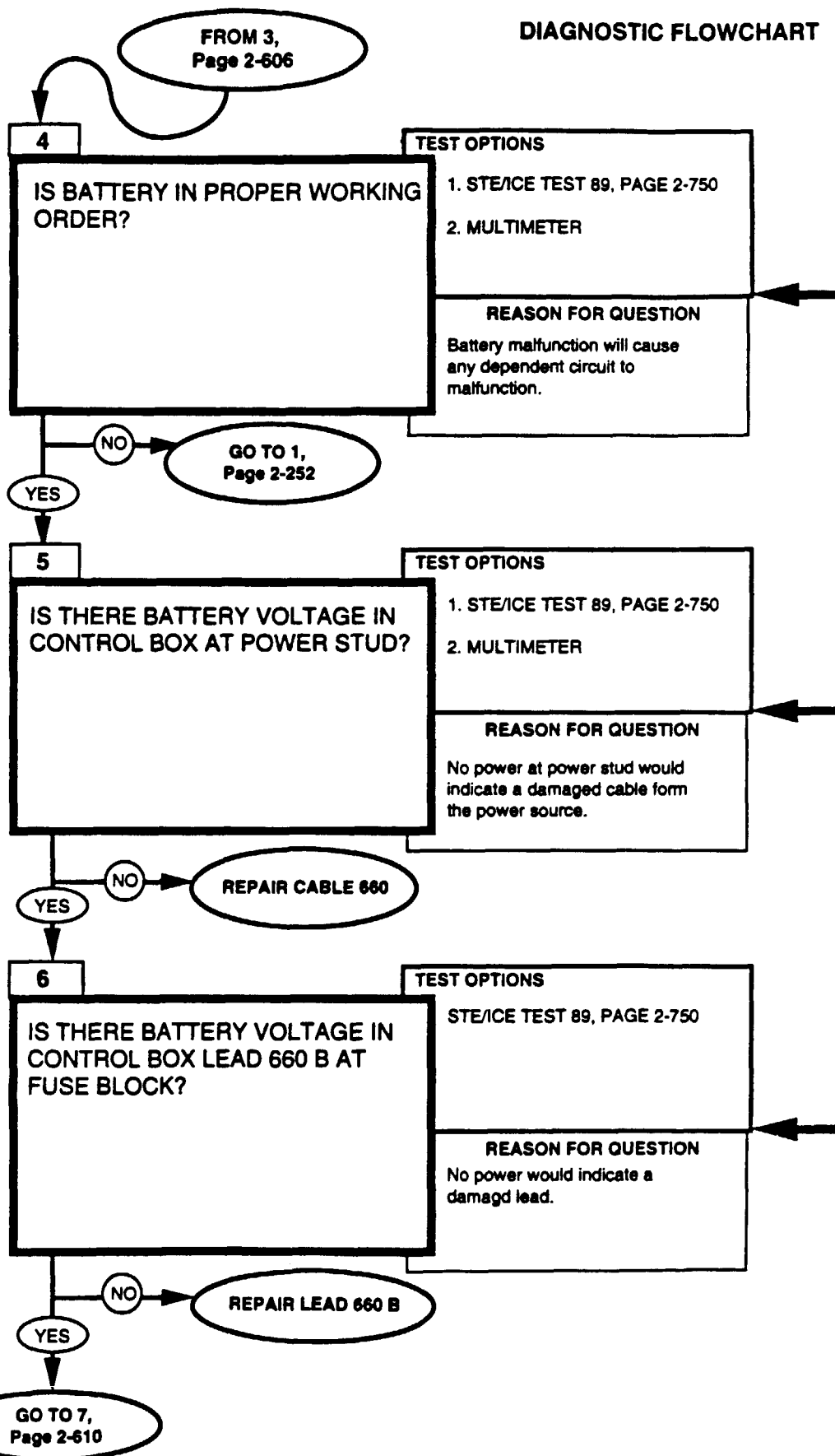
**AMBULANCE  
(Blower Fan)  
(M997 Only)  
(Refer to Fig. 15.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK LINKAGE OK
POSSIBLE PROBLEMS
BATTERY CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

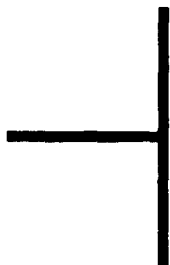
KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK LINKAGE OK BATTERY OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 721 LEAD 721 A RELAY

KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK LINKAGE OK BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 660 B LEAD 721 LEAD 721 A RELAY



REFERENCE INFORMATION

AMBULANCE

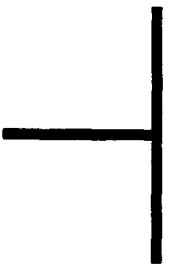


0-45 DC VOLTS  
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point,  
BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.



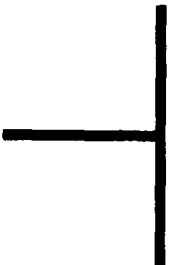
Repair lead, refer to (para. 4-85).

BATTERY VOLTAGE  
MULTIMETER

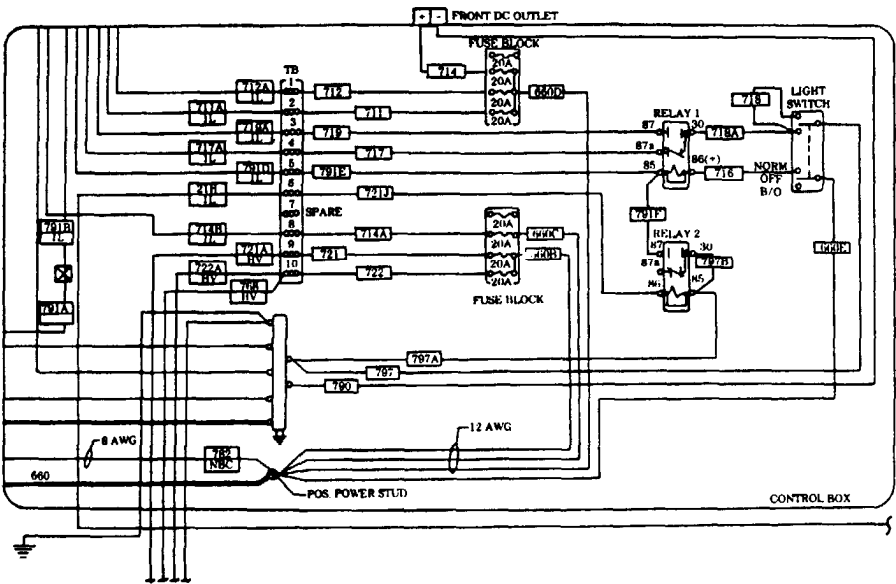
1. Set the voltmeter to a DC volts scale of at least  
40 volts.

2. Connect the RED lead to positive and the  
BLACK lead to negative.

3. Be sure to read the correct scale.



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to  
(para. 4-85).



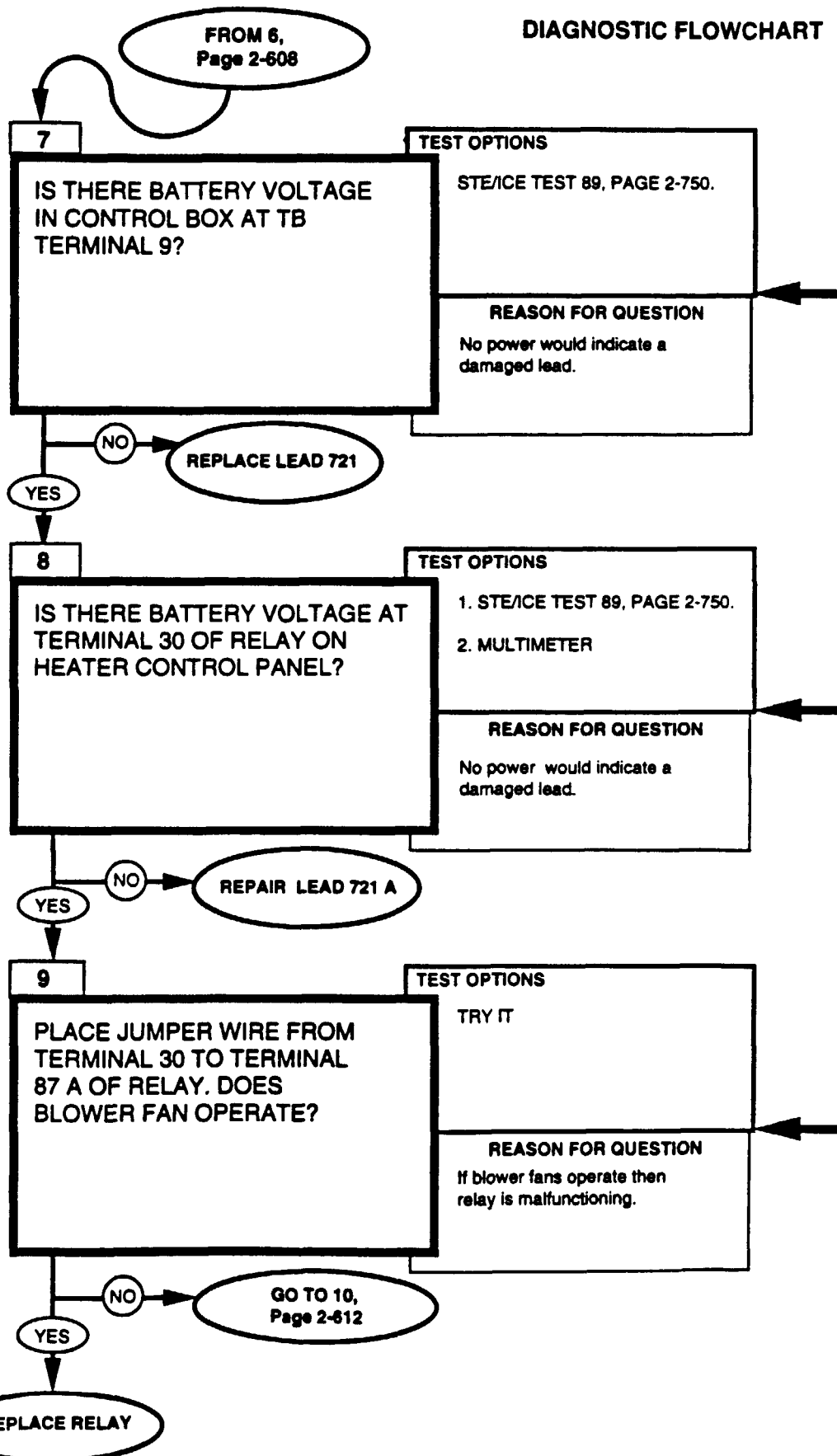
**AMBULANCE  
(Blower Fan)  
(M997 Only)  
(Refer to Fig. 15.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK LINKAGE OK BATTERY OK CABLE 660 OK LEAD 660 B OK
POSSIBLE PROBLEMS
LEAD 721 LEAD 721 A RELAY

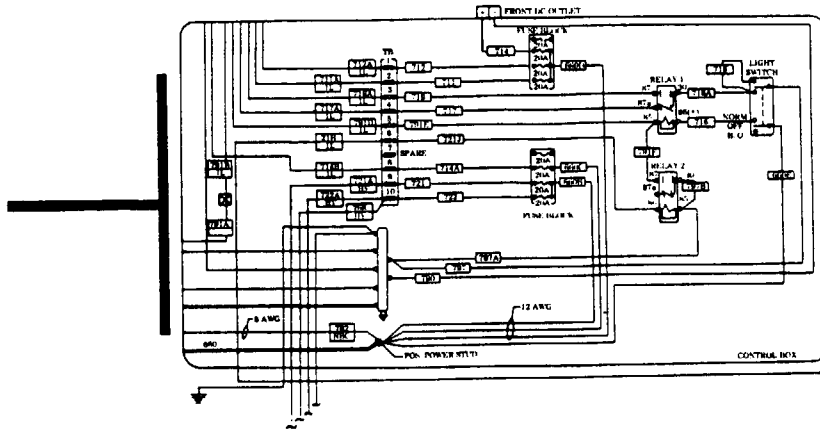
KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK LINKAGE OK BATTERY OK LEAD 660 OK LEAD 660 B OK LEAD 721 OK
POSSIBLE PROBLEMS
LEAD 721 A RELAY

KNOWN INFO
CONTROL LEVER POSITION OK FUSE OK LINKAGE OK BATTERY OK CABLE 660 OK LEAD 721 OK LEAD 721 A OK
POSSIBLE PROBLEMS
RELAY



# REFERENCE INFORMATION

## AMBULANCE



### 0-45 DC VOLTS STE/ICE-R TEST 89

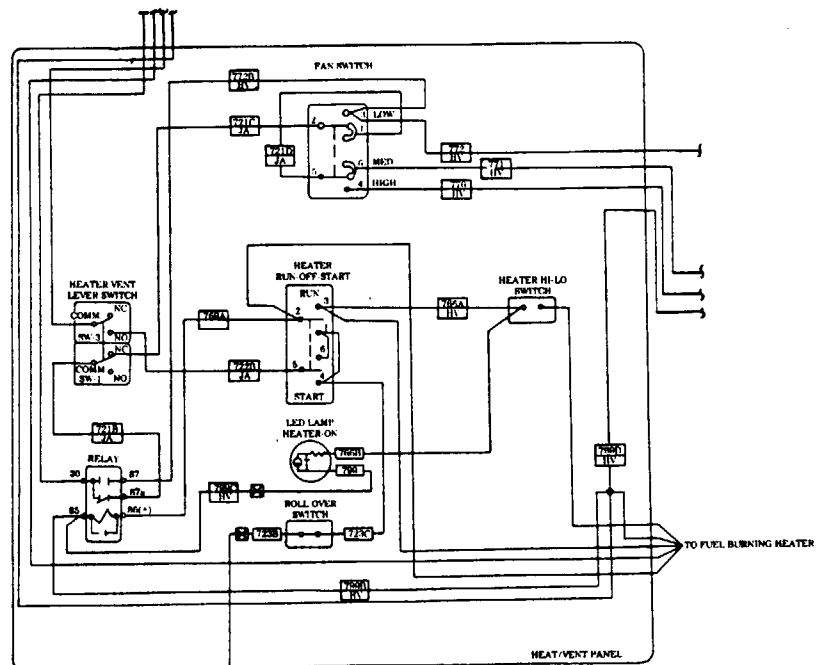
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

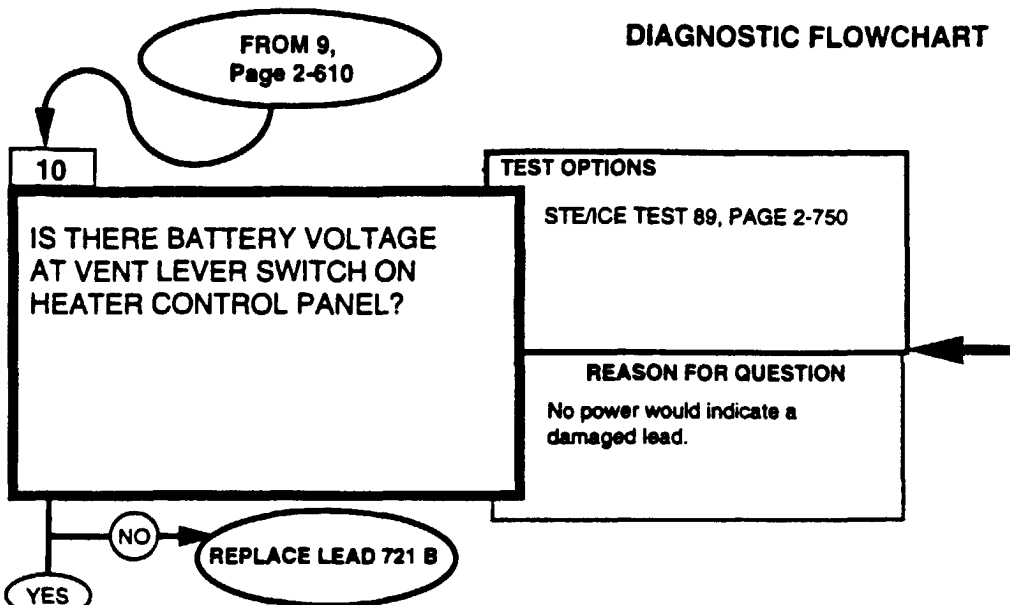
Replace relay, refer to (para. 4-120).



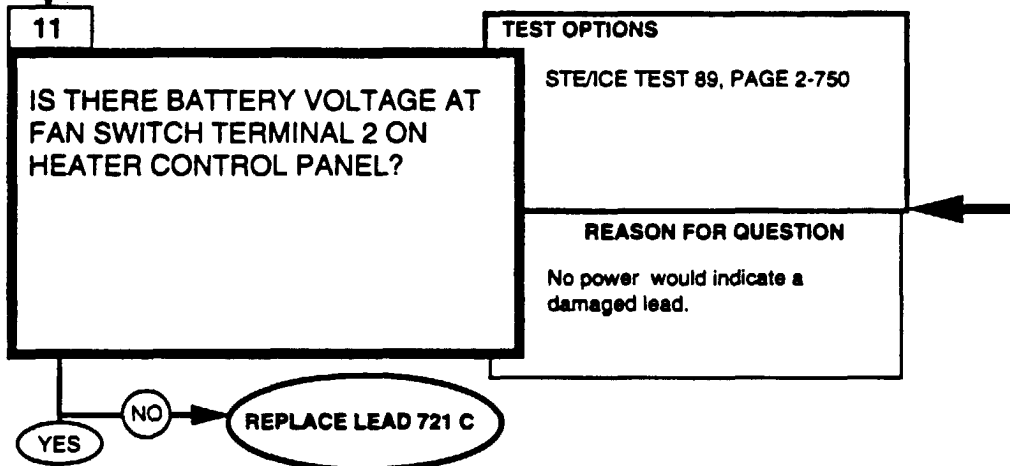
**AMBULANCE  
(Blower Fan)  
(M997 Only)  
(Refer to Fig. 15.)**

**DIAGNOSTIC FLOWCHART**

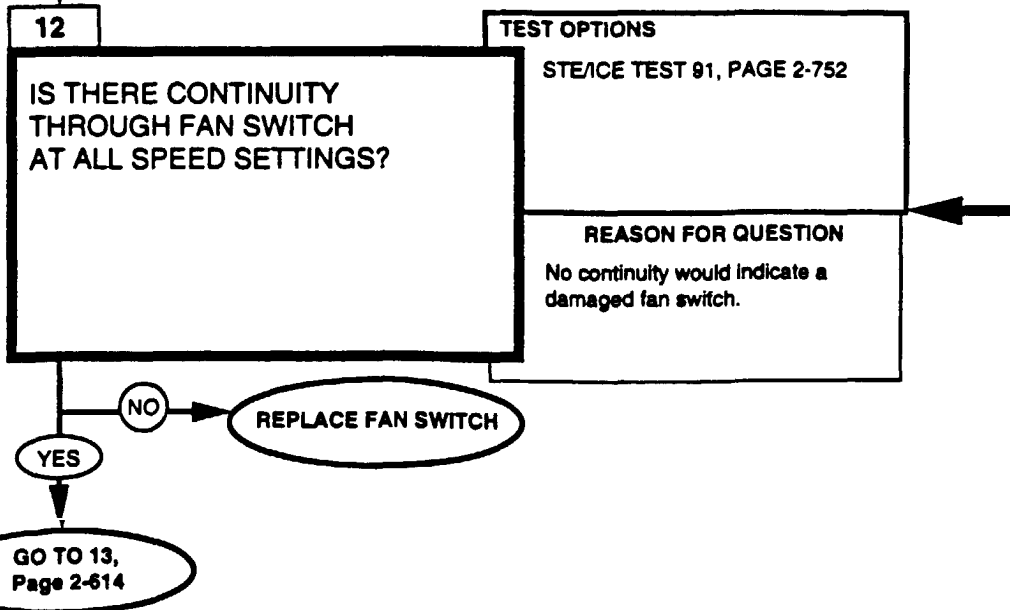
<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
LEAD 721 B LEAD 721 C FAN SWITCH



<b>KNOWN INFO</b>
LEAD 721 B OK
<b>POSSIBLE PROBLEMS</b>
LEAD 721 A FAN SWITCH



<b>KNOWN INFO</b>
LEAD 721 B OK LEAD 721 C OK
<b>POSSIBLE PROBLEMS</b>
FAN SWITCH

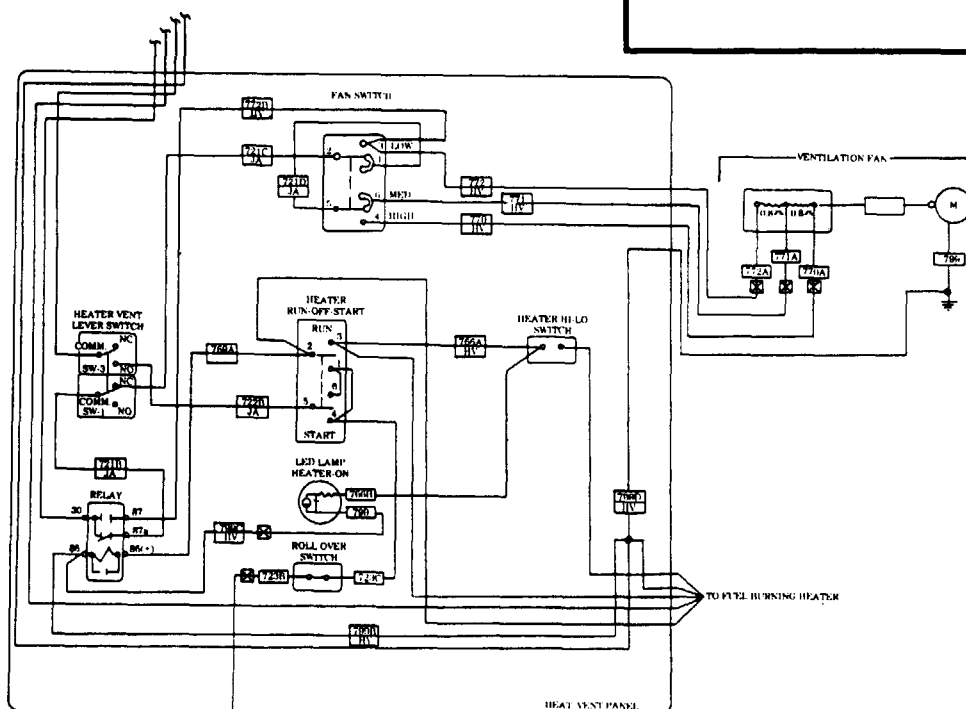


# REFERENCE INFORMATION

# AMBULANCE

## 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



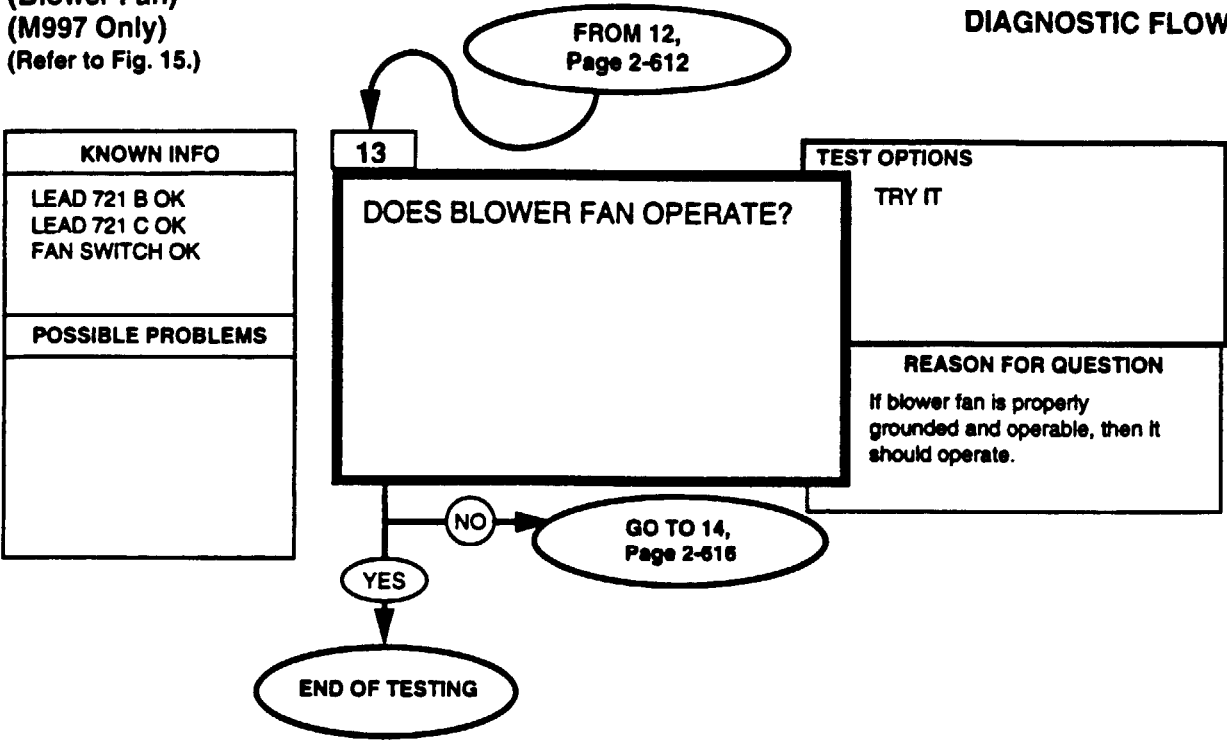
## 0-4500 OHMS STE/ICE -R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

Replace fan switch, refer to (para. 4-127).

**AMBULANCE  
(Blower Fan)  
(M997 Only)  
(Refer to Fig. 15.)**

**DIAGNOSTIC FLOWCHART**





REFERENCE INFORMATION

AMBULANCE

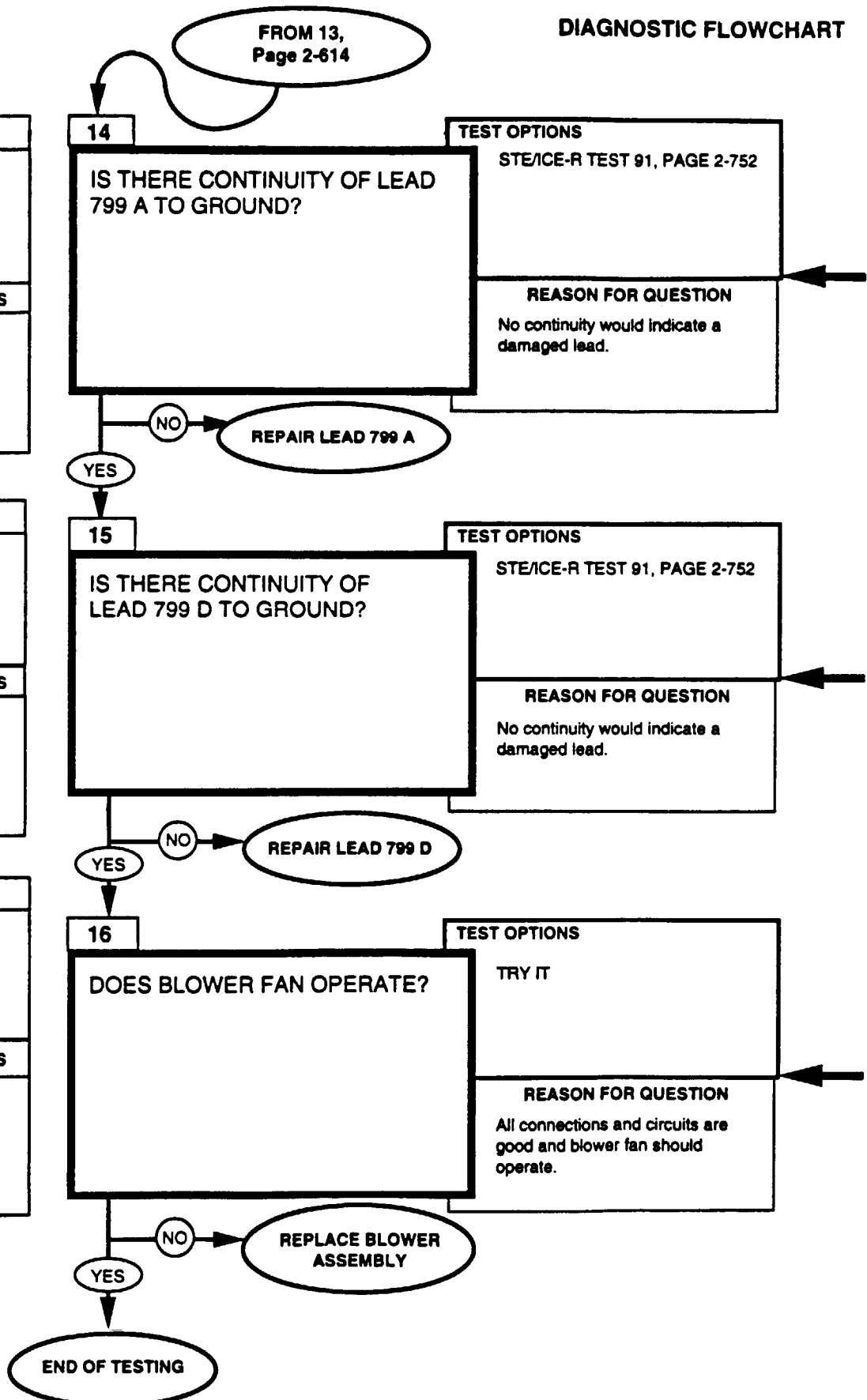
**AMBULANCE  
(Blower Fan)  
(M997 Only)  
(Refer to Fig.15.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 799 A LEAD 799 D BLOWER ASSEMBLY

KNOWN INFO
LEAD 799 A OK
POSSIBLE PROBLEMS
LEAD 799 D BLOWER ASSEMBLY

KNOWN INFO
LEAD 799 A OK LEAD 799 D OK
POSSIBLE PROBLEMS
BLOWER ASSEMBLY



## REFERENCE INFORMATION

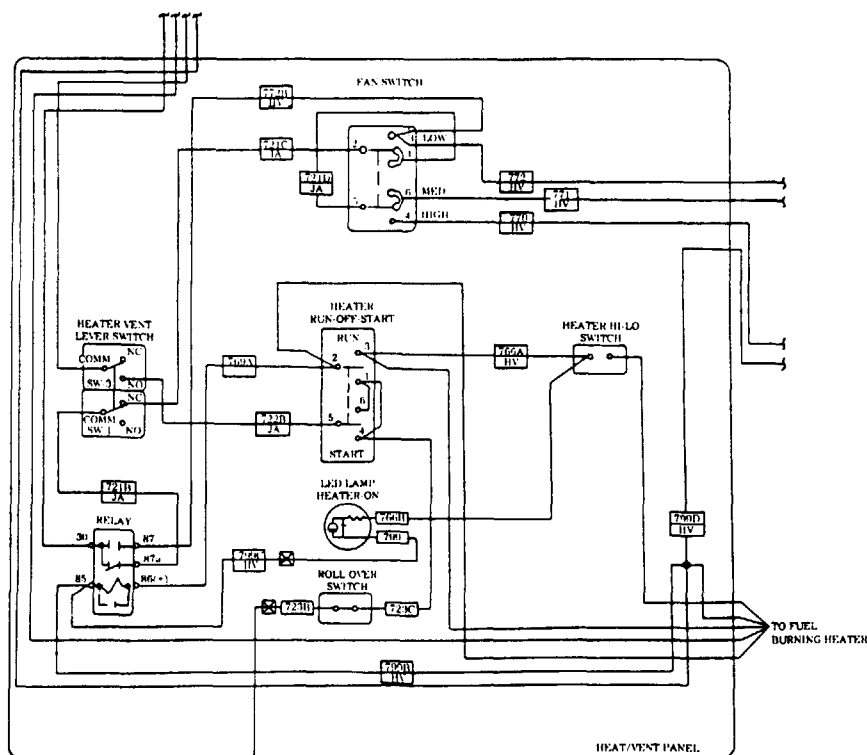
## AMBULANCE

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

### 0-4500 OHMS STE/ICE -R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).



Replace blower assembly, refer to (para. 11-212).

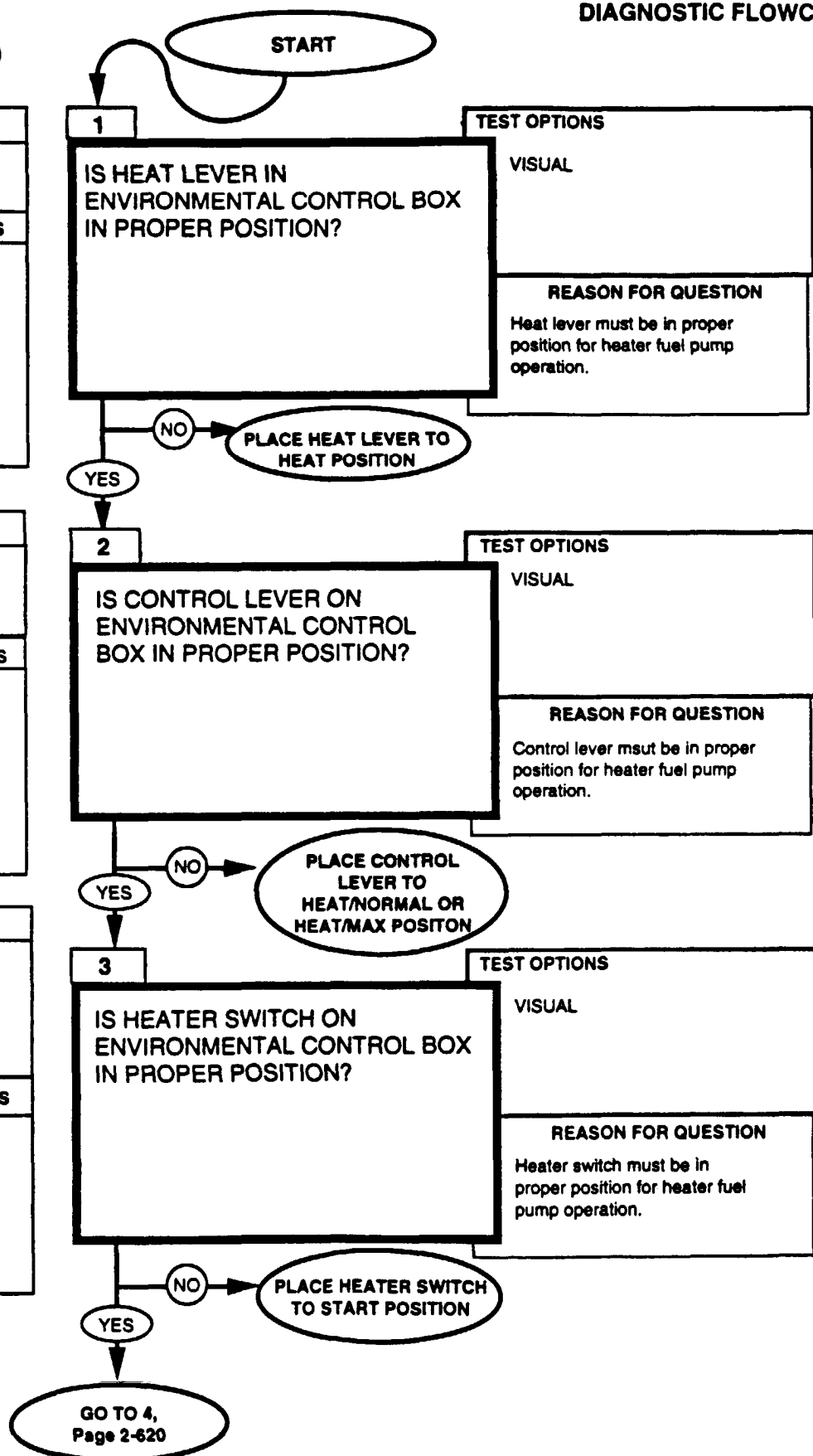
# DIAGNOSTIC FLOWCHART

## AMBULANCE (Heater Fuel Pump) (Refer to Figs.14-16.)

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
HEAT LEVER POSITION CONTROL LEVER POSITION HEATER SWITCH POSITION FUSE BATTERY CABLE 660 LEAD 798 FUEL PUMP

KNOWN INFO
HEAT LEVER POSITION OK
POSSIBLE PROBLEMS
CONTROL LEVER POSITION HEATER SWITCH POSITION FUSE BATTERY CABLE 660 LEAD 798 FUEL PUMP

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK
POSSIBLE PROBLEMS
HEATER SWITCH POSITION FUSE BATTERY CABLE 660 LEAD 798 FUEL PUMP



**REFERENCE INFORMATION**

**AMBULANCE**

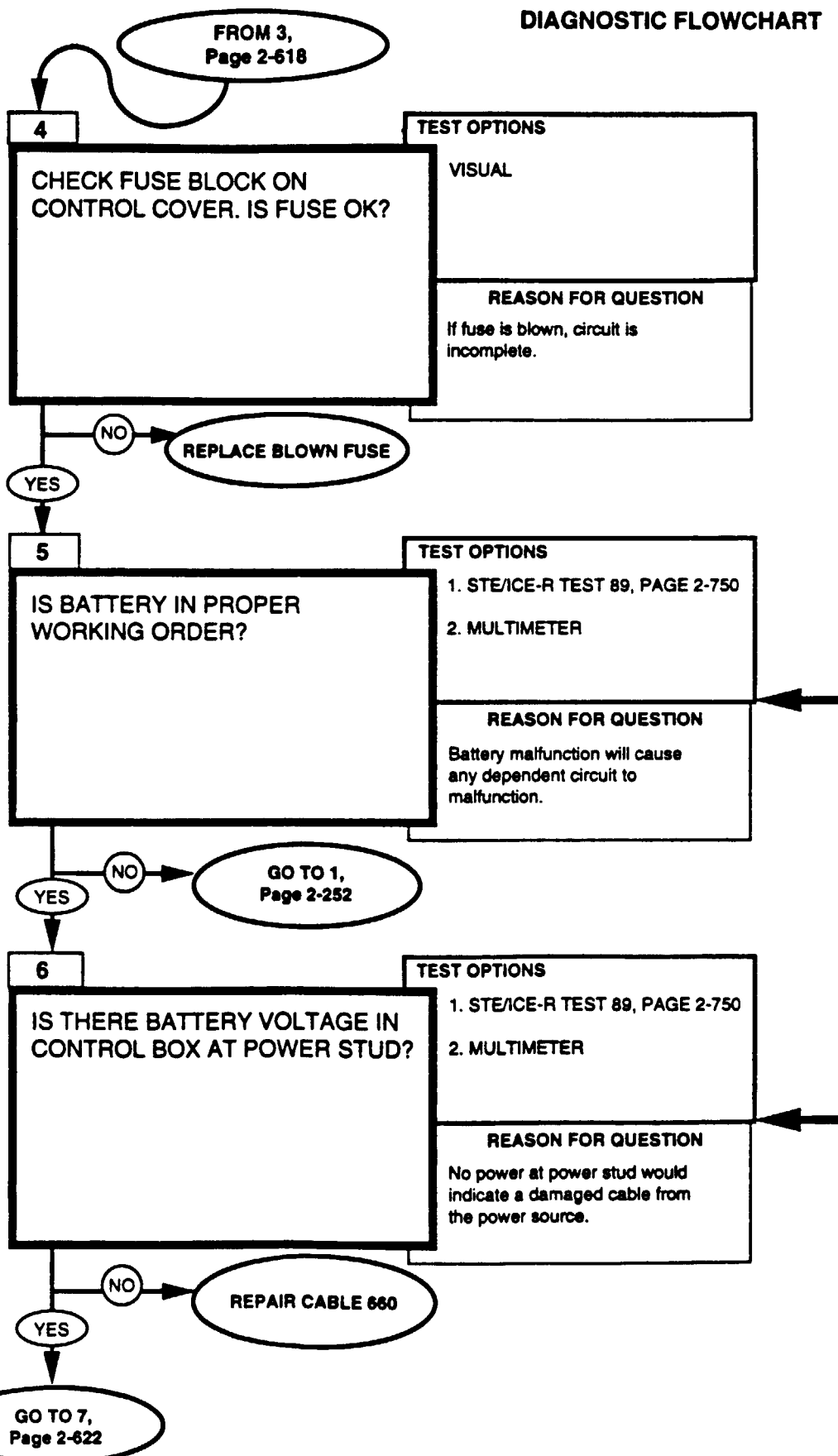
**AMBULANCE**  
(Heater Fuel Pump)  
(Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
FUSE BATTERY CABLE 660 LEAD 798 FUEL PUMP

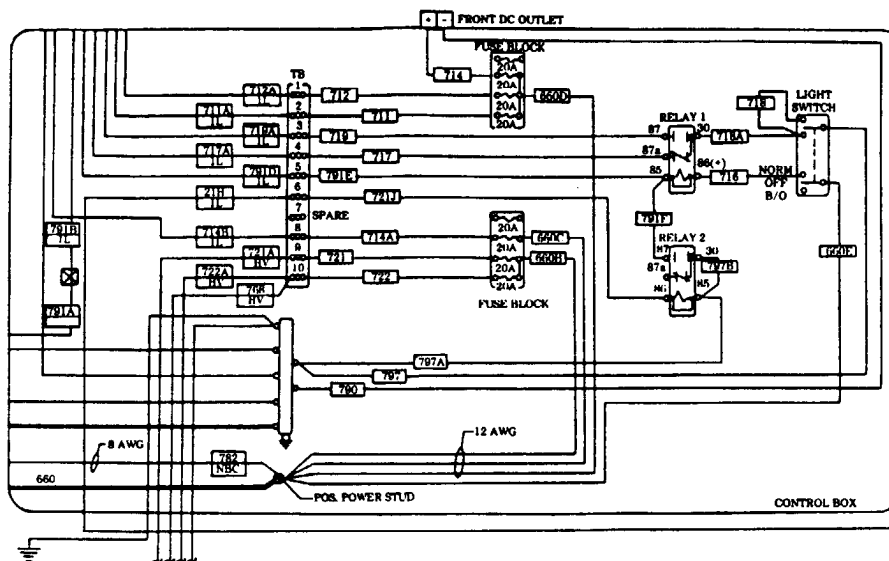
KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
BATTERY CABLE 660 LEAD 798 FUEL PUMP

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK HEATER SWITCH POSITION OK FUSE OK BATTERY OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 798 FUEL PUMP



# REFERENCE INFORMATION

# AMBULANCE



## 0-45 DC VOLTS STEICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

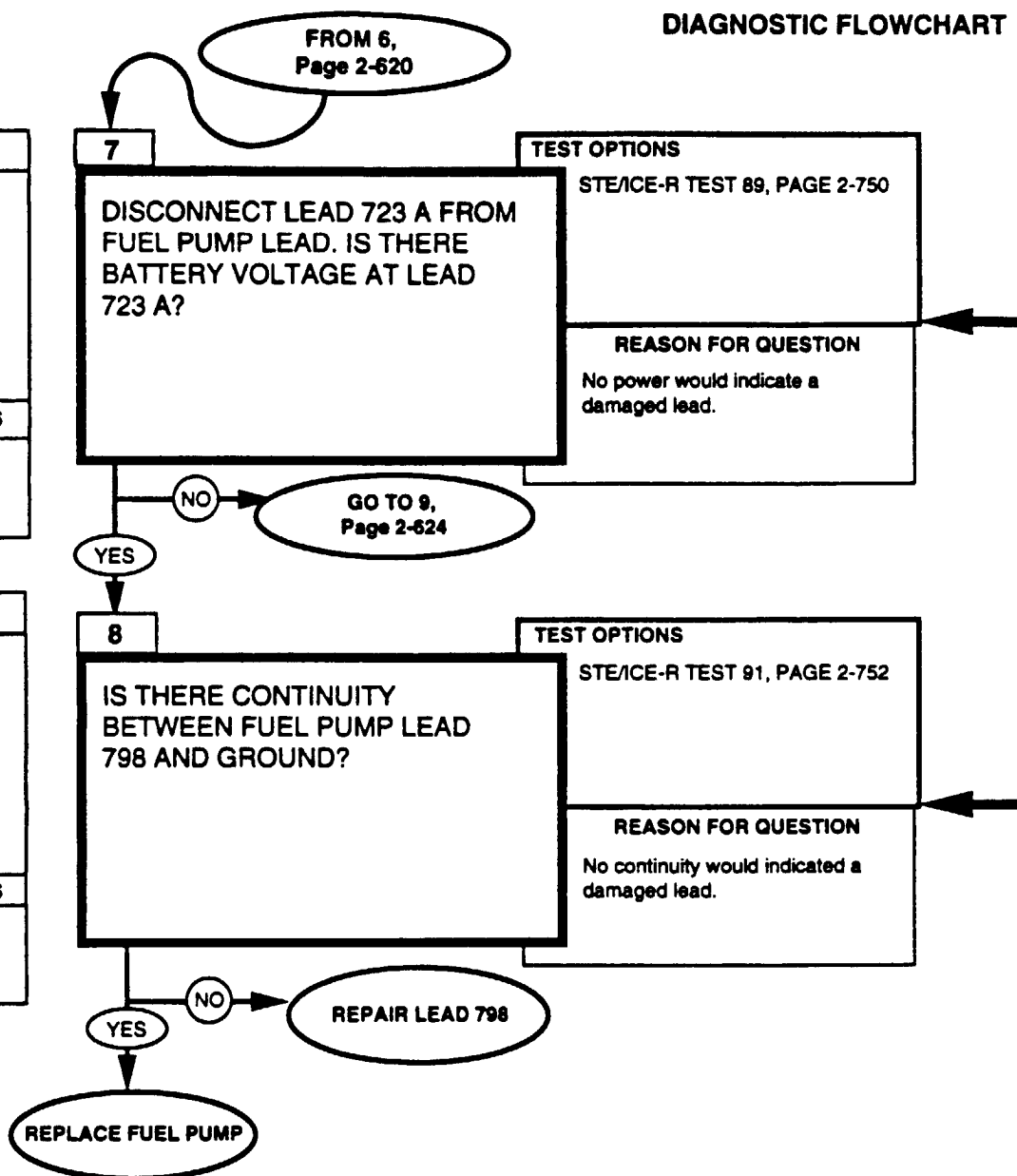
Repair lead, refer to (para. 4-85).

**AMBULANCE**  
**(Heater Fuel Pump)**  
 (Refer to Figs.14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
HEATER SWITCH POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 798 FUEL PUMP

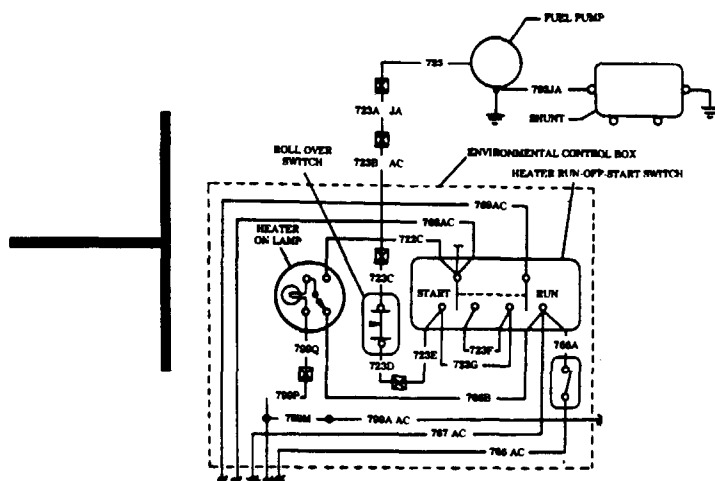
KNOWN INFO
HEAT LEVER POSITION OK
CONTROL LEVER POSITION OK
HEATER SWITCH POSITION OK
FUSE OK
BATTERY OK
CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 798 FUEL PUMP





## REFERENCE INFORMATION

## AMBULANCE



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

Replace heater fuel pump, refer to (para. 11-194).

### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

### 0-4500 OHMS STE/ICE -R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms STE/ICE displays "9.9.9.9."

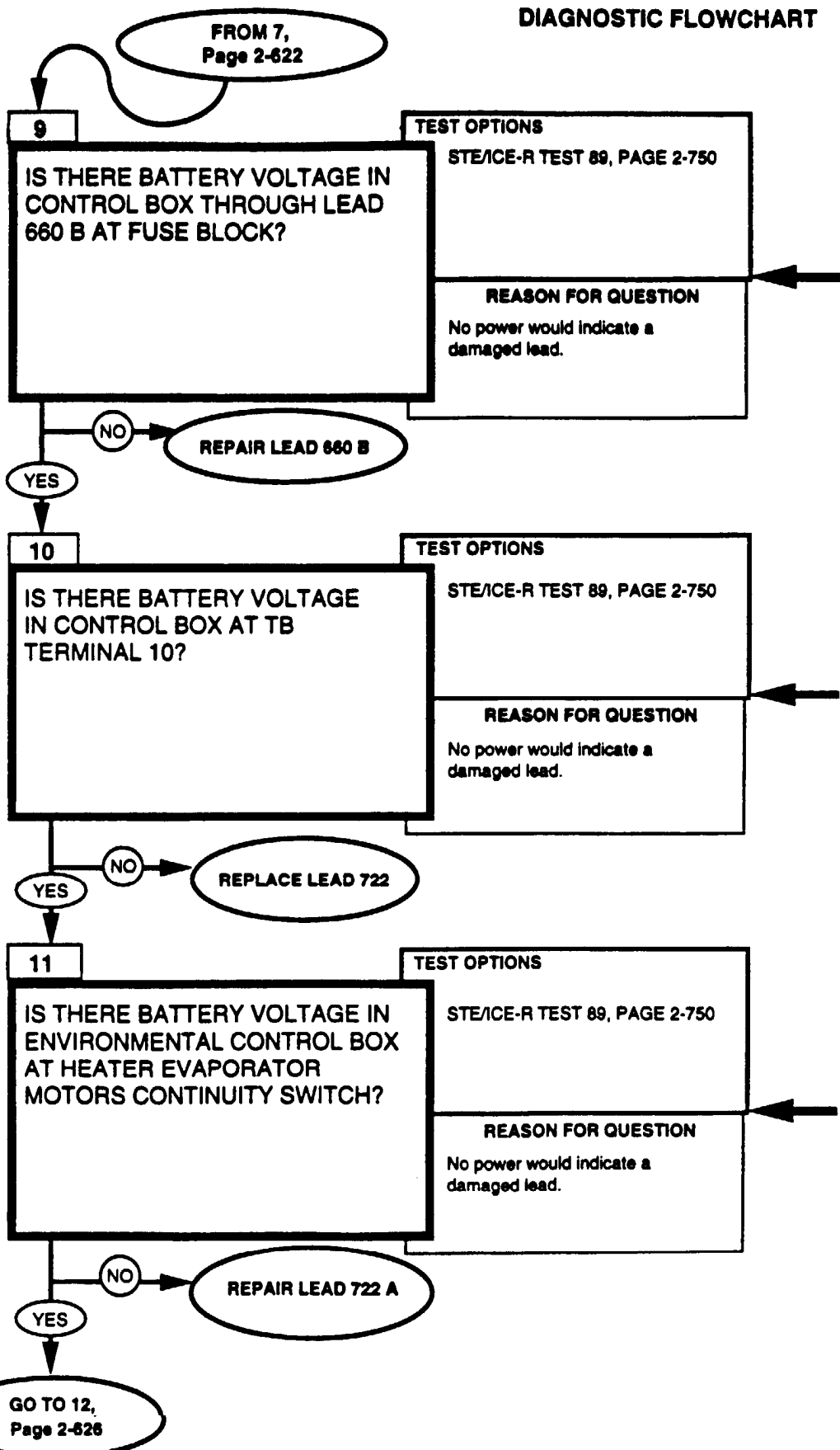
**AMBULANCE**  
**(Heater Fuel Pump)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 660 B LEAD 722 LEAD 722 A HEATER CONTINUITY SWITCH LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 722 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

KNOWN INFO
LEAD 660 B OK
POSSIBLE PROBLEMS
LEAD 722 LEAD 722 A HEATER CONTINUITY SWITCH LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 722 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

KNOWN INFO
LEAD 660 B OK LEAD 722 OK
POSSIBLE PROBLEMS
LEAD 722 A HEATER CONTINUITY SWITCH LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 722 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP



## REFERENCE INFORMATION

## AMBULANCE

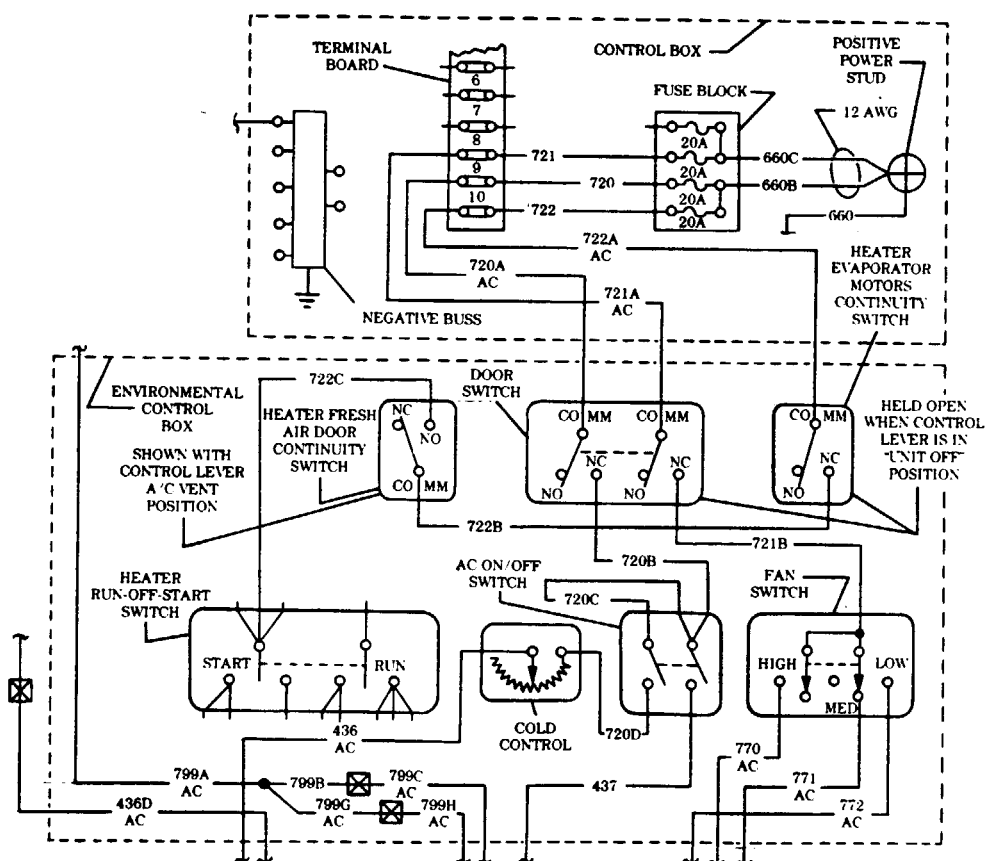
**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point,  
BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to  
(para. 4-85).

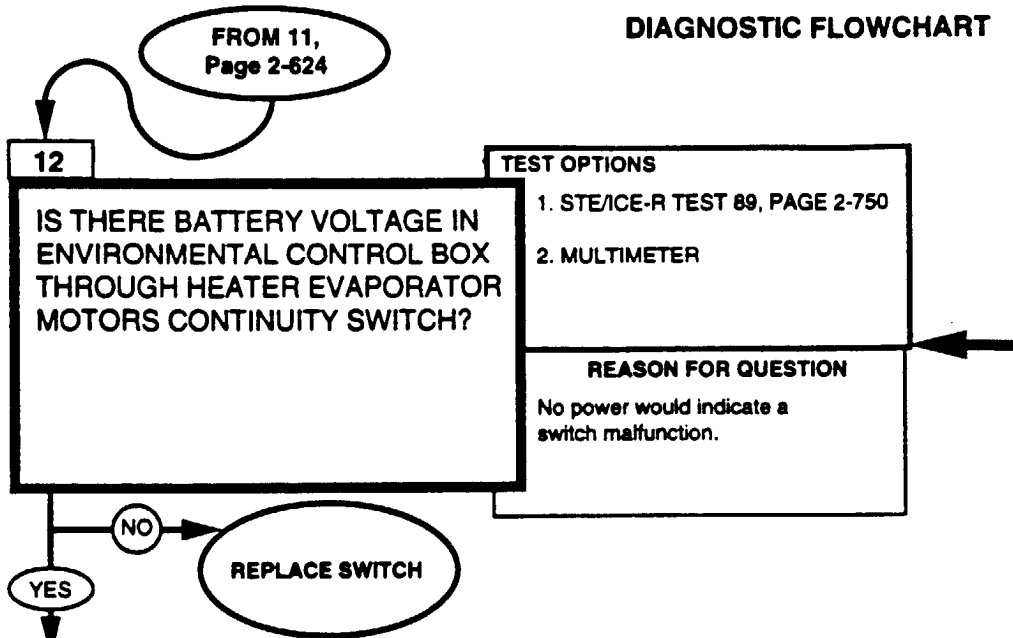


Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to  
(para. 4-85).

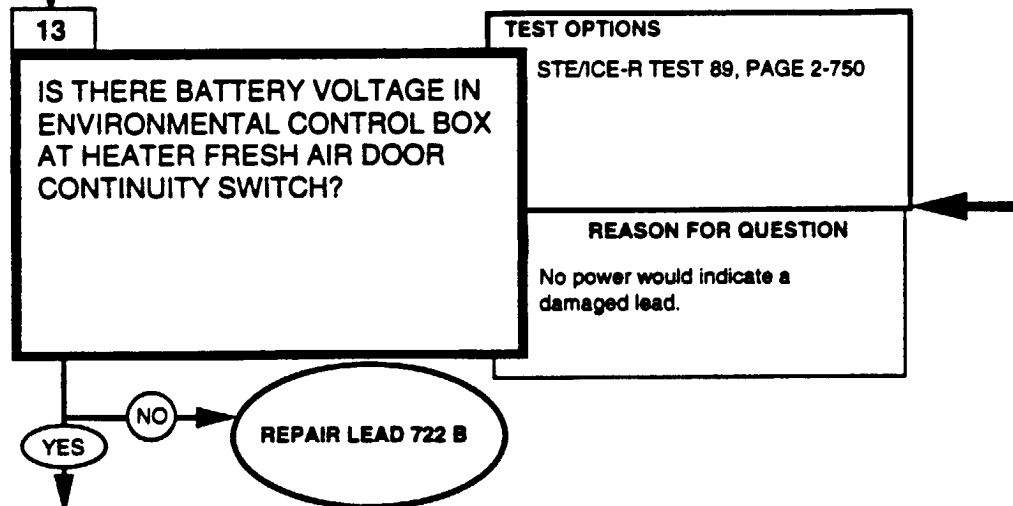
**AMBULANCE**  
**(Heater Fuel Pump)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

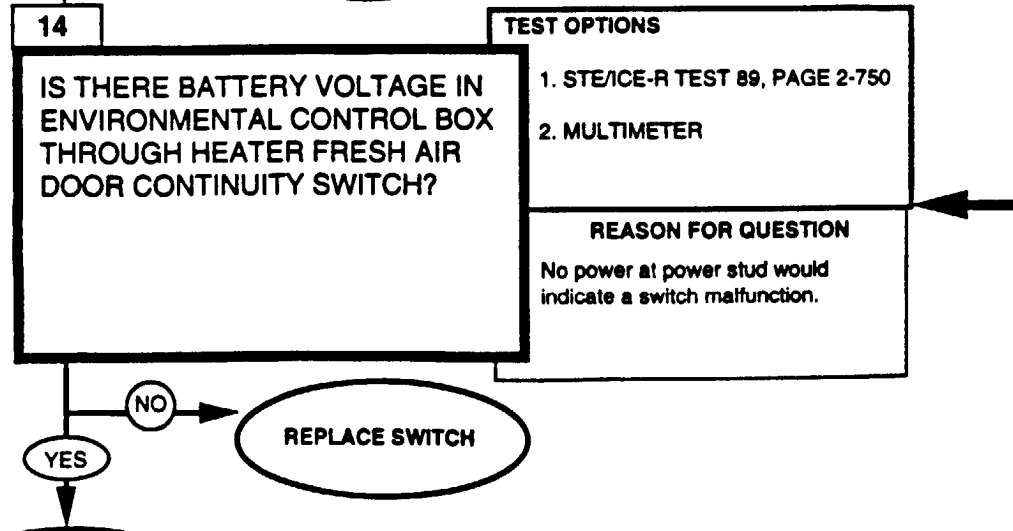
KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK
POSSIBLE PROBLEMS
HEATER CONTINUITY SWITCH LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP



KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK
POSSIBLE PROBLEMS
LEAD 722 B HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP



KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK
POSSIBLE PROBLEMS
HEATER FRESH AIR SWITCH LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP



GO TO 15,  
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# REFERENCE INFORMATION

# AMBULANCE

Replace Heater Evaporator Motors continuity switch, refer to DS Maintenance.

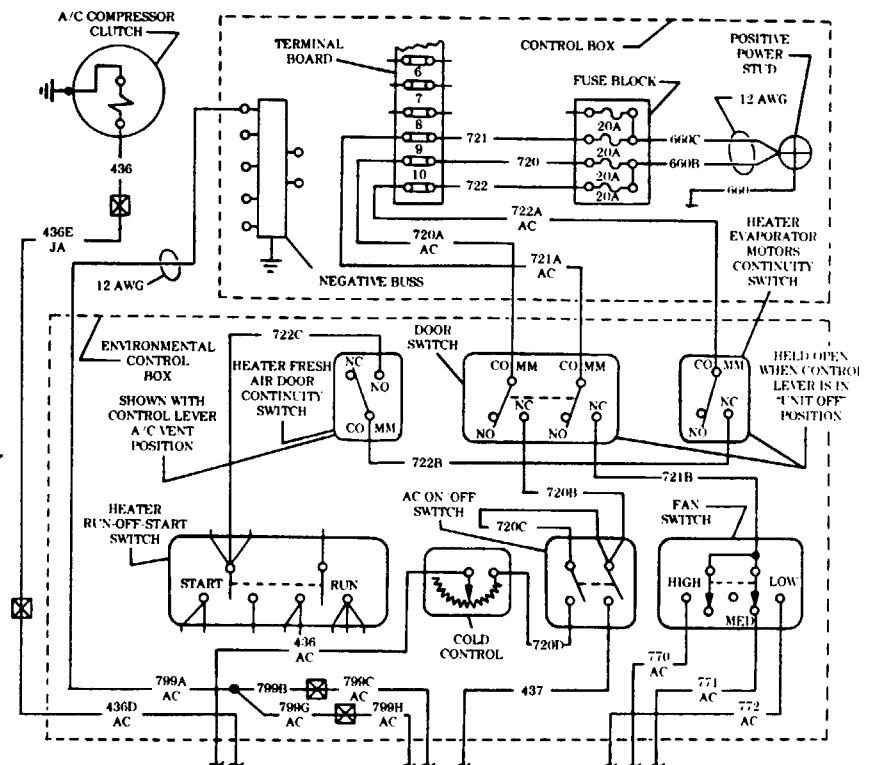
## 0-45 DC VOLTS STE/CE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

1. Set the voltmeter to a DC volts scale of at least 40 volts.
2. Connect the RED lead to positive and the BLACK lead to negative.
3. Be sure to read the correct scale.

Replace Heater Fresh Air Door continuity switch, refer to DS Maintenance.



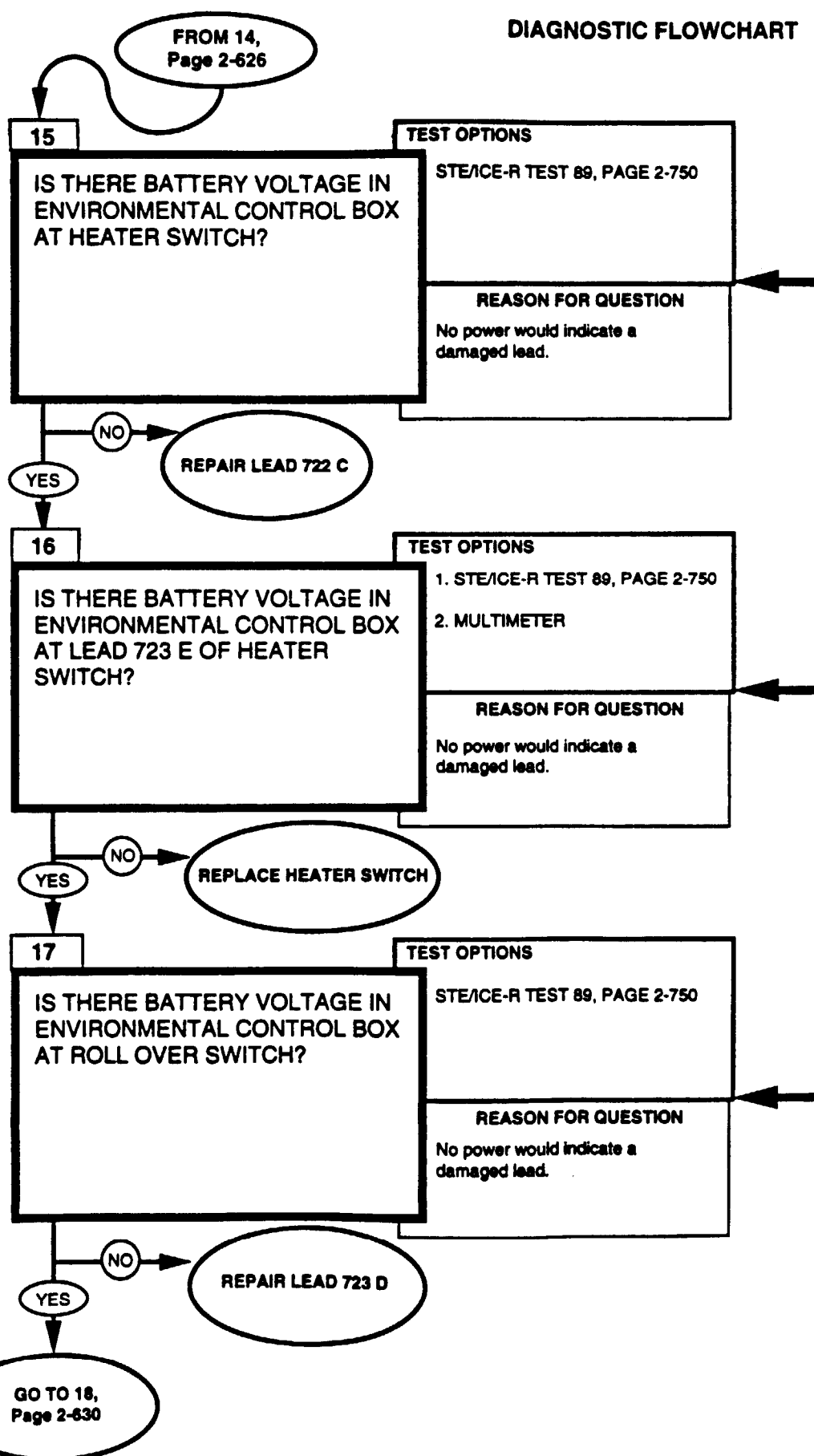
**AMBULANCE**  
**(Heater Fuel Pump)**  
**(Refer to Figs. 14-16.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK HEATER FRESH AIR SWITCH OK
POSSIBLE PROBLEMS
LEAD 722 C HEATER SWITCH LEAD 723 D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK HEATER FRESH AIR SWITCH OK LEAD 722 C OK
POSSIBLE PROBLEMS
HEATER SWITCH LEAD 723 D ROLL OVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK HEATER FRESH AIR SWITCH OK LEAD 722 C OK HEATER SWITCH OK
POSSIBLE PROBLEMS
LEAD 723D ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP



REFERENCE INFORMATION

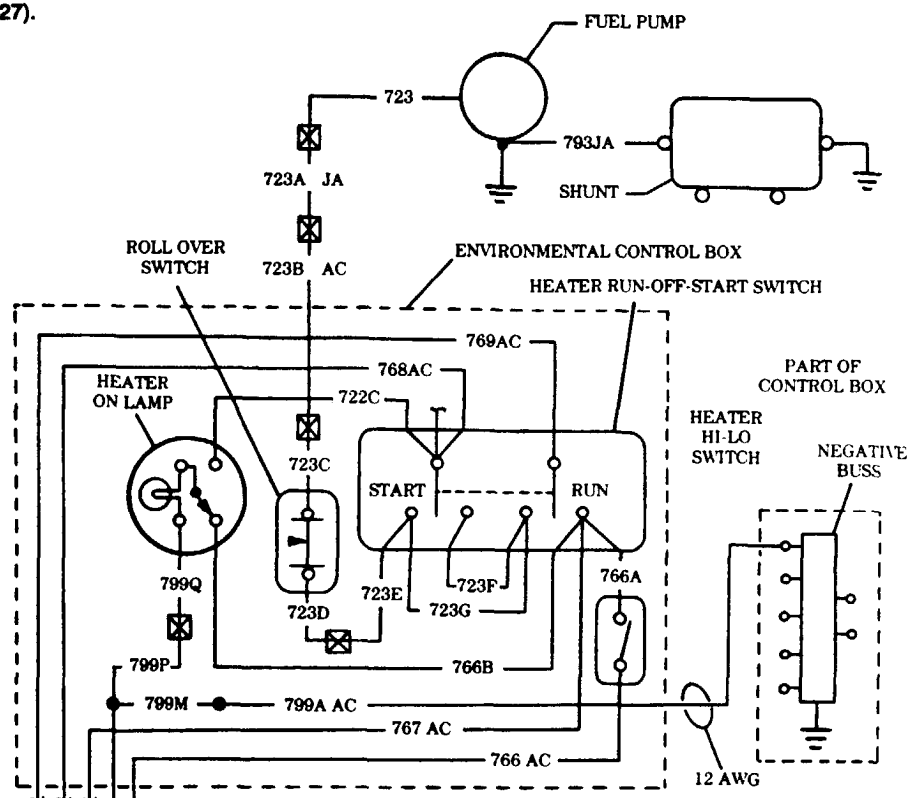
AMBULANCE

Repair lead, refer to (para. 4-85).

