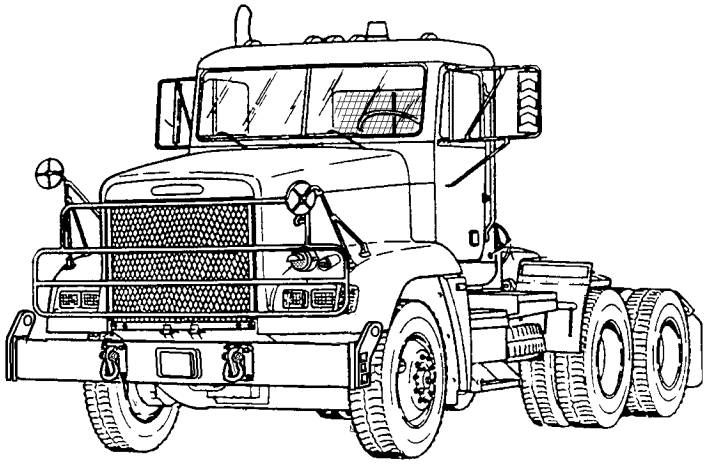
TM 9-2320-302-20

UNIT MAINTENANCE MANUAL

FOR

TRUCK, TRACTOR, LINE HAUL:
52,000 GVWR, 6 X 4, M915A3
(NSN 2320-01-432-4847)



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HEADQUARTERS, DEPARTMENT OF THE ARMY

May 2001

LIST OF EFFECTIVE PAGES/WORK PACKAGES

NOTE

A vertical line in the outer margins of the page indicates the portion of text affected by the change. Changes to illustrations are indicated by miniature pointing hands. Change to wiring diagrams is indicated by shaded areas.

Dates of issue for original and change pages/work packages are:

Original	28 May 2001
Change	Not Applicable

TOTAL NUMBER OF PAGES FOR FRONT AND REAR MATTER IS 52 AND TOTAL NUMBER OF WORK PACKAGES IS 236 CONSISTING OF THE FOLLOWING:

Page/WP No.	***Change No.**
Cover (Back Blank)	0
A (B Blank)	0
a to h	0
i to vii (viii Blank)	0
WP 0001 00 to 0236 00	0
Index-1 to Index-18	0
FO-1 and FO-2	0
Authentication Page (Back Blank)	0
Sample DA Form 2028-2	0
Blank DA Form 2028-2	0
Metric Conversion Chart	0
Back Cover	0

* Zero in this column indicates an original page or work package.

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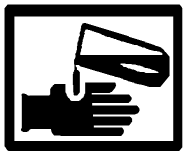
WARNING SUMMARY

This warning summary contains general safety warnings and hazardous materials warnings that must be understood and applied during operation and maintenance of this equipment. Failure to observe these precautions could result in serious injury or death to personnel. Also included are explanations of safety and hazardous materials icons used within the technical manual.

BIOLOGICAL - abstract symbol bug shows that a material may contain bacteria or viruses that present a danger to life or health.



CHEMICAL - drops of liquid on hand shows that the material will cause burns or irritation to human skin or tissue.

EAR PROTECTION - headphones over ears shows that noise level will harm ears.

ELECTRICAL - electrical wire to arm with electricity symbol running through human body shows that shock hazard is present.

EYE PROTECTION - person with goggles shows that the material will injure the eyes.

FIRE - flame shows that a material may ignite and cause burns.

FLYING PARTICLES - arrows bouncing off face with face shield shows that particles flying through the air will harm face.

HEAVY OBJECT - human figure stooping over heavy object shows physical injury potential from improper lifting technique.

HEAVY PARTS - hand with heavy object on top shows that heavy parts can crush and harm.

HEAVY PARTS - heavy object on human figure shows that heavy parts present a danger to life or limb.

HOT AREA - hand over object radiating heat shows that part is hot and can burn.

VAPOR - human figure in a cloud shows that material vapors present a danger to life or health.

FOR INFORMATION ON FIRST AID, REFER TO FM 21-11.

WARNING

CARBON MONOXIDE (EXHAUST GASES) CAN KILL!

- Carbon monoxide is a colorless, odorless, deadly poison which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air containing carbon monoxide produces symptoms of headache, dizziness, loss of muscular control, apparent drowsiness, and coma. Permanent brain damage or death can result from severe exposure.
- Carbon monoxide occurs in exhaust fumes of internal combustion engines. Carbon monoxide can become dangerously concentrated under conditions of inadequate ventilation. The following precautions must be observed to ensure safety of personnel when engine of truck is operated.

1. DO NOT operate truck engine in enclosed areas.
2. DO NOT idle truck engine without adequate ventilation.
3. DO NOT drive truck with inspection plates or cover plates removed.
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 fresh air.
   - Keep person warm.
   - Do not permit physical exercise.
   - Administer cardiopulmonary resuscitation (CPR), if necessary.
   - Notify a medic.
6. BE AWARE. The field protective mask for nuclear-biological-chemical (NBC) protection will not protect you from carbon monoxide poisoning.

The Best Defense Against Carbon Monoxide Poisoning Is Good Ventilation!

WARNING

ADHESIVES AND SEALING COMPOUNDS

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

WARNING

AIR LINES AND FITTINGS

- DO NOT disconnect any air system lines or fittings unless vehicle engine is shut down and air system pressure is relieved. Failure to follow this warning could result in serious injury to personnel.
- Ensure that all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.
- Always wear eye protection when disconnecting air lines. Residual air will be expelled. Failure to follow this warning may result in serious eye injury.

WARNING

BATTERIES

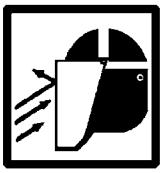
- To avoid eye injury, eye protection is required when working around batteries. DO NOT smoke, use open flame, make sparks or create other ignition sources around batteries. If a battery is giving off gases, it can explode and cause injury to personnel. Remove all jewelry such as rings, ID tags, watches, and bracelets. If jewelry or a tool contacts a battery terminal, a direct short will result in instant heating, injury to personnel, and damage to equipment.
- Sulfuric acid contained in batteries can cause serious burns. If battery corrosion or electrolyte makes contact with skin, eyes or clothing, take immediate action to stop the corrosive burning effects. Failure to follow these procedures may result in death or serious injury to personnel.

  1. **Eyes.** Flush with cold water for no less than 15 minutes and seek medical attention immediately.
  2. **Skin.** Flush with large amounts of cold water until all acid is removed. Seek medical attention as required.
  3. **Internal.** If corrosion or electrolyte is ingested, drink large amounts of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil. Seek medical attention immediately.
  4. **Clothing/Equipment.** Wash area with large amounts of cold water. Neutralize acid with baking soda or household ammonia.

WARNING

BRAKES

- When caging brakes, block wheels to keep truck from moving when brakes are released. Failure to follow this warning may result in death or injury to personnel or damage to equipment.
- Brake chamber contains spring under great pressure. To prevent personnel injury, never work directly behind chamber. If caging bolt will not engage properly, spring may be broken.
- DO NOT remove clamp ring around spring brake chamber. It is under tension and can cause personnel injury if released.
- When spring brakes are applied, vehicle will stop quickly which could result in injury to personnel. Also, vehicle cannot be driven again until malfunction is repaired and enough air supply is present for operation of service brakes.



WARNING

COMPRESSED AIR

Compressed air used for cleaning or drying purposes, or for clearing restrictions, should never exceed 30 psi (207 kPa). Wear protective clothing (goggles/shield, gloves, etc.) and use caution to avoid injury to personnel.

WARNING

DIESEL FUEL HANDLING

- DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel and damage to vehicle.
- Fuel vapors are toxic. Avoid prolonged exposure or breathing of fumes. Work in a well-ventilated area. Failure to follow this warning could result in serious injury to personnel.

WARNING

ETHER QUICK-START SYSTEM

Ether fuel is extremely flammable and toxic. DO NOT smoke and make sure you are in a well-ventilated area away from heat, open flames or sparks. Wear eye protection. Avoid contact with skin and eyes and avoid breathing ether fumes. If fluid enters or fumes irritate the eyes, wash immediately with large quantities of clean water for 15 minutes. Seek medical attention immediately if ether is inhaled or causes eye irritation. Failure to follow this warning may cause death or serious injury to personnel.

WARNING

FIRE EXTINGUISHER

Discharging large quantities of dry chemical fire extinguisher in cab may result in temporary breathing difficulty during and immediately after the discharge event. If at all possible, discharge fire extinguisher from outside the cab. Ventilate cab thoroughly prior to reentry.

WARNING

HAZARDOUS WASTE DISPOSAL

When servicing this vehicle, performing maintenance, or disposing of materials such as engine coolant, transmission fluid, lubricants, battery acids or batteries, and CARC paint, consult your unit/local hazardous waste disposal center or safety office for local regulatory guidance. If further information is needed, please contact The Army Environmental Hotline at 1-800-872-3845.

WARNING

HEARING PROTECTION

Hearing protection is required when operating vehicle at more than 45 mph (72 kph) with windows open for an extended period of time. Hearing protection is also required when personnel are within 1 meter (3.1 ft) of vehicle when operating at low engine idle (600 rpm) and within 3.5 meters (11 ft) of vehicle when operating at high idle (1600 rpm). Failure to follow this warning may result in hearing damage.

WARNING

NBC EXPOSURE

If NBC exposure is suspected, all air cleaner media should be handled by personnel wearing protective equipment. Consult your NBC Officer or NBC NCO for appropriate handling or disposal procedures.

To order this NBC decal use:

National Stock Number (NSN) - 7690-01-114-3702
Part Number (PN) - 12296626
Commercial and Government Entity Code (CAGEC) - 19207

WARNING

PRESSURIZED COOLING SYSTEM

DO NOT remove radiator cap or drain antifreeze unless engine is cold. Remove radiator cap in two steps. First, place a thick cloth over cap and slowly turn cap left to first stop. Pause and allow pressure to escape. Turn cap further left until it can be removed. This is a pressurized cooling system and escaping steam, hot water or coolant will cause serious burns.

WARNING

R-134A REFRIGERANT

- Liquid refrigerant, when exposed to air, quickly evaporates and will freeze skin or eye tissue. Use care to prevent refrigerant from touching your skin or eyes. Serious injury or blindness may result if you come in contact with refrigerant.
- Refrigerant R-134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R-134a may form, resulting in a fire or explosion, which could cause personnel injury.
- DO NOT work in an area where refrigerant may contact an open flame or burning material such as a cigarette. When refrigerant contacts extreme heat, refrigerant breaks down into poisonous phosgene gas which, if breathed, causes severe respiratory irritation. DO NOT breathe fumes from an open flame leak detector.

WARNING

SLAVE STARTING

- When slave starting truck, use NATO slave cable that DOES NOT have loose or missing insulation.
- DO NOT proceed if suitable cable is not available.
- DO NOT use civilian-type jumper cables.

WARNING

TIRE CHANGING

Whenever wheel lug nuts require tightening or a wheel has been removed and replaced, lug nuts must be tightened to the required torque. Failure to follow this warning may result in serious injury to personnel and damage to equipment.

WARNING

TOWING

Brakes will be released when air is applied to a disabled vehicle. DO NOT connect air lines to a disabled vehicle without blocking wheels and connecting tow bar between vehicles. Failure to follow this warning could result in death or injury to personnel and damage to equipment.