Replace Heater Switch, refer to (para. 4-126 or 4-127).

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS STEACE-R TEST 89
<ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC volts.</li> <li>3. Displayed reading is in volts.</li> </ol>
BATTERY VOLTAGE MULTIMETER
<ol style="list-style-type: none"> <li>1. Set the voltmeter to a DC volts scale of at least 40 volts.</li> <li>2. Connect the RED lead to positive and the BLACK lead to negative.</li> <li>3. Be sure to read the correct scale.</li> </ol>



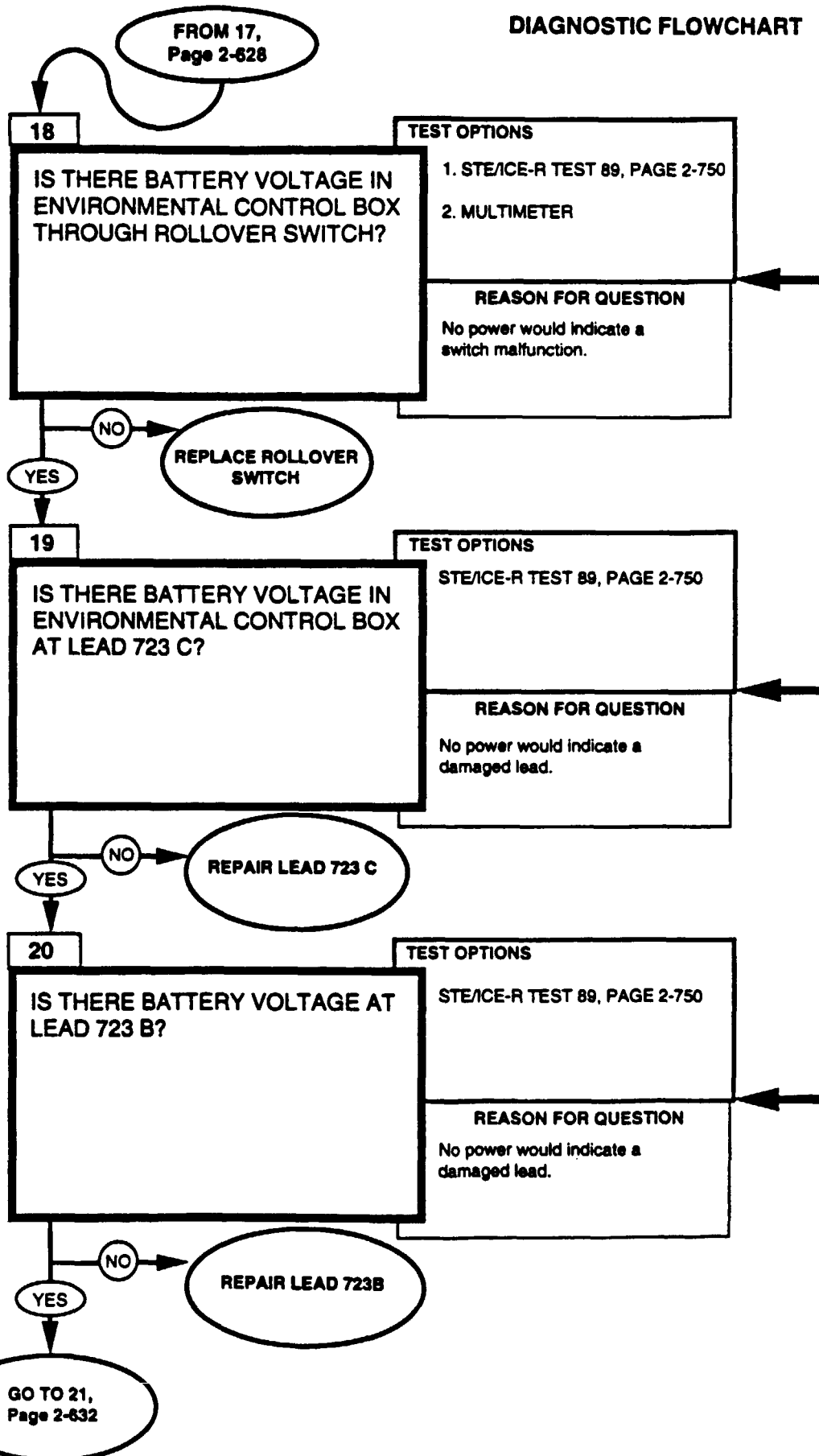
**AMBULANCE**  
**(Heater Fuel Pump)**  
**(Refer to Figs. 14-16.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK HEATER FRESH AIR SWITCH OK LEAD 722 C OK HEATER SWITCH OK LEAD 723 D OK
POSSIBLE PROBLEMS
ROLLOVER SWITCH LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK HEATER FRESH AIR SWITCH OK LEAD 722 C OK HEATER SWITCH OK LEAD 723 D OK ROLLOVER SWITCH OK
POSSIBLE PROBLEMS
LEAD 723 C LEAD 723 B LEAD 723 A FUEL PUMP

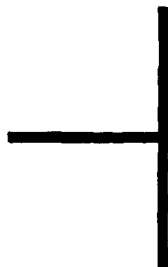
KNOWN INFO
LEAD 660 B OK LEAD 722 OK LEAD 722 A OK HEATER CONTINUITY SWITCH OK LEAD 722 B OK HEATER FRESH AIR SWITCH OK LEAD 722 C OK HEATER SWITCH OK LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 C OK
POSSIBLE PROBLEMS
LEAD 723 B LEAD 723 A FUEL PUMP



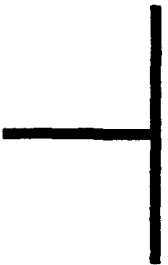


REFERENCE INFORMATION

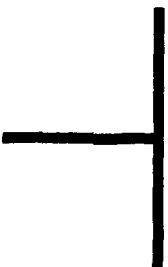
AMBULANCE



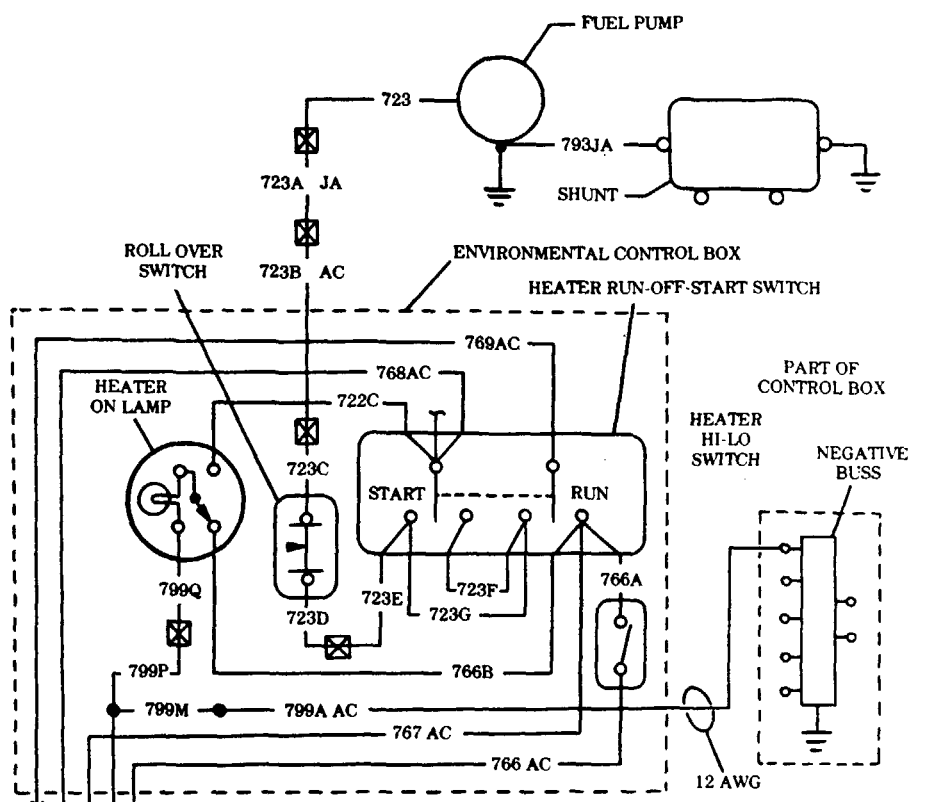
Replace Rollover Switch,  
refer to (para. 4-126 or 4-127).



Repair lead,  
refer to (para. 4-85).  
Repair lead connector,  
refer to (para. 4-85).



0-45 DC VOLTS STE/ICE-R TEST 89
<ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC volts.</li> <li>3. Displayed reading is in volts.</li> </ol>
BATTERY VOLTAGE MULTIMETER
<ol style="list-style-type: none"> <li>1. Set the voltmeter to a DC volts scale of at least 40 volts.</li> <li>2. Connect the RED lead to positive and the BLACK lead to negative.</li> <li>3. Be sure to read the correct scale.</li> </ol>

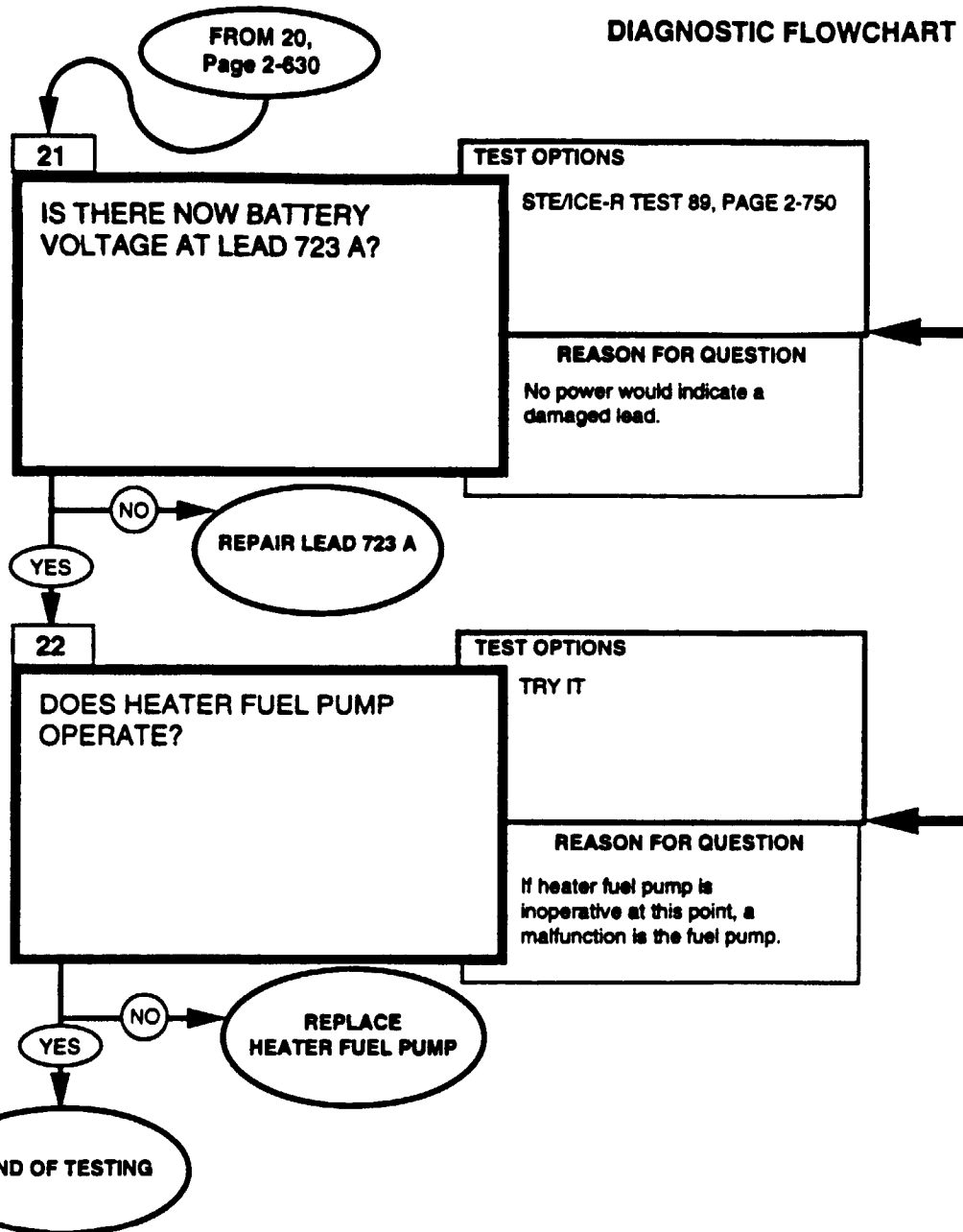


**AMBULANCE**  
**(Heater Fuel Pump)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK
ROLL OVER SWITCH OK
LEAD 723 C OK
LEAD 723 B OK
POSSIBLE PROBLEMS
LEAD 723 A
FUEL PUMP

KNOWN INFO
LEAD 660 B OK
LEAD 722 OK
LEAD 722 A OK
HEATER CONTINUITY SWITCH OK
LEAD 722 B OK
HEATER FRESH AIR SWITCH OK
LEAD 722 C OK
HEATER SWITCH OK
LEAD 723 D OK
ROLL OVER SWITCH OK
LEAD 723 C OK
LEAD 723 B OK
LEAD 723 A OK
POSSIBLE PROBLEMS
FUEL PUMP



REFERENCE INFORMATION

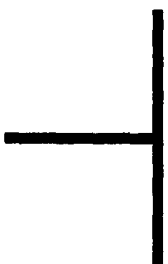
AMBULANCE



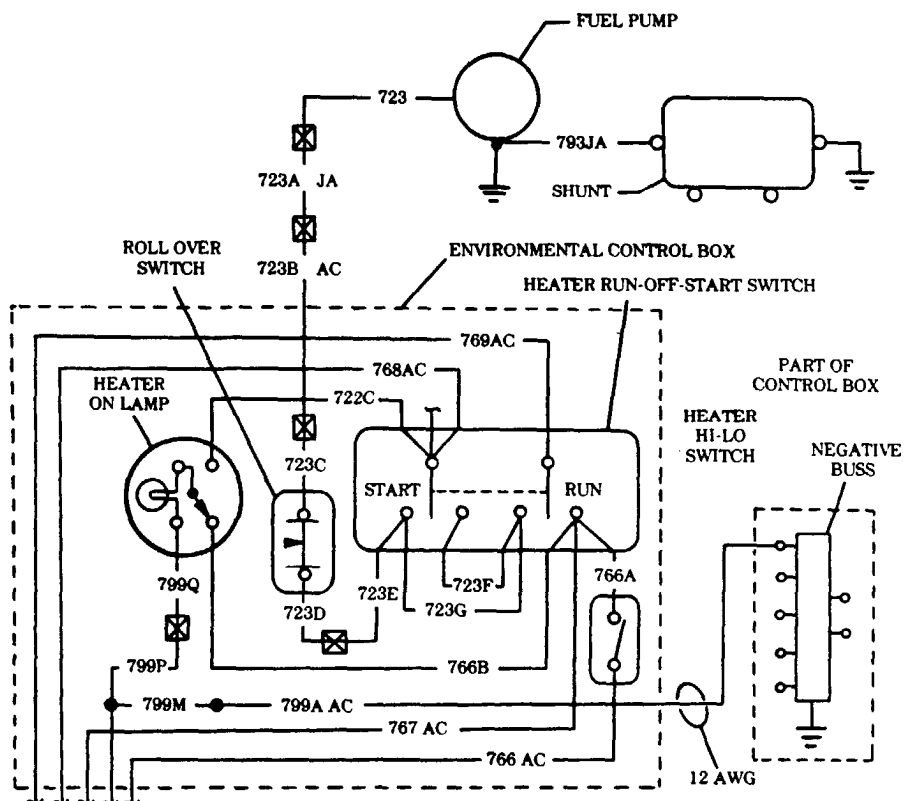
Repair lead,  
refer to (para. 4-85).  
Repair lead connector,  
refer to (para. 4-85).

**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



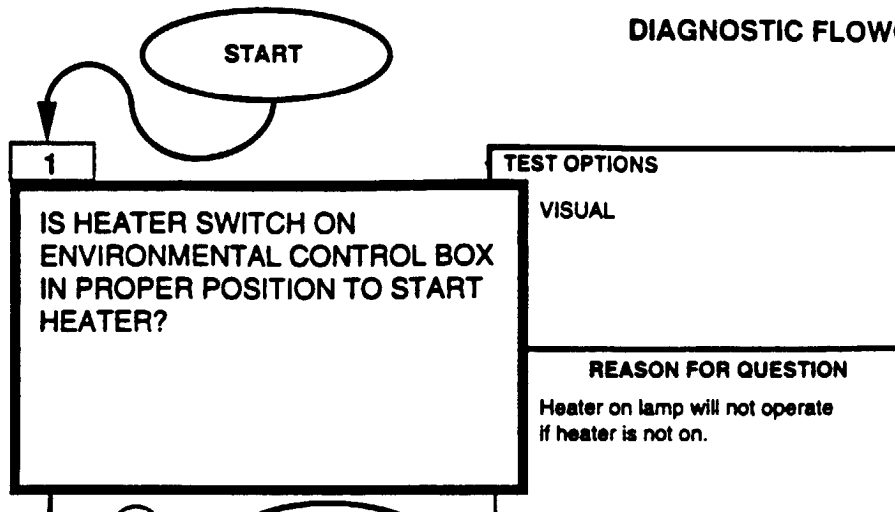
Replace Heater Fuel Pump,  
refer to (para. 11-194).



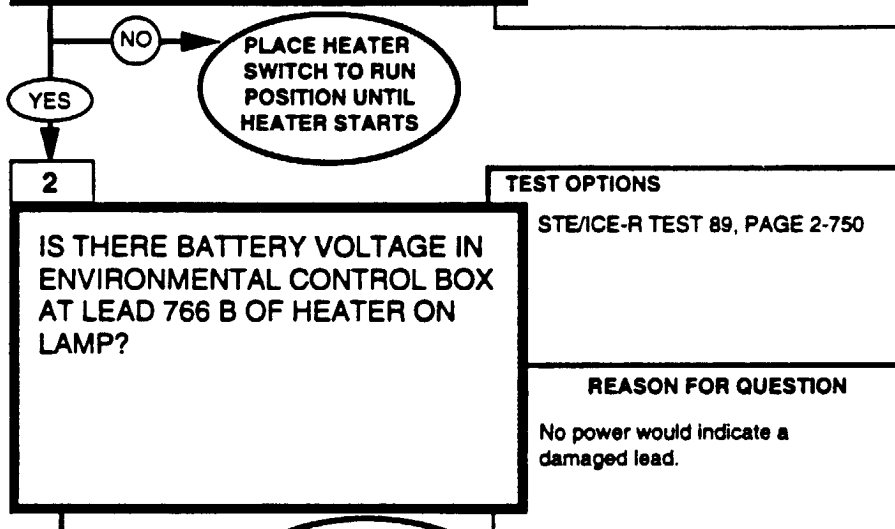
**AMBULANCE**  
**(Heater On Lamp)**  
 (Heater Operates)  
 (Refer to Figs. 15, 16.)

**DIAGNOSTIC FLOWCHART**

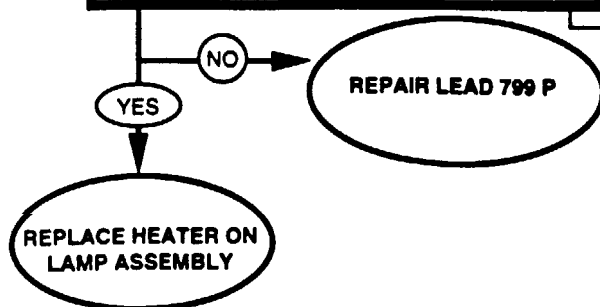
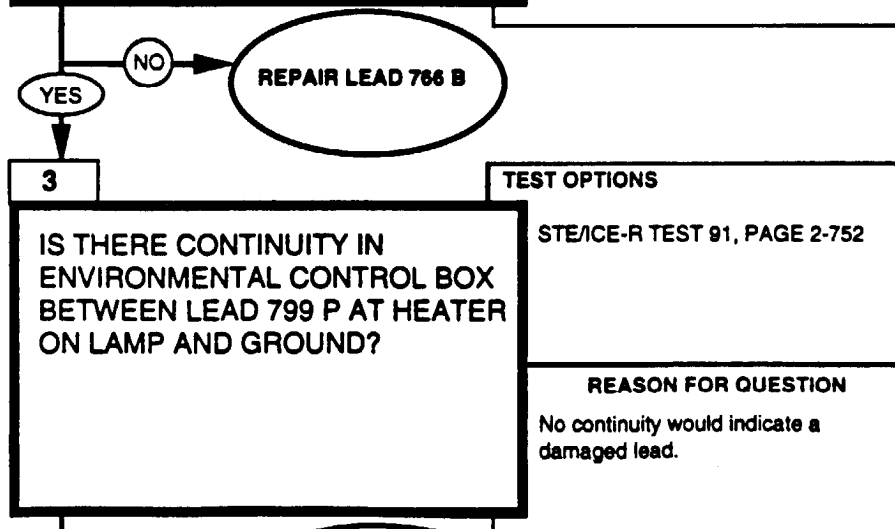
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
HEATER SWITCH POSITION LEAD 766 B LEAD 799 P HEATER ON LAMP



KNOWN INFO
HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
LEAD 766 B LEAD 799 P HEATER ON LAMP

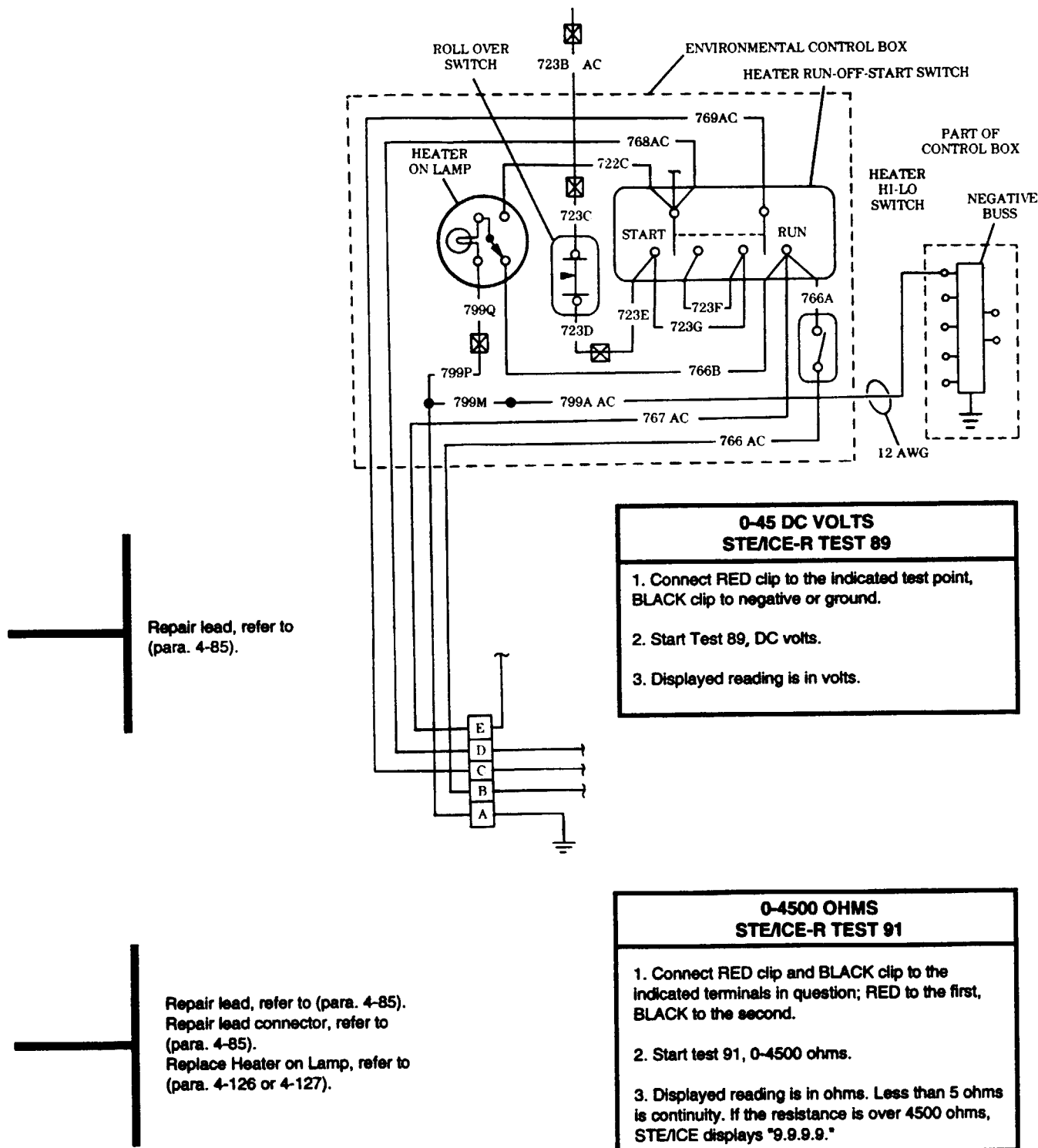


KNOWN INFO
HEATER SWITCH POSITION OK LEAD 766 B OK
POSSIBLE PROBLEMS
LEAD 799 P HEATER ON LAMP



## REFERENCE INFORMATION

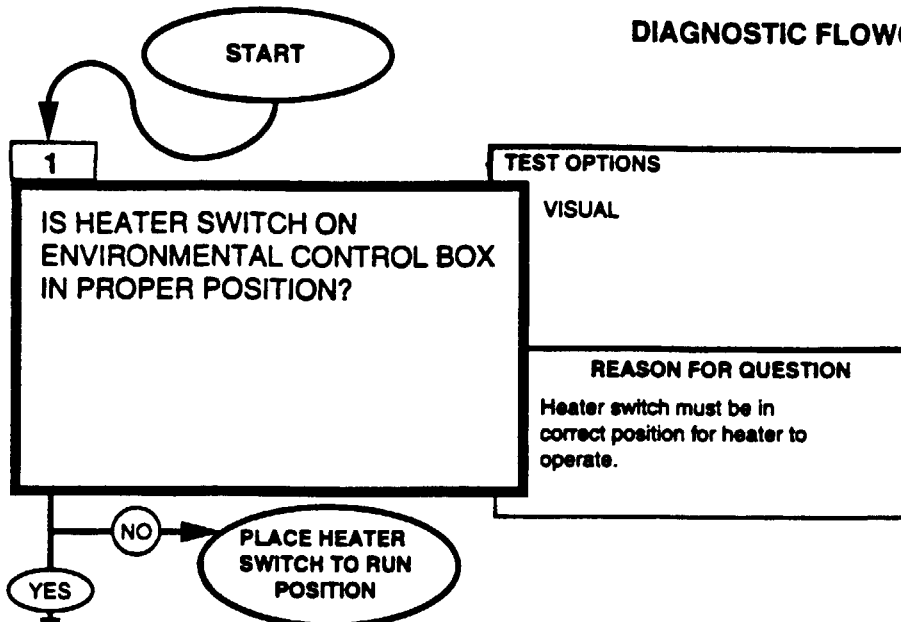
## AMBULANCE



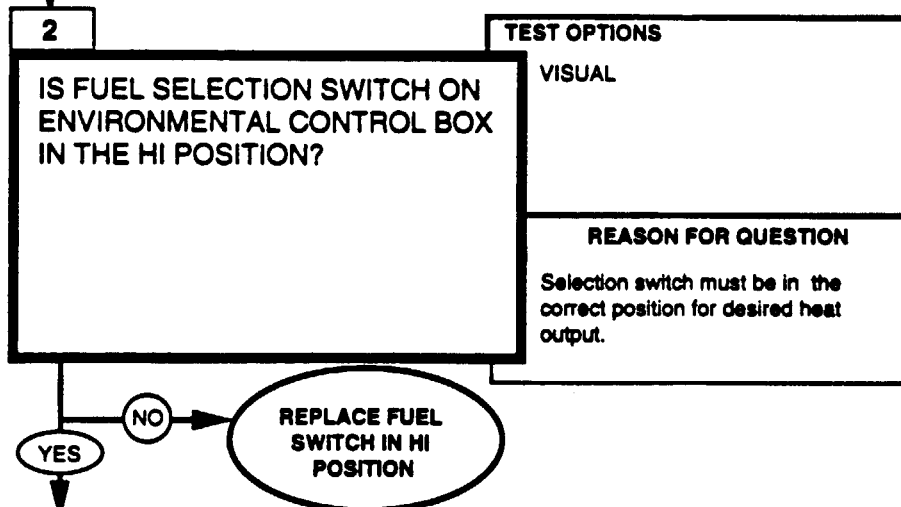
**AMBULANCE**  
(Heater Output)  
(Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

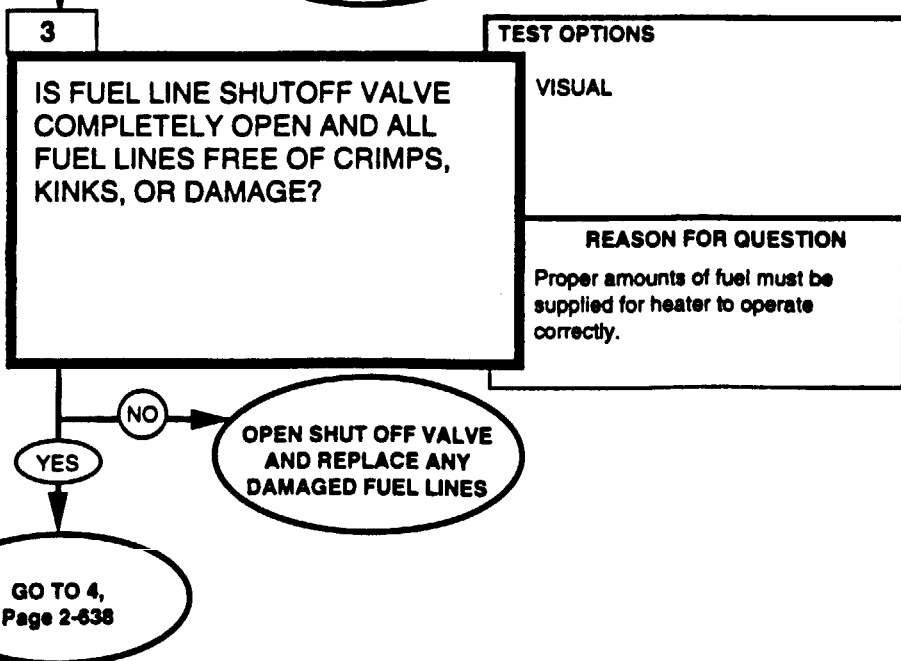
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
HEATER SWITCH POSITION FUEL SWITCH POSITION FUEL SHUTOFF VALVE POSITION FUEL LINES FUEL FILTER LEAD 766 A FUEL SWITCH



KNOWN INFO
HEATER SWITCH POSITION OK
POSSIBLE PROBLEMS
FUEL SWITCH POSITION FUEL SWITCH VALVE POSITION FUEL LINES FUEL FILTER LEAD 766 A FUEL SWITCH

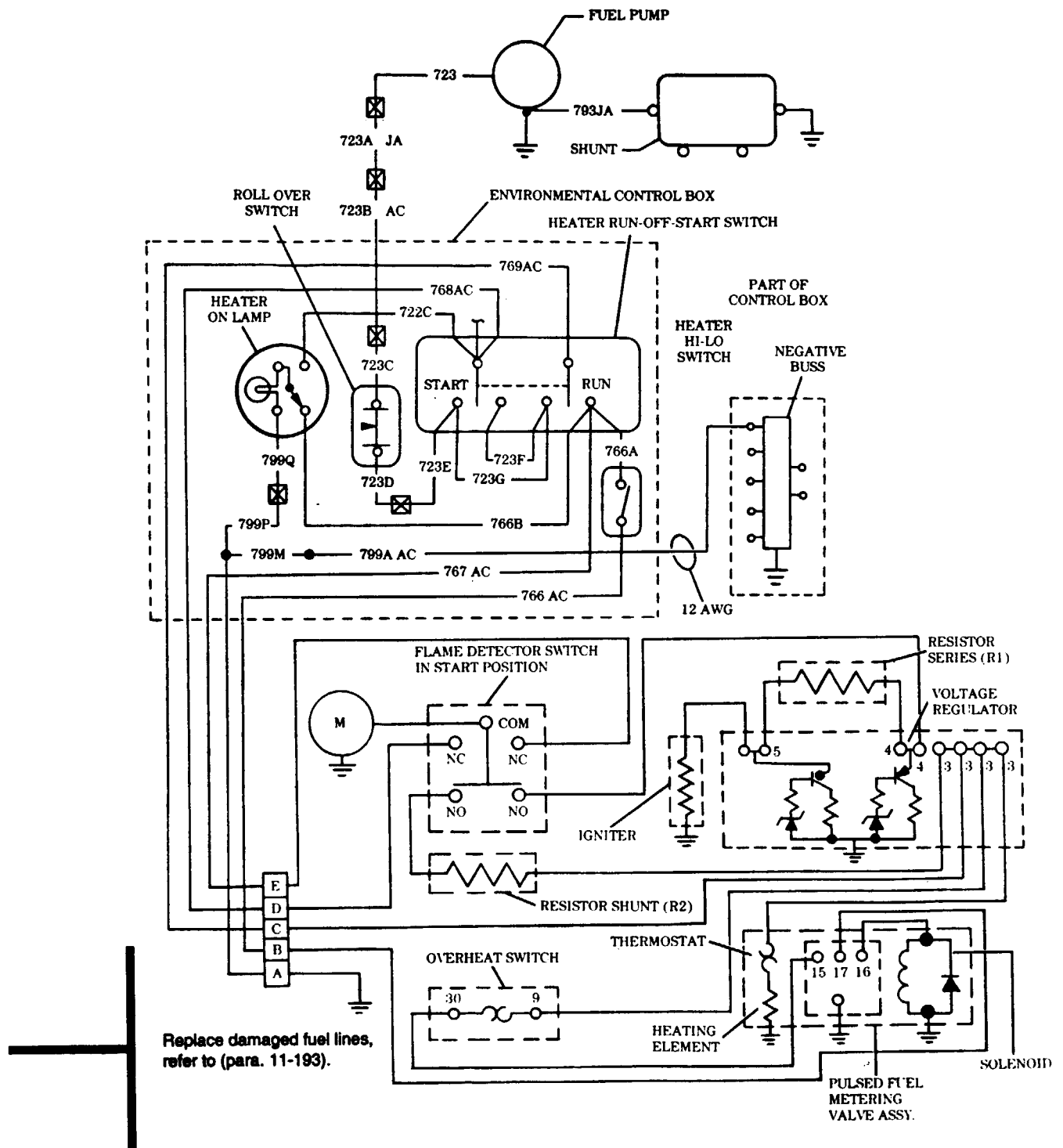


KNOWN INFO
HEATER SWITCH POSITION OK FUEL SWITCH OK
POSSIBLE PROBLEMS
FUEL SWITCH VALVE POSITION FUEL LINES FUEL FILTER LEAD 766 A FUEL SWITCH



# REFERENCE INFORMATION

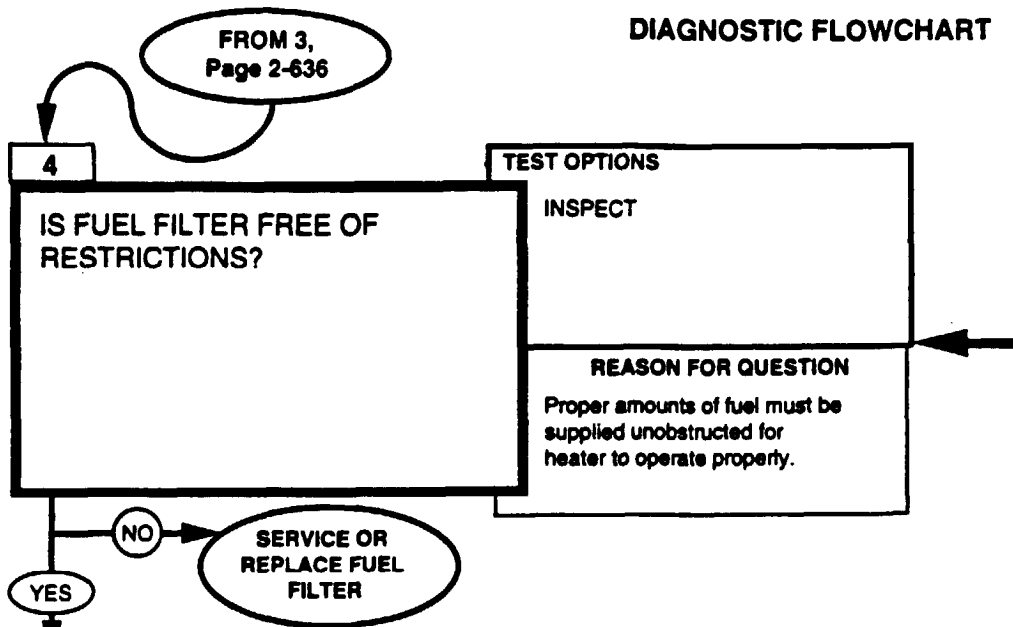
# AMBULANCE



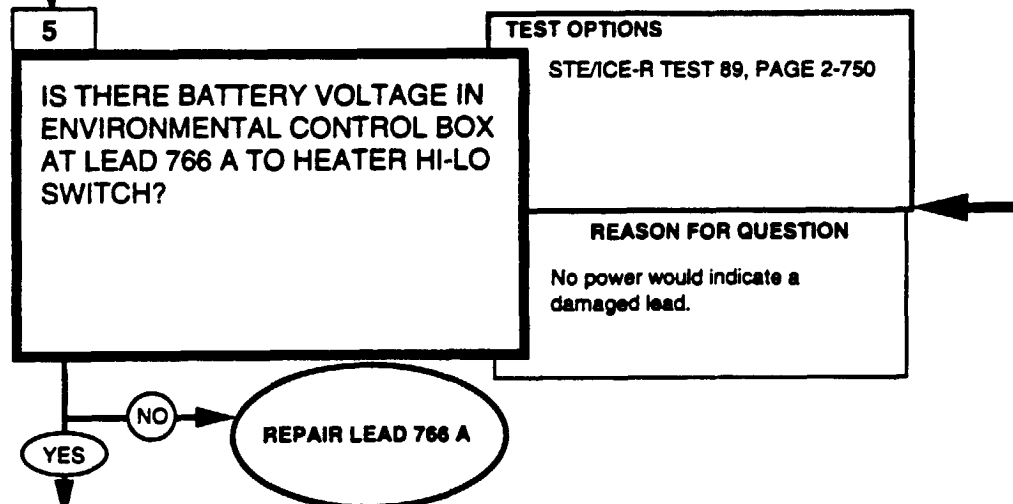
**AMBULANCE**  
(Heater Output)  
(Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

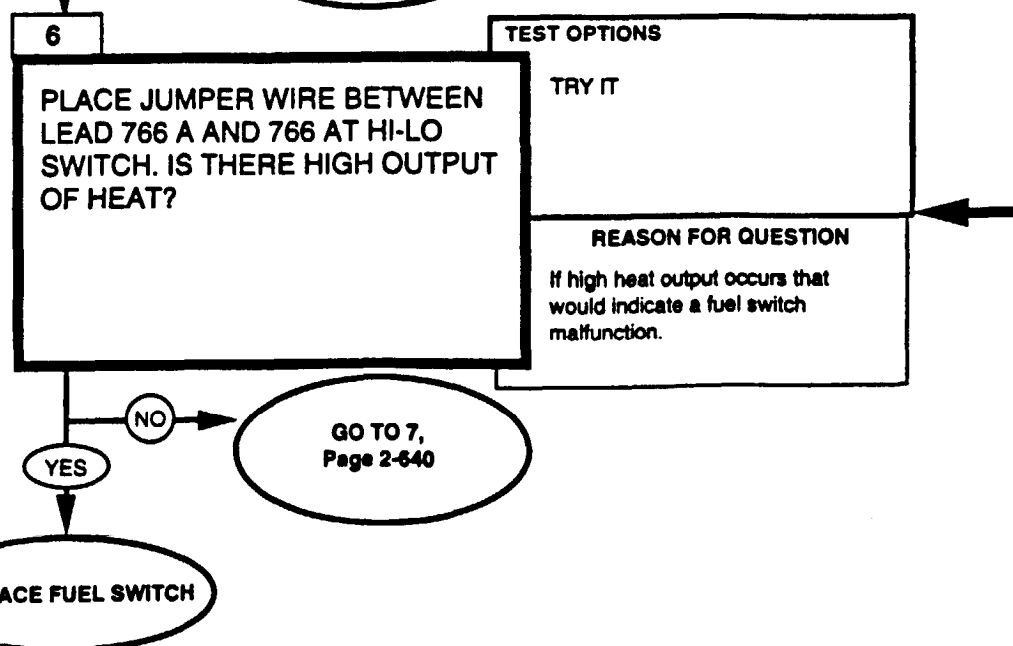
KNOWN INFO
HEATER SWITCH POSITION OK FUEL SWITCH POSITION OK FUEL SHUTOFF VALVE POSITION OK FUEL LINES OK
POSSIBLE PROBLEMS
FUEL FILTER LEAD 766 A FUEL SWITCH



KNOWN INFO
HEATER SWITCH POSITION OK FUEL SWITCH POSITION OK FUEL SHUTOFF VALVE POSITION OK FUEL LINES OK FUEL FILTER OK
POSSIBLE PROBLEMS
LEAD 766 A FUEL SWITCH



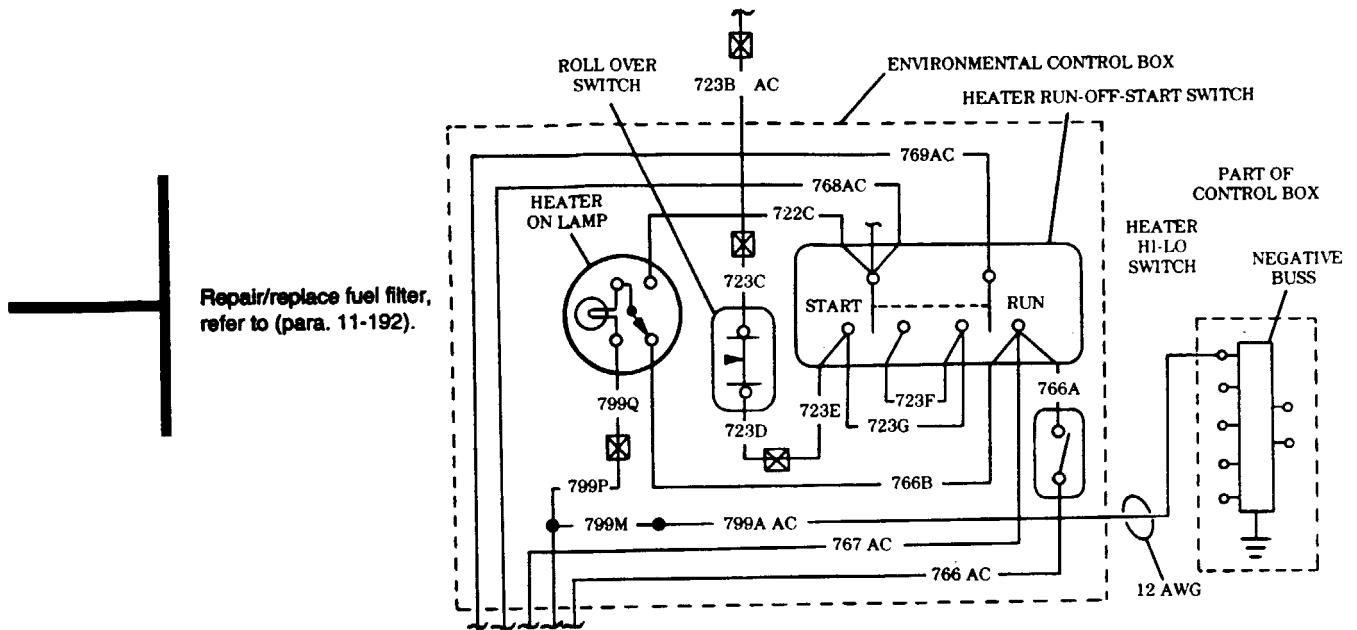
KNOWN INFO
HEATER SWITCH POSITION OK FUEL SWITCH POSITION OK FUEL SHUTOFF VALVE POSITION OK FUEL LINES OK FUEL FILTER OK LEAD 766 A OK
POSSIBLE PROBLEMS
FUEL SWITCH





# REFERENCE INFORMATION

## AMBULANCE



Repair/replace fuel filter, refer to (para. 11-192).

Repair lead, refer to (para. 4-85).

Replace fuel switch, refer to (para. 4-127).

### 0-45 DC VOLTS STEACE-R TEST 89

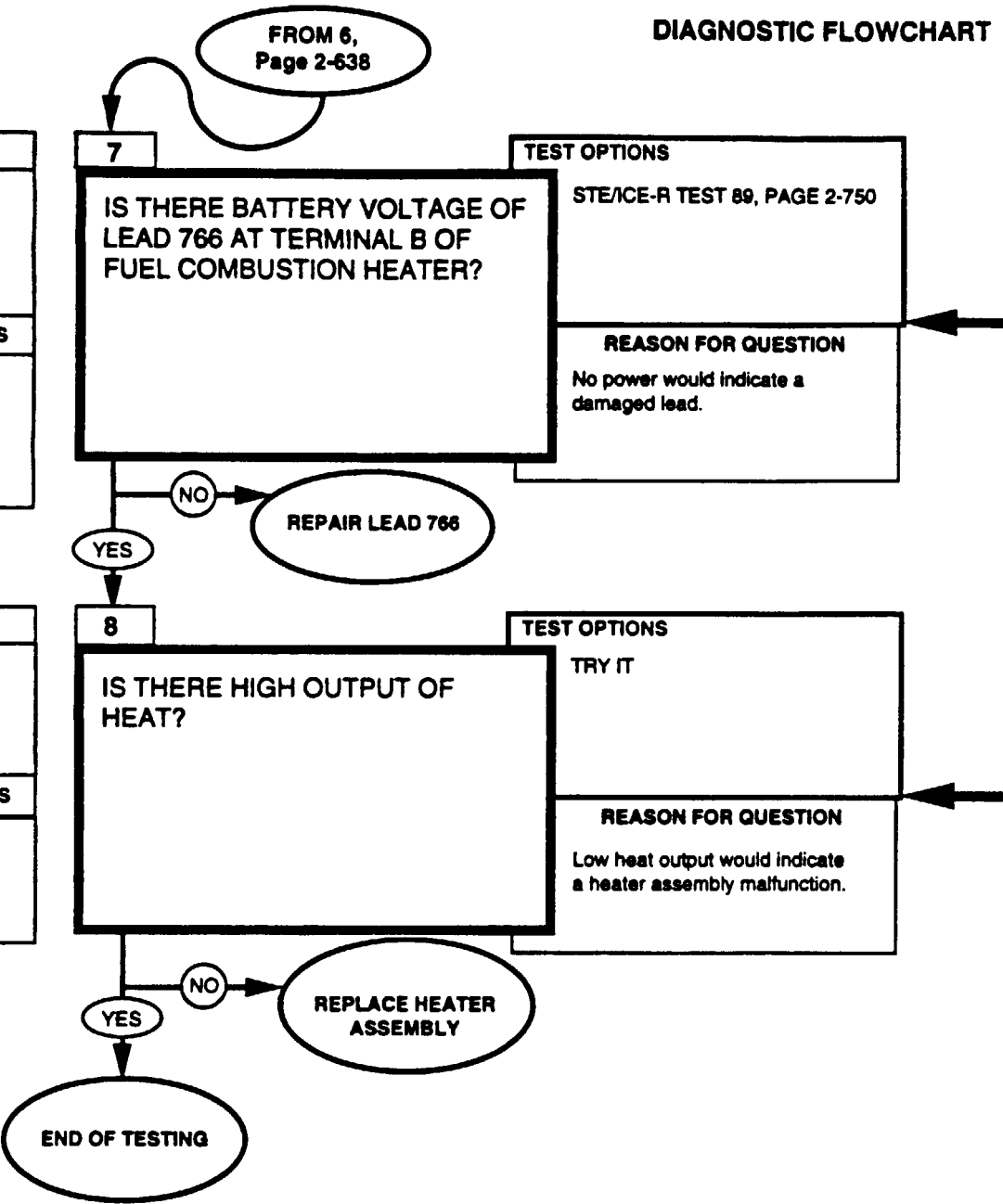
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**AMBULANCE**  
**(Heater Output)**  
**(Refer to Figs. 14-16.)**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 766 HEATER ASSEMBLY

KNOWN INFO
LEAD 766 OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY

**DIAGNOSTIC FLOWCHART**



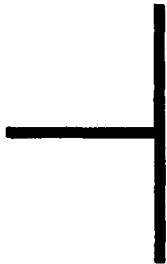
REFERENCE INFORMATION

AMBULANCE

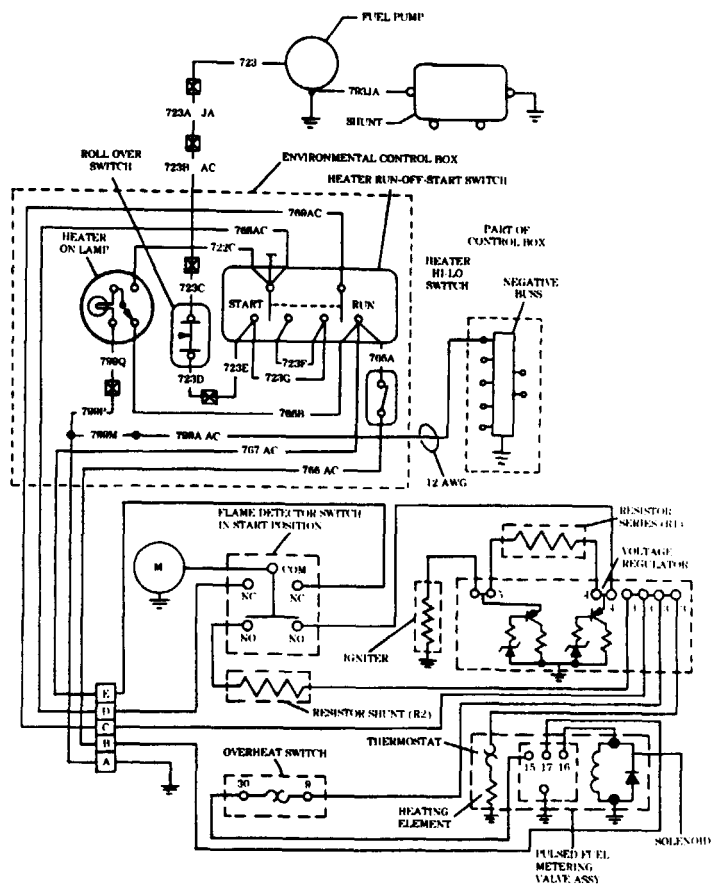


Repair lead, refer to (para. 4-85).  
Repair lead connector,  
refer to (para. 4-85).

0-45 DC VOLTS STE/ICE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



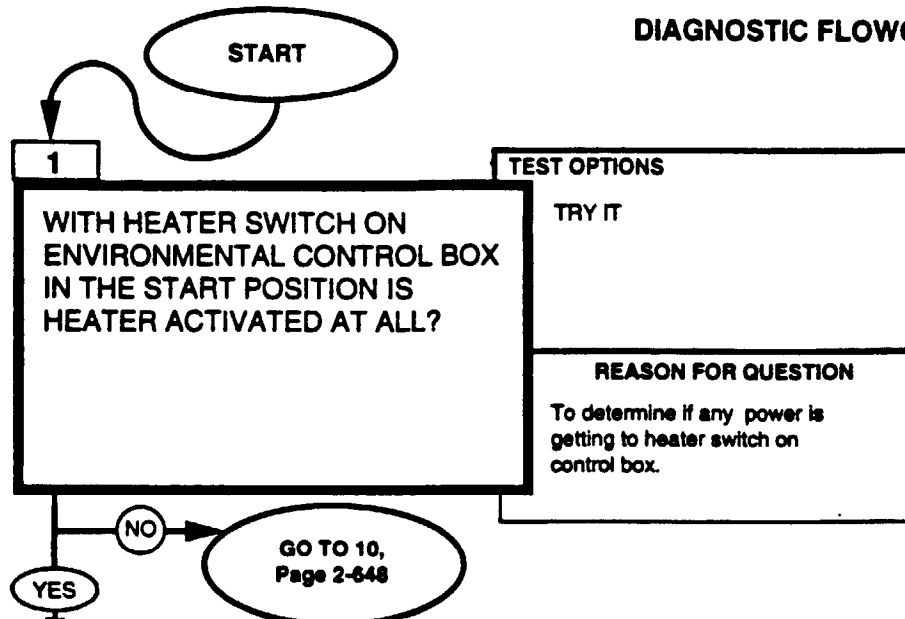
Replace heater assembly,  
refer to (para. 11-190 or 11-209).



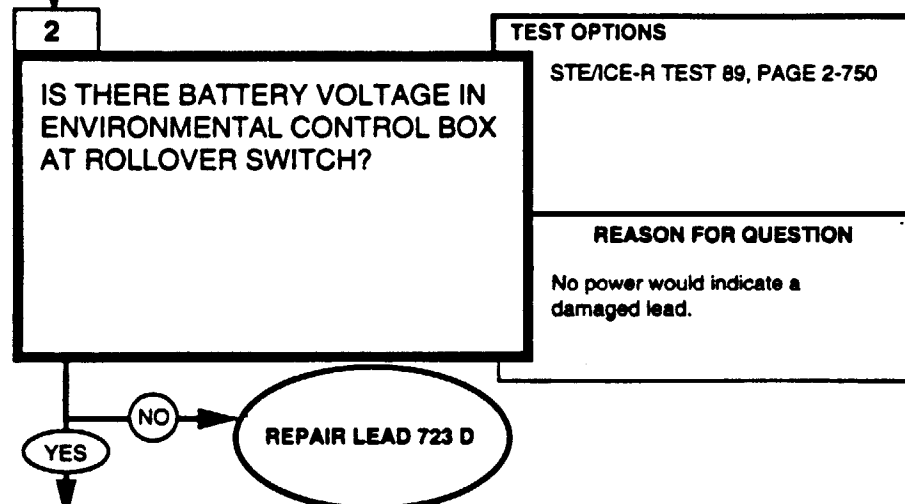
# DIAGNOSTIC FLOWCHART

**AMBULANCE**  
(Heater Starting)  
(Refer to Figs. 14-16.)

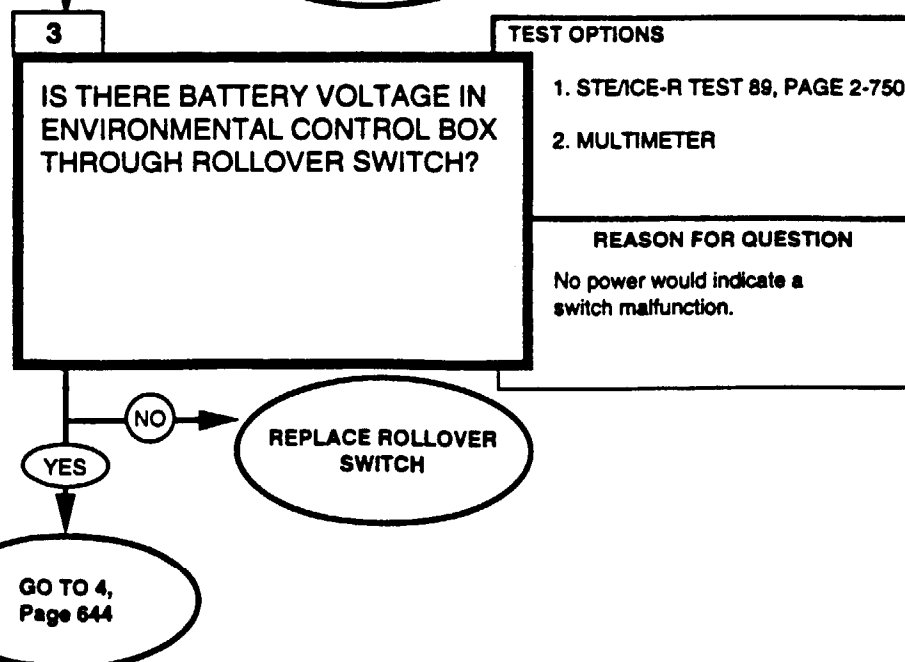
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 723 D ROLLOVER SWITCH LEAD 723 B LEAD 723 A LEAD 798 FUEL PUMP LEAD 768



KNOWN INFO
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 723 D ROLLOVER SWITCH LEAD 723 B LEAD 723 A LEAD 798 FUEL PUMP LEAD 768

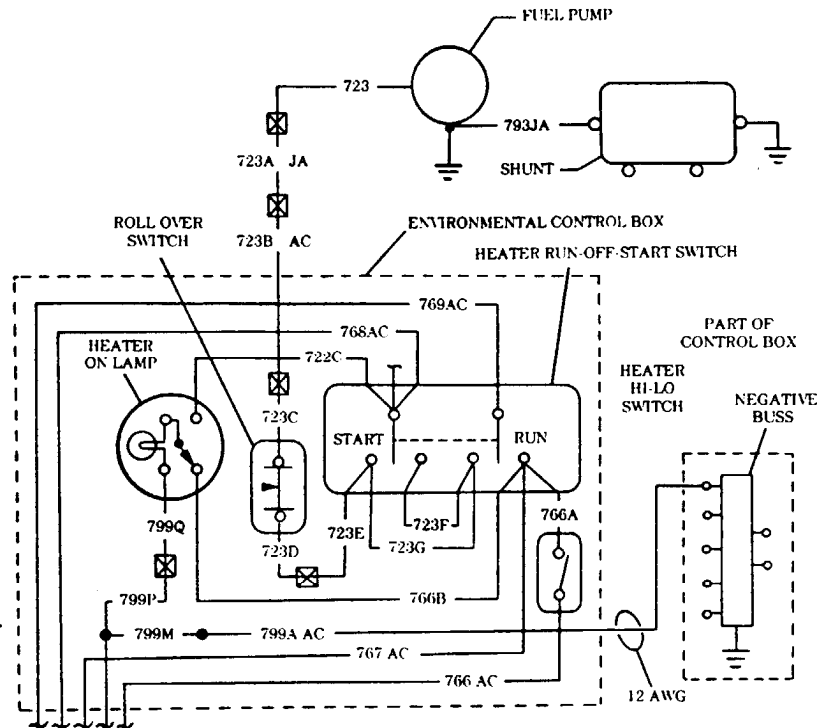


KNOWN INFO
LEAD 723 D OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY ROLL OVER SWITCH LEAD 723 B LEAD 723 A LEAD 798 FUEL PUMP LEAD 768



REFERENCE INFORMATION

AMBULANCE



Repair lead, refer to (para. 4-85).  
Repair lead connector,  
refer to (para. 4-85).

Replace Rollover Switch,  
refer to (para. 4-127).

**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.

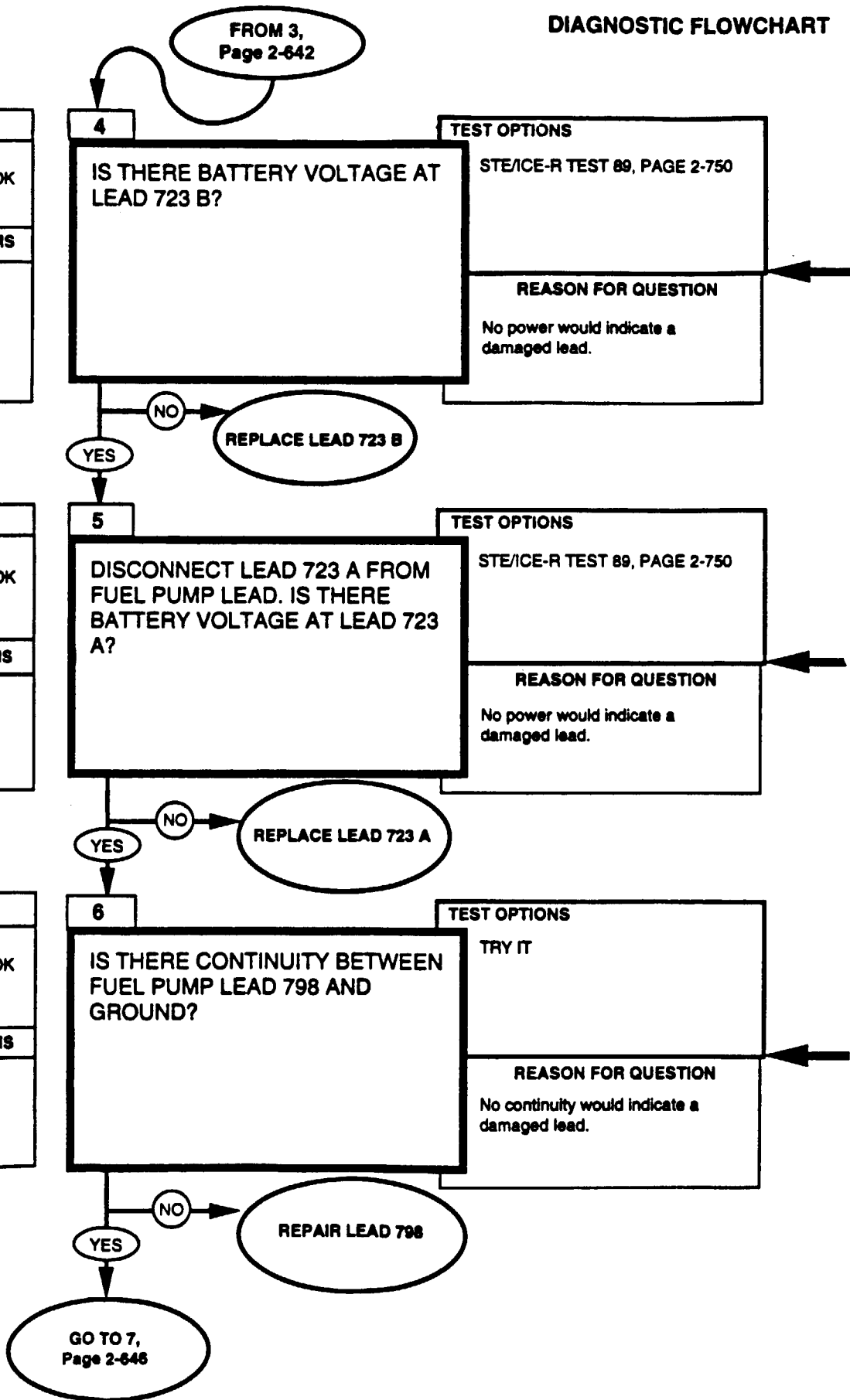
**AMBULANCE**  
**(Heater Starting)**  
(Refer to Figs. 14-16.)

KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 723 B LEAD 723 A LEAD 798 FUEL PUMP LEAD 768

KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 723 A LEAD 798 FUEL PUMP LEAD 768

KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK LEAD 723 A OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 798 FUEL PUMP LEAD 768

**DIAGNOSTIC FLOWCHART**



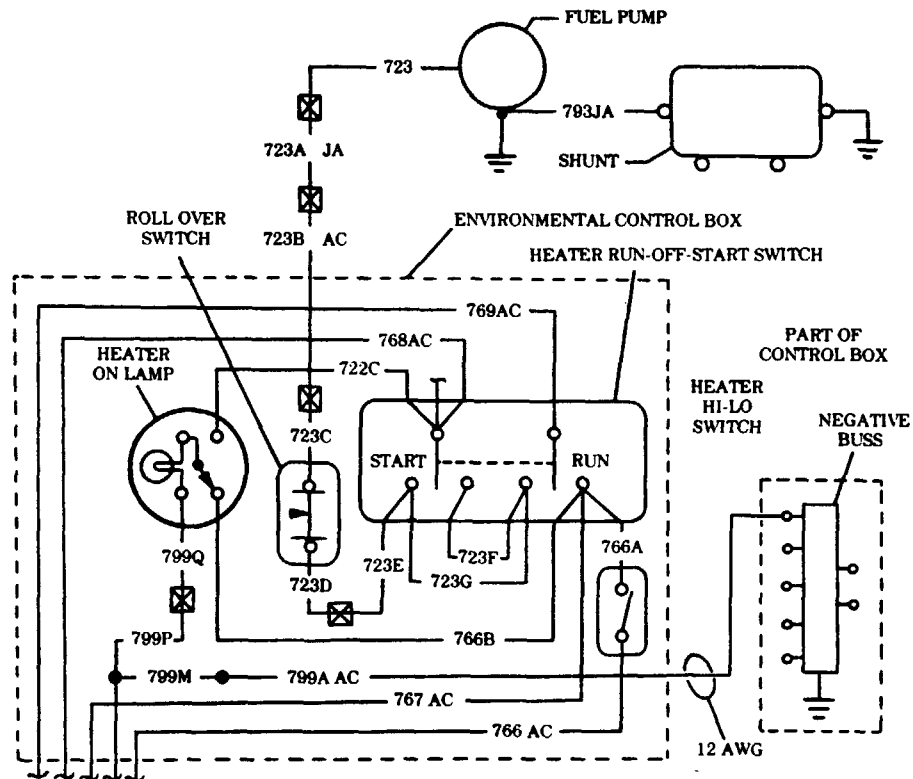
REFERENCE INFORMATION

AMBULANCE

Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

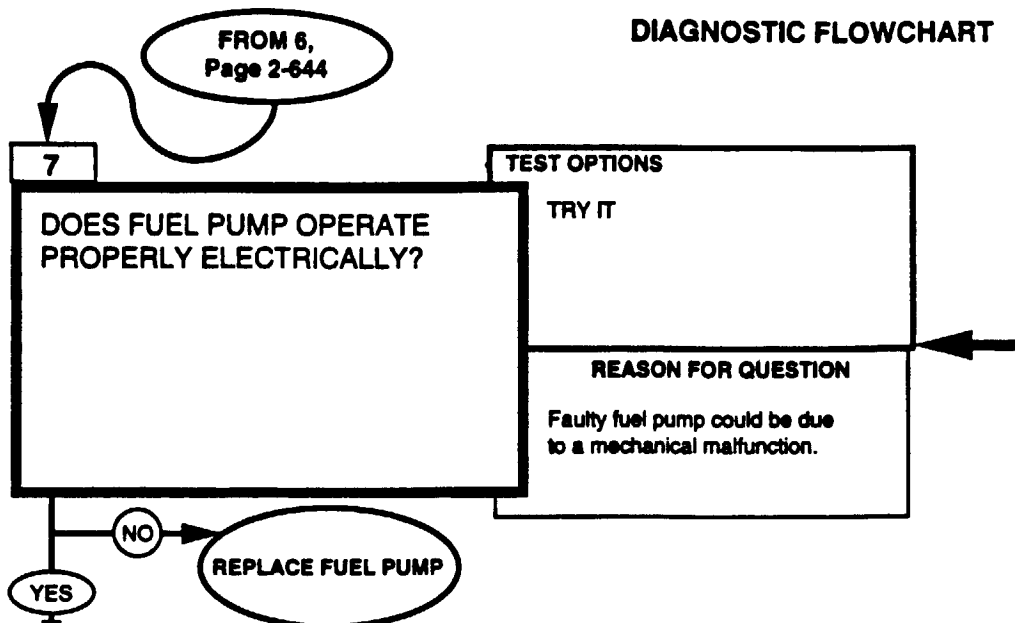


Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

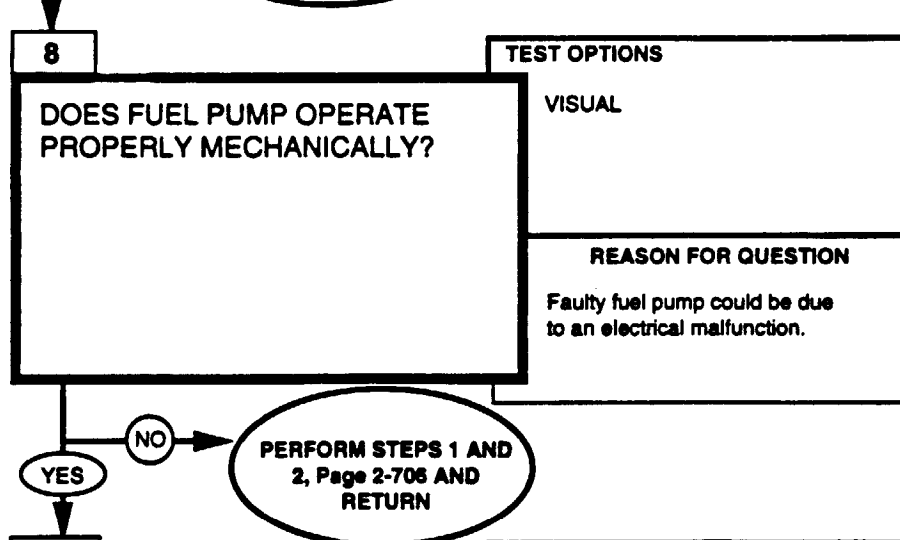
**AMBULANCE  
(Heater Starting)  
(Refer to Figs. 14-16.)**

**DIAGNOSTIC FLOWCHART**

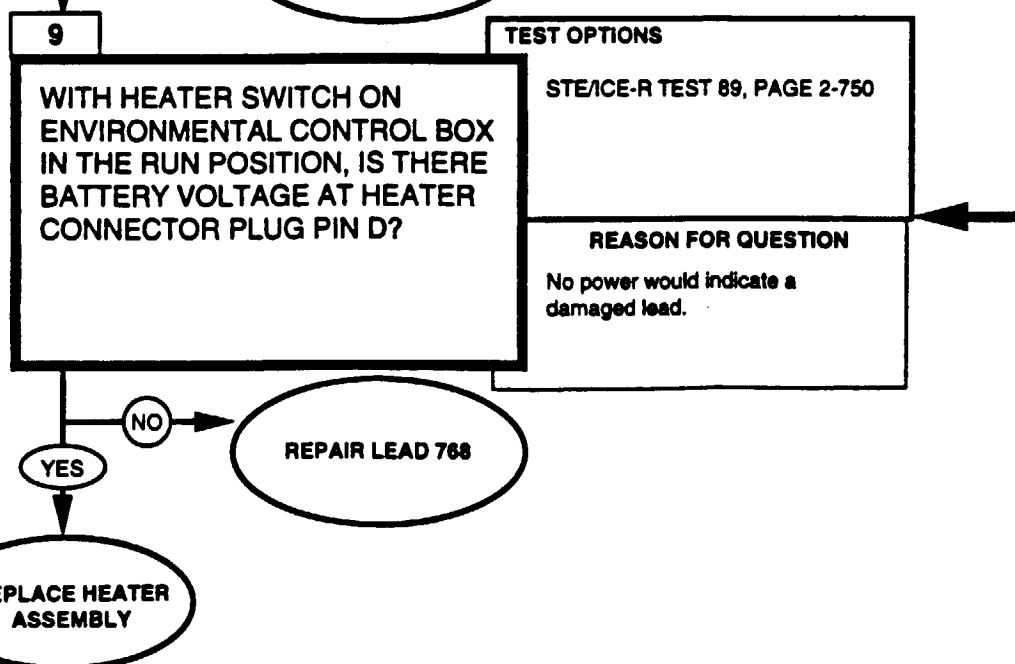
KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK LEAD 723 A OK LEAD 798 OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY FUEL PUMP LEAD 768



KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK LEAD 723 A OK LEAD 798 OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY FUEL PUMP LEAD 768



KNOWN INFO
LEAD 723 D OK ROLLOVER SWITCH OK LEAD 723 B OK LEAD 723 A OK LEAD 798 OK FUEL PUMP OK
POSSIBLE PROBLEMS
HEATER ASSEMBLY LEAD 768

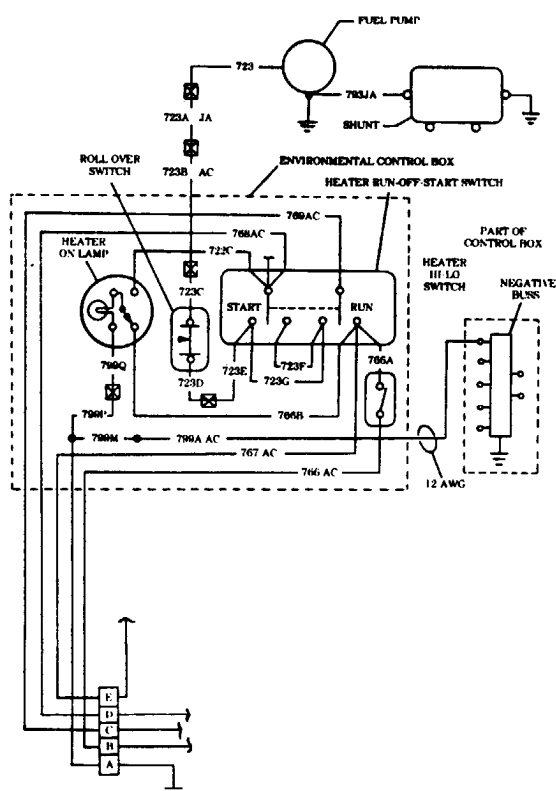




## REFERENCE INFORMATION

## AMBULANCE

Replace fuel pump, refer to (para. 11-194).



Replace heater assembly, refer to (para. 11-190 or 11-209).

### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

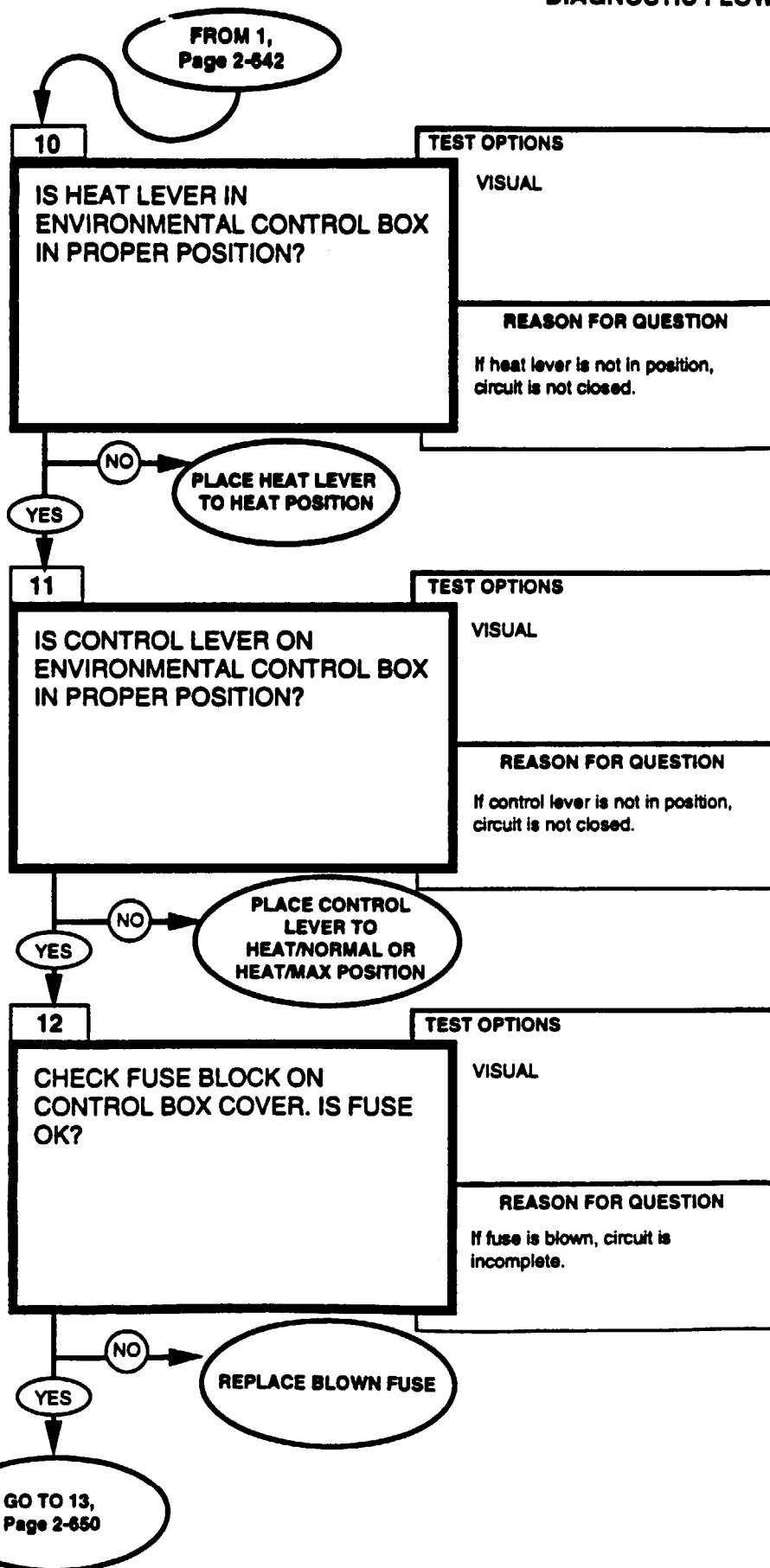
**AMBULANCE**  
**(Heater Starting)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
POSSIBLE PROBLEMS
HEAT LEVER POSITION CONTROL LEVER POSITION FUSE BATTERY CABLE 660 LEAD 660 B LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

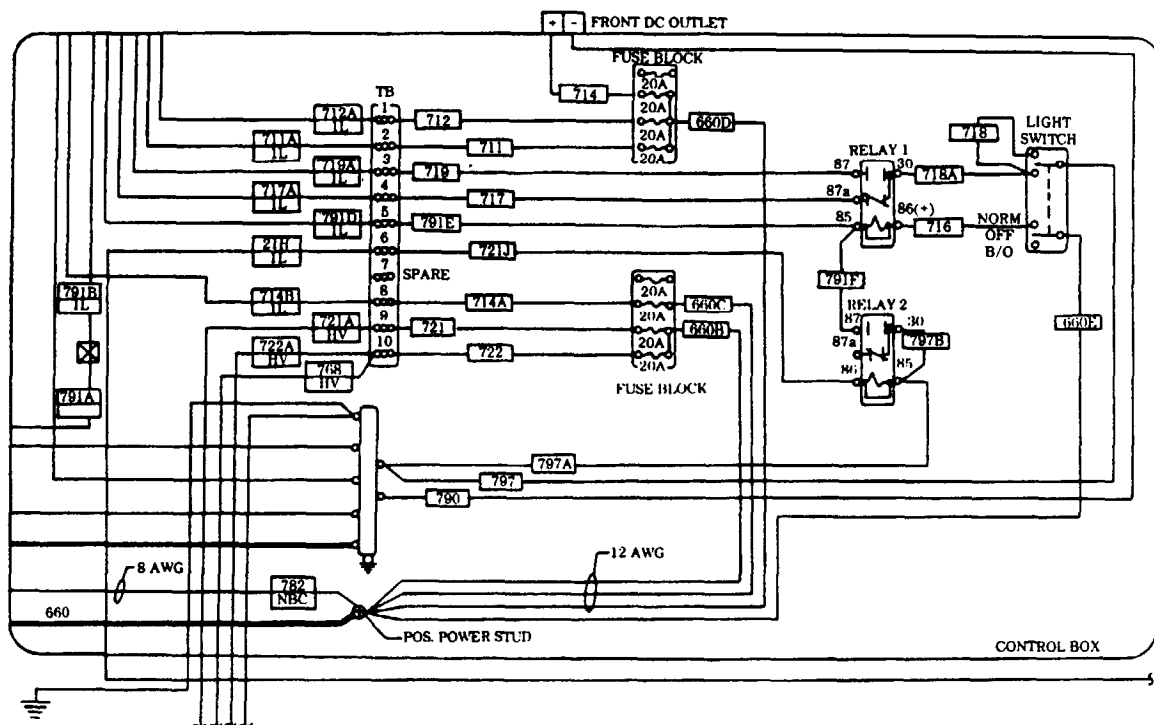
KNOWN INFO
HEAT LEVER POSITION OK
POSSIBLE PROBLEMS
CONTROL LEVER POSITION OK FUSE BATTERY CABLE 660 LEAD 660 B LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK
POSSIBLE PROBLEMS
FUSE BATTERY CABLE 660 LEAD 660 B LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY



REFERENCE INFORMATION

AMBULANCE



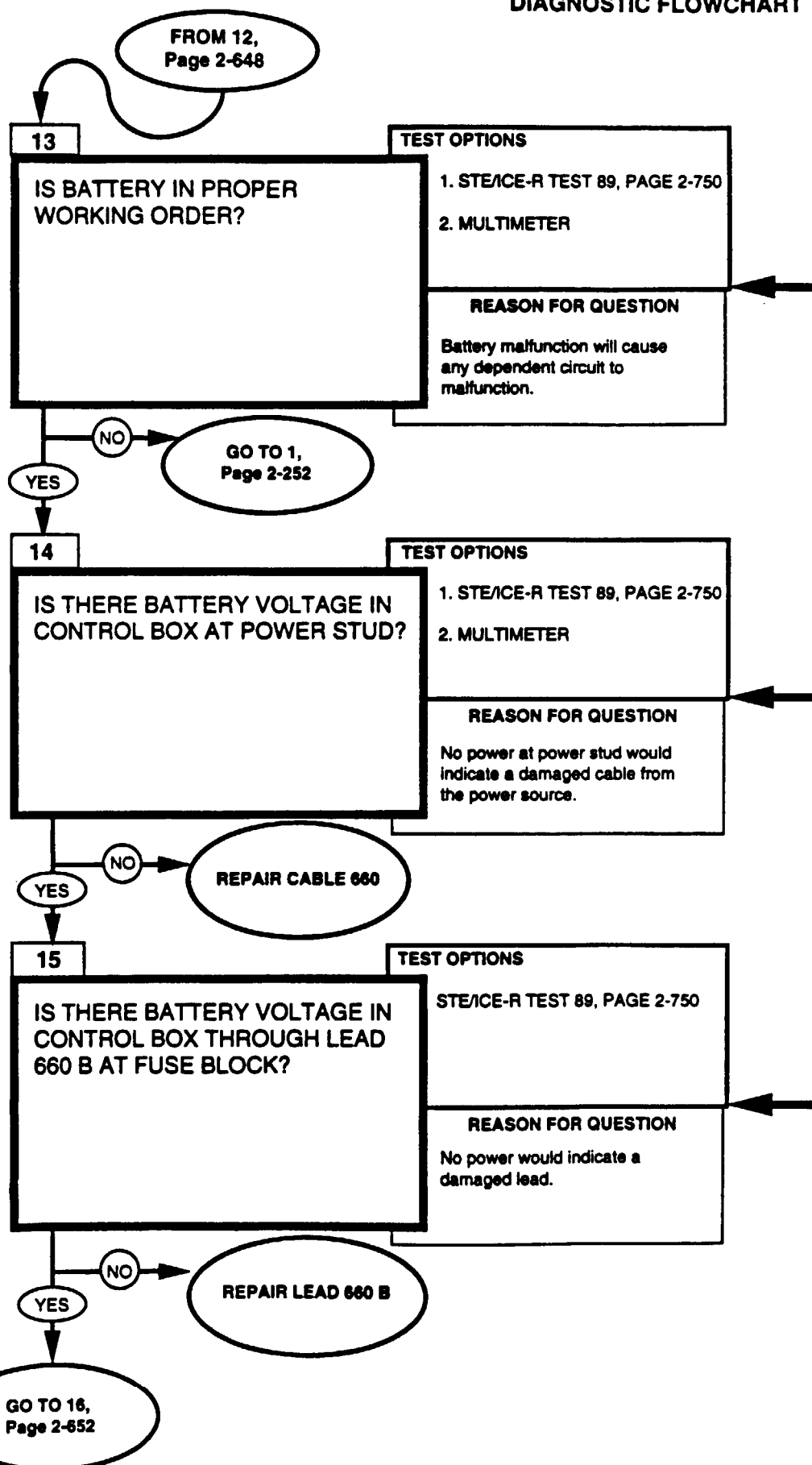
**AMBULANCE**  
(Heater Starting)  
(Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK
POSSIBLE PROBLEMS
FUSE BATTERY CABLE 660 LEAD 660 B LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 660 B LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 660 B LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

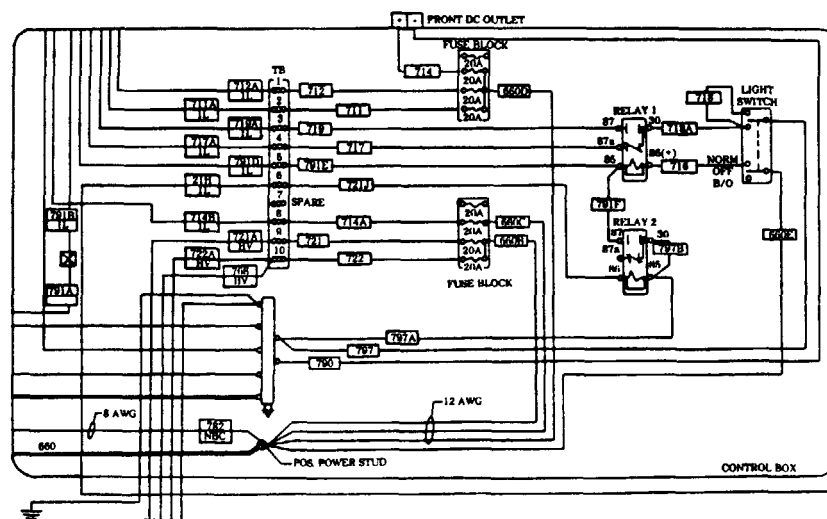


REFERENCE INFORMATION

AMBULANCE

0-45 DC VOLTS STE/CE-R TEST 89
<ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC volts.</li> <li>3. Displayed reading is in volts.</li> </ol>
BATTERY VOLTAGE MULTIMETER
<ol style="list-style-type: none"> <li>1. Set the voltmeter to a DC volts scale of at least 40 volts.</li> <li>2. Connect the RED lead to positive and the BLACK lead to negative.</li> <li>3. Be sure to read the correct scale.</li> </ol>

Repair lead, refer to (para. 4-85).



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

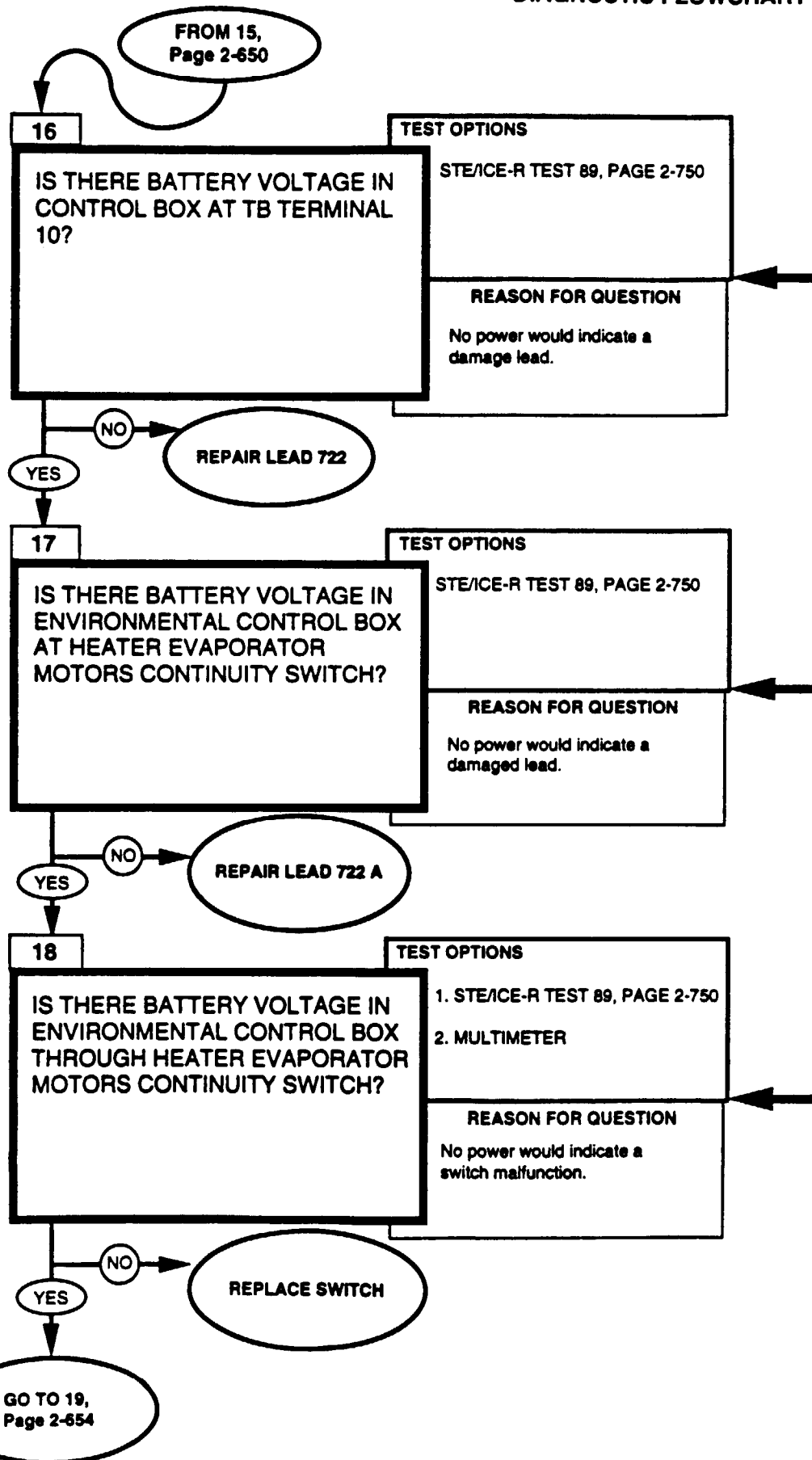
**AMBULANCE**  
**(Heater Starting)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK
POSSIBLE PROBLEMS
LEAD 722 LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

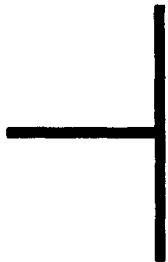
KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK
POSSIBLE PROBLEMS
LEAD 722 A CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK LEAD 722 A OK
POSSIBLE PROBLEMS
CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

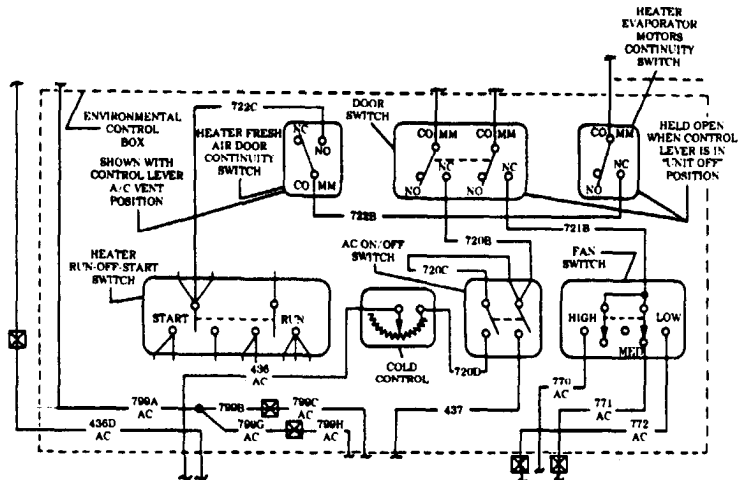


REFERENCE INFORMATION

AMBULANCE



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).



Replace Heater Evaporator  
Motors continuity switch,  
refer to DS Maintenance.

**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

**BATTERY VOLTAGE  
MULTIMETER**

1. Set the voltmeter to volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.

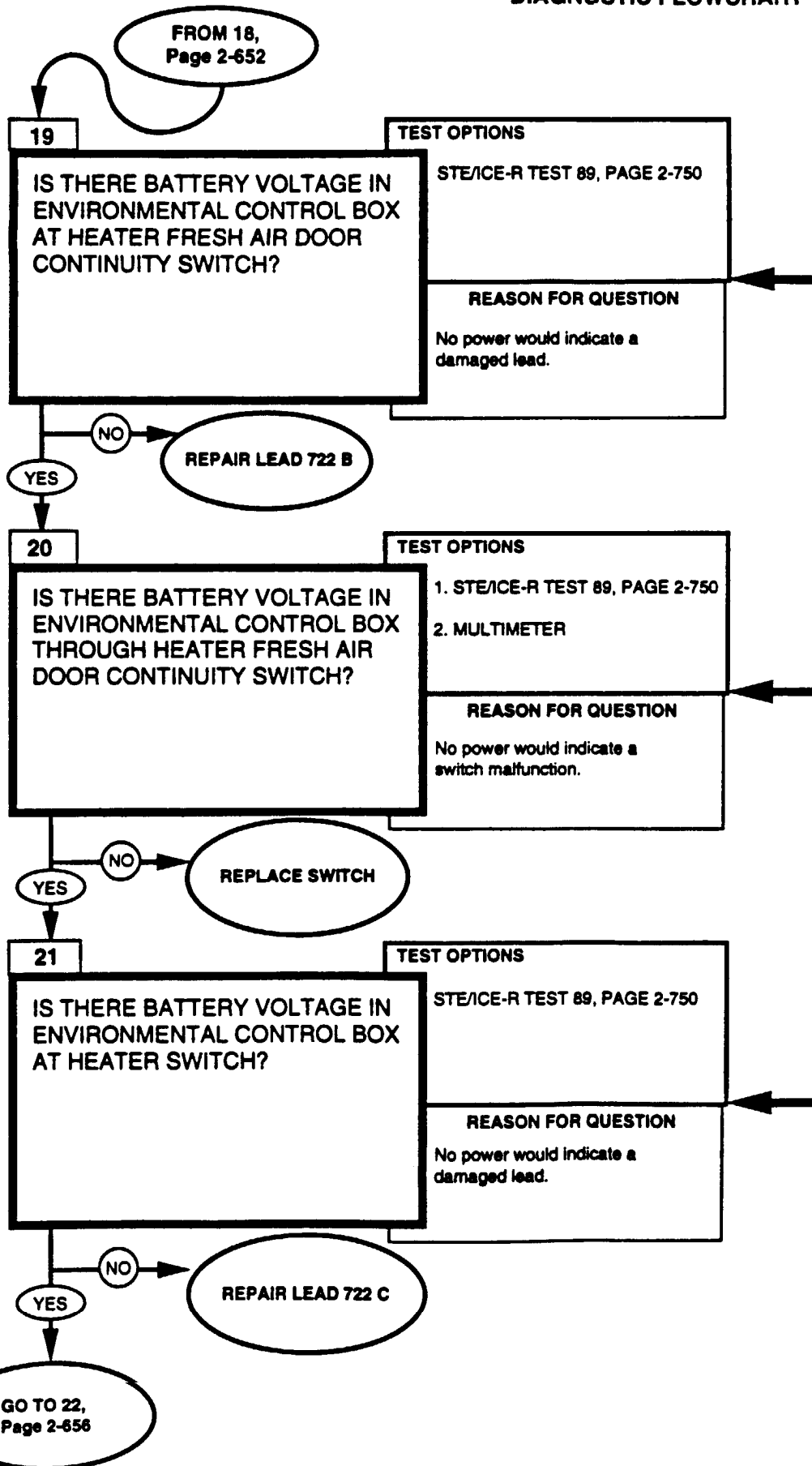
**AMBULANCE**  
**(Heater Starting)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

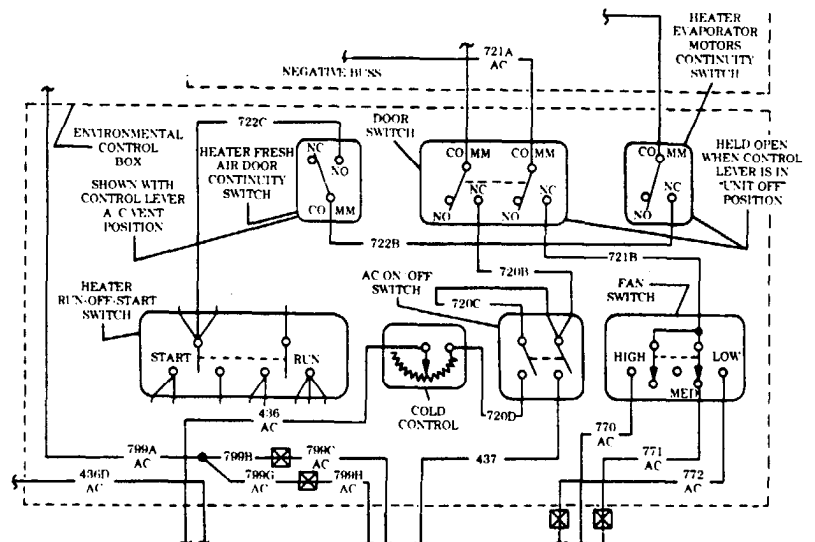
KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B LEAD 722 OK LEAD 722 A OK
POSSIBLE PROBLEMS
CONTINUITY SWITCHES LEAD 722 B LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK LEAD 722 A OK LEAD 722 B OK
POSSIBLE PROBLEMS
LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK LEAD 722 A OK CONTINUITY SWITCHES OK LEAD 722 B OK
POSSIBLE PROBLEMS
LEAD 722 C HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY







**AMBULANCE**  
**(Heater Starting)**  
 (Refer to Figs. 14-16.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 772 OK LEAD 772 A OK CONTINUITY SWITCHES OK LEAD 722 B OK LEAD 722 C OK

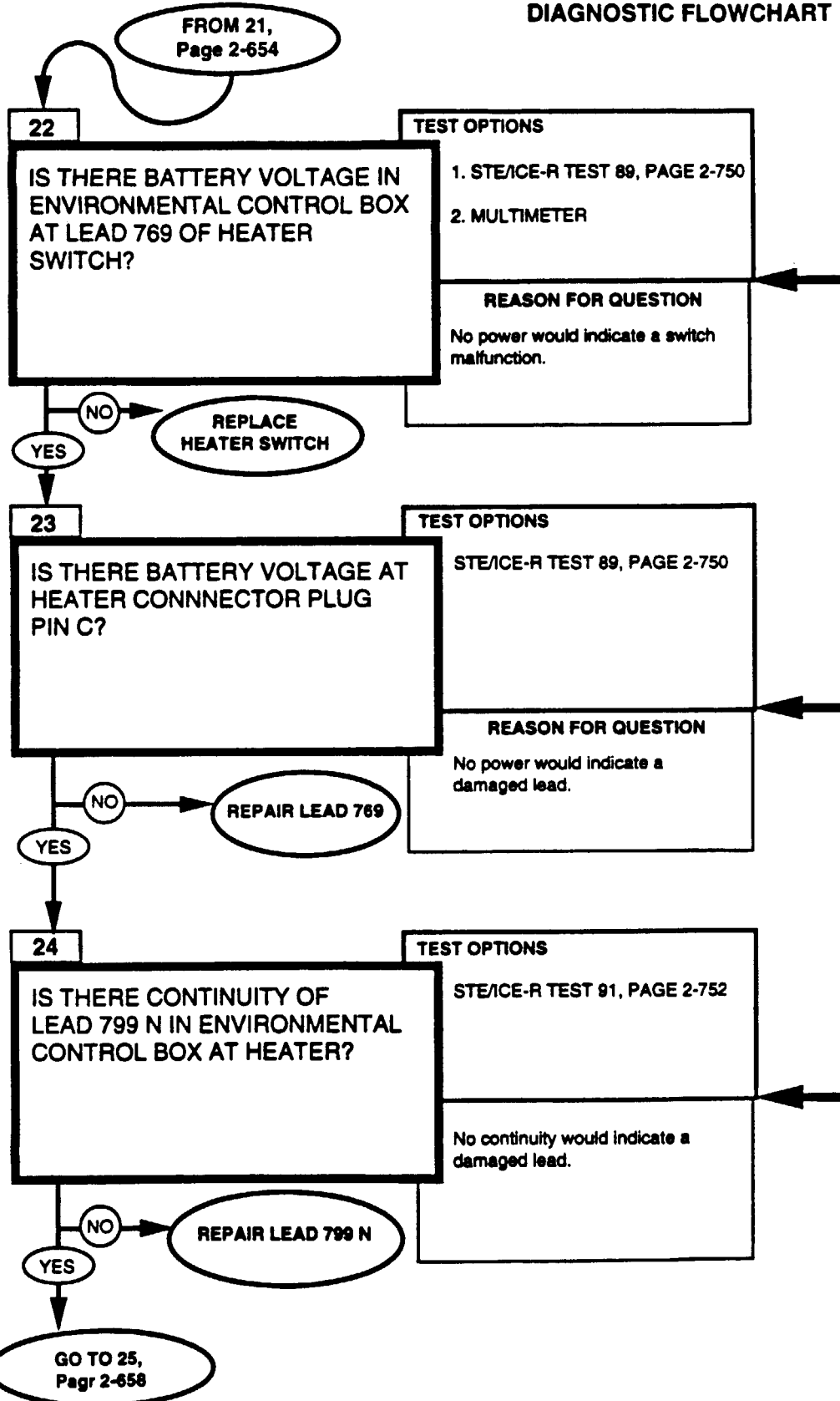
POSSIBLE PROBLEMS
HEATER SWITCH LEAD 769 LEAD 799 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 772 OK LEAD 772 A OK CONTINUITY SWITCHES OK LEAD 722 B OK LEAD 722 C OK HEATER SWITCH OK

POSSIBLE PROBLEMS
LEAD 769 LEAD 769 N HEATER ASSEMBLY

KNOWN INFO
HEAT LEVER POSITION OK CONTROL LEVER POSITION OK FUSE OK BATTERY OK CABLE 660 OK LEAD 660 B OK LEAD 722 OK CONTINUITY SWITCHES OK LEAD 722 B OK LEAD 722 C OK HEATER SWITCH OK LEAD 769 OK

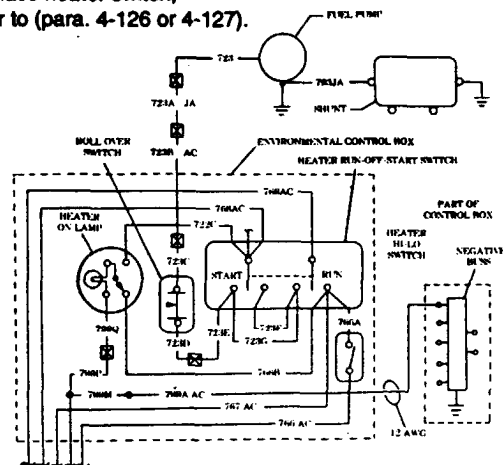
POSSIBLE PROBLEMS
LEAD 799 N HEATER ASSEMBLY



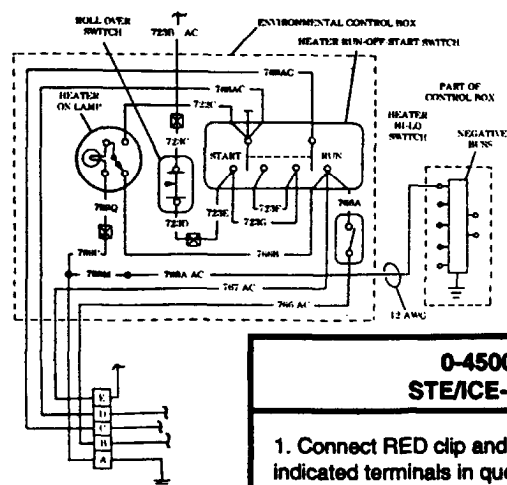
## REFERENCE INFORMATION

## AMBULANCE

**Replace heater switch, refer to (para. 4-126 or 4-127).**



**Repair lead, refer to (para. 4-85).**  
**Repair lead connector, refer to (para. 4-85).**



Repair lead, refer to (para. 4-85).  
Repair lead connector, refer to (para. 4-85).

0-45 DC VOLTS  
STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

## BATTERY VOLTAGE MULTIMETER

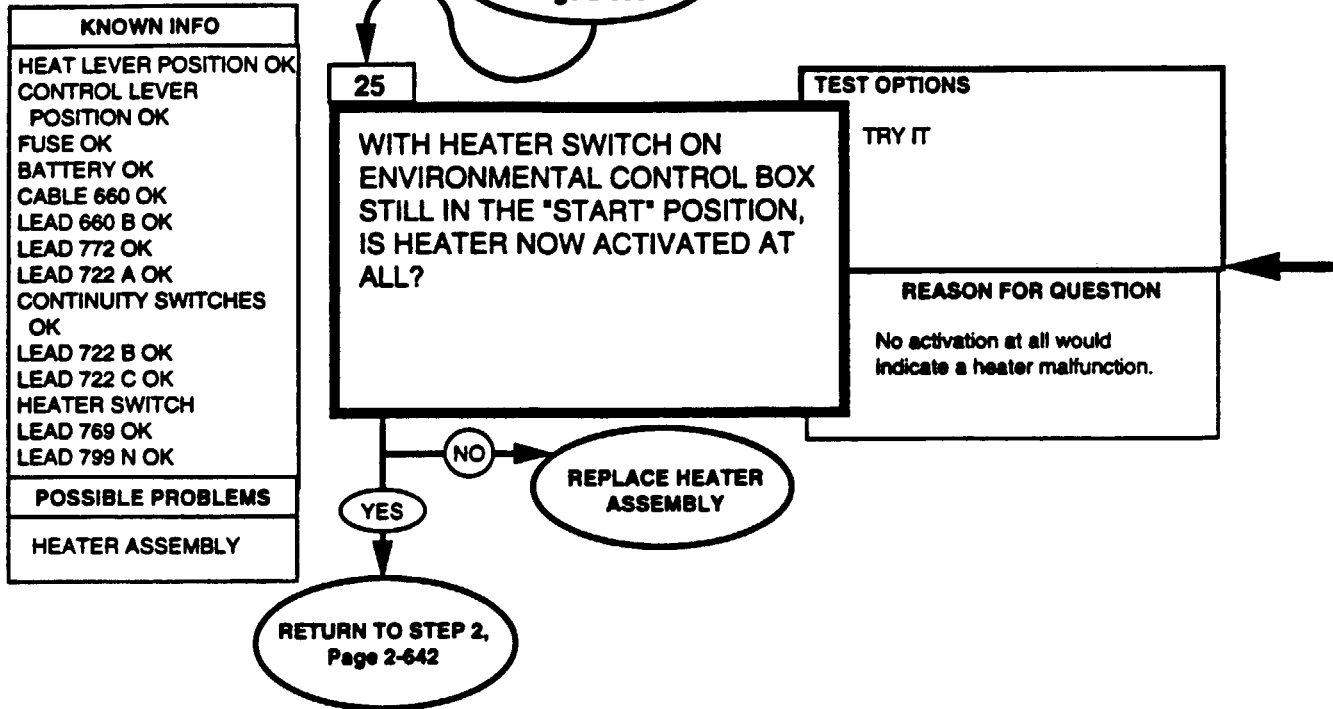
1. Set the voltmeter to volts scale of at least 40 volts.
2. Connect the RED lead to positive and the black lead to negative.
3. Be sure to read the correct scale.

**0-4500 OHMS**  
**STE/ICE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

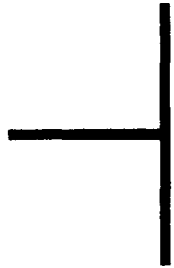
**AMBULANCE**  
**(Heater Starting)**  
**(Refer to Figs. 14-16.)**

**DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

AMBULANCE

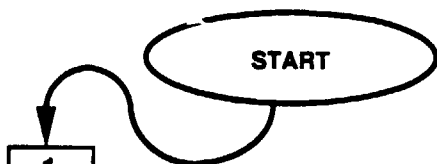


Replace heater assembly,  
refer to (paras.11-190 or 11-209).

**AMBULANCE**  
**(NBC Filter Blower)**  
 (Refer to Fig. 17.)

**DIAGNOSTIC FLOWCHART**

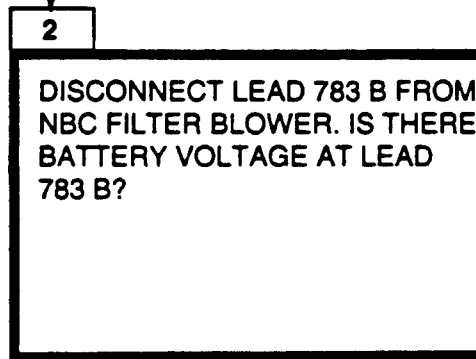
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
NBC SWITCH POSITION DAMAGED LEADS/ COMPONENTS NBC FILTER BLOWER



TEST OPTIONS
VISUAL
REASON FOR QUESTION
If switch is open, no power is supplied to NBC filter blower.



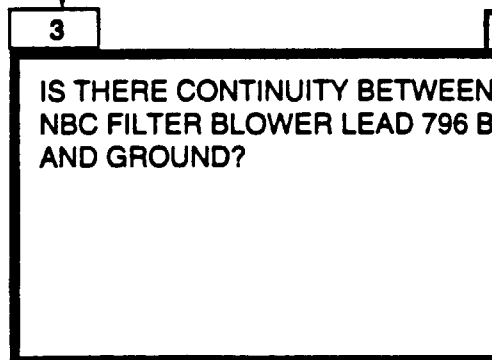
KNOWN INFO
NBC SWITCH POSITION OK
POSSIBLE PROBLEMS
DAMAGED LEADS/ COMPONENTS NBC FILTER BLOWER



TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750
REASON FOR QUESTION
No power would indicate damaged leads and/or components.



KNOWN INFO
NBC SWITCH POSITION OK
POSSIBLE PROBLEMS
DAMAGED LEADS/ COMPONENTS NBC FILTER BLOWER

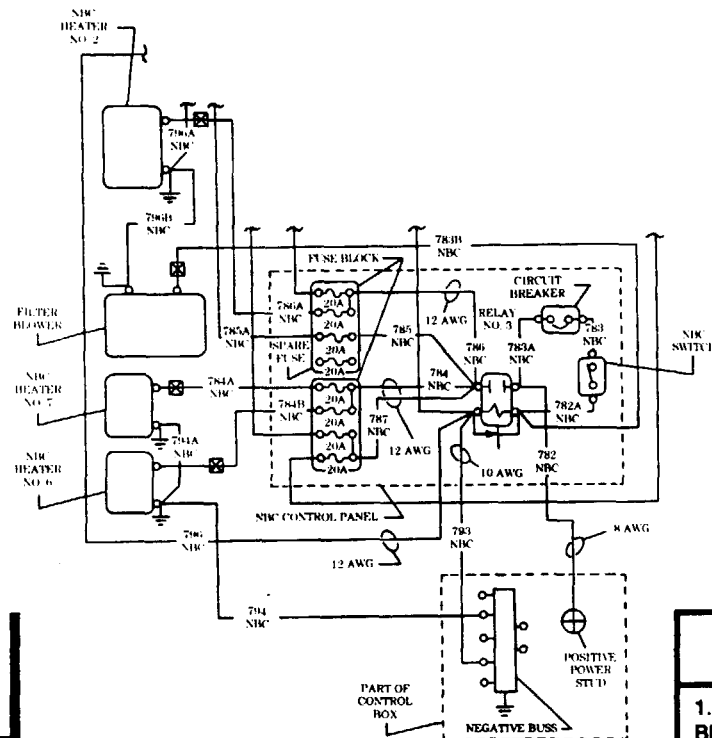


TEST OPTIONS
STE/ICE-R TEST 91, PAGE 2-752
REASON FOR QUESTION
No continuity would indicate damaged leads and/or components.



## REFERENCE INFORMATION

## AMBULANCE


**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Replace NBC filter blower,  
refer to DS Maintenance.

**0-4500 OHMS  
STE/CE-R TEST 91**

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/CE displays "9.9.9.9."

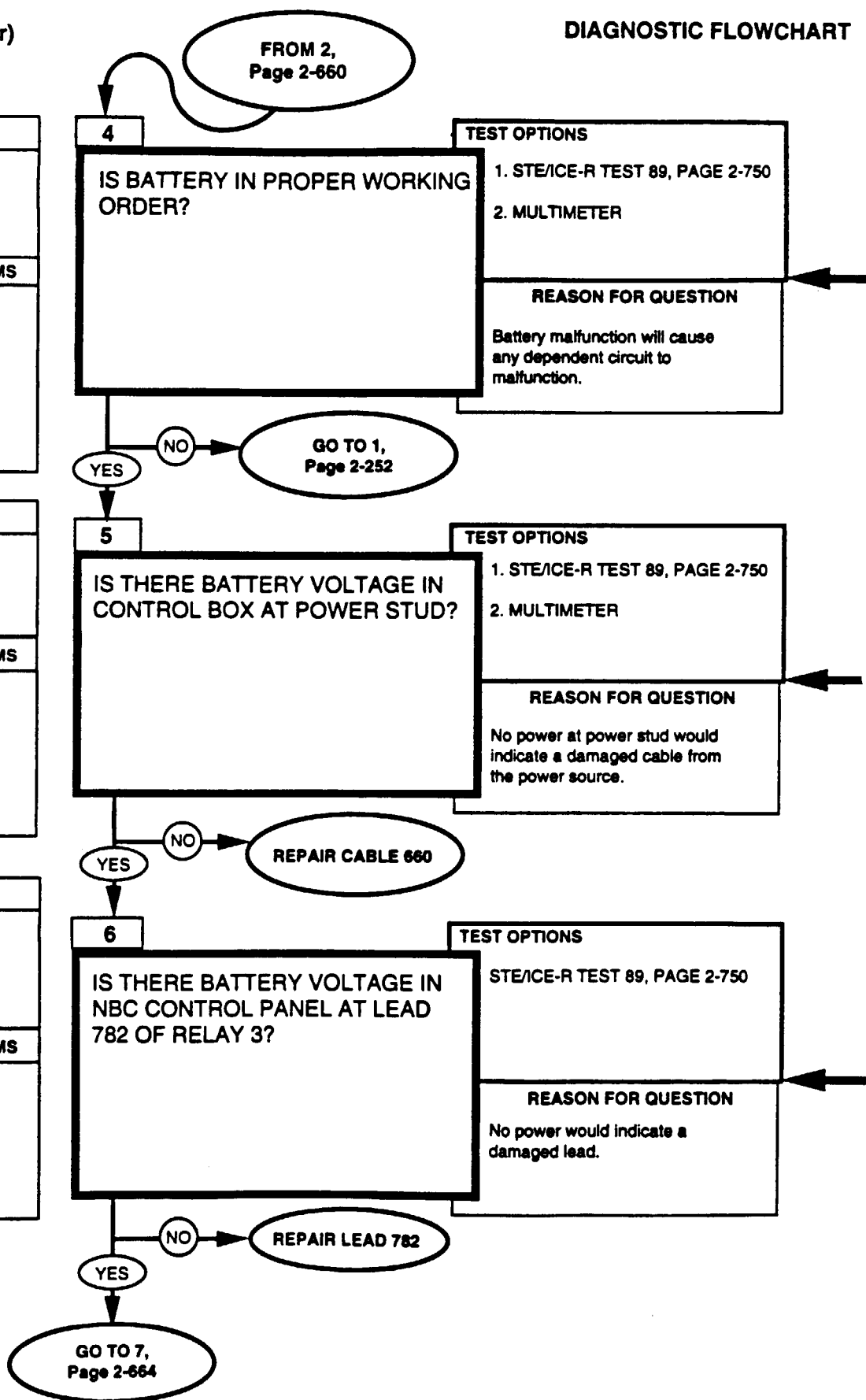
**AMBULANCE**  
**(NBC Filter Blower)**  
 (Refer to Fig. 17.)

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
BATTERY CABLE 660 LEAD 782 LEAD 782 A CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

KNOWN INFO
BATTERY OK
POSSIBLE PROBLEMS
CABLE 660 LEAD 782 LEAD 782 A CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

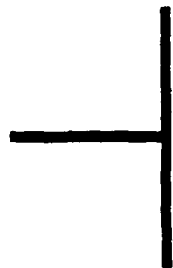
KNOWN INFO
BATTERY OK CABLE 660 OK
POSSIBLE PROBLEMS
LEAD 782 LEAD 782 A CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B





REFERENCE INFORMATION

AMBULANCE

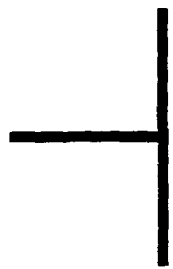


0-45 DC VOLTS  
STE/CE-R TEST 89

1. Connect RED clip to the indicated test point,  
BLACK clip to negative or ground.

2. Start Test 89, DC volts.

3. Displayed reading is in volts.



Repair lead, refer to (para. 4-85).

BATTERY VOLTAGE  
MULTIMETER

1. Set the voltmeter to a DC volts scale of at  
least 40 volts.

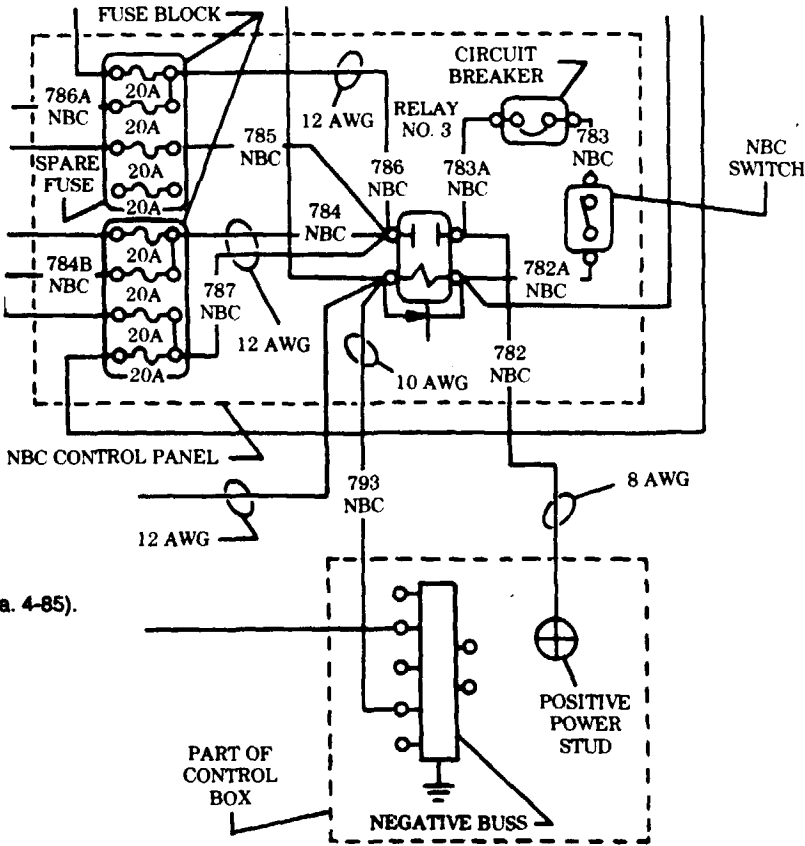
2. Connect the RED lead to positive and the  
BLACK lead to negative.

3. Be sure to read the correct scale.



Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).



**AMBULANCE  
(NBC Filter Blower)  
(Refer to Fig. 17.)**

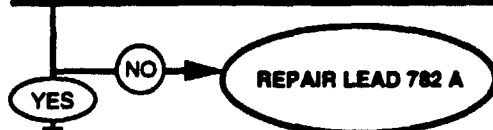
**DIAGNOSTIC FLOWCHART**

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK
POSSIBLE PROBLEMS
LEAD 782 A CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B



IS THERE BATTERY VOLTAGE IN  
NBC CONTROL PANEL AT  
CIRCUIT BREAKER?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750
REASON FOR QUESTION
No power would indicate a damaged lead.

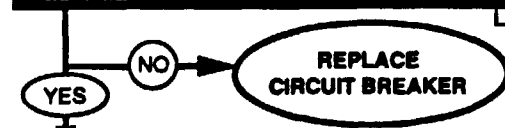


KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK
POSSIBLE PROBLEMS
CIRCUIT BREAKER LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

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IS THERE BATTERY VOLTAGE IN  
NBC CONTROL PANEL THROUGH  
CIRCUIT BREAKER?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750
REASON FOR QUESTION
No power would indicate a damaged circuit breaker.

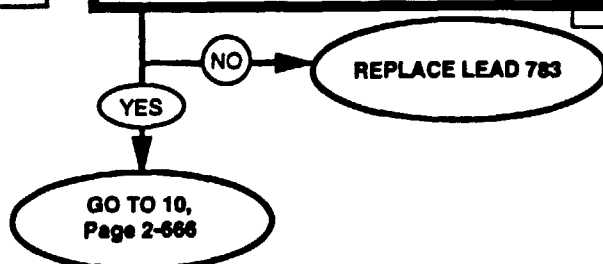


KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK
POSSIBLE PROBLEMS
LEAD 783 NBC SWITCH LEAD 783 A LEAD 783 B

9

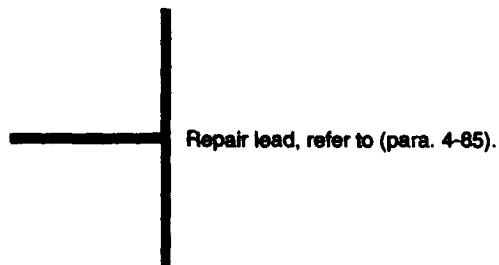
IS THERE BATTERY VOLTAGE IN  
NBC CONTROL PANEL AT NBC  
SWITCH?

TEST OPTIONS
STE/ICE-R TEST 89, PAGE 2-750
REASON FOR QUESTION
No power would indicate a damaged lead.

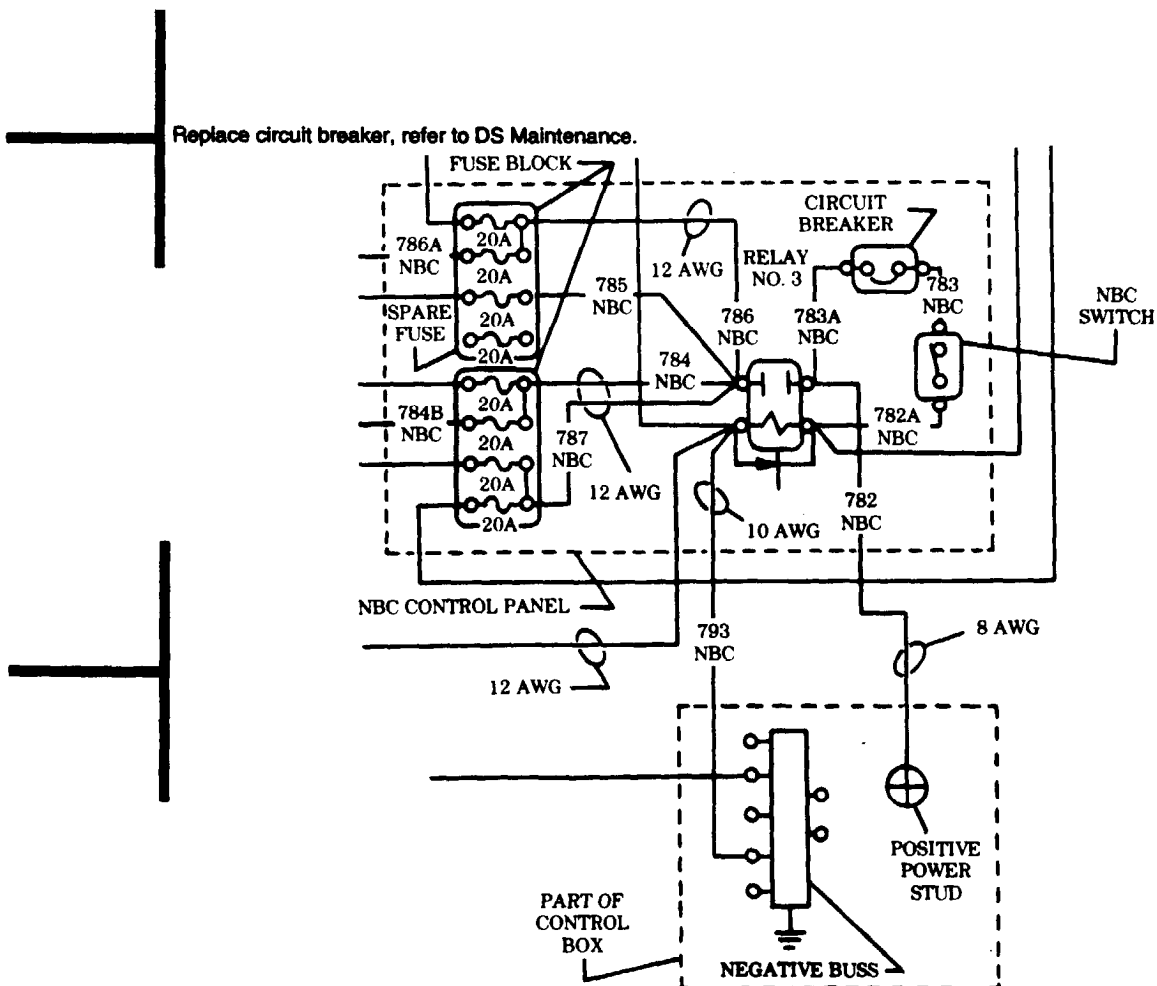


REFERENCE INFORMATION

AMBULANCE



0-45 DC VOLTS STE/CE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



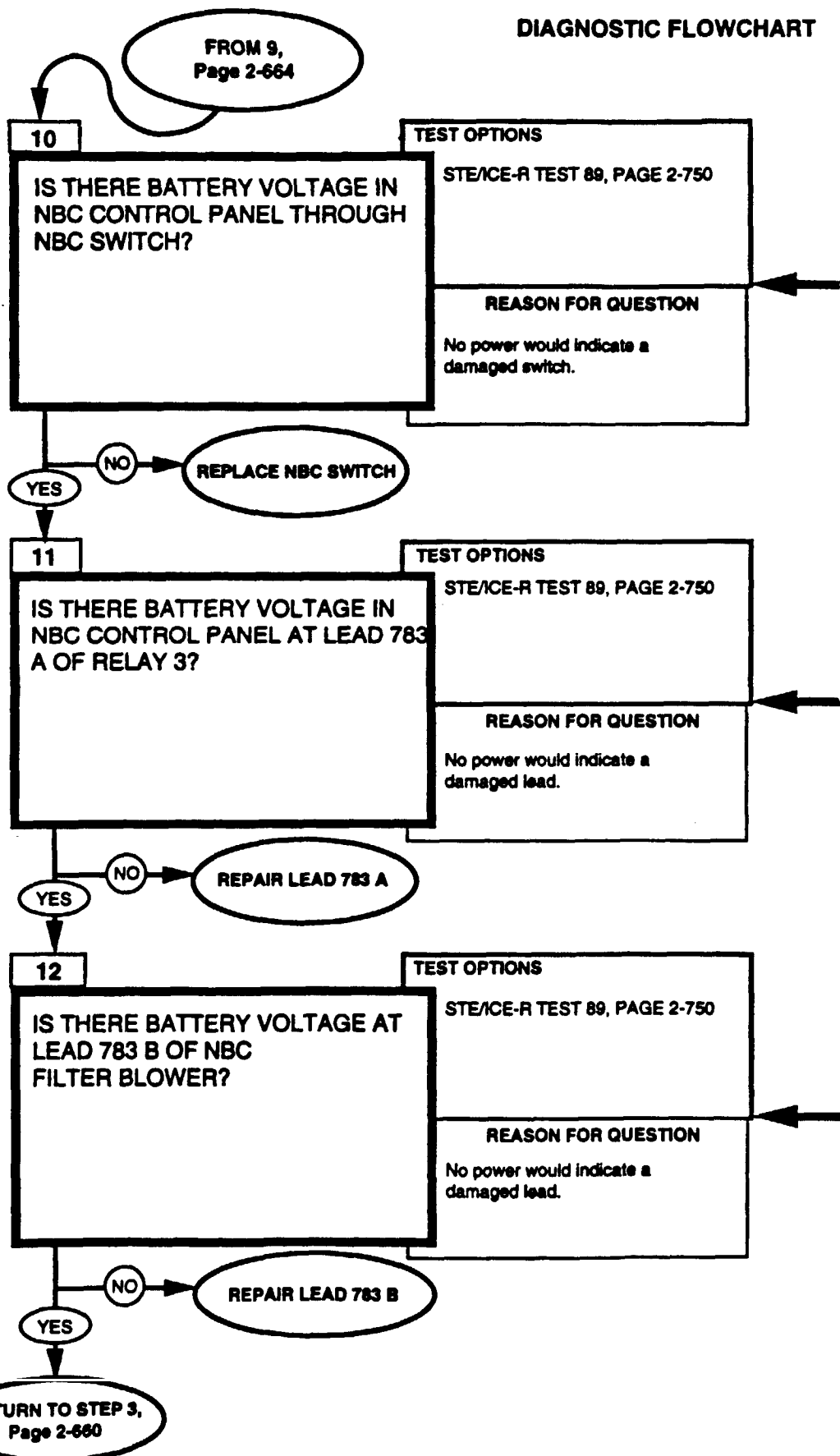
**AMBULANCE  
(NBC Filter Blower)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK LEAD 783 OK
POSSIBLE PROBLEMS
NBC SWITCH LEAD 783 A LEAD 783 B

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK LEAD 783 OK NBC SWITCH OK
POSSIBLE PROBLEMS
LEAD 783 A LEAD 783 B

KNOWN INFO
BATTERY OK CABLE 660 OK LEAD 782 OK LEAD 782 A OK CIRCUIT BREAKER OK LEAD 783 OK NBC SWITCH OK LEAD 783 A OK
POSSIBLE PROBLEMS
LEAD 783 B

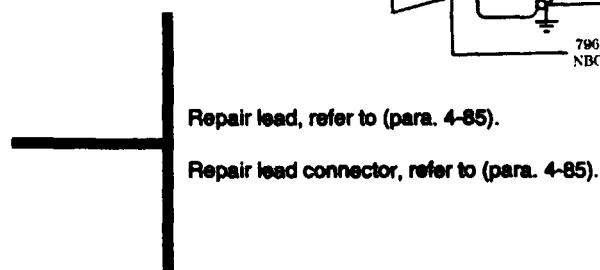
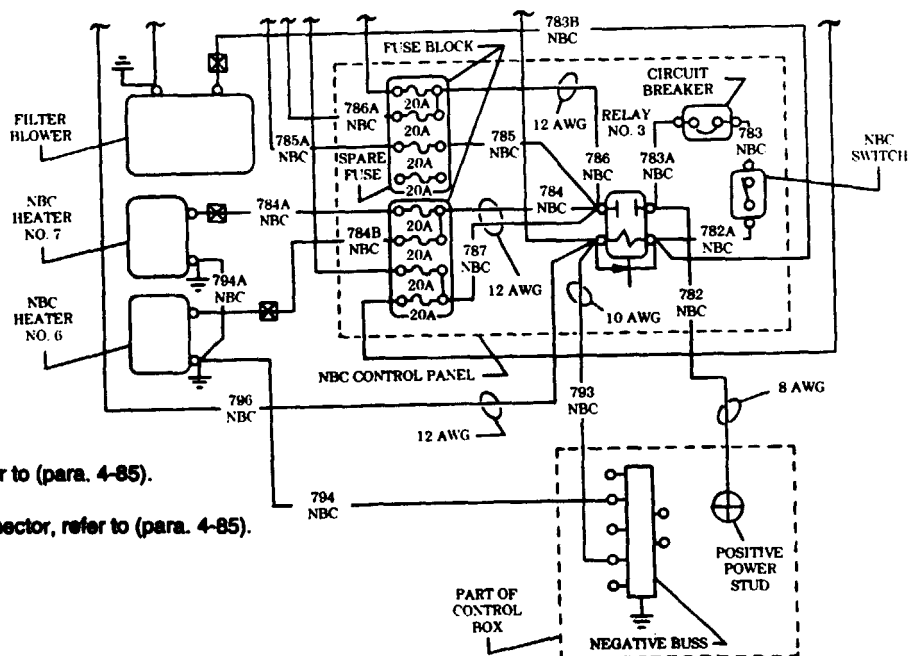
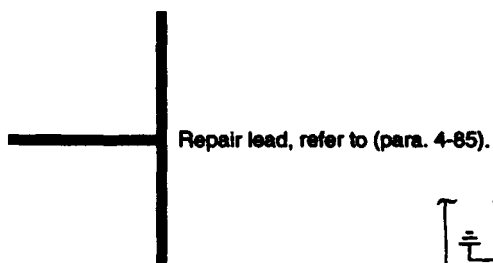


# REFERENCE INFORMATION

# AMBULANCE



0-45 DC VOLTS STE/CE-R TEST 89
1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



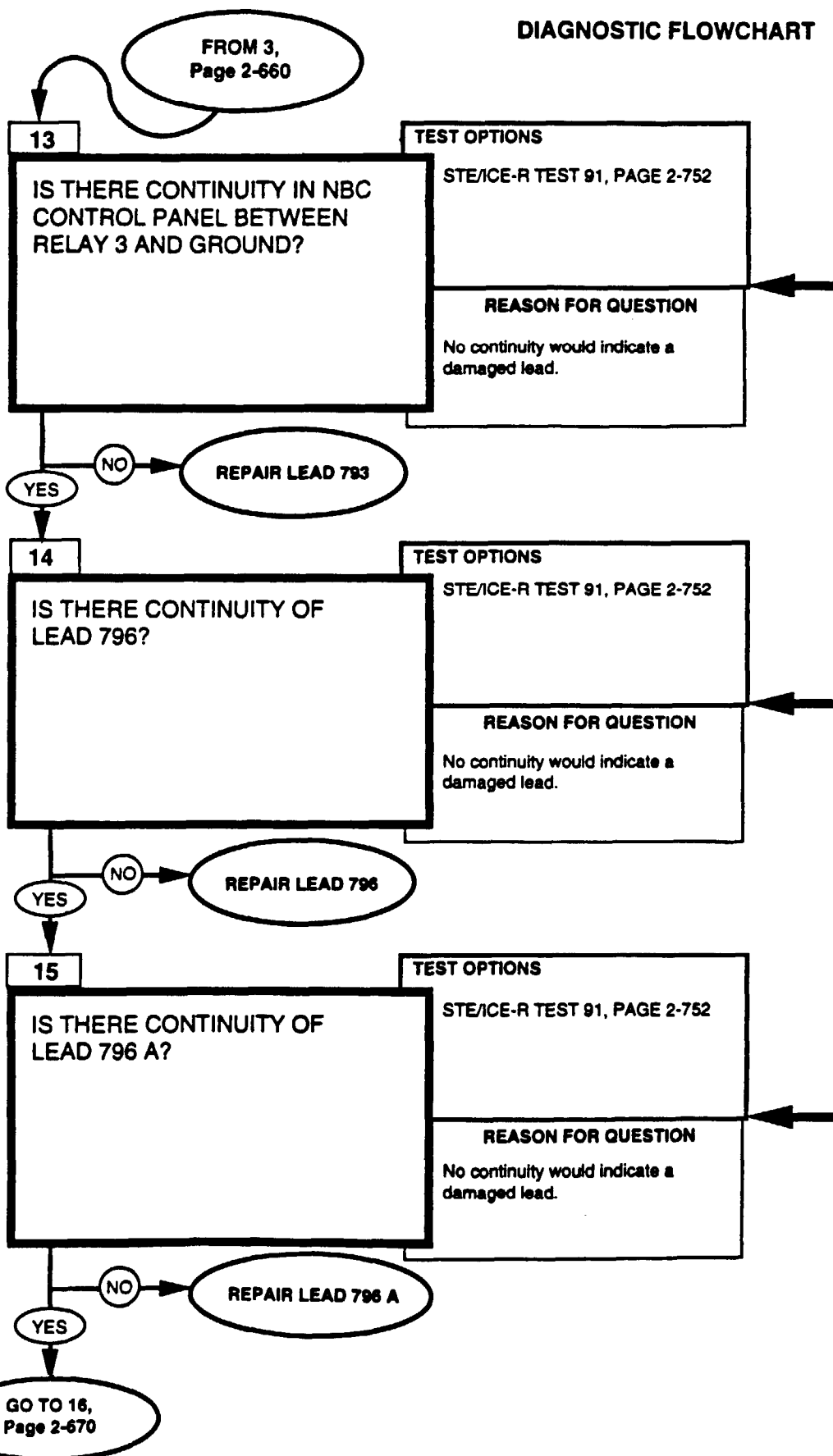
**AMBULANCE  
(NBC Filter Blower)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 793 LEAD 796 LEAD 796 A LEAD 796 B NBC FILTER BLOWER

KNOWN INFO
LEAD 793 OK
POSSIBLE PROBLEMS
LEAD 796 LEAD 796 A LEAD 796 B NBC FILTER BLOWER

KNOWN INFO
LEAD 793 OK LEAD 796 OK
POSSIBLE PROBLEMS
LEAD 796 A LEAD 796 B NBC FILTER BLOWER



REFERENCE INFORMATION

AMBULANCE

Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

**0-4500 OHMS  
STE/ICE-R TEST 91**

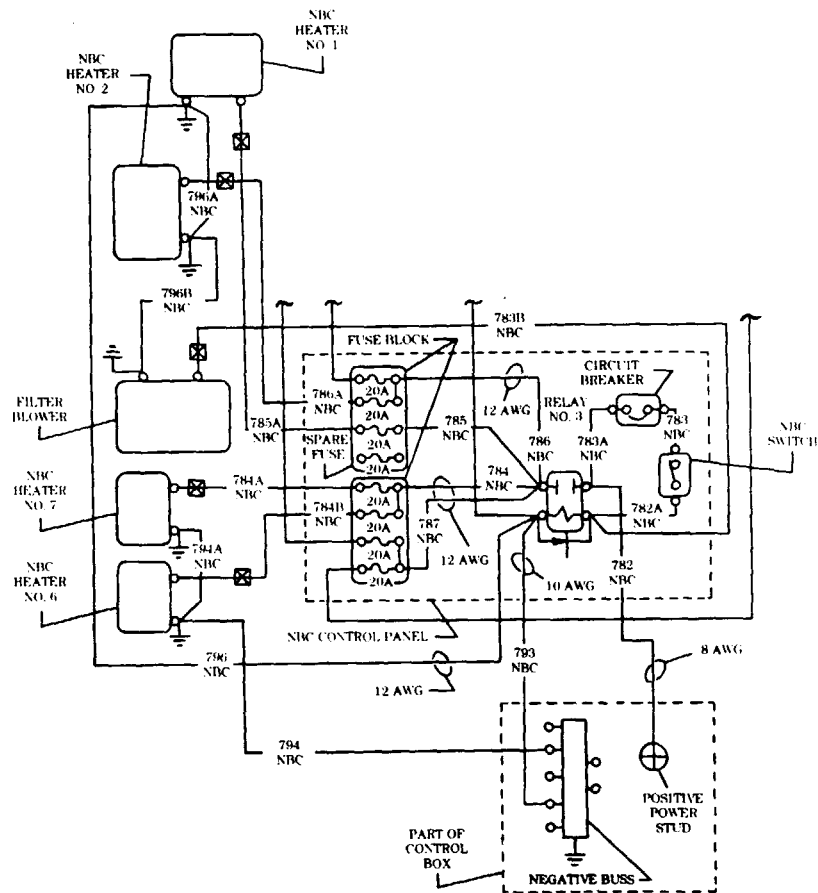
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.