WARNING

WORK SAFETY

- Hydraulic jack is intended only for lifting truck, not for supporting vehicle to perform maintenance. DO NOT get under truck after it is raised unless it is properly supported with blocks or jackstands. Failure to observe this warning may result in death or injury to personnel.

- Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Ensure that any lifting device used is in good condition and of suitable load capacity. Keep clear of heavy parts supported only by lifting device. Failure to follow this warning may result in death or injury to personnel.

- Improper use of lifting equipment and improper attachment of cables to vehicle can result in serious personnel injury and equipment damage. Observe all standard rules of safety.

- ALWAYS install hood prop after opening hood. Failure to follow this warning could result in severe injury to personnel.

TECHNICAL MANUAL
TM 9-2320-302-20

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 28 May 2001

UNIT MAINTENANCE MANUAL

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TRUCK, TRACTOR, LINE HAUL:
52,000 GVWR, 6 X 4, M915A3
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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (*Recommended Changes to Equipment Technical Publications*), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is http://aeps.ria.army.mil. If you need a password, scroll down and click on "ACCESS REQUEST FORM". The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or e-mail your letter, DA Form 2028 direct to: AMSTA-LC-CI/TECH PUBS, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The e-mail address is: TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

Table of Contents

Page Number

Warning Summary . . . . . a
How to Use This Manual. vii

CHAPTER 1 INTRODUCTORY INFORMATION WITH THEORY OF OPERATION

WP 0001 00 General Information 0001 00-1
WP 0002 00 Equipment Description and Data 0002 00-1
WP 0003 00 Theory of Operation. 0003 00-1

CHAPTER 2 UNIT TROUBLESHOOTING PROCEDURES

WP 0004 00 Troubleshooting Introduction. 0004 00-1
WP 0005 00 Troubleshooting Symptom Index 0005 00-1
WP 0006 00 Engine Troubleshooting 0006 00-1
WP 0007 00 DDEC Engine Troubleshooting 0007 00-1
WP 0008 00 Exhaust System Troubleshooting 0008 00-1
WP 0009 00 Cooling System Troubleshooting 0009 00-1
WP 0010 00 Electrical System Troubleshooting 0010 00-1
WP 0011 00 Transmission and Driveline Systems Troubleshooting 0011 00-1
WP 0012 00 Brake System Troubleshooting 0012 00-1
WP 0013 00 Anti-lock Brake System (ABS) Troubleshooting and Testing 0013 00-1

Table of Contents - Continued

		Page Number
WP 0014 00	Air System Troubleshooting	0014 00-1
WP 0015 00	Steering System Troubleshooting	0015 00-1
WP 0016 00	Chassis and Fifth Wheel Troubleshooting	0016 00-1
WP 0017 00	Air Conditioning System Troubleshooting and Testing	0017 00-1
WP 0018 00	Collision Warning System (CWS) Troubleshooting	0018 00-1

CHAPTER 3 UNIT MAINTENANCE INSTRUCTIONS

WP 0019 00	Service Upon Receipt	0019 00-1
WP 0020 00	Unit Preventive Maintenance Checks and Services (PMCS) Introduction	0020 00-1
WP 0021 00	Unit Preventive Maintenance Checks and Services (PMCS)	0021 00-1
WP 0022 00	Oil Fill Tube Maintenance	0022 00-1
WP 0023 00	Oil Level Dipstick, Tube, and Adapter Replacement	0023 00-1
WP 0024 00	Oil Filter Element Replacement	0024 00-1
WP 0025 00	Oil Cooler and Oil Filter Adapter Maintenance	0025 00-1
WP 0026 00	Oil Sample Valves Replacement	0026 00-1
WP 0027 00	Air Compressor Discharge Hose Replacement	0027 00-1
WP 0028 00	Air Compressor Governor Replacement and Adjustment	0028 00-1
WP 0029 00	Air Compressor Replacement	0029 00-1
WP 0030 00	Fuel Hoses and Fittings Replacement	0030 00-1
WP 0031 00	Fuel Strainer and Filter Element Replacement	0031 00-1
WP 0032 00	Fuel Filter Adapters Replacement	0032 00-1
WP 0033 00	Fuel Tank and Mounting Brackets Replacement	0033 00-1
WP 0034 00	Fuel Pump Replacement	0034 00-1
WP 0035 00	Automatic Ether Starting Aid Maintenance	0035 00-1
WP 0036 00	Air Cleaner, Air Intake Duct, and Turbo Bypass Valve Maintenance	0036 00-1
WP 0037 00	Air Intake Tubes and Hoses Replacement	0037 00-1
WP 0038 00	Charge Air Cooler and Air Recirculation Shield Replacement	0038 00-1
WP 0039 00	Exhaust System Muffler, Stack, and Heat Shield Replacement	0039 00-1
WP 0040 00	Exhaust System Flex Pipe, Clamps, and Heat Shield Replacement	0040 00-1
WP 0041 00	Drain and Fill Cooling System	0041 00-1
WP 0042 00	Coolant Hoses, Pipes, and Clamps Replacement	0042 00-1
WP 0043 00	Thermostat and Thermostat Housing Cover Replacement	0043 00-1
WP 0044 00	Radiator Support Rod Replacement	0044 00-1
WP 0045 00	Radiator Replacement	0045 00-1
WP 0046 00	Fan Belt Replacement and Adjustment	0046 00-1
WP 0047 00	Fan Impeller and Shroud Replacement	0047 00-1
WP 0048 00	Fan Clutch Solenoid Replacement	0048 00-1
WP 0049 00	Fan Clutch and Drive Pulley Replacement	0049 00-1
WP 0050 00	Water Filter Element Replacement	0050 00-1
WP 0051 00	Water Filter Adapter and Bracket Replacement	0051 00-1
WP 0052 00	Water Pump Maintenance	0052 00-1
WP 0053 00	Spindle and Housing Replacement	0053 00-1
WP 0054 00	Alternator Belt Replacement and Adjustment	0054 00-1
WP 0055 00	Alternator Replacement	0055 00-1
WP 0056 00	Starter Replacement	0056 00-1
WP 0057 00	Voltage Regulator Replacement	0057 00-1
WP 0058 00	Battery Equalizer Replacement	0058 00-1
WP 0059 00	Starter Relay Replacement	0059 00-1

Table of Contents - Continued

		Page Number
WP 0060 00	Left Panel Gages and Lamps Replacement	0060 00-1
WP 0061 00	Center Gage Panel Maintenance	0061 00-1
WP 0062 00	Right Gage Panel and Lamps Replacement	0062 00-1
WP 0063 00	Upper Right Dash Panel Replacement	0063 00-1
WP 0064 00	Left Hand Switch Panel Maintenance	0064 00-1
WP 0065 00	Right Hand Switch Panel Replacement	0065 00-1
WP 0066 00	Control Module Replacement	0066 00-1
WP 0067 00	Heater and Air Conditioning Control Panel Replacement	0067 00-1
WP 0068 00	12V Power Receptacle Replacement	0068 00-1
WP 0069 00	Fiber Optic Light Source Replacement	0069 00-1
WP 0070 00	Check Engine Switch and Jumper Harness Replacement	0070 00-1
WP 0071 00	Fuse, Relay, Circuit Breaker, and Holder Replacement	0071 00-1
WP 0072 00	Master Battery Switch Replacement	0072 00-1
WP 0073 00	Turn Signal Switch Replacement	0073 00-1
WP 0074 00	Electronic Throttle Replacement	0074 00-1
WP 0075 00	Electronic Control Module Replacement	0075 00-1
WP 0076 00	NATO Slave Receptacle Replacement	0076 00-1
WP 0077 00	Utility Power Receptacle Replacement	0077 00-1
WP 0078 00	Trailer Electrical Receptacles Replacement	0078 00-1
WP 0079 00	Parking Brake Pressure Switch Replacement	0079 00-1
WP 0080 00	Water Level Module Replacement	0080 00-1
WP 0081 00	Water Level Probe Replacement	0081 00-1
WP 0082 00	Headlamp Adjustment	0082 00-1
WP 0083 00	Headlamp and Headlight Replacement	0083 00-1
WP 0084 00	Blackout Drive, Marker Light, and Wiring Harness Replacement	0084 00-1
WP 0085 00	Right Front Blackout Marker Replacement	0085 00-1
WP 0086 00	Rear Blackout Marker Replacement	0086 00-1
WP 0087 00	Taillight Maintenance	0087 00-1
WP 0088 00	Side Marker/Turn Signal Light Replacement	0088 00-1
WP 0089 00	Clearance Light Replacement	0089 00-1
WP 0090 00	Utility Light Maintenance	0090 00-1
WP 0091 00	Interior Light Unit and Bulb Replacement	0091 00-1
WP 0092 00	Fuel Pressure Sensor Replacement	0092 00-1
WP 0093 00	Fuel Temperature Sensor Replacement	0093 00-1
WP 0094 00	Fuel Level Sending Unit Replacement	0094 00-1
WP 0095 00	Oil Pressure Sensor Replacement	0095 00-1
WP 0096 00	Oil Temperature Sensor Replacement	0096 00-1
WP 0097 00	Oil Pressure Sending Unit Replacement	0097 00-1
WP 0098 00	Water Temperature Sensor Replacement	0098 00-1
WP 0099 00	Water Level Sensor Replacement	0099 00-1
WP 0100 00	Fan Temperature Sensor Replacement	0100 00-1
WP 0101 00	Air Temperature Sensor Replacement	0101 00-1
WP 0102 00	Turbo Boost Sensor (TBS) Replacement	0102 00-1
WP 0103 00	Timing Reference Sensor Replacement	0103 00-1
WP 0104 00	Synchronous Reference Sensor Replacement	0104 00-1
WP 0105 00	Air Pressure Sending Units (Primary/Secondary) Replacement	0105 00-1
WP 0106 00	Front Anti-lock Brake System (ABS) Sensor Replacement	0106 00-1

Table of Contents - Continued

		Page Number
WP 0107 00	Rear Anti-lock Brake System (ABS) Sensor Replacement	0107 00-1
WP 0108 00	Anti-lock Brake System (ABS) Electronic Control Unit Replacement	0108 00-1
WP 0109 00	Brake Light/Trailer Brake Light Sending Unit Replacement	0109 00-1
WP 0110 00	Collision Warning System (CWS) Antenna Alignment	0110 00-1
WP 0111 00	Collision Warning System (CWS) Maintenance	0111 00-1
WP 0112 00	Electric Horn Replacement	0112 00-1
WP 0113 00	Battery Replacement	0113 00-1
WP 0114 00	Battery Box Replacement.	0114 00-1
WP 0115 00	Battery Cables Replacement	0115 00-1
WP 0116 00	Stop/Tail/Backup Lights Wiring Harness Replacement	0116 00-1
WP 0117 00	Automatic Ether Starting Aid Wiring Harnesses Replacement	0117 00-1
WP 0118 00	Cab-to-Frame Ground Wire Replacement	0118 00-1
WP 0119 00	Electrical Connectors Maintenance	0119 00-1
WP 0120 00	Shift Selector and Shift Tower Replacement	0120 00-1
WP 0121 00	Transmission Oil Fill/Level Check Tube Replacement	0121 00-1
WP 0122 00	Transmission Oil Cooler Lines and Fittings Replacement.	0122 00-1
WP 0123 00	Transmission Oil Filter Elements Replacement	0123 00-1
WP 0124 00	Transmission Electronic Control Unit (ECU) Replacement	0124 00-1
WP 0125 00	Transmission Electronic Control Unit (ECU) Wiring Harness Replacement	0125 00-1
WP 0126 00	Transmission Speed Sensor Replacement	0126 00-1
WP 0127 00	Transmission Oil Cooler Replacement	0127 00-1
WP 0128 00	Transmission Breather Replacement	0128 00-1
WP 0129 00	Driveline Replacement	0129 00-1
WP 0130 00	Driveline U-Joints and Bearings Replacement	0130 00-1
WP 0131 00	Front Axle Toe in Alignment	0131 00-1
WP 0132 00	Front Axle Stop Cushion Replacement	0132 00-1
WP 0133 00	Rear Axle Breather Replacement	0133 00-1
WP 0134 00	Brake Pedal Replacement.	0134 00-1
WP 0135 00	Front Brakeshoe Replacement	0135 00-1
WP 0136 00	Front Brake Spider and Brake Chamber Bracket Replacement	0136 00-1
WP 0137 00	Rear Brakeshoe Replacement.	0137 00-1
WP 0138 00	Rear Brake Spider and Brake Chamber Bracket Replacement	0138 00-1
WP 0139 00	Slack Adjuster Adjustment.	0139 00-1
WP 0140 00	Slack Adjuster and S-cam Replacement	0140 00-1
WP 0141 00	Front Air Brake Chamber Replacement	0141 00-1
WP 0142 00	Rear Air Brake Chamber Replacement	0142 00-1
WP 0143 00	Primary I Air Tank and Fittings Replacement	0143 00-1
WP 0144 00	Primary II Air Tank and Fittings Replacement	0144 00-1
WP 0145 00	Secondary Air Tank and Fittings Replacement	0145 00-1
WP 0146 00	Air Supply Tank And Fittings Replacement	0146 00-1
WP 0147 00	Air Tube Replacement	0147 00-1
WP 0148 00	Constant Air Junction Block Replacement	0148 00-1
WP 0149 00	Cab Air Junction Block Replacement	0149 00-1
WP 0150 00	Tractor Protection Valves Replacement.	0150 00-1
WP 0151 00	Rear Relay Valve Replacement	0151 00-1
WP 0152 00	Front Service Brake Relay Valve Replacement	0152 00-1
WP 0153 00	Front Gladhands Replacement	0153 00-1
WP 0154 00	Rear Gladhand Replacement	0154 00-1

Table of Contents - Continued

		Page Number
WP 0155 00	Front Quick-release Valve Replacement	0155 00-1
WP 0156 00	Rear Quick-release Valve Replacement	0156 00-1
WP 0157 00	Air Dryer Replacement	0157 00-1
WP 0158 00	Air Dryer Canister Replacement	0158 00-1
WP 0159 00	Trailer Hand Brake Replacement	0159 00-1
WP 0160 00	Parking Brake and Trailer Air Supply Valve Replacement	0160 00-1
WP 0161 00	Foot Brake Valve Replacement	0161 00-1
WP 0162 00	Front Anti-lock Brake System (ABS) Air Solenoid Replacement	0162 00-1
WP 0163 00	Rear Anti-lock Brake System (ABS) Air Solenoid Replacement	0163 00-1
WP 0164 00	Front and Dual Rear Wheel Lug Nut Installation	0164 00-1
WP 0165 00	Front Hub, Drum, Wheel Bearings, and Seal Replacement	0165 00-1
WP 0166 00	Rear Hub, Drum, Wheel Bearings, and Seal Replacement	0166 00-1
WP 0167 00	Steering Wheel Replacement	0167 00-1
WP 0168 00	Universal Shaft Replacement and Repair	0168 00-1
WP 0169 00	Pitman Arm and Drag Link Maintenance	0169 00-1
WP 0170 00	Power Steering Reservoir and Hose Maintenance	0170 00-1
WP 0171 00	Right Step Replacement	0171 00-1
WP 0172 00	Left Step Replacement	0172 00-1
WP 0173 00	Left Side Platform Replacement	0173 00-1
WP 0174 00	Right Rear Step Replacement	0174 00-1
WP 0175 00	Front Bumper Replacement	0175 00-1
WP 0176 00	Spare Wheel Hoist Replacement	0176 00-1
WP 0177 00	Rear Tie Down Replacement	0177 00-1
WP 0178 00	Fifth Wheel Adjustment	0178 00-1
WP 0179 00	Pintle Hook Replacement and Repair	0189 00-1
WP 0180 00	Towing Bracket Replacement	0180 00-1
WP 0181 00	Taillight Bracket Replacement	0181 00-1
WP 0182 00	Front Shock Absorber Replacement	0182 00-1
WP 0183 00	Rear Shock Absorber Replacement	0183 00-1
WP 0184 00	Brush Guard Replacement	0184 00-1
WP 0185 00	Engine Hood Assembly Replacement	0185 00-1
WP 0186 00	Hood Assembly Repair	0186 00-1
WP 0187 00	Hood Adjustment	0187 00-1
WP 0188 00	Hood Latch Replacement	0188 00-1
WP 0189 00	Hood Liner Replacement	0189 00-1
WP 0190 00	Hood Prop and Mount Replacement	0190 00-1
WP 0191 00	Seat Replacement	0191 00-1
WP 0192 00	Seat Repair	0192 00-1
WP 0193 00	Seat Belt Replacement	0193 00-1
WP 0194 00	Front Splash Guard and Fender Extension Maintenance	0194 00-1
WP 0195 00	Rear Fender Replacement	0195 00-1
WP 0196 00	Mud Flap Assembly Replacement	0196 00-1
WP 0197 00	Personal Gear Storage Box and Mounting Bracket Replacement	0197 00-1
WP 0198 00	Basic Issue Items (BII) Storage Box and Mounting Bracket Replacement	0198 00-1
WP 0199 00	Storage Box Latch Replacement	0199 00-1
WP 0200 00	Rear Platform Replacement	0200 00-1
WP 0201 00	Floor Mats Replacement	0201 00-1

Table of Contents - Continued

		Page Number
WP 0202 00	Cab Liners Replacement	0202 00-1
WP 0203 00	Head Liners Replacement	0203 00-1
WP 0204 00	Cab Overhead Storage Compartment Replacement	0204 00-1
WP 0205 00	Steering Column Cover Replacement	0205 00-1
WP 0206 00	Cab Door Adjustment	0206 00-1
WP 0207 00	Transmission Tunnel Access Cover Replacement	0207 00-1
WP 0208 00	Rear View Mirror Replacement	0208 00-1
WP 0209 00	Spotter Mirror Replacement	0209 00-1
WP 0210 00	Windshield Wiper Motor and Linkage Replacement	0210 00-1
WP 0211 00	Windshield Washer Reservoir Replacement	0211 00-1
WP 0212 00	Windshield Wiper and Wiper Arm Replacement	0212 00-1
WP 0213 00	Vehicle Jack Mounting Bracket Replacement	0213 00-1
WP 0214 00	Air Horn and Valve Replacement	0214 00-1
WP 0215 00	Data and Instruction Plates Replacement	0215 00-1
WP 0216 00	M16 Rifle Mounting Bracket Replacement	0216 00-1
WP 0217 00	Cup Holder Replacement	0217 00-1
WP 0218 00	Cab Roof Air Deflector Replacement	0218 00-1
WP 0219 00	HVAC Air Cylinder Replacement	0219 00-1
WP 0220 00	HVAC Blower Motor Replacement	0220 00-1
WP 0221 00	HVAC Heater Core Replacement	0221 00-1
WP 0222 00	Air Conditioner Resister Block Replacement	0222 00-1
WP 0223 00	Air Conditioner Thermostatic Switch Replacement	0223 00-1
WP 0224 00	Air Conditioner Binary Switch Replacement	0224 00-1
WP 0225 00	Air Conditioner Leak Test	0225 00-1
WP 0226 00	Air Conditioner Compressor Magnetic Clutch Replacement	0226 00-1
WP 0227 00	M13 Decontamination Kit Mounting Bracket Replacement	0227 00-1
WP 0228 00	General Maintenance Instructions	0228 00-1
WP 0229 00	Arctic Heater Replacement (WEBASTO)	0229 00-1
WP 0230 00	Illustrated List of Manufactured Items	0230 00-1
WP 0231 00	Torque Limits	0231 00-1

CHAPTER 4 SUPPORTING INFORMATION

WP 0232 00	References	0232 00-1
WP 0233 00	Maintenance Allocation Chart (MAC) Introduction	0233 00-1
WP 0234 00	Maintenance Allocation Chart (MAC)	0234 00-1
WP 0235 00	Expendable and Durable Items List	0235 00-1
WP 0236 00	Tool Identification List	0236 00-1
	Index	Index-1
	DDEC III/IV Wiring Diagram	FO-1
	OEM Responsibility	FO-2

HOW TO USE THIS MANUAL

This manual is designed to help you maintain the M915A3 Tractor Truck.

FEATURES OF THIS MANUAL:

- A Table of Contents is provided at the beginning of this manual.
- WARNINGs, CAUTIONs, NOTEs, subject headings, and other important information are highlighted in **BOLD** print as a visual aid.

WARNING

A WARNING indicates a hazard which results in death or serious injury.

CAUTION

A CAUTION is a reminder of safety practices or directs attention to usage practices that may result in damage to equipment.

NOTE

A NOTE is a statement containing information that will make the procedures easier to perform.

- Statements and words of particular importance are printed in CAPITAL LETTERS to create emphasis.
- Instructions are located with illustrations that show the specific task on which the mechanic is working.
- Dashed leader lines used in illustrations indicate that called out items are not visible (i.e. they are located within the structure). Dashed leader lines in the Lubrication Chart indicate that lubrication is required on BOTH sides of the equipment.
- Technical instructions include metric units in addition to standard units. A metric conversion chart is provided on the inside back cover.
- An alphabetical index is provided at the end of the manual to assist in locating information not readily found in the Table of Contents.

FOLLOW THESE GUIDELINES WHEN YOU THIS MANUAL:

- Read through this manual and become familiar with its contents before attempting to maintain the vehicle.
- A Warning Summary is provided at the beginning of this manual and should be read before attempting to maintain the vehicle.

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CHAPTER 1
INTRODUCTORY INFORMATION WITH THEORY OF OPERATION

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GENERAL INFORMATION 0001 00

SCOPE

1. **Type of Manual.** This manual is for use in performing Unit Maintenance on the M915A3 Tractor Truck.

2. **Equipment Name and Model Number.** Truck, Tractor, Line Haul: 52,000 GVWR, 6 X 4, M915A3.

3. **Purpose of Equipment.** The M915A3 Tractor Truck is a 6 X 4 prime mover of semitrailers used primarily to transport containers, bulk cargo, and petroleum products over primary and secondary roads under worldwide climatic conditions in a military environment.

MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, *Functional User's Manual for the Army Maintenance Management System (TAMMS*), as contained in the Maintenance Management Update.

REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRS)

If your truck 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. Put it on an SF Form 368 *(Product Quality Deficiency Report)*. Mail it to us at: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-LC-CIP-WT, Rock Island, Illinois 61299-7630. We will send you a reply.