2. Start Test 91, 0-4500 ohms.

3. Displayed reading in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

Repair lead, refer to (para. 4-85).

Repair lead, refer to (para. 4-85).

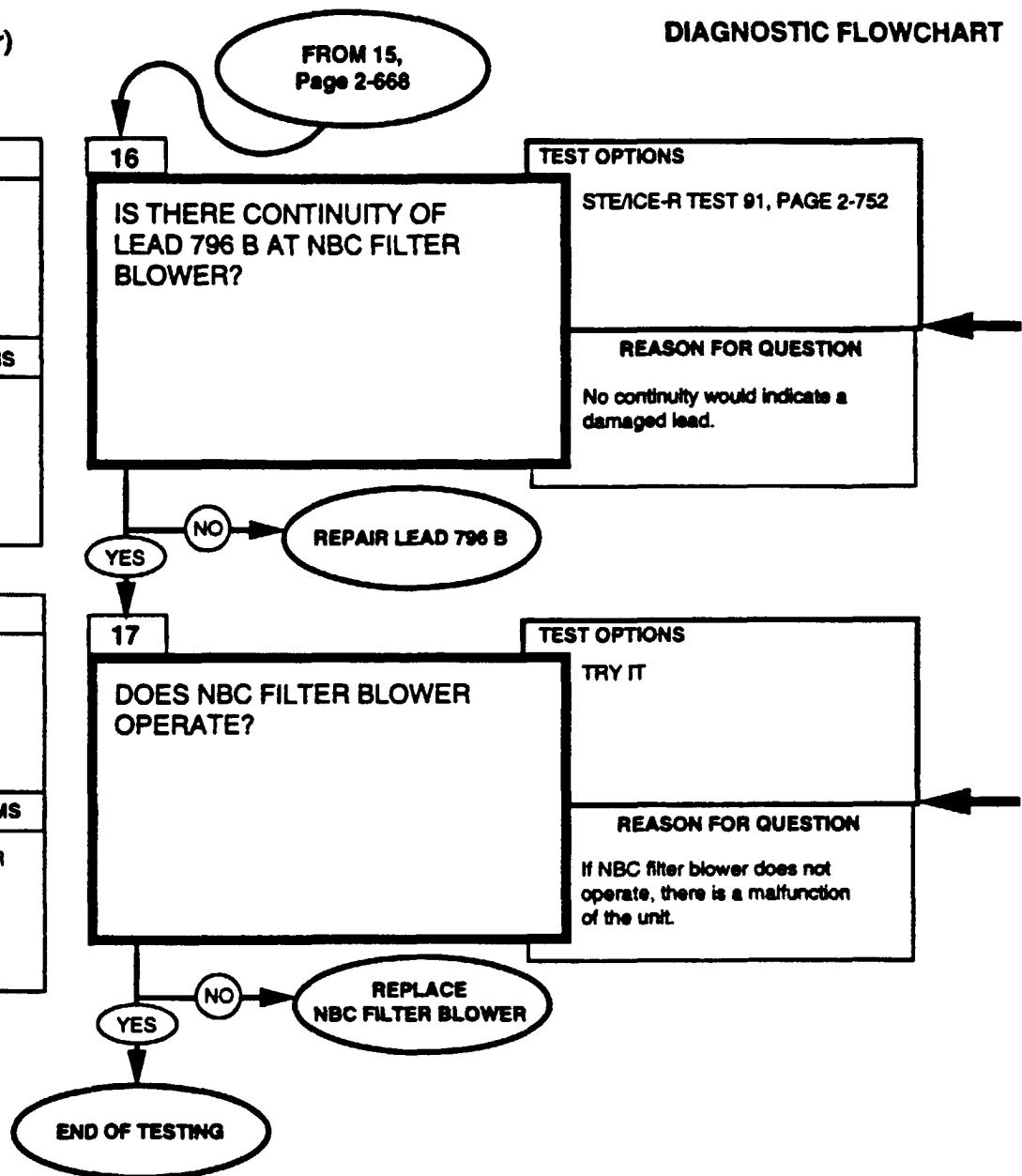


**AMBULANCE  
(NBC Filter Blower)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 793 OK LEAD 796 OK LEAD 796 A OK
POSSIBLE PROBLEMS
LEAD 796 B NBC FILTER BLOWER

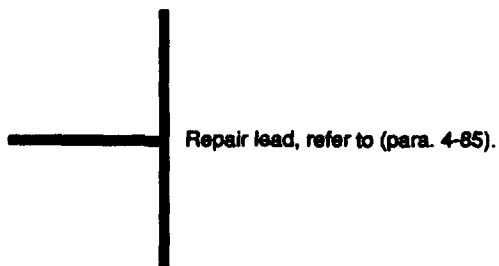
KNOWN INFO
LEAD 793 OK LEAD 796 OK LEAD 796 A OK LEAD 796 B OK
POSSIBLE PROBLEMS
NBC FILTER BLOWER



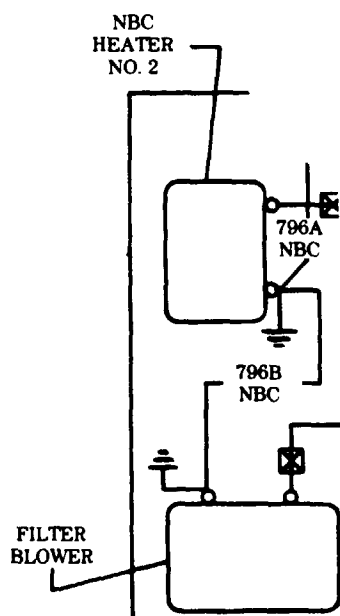
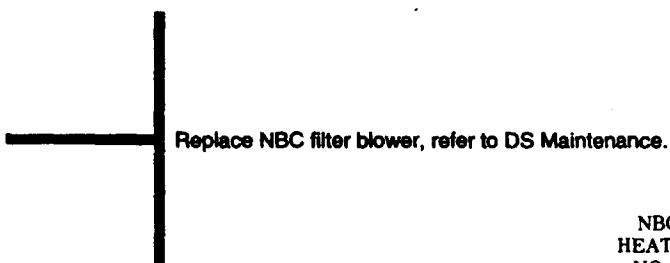


REFERENCE INFORMATION

AMBULANCE



0-4500 OHMS STE/CE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



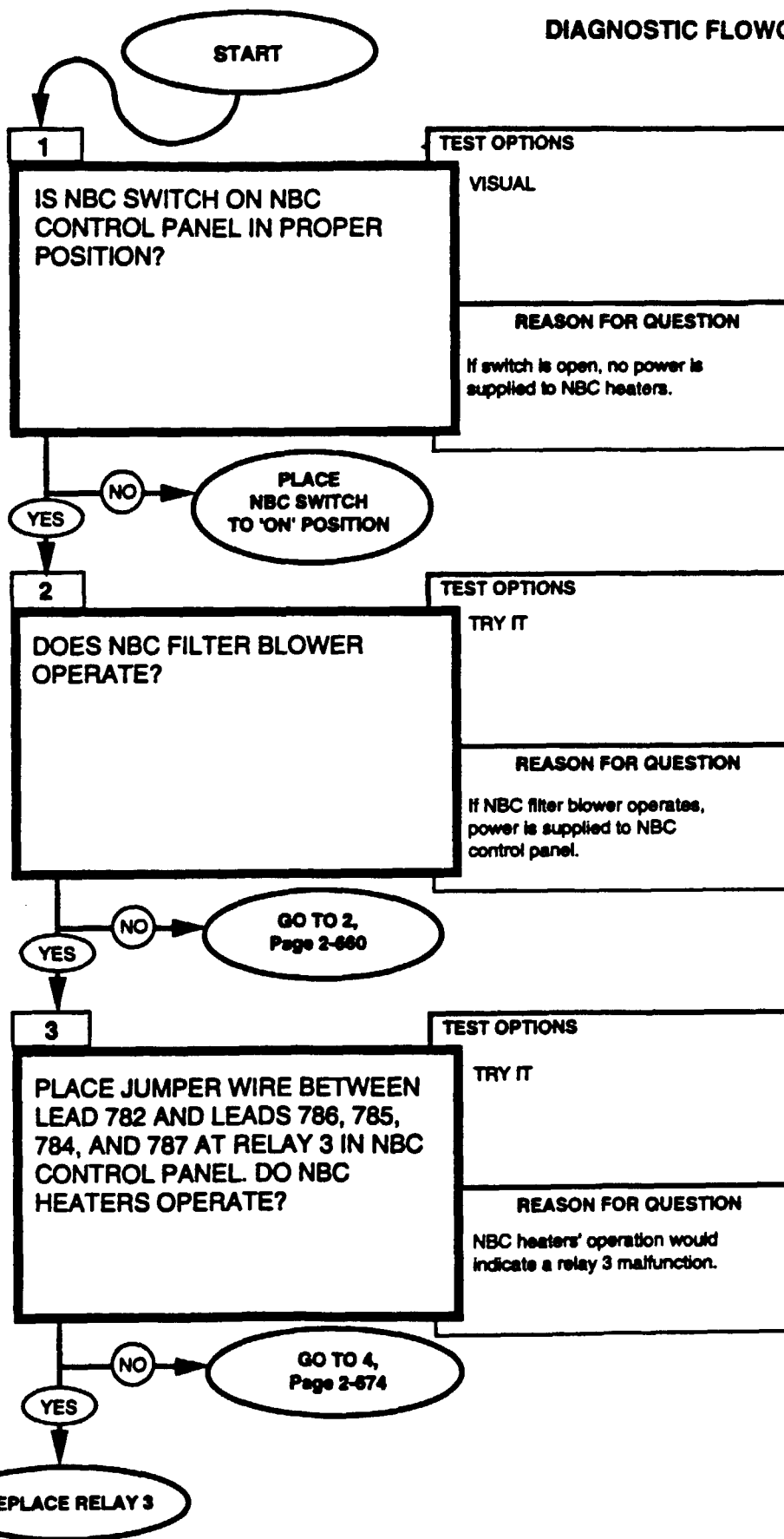
**AMBULANCE  
(NBC Heaters)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

<b>KNOWN INFO</b>
NOTHING
<b>POSSIBLE PROBLEMS</b>
RELAY 3

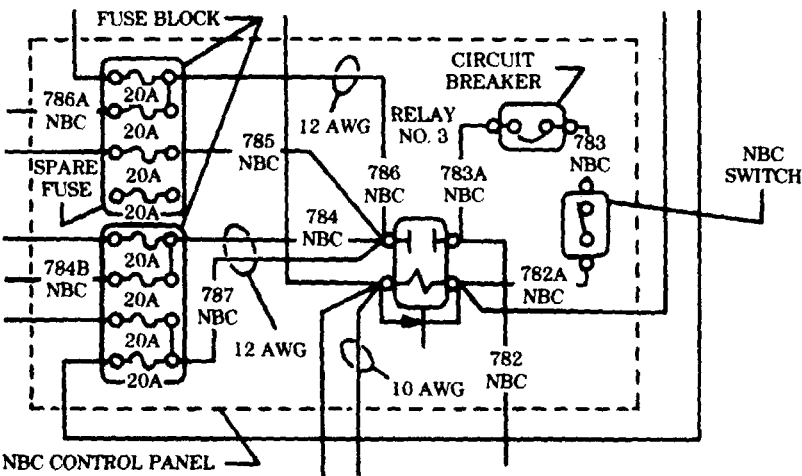
<b>KNOWN INFO</b>
<b>POSSIBLE PROBLEMS</b>
RELAY 3

<b>KNOWN INFO</b>
<b>POSSIBLE PROBLEMS</b>
RELAY 3



REFERENCE INFORMATION

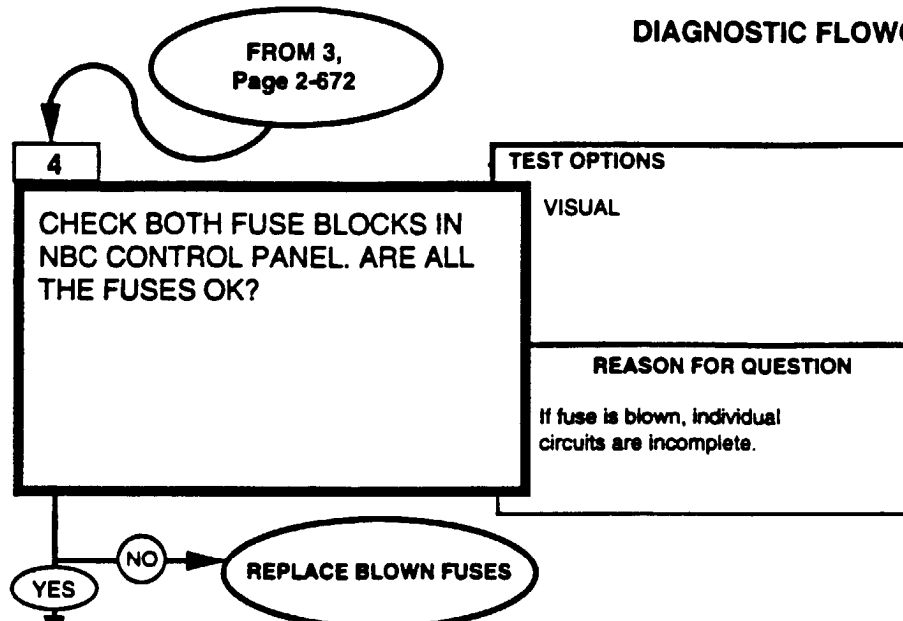
AMBULANCE



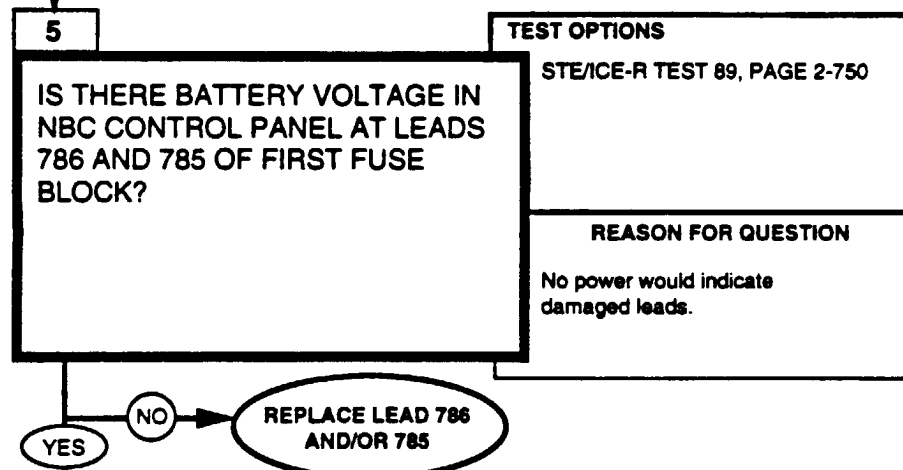
**AMBULANCE  
(NBC Heaters)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

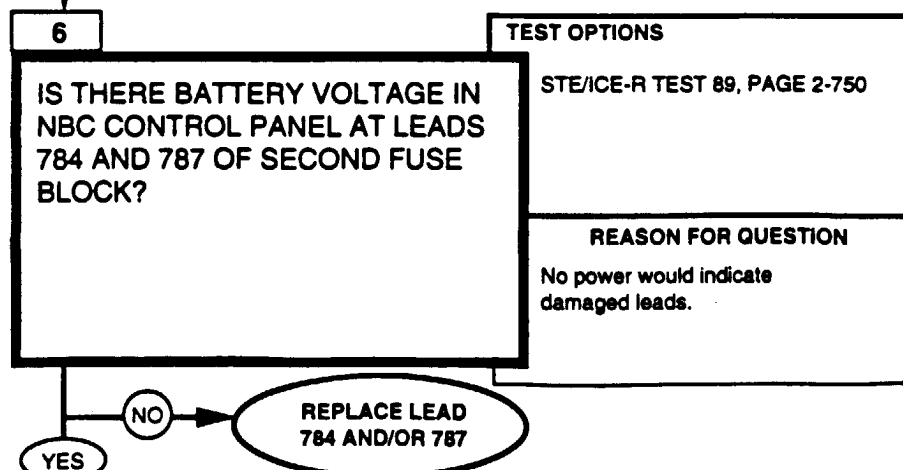
<b>KNOWN INFO</b>
PREVIOUSLY CORRECTED INFORMATION
<b>POSSIBLE PROBLEMS</b>
FUSES LEAD 786 LEAD 785 LEAD 784 LEAD 787 DAMAGED LEADS



<b>KNOWN INFO</b>
FUSES OK
<b>POSSIBLE PROBLEMS</b>
LEAD 786 LEAD 785 LEAD 784 LEAD 787 DAMAGED LEADS



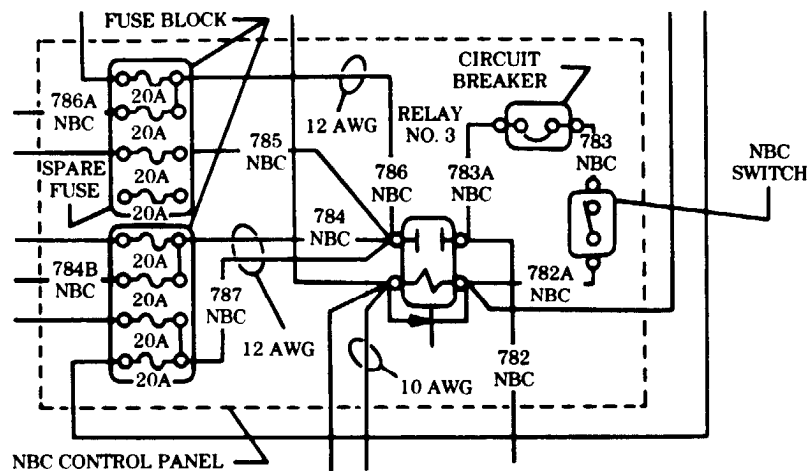
<b>KNOWN INFO</b>
FUSES OK LEAD 786 OK LEAD 785 OK
<b>POSSIBLE PROBLEMS</b>
LEAD 784 LEAD 787 DAMAGED LEADS



**GO TO 7,  
Page 2-676**

## REFERENCE INFORMATION

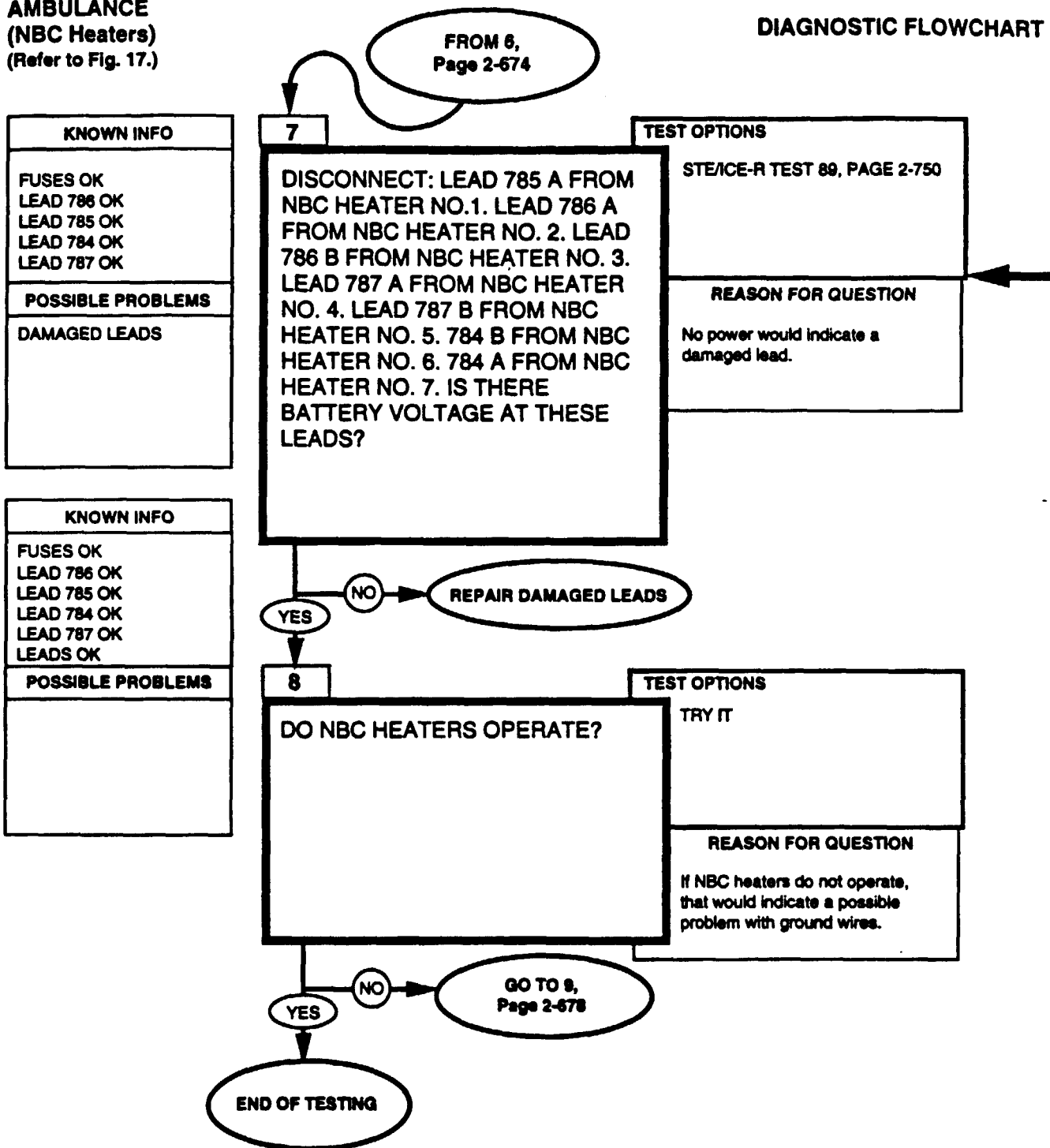
## AMBULANCE


**0-45 DC VOLTS  
STE/CE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

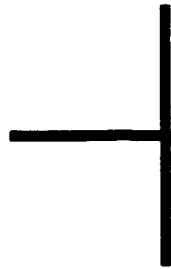
**AMBULANCE  
(NBC Heaters)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

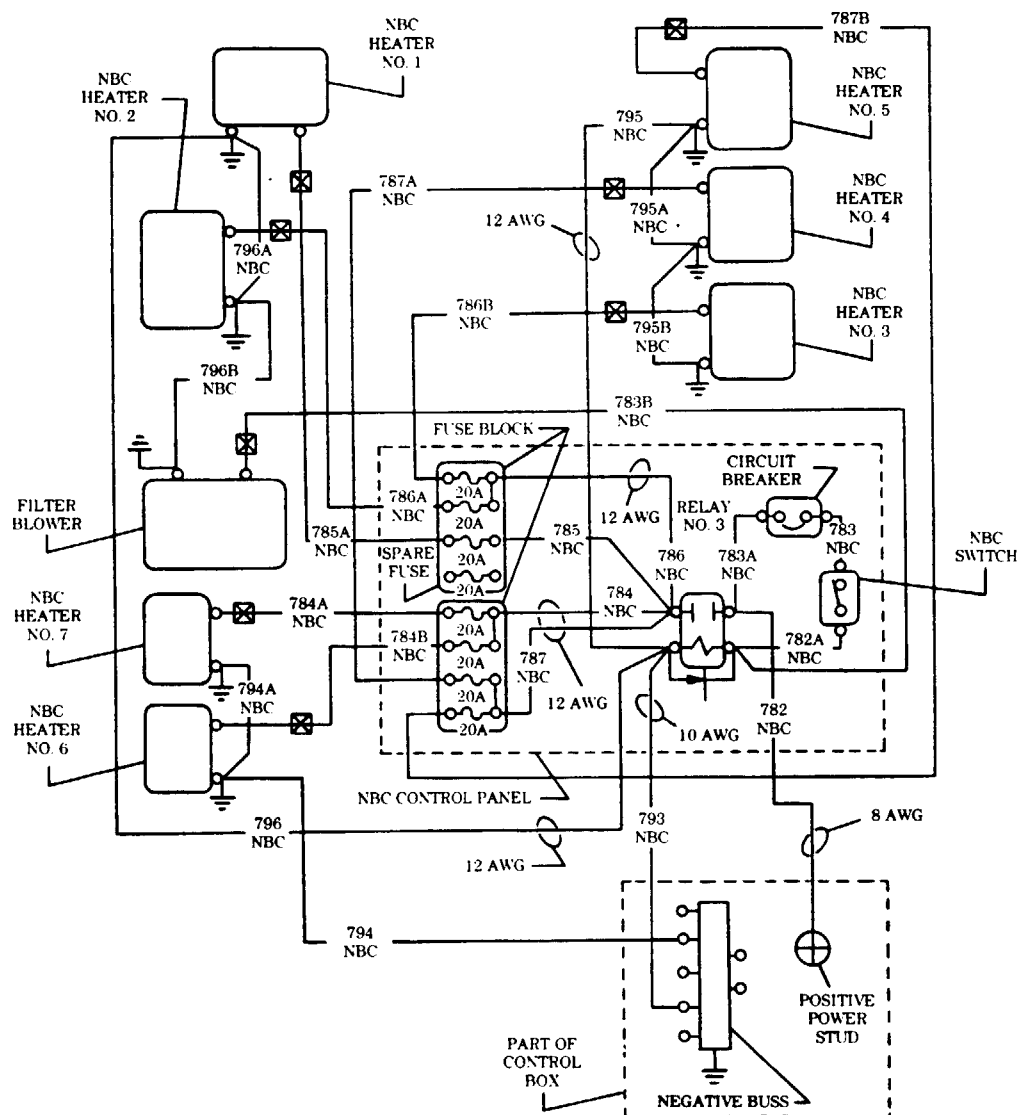


## REFERENCE INFORMATION

## AMBULANCE


**0-45 DC VOLTS  
STE/ICE-R TEST 89**

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.



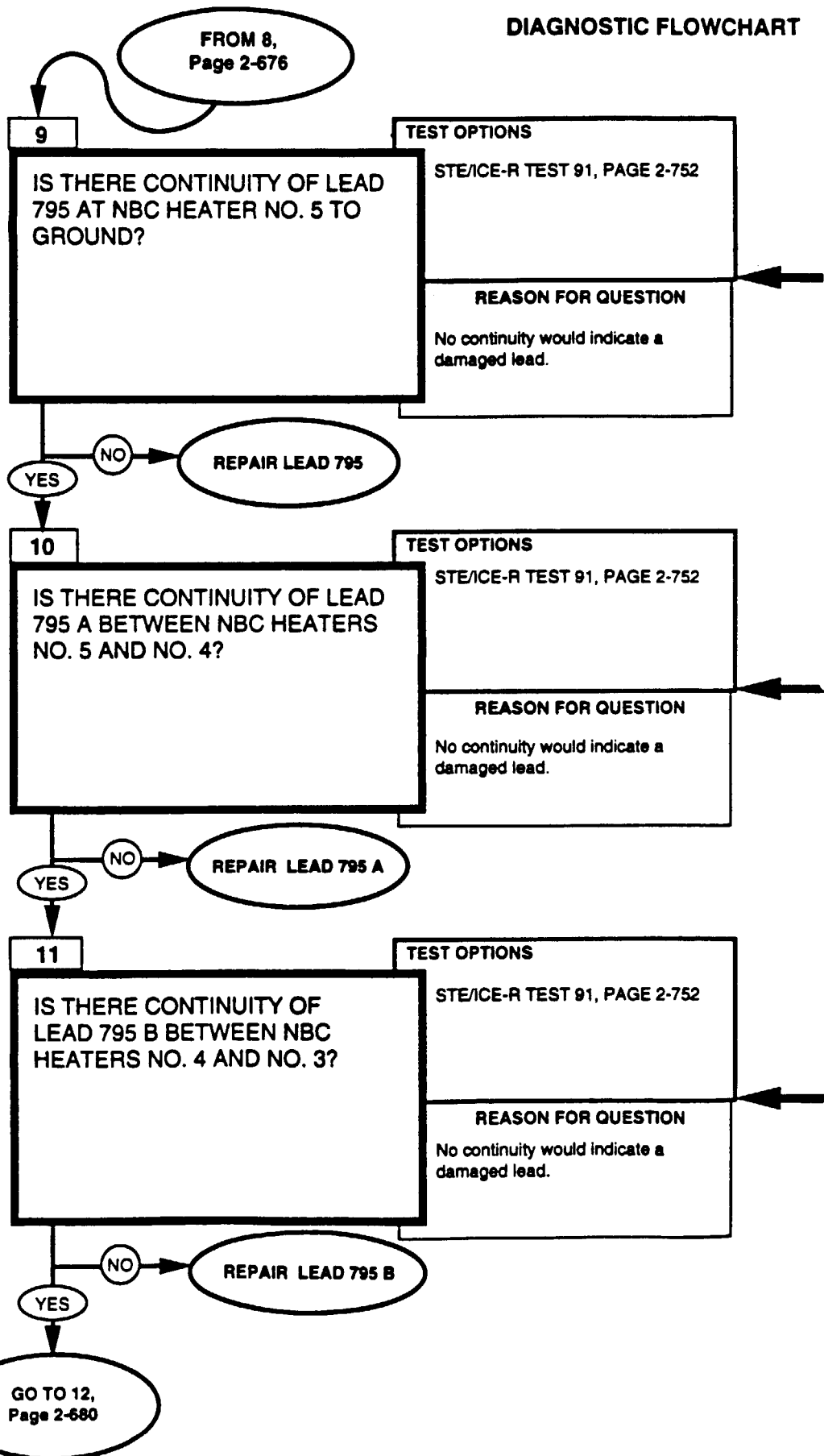
**AMBULANCE  
(NBC Heaters)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
PREVIOUSLY CORRECTED INFORMATION
POSSIBLE PROBLEMS
LEAD 795 LEAD 795 A LEAD 795 B LEAD 794 LEAD 794 A NBC HEATERS

KNOWN INFO
LEAD 795 OK
POSSIBLE PROBLEMS
LEAD 795 A LEAD 795 B LEAD 794 LEAD 794 A NBC HEATERS

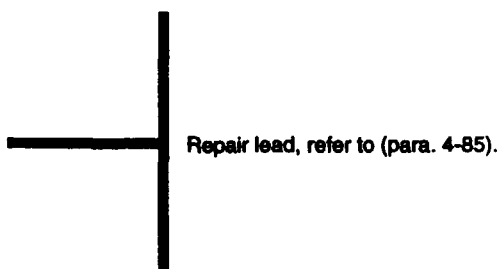
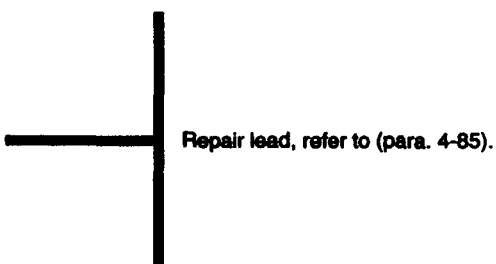
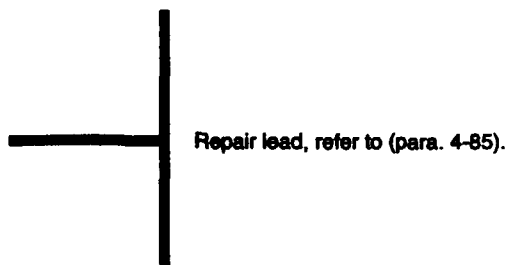
KNOWN INFO
LEAD 795 OK LEAD 795 A OK
POSSIBLE PROBLEMS
LEAD 795 B LEAD 794 LEAD 794 A NBC HEATERS



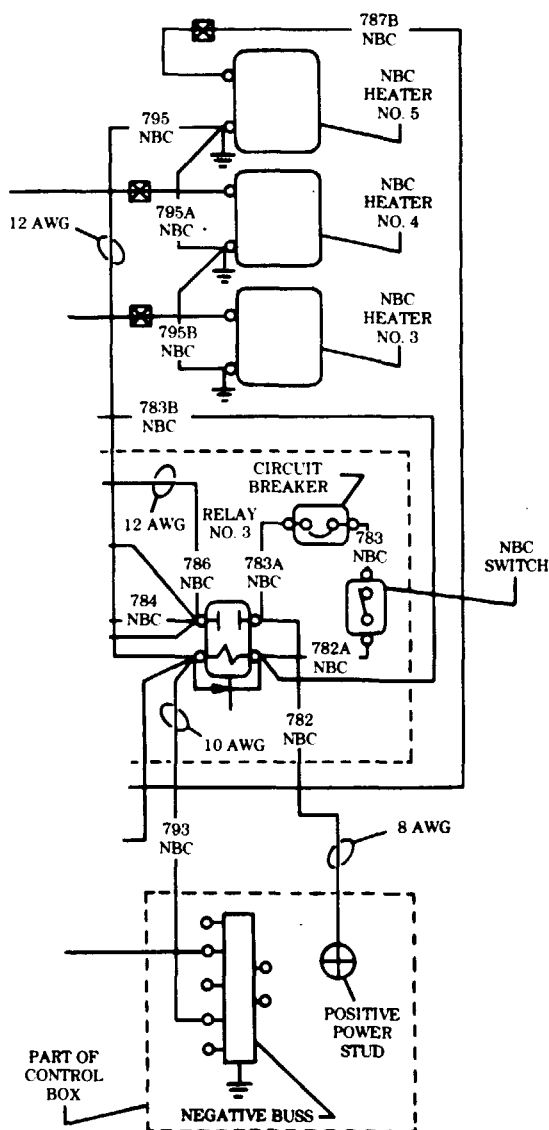


## REFERENCE INFORMATION

## AMBULANCE



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



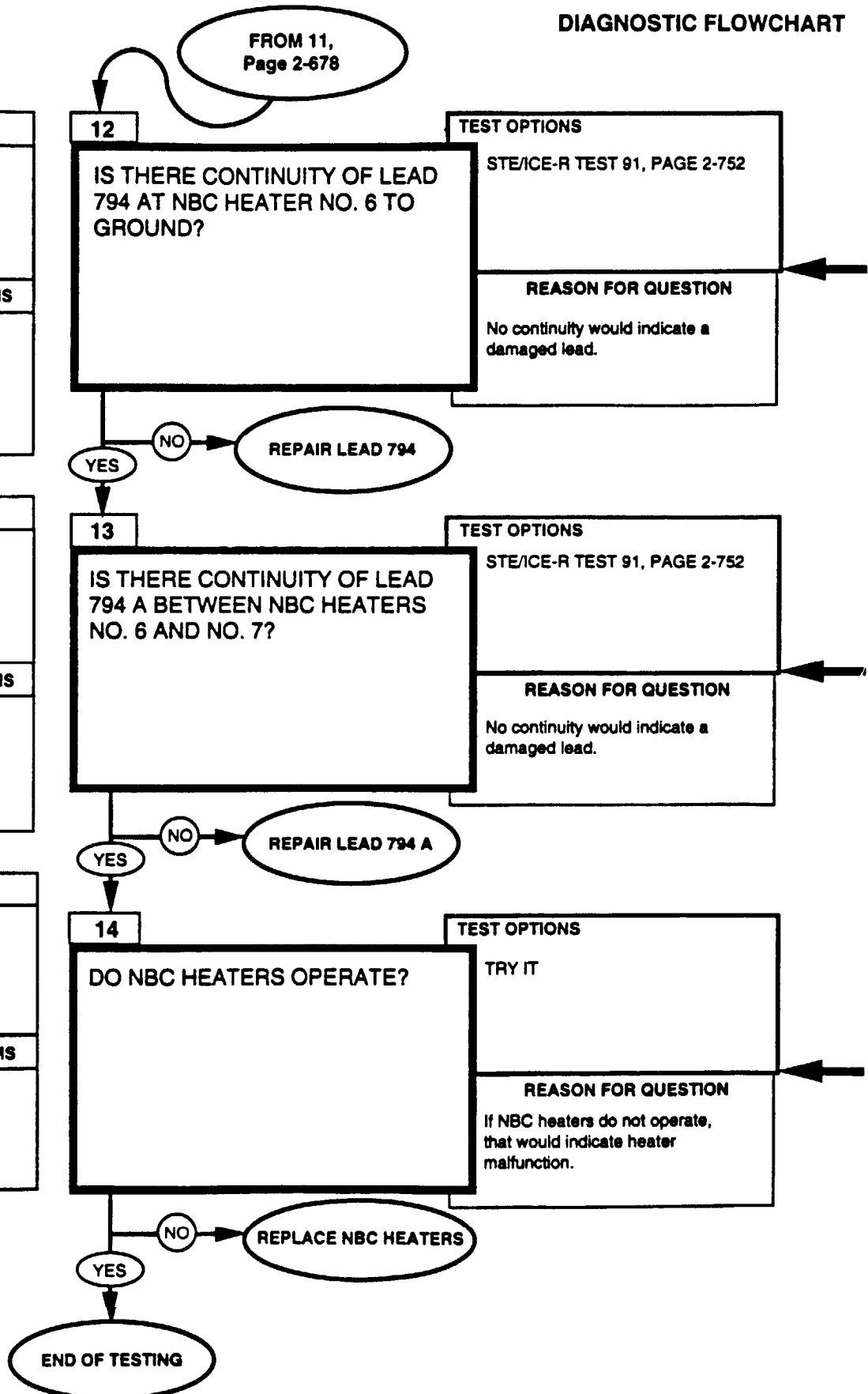
**AMBULANCE  
(NBC Heaters)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
LEAD 795 OK LEAD 795 A OK LEAD 795 B OK
POSSIBLE PROBLEMS
LEAD 794 LEAD 794 A NBC HEATERS

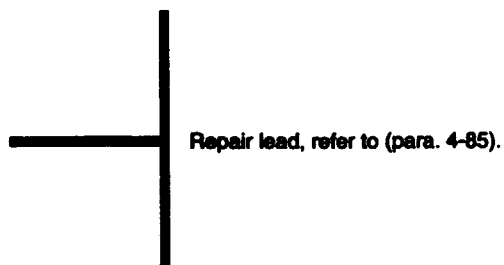
KNOWN INFO
LEAD 795 OK LEAD 795 A OK LEAD 795 B OK LEAD 794 OK
POSSIBLE PROBLEMS
LEAD 794 A NBC HEATERS

KNOWN INFO
LEAD 795 OK LEAD 795 A OK LEAD 795 B OK LEAD 794 OK LEAD 794 A OK
POSSIBLE PROBLEMS
NBC HEATERS

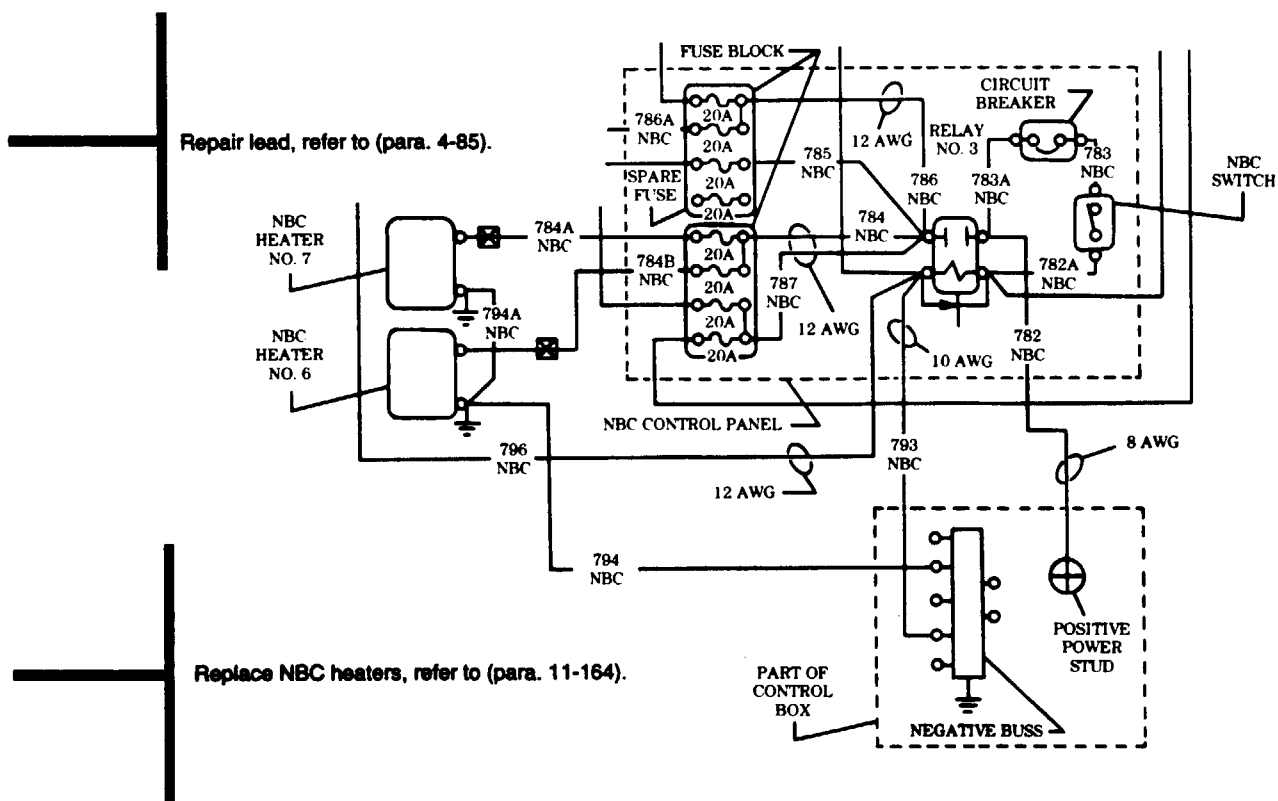


## REFERENCE INFORMATION

## AMBULANCE



0-4500 OHMS STE/ICE-R TEST 91
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."



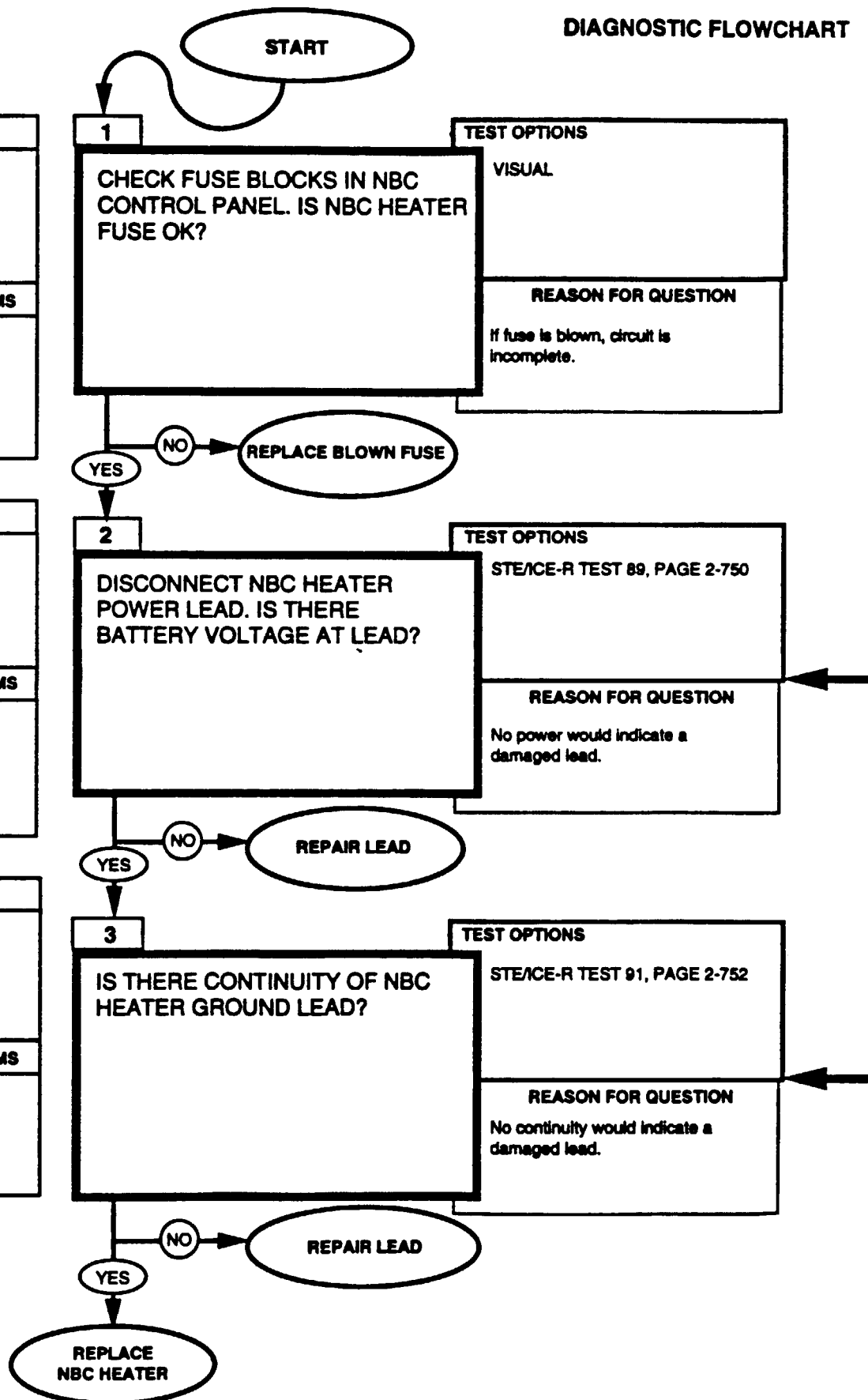
**AMBULANCE  
(NBC Heater)  
(Refer to Fig. 17.)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
FUSE POWER LEAD NBC HEATER GROUND LEAD

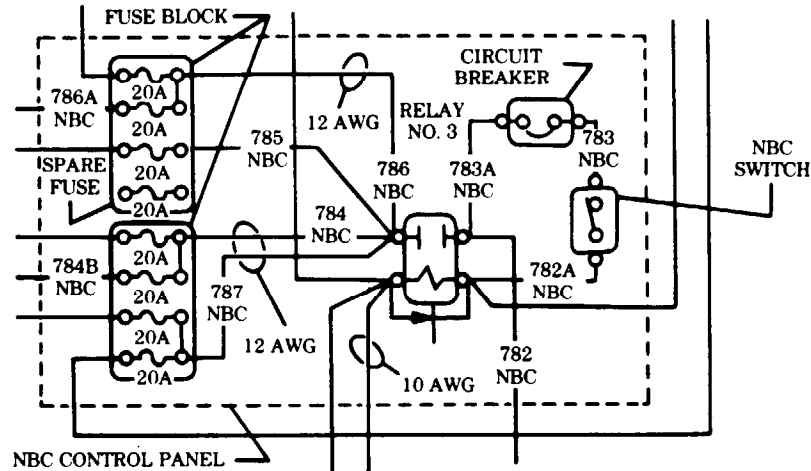
KNOWN INFO
FUSE OK
POSSIBLE PROBLEMS
POWER LEAD NBC HEATER GROUND LEAD

KNOWN INFO
FUSE OK POWER LEAD OK
POSSIBLE PROBLEMS
NBC HEATER GROUND LEAD



## REFERENCE INFORMATION

## AMBULANCE



Repair lead, refer to (para. 4-85).

Repair lead connector, refer to (para. 4-85).

#### 0-45 DC VOLTS STE/ICE-R TEST 89

1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.
2. Start Test 89, DC volts.
3. Displayed reading is in volts.

Repair lead, refer to (para. 4-85).

Replace NBC heater, refer to (para. 11-164).

#### 0-4500 OHMS STE/ICE-R TEST 91

1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start Test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays "9.9.9.9."

## Electrical Troubleshooting

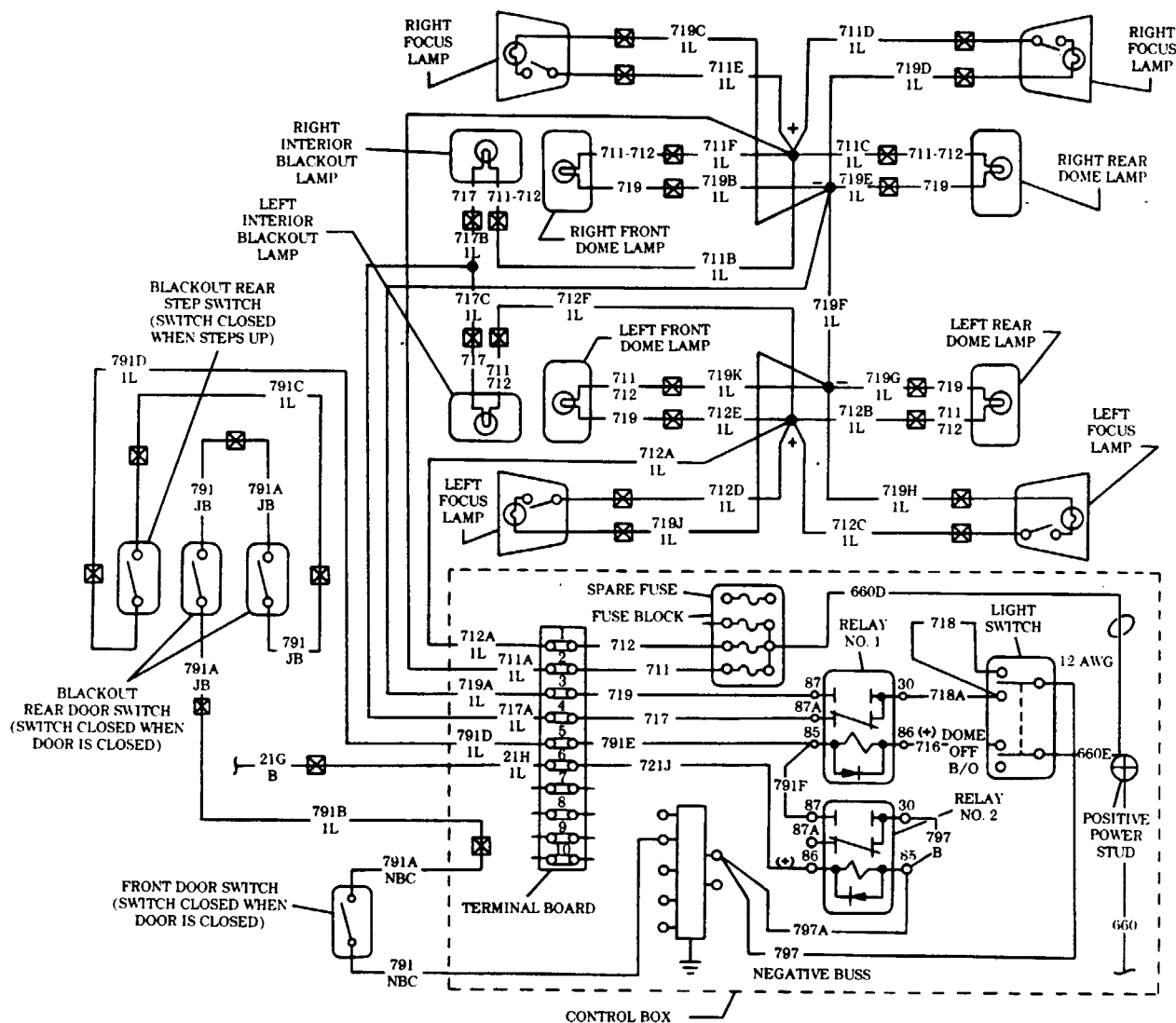
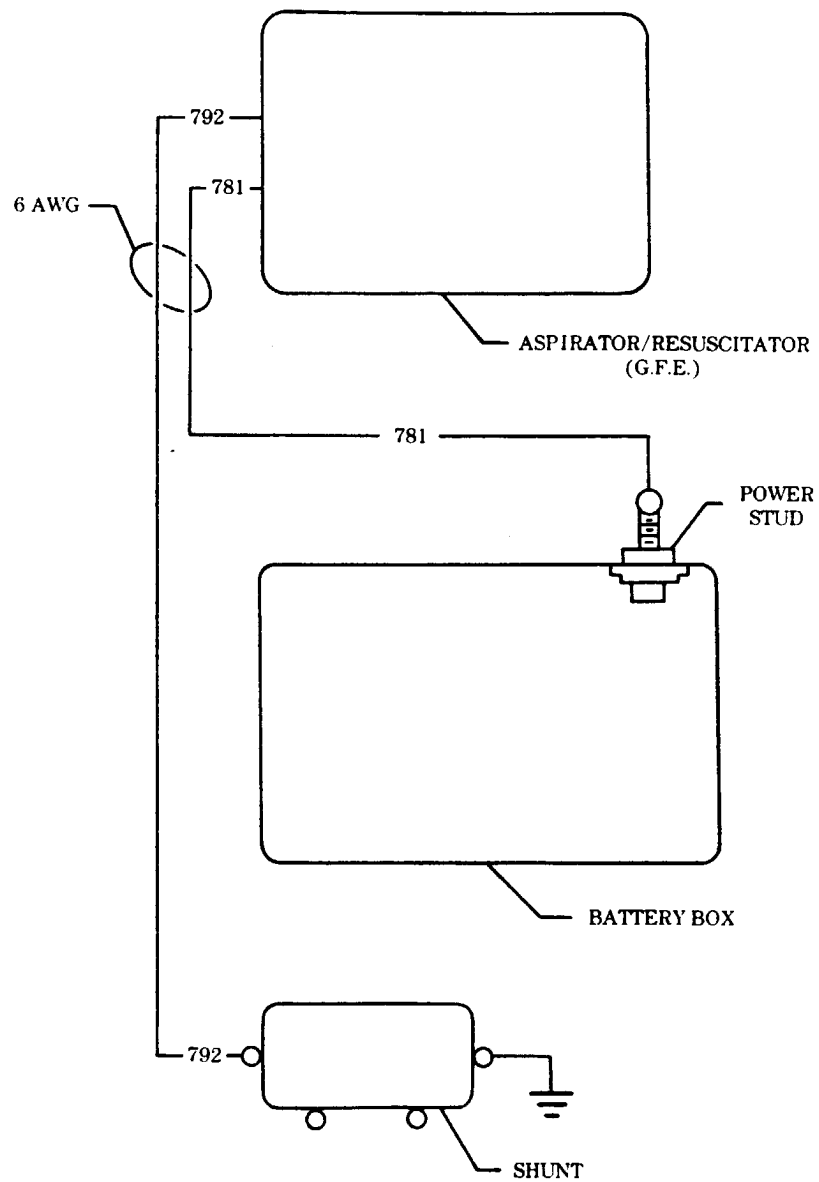
**MALFUNCTION  
TEST OR INSPECTION**