CORROSION PREVENTION AND CONTROL (CPC)

1. Corrosion Prevention and Control (CPC) of Army materiel is a continuing concern. It is important that any corrosion problems with this item be reported so that the problem can be corrected and improvements can be made to prevent the problem in future items.

2. While corrosion is typically associated with rusting of metals, it can also include deterioration of other materials, such as rubber and plastic. Unusual cracking, softening, swelling or breaking of these materials may be a corrosion problem.

3. If a corrosion problem is identified, it can be reported using SF Form 368 *(Product Quality Deficiency Report).* Use of key words such as "corrosion," "rust," "deterioration," or "cracking" will ensure that the information is identified as a CPC problem. The form should be submitted to the address specified in DA Pam 738-750.

OZONE DEPLETING SUBSTANCES (ODS)

Listing to be provided by requiring activity.

DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

For destruction of Army materiel to prevent enemy use, refer to TM 750-244-6.

PREPARATION FOR STORAGE OR SHIPMENT

For preparation for storage or shipment procedures, refer to TM 740-90-1 and MIL-V-62038D.

WARRANTY INFORMATION

The vehicle is warranted by Freightliner Corporation in accordance with TB 9-2320-302-15. Warranty starts on the date found in block 23, DA Form 2408-9 in the logbook. Report all defects in material or workmanship to your supervisor, who will take appropriate action.

NOMENCLATURE CROSS-REFERENCE LIST

COMMON NAME	OFFICIAL NOMENCLATURE
Cold Start System	Ether Quick-start System
Engine Coolant	Antifreeze, Ethylene Glycol Mixture
Gladhand	Quick Disconnect Coupling
Jake Brake	Engine Brake
Komfort Loc®	Seat Belt Adjustment
TufTrac	Rear Suspension System

LIST OF ABBREVIATIONS

NOTE

Refer to MIL-STD-12D for standard abbreviations.

ABBREVIATION	DEFINITION
ABS	Anti-lock Brake System
C	Centigrade or Celsius
CEL	Check Engine Light
CID	Cubic Inch Displacement
cm	Centimeter
CWS	Collision Warning System
DDEC	Detroit Diesel Electronic Controlled
DDL	Diagnostic Data Link
DDR	Diagnostic Data Reader
ECU	Electronic Control Unit
F	Fahrenheit
GCWR	Gross Combination Weight Rating
GVWR	Gross Vehicle Weight Rating
kg	Kilogram
km	Kilometer
kPa	Kilopascal
kph	Kilometers per Hour
kW	Kilowatt
l	Liter
lb	Pound
lb-ft	Pound foot
lph	Liters per Hour
m	Meter
mm	Millimeter
MTS	Movement Tracking System

LIST OF ABBREVIATIONS - CONTINUED

ABBREVIATION	DEFINITION
Nm	Newton Meter
PMCS	Preventive Maintenance Checks and Services
psi	Pounds per Square Inch
rpm	Revolutions per Minute

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EQUIPMENT DESCRIPTION AND DATA 0002 00

EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

1. **Characteristics.**

   a. The M915A3 Tractor Truck is used to transport M871, M872, and M1062 semitrailers on line haul missions.

   b. It has a Gross Vehicle Weight Rating (GVWR) of 52,000 lb (23,608 kg) and is equipped with a two-way oscillating, sliding fifth wheel compatible with a two-inch kingpin. Maximum towed load on kingpin is 30,000 lb (13,620 kg).

2. **Capabilities and Features.**

   a. While operating on Class I roads, the fully loaded M915A3 can maintain a speed of 65 mph (105 kph) on level roads and 29 mph (47 kph) while ascending a 3 percent grade. It has a minimum turning diameter, curb-to-curb, of 53 ft 9 in (16.4 m).

   b. Average cruising ranges at Gross Combination Weight Rating (GCWR) with a full tank of fuel will vary based on conditions (e.g., varying loads, prolonged idle, and climatic conditions). Cruising range is optimally 400 miles (640 km).

   c. The M915A3 is equipped with an instrument panel mounted speedometer and tachometer which register truck ground speed and engine speed.

   d. The M915A3 has the following capabilities and features:

      (1) air-activated front and rear non-asbestos cam brakes with a four-channel anti-lock brake system (ABS) to provide significantly improved handling and braking during emergency stops

      (2) operation in temperatures from -25°F (-32°C) to +125°F (+52°C), and to -40°F (-40°C) with arctic kit installed

      (3) start and climb capability of a 20 percent grade at GCWR in both forward and reverse directions

      (4) fording capability up to 20 in (51 cm) deep for 5 minutes without damage or requiring maintenance before operations can continue

      (5) two-passenger aluminum corrosion-proof cab with a 90 degree tilt-forward hood for service accessibility

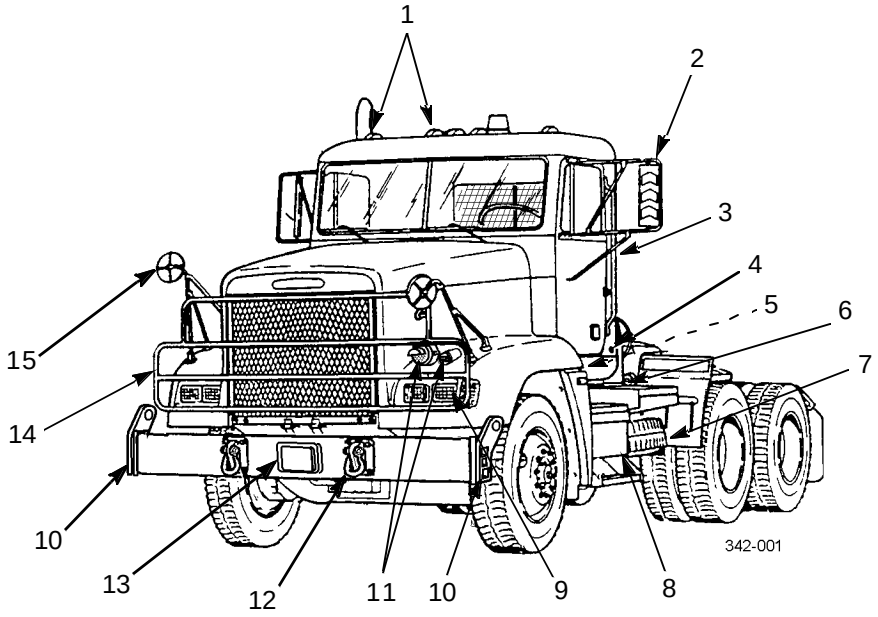
      (6) six cylinder, 12.7 liter, 430 horsepower, in-line turbocharged diesel engine built by Detroit Diesel

      (7) Allison HD 4560P six-speed automatic transmission

      (8) Collision Warning System (CWS) that warns the driver of potentially dangerous driving situations by activating visual and audible alerts.

   e. For operation in arctic conditions, the M915A3 can be equipped with an arctic heater mounted under the cab, above the battery box. This provides heat for the cab and engine cooling system. The arctic heater may be operated prior to starting the engine to provide preheating of engine block.

LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

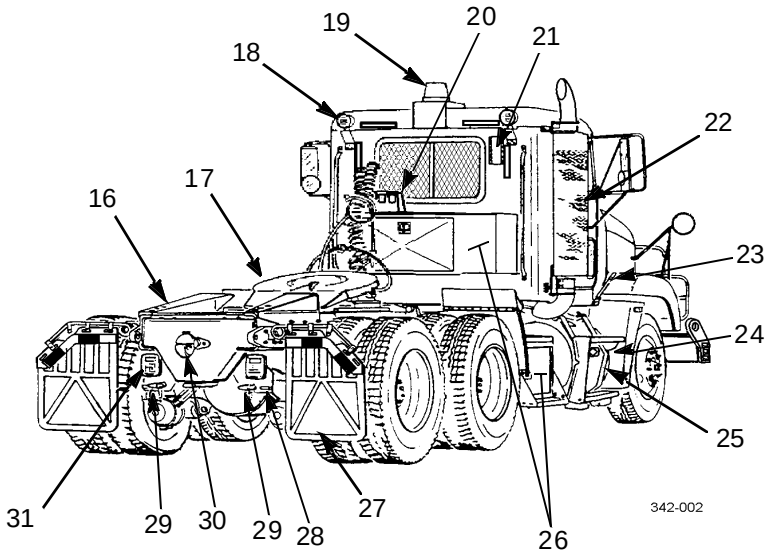


KEY	COMPONENT	DESCRIPTION
1	Marker Clearance Lights	Indicate outline of truck.
2	Side Mirrors (Heated)	Provide driver with a view of sides of truck and semitrailer, if towing.
3	Grabhandles	Provide a hand hold for personnel climbing on truck.
4	Utility Power Receptacle	Supplies power for work lights. Located on both sides of truck.
5	Air Horn	Provides an audible alert.
6	Master Battery Switch	Provides battery power to truck.
7	Spare Wheel and Tire	Extra wheel and tire used in case of a flat tire.
8	Battery Box and Steps	Holds vehicle batteries and provides steps to access cab.
9	Front Service Lights	Include headlights and turn signals.
10	Bumper Extensions	Provide adjustable attachment point for slings.
11	Blackout Lights	Used during blackout conditions. Include marker and drive lights.
12	Towing Eyes	Provide attachment points for towing device.

LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED

KEY	COMPONENT	DESCRIPTION
13	CWS Antenna	Forward looking collision warning system antenna.
14	Brush Guard	Protects front of hood and components under hood from damage.
15	Spotting Mirrors	Provide added visibility to sides and front of truck.

LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED



KEY	COMPONENT	DESCRIPTION
16	Ramp	Sloped surface serves as an approach to fifth wheel and facilitates coupling of semitrailer.
17	Fifth Wheel	Coupling device for semitrailers with kingpins.
18	Utility Lights	Illuminate area in back of cab. There is one light on each side of cab.
19	Strobe Warning Light	Strobe light alerts other vehicles of presence of truck.
20	Intervehicular Receptacles Installation	Contains 12-volt commercial, 24-volt military, and trailer ABS receptacles.
21	Antenna Mount	Mount for radio antenna.
22	Exhaust Muffler	Deadens noise of engine exhaust.
23	Hood Latch	Locks hood closed. Located on both sides of hood.
24	CWS Side Sensor	Side looking collision warning system sensor.
25	Fuel Tank	Holds fuel. Steps mounted to tank provide access to cab.
26	Storage Boxes	Provide stowage area for BII and other items.
27	Mud Flaps	Prevent water and debris from spraying up on passers by or towed semitrailer.

LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED

KEY	COMPONENT	DESCRIPTION
28	Blackout Lights	Used during blackout conditions.
29	Trailer Gladhands	Provide air supply for trailer brakes.
30	Pintle Hook	Coupling device for trailers with lunettes.
31	Taillights	Contain composite tail, stop, backup, and turn signal lights.

EQUIPMENT DATA

Dimensions:

Length (Overall)	276 in (701 cm)
Height (Overall)	118 in (300 cm)
Width (Overall)	100 in (254 cm)
Wheelbase	162 in (411 cm)
Ground Clearance	9 in (23 cm)
Angle of Approach	27°

Weights:

Curb	19,080 lb (8662 kg)
GVWR	52,000 lb (23,608 kg)
GCWR	105,000 lb (46,670 kg)
Front Axle (Loaded)	12,000 lb (5448 kg)
Rear Axle (Loaded)	40,000 lb (18,160 kg)

Capacities:

Engine Oil (Refill w/Filters)	41 qt (38.8 l)
Cooling System	65 qt (61.5 l)
Fuel Tank	100 gal. (378.5 l)
Power Steering Reservoir	2 qt (1.9 l)
Transmission	51 qt (48 l)
Rear Axle (Forward/Rear)	13/14.5 qt (12.3/13.7 l)

Engine:

Manufacturer	Detroit Diesel
Type	4-stroke, in-line turbocharged diesel
Model	DDEC IV
Cylinders	6
Displacement	755 CID (12.7 l)
Torque @ 1200 rpm	1400 lb-ft (1898 Nm)
Maximum Horsepower @ 2100 rpm	430 (320.6 kW)
Maximum Governed Speed	2100 rpm
Oil Filter Type	2 full flow, replaceable elements
Oil Filter Quantity	2

Fuel System:

Type	diesel fuel injected
Fuel Filter Type	1 primary, 1 secondary replaceable element
Air Cleaner:	
Type	dry element
Quantity	1

EQUIPMENT DATA - CONTINUED

Cooling System:

Radiator Working Pressure	10 psi (69 kPa)
Coolant Inhibitor Filter	1 replaceable element

Electrical System:

Type	dual 12/24 volt
Batteries:	
Quantity	4
Voltage	12 volt

Transmission:

Manufacturer	Allison
Model	HD 4560P
Type	6-speed automatic
Shift Selector	pushbutton

Front Axle:

Manufacturer	Rockwell
Type	I-beam, FF961
Rated Capacity	12,000 lb (5448 kg)
Maximum Steering Angle	32°

Rear Axle (Tandem):

Manufacturer	Rockwell, RT 40-145P
Rated Capacity	38,000 lb (17,252 kg)
Ratio	4.44:1
Inter-axle Differential	bevel gear
Traction Control	air controlled

Brake System:

Actuation	air-mechanical
Pressure Range	60-120 psi (414-827 kPa)
Airbrake Chambers:	
Service	2 on front axle
Failsafe (Spring)	4 on forward-rear and rear-rear axles
ABS (Anti-lock Brake System):	
Type	4-channel
Location	front axle and rear-rear axle

Wheels:

Size	22.5 x 8.25 in
Number of Studs/Stud Size	10/1.125 in

Tires:

Type	tubeless, radial on-highway
Size	11R22.5
Ply Rating	14PR
Load Range	H

EQUIPMENT DATA - CONTINUED

Tires - Continued:

Inflation Pressure (Maximum Load):	
Front	105 psi (724 kPa)
Rear	100 psi (690 kPa)
Spare	105 psi (724 kPa)

Steering:

Manufacturer	TRW
Steering Gear Type	single gear
Actuation	hydraulic power booster
Power Steering Pump	Eaton B165R
Turning Diameter	53 ft 9 in (16.4 m)
Steering Column and Wheel:	
Type	tilt, telescoping
Tilt Range	15°
Telescoping Range	2-5/8 in (67 mm)

Suspension:

Front	Single leaf spring w/shock absorbers
Rear	TufTrac w/shock absorbers

Towing Attachments:

Pintle Hook:	
Manufacturer	Holland
Model	no. 760
Rated Capacity	30 tons (27.2 metric tons)
Towing Eyes:	
Quantity	2 front, 2 rear
Maximum Load Capacity, Each (Up to 45° Angle Front Long. Axis)	60,000 lb (27,240 kg)
Fifth Wheel:	
Manufacturer	Holland
Type	36 in (91.4 cm) diameter, 2-way oscillating, low lube
Capacity	30,000 lb (13,620 kg)
Height (Empty)	52 in (132.1 cm)
Pitch (Fwd/Aft)	15/10°
Kingpin Size	2 in (5.1 cm)

Cab:

Manufacturer	Freightliner
Construction	aluminum
Type	2-passenger, tilt-forward hood
Air Deflector	adjustable

EQUIPMENT DATA - CONTINUED

Accessories:

Utility Lights	2 fixed, top rear of cab
Air Horn	1, under cab

Military Load Classification:

Vehicle w/o Trailer	8
Vehicle w/Trailer:	
M871	14/35 (unloaded/loaded)
M872	14/46 (unloaded/loaded)
M1062	11/34 (unloaded/loaded)

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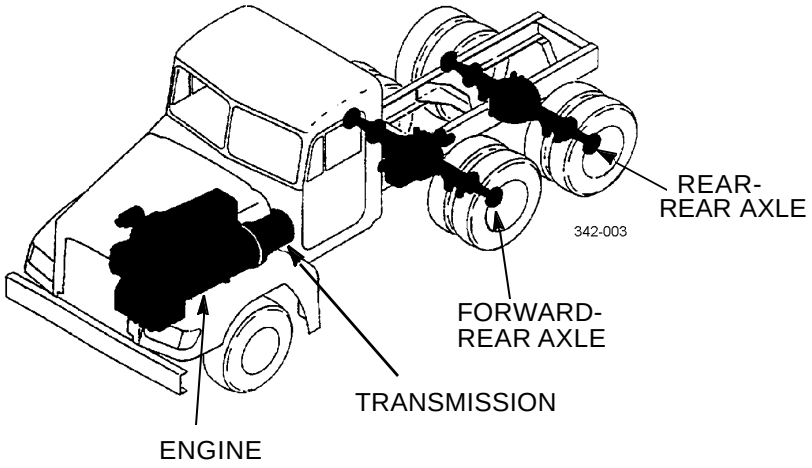
THEORY OF OPERATION 0003 00

INTRODUCTION

1. The M915A3 Tractor Truck consists of the following functional systems: drive train, fuel system, exhaust system, cooling system, electrical system, air system, brake system, steering system, traction control system, suspension system, air conditioning system, and collision warning system.
2. This work package explains how the components and systems of the M915A3 work together. A functional description is provided for each major component and system.

DRIVE TRAIN

The drive train of the M915A3 consists of a Detroit Diesel, DDEC IV engine and an Allison 6-speed automatic transmission connected to RT 40-145P rear tandem axles.

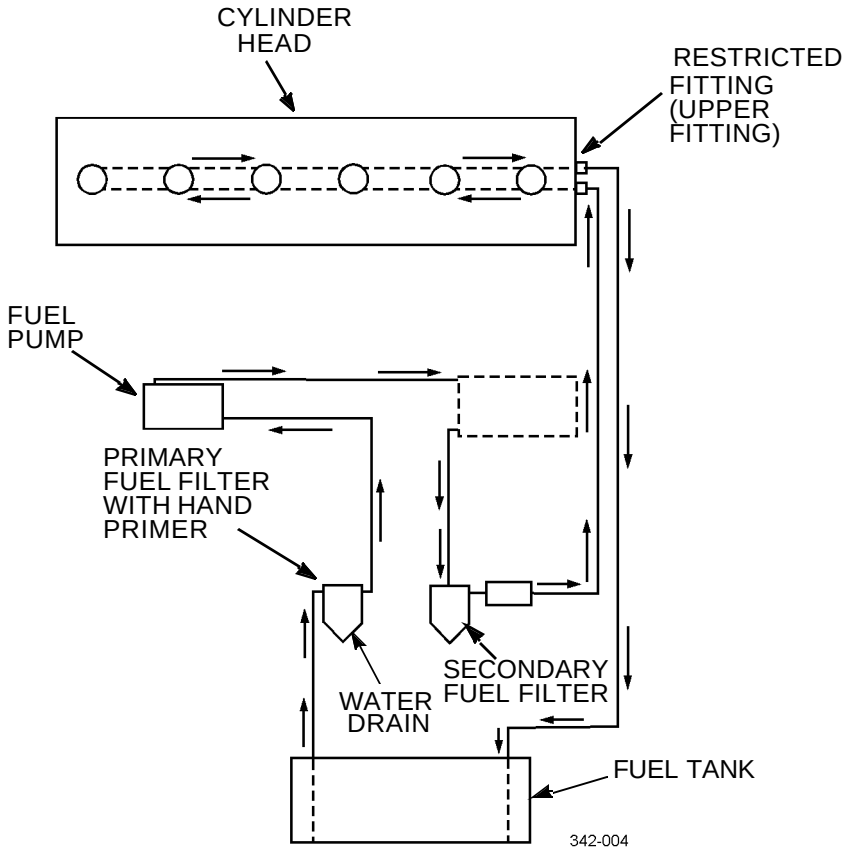


FUEL SYSTEM

1. Fuel to power the engine is pumped out of the fuel tank by an engine-mounted fuel pump. The engine fuel system consists of one electronic unit injector per cylinder, a transfer pump, low-pressure fuel lines, and primary and secondary fuel filters.
2. The engine is governed by an electronic control system. The system controls idle speed and limits engine maximum speed. The driver controls engine speed through the position of the electronic throttle position sensor (foot pedal).
3. Fuel filters are spin-on types. The primary fuel filter has a hand fuel primer pump and a water drain.
4. Fuel may be drained from the tank through the drain port located on the bottom of the tank.
5. There is a computer-controlled ether quick-start system for use in cold weather.

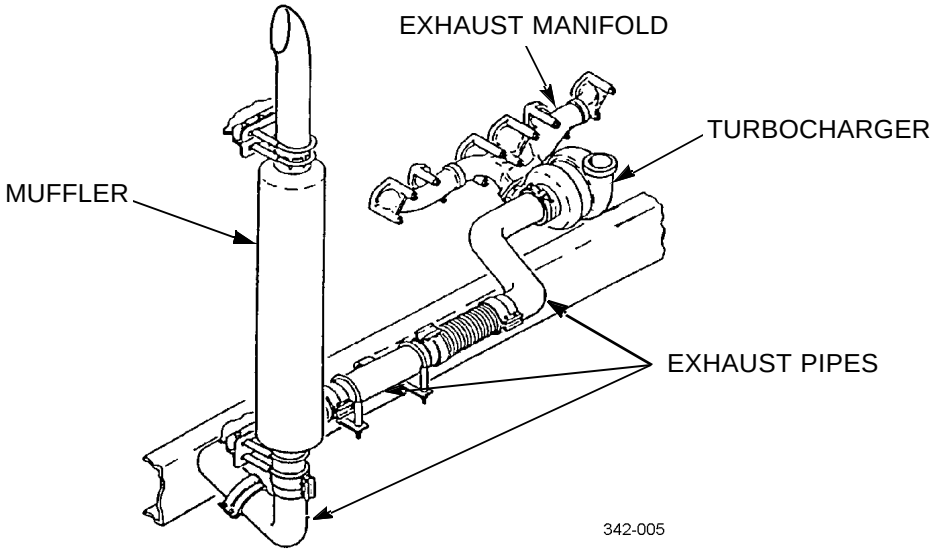
THEORY OF OPERATION - CONTINUED **0003 00**

FUEL SYSTEM - CONTINUED



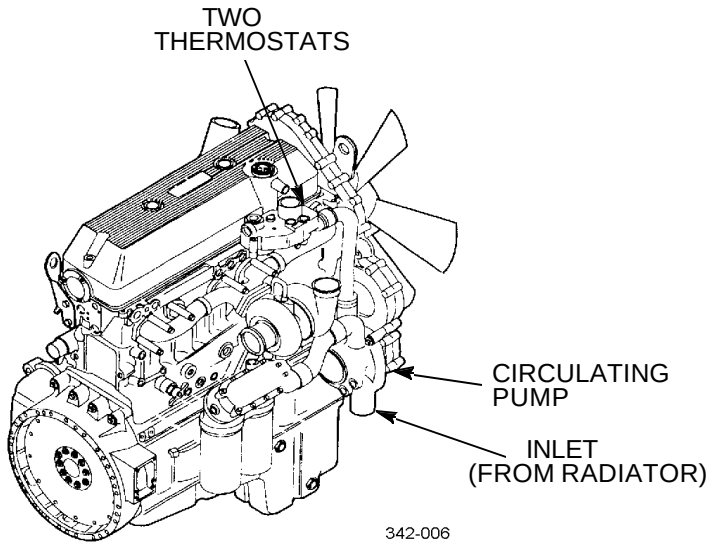
EXHAUST SYSTEM

The exhaust system removes exhaust gases from the engine through the exhaust manifold and turbocharger. The gases flow into exhaust pipes and a muffler to the atmosphere above the cab.