Figure 11. Lighting System

**MALFUNCTION  
TEST OR INSPECTION***Figure 12. Aspirator System*

## Electrical Troubleshooting

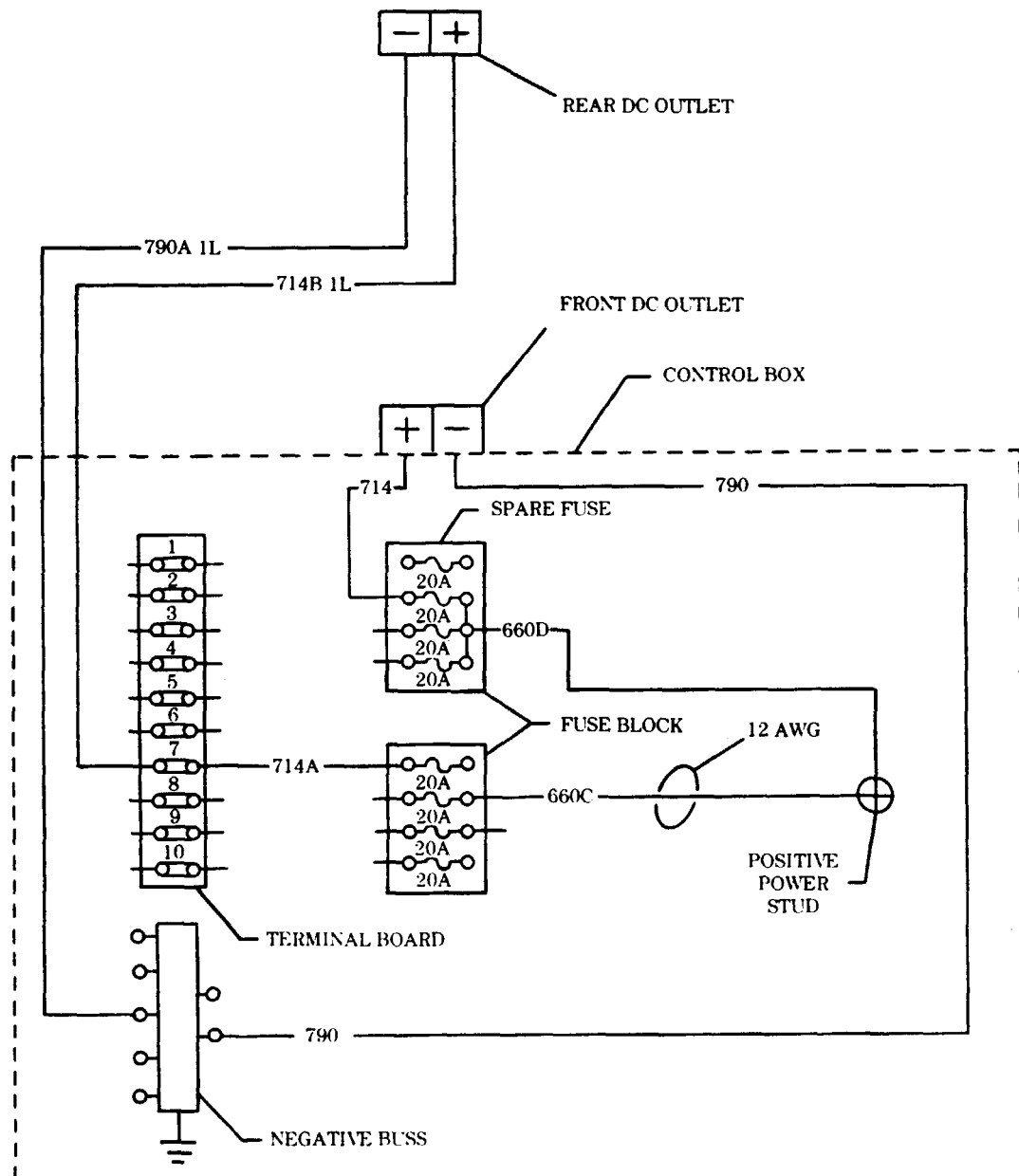
MALFUNCTION  
TEST OR INSPECTION

Figure 13. DC Voltage System



## Electrical Troubleshooting

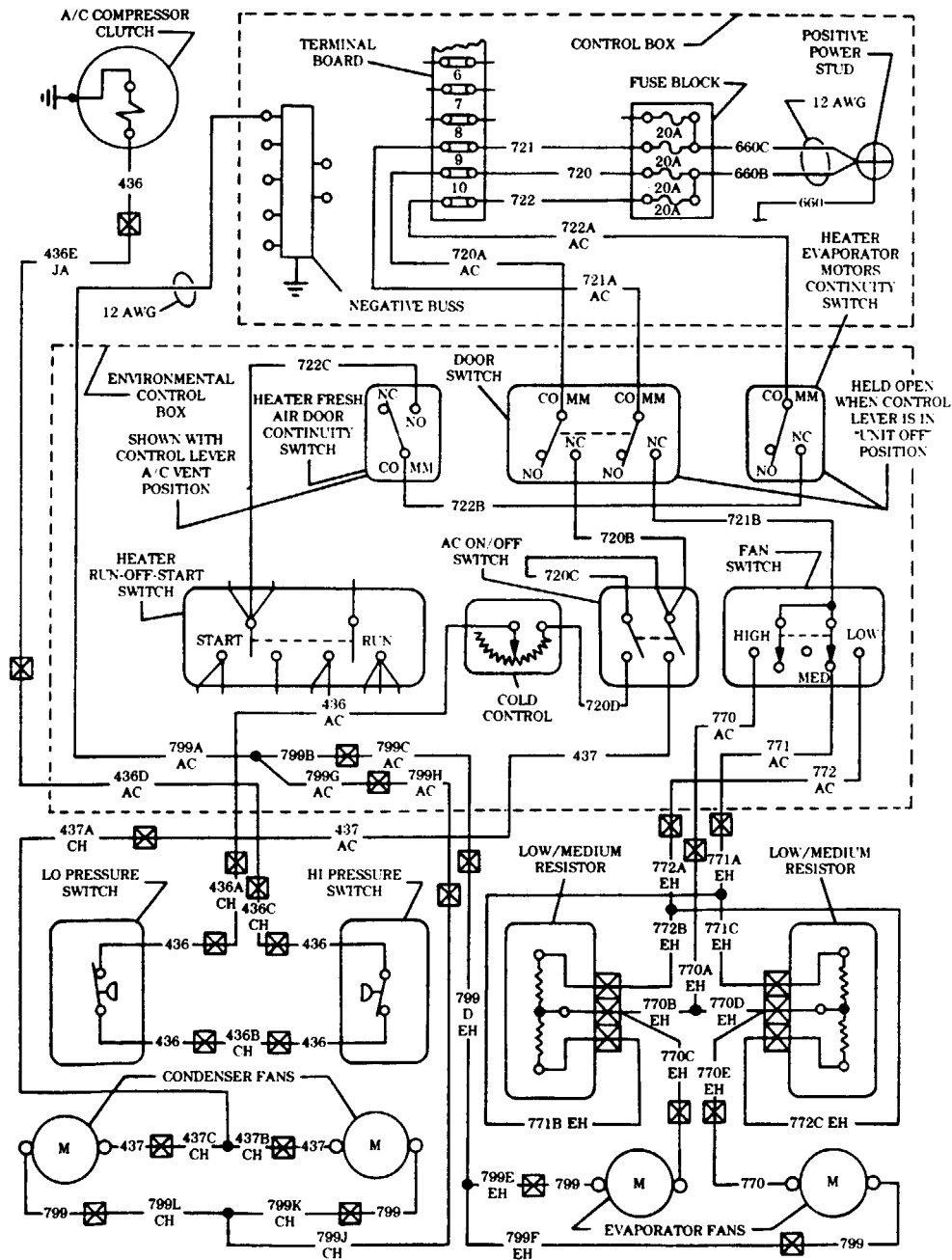
**MALFUNCTION  
TEST OR INSPECTION**


Figure 14. Air-Conditioning Control System

## Electrical Troubleshooting

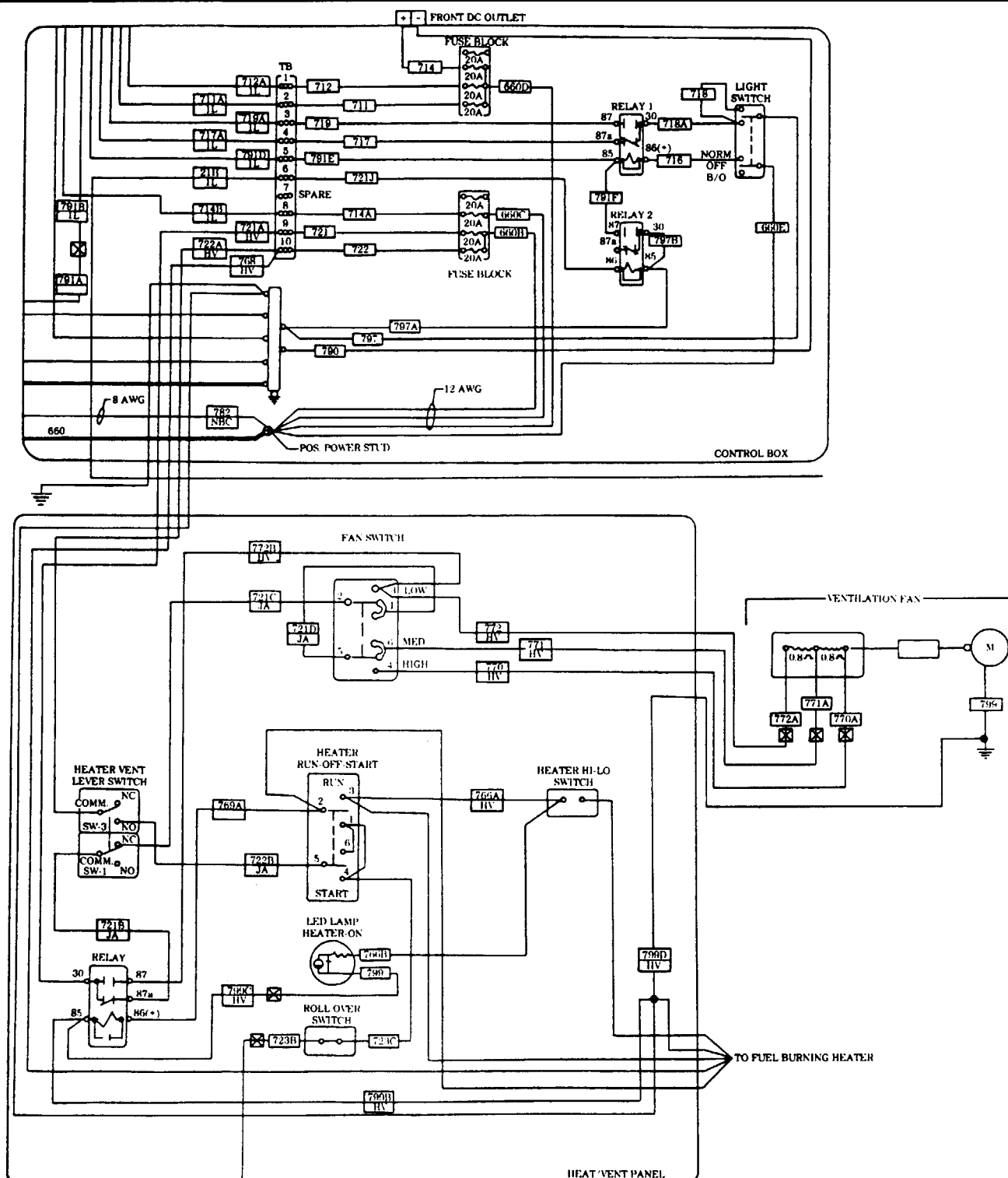
**MALFUNCTION  
TEST OR INSPECTION**


Figure 15. M996 and M996A1 Heater/Ventilation Control Box and Blower Fan

**MALFUNCTION  
TEST OR INSPECTION**

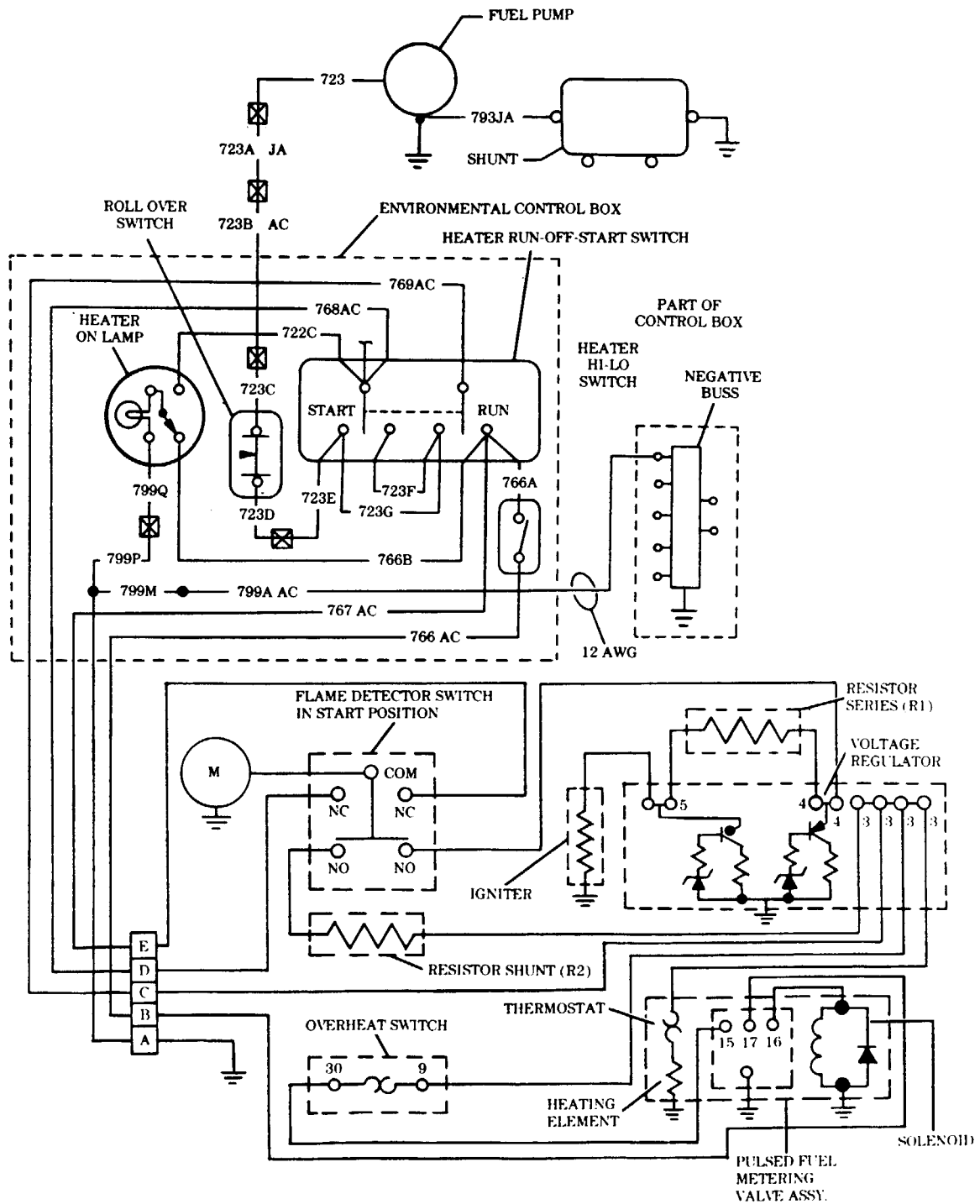


Figure 16. Heater Control System

## Electrical Troubleshooting

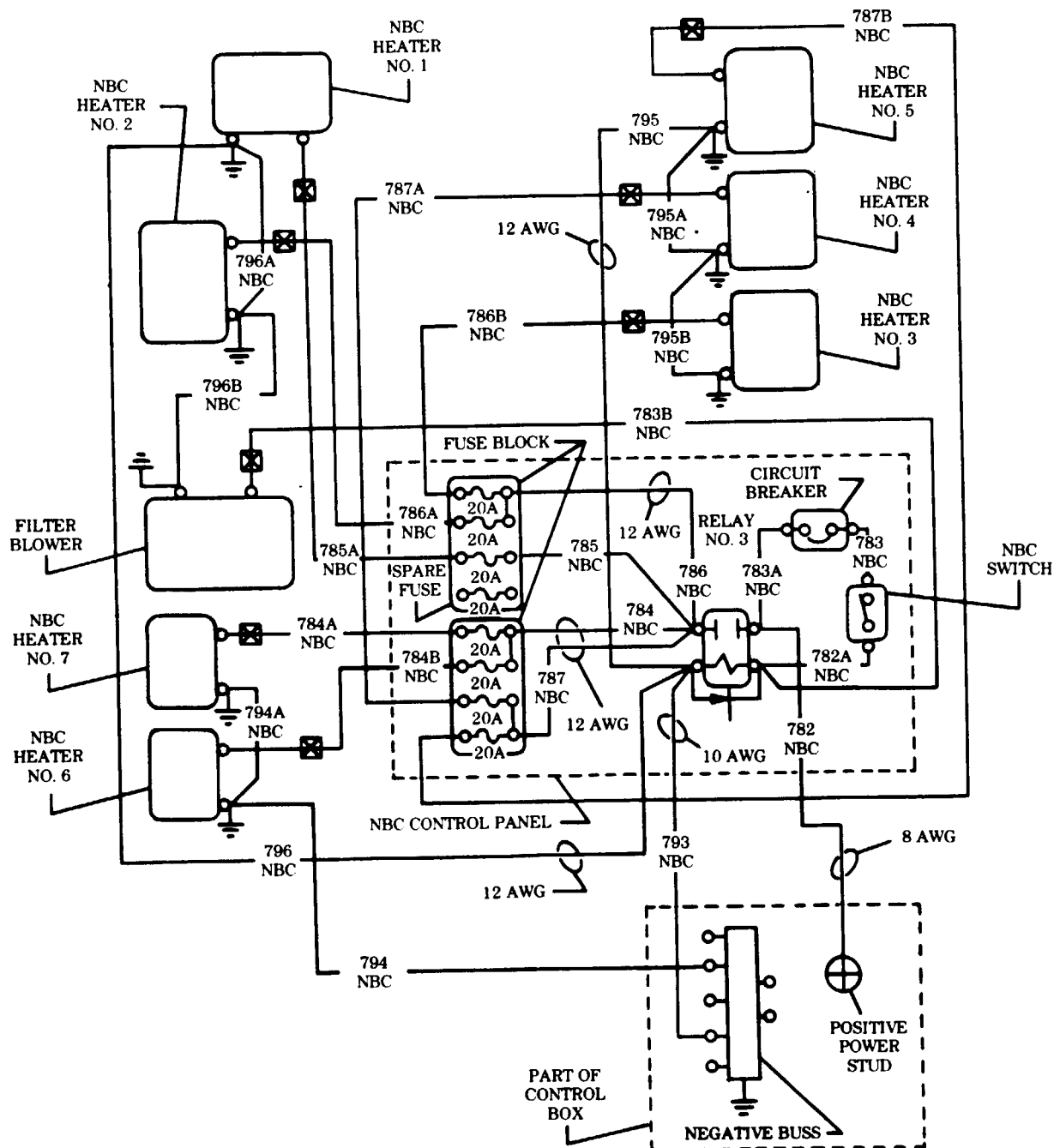
**MALFUNCTION  
TEST OR INSPECTION**


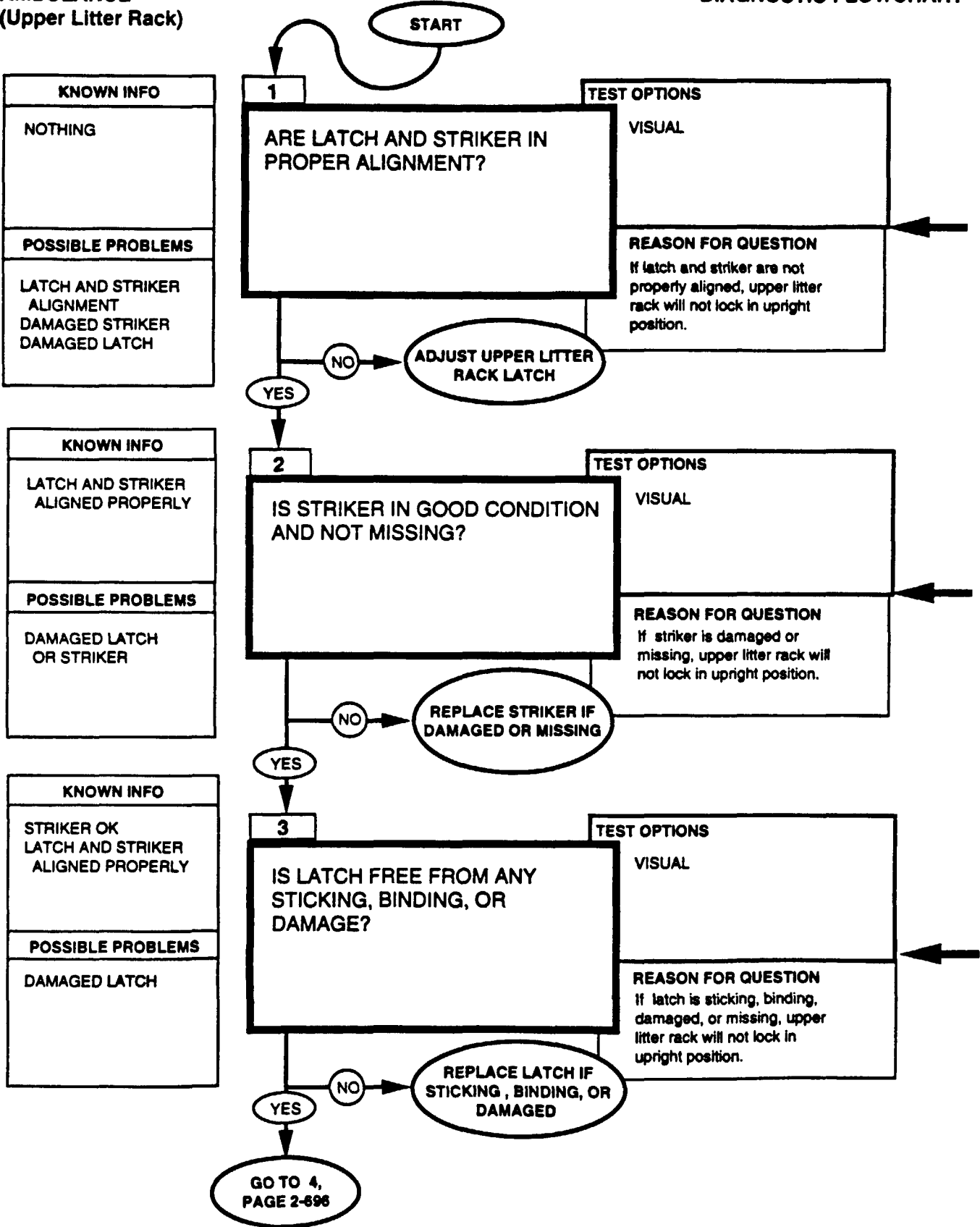
Figure 17. NBC Control System

**2-40. AMBULANCE MECHANICAL SYSTEM TESTS**

These ambulance system mechanical tests may be run anytime you think you have an ambulance mechanical problem or if you were sent here by another test chain. Just follow the path, answering the questions. Additional information and notes are given on the facing page when necessary.

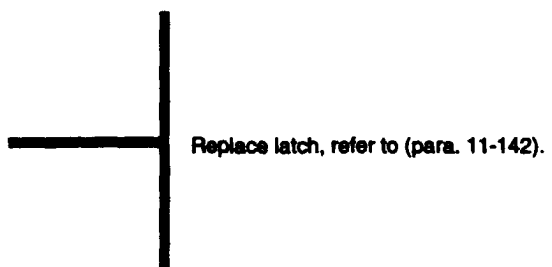
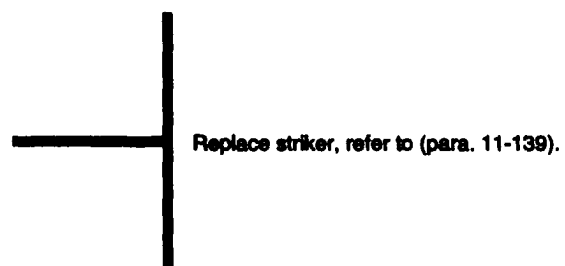
**AMBULANCE**  
**(Upper Litter Rack)**

**DIAGNOSTIC FLOWCHART**



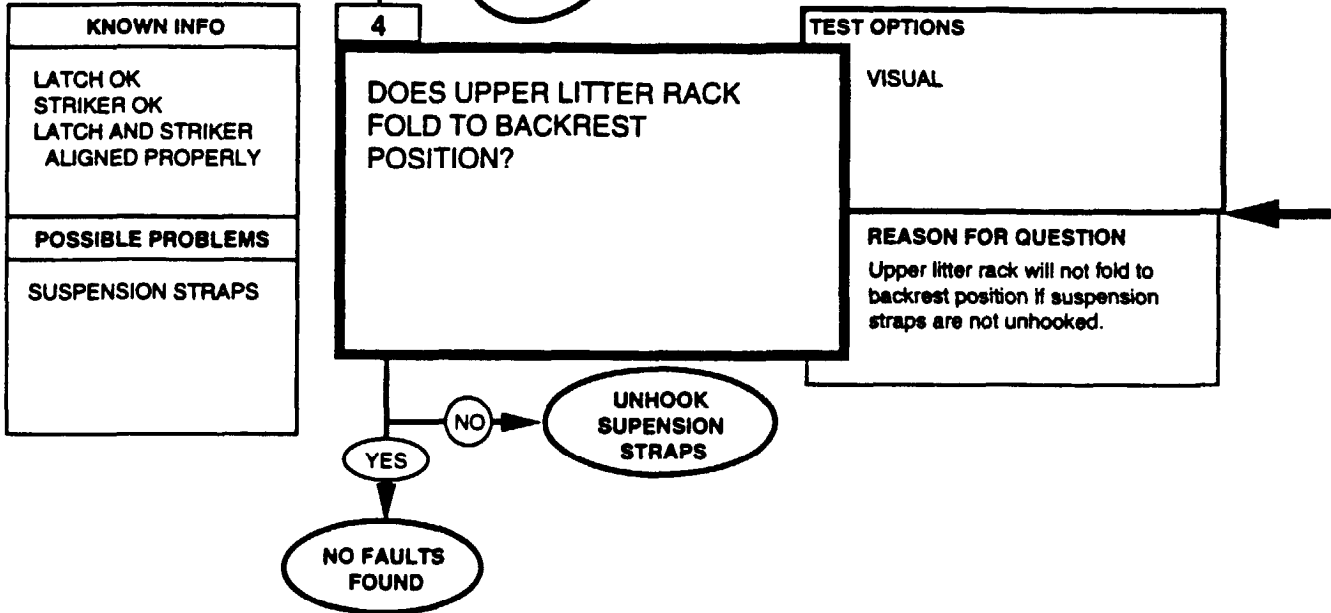
**REFERENCE INFORMATION**

**AMBULANCE**



AMBULANCE SYSTEM  
(Upper Litter Rack)

DIAGNOSTIC FLOWCHART





**REFERENCE INFORMATION**

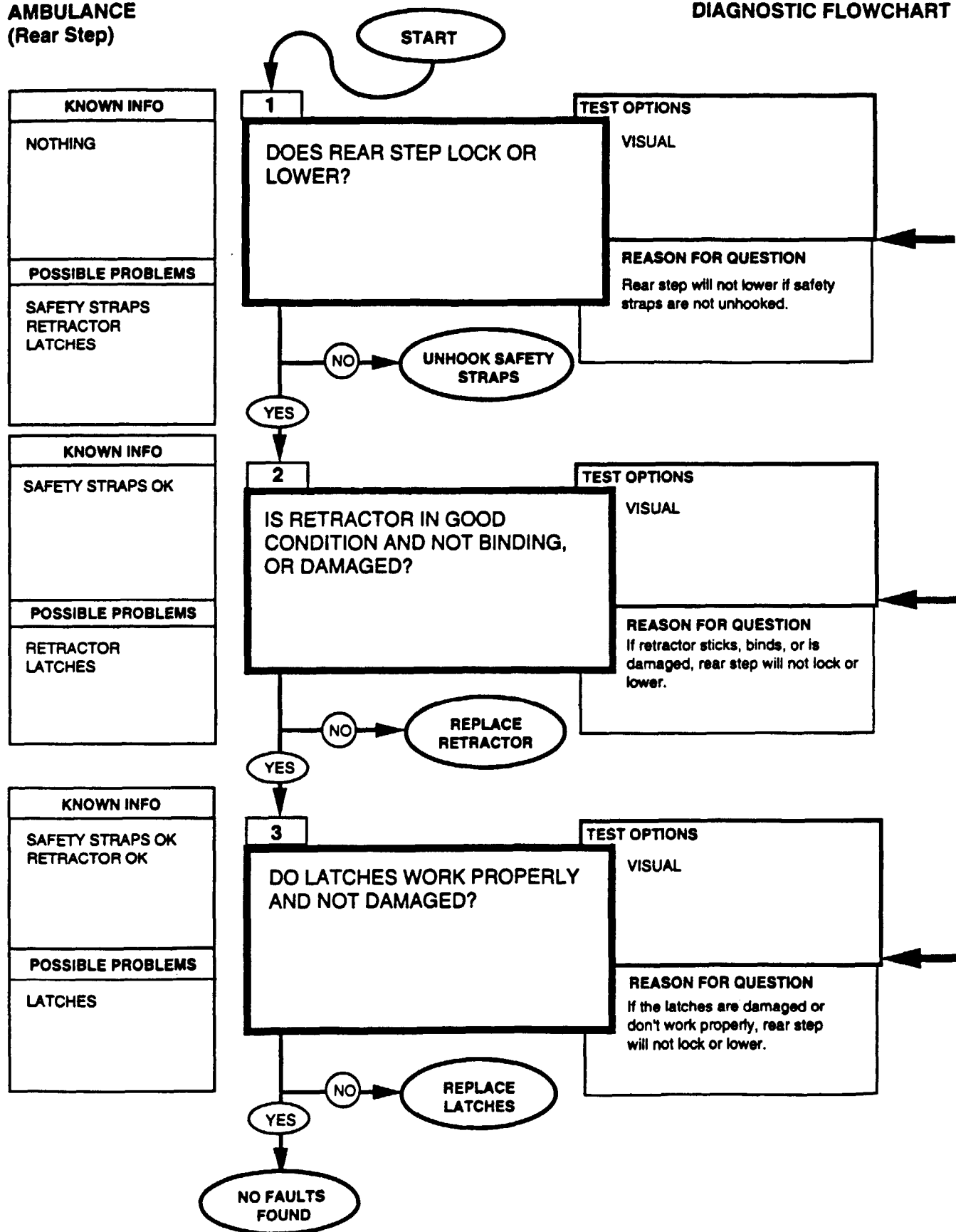
**AMBULANCE**



Unhook suspension straps, refer to (TM 9-2320-280-10).


**AMBULANCE  
(Rear Step)**

**DIAGNOSTIC FLOWCHART**



**REFERENCE INFORMATION**


**AMBULANCE**



Unhook safety straps, refer to (TM 9-2320-280-10).



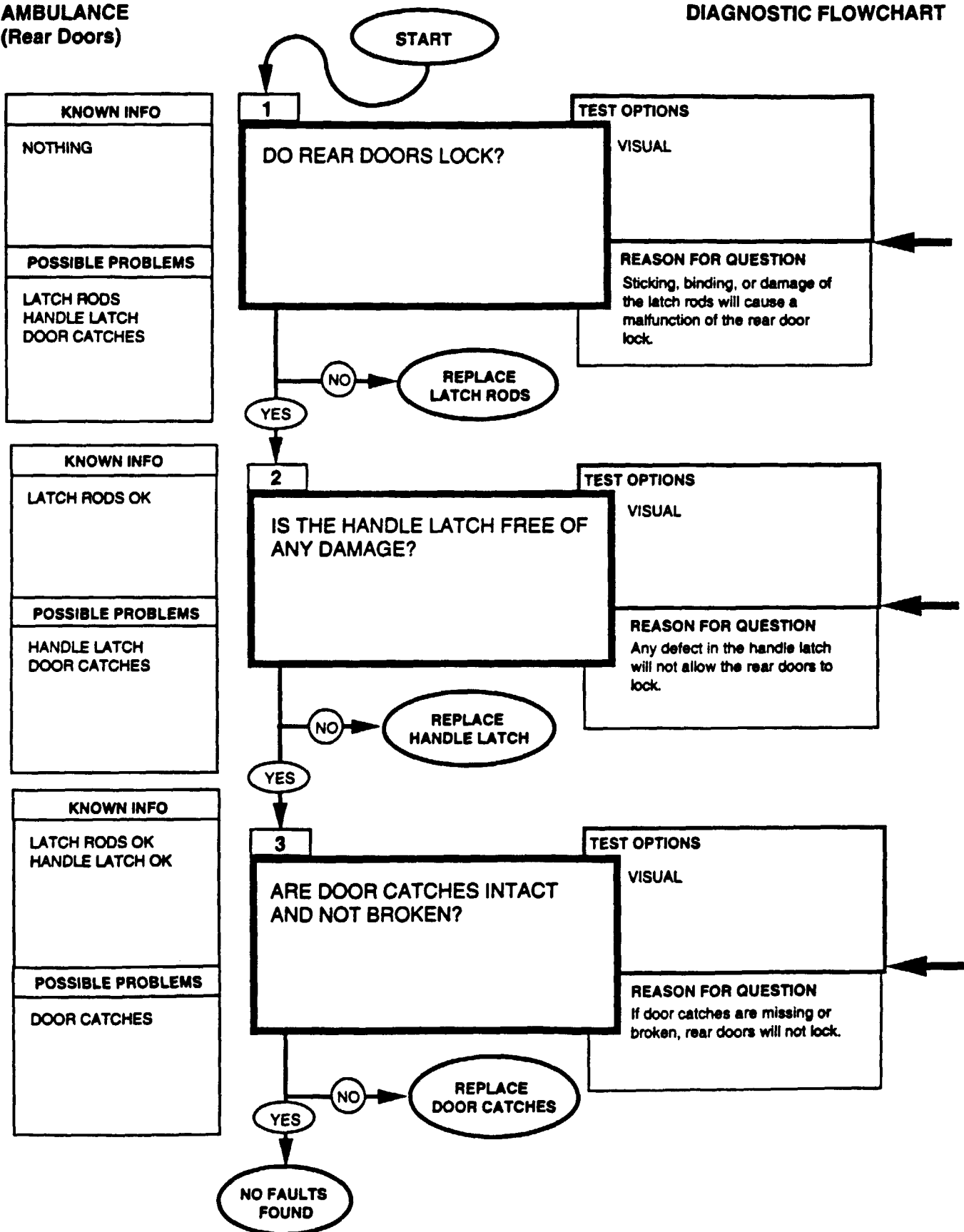
Replace retractor, refer to (para. 11-137).



Replace latches, refer to (para. 11-135).

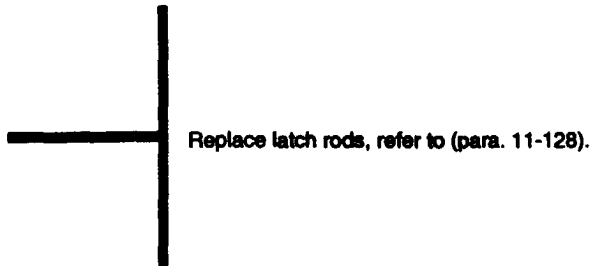
**AMBULANCE  
(Rear Doors)**

**DIAGNOSTIC FLOWCHART**



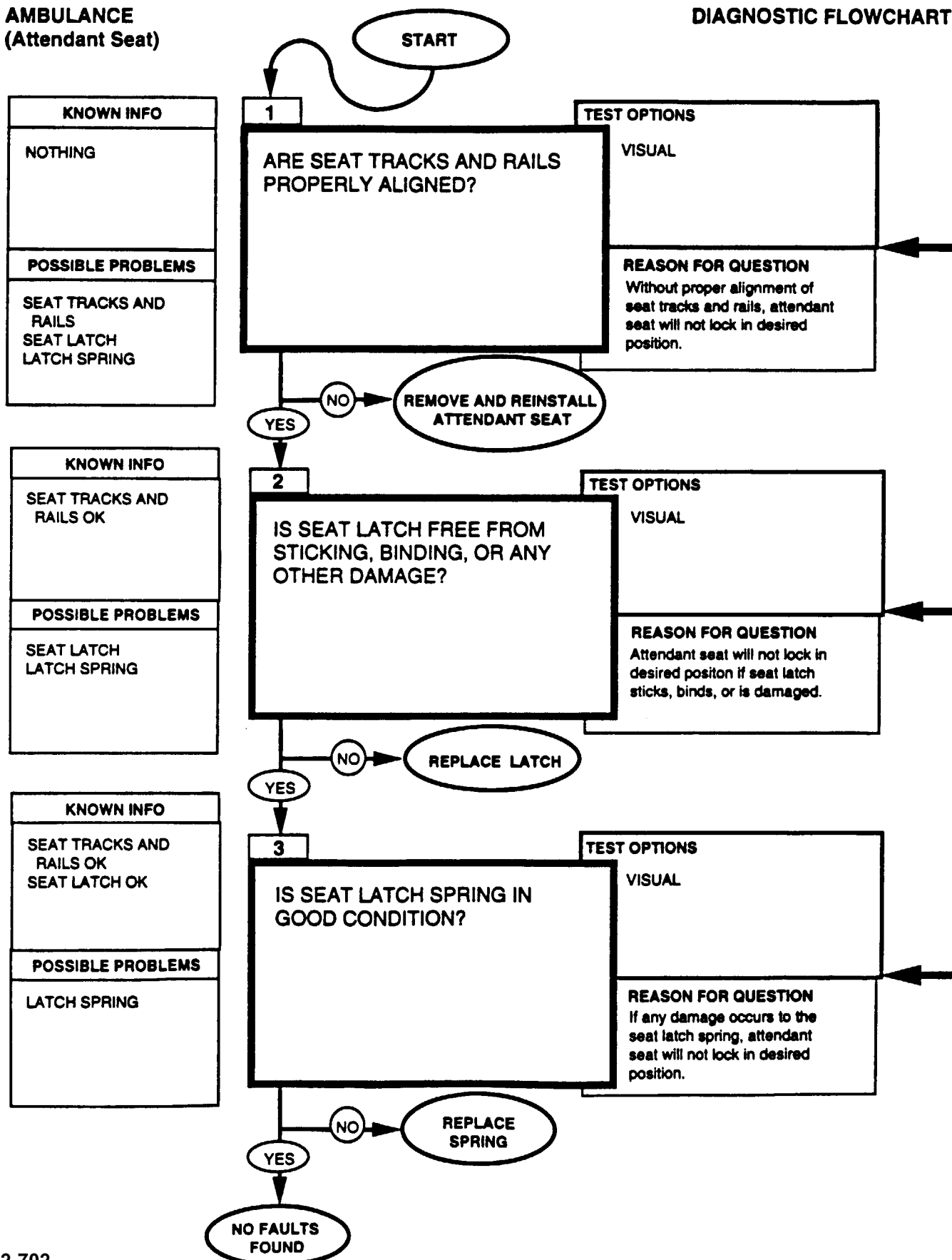
**REFERENCE INFORMATION**

**AMBULANCE**



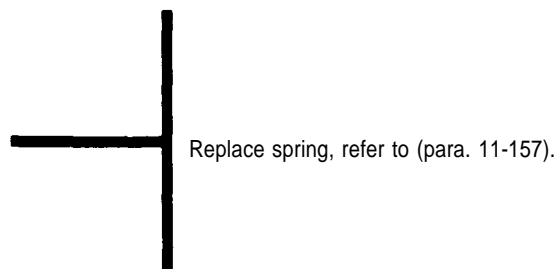
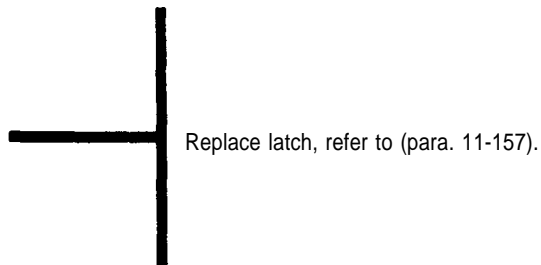
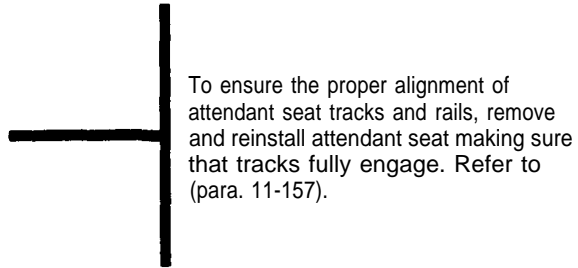
**AMBULANCE  
(Attendant Seat)**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

## AMBULANCE

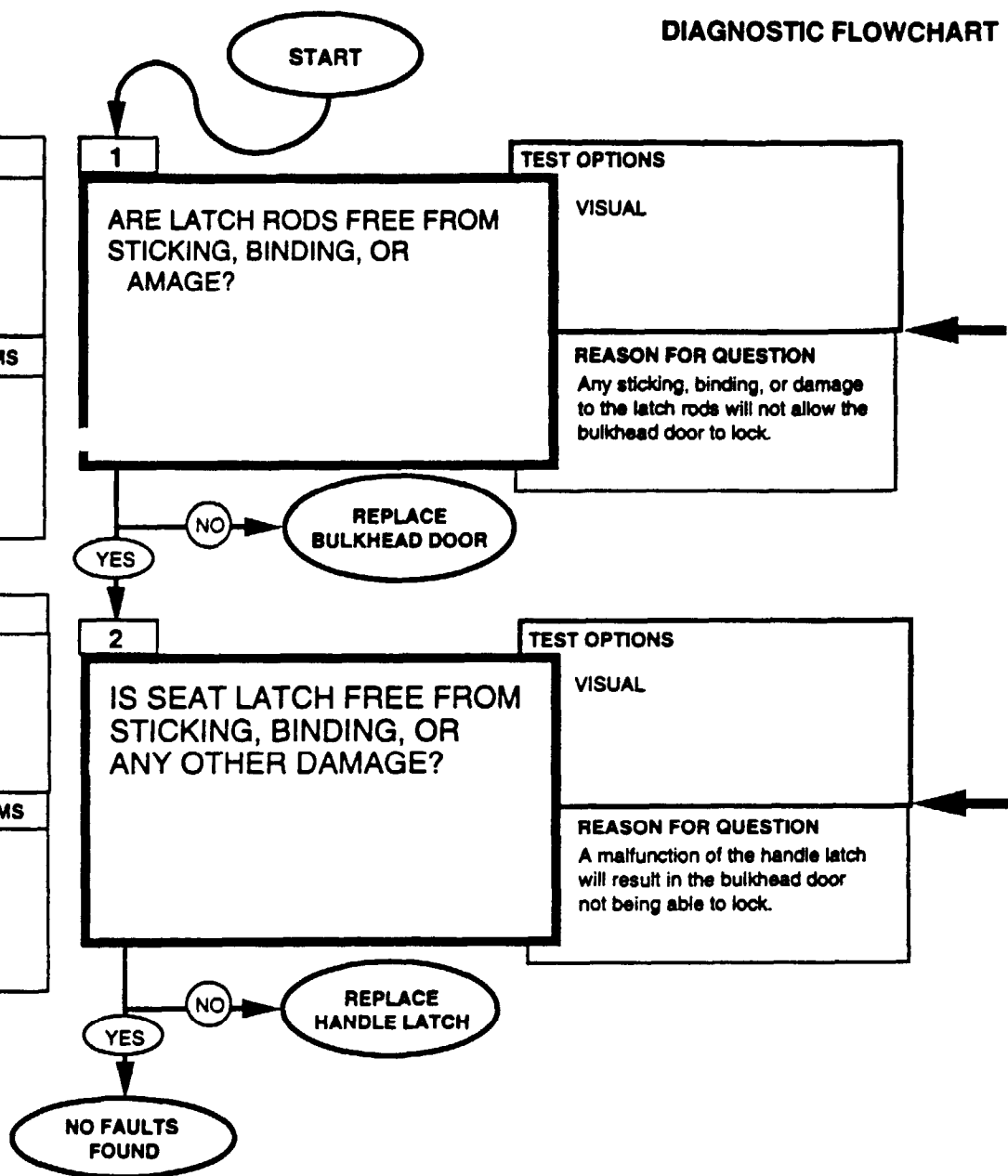


# DIAGNOSTIC FLOWCHART

## AMBULANCE (Bulkhead Door)

KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
LATCH RODS HANDLE LATC

KNOWN INFO
LATCH RODS OK
POSSIBLE PROBLEMS
HANDLE LATCH





REFERENCE INFORMATION

AMBULANCE



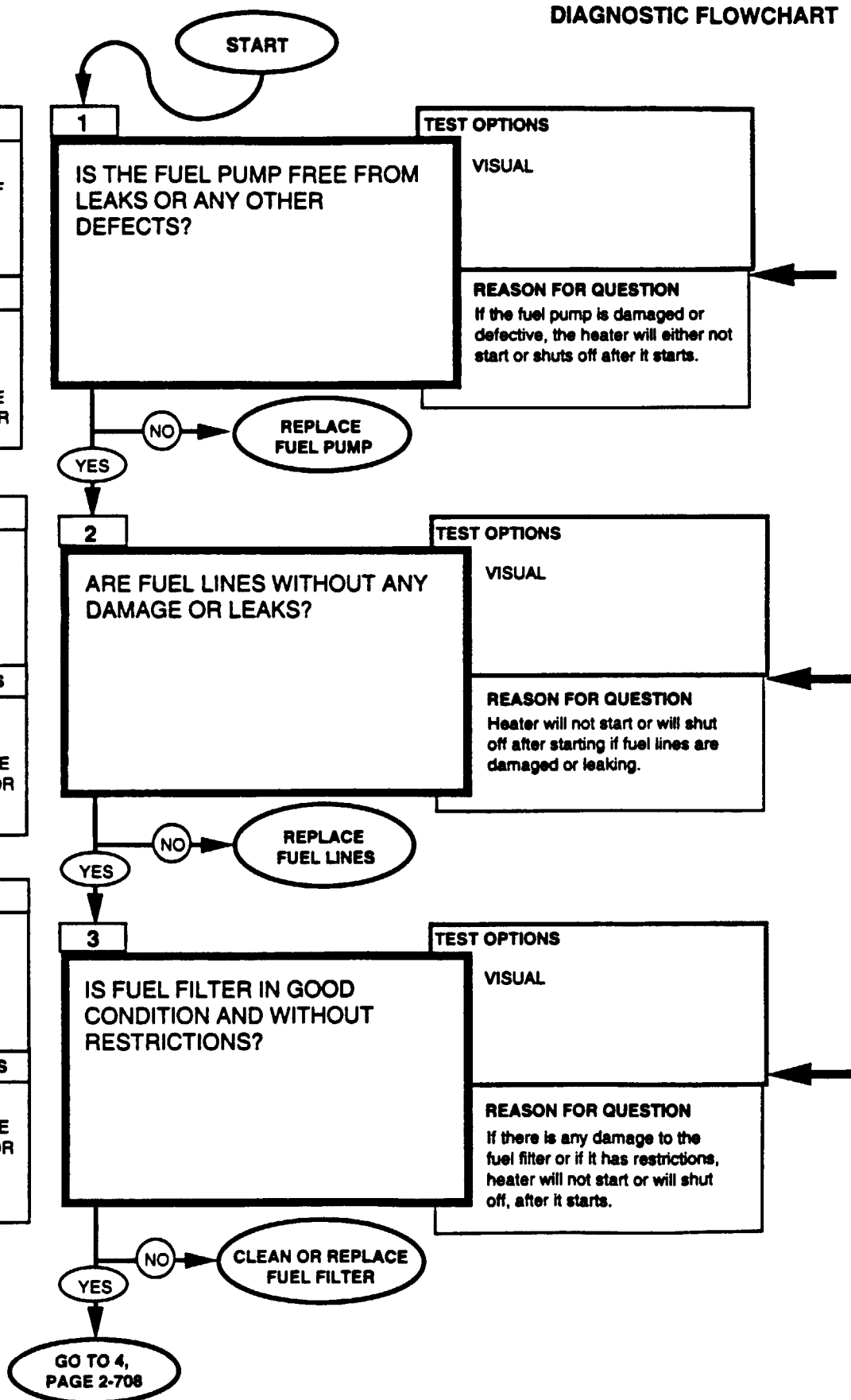
**AMBULANCE  
(Heater)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
HEATER DOES NOT START OR SHUTS OFF
POSSIBLE PROBLEMS
ELECTRIC FUEL PUMP FUEL LINES HEATER FUEL FILTER HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR

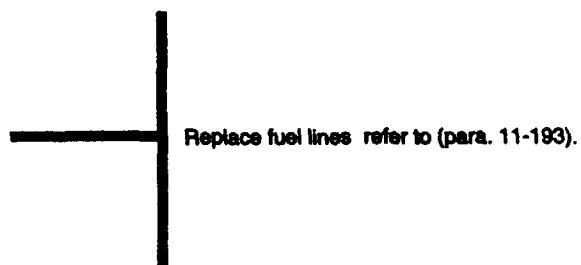
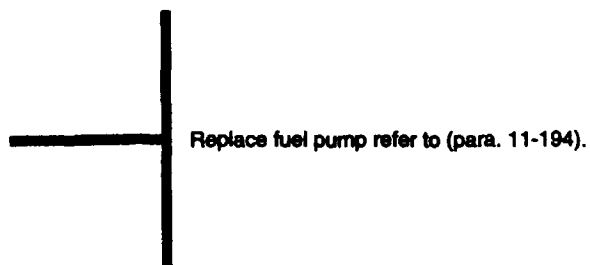
KNOWN INFO
FUEL PUMP OK
POSSIBLE PROBLEMS
FUEL LINES FUEL FILTER HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR

KNOWN INFO
FUEL PUMP OK FUEL LINES OK
POSSIBLE PROBLEMS
FUEL FILTER HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR



REFERENCE INFORMATION

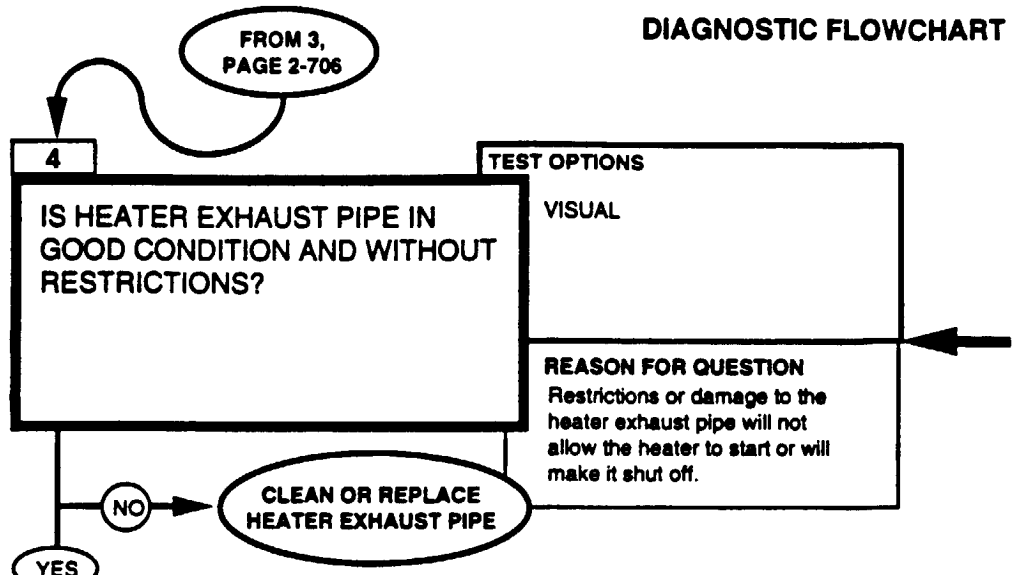
AMBULANCE



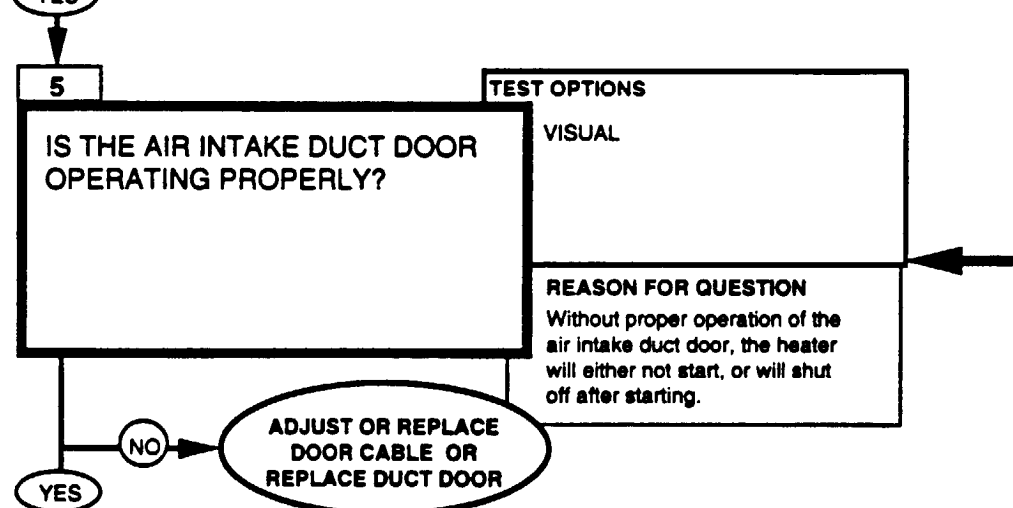
# AMBULANCE HEATER

## DIAGNOSTIC FLOWCHART

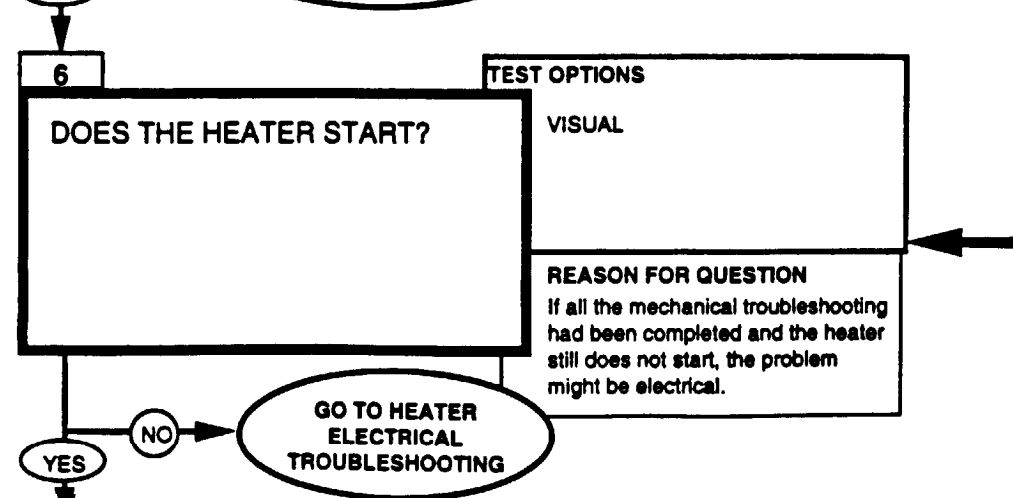
KNOWN INFO
FUEL PUMP OK FUEL LINES OK FUEL FILTER OK
POSSIBLE PROBLEMS
HEATER EXHAUST PIPE AIR INTAKE DUCT DOOR



KNOWN INFO
FUEL PUMP OK FUEL LINES OK FUEL FILTER OK HEATER EXHAUST PIPE OK
POSSIBLE PROBLEMS
AIR INTAKE DUCT DOOR




KNOWN INFO
FUEL PUMP OK FUEL LINES OK FUEL FILTER OK HEATER EXHAUST PIPE OK AIR INTAKE DUCT DOOR OK
POSSIBLE PROBLEMS
ELECTRICAL




OTHER CAUSES NOTIFY DS MAINTENANCE

REFERENCE INFORMATION

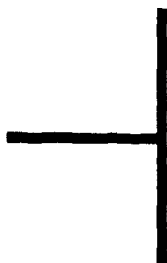
AMBULANCE



Clean or replace heater exhaust pipe, refer to (para. 11-189 or 11-207).



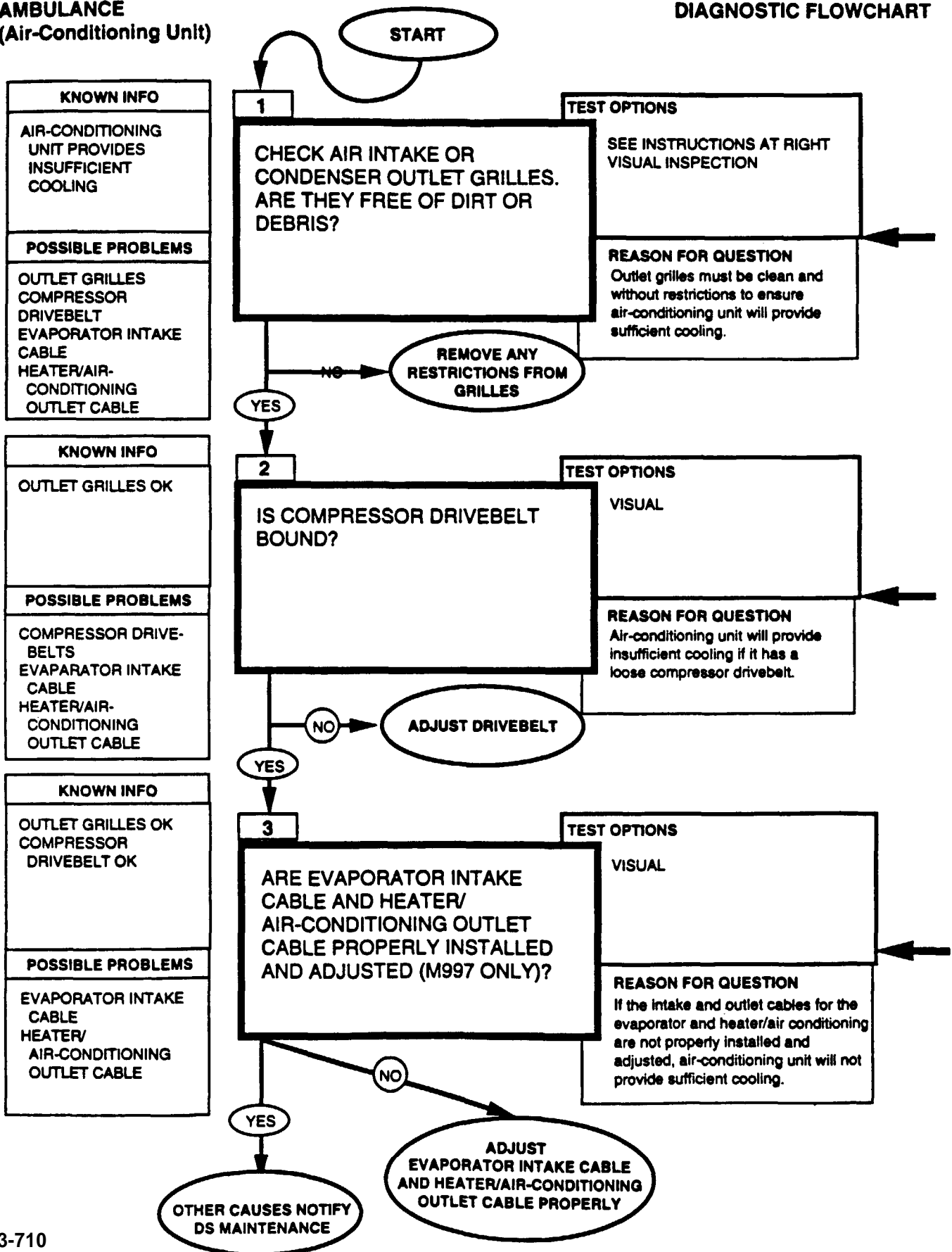
Adjust or replace door cable, refer to (para. 11-199).  
Replace duct door, refer to (para. 11-185).



At the completion of the mechanical troubleshooting steps, the heater should start. If not, there might be an electrical problem. Refer to electrical troubleshooting section, para. 2-39 (heater electrical troubleshooting, page 2-636).


**AMBULANCE  
(Air-Conditioning Unit)**

**DIAGNOSTIC FLOWCHART**



## REFERENCE INFORMATION

## AMBULANCE



Turn on air-conditioning and set controls to maximum cooling and blower speed settings (TM 9-2320-280-10). Maintain engine speed at 1500 rpm with hand throttle. Verify rpm with STE/ICE equipment. Open ambulance body doors to allow flow of fresh air through vehicle. Run air-conditioner five minutes to allow temperature and pressure to stabilize. Check outlet ducts for cool air.



Adjust drivebelt, refer to (para. 11-202).



Properly adjust evaporator intake cable and heater/air-conditioning outlet cable, refer to (para. 11-199).

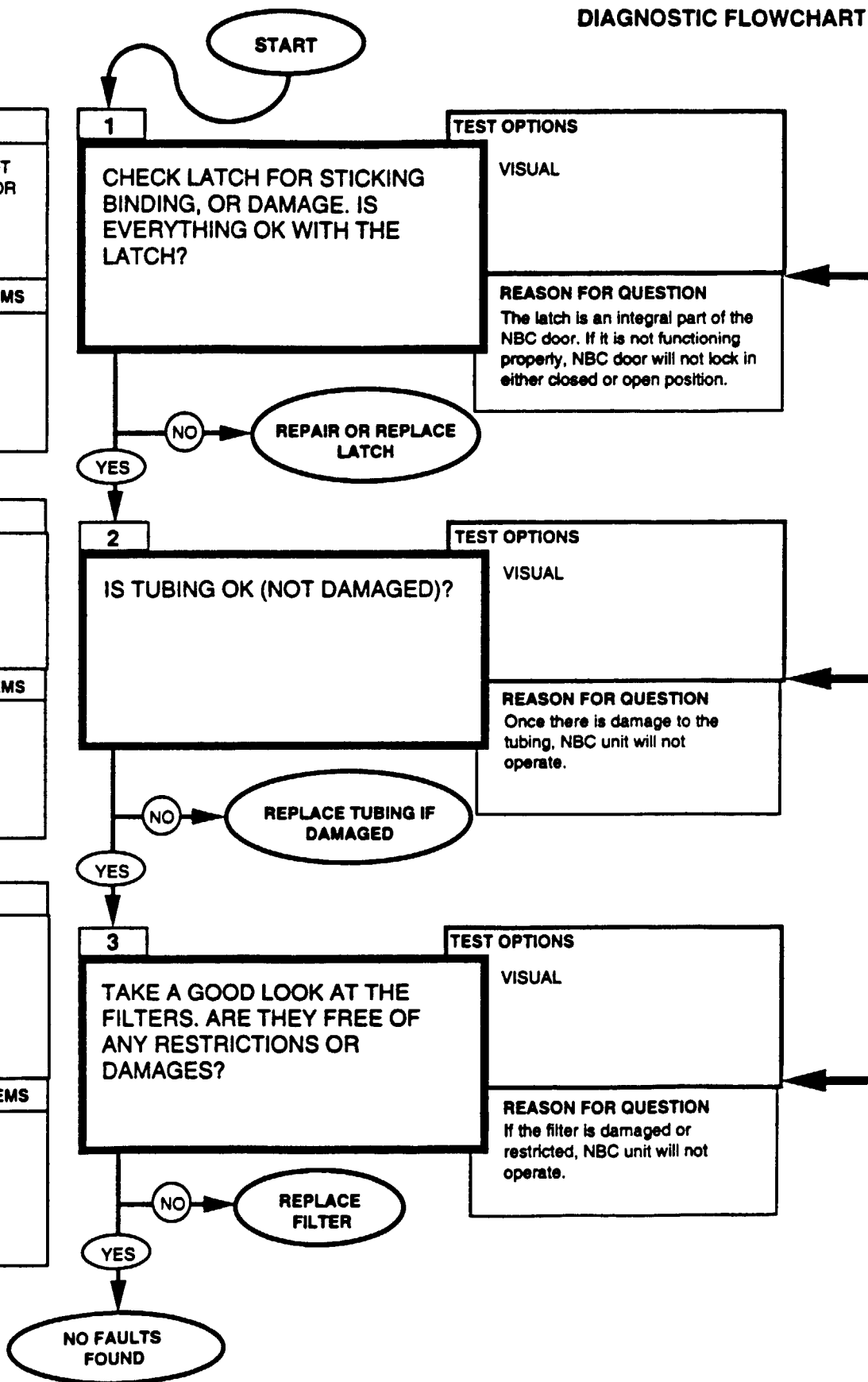
**AMBULANCE  
(NBC Door/Unit)**

**DIAGNOSTIC FLOWCHART**

KNOWN INFO
NBC DOOR WILL NOT LOCK IN CLOSED OR OPEN POSITION (M997 ONLY)
POSSIBLE PROBLEMS
LATCH

KNOWN INFO
NBC UNIT FAILS TO OPERATE LATCH OK
POSSIBLE PROBLEMS
TUBING FILTER

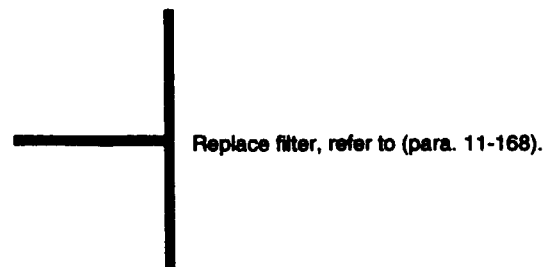
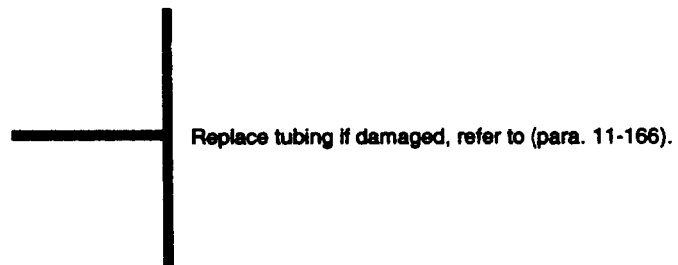
KNOWN INFO
TUBING OK LATCH OK
POSSIBLE PROBLEMS
FILTER





**AMBULANCE**

**REFERENCE INFORMATION**



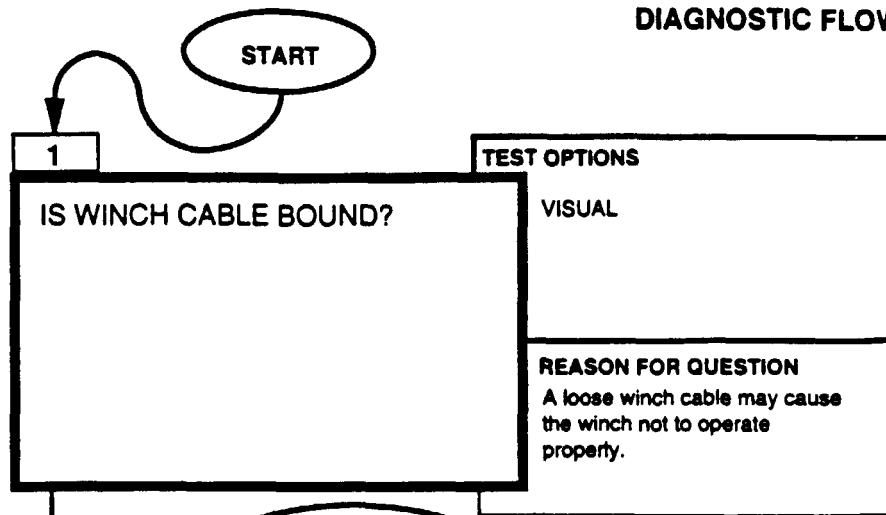
**2-41. WINCH SYSTEM TESTS**

These winch system tests may be run anytime you think you have a winch problem or if you were sent here by another test chain, Just follow the path and answer the questions. Additional information and notes are given on the facing page when necessary.