COOLING SYSTEM

The cooling system consists of one circulating pump, a remote-mounted coolant filter, two 180°F (82°C) thermostats for controlling fluid flow, a transmission oil cooler, a radiator, and a belt-driven fan. The cooling system cools the engine by circulating pressurized ethylene-glycol based coolant through the engine and radiator.



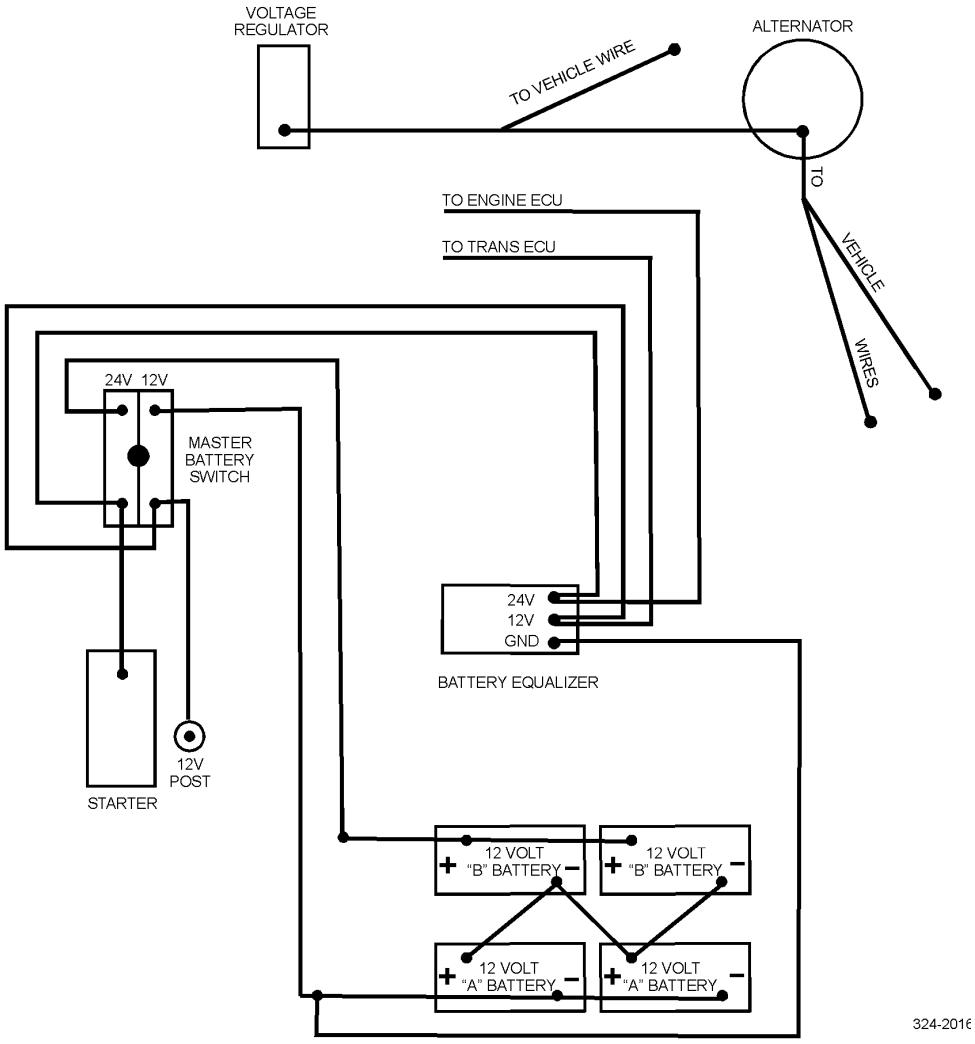
DDEC IV ENGINE

ELECTRICAL SYSTEM

1. Four 12-volt batteries connected in series-parallel supply the 12-volt electrical system and provide 24 volts for the starter motor, blackout lights, accessories, and trailer connectors.
2. The Dual Voltage Alternator Control (DUVAC), mounted on the firewall in the engine compartment, regulates the distribution of 12 and 24 volts.

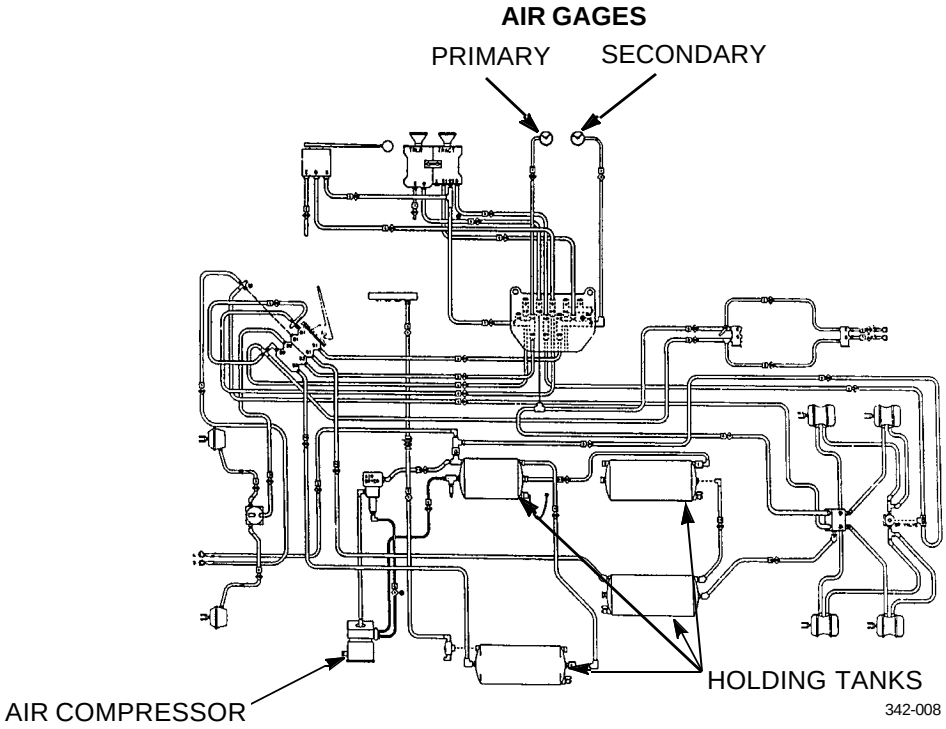
THEORY OF OPERATION - CONTINUED 0003 00

ELECTRICAL SYSTEM - CONTINUED



AIR SYSTEM

The air system consists of the air compressor, air dryer, air reservoirs, and various air lines. Also included in the air system are air pressure gages, located on the instrument panel, for monitoring air pressure for safe operation of all air-operated components of the vehicle.



BRAKE SYSTEM

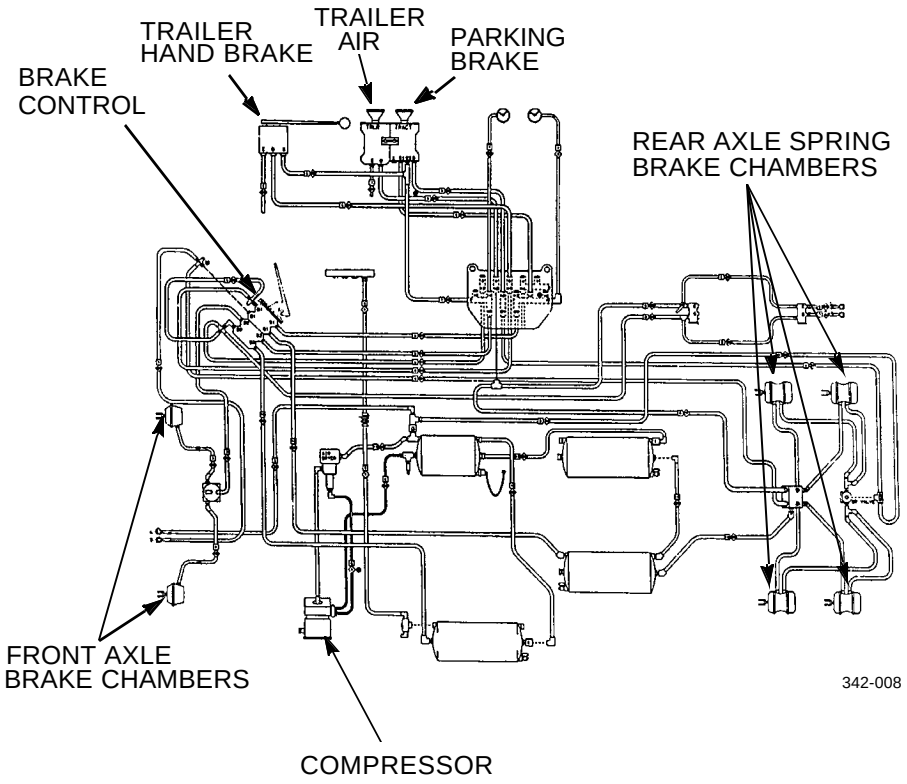
1. The dual air brake system consists of two independent air brake systems that use a single set of brake controls. Each system has its own reservoirs, plumbing, and brake chambers. The primary system operates the service brakes on the rear axle and the secondary system operates the service brakes on the front axle. On tractor-trailer configurations, service brake signals from both systems are sent to the trailer.
2. Loss of air pressure in the primary system causes the rear service brakes to become inoperative. Front brakes will continue to be operated by secondary system air pressure. In addition, trailer brakes will be operated by the secondary system. Loss of secondary system air pressure causes the front axle brakes to become inoperative. Rear service brakes and trailer brakes will be operated by the primary system.

THEORY OF OPERATION - CONTINUED **0003 00**

BRAKE SYSTEM - CONTINUED

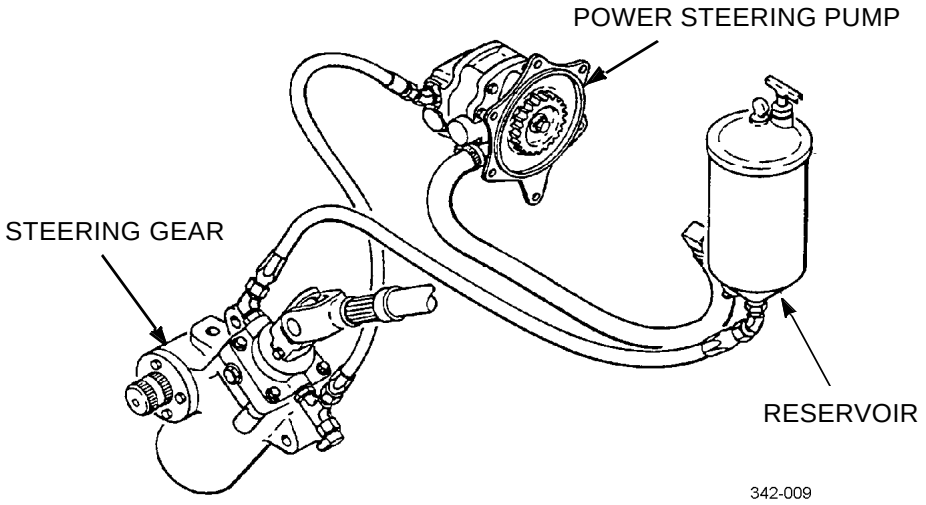
3. The warning light and buzzer inside the cab are activated if air pressure drops below 64 psi (441 kPa) in either brake system. If this happens, check air pressure gages to determine which system has low air pressure. Although vehicle speed can be reduced using the foot brake control pedal, either the front or rear service brakes will not operate, resulting in a longer stopping distance. Bring vehicle to a safe stop and have the air system repaired before continuing.
4. If the primary brake system becomes inoperative, the spring parking brakes automatically apply when air pressure drops to 35-45 psi (241-310 kPa).
5. The vehicle has a four-channel anti-lock brake system (ABS) and cam-operated service brakes with non-asbestos brake-shoes.
6. The M915A3 has automatically adjusting slack adjusters. On all axles, brake chambers have a stroke alert indicator which allows the operator to monitor brakeshoe wear.

AIR CONTROLS



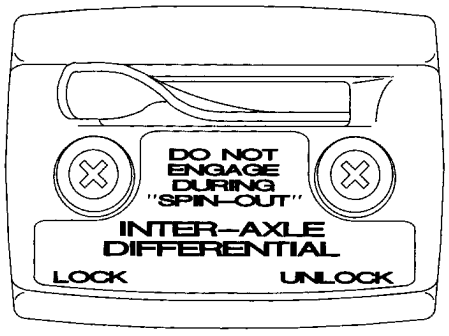
STEERING SYSTEM

1. The power steering system consists of an integral steering gear (which includes a manual steering mechanism and hydraulic control valve), hydraulic hoses, power steering pump, reservoir, and other components.
2. The power steering pump, driven by the engine, provides the power-assist for the steering system.



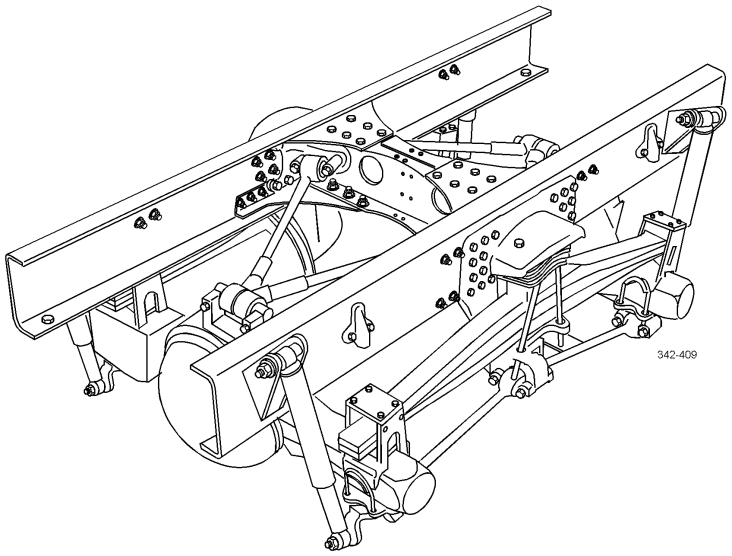
TRACTION CONTROL SYSTEM

The inter-axle differential lock is controlled by the air operated lever labeled INTER-AXLE DIFFERENTIAL on the driver's instrument panel. Under normal driving conditions, the control lever should be in the UNLOCKED position. During poor driving conditions, the control lever may be moved to the LOCKED position to improve traction. When the inter-axle differential lock is applied, the drive shaft becomes a solid connection between the two rear axles.



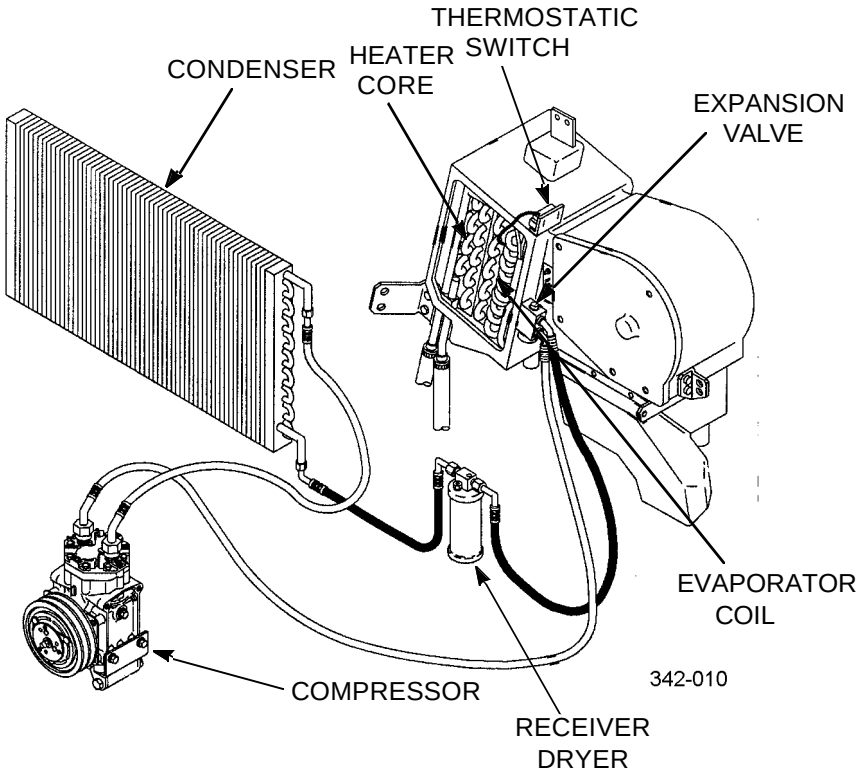
REAR SUSPENSION SYSTEM

The TufTrac rear suspension system consists two parabolic taper-leaf springs and two shock absorbers per side and an arrangement of torque rods. The suspension system is designed to provide a high degree of ground clearance and articulation while maintaining an equal load over each wheel. Ride characteristics are similar, whether loaded or unloaded.



AIR CONDITIONING SYSTEM

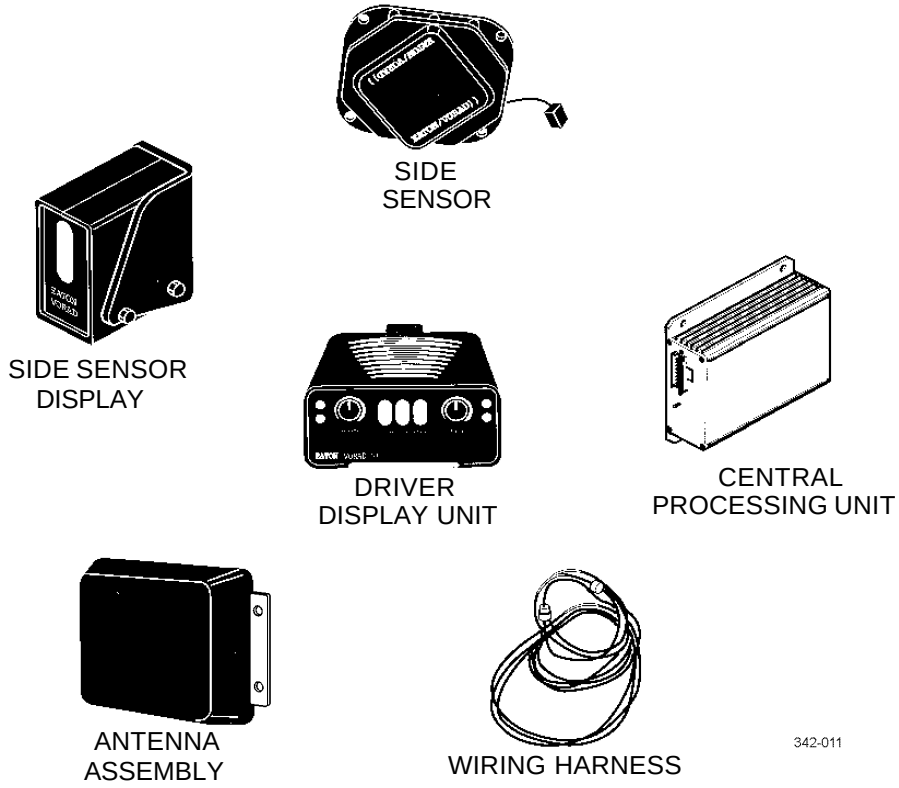
1. The air conditioning unit is part of the heater and is mounted under the glove compartment. It is a single unit consisting of a heater core, air conditioning evaporator coil, blower motor, control valves, and air ducts.
2. The system is turned on by the mode control lever on the instrument panel in the cab. The four-speed blower switch controls flow rate.
3. An even cab temperature is maintained by controlling the coolant flow through the heater core, or refrigerant flow through the evaporator coil.



THEORY OF OPERATION - CONTINUED **0003 00**

COLLISION WARNING SYSTEM (CWS)

1. The Collision Warning System (CWS) consists of an antenna assembly, central processing unit, driver display unit, side sensor, side sensor display, and wiring harness.
2. The CWS is a forward and side looking radar system that transmits and receives signals reflected off of objects to the front and side of the tractor.
3. The forward looking antenna assembly determines distance, azimuth, and approximate speed of vehicle forward of the tractor.
4. The side sensor detects vehicles or objects from two to ten feet, moving or stationary, alongside the tractor.



CHAPTER 2
UNIT TROUBLESHOOTING PROCEDURES

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TROUBLESHOOTING INTRODUCTION 0004 00

INTRODUCTION

Troubleshooting procedures are grouped by work packages, containing information you need to fault locate malfunctions on the M915A3 Tractor Truck. A troubleshooting symptom index in WP 0005 00 is provided to aid in locating a malfunction or symptom and direct you to the appropriate troubleshooting table (work package) containing a listing of malfunctions, test and inspection procedures, and corrective actions. The corrective action column further directs you to the required corrective maintenance procedure within this manual by work package number. However, if the required maintenance procedure is beyond Unit Maintenance capabilities, the direction is to notify Direct Support Maintenance.

PRELIMINARY TROUBLESHOOTING PROCEDURES

NOTE

Fluid leaks are classified as either Class I, Class II or Class III

Class I: Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

Class II: Leakage of fluid great enough to form drops, but not enough to cause drops to drip from item being checked/inspected.