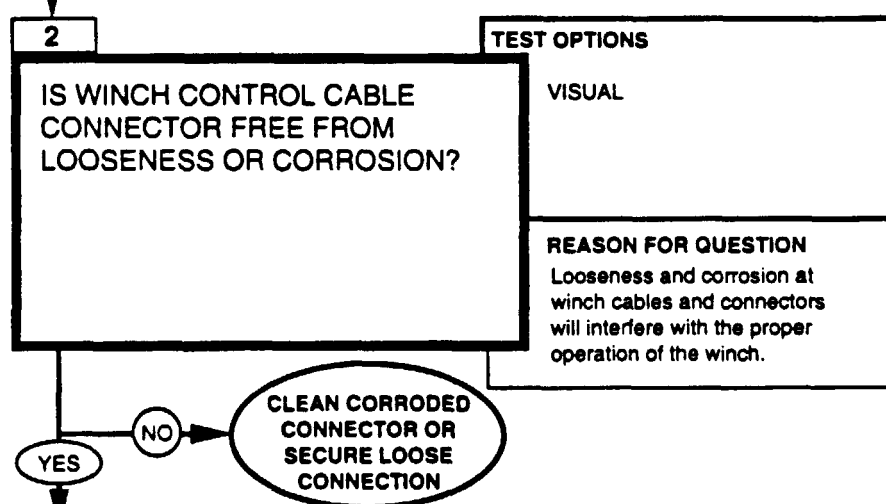
# WINCH

## DIAGNOSTIC FLOWCHART

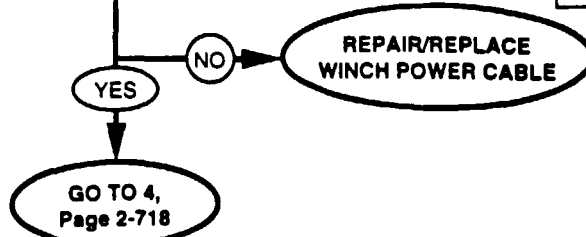
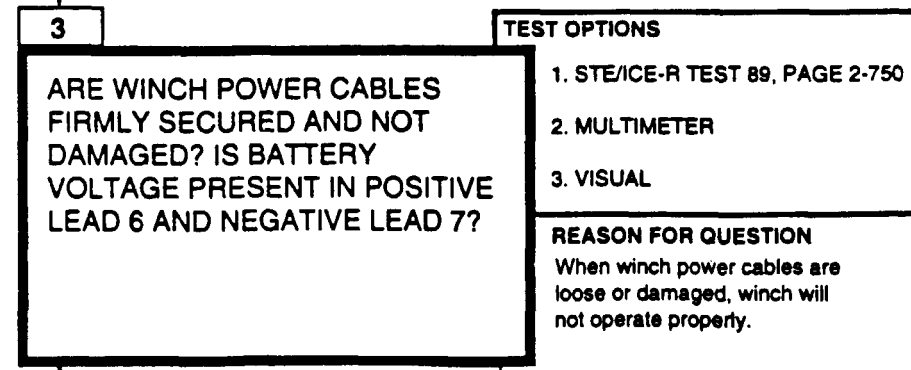
KNOWN INFO
NOTHING
POSSIBLE PROBLEMS
WINCH CABLE WINCH CONTROL CABLE CONNECTOR WINCH POWER CABLES WINCH WINCH CONTROL



KNOWN INFO
WINCH CABLE OK
POSSIBLE PROBLEMS
WINCH CONTROL CABLE CONNECTOR WINCH POWER CABLES WINCH WINCH CONTROL

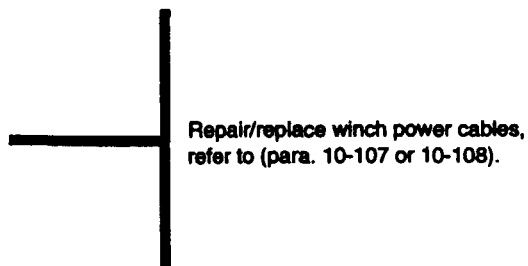


KNOWN INFO
WINCH CABLE OK WINCH CONTROL CABLE CONNECTOR OK
POSSIBLE PROBLEMS
WINCH POWER CABLES WINCH WINCH CONTROL



REFERENCE INFORMATION

WINCH

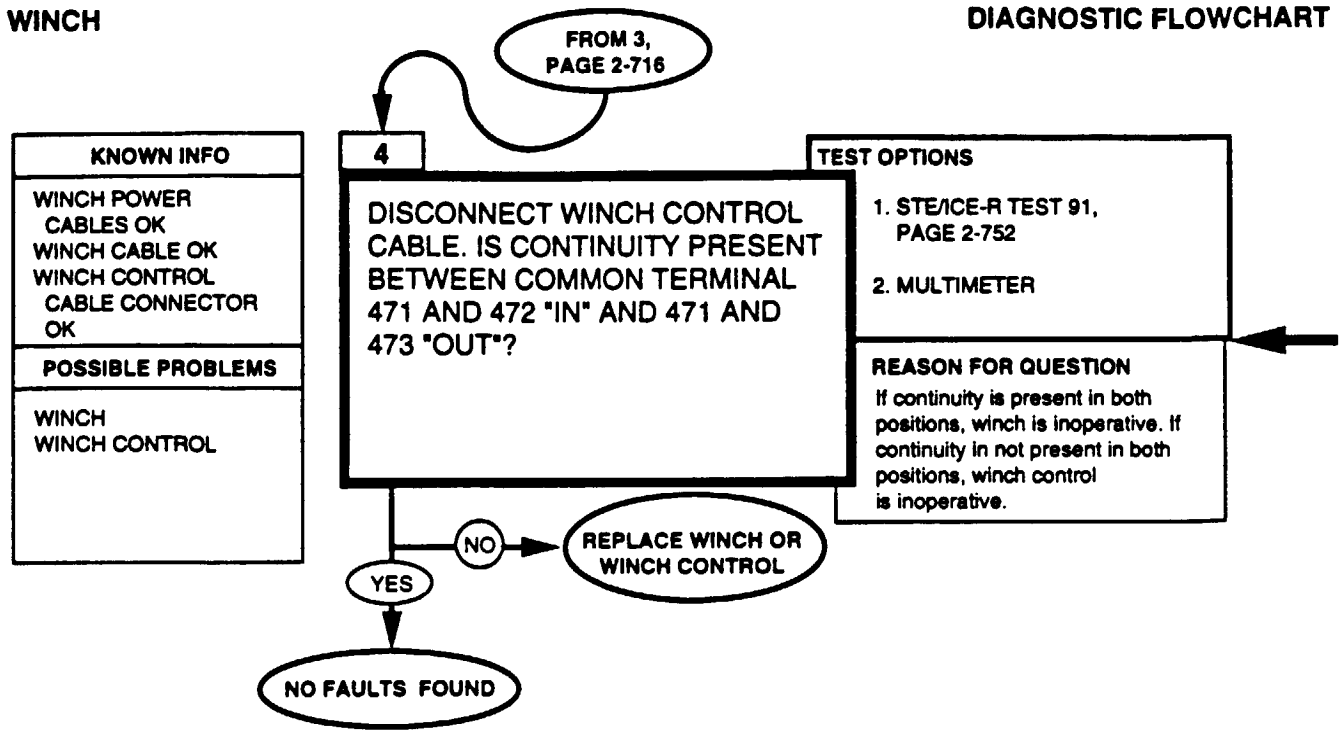


0-45 DC VOLTS STE/ICE-R TEST 89
<ol style="list-style-type: none"> <li>1. Connect RED clip to the indicated test point, BLACK clip to negative or ground.</li> <li>2. Start Test 89, DC volts.</li> <li>3. Displayed reading is in volts.</li> </ol>

BATTERY VOLTAGE MULTIMETER
<ol style="list-style-type: none"> <li>1. Set the voltmeter to a DC volts scale of at least 40 volts.</li> <li>2. Connect the RED lead to positive and the BLACK lead to negative.</li> <li>3. Be sure to read the correct scale.</li> </ol>

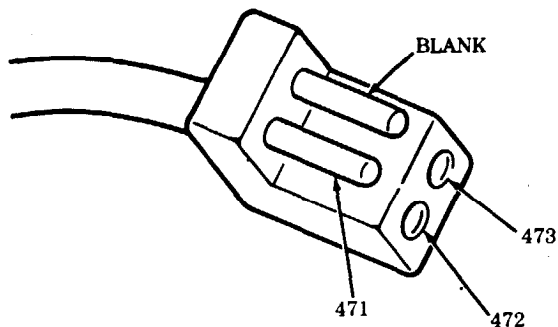
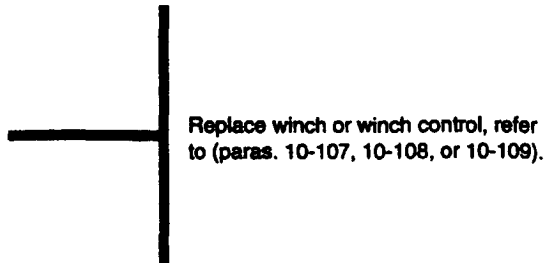
WINCH

DIAGNOSTIC FLOWCHART



# REFERENCE INFORMATION

## WINCH



### 0-4500 OHMS STE/CE-R TEST 91

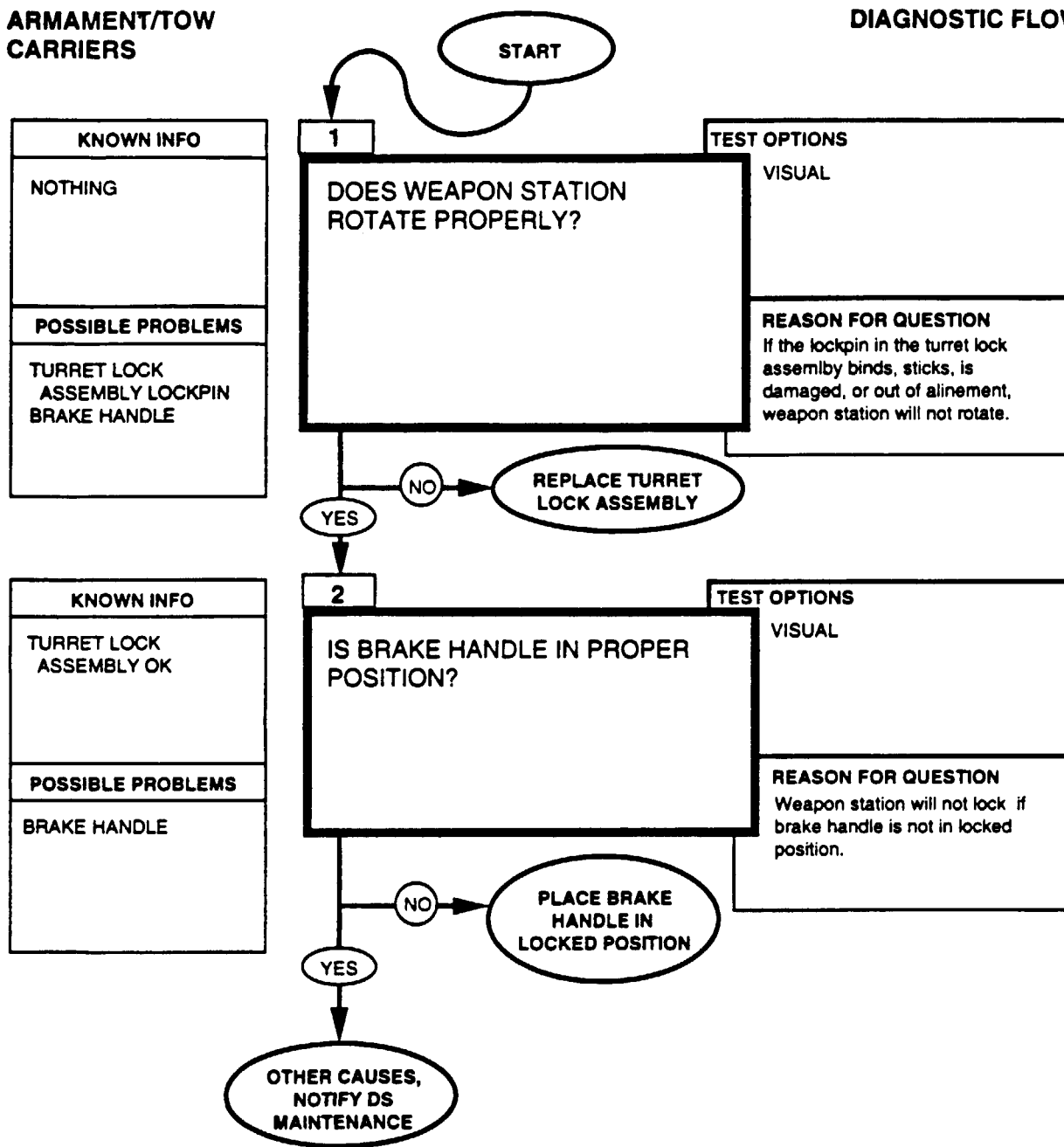
1. Connect RED clip and BLACK clip to the indicated terminals in question; RED to the first, BLACK to the second.
2. Start test 91, 0-4500 ohms.
3. Displayed reading is in ohms. Less than 5 ohms is continuity. If the resistance is over 4500 ohms, STE/ICE displays, "9.9.9.9."

### CONTINUITY (RESISTANCE) MULTIMETER

1. Set the voltmeter to an ohms scale of about 1000 ohms.
2. Connect the RED and BLACK leads to the connections stated in the question.
3. Be sure to read the correct scale. Less than 5 ohms indicates continuity. For an open circuit, the meter should peg full scale (needle all the way to the left).

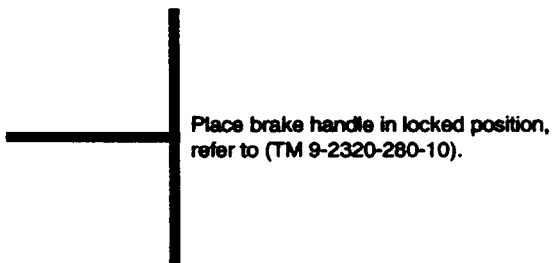
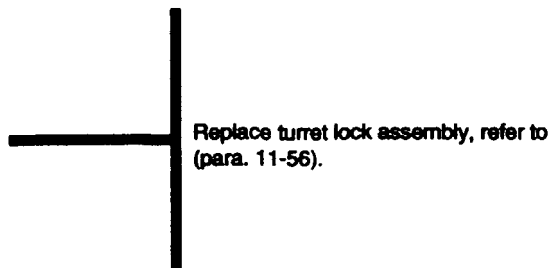
**ARMAMENT/TOW  
CARRIERS**

**DIAGNOSTIC FLOWCHART**



REFERENCE INFORMATION

ARMAMENT/TOW CARRIERS





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**2-42. DCA TROUBLESHOOTING**

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These DCA tests can be run anytime you think there is a problem with the vehicle's DCA or its on board transducers. Do not use this paragraph to test the STE/ICE-R and its cables and transducers. Refer to TM 9-4910-571-12&P to test the STE/ICE-R. This paragraph will also supply instructions on how to use the STE/ICE-R in the TK mode to substitute for tests run through the DCA.

The HMMWV is equipped with three transducers - the pulse tachometer, the fuel pressure transducer, and the current shunt. A power test (12, 13) or RPM test (10) uses the pulse tachometer. The fuel pressure test (24) uses the pressure transducer. All of the starting circuit tests and battery tests done through the DCA use the shunt. Check to see that the wires are connected to the transducer for the test you're trying to run. There is a four wire connector for the fuel pressure transducer, a two wire connector for the pulse tachometer, and there are four wires connected to the shunt in addition to the battery cables.

The fold-out page FO-16 gives a cross reference between DCA tests and TK tests. Use this cross reference to find out how to substitute TK tests for DCA tests if you have a bad DCA. The Location of Parts page has a schematic of the HMMWV DCA.

# DCA TROUBLESHOOTING

# DIAGNOSTIC FLOWCHART

KNOWN INFO
STE/ICE-R OK CABLES OK TK OK RUNNING A DCA TEST
POSSIBLE PROBLEMS
DCA TRANSDUCERS VEHICLE SYSTEMS

1

START

WERE YOU RUNNING A FUEL PRESSURE, RPM, OR POWER TEST?

YES

NO

GO TO A  
Page 2-728

TEST OPTIONS
SEE NOTE TO RIGHT ABOUT THIS PARAGRAPH.
REASON FOR QUESTION
You need to know which transducer is causing the problem.

KNOWN INFO
STE/ICE-R OK W1 CABLE OK
POSSIBLE PROBLEMS
DCA TRANSDUCERS VEHICLE SYSTEMS

2

WERE YOU RUNNING STE/ICE-R TEST #24, FUEL PRESSURE?

YES

NO

GO TO B  
Page 2-730

TEST OPTIONS
N/A
REASON FOR QUESTION
You need to know which transducer is causing the problem.

KNOWN INFO
STE/ICE-R OK W1 CABLE OK RUNNING TEST 24
POSSIBLE PROBLEMS
DCA TRANSDUCERS VEHICLE SYSTEMS

3

DISCONNECT CONNECTOR DIRECTLY BEFORE FUEL PRESSURE TRANSDUCER. INSPECT FOR BENT PINS. DOES EVERYTHING LOOK OK?

YES

NO

REPAIR OR REPLACE WIRING/ TRANSDUCER AS NEEDED

GO TO 4,  
Page 2-728

TEST OPTIONS
VISUAL INSPECTION
REASON FOR QUESTION
If the transducer pins are bent or broken you will get bad measurements.

## REFERENCE INFORMATION

## DCA TROUBLESHOOTING

### NOTE

The diagnostics in this chapter assume you have already run a test through the DCA. If you haven't run a test and are here to test the entire DCA, run tests 10 (RPM), 24 (Fuel Pressure) and 80 (BatteryCurrent) Make note of the results for later.

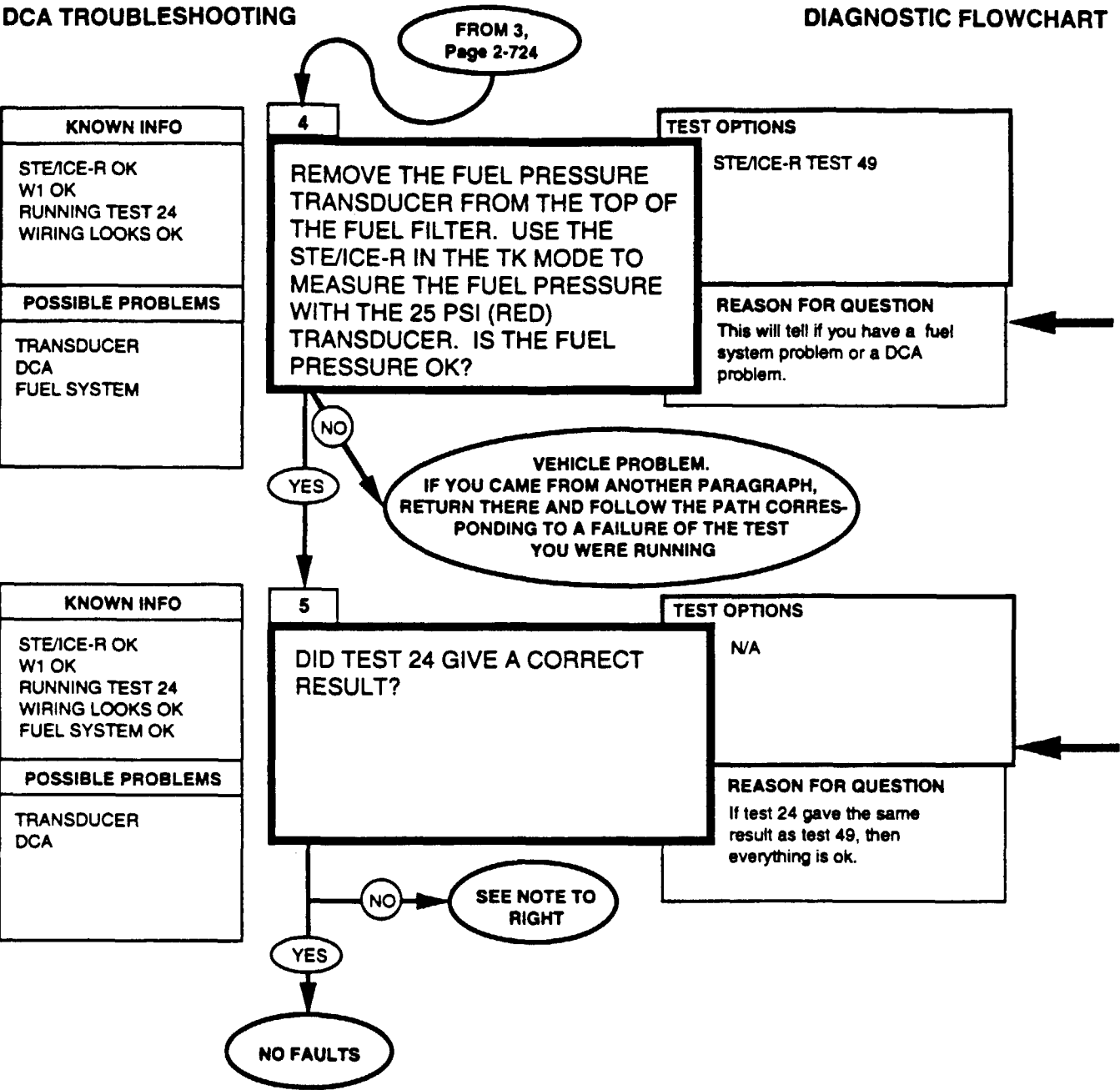
If you want to test the entire DCA harness, answer YES here and then return and answer NO when you've finished the test chain. Answer NO here to test the shunt.

Answer NO here to test the pulse tachometer.

Repair wiring or replace transducer, refer to (para 4-26).

DCA TROUBLESHOOTING

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## DCA TROUBLESHOOTING

The fuel pressure should always be greater than 3 psi. If you get about the same pressure with the 2 transducers, then you have a fuel system problem. Remove fuel pressure transducer, refer to (para 4-26). Make sure the STE/ICE-R is powered by a W5 cable.

### STE/ICE-R TEST 49 0 TO 25 PSIG PRESSURE

1. CONNECT RED TRANSDUCER TO FUEL FILTER.
2. CONNECT TRANSDUCER TO A W4 CABLE. MAKE SURE THE SYSTEM UNDER TEST IS NOT PRESSURIZED. CONNECT OTHER END OF W4 TO J2 OR J3. PERFORM OFFSET TEST.
3. TURN ON SYSTEM AND READ PRESSURE.

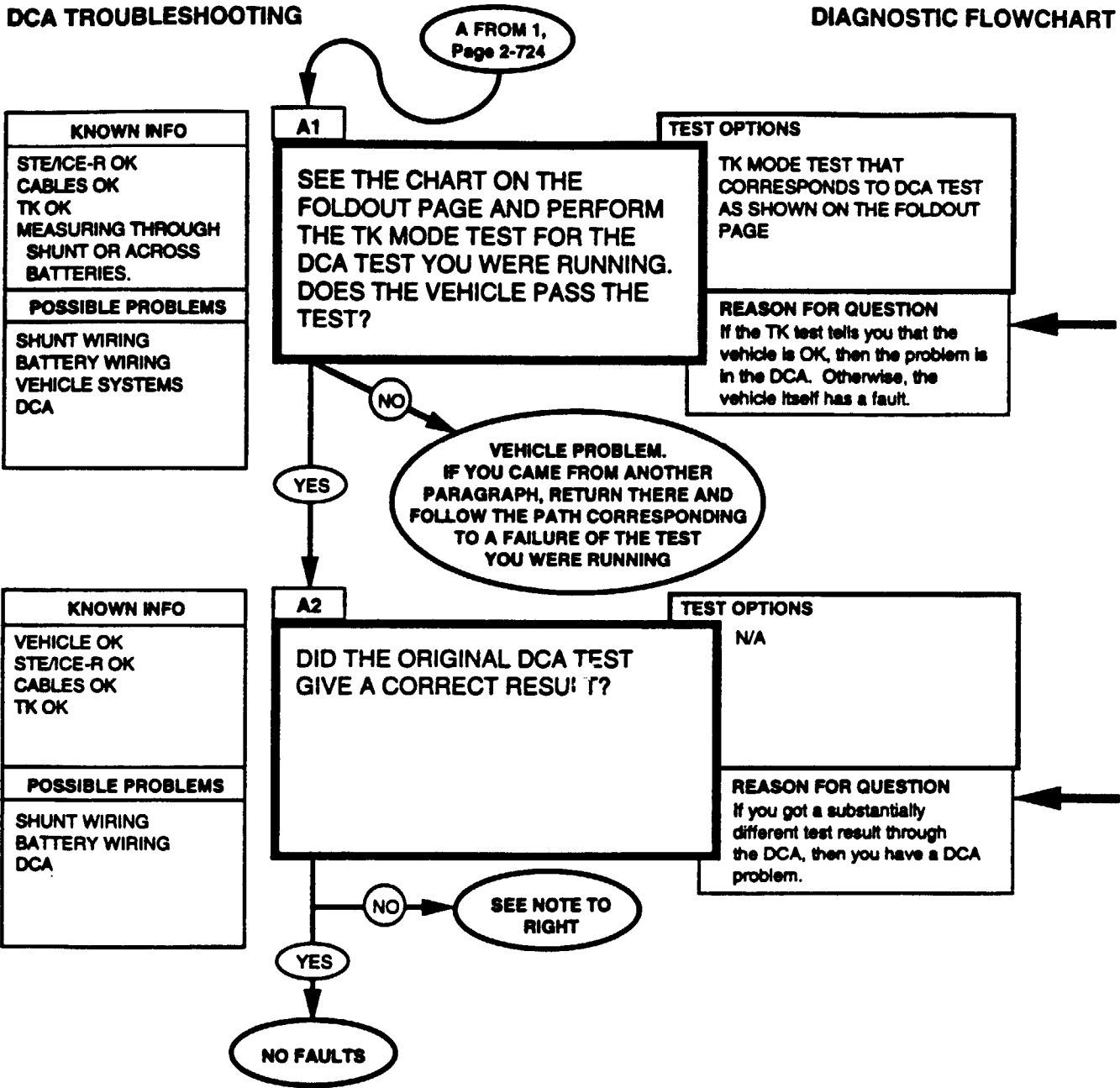
You will have to decide if test 24 gave the wrong result. If test 24 gave a substantially different result than test 49, answer NO to this question.

#### NOTE

VEHICLE DCA FAULTY. Use the STE/ICE-R in the TK mode for the rest of your testing. See the chart on the foldout page for a way to run the rest of the DCA tests in the TK Mode. Have DS maintenance repair the DCA when you're finished.

DCA TROUBLESHOOTING

DIAGNOSTIC FLOWCHART



## REFERENCE INFORMATION

## DCA TROUBLESHOOTING

Make sure the STE/ICE-R is powered by a W5 cable.

If the TK mode test tells you that the vehicle has a fault, then return to the paragraph you came from. If the vehicle tests OK, continue here.

You will have to decide if the DCA test result is wrong. If the TK test gave a substantially different result than the DCA test, answer NO to this question.

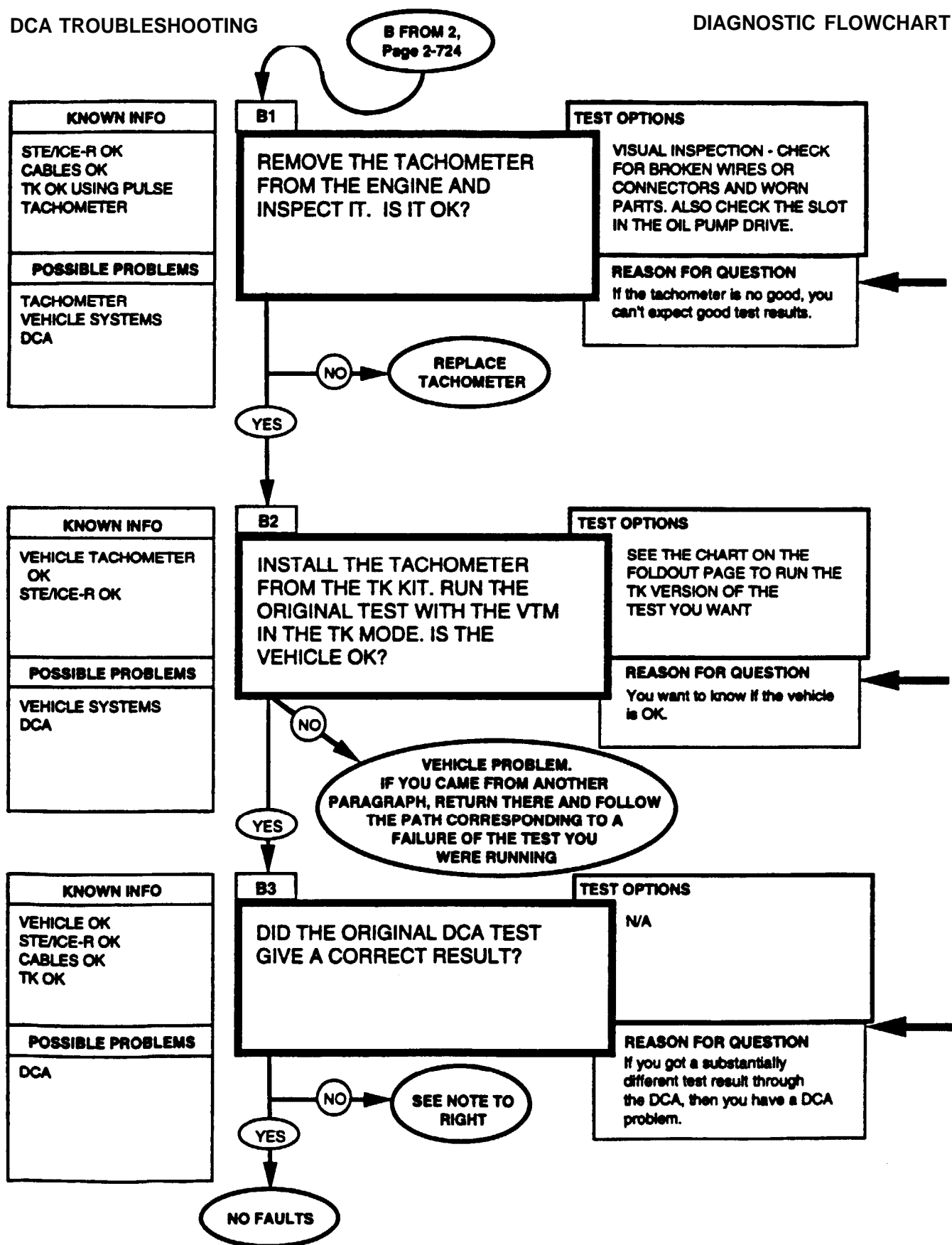
### NOTE

VEHICLE DCA FAULTY. Use the STE/ICE-R in the TK mode for the rest of your testing. See the chart on the foldout page for a way to run the rest of the DCA tests in the TK Mode. Have DS maintenance repair the DCA when you're finished.

You can check the connections at the shunt and the power stud to see if they are OK. Look at the schematic for help.

DCA TROUBLESHOOTING

DIAGNOSTIC FLOWCHART





## REFERENCE INFORMATION

## DCA TROUBLESHOOTING

Remove tachometer, refer to (para 4-13). If you find the tachometer defective, replace it and return to where you came from and rerun the original DCA test. If it fails again return to this question and answer "YES".

Make sure the STE/ICE-R is powered by the W5 cable.

If you don't find any faults in the vehicle, the slot in the oil pump drive could be too worn to drive the tachometer. If you see this, notify DS maintenance.

You will have to decide if the DCA test result is wrong. If the TK test gave a substantially different result than the DCA test, answer "NO" to this question.

### NOTE

Vehicle DCA faulty. Use the STE/ICE-R in the TK mode for the rest of your testing. See the chart on the foldout page for a way to run the rest of the DCA tests in the TK mode. Have DS maintenance repair the DCA when you're finished.

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**2-43. STE/ICE-R TEST PROCEDURES**


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This paragraph will be helpful when using the STE/ICE-R to answer diagnostic questions. Use this paragraph as a reference if you need additional information about a specific test. This paragraph contains information such as possible errors, test procedure, control codes, and additional notes as necessary. The following chart will help you find the test you need. The STE/ICE setup and internal checks (test no. G01, Page 2-763) must be performed prior to performing tests. A complete description and operation of the STE/ICE-R is found on Page 2-753. See TM 9-4910-571-12&P for additional information.

TEST NAME	TEST #	PAGE #
ENGINE RPM (AVERAGE)	10	2-734
POWER TEST (RPM/SEC)	12	2-735
POWER TEST (PERCENT)	13	2-736
COMPRESSION UNBALANCE TEST	14	2-737
FUEL SUPPLY PRESSURE (PSI)	24	2-733
PRESSURE (PSI) 0 TO 1000	50	2-739
BATTERY VOLTAGE	67	2-740
STARTER MOTOR VOLTAGE	68	2-741
STARTER NEGATIVE CABLE VOLTAGE DROP	69	2-742
STARTER SOLENOID VOLTS	70	2-743
STARTER CURRENT AVERAGE	71	2-744
CURRENT FIRST PEAK	72	2-745
BATTERY INTERNAL RESISTANCE	73	2-746
STARTER CIRCUIT RESISTANCE	74	2-747
BATTERY RESISTANCE CHANGE	75	2-748
BATTERY CURRENT	80	2-749
DC VOLTAGE 0 TO 45 VOLTS	39	2-750
DC CURRENT 0 TO 1500 AMPS	90	2-751
RESISTANCE AND CONTINUITY 0 TO 4500 OHMS	91	2-752

## ENGINE RPM (Average) TEST #10

### Description:

This procedure measures engine speed in the range 50 to 5000 RPM. At speeds below 50 RPM the VTM will display 0. At speeds above 5000 RPM the display may give a false reading. Test requires DCA hookup only.

### Pre-Test Procedures

Run Confidence Test.

### Typical Applications:

Check Engine Speed

### Possible Error Messages

E014 Incorrect # of cylinders entered

### Test Procedure:

1. Set TEST SELECT switches to 10
2. Press and release TEST button
3. Start engine
4. Observe displayed value (RPM).

## POWER TEST (RPM/SEC) TEST #12

### Description:

This procedure measures an engine's power producing potential in units of RFM/SEC. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test. Warm up engine to operating temperature.

### Typical Applications:

Check engine power in units of RPM/SEC.

### Possible Error Messages:

E009 Engine not running at start of test.  
 E011 Throttle control operated incorrectly.  
 E012 Ignition adapter/pulse tachometer missing.  
 E014 Incorrect number of cylinder entries.  
 E033 Error in entry of power test  
**constants**

### Test Procedure:

1. Start and idle engine
2. Set TEST SELECT switches to 10
3. Press and release TEST button
4. Observe displayed value (RPM) to adjust idle Speed if necessary.
5. Press down sharply on accelerator end observe displayed value (RPM) to adjust governor speed if necessary.
6. Set TEST SELECT switches to 12.
7. Press and release TEST button.
8. Wait for prompting message CIP to appear.
9. When CIP appears on display, press down sharply on engine accelerator end hold it to the floor. When VTM displays a number, release accelerator.
10. Observe displayed value (RFM/SEC).

### NOTES

Engine idle speed must rechecked before performing power test. Idle speed must be within the range 625-675 RPM (6.2L and 6.5L) range to run test.  
 Engine governor no bad speed must be checked before performing power test. Governor no-load speed must be within the 3900-4100 RPM (6.2L) end 3600-3600 RPM (6.5L) range to run test.

## POWER TEST (PERCENT) TEST #13

### Description:

This procedure measures the percentage of engine's power producing potential as compared to a good engine. Test requires DCA hookup only.

### Pm-Test Procedures:

Run Confidence Test. Warm up engine to operating temperature.

### Typical Applications:

#### Check engine power

### Possible Error Messages:

E009 Engine not running at start of test.  
E011 Throttle control operated incorrectly.  
E012 Ignition adapter/pulse tachometer missing.  
E024 Test not valid for VID entered

### Test Procedure:

1. Start and idle engine
2. Set TEST SELECT switches to 10
3. Press and release TEST button
4. Observe displayed value (RPM) to adjust idle speed if necessary.
5. Press down sharply on on engine accelerator and observe displayed value (RPM) to adjust governor speed if necessary.
6. Set TEST SELECT switches to 13.
7. Press and release TEST button.
8. Wait for prompting message CIP to appear.
9. When CIP appears on display, press down sharply on engine accelerator and hold it to the floor. When VTM displays OFF, release accelerator.
10. A number will be displayed after the engine has returned to idle speed. This number is the test result in units of percent of nominal rated power.

### NOTES:

Engine idle speed must be checked before performing power test. Idle speed must be within the 625-675 RPM (6.2L and 6.5L) range to run test. Engine governor no load speed must be checked before performing power test. Governor no load speed must be within the 3600-3800 RPM (6.2L) and 3900-4100 RPM (6.5L) range to run test.

**COMPRESSION UNBALANCE TEST #14 (6.2L ONLY)****Description:**

This procedure compares the compression between the highest and lowest cylinders and displays the unbalance in percent. Test requires DCA hookup only.

**Pre-Test Procedures:**

Run Confidence Test. Warmup engine to operating temperature. Run first-peak series tests 72,73,74, 75.

**Typical Applications:**

Check compression unbalance of engine with VTM powered from battery of vehicle being tested.

**Possible Error Messages:**

E006 VTM doesn't detect battery Voltage.  
 E013 VTM cannot use data received.  
 E027 Error in entry of compression Unbalance constants.  
 E032 Vehicle's cranking speed is varying too much for a compression unbalance measurement.

**Test Procedure:**

1. Set up engine to prevent Starting by disconnecting wire 54A. Stop Engine. Shut off fuel before cranking. Crank engine without fuel for 5 seconds to clear fuel from cylinders.
2. Set TEST SELECT switches to 14.
3. Press and release TEST button.
4. Wait until GO appears on display before proceeding.
5. When GO appears, crank engine. Display will change to while engine is turning.
6. When OFF or E013 appears, stop cranking.
7. If OFF appears, wait for message to appear.
  - (A) The number displayed will be the percent unbalance between the highest and lowest cylinders. A number above 25 is a failure.
  - (B) If GO appears, repeat from step 2.
  - (C) A FAIL message usually means compression is too far unbalanced to measure with STE/ICE.

**NOTE**

If E013 appears, test data cannot be analyzed because of weak batteries, or interrupted cranking during test. Correct problem and repeat from Step 2.

## FUEL SUPPLY PRESSURE (psi) TEST # 24

### Description:

This procedure measures the return pressure, in order to detect line blockage, leaks or insufficient restrictor back pressure. Test requires DCA hookup only.

### Pre-Test Procedure-

Run Confidence Test. Wait for 1 minute after turning engine off to run this test.

### Typical Applications:

Fuel Supply Pressure

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Turn off vehicle.
2. Set TEST SELECT switch to 24.
3. Press and hold TEST button until CAL appears on display.
4. Release TEST button and wait for offset value to appear on display. If offset is within -15 to 15 proceed. If not, go to DCA Troubleshooting Procedure
5. Press and release TEST button.
6. Start engine
7. Observe displayed value.

### Possible Error Messages:

E005 offset not performed.

## PRESSURE (psi) 0 TO 1000 TEST #50

### Description:

This procedure measures pressure, in the 0 to 1000 PSIG range. Test requires the use of the TK adapters and transducers.

### Pre-Test Procedures

Run Confidence Test.

### Typical Applications:

Oil Pressure

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Attach connector P1 of cable W4 to J2 TK or J3 TK.
2. Install blue striped pressure transducer where pressure is to be measured. Attach connector P2 of cable W4 to transducer.
3. Set TEST SELECT switch to 50. Press and hold TEST button until CAL appears on display.
4. Release TEST button and wait for offset value to appear on display. If offset is within -150 to 150 proceed. If not, go to DCA Troubleshooting Procedure.
5. Energize system
6. Press and release TEST button.
7. Observe displayed value.

### Possible Error Messages

E005 Offset not performed.  
E002 Transducer not connected



## BATTERY VOLTAGE TEST #67

### Description:

This procedure measures battery voltage in the 9 to 32 range volts. The voltage is measured directly at the power source of the VTM, and maybe done with the vehicle operating or shut down. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test.

### Typical Applications:

Check Battery Voltage

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Set TEST SELECT switch to 67.
2. Press and release TEST button.
3. If .9.9.9.9 is displayed, voltage is not within the test range.
4. Observe displayed value (volts).

### Possible Error Messages:

none

## STARTER MOTOR VOLTAGE TEST #68

### Description:

This procedure measures the voltage present at the starter motor positive terminal, in the 0-32 volts range. Test requires DCA hookup only.

### Pm-Test Procedures:

Run Confidence Test.

### Typical Applications:

Check Starter Motor Voltage

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Disconnect Fuel Solenoid wire 54A to prevent starting.
2. Set TEST SELECT switch to 68.
3. Press and release TEST button.
4. Crank the engine and observe the displayed Voltage.

### Possible Error Messages:

none

## STARTER NEGATIVE CABLE VOLTAGE DROP TEST #69

### Description:

This procedure measures the voltage drop on the starter path. A high voltage (>2V) indicates excessive ground path resistance. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test.

### Typical Applications:

Check Starter Negative Cable Voltage Drop.

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Disconnect Fuel Solenoid wire 54A to prevent starting.
2. Set TEST SELECT switch to 69.
3. Press and release TEST button.
4. Crank the engine and observe the displayed voltage.

### Possible Error Messages:

None

**STARTER SOLENOID VOLTS TEST #70****Description:**

This procedure measures the voltage present at the starter solenoids positive terminal. Test requires DCA hookup only.

**Pre-Test Procedures:**

Run Confidence Test.

**Typical Applications:**

Check Starter Solenoid Volts.

**Control Functions:**

01,02,03,04,08

**Test Procedure:**

1. Disconnected Fuel Solenoid wire 54A to prevent starting.
2. Set TEST SELECT switch to 70.
3. Press and release TEST button.
4. Crank the engine and observe the displayed voltage.

**Possible Error Messages:**

None

## STARTER CURRENT AVERAGE TEST #71

### Description:

This procedure measures the average starter current in the 0 - 1000 amps range. Test requires DCA hookup only.

### Pre-Test Procedures

Run Confidence Test.

### Typical Applications:

Check Starter Current.

### Control Functions:

01,02,03,04,08

### Test Procedure:

1. Disconnect fuel solenoid wire 54A to prevent starting.
2. Set TEST SELECT switch to 71.
3. Press and hold TEST button until CAL appears on display.
4. Release TEST button and wait for offset value to appear on display. If offset is within -150 to 150, proceed. If not, go to DCA Troubleshooting Procedure.
5. Press and release TEST button.
6. Crank engine.
7. Observe the displayed starter current.

### Possible Error Messages

E005 Offset not performed.

**CURRENT FIRST PEAK TEST #72****Description:**

This procedure measures the overall condition of the complete starting system. Test requires DCA hookup only.

**Pre-Test Procedures:**

Run Confidence Test. Warm up engine to operating temperature. Turn off all electrical accessories.

**Typical Applications:**

Check condition of starting system on C1 engines with VTM powered from battery of vehicle tested.

**Possible Error Messages:**

E002 Transducer not connected.  
 E005 Offset not performed.  
 E008 VTM does not detect battery voltage.  
 E013 VTM cannot use data received.  
 E020 No first peak information was detected by the VTM.  
 E021 VTM cannot calculate result because current is over current probe's range.

**Test Procedure:**

1. Disconnect fuel solenoid wire 54A to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 72.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display. If offset is within the range -150 to 150, proceed. If not, go to DCA Troubleshooting Procedure.
6. Press and release TEST button.
7. When GO appears on display, crank engine for 2 seconds or until one of the following appears on the display OFF
  - .9.9.9.9
  - A number
  - An error message
8. Observe displayed value (amps).

**NOTES:**

If .9.9.9.9 is displayed, current first peak was too high and cannot be measured with VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persists after 3 tests, VTM cannot perform test.

## BATTERY INTERNAL RESISTANCE TEST #73

### Description:

This procedure measures the internal battery resistance. Internal battery resistance is a measure of the state of the batteries. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test. Turn off all electrical accessories.

### Typical Applications:

Evaluate batteries on CI engines with VTM being powered from battery of vehicle tested.

### Possible Error Messages:

E002 Transducer not connected  
E005 Offset not performed  
E008 VTM does not detect battery voltage  
E013 VTM cannot use data received.  
E020 No first peak information was detected by the VTM.  
E021 VTM cannot calculate result because current is over current probe's range.

### Test Procedure:

1. Disconnect fuel solenoid wire 54A from the injector pump to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 73.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display. If offset is within the -150 to 150 range, proceed. If not, go to DCA Troubleshooting Procedure
6. Press and release TEST button.
7. When GO appears on display, crank engine for 2 seconds or until one of the following appears on the display  
OFF  
.9.9.9.9  
A number  
An error message
8. Observe displayed value (milliohms). The limit is 25 milliohms per battery pair.
9. Test #75 is Battery Resistance Change. You can run that test after this one if you want to.

### NOTES:

If .9.9.9.9 is displayed, battery internal resistance was too high and cannot be measured with VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persists after 3 tests, VTM cannot perform test.

## STARTER CIRCUIT RESISTANCE TEST #74

### Description:

This procedure measures starter circuit resistance. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test Warm up engine to operating temperature. Turn off all electrical accessories.

### Typical Applications:

Check resistance of complete starting system in CI engines with VTM powered from batteries of Vehicle being tested.

### Possible Error Messages

E002 Transducer not connected.  
 E005 Offset not performed.  
 E003 VTM does not detect battery voltage.  
 E013 VTM cannot use data received.  
 E020 No first peak information was detected by the VTM.  
 E021 VTM cannot calculate result because current is over current probe's range.

### Test Procedure:

1. Disconnect fuel Solenoid wire 54A to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 74.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display. If offset is within the range -150 to 150, proceed. If not, go to DCA Troubleshooting Procedure.
6. Press and release TEST button.
7. When GO appears on display, crank engine for 2 seconds or until one of the following appears on the display OFF
  - .9.9.9.9
  - A number
  - An error message
8. Observe displayed value(milliohms).

### NOTES

If .9.9.9.9 is displayed, the starter circuit resistance value was too high and cannot be measured with VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persists after 3 tests, VTM cannot perform test.



## BATTERY RESISTANCE CHANGE TEST #75

### Description:

This procedure measures the change of battery resistance. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test. Warm up engine to operating temperature. Turn off all electrical accessories.

### Typical Applications:

Evaluate batteries in CI engines with VTM powered from batteries of vehicle being tested.

### Possible Error Messages

E002 Transducer not connected.  
E005 Offset not performed.  
E006 VTM does not detect battery voltage.  
E013 VTM cannot use data received.  
E020 No first peak information was detected by the VTM.  
E021 VTM cannot calculate result because current is over current probe's range.

### Test Procedure:

1. Disconnect fuel solenoid wire 54A to prevent starting.
2. Make sure all vehicle accessories are off.
3. Set TEST SELECT switches to 75.
4. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display. If offset is within the -150 to 150 range, proceed. If not, go to DCA Troubleshooting Procedure.
6. Press and release TEST button.
7. When GO appears on display, engage starter for 2 seconds or until one of the following appears on the display  
OFF  
.9.9.9.9  
A number  
An error message
8. Observe displayed value (milliohms/second). The limit is 50 milliohms per battery pair. A lower number is better than a higher one.

### NOTES

If .9.9.9.9 is displayed, the battery resistance change value is beyond the range of the VTM and cannot be measured with the VTM.

If E013 is displayed, then check battery connections and correct as necessary. Repeat Step 6. If E013 persists after 3 tests, VTM cannot perform test.

## BATTERY CURRENT TEST #80

### Description:

This procedure measures current to or from the battery. Test requires DCA hookup only.

### Pre-Test Procedures:

Run Confidence Test.

### Typical Applications:

Evaluate batteries in CI engines.

### Control Functions

01,02,03,04

### Test Procedure:

1. set TEST SELECT switch to 80.
2. Press and hold TEST button until CAL appears on display.
3. Release TEST button and wait for offset value to appear on display. If offset is within -150 to 150, proceed. If not, go to DCA Troubleshooting Procedure.
4. Press and release TEST button.
5. Observe displayed value (amps).

### Possible Error Messages:

E005 Offset not Performed.

## DC VOLTAGE 0 TO 45 VOLTS TEST #89

### Description:

This procedure measures voltage in the range of -45 to 45 volts. The VTM is used as a DC voltmeter with the decimal point in the correct position. This test must be done with the component being tested turned on. Test requires the use of the TK adapters and transducers

### Pre-Test Procedures

Run Confidence Test.

### Typical Applications:

- Fuel Solenoid
- Starter Solenoid
- Alternator Output
- Any DC Voltage measurement

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Connect test probe cable W2. Attach P1 to J4.
2. Connect the desired test leads to P2.
3. Set TEST SELECT switch to 89.
4. Short leads together. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display.
6. If offset is within -6.8 to 6.8 proceed. If not, go to DCA Troubleshooting Procedure.
7. Press and release TEST button. Observe displayed value.

### Possible Error Messages

E005 Offset not performed.

**DC CURRENT 0 TO 1500 AMPS TEST #90****Description:**

This procedure measures DC current in the range of 0 to 1500 amps. The VTM is used as an ammeter with the decimal point in the right position. This test may be done with the vehicle/equipment operating. Test requires the use of the TK adapters and transducers.

**Pre-Test Procedures**

Run Confidence Test.

**Typical Applications:**

- Alternator output
- Average Starter Current
- Battery Current
- Any DC Current up to 1500 Amps

**Control Functions:**

01,02,03,04,06

**Test Procedure:**

1. Connect test probe cable W4.
2. Attach P1 to J2 or J3. Connect the Current Probe to P2.
3. Set TEST SELECT switch to 90.
4. Clamp probe to de-energized wire.
5. Press and hold TEST button until CAL appears on display.
6. Release TEST button and wait for offset value to appear on display. If offset is within 225 to -225 proceed. If not, go to DCA Troubleshooting Procedure.
7. Energize circuit. Press and release TEST button.
8. Observe displayed value. A negative reading indicates the probe is backwards. Reverse and repeat from step 4.

**Possible Error Messages**

E002 Offset not performed.  
E005 Transducer not connected.

## RESISTANCE AND CONTINUITY 0 TO 4500 OHMS TEST #91

### Description:

This procedure measures resistance in the range of 0 to 4500 ohms. The VTM is used as an ohmmeter, and test results are always displayed with the decimal point in the right position. Additionally, any voltage present in the device being tested will adversely affect test results. Make sure the circuit or component being tested is shut off. Test requires the use of the TK adapters and transducers.

### Typical Applications:

- Continuity checks
- Resistance measurements
- Switch and relay functions

### Pre-Test Procedures

Run Confidence Test.

### Control Functions:

01,02,03,04,06

### Test Procedure:

1. Connect test probe cable W2. Attach P1 to J4.
2. Connect the desired test leads to P2.
3. Set TEST SELECT switch to 91.
4. Short leads together. Press and hold TEST button until CAL appears on display.
5. Release TEST button and wait for offset value to appear on display.
6. If offset is within -225 to 225 proceed. If no go to DCA Troubleshooting Procedure
7. Press and release TEST button. Observe displayed value.

### Possible Error Messages

E005 Offset not Performed.  
E022 External voltage detected while measuring resistance.

**a. STE/ICE-R Description and Operation.** The following describes the operation of the Simplified Teat Equipment/Internal Combustion Engines (STE/ICE-R) system and contains detailed operating procedures. It is used to test the serviceability of HMMWV vehicles and to perform primary fault detection and isolation. After the technician has identified a faulty part or subsystem, he is referred to a paragraph number for replacement or repair procedures for individual parts.

**b. Description and Operation.** STE/ICE-R is a testing system that performs tests and measurement on internal combustion engines. STE/ICE-R measures standard voltage, current, resistance, pressure, temperature, and speed. Special tests, such as compression balance tests and starter system evaluations, are performed by STE/ICE-R. Standard equipment functions including vacuum pressure gauge, compression gauge, low-current tester, and multimeter are features of the STE/ICE-R set. STE/ICE-R is portable and operates on either 12- or 24-volt vehicle batteries or equivalent power source. The STE/ICE-R system consists of a vehicle test meter (VTM), a transducer kit (TK), four electrical cables, a transit case, and technical publications.

### **c. Vehicle Test Meter.**

**1. General.** The VTM provides a method for the technician to test vehicle electrical and mechanical components. Readings are either pass/fail indications or digital displays in units familiar to the technician (psi, rpm, volts, ohms, amps, etc.). The diagnostic connector assembly (DCA) is permanently mounted in the vehicle and provides accessibility to the most frequently needed test points. The use of the VTM through the DCA is referred to as DCA mode. The VTM interfaces with the vehicle directly with a transducer from the transducer kit (TK). The use of the VTM through the TK is referred to as TK mode. The DCA and the TK can be used at the same time. This may be necessary when the diagnostic connector assembly has a missing transducer. If a transducer is missing, a no sensor indication (E002) is displayed when a measurement is made. If this happens, the TK mode can be used to make the measurement. The use of the VTM through the DCA and TK is referred to as the combined mode. Additional tests can be done that involve manually probing and/or connecting transducer to appropriate test points. Operating power for the VTM is drawn from the vehicle batteries or some equivalent battery source. Power is routed to the VTM through the DCA connected to the battery. The STE/ICE-R general purpose testing capabilities that may be applied to the vehicle are: 0-1000 psi pressure, 0-45 volts dc and 0-40k ohms resistance. The following control functions can be performed in conjunction with the special tests: interleave (displays rpm with next test), display maximum value, and display minimum value, and display peak-to-peak value.

**2. Controls and Indicators.** The controls and readout display on the VTM are illustrated. The following paragraphs describe how the controls are used and how the display functions.

**(a) Power Switch (PUSH ON/PULL OFF).** The power switch controls DC power to the VTM. The VTM can operate from a 12-volt or 24-volt battery system. When the power switch is pushed in (PUSH ON), the VTM power is on. To shut the VTM off, pull out the power switch (PULL OFF). The power switch contains a 4-amp circuit breaker. The power switch will pop out automatically if something is wrong which causes the VTM to use more power than it should. If the switch pops out, check your hookup carefully and try again before returning the VTM to direct support maintenance.

**(b) TEST SELECT Switches.** The TEST SELECT switches are used to select the actual test to be performed. There are ten positions on each switch numbered 0 through 9. The number dialed into these switches is read by the VTM when you press the test button. Changing the TEST SELECT switch positions has no effect until the TEST button is pushed.

**(c) TEST Button.** Depressing and releasing the TEST button causes the test measurement to begin. Observe the measured value on the readout display. The reading will be in units normally used for the particular vehicle measurement. These units are listed on the flip cards. The TEST button must be pressed and immediately released. Depressing and holding the TEST button down initiates an offset test. Offset tests are described in TM 9-4910-571-12&P.

**(d) Readout Display.** The readout display will show different types of readouts during testing up to a maximum of 4-characters (for example .8.8.8.8). The types of readouts are described in detail in paragraph 3 below and are summarized as follows:

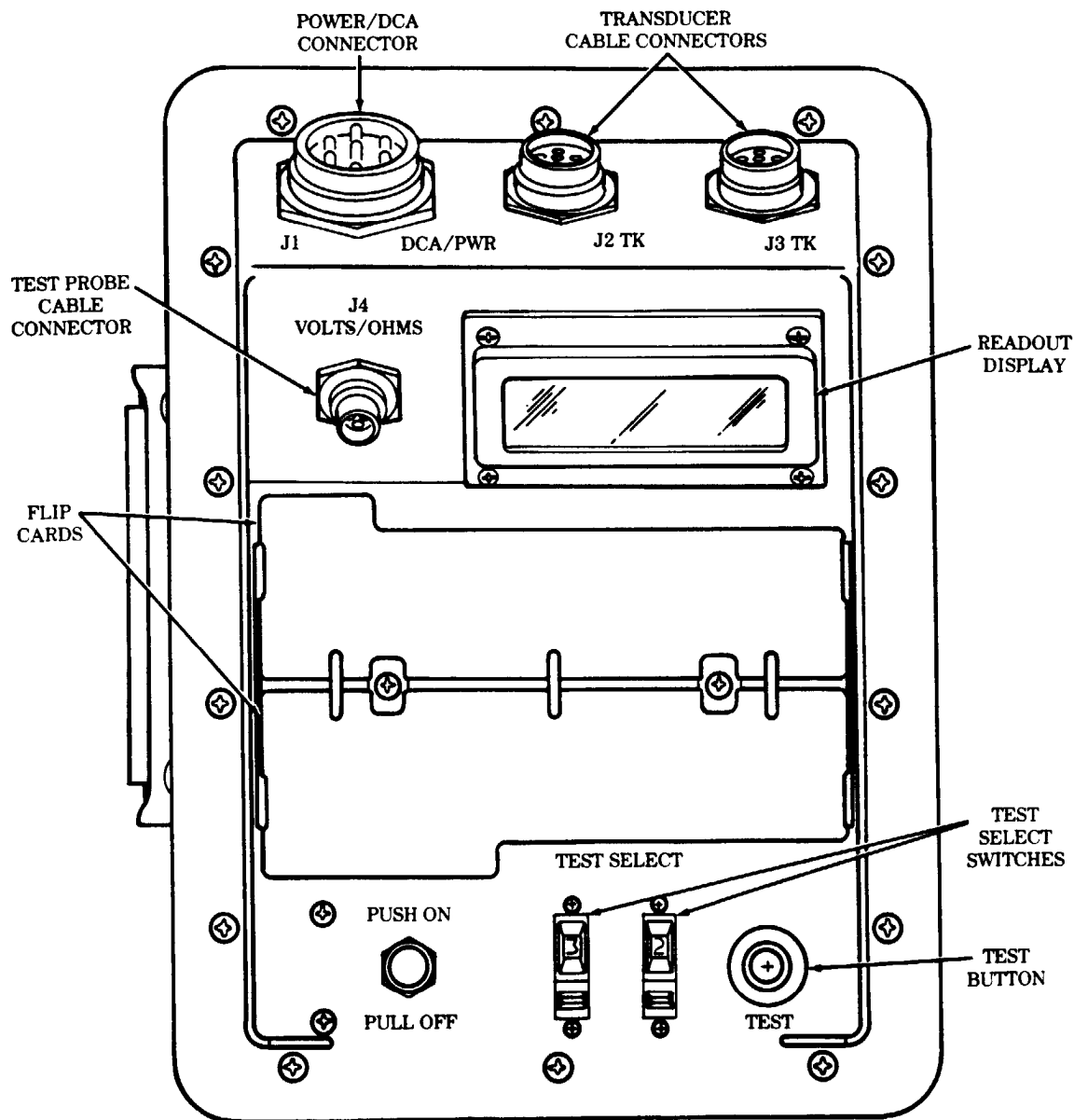
**(1) Statue Readout.** This type of readout keeps the technician informed of what is happening, such as power applied, failed test, etc.

(2) **Numerical Readout.** This type of readout is the measured value in units of the measurement being made. If you are measuring 0-45 volts dc, the number 24 on the display indicates 24 volts.

(3) **Error Readout.** This type of readout indicates that the wrong test number was selected, the transducer is not connected, or the VTM is faulty.

(e) **Flip Cards.** The flip cards list the 2-digit test number system for selecting the various tests. The cards also summarize the test and operating instructions contained herein.

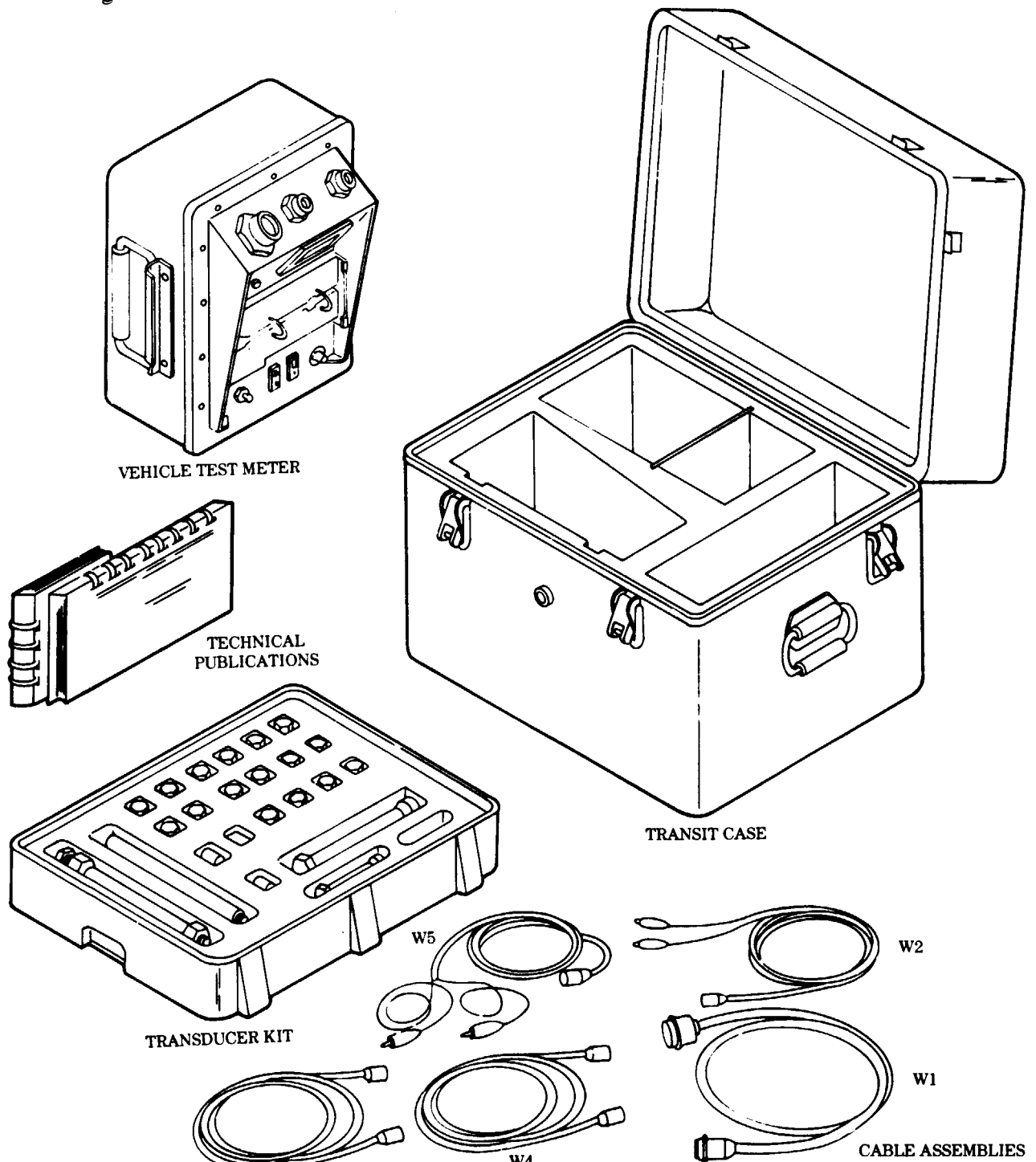
(f) **Power/DCA Connector J1.** Connector J1 connects the VTM to either a vehicle diagnostic connector using the DCA cable, or to the vehicle batteries using the power cable. Operating power and signals from the installed transducers are supplied to the VTM through the DCA cable.



VTM CONTROLS AND READOUT DISPLAY

**(g) Transducer Cable Connectors J2, J3.** Connector J2 or J3 connects the VTM to any transducer in the transducer kit. Operating power is supplied to the transducer and signals from the transducers are supplied to the VTM through the cable. Connectors J2 and J3 are identical and can be interchanged with each other or used in combination.

**(h) Test Probe Cable Connector J4.** Connector J4 connects test leads to the VTM when doing manual voltage resistance tests.

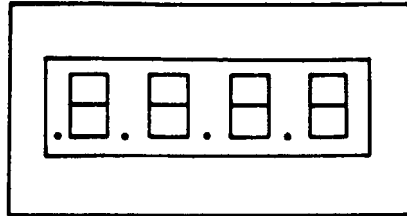


SIMPLIFIED TEST EQUIPMENT INTERNAL COMBUSTION ENGINE (STE/ICE) SYSTEM

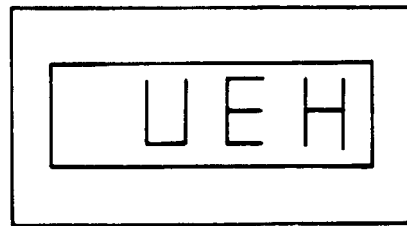


**3. Readouts.** The following paragraphs describe the different types of readouts that can occur during testing.

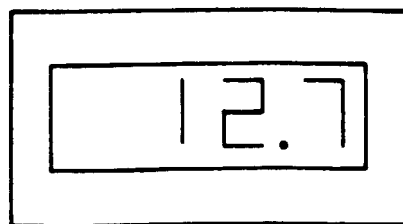
**(a) Status Readout.** A status readout keeps the technician informed of what is happening. For example, .8.8.8.8 is displayed each time the power switch is pushed on. It means that power is applied, and that all elements of the display are operative, it changes to --- 1.5 seconds later, indicating that the VTM is ready to be used for testing. The status readout displays are described in table 2-1.



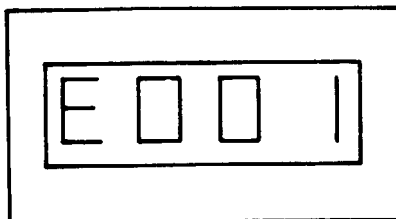
**(b) Prompting Message.** A prompting message is a technician action message. It is a signal for you to do something such as crank the engine. For example, UEH tells you to enter the vehicle type identification number into the VTM. After the technical action is performed, the test will automatically continue. Prompting messages are listed in table 2-2.



**(c) Numerical Readout.** A numerical readout is the measured value in units of the measurement being made. For example, if you are measuring 0-45 volts dc, 12.7 is volts dc. If you are measuring 0-25 psig pressure, 12.7 is psig. The units for each test are listed on the flip card. The numbers displayed in the VTM are always positive unless there is a minus shown to make them negative.



(d) **Error Readout. E0001 is a typical error readout.** There are 15 different readouts. All error readouts start with E. An error readout is a warning that you forgot to connect the transducer, selected a wrong test number, failed to start the engine, etc. All of the error messages mean you must correct the problem before continuing testing. Error readouts are listed in table 2-3. If the error message does not go away after corrective action, refer to TM 9-4910-571-12&P.



(e) **Confidence Error Readouts. C004 is a typical error readout** resulting from the detection of a faulty VTM during confidence test. For detailed information concerning confidence error readouts refer to TM 9-4910-571-12&P.

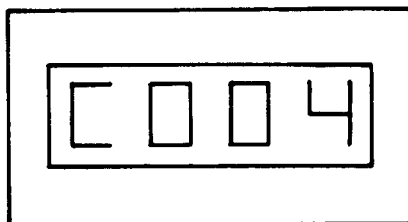


Table 2-1. Status Readouts.

VTM Readout	Interpretation
.8.8.8.8	A readout of .8.8.8.8 appears for 1 to 2 seconds each time the power is applied to the VTM. It means that there is power to the VTM, and that all elements of the readout display are operative.
---	A readout of ---- indicates the following <ul style="list-style-type: none"> <li>(1) After power turn on it signifies that the VTM is ready for testing.</li> <li>(2) During a compression unbalance test it signifies testing is in progress.</li> </ul>
.9.9.9.9	A readout of .9.9.9.9 indicates that the VTM is reading a test value beyond the range of its measurement, capability. Either (1) the wrong test number is selected for the parameter being measured, or (2) there is a fault in the vehicle.
PASS FAIL	A PASS or FAIL readout is the result of a test that checks the condition of a component being measured. A PASS/FAIL readout means just that — the component either passes the test or fails the test.

Table 2-2. Prompting Messages

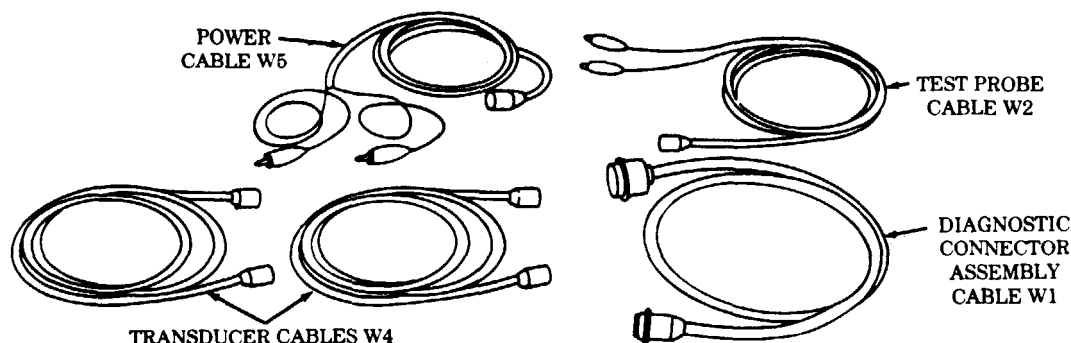
VTM Readout	Interpretation
UEH	Signal to ECT switches. Vehicle ID numbers are found under TEST DATA on the flip card, on the vehicle test cards.
Go	Signal to technician to crank engine in compression balance or first peak tests.
OFF	Signal to technician to stop cranking in compression balance test or to release the accelerator in the CI over test.
CAL	Signal to the technician to release the TEST button during an offset test.
66	Numbers are used for prompting messages in several tests. In confidence test, a readout of 66 signals the technician to dial in 99. In test no. 12, the first numerical readout signals the technician to shut off fuel.

Table 2-3. Error Readouts

VTM Readout	Interpretation
E000	Occurs if you request the VTM for information it does not have. For example, if you request the vehicle ID and it has not been entered.
E001	Occurs in either the DCA or TK mode of operation. It indicates that a non-existent test number has been dialed into the TEST SELECT switches.
E002	Indicates that the required transducer is not connected.
E003	Indicates that a test number has been dialed which does not apply to the vehicle under test. It can only occur in the DCA mode.
E004	Indicates that a vehicle identification number or number of cylinders information has not been entered.
E005	Indicates that the transducer offset test was not performed.
E007	Indicates a conflict between the vehicle identification number (VID) dialed in the the number of cylinders dialed in. It may occur in response to either VID entry or number-of-cylinders entry.
E008	Indicates the VTM is not receiving the required voltage signal for the test selected. This error code is related only to starter and compression balance tests.
E009	Indicates that the engine was not running at the start of the test.
E010	Indicates that a wrong vehicle identification number was dialed into the VTM.
E011	Indicates that throttle control was operated incorrectly during power test taking too much time to either accelerate or decelerate.
E013	Indicates bad data were taken for the test in progress. Repeat the test one (1) time.
E014	Indicates that a wrong number of cylinders was dialed into the VTM.
E018	Indicates that an engine RPM or AC frequency test was terminated automatically to protect the VTM. Termination is only after several minutes of no-signal operation. Most likely the VTM was left on the vehicle and the engine stalled.

#### d. Cable Assemblies.

1. **General.** The cable assemblies are shown below and are referred to by the cable number and by a name which describes how the cable is used. If necessary, the two transducer cables (W4) can be joined with the adapter supplied in the transducer kit to make one long cable.



CABLE ASSEMBLIES

2. **Installation.** When cables are connected, large key on the cable connector mates with a keyway on the transducer connector or the VTM connector for proper installation. If you experience any difficulty during testing and suspect that a cable is bad, refer to TM 9-4910-571-12&P for checking cable continuity.

#### e. Transducer Kit.

Table 2-4. Transducer Kit Components

ITEM NO.	TK NO.	PART NO.	QTY	ITEM
1	10	11669227	1	Hose and fitting assy (spark plug adapter)
2	11	12258878	1	Current probe
3	12	12258853-1	1	Pipe thread reducer, 3/4 MPT to 1/4 FPT
4	13	12258853-3	1	Pipe thread reducer, 1/2 MPT to 1/4 FPT
5	14	12258853-2	2	Pipe thread reducer, 3/8 MPT to 1/4 FPT
6	15	444620	1	Hex head plug, 1/4 MPT
7	16	5327970	1	Hex head plug, 1/8 MPT
8	17	12258876	1	Pressure transducer, 0-1000 psig
9	21	12258881	1	Snubber
10	20	3204X2	2	Adapter, 1/8 MPT to 1/4 FPT
11	19	3304X2	1	Coupling reducer, 1/8 FPT to 1/4 FPT
12	18	234X5	1	Male connector, 5/16 tube to 1/4 MPT
13	22	12258877	1	Pressure transducer, -30 in. Hg to 25 psig
14	23	444152	1	Street tee, 1/2 pipe thread
15	24	3750X4	1	Street tee, 1/4 pipe thread
16	25	547002	1	Street tee, 1/8 pipe thread
17	26	12258879-2	1	Street elbow, 1/4 pipe thread
18	27	12258879-1	1	Street elbow, 1/8 pipe thread
19	34	12258875	1	Pulse tachometer
20	32	12258880	1	Fuel line adapter
21	31	MS53099-2	1	Tachometer drive adapter
22	30	7540877	1	Ignition adapter
23	29	MS3119E14-19	1	Adapter (connector-to-connector)
24	28	12258762	1	Tee, inverted flare
25	33	8840543	1	Air chuck
26	35	11669236	1	Hose assembly, 1/8 MPT
27	36	12258852	1	Pipe nipple, 1/8 MPT

**1. General.** The transducer kit contains a pulse tachometer transducer, a pressure and a vacuum transducer and the necessary adapters (bushing, plugs, tees, etc.). Also included in the kit is a current probe for measuring current and a test probe cable for measuring voltage and resistance.

Not all fittings have part number markings. The legend will help to identify the items.

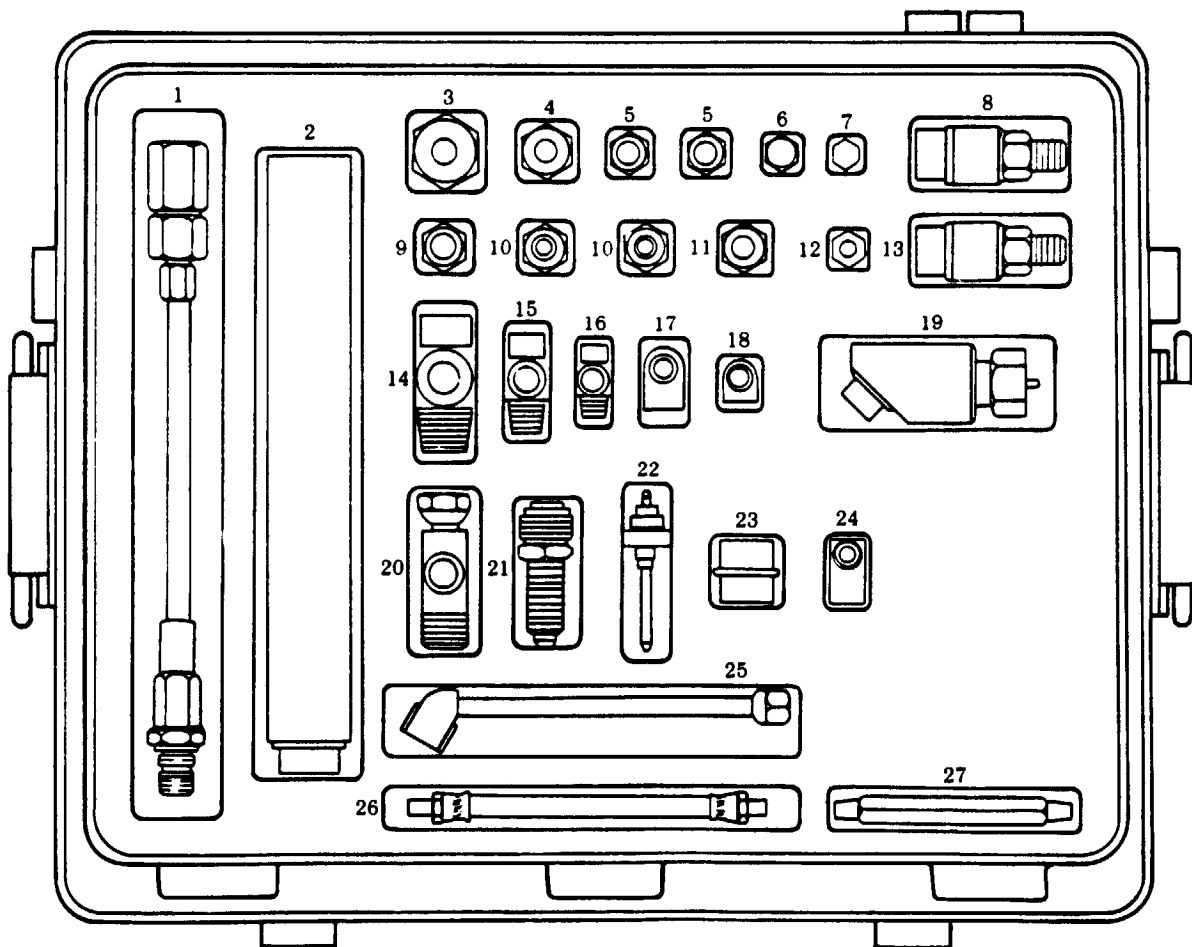
Before installing any transducer kit item on the vehicle, be sure to clean the mounting surfaces. This is particularly important if you are going to open fuel lines or tap into manifolds. Dirt particles entering the engine can cause damage to both the engine and the transducer kit item.

The transducers should be kept clean, free of dirt and grease, and handled with reasonable care.

**2. Pressure Transducer.** The pressure transducers have a small breather hole on the side of the housing which should be kept unplugged. Do not use high pressure.

**3. Pulse Tachometer.** Make sure that the slotted hole in the engine tachometer drive shaft is clear and not hard packed before installing the pulse tachometer.

**4. Threaded Adapters.** Observe threaded fittings carefully to avoid engaging straight threads with pipe threads. Each measurement device (transducer) in the transducer kit has its own identification resistor. The VTM uses this identification resistor to check that the correct transducer is connected for the measurement being made. If the correct transducer is not connected, error code E002 will be displayed.



TRANSDUCER KIT

## 2-44. VEHICLE TESTING

**a. General.** To troubleshoot a vehicle problem, the technician can use the STE/ICE-R (vehicle test meter and transducers) and the vehicle test card.

**b. Data Entry Tests.** For information regarding Data Entry, Cylinder Entry, Vehicle ID Entry, and Data Display Tests, refer to TM 9-4910-571-12&P.

**c. Offset Tests.** The STE/ICE-R VTM performs a test by setting the TEST Select switches to the test number and pressing the TEST button. For some tests, an offset test is required before the test itself can be performed. This is done by selecting the number of the desired test and holding the TEST button down for several seconds.

The offset test nulls out characteristic differences in the VTM, test leads, and transducers. It zeros the meter. Once the offset is performed, the VTM automatically corrects for the offset before displaying measured values. The displayed offset value should be checked against limits on the vehicle test card. If the displayed value is outside these limits, either the transducer or the test cable is faulty and must be replaced. This is another form of self-test. The offset is performed when each transducer is connected. All tests requiring offset are identified by a star (\*) on the flip cards and by OFFSET LIMITS on the vehicle test cards. The offset test is performed with the test probe cable or transducer connected to the VTM. Care should be taken to see that no stimulus is applied to the transducer. Test probe cable leads should be shorted together. To perform an offset test, dial the test number into the TEST SELECT switches. Press and hold the TEST button until the prompting message CAL appears on the display. A few seconds after release of the TEST button, a number will appear. This is the measured offset value associated with the test probe cable or transducer and cable.

**d. Control Tests.** These tests are used to change (or control) the way a vehicle test is displayed or the way it is run. There are five control tests:

01 Interleave (displays RPM with next test).

02 Display minimum value for next test.

03 Display maximum value for next test.

04 Display peak-to-peak value for next test.

06 Interleave.

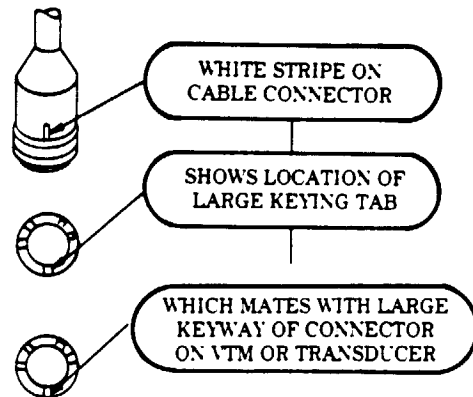
Control tests 01, 02, 03, 04, and 06 specify the action to be taken by the next test only. A subsequent test will reset the control.

**1. Interleave (Test 01).** This test alternately measures engine speed and a second parameter such as fuel pressure or alternator voltage. To initiate interleave, dial 01 into the TEST SELECT switches and press and release the TEST button. The prompting message CON will signal the technician to dial into the second test number and again press and release the TEST button.

**2. Minimum Value (Test 02).** This test displays the minimum value measured during a test. To initiate a minimum value display, dial 02 into the TEST SELECT switches and press and release the TEST button. The prompting message PASS will signal the technician to dial in the desired test number and again press and release the TEST button. The minimum value is displayed and updated whenever a lower minimum value is measured. Entering 02 and the test number again will reset the process and a new minimum value will be displayed.

**3. Maximum Value (Test 03).** This test displays the maximum value measured during a test. To initiate a maximum value display, dial 03 into the TEST SELECT switches and press and release the TEST button. The prompting message PASS will signal the technician to dial in the desired test number and again press and release the TEST button. The maximum value is displayed and updated whenever a higher maximum value is measured. Entering 03 and the test number again will reset the process and a new maximum value will be displayed.

**4. Peak-to-Peak Value (Test 04).** This test displays the peak-to-peak value of 0-45 volts DC (89), 0-1500 amps DC (90), and battery volts (67). To start a peak-to-peak measurement, dial 04 into the TEST SELECT switches and press the TEST button. The prompting message PASS will signal the operator to dial in one of the three numbers (89, 90, 67) and again press the TEST button.



**CONNECTOR KEY LOCATION**

Table 2-1. STE/ICE-R GO-Chain Tests.

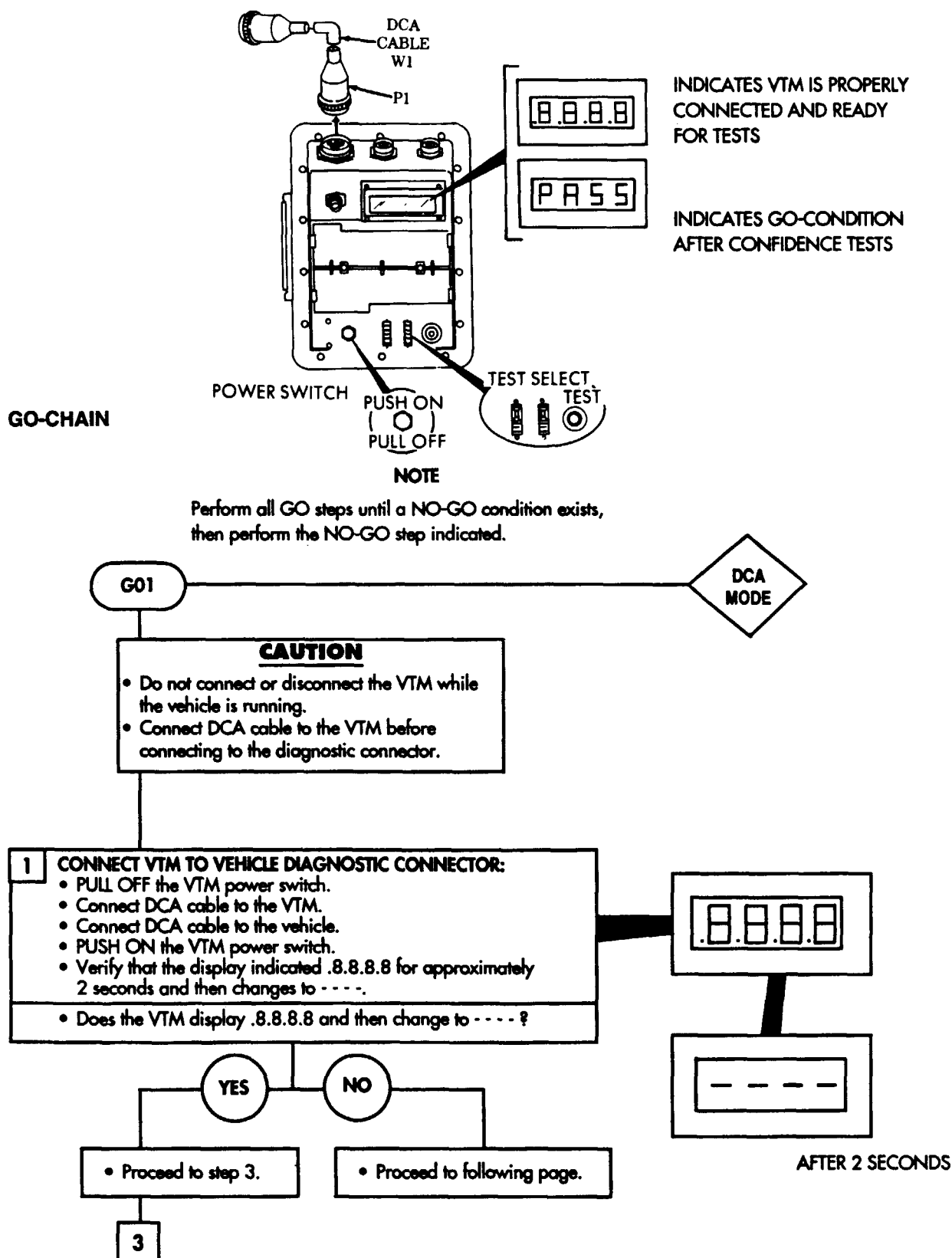




Table 2-1. STE/ICE-R GO-Chain Tests. (Cont'd)

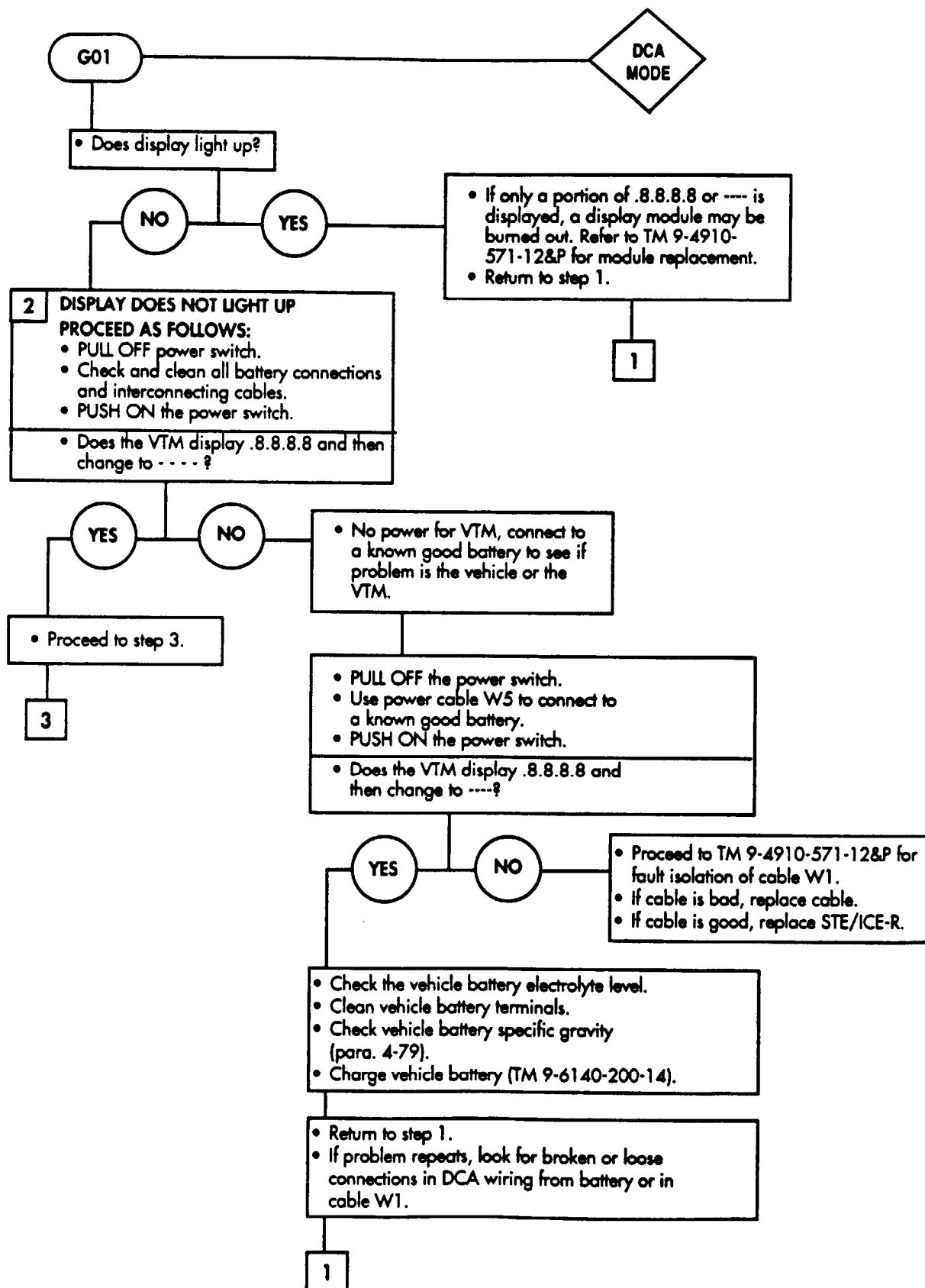


Table 2-1. STE/ICE-R GO-Chain Tests. (Cont'd)

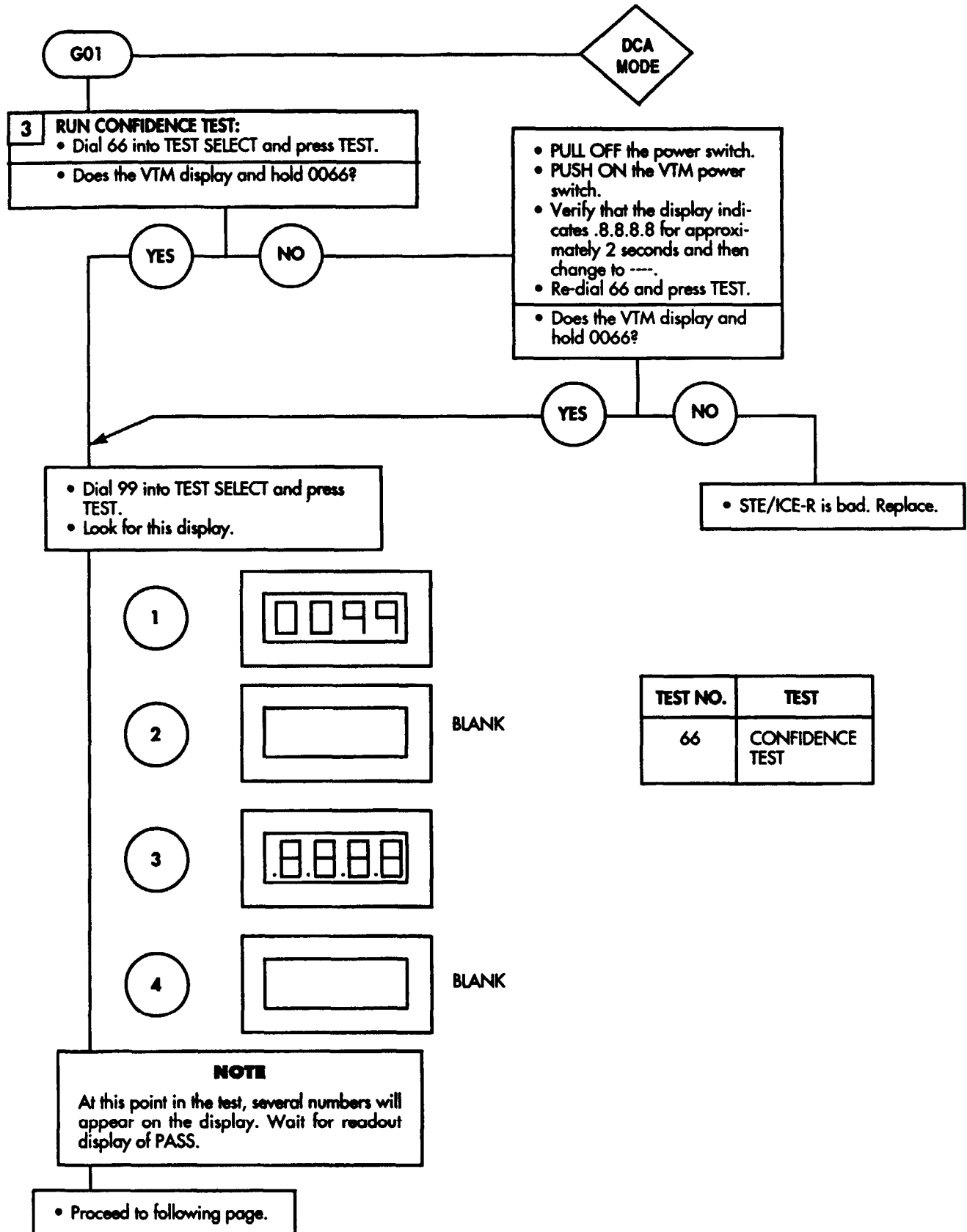
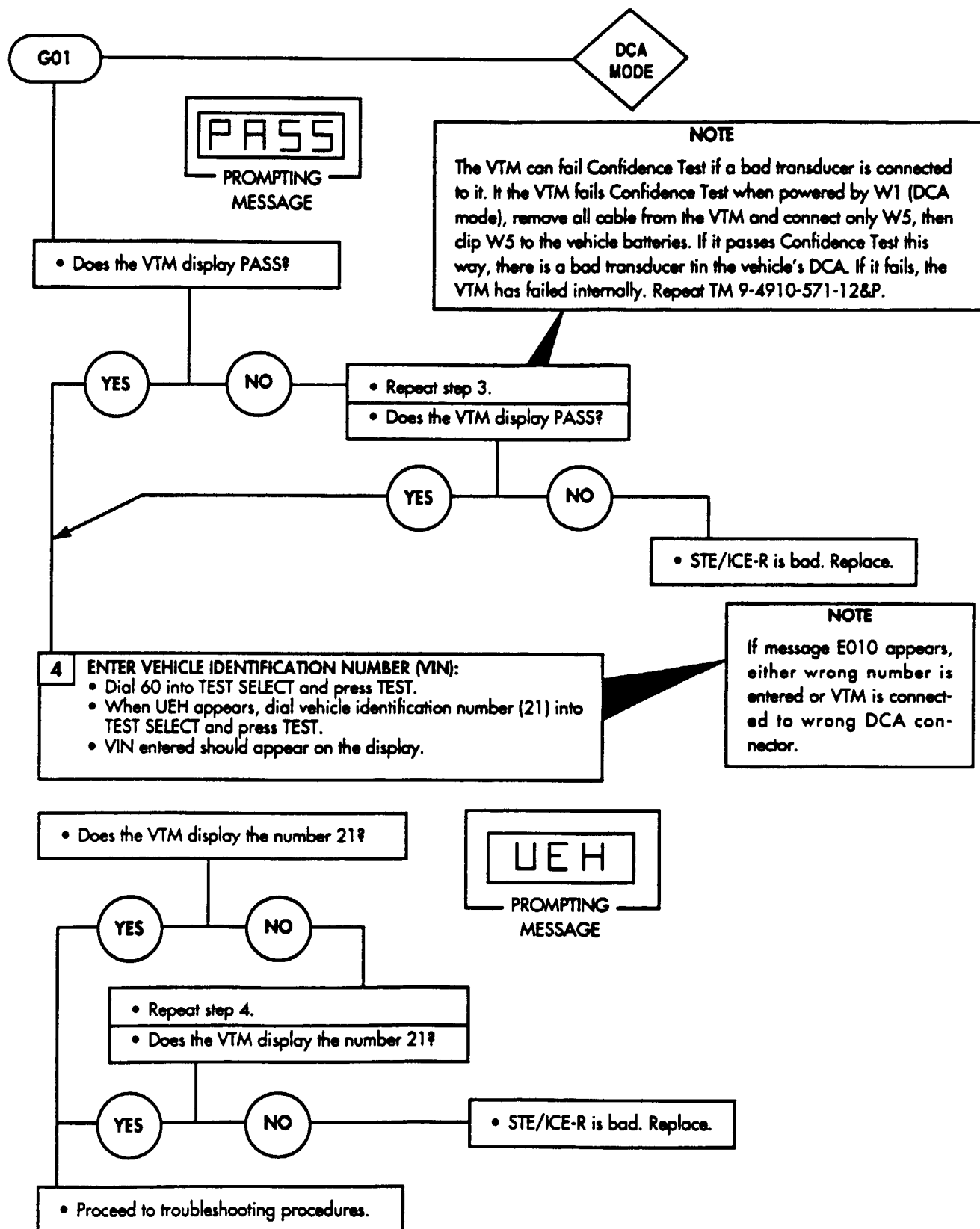


Table 2-1. STE/ICE-R GO-Chain Tests. (Cont'd)



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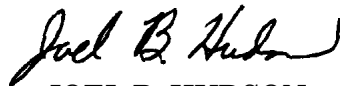
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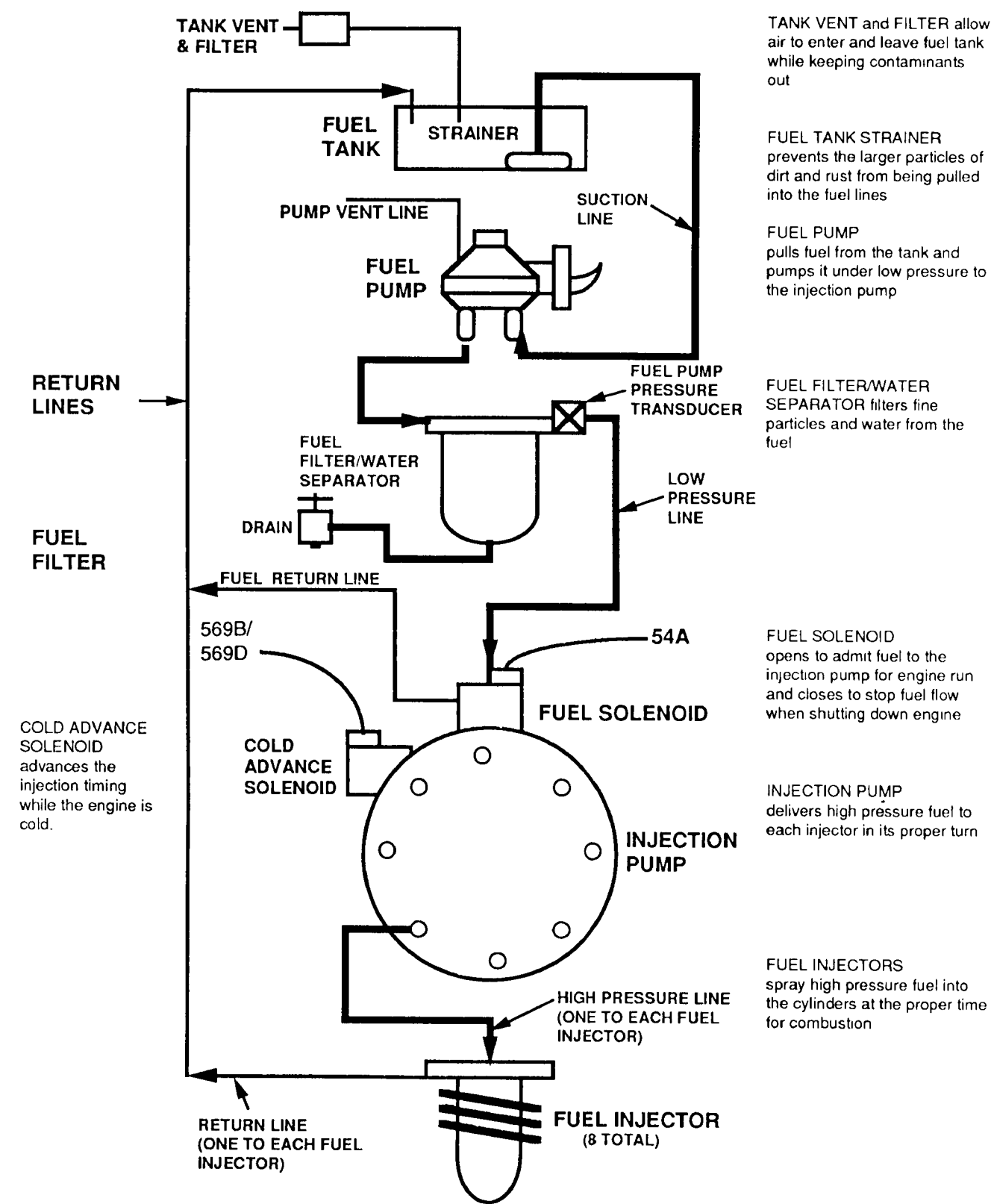
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1	2-316					Under E-1, test options should include STE/ICE-R test 91.
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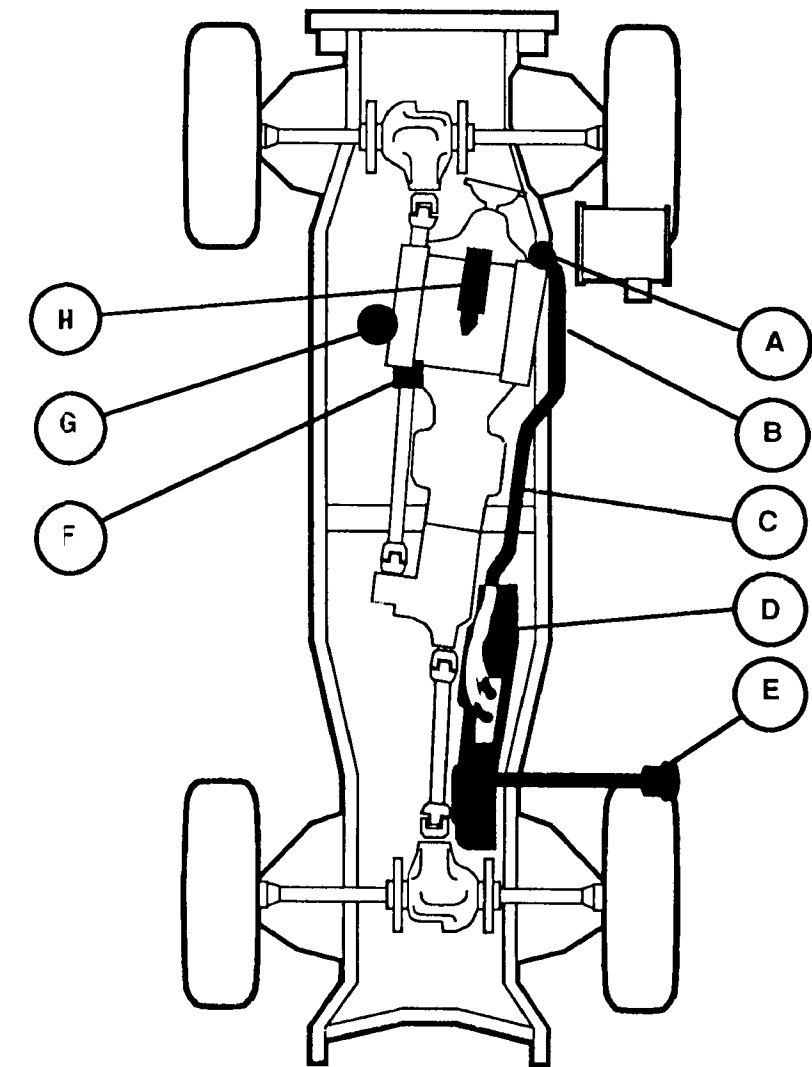
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<i>*Reference to line numbers within the paragraph or subparagraph.</i>						
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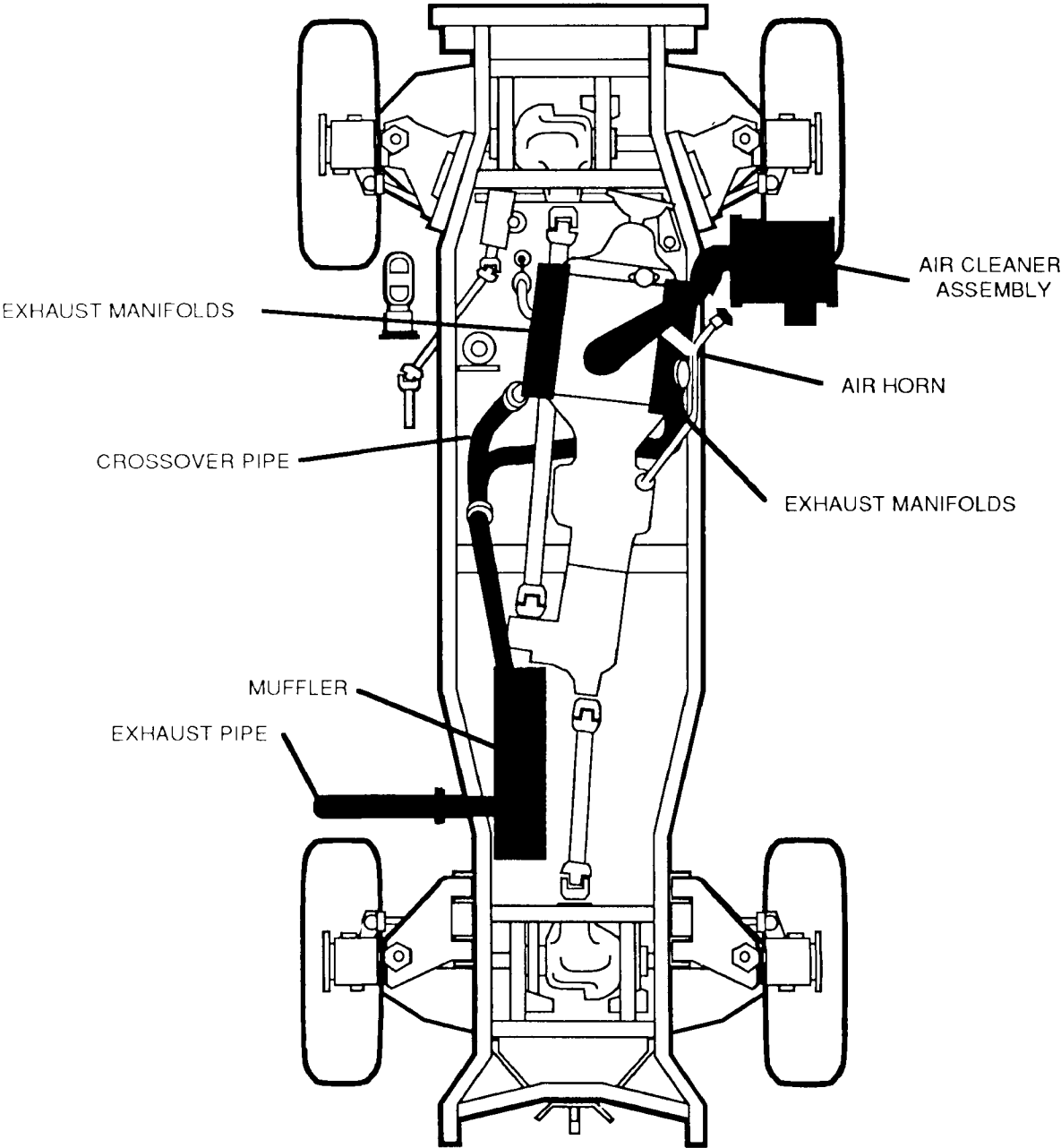


- (A) FUEL LIFT PUMP  
DRAWS FUEL FROM FUEL TANK THRU THE SUPPLY LINE AND PUMPS IT TO THE FUEL FILTER
- (B) FUEL RETURN LINE  
DIRECTS UNUSED FUEL FROM THE INJECTION PUMP BACK TO THE FUEL TANK
- (C) FUEL SUPPLY LINE  
DIRECTS FUEL FROM FUEL TANK TO THE SYSTEM
- (D) FUEL TANK  
STORES 25 GALLONS OF DIESEL FUEL
- (E) FUEL FILLER CAP  
LOCATED AT RIGHT REAR SIDE OF VEHICLE, THE CAP IS REMOVED TO PERMIT FUEL TANK SERVICING
- (F) FUEL INJECTORS  
RECEIVE METERED FUEL FROM THE INJECTION PUMP AND SPRAYS FUEL INTO THE COMBUSTION CHAMBER
- (G) FUEL FILTER/WATER SEPARATOR  
FILTERS WATER AND SEDIMENT FROM FUEL BEFORE FUEL ENTERS THE INJECTION PUMP
- (H) INJECTION PUMP  
DIRECTS METERED AND PRESSURIZED FUEL TO THE EIGHT INJECTOR NOZZLES. IT IS MOUNTED ON TOP OF THE ENGINE UNDER THE INTAKE MANIFOLD

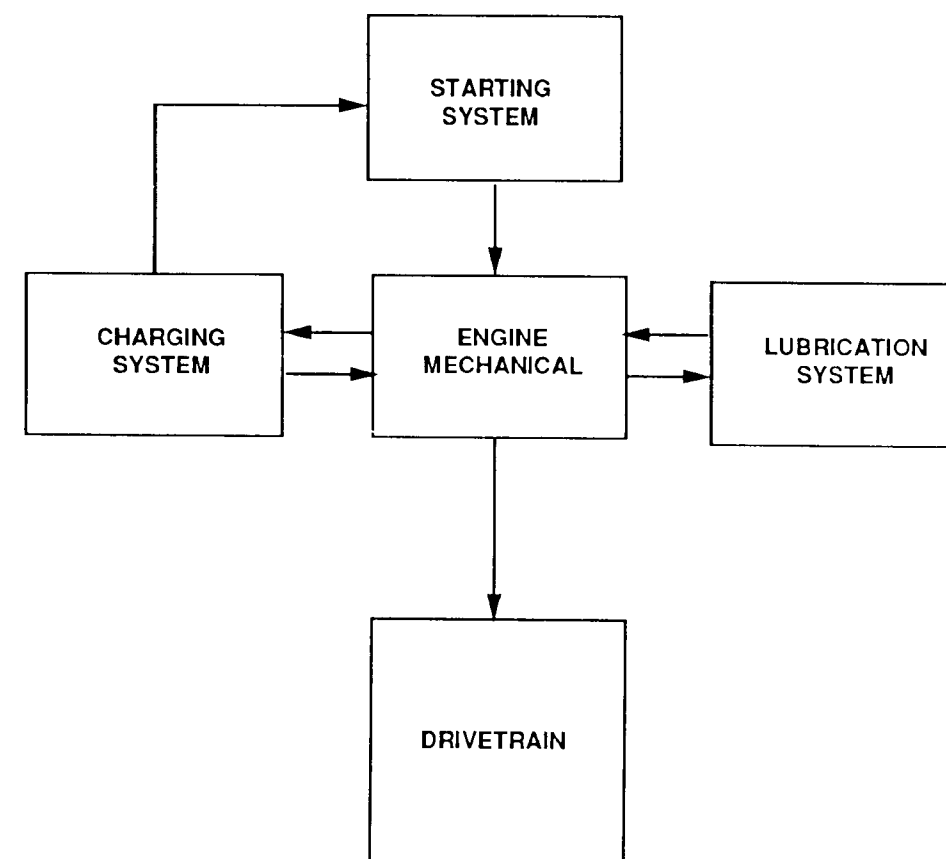


FO-1 Fuel System Functional Flow and Locations of Parts Diagrams  
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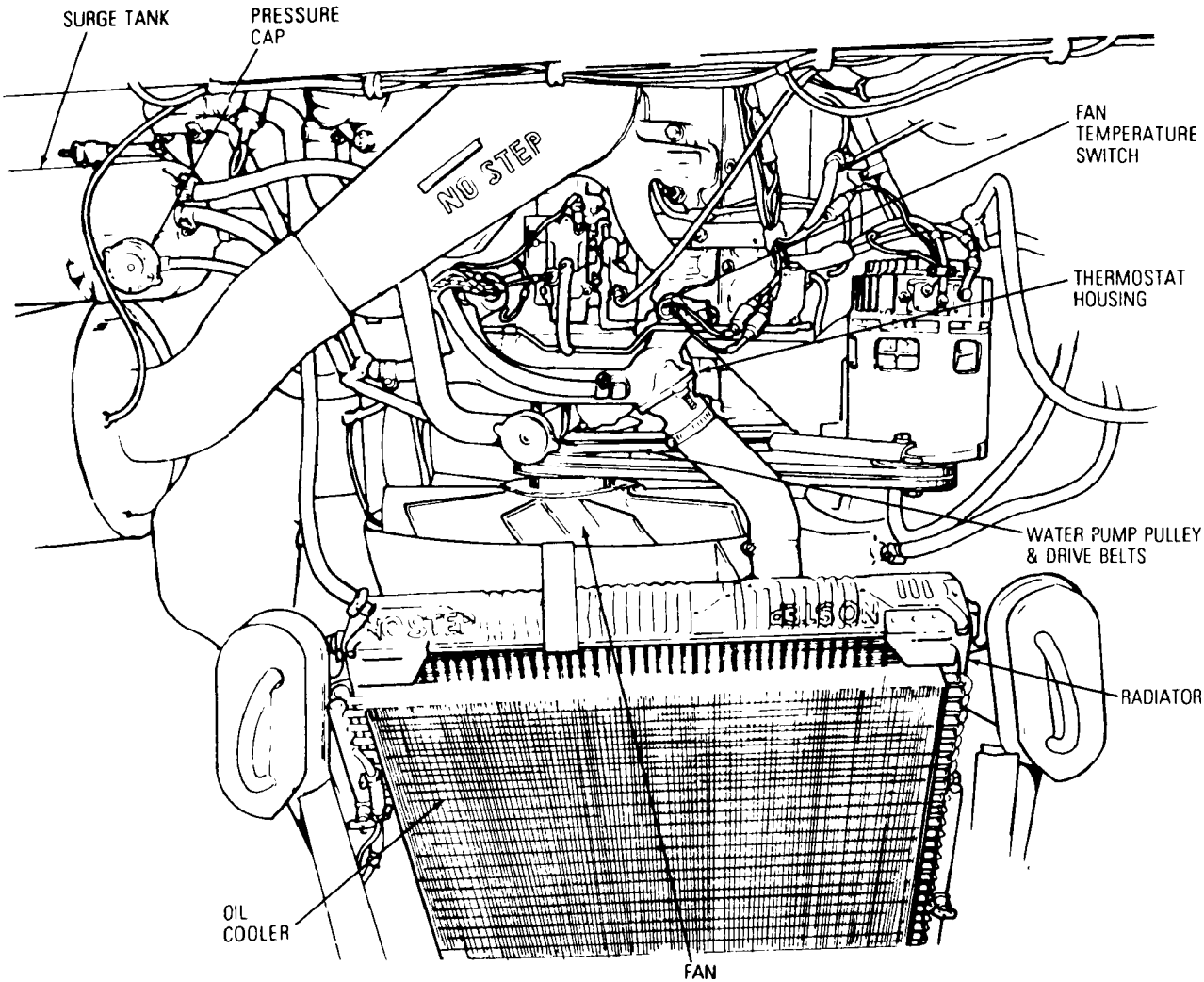
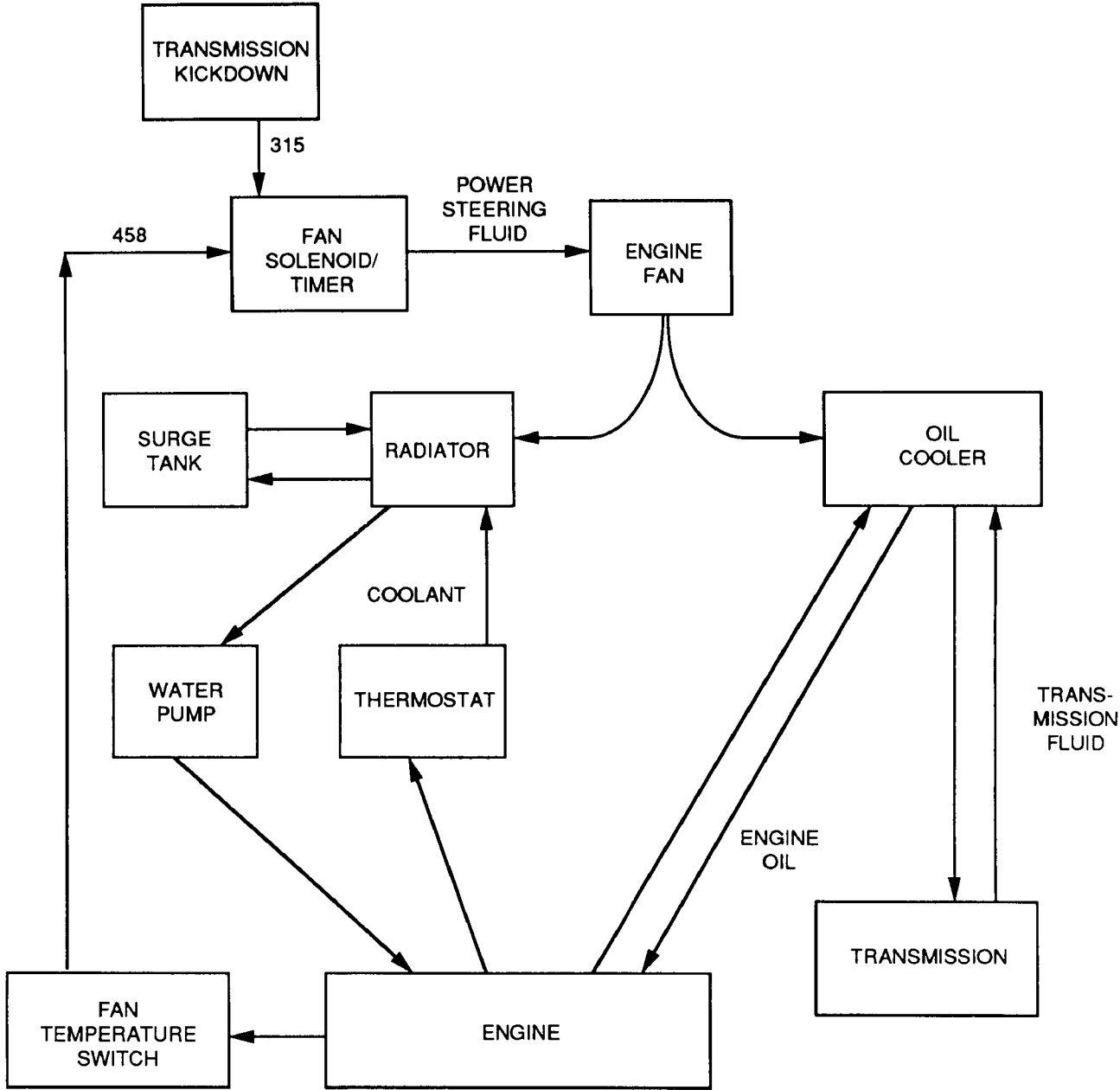
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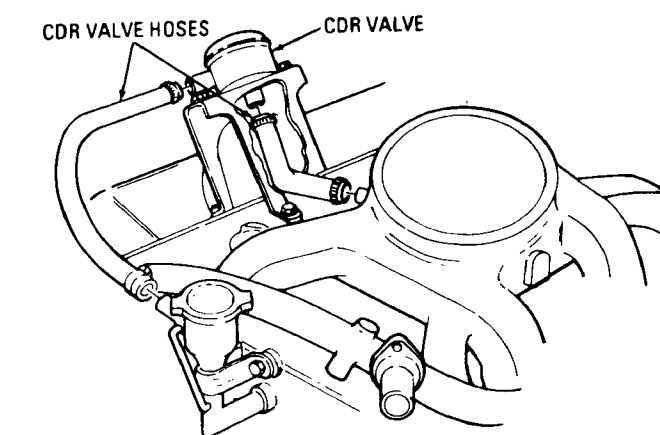
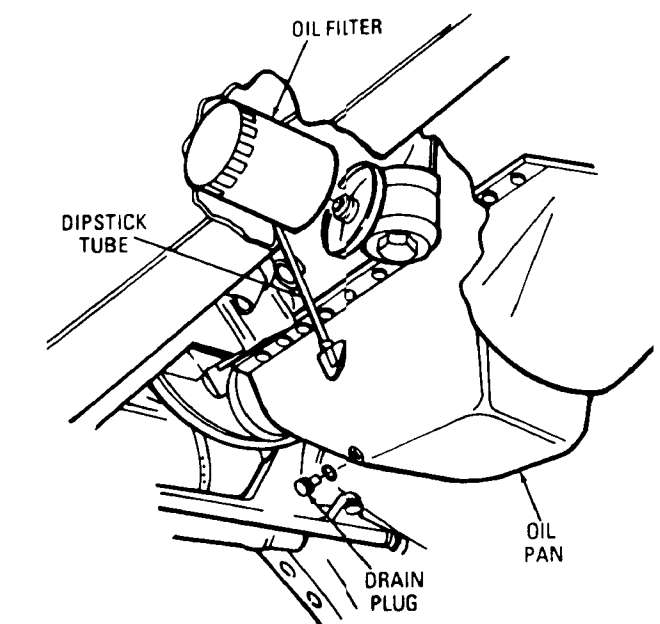
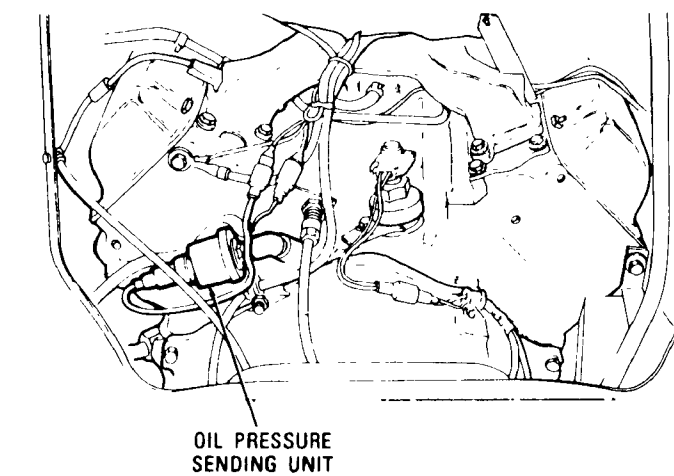
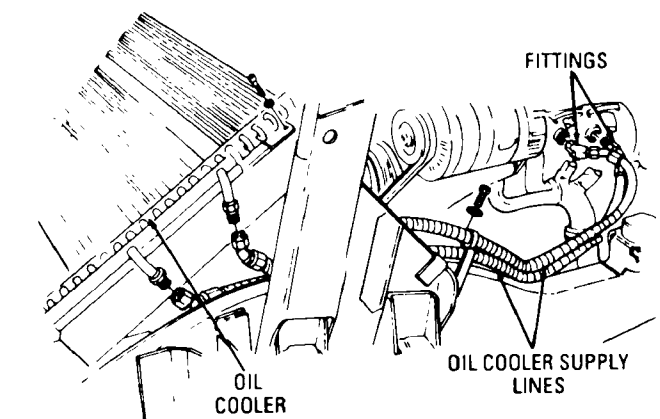
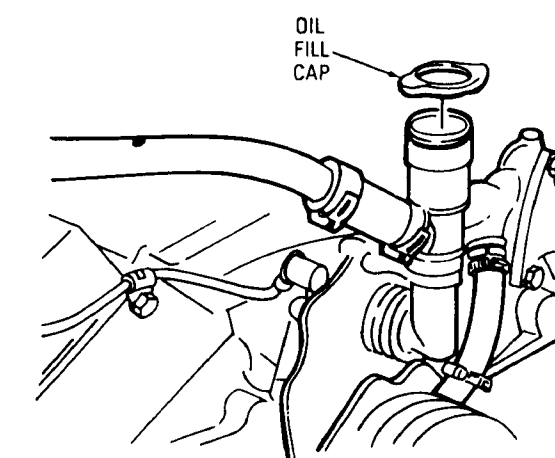
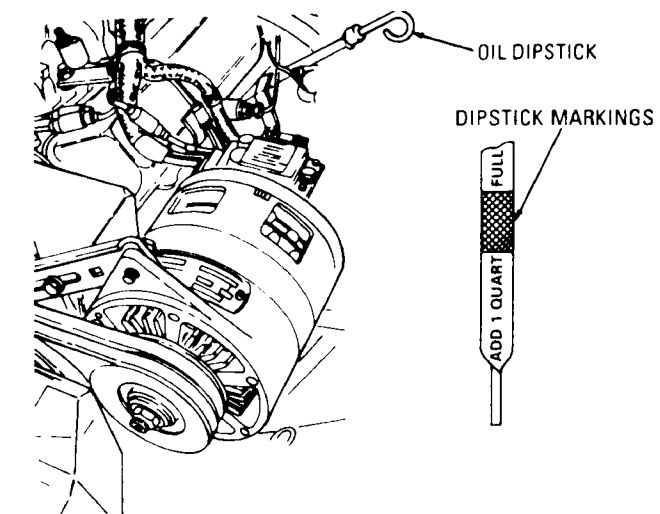
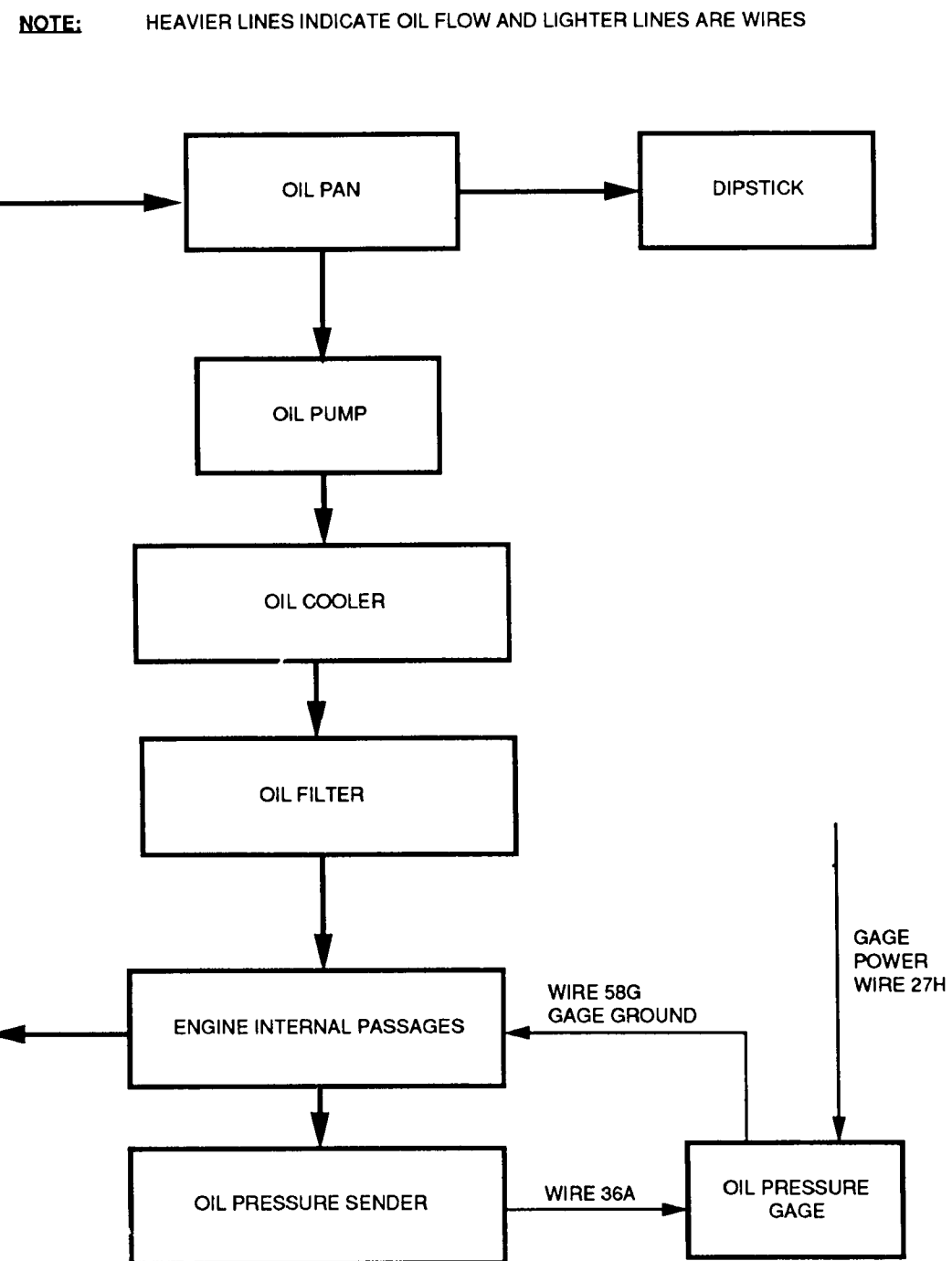
FO-2 Intake Air/Exhaust Functional Flow and Location of Parts Diagrams  
FP-3/(FP-4 Blank)



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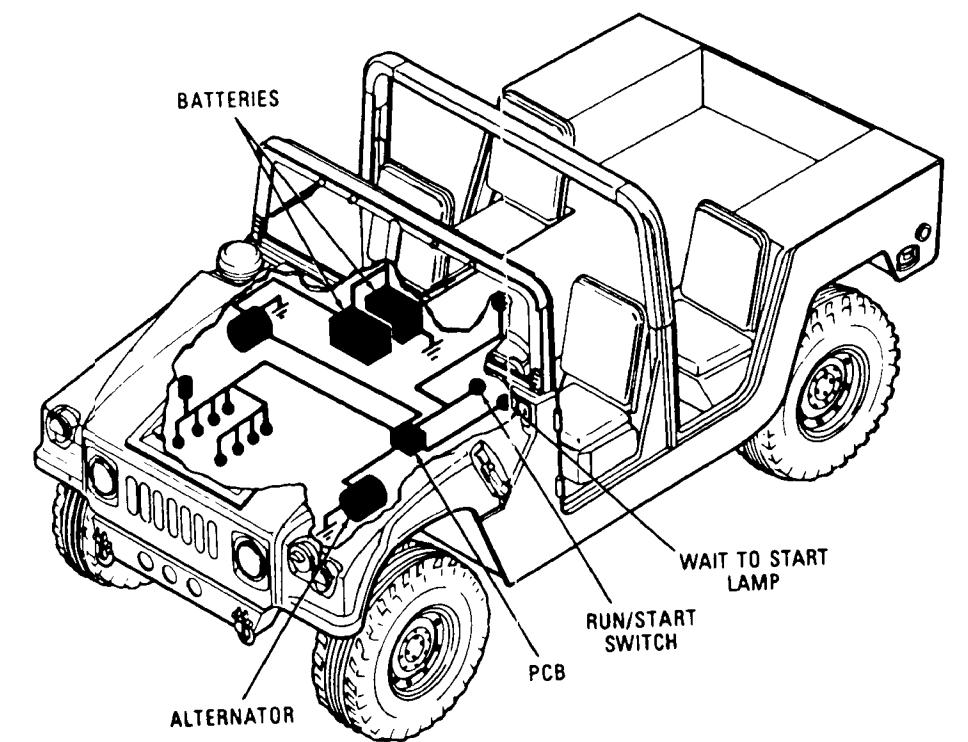
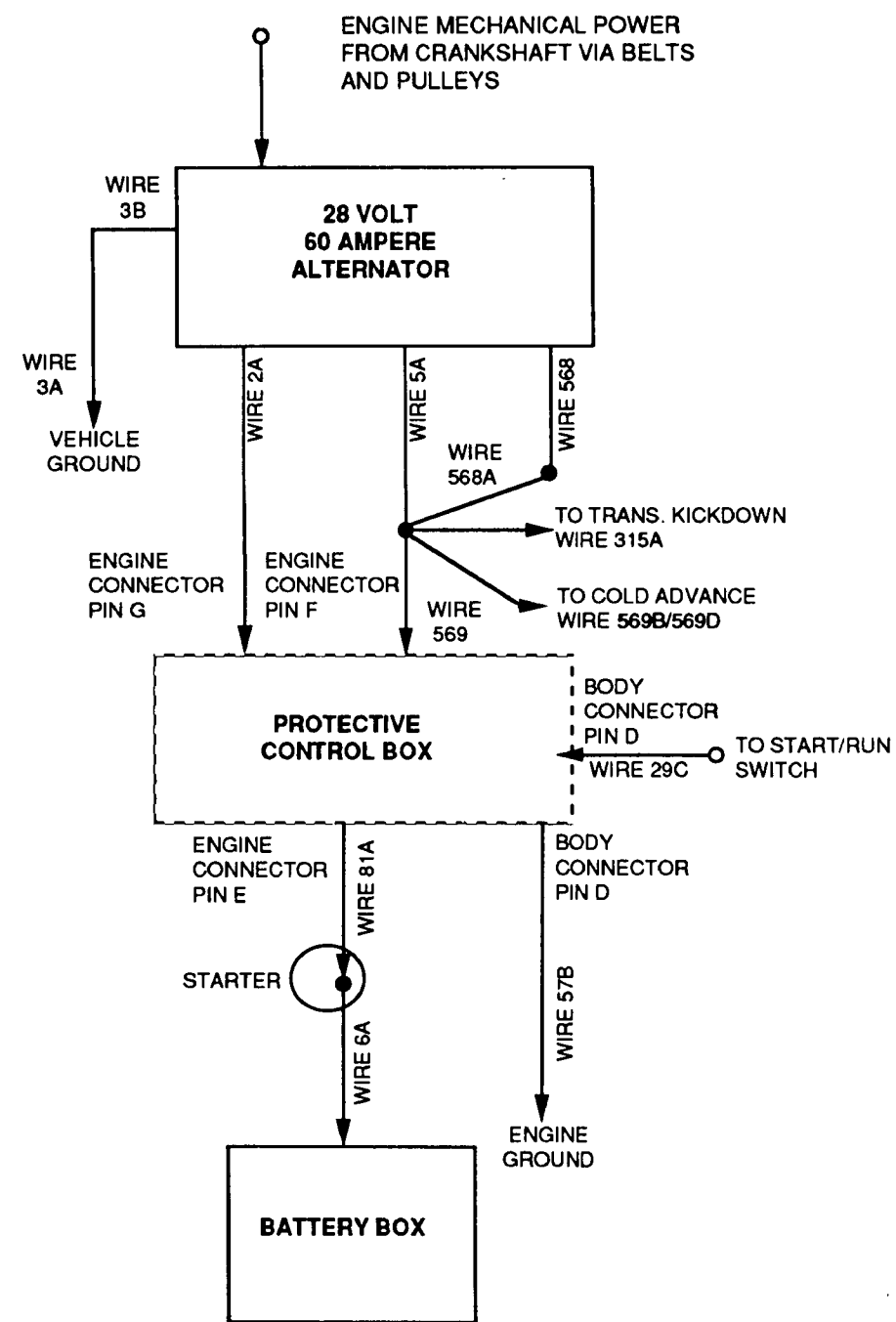


FO-4 Cooling Functional Flow  
and LOfation of Parts Diagrams  
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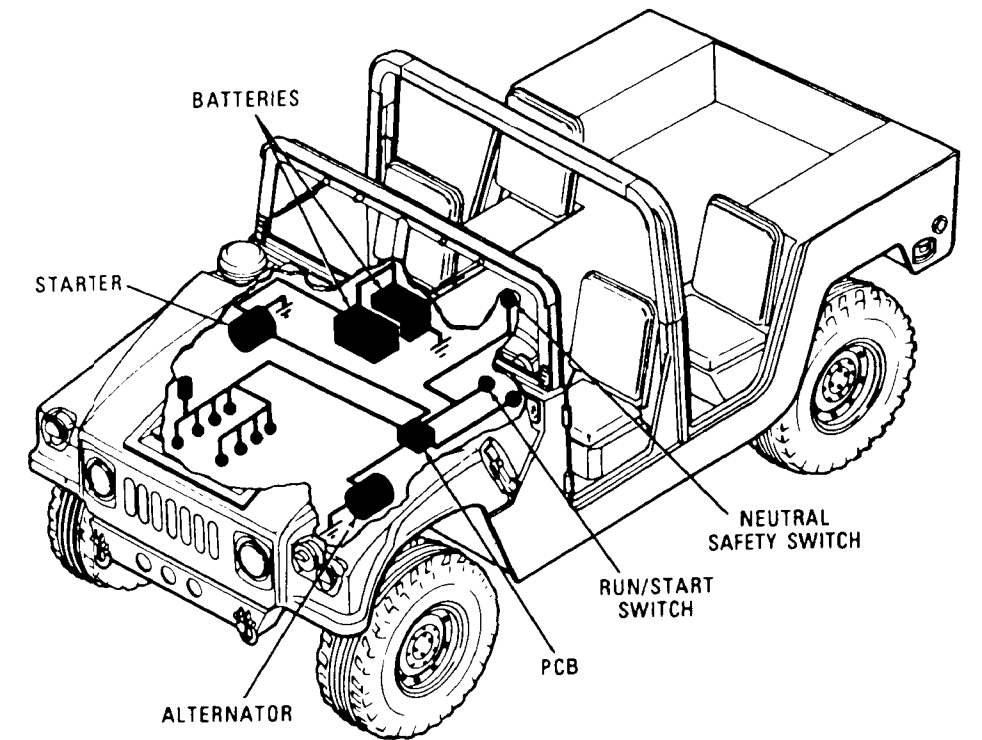
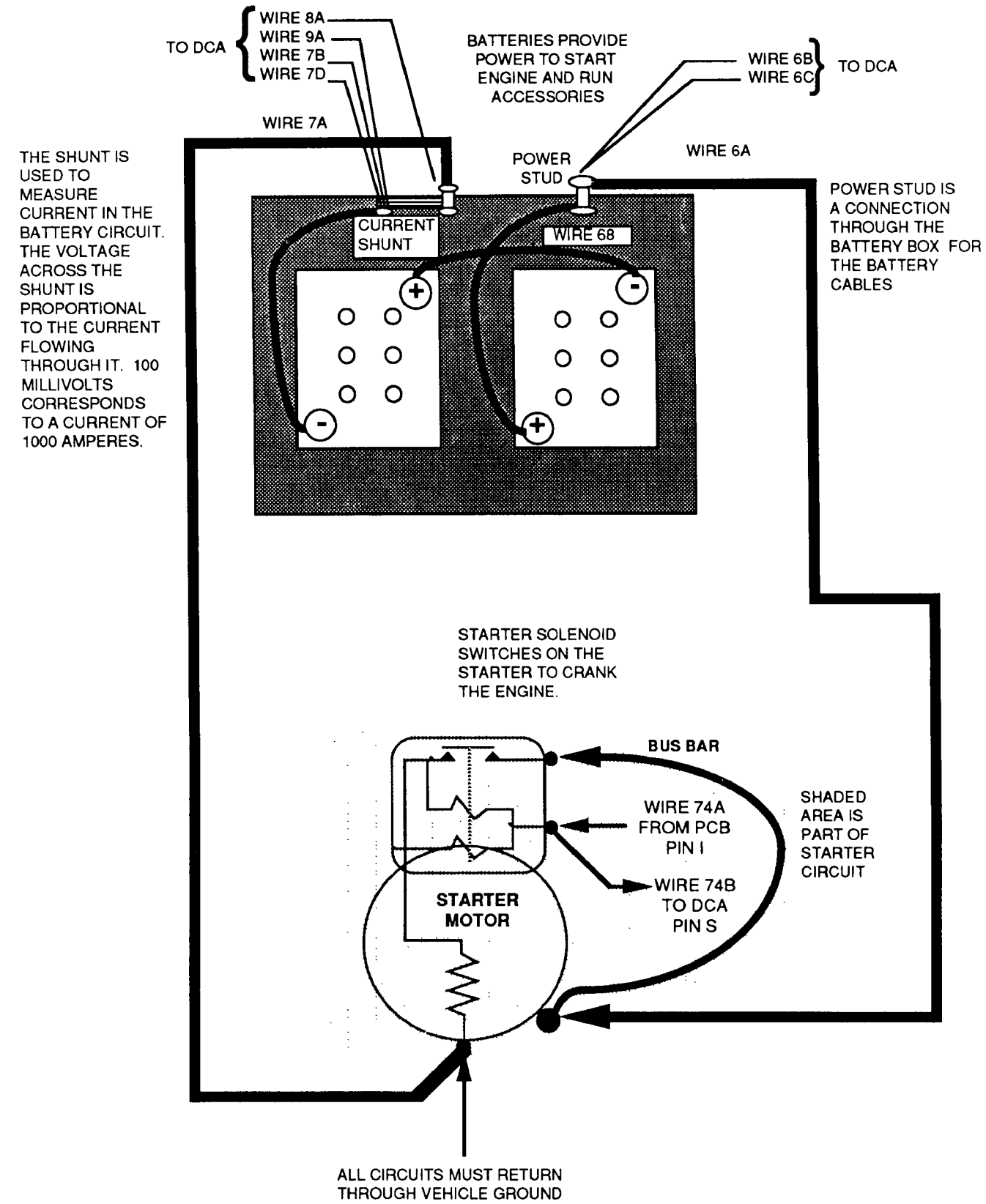


FO-5 Engine Lubrication Functional Flow and Location of Parts Diagrams  
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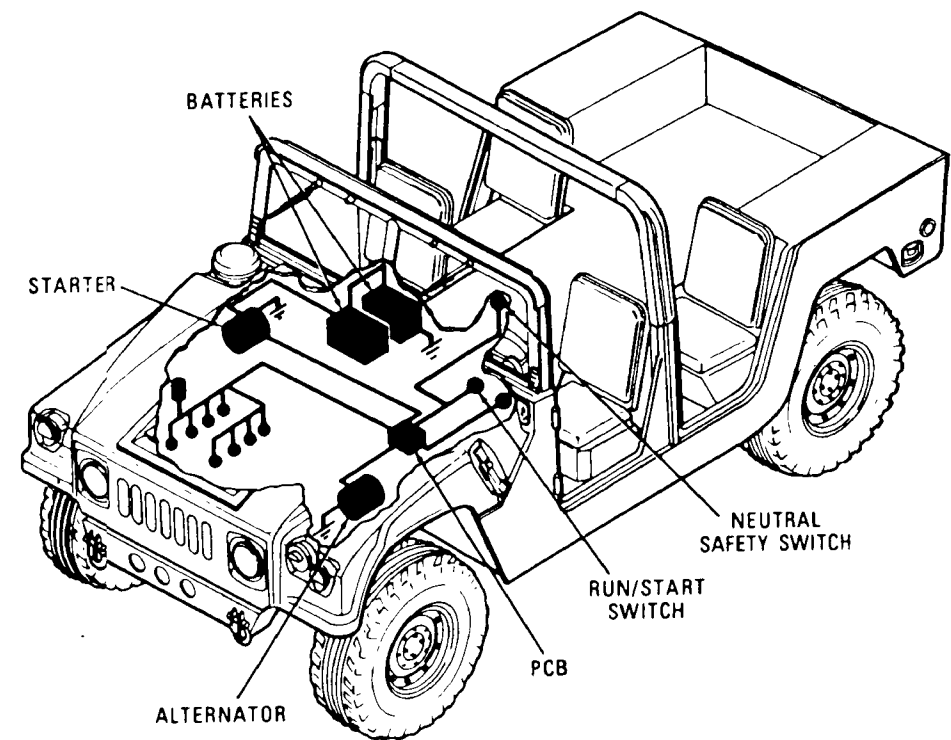
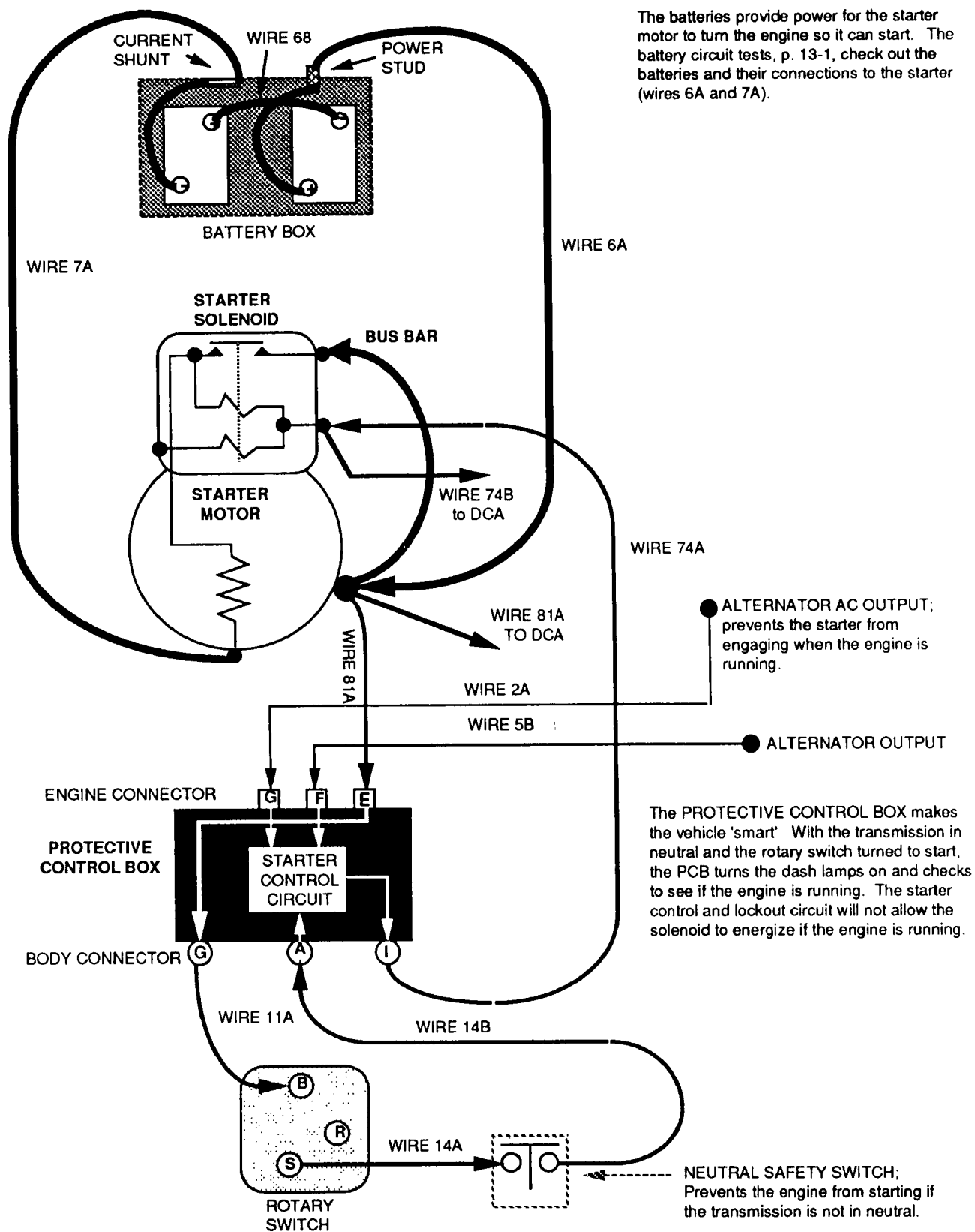




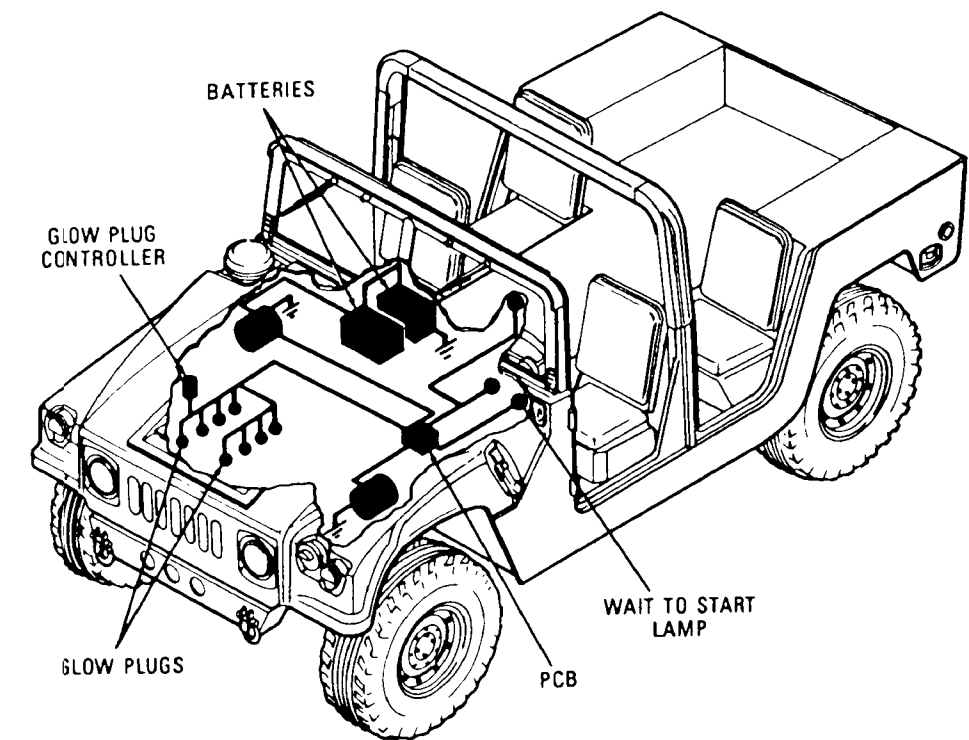
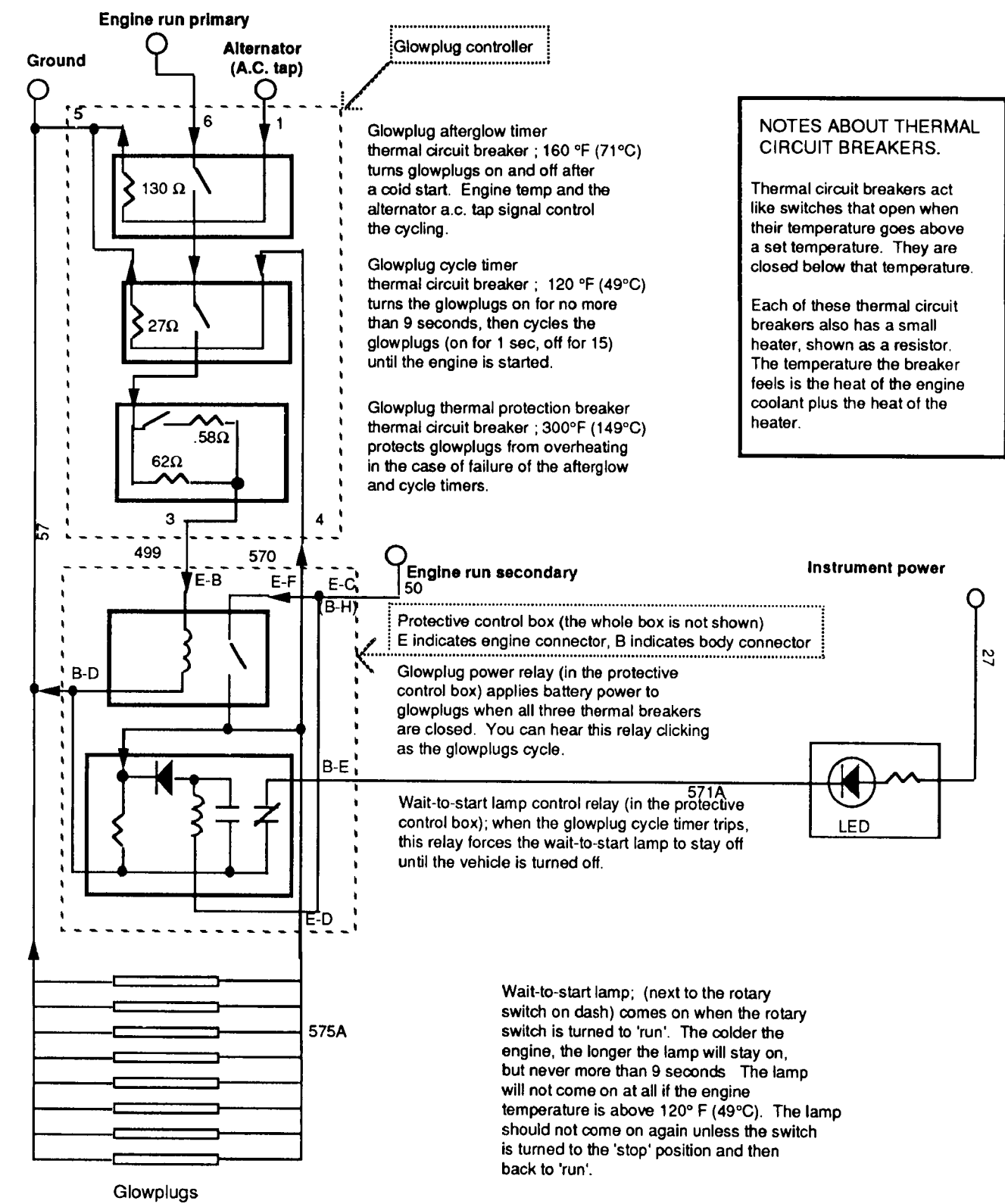
FO-6 Alternator Functional Flow and Location of Parts Diagrams  
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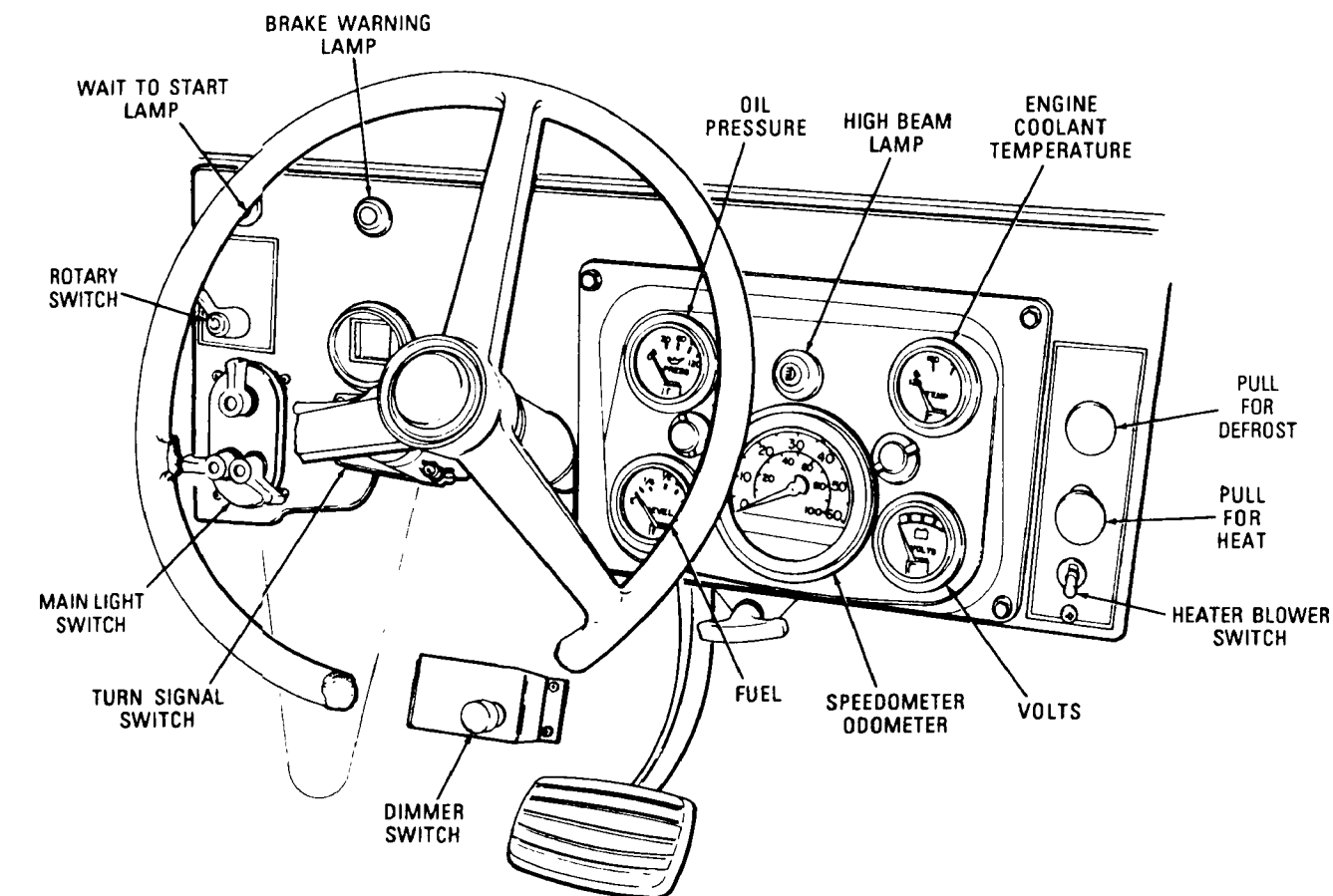
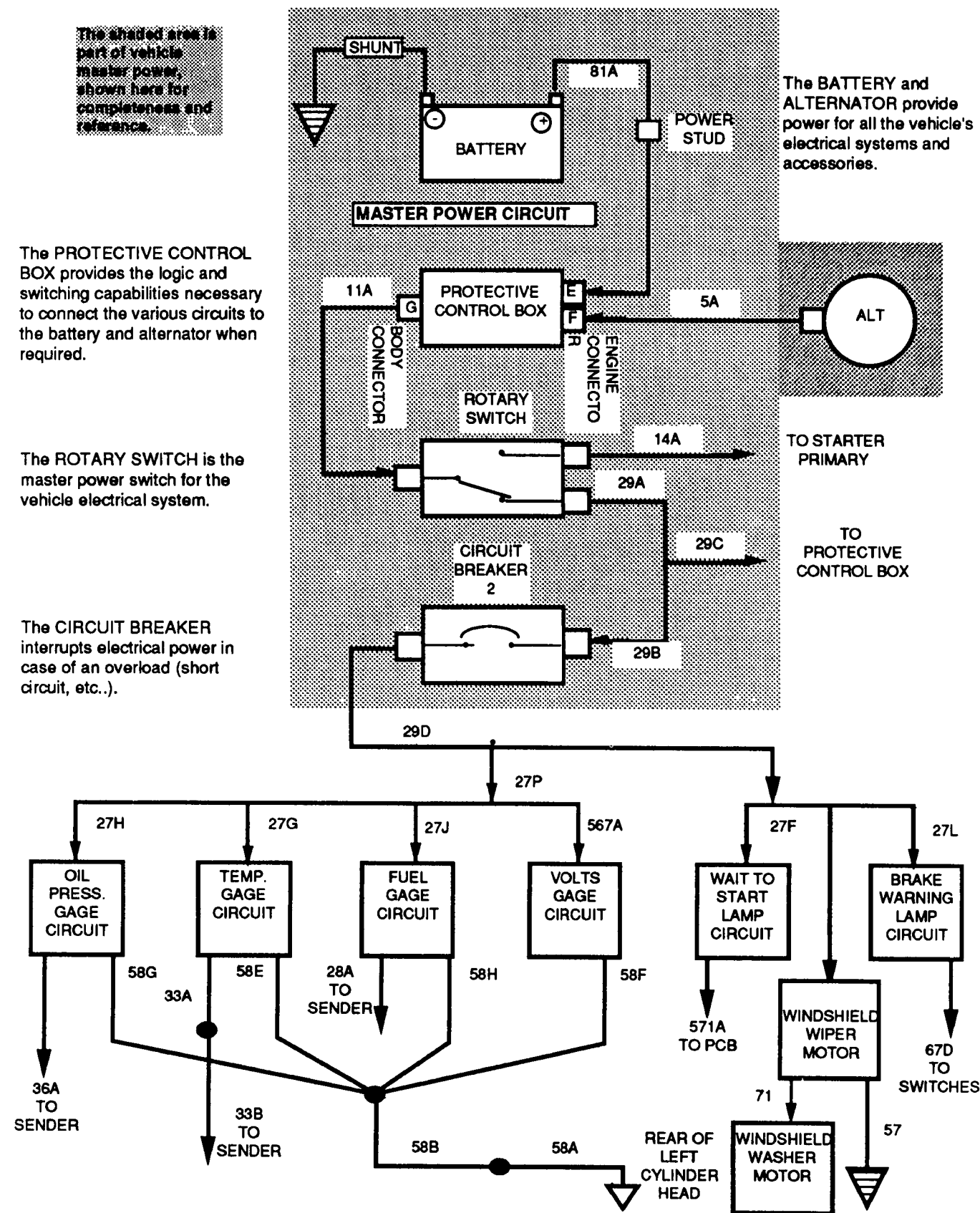


FO-7 Battery Functional Flow  
and Location of Parts Diagrams  
FP-13/(FP-14 Blank)

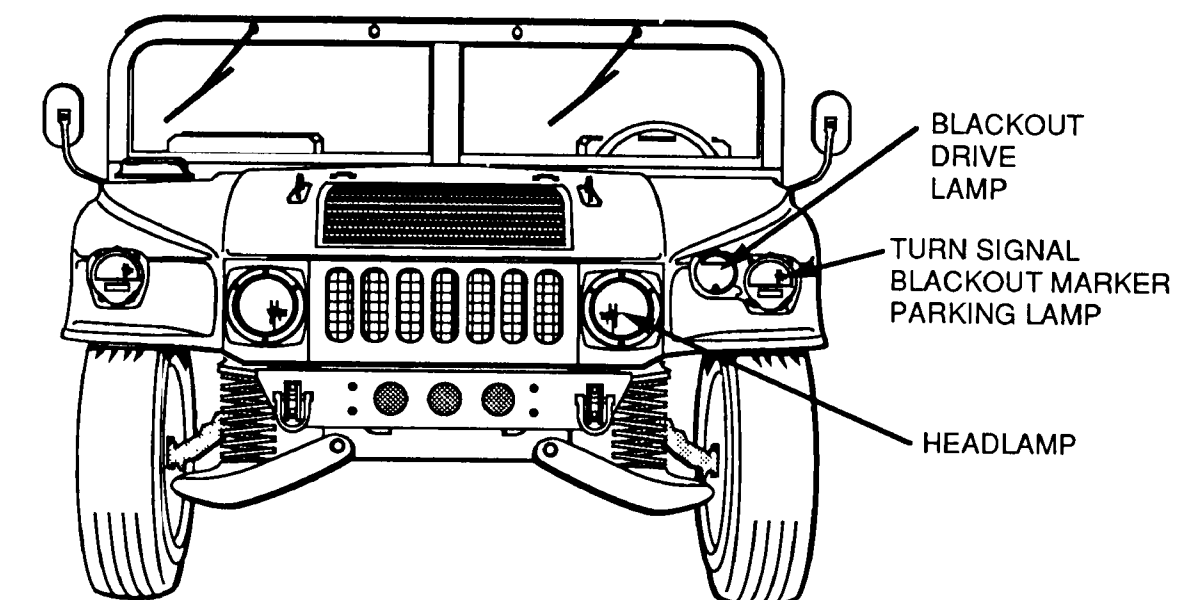
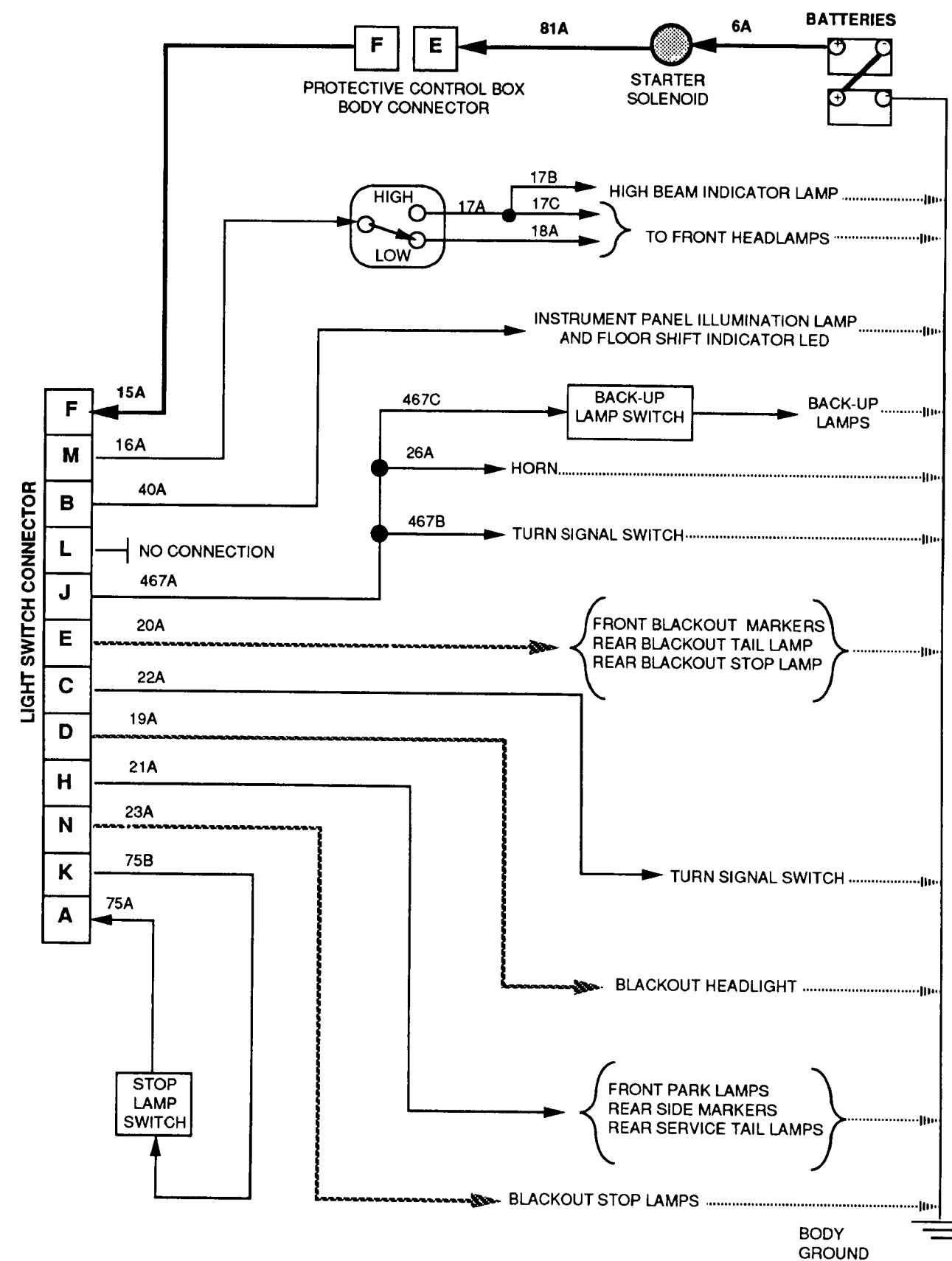


FO-8 Starter Circuit Functional Flow and Location of Parts Diagrams  
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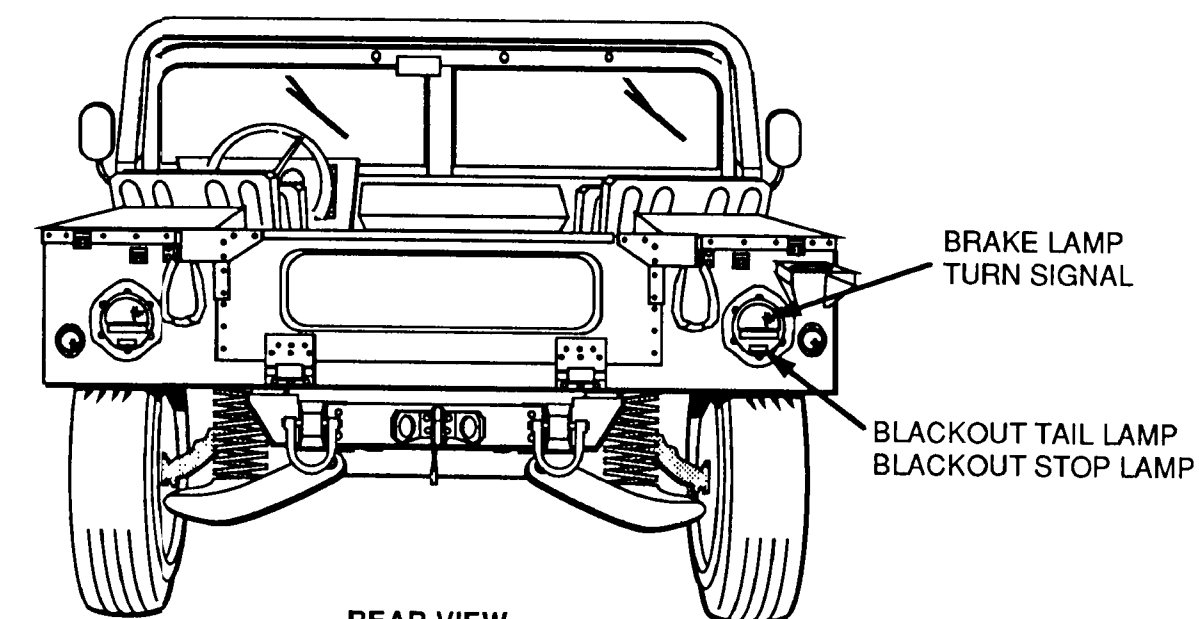




FO-10 Instruments Functional Flow and Location of Parts Diagrams  
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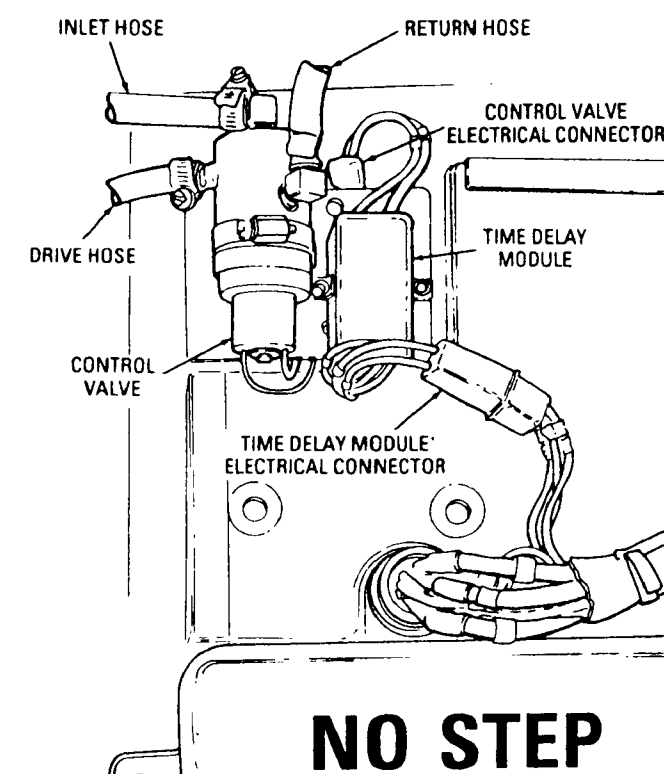
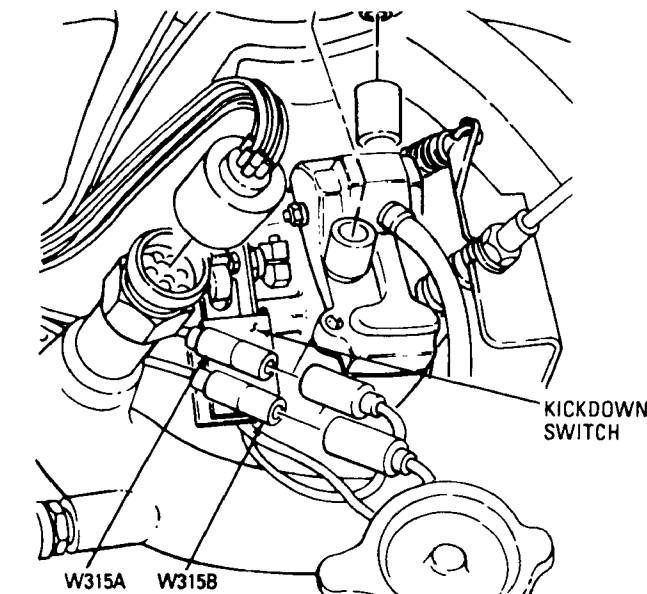
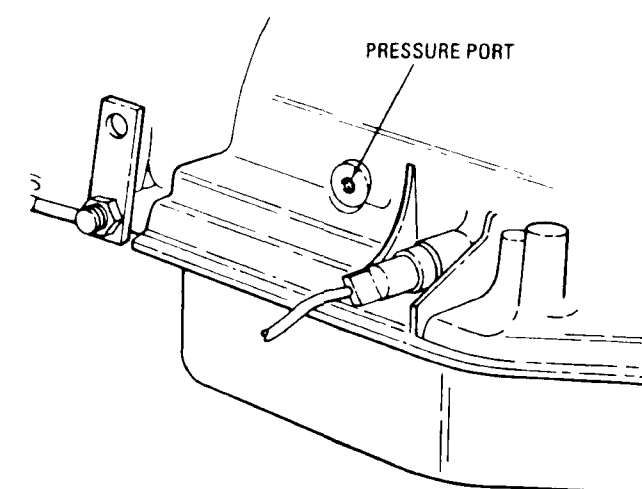
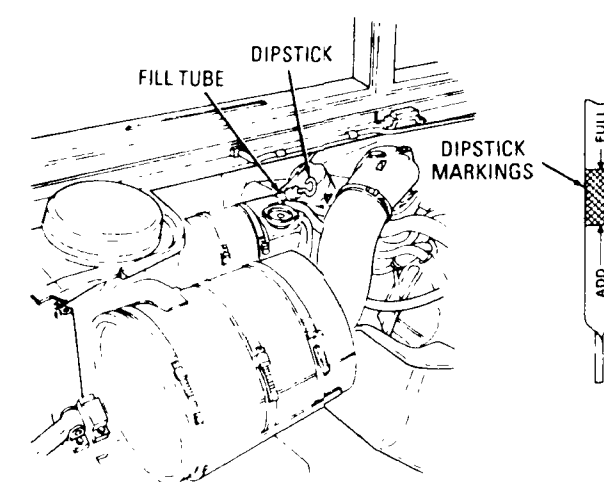
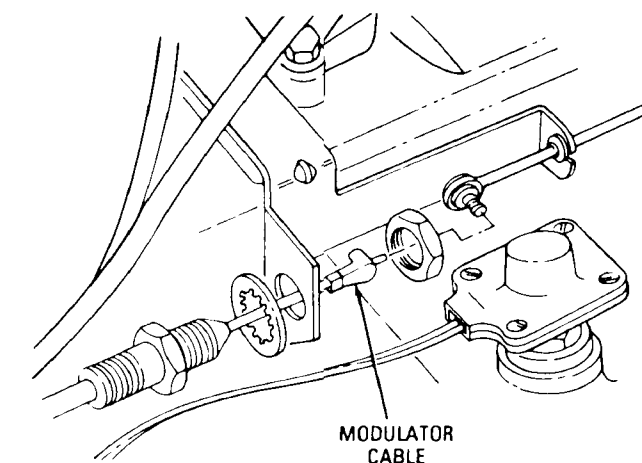
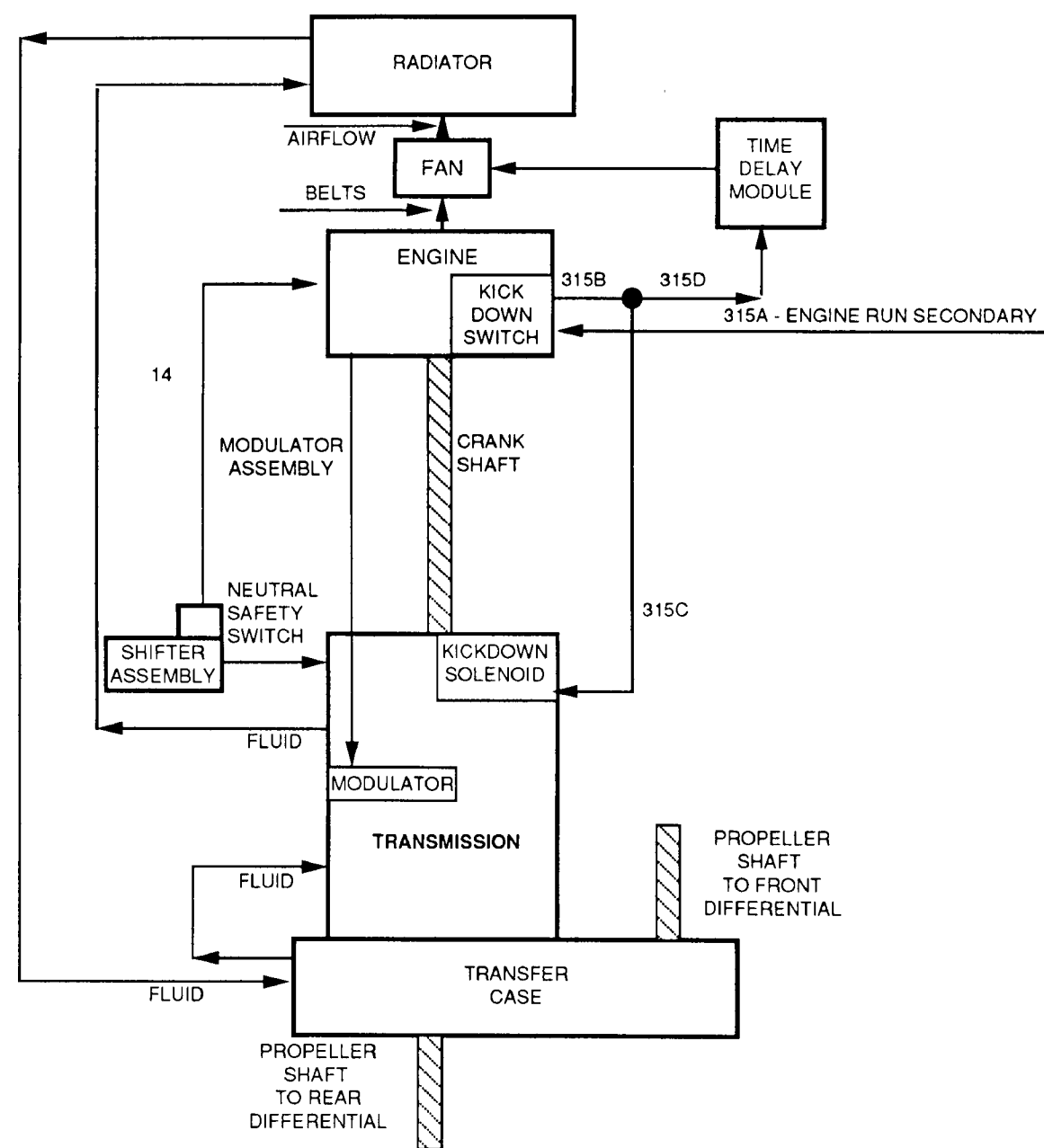


**FRONT VIEW**

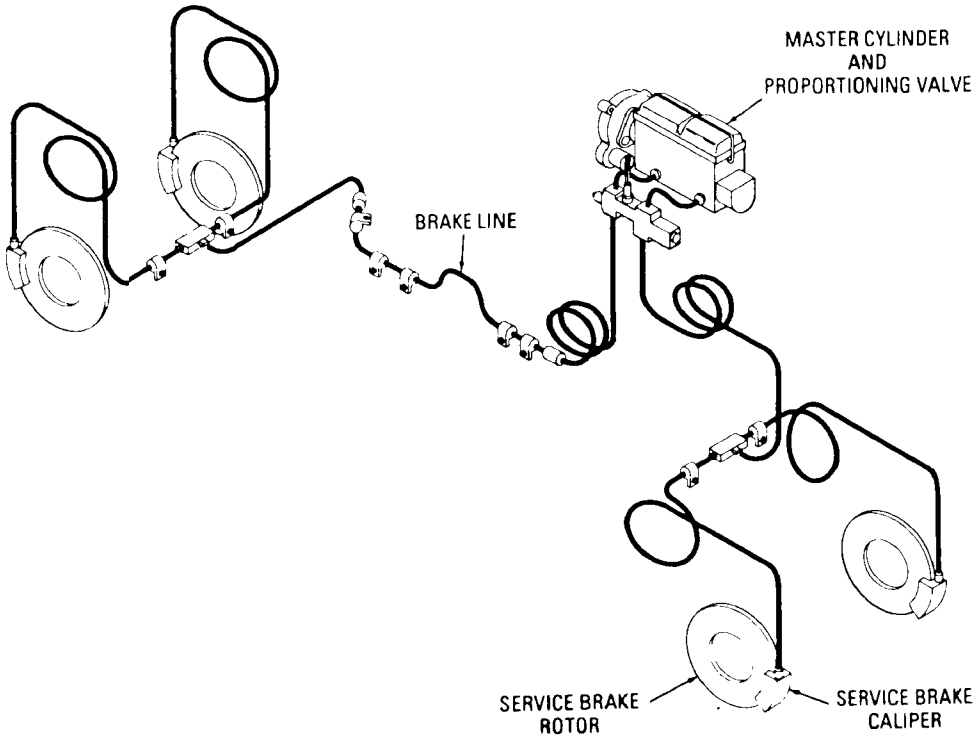
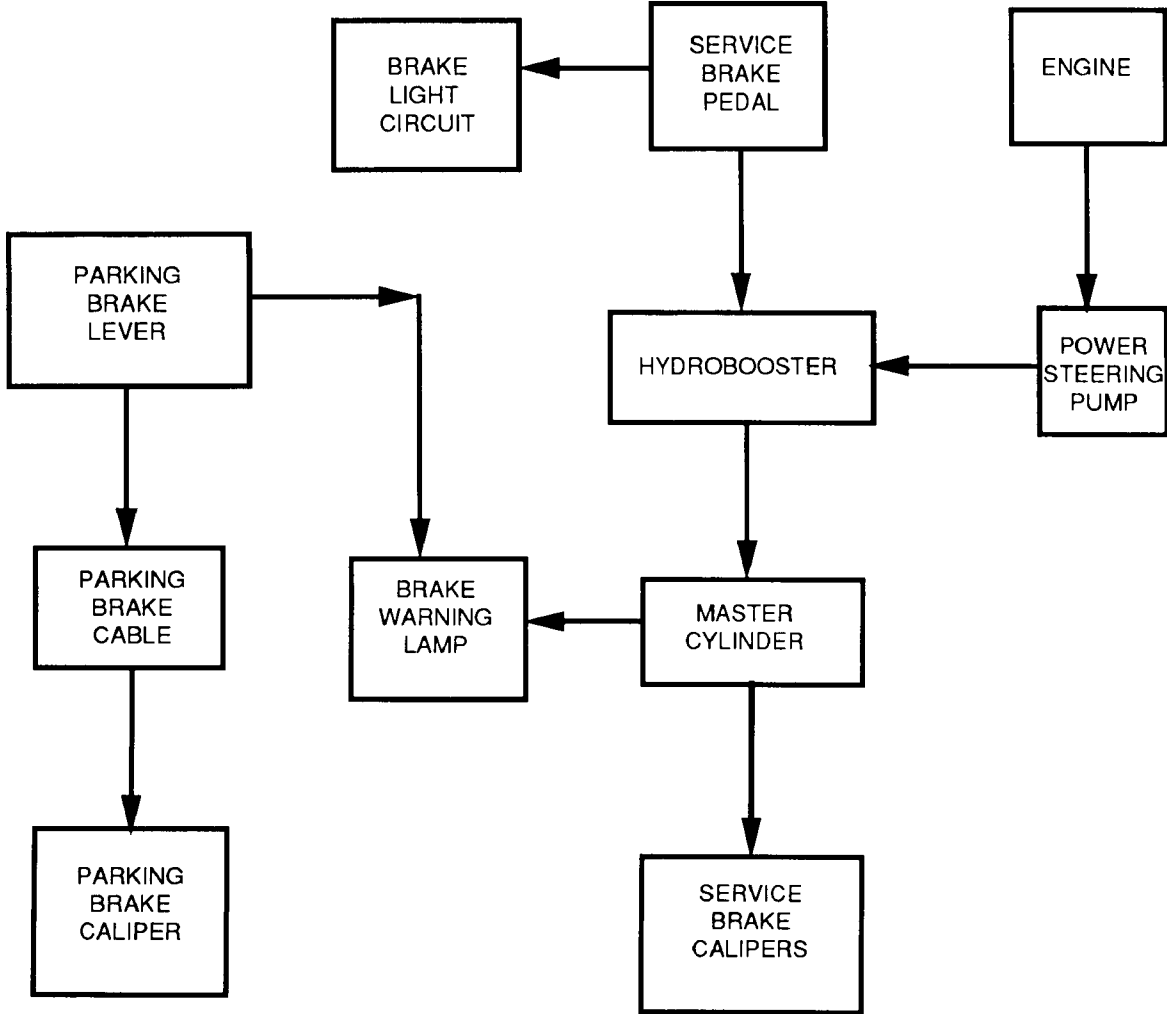


**REAR VIEW**

FO-11 Lights Functional Flow  
and Location of Parts Diagrams  
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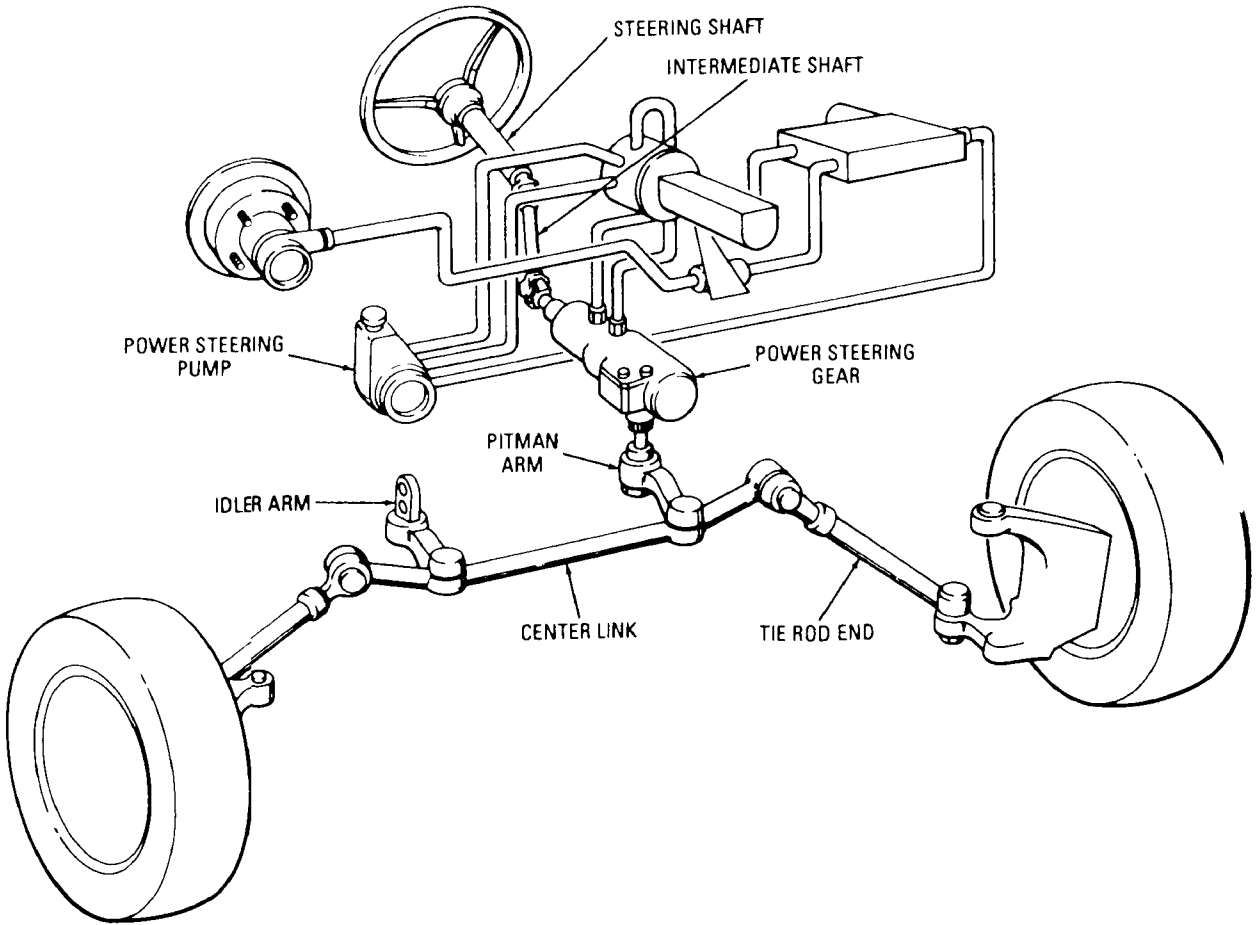
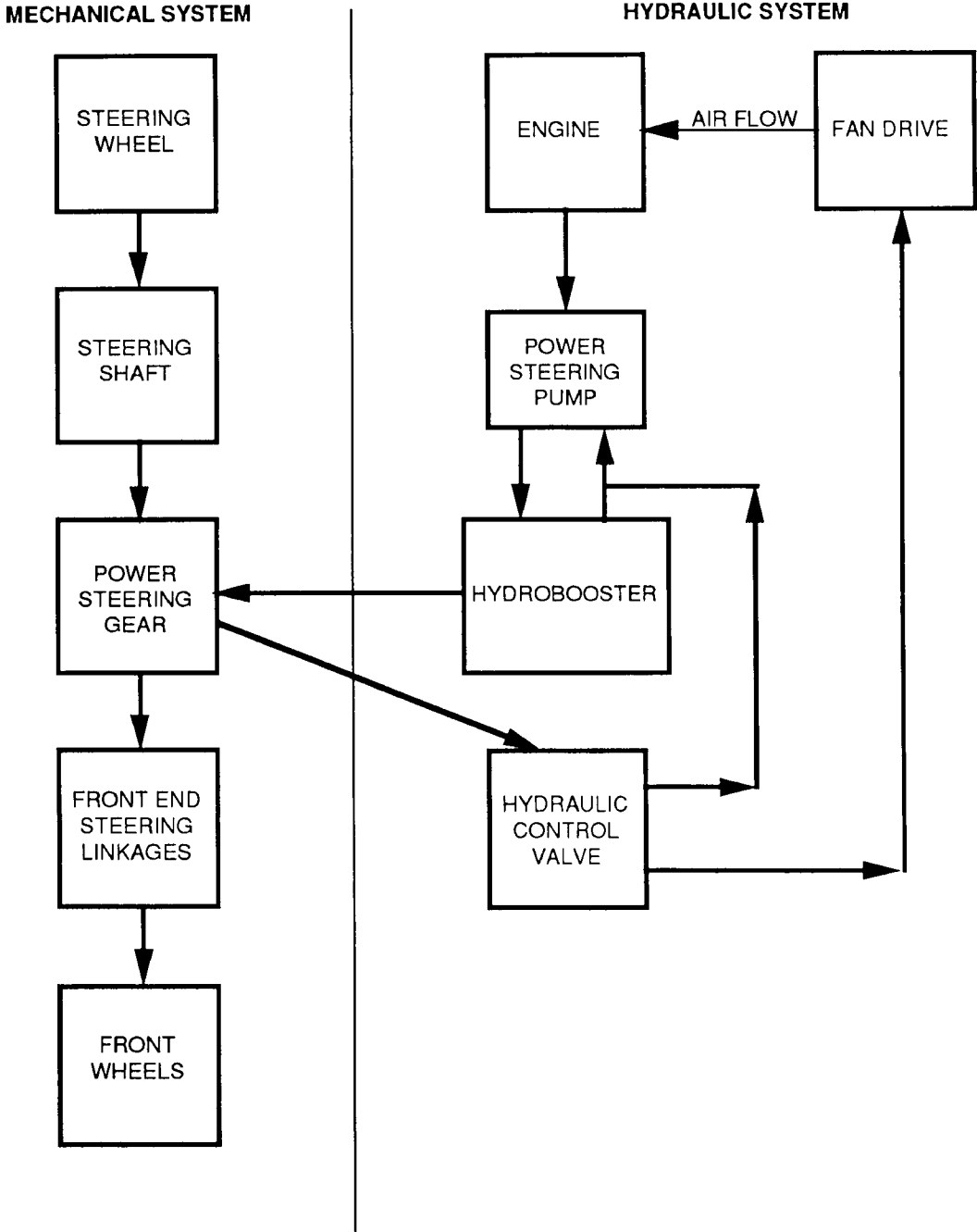


FO-12 Transmission Functional Flow  
and Location of Parts Diagrams  
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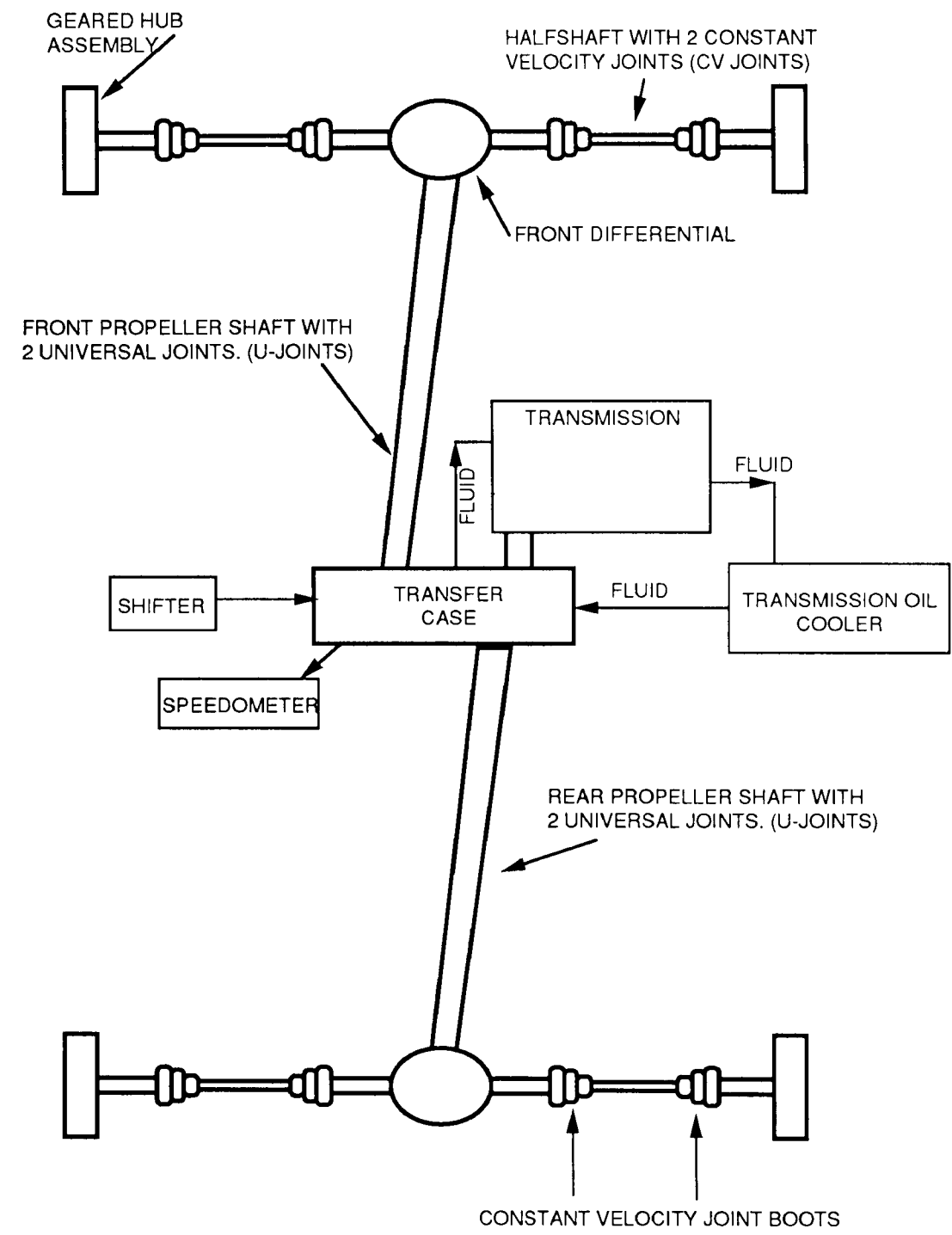


FO-13 Brakes Functional Flow  
and Location of Parts Diagrams  
FP-25/(FP-26 Blank)





FO-14 Steering Functional Flow  
and Location of Parts Diagrams  
FP-27/(FP-28 Blank)

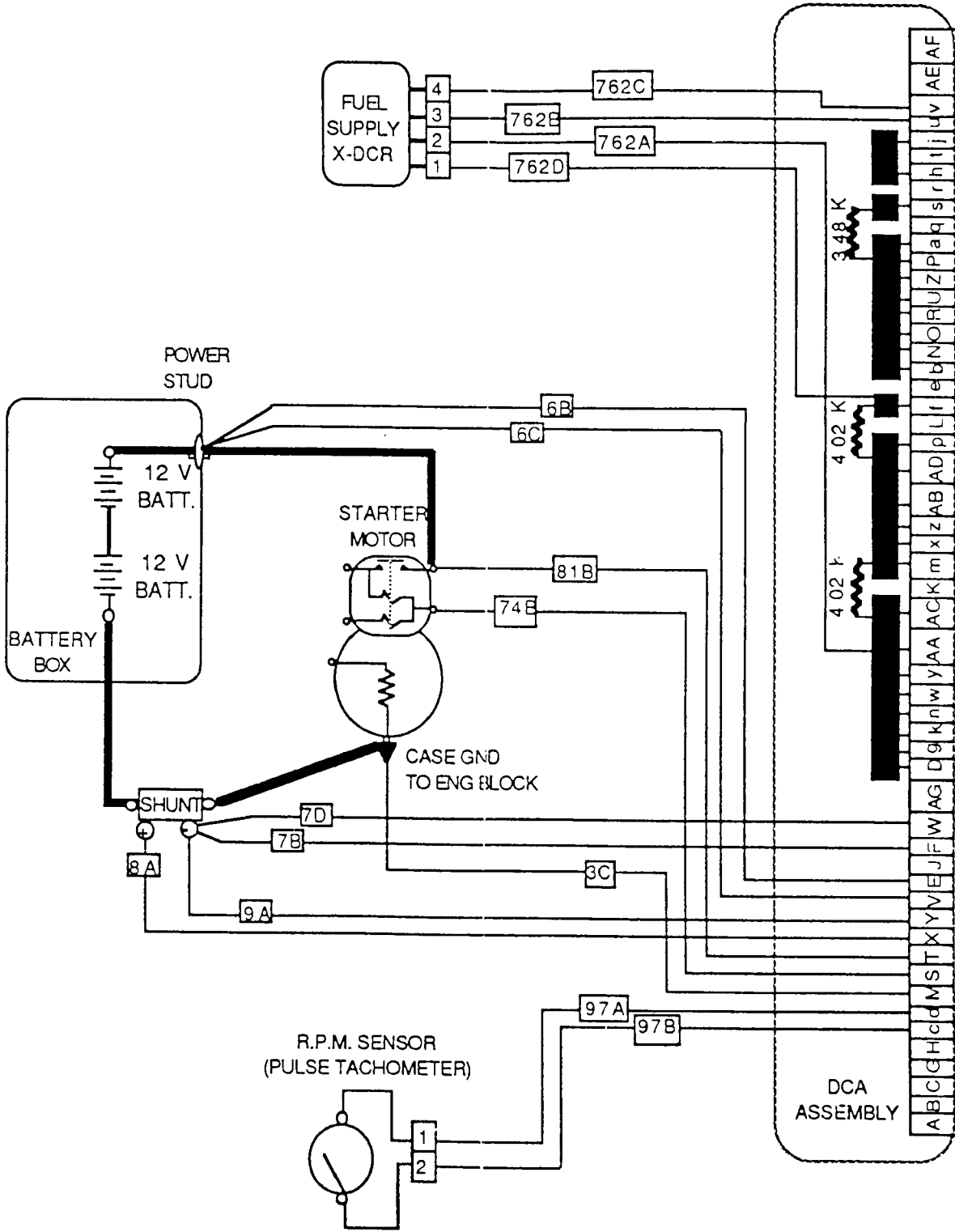


NOT APPLICABLE TO THIS SYSTEM

DCA TO TK CROSS REFERENCE

This table assumes that the VTM is powered by the W5 cable. For additional information on any of these tests, see Chapter 23 or TM 9-4910-571-12&P. Tests 72,73,74, and 75 are known as a first peak series, and data for all four of these tests is taken simultaneously.

DCA TEST	PARAMETER	USE TK ITEM	TEST NO.	MEASUREMENT POINTS
10	RPM	34-PULSE TACH. WITH A W4 CABLE	10	PUT IN PLACE OF VEHICLE TACH.
12	POWER (RPM/SEC)	34-PULSE TACH. WITH A W4 CABLE	12	PUT IN PLACE OF VEHICLE TACH.
13	POWER (PERCENT)	34-PULSE TACH. WITH A W4 CABLE	13	PUT IN PLACE OF VEHICLE TACH.
14	COMPRESSION UNBALANCE	NONE REQUIRED	14	VTM TAKES DATA THROUGH W5 (POWER) CABLE
24	FUEL PRESSURE	22-RED PRESSURE TRANSDUCER	49	INSTALL IN PLACE OF VEHICLE FUEL PRESSURE TRANSDUCER.
67	BATTERY VOLTAGE	NONE REQUIRED	67	VTM TAKES DATA THROUGH W5 (POWER) CABLE
68	STARTER MOTOR VOLTS	W2 CABLE	89	ATTACH RED CLIP TO STARTER POSITIVE TERMINAL (WIRE 6A),BLACK TO BATTERY SIDE OF SHUNT
69	STARTER NEG. CABLE DROP	W2 CABLE	89	ATTACH RED CLIP TO STARTER GROUND TERMINAL (WIRE 7A),BLACK TO BATTERY SIDE OF SHUNT
70	STARTER SOL. VOLTS	W2 CABLE	89	ATTACH RED CLIP TO STARTER SOLENOID TERMINAL (WIRE 74A),BLACK TO STARTER GROUND TERMINAL
71	STARTER CURRENT	11- CURRENT PROBE	90	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
72	CURRENT FIRST PEAK	11- CURRENT PROBE	72	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
73	BATTERY RESISTANCE	11- CURRENT PROBE	73	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
74	STARTER CIRCUIT RESISTANCE	11- CURRENT PROBE	74	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
75	BATTERY RESISTANCE CHANGE	11- CURRENT PROBE	75	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.
80	BATTERY CURRENT	11- CURRENT PROBE	90	PUT PROBE AROUND NEGATIVE BATTERY CABLE BETWEEN THE SHUNT AND THE BATTERY PACK.



# THE METRIC SYSTEM AND EQUIVALENTS

## LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches  
 1 Meter = 100 Centimeters = 1,000 Millimeters = 39.37 Inches  
 1 Kilometer = 1,000 Meters = 0.621 Miles

## SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches  
 1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet  
 1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

## CUBIC MEASURE

1 Cu Centimeter = 1,000 Cu Millimeters = 0.06 Cu Inches  
 1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

## LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces  
 1 Liter = 1,000 Milliliters = 33.82 Fluid Ounces

## TEMPERATURE

Degrees Fahrenheit (F) =  $^{\circ}\text{C} \cdot 9 \div 5 + 32$   
 Degrees Celsius (C) =  $\text{F}^{\circ} - 32 \cdot 5 \div 9$   
 212° Fahrenheit is equivalent to 100° Celsius  
 90° Fahrenheit is equivalent to 32.2° Celsius  
 32° Fahrenheit is equivalent to 0° Celsius

## WEIGHTS

1 Gram = 0.001 Kilograms = 1,000 Milligrams = 0.035 Ounces  
 1 Kilogram = 1,000 Grams = 2.2 Lb  
 1 Metric Ton = 1,000 Kilograms = 1 Megagram = 1.1 Short Tons

## APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Millimeters	25.4
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.4536
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds Per Square Inch	Kilopascals	6.895
Miles Per Gallon	Kilometers Per Liter	0.425
Miles Per Hour	Kilometers Per Hour	1.609
TO CHANGE	TO	MULTIPLY BY
Millimeters	Inches	0.03937
Centimeters	Inches	0.3937
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.2046
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds Per Square Inch	0.145
Kilometers Per Liter	Miles Per Gallon	2.354
Kilometers Per Hour	Miles Per Hour	0.621