Class III: Leakage of fluid great enough to form drops that fall from item being checked/inspected.

Before starting any specific troubleshooting procedures, perform the following:

a. Visually check for ruptured oil hoses or tubes and for Class II or Class III leaks.

b. Check for mechanical jamming or binding caused by rocks or other foreign matter.

c. Check fluid levels in subject area and service as required (TM 9-2320-302-10 or WP 0021 00).

ELECTRICAL TROUBLESHOOTING

1. Analyze the symptoms and conditions and use common sense and logic to determine the most likely cause for the problem, then troubleshoot that circuit first. The more information you have concerning the problem, the easier it will be to troubleshoot.

2. Isolate to the subsystem level (in cases where more than one subsystem is involved); next isolate the problem to a single circuit within the subsystem; then, isolate the problem to the faulty component using the troubleshooting symptom index (WP 0005 00).

3. Frayed, broken, loose or corroded wiring is a common source of problems in any electrical circuit. Always make visual inspection before starting detail troubleshooting. Observe in particular contacts to ground. Components with case grounds are especially troublesome.

CAUTION

When making continuity checks, make sure the test equipment is isolated from power source.

4. Most of the checks are made by voltage checks. Pay particular attention to the voltages being checked in the procedures. This equipment has a combination of 12 and 24 volt systems. Instructions prior to the step instruct to disconnect at test point from the potential malfunctioning component. Once the check has been made, either repair the component or go to the referenced step. If going to another step, reconnect connection or do as otherwise instructed, such as install jumper wires using Jumper Wire Kit. When ready to make the prescribed check, apply power to the circuit (if required). A helper may be required if the switch or power source is out of reach. Release the power function prior to going on, to avoid damage to equipment.

DDEC ENGINE TROUBLESHOOTING

1. Troubleshooting the DDEC engine and related systems is preformed by locating the malfunction within the troubleshooting symptom index (WP 0005 00), then referring to WP 0006 00 or WP 0007 00 for the required test or inspection steps. The troubleshooting table in WP 0006 00 contains general procedures to identify and correct an engine or engine related malfunction. The table also references the use of Check Engine Lights (CEL) and Stop Engine Lights (SEL) flash codes to identify a problem. The information to utilize a Diagnostic Data Reader is also provided to aid in identifying a malfunction.
2. Also available to troubleshoot the DDEC engine is The Detroit Diesel Data Link diagnostic CD Rom, used with a PC or the SPORT computer.

TROUBLESHOOTING SYMPTOM INDEX 0005 00

Malfunction/Symptom **Page Number**

ENGINE

1. Engine Fails to Crank or Cranks Slowly 0006 00-1
2. Engine Does Not Crank 0006 00-1
3. Engine Cranks, But Does Not Start 0006 00-2
4. Engine Stops, But Is Not Seized 0006 00-2
5. Erratic Engine Operation 0006 00-3
6. Excessive Exhaust Smoke 0006 00-3
7. Low Oil Pressure 0006 00-4
8. High Oil Consumption 0006 00-4
9. Engine Overheats 0006 00-4

ELECTRICAL SYSTEM

Engine Brake System

Engine Brake (Jake Brake) Inoperative or Operates Erratically 0010 00-1

Engine Fan Circuit

Engine Fan Does Not Operate or Fails to Start at 190°F-210°F (87°C-98°C) 0010 00-1

Charging Circuits

1. Batteries Not Charging, Voltmeter Does Not Indicate Voltage 0010 00-2
2. +12 VDC Circuits Not Charging, +24 VDC Circuits Normal 0010 00-2
3. +24 VDC Circuits Not Charging, +12 VDC Circuits Normal 0010 00-2

Headlight Circuits

1. Neither Headlight Operates When Switch Is Turned On 0010 00-3
2. Left/Right Headlight Fails to Operate When Switch Is Turned On 0010 00-3
3. Neither Headlight Low/High Beam Operates When Turn Signal Switch Lever Is Set 0010 00-3
4. Left/Right High Beam Does Not Operate 0010 00-4
5. Left/Right Low Beam Does Not Operate 0010 00-4

Marker and Taillight Circuits

1. None of Marker and Taillights Operate 0010 00-4
2. Left/Right Front Marker Light Does Not Operate 0010 00-4
3. One or More Cab Marker Lights Does Not Operate 0010 00-5
4. Both Taillights Do Not Operate, But All Marker Lights Operate 0010 00-5

Blackout Light Circuits

1. None of Blackout (B/O) Lights Operate 0010 00-5
2. None of Blackout (B/O) Stoplights Operate 0010 00-5
3. One or None of Blackout (B/O) Marker Lights Operate 0010 00-6
4. One or None of Blackout (B/O) Drive Lights Operate 0010 00-6

Turn Signal and Stoplight Circuits

1. Stoplights Do Not Operate 0010 00-7
2. Left/Right Stoplight Does Not Operate 0010 00-7
3. Flasher Lights Do Not Operate 0010 00-8

Malfunction/Symptom **Page Number**

ELECTRICAL SYSTEM - CONTINUED

Turn Signal and Stoplight Circuits - Continued

4. Turn Signal Lights Do Not Operate 0010 00-8
5. Turn Signal Indicator Light Does Not Operate, But Turn Signals Operate Normally 0010 00-8

Dome Light Circuits

1. Dome Lights Do Not Operate 0010 00-8
2. One Dome Light Operates, But Other Dome Light Does Not Operate in Either Mode 0010 00-9
3. Dome Light Operates in On/Off Switch Mode Only 0010 00-9

Auxiliary Light Circuits

1. Auxiliary Lights or Accessory Circuits Do Not Operate 0010 00-9
2. No Power to Auxiliary Heater Fan Power Relay 0010 00-10

Worklight Power Receptacle Circuits

1. Worklight Power Receptacles Do Not Operate 0010 00-10
2. One Worklight Power Receptacle Does Not Operate, But Other Receptacle Operates Normally 0010 00-10

Backup Light Circuits

1. Backup Lights Do Not Operate 0010 00-11
2. Right/Left Backup Light Does Not Operate 0010 00-11

Utility Light Circuits

1. Utility Lights Do Not Operate 0010 00-11
2. Only One Utility Light Operates 0010 00-12
3. Utility Light Indicator Light Does Not Operate, But Utility Lights Operate Normally 0010 00-12

Electrical Horn Circuits

Electrical Horn Does Not Operate 0010 00-12

Tractor Beacon Light Circuits

Tractor Beacon Light Does Not Operate 0010 00-13

Panel Lights Circuits

1. Panel Lights Do Not Operate 0010 00-14
2. Heater Control Light Does Not Operate, But Other Heater Circuits Operate Normally 0010 00-14
3. One or More Gage Lights Do Not Operate 0010 00-14
4. Fiber Optics Do Not Operate 0010 00-14
5. Panel Lights Do Not Dim 0010 00-14
6. Panel Lights Do Not Brighten 0010 00-14

Radio Circuits

Power Source for 24VDC Radio Does Not Operate 0010 00-15

Instrument Wiring Circuits

1. Instruments on Dashboard Do Not Operate 0010 00-15
2. Water Temperature Gage Does Not Operate 0010 00-15
3. Transmission Oil Temperature Gage Does Not Operate 0010 00-15
4. Fuel Level Gage Does Not Operate 0010 00-16

Malfunction/Symptom **Page Number**

ELECTRICAL SYSTEM - CONTINUED

Instrument Wiring Circuits - Continued

5. Voltmeter Does Not Operate, But Warning Light Operates Normally 0010 00-16
6. Axle Lock Indicator Light Does Not Operate 0010 00-16

Ether Cold-start Circuit

Ether Cold-Start Does Not Operate When Container Has Ether 0010 00-17

Air Dryer Heater Circuit

Air Dryer Heater Does Not Operate 0010 00-17

Standard Heater Circuits

Heater Fan Does Not Operate at Any Speed. 0010 00-17

TRANSMISSION AND DRIVELINE SYSTEMS

Transmission

1. Shift Selector Display Is Blank 0011 00-1
2. Vehicle Does Not Start (Engine Does Not Crank). 0011 00-1

Transmission Shifting

1. DO NOT SHIFT Light Will Not Go Out at Start-up 0011 00-1
2. DO NOT SHIFT Light Flashes Intermittently 0011 00-2
3. No DO NOT SHIFT Light at Ignition 0011 00-2
4. ECU Will Not Turn Off When Ignition Switch Is Turned Off. 0011 00-2
5. Transmission Will Not Shift to Forward or Reverse (Stays In Neutral) 0011 00-2
6. Transmission Will Not Stay in Forward or Reverse 0011 00-2
7. Transmission Will Not Make a Specific Shift 0011 00-3
8. Transmission Does Not Shift Properly (Rough Shifts, Shifts Occurring at Too Low or Too High Speed. 0011 00-3

Abnormal Activities or Responses from Transmission

1. Excessive Creep in First and Reverse Gears 0011 00-3
2. No Response to Shift Selector 0011 00-3
3. Vehicle Moves Forward in Neutral 0011 00-3
4. Vehicle Move Backward in Neutral 0011 00-3
5. Engine Overspeed on Full-throttle Upshifts 0011 00-3
6. Excessive Slippage and Clutch Chatter 0011 00-4
7. Abnormal Stall Speeds (Stall in First Range - 6 Speed) 0011 00-4
8. Overheating in All Ranges 0011 00-4
9. Fluid Comes out Fluid Fill Tube and/or Breather 0011 00-4
10. Noise Occurring Intermittently (Buzzing) 0011 00-5
11. Leaking Fluid (Output Shaft). 0011 00-5
12. Transmission Leaks (Input) 0011 00-5
13. Dirty Transmission Fluid 0011 00-5

Malfunction/Symptom **Page Number**

TRANSMISSION AND DRIVELINE SYSTEMS - CONTINUED

Forward-rear Axle and Rear-rear Axle Driveline Assemblies

1. No Drive at Forward-rear Axle and/or Rear-rear Axle 0011 00-5
2. Vibration or Noise During or While Driving 0011 00-6

BRAKE SYSTEM

1. Vehicle Does Not Slow Down Quickly Enough When Brakes Are Applied. 0012 00-1
2. Brakes Do Not Release or Release Too Slowly. 0012 00-1
3. Brakes Are Uneven, Drag or Pull When Applied 0012 00-1

ANTI-LOCK BRAKE SYSTEM

Refer to Anti-lock Brake System (ABS) Troubleshooting and Testing. 0013 00-1

AIR SYSTEM

1. Loss of Air Pressure 0014 00-1
2. Loss of Air Supply Function 0014 00-1
3. Air Dryer Leaks 0014 00-1
4. Air Dryer Fails to Absorb Moisture 0014 00-1

STEERING SYSTEM

1. Loss of Steering Control 0015 00-1
2. Difficult Steering 0015 00-1
3. Tie Rod, Drag Link or Pitman Arm Fails 0015 00-1
4. Hose Assembly Fail (Leaks) 0015 00-1
5. Power Steering Reservoir Leaks 0015 00-1

CHASSIS AND FIFTH WHEEL

1. Pintle Will Not Lock or Swivel 0016 00-1
2. Trailer Will Not Couple or Becomes Uncoupled. 0016 00-1
3. Restricted Motion Between Tractor and Trailer. 0016 00-1

AIR CONDITIONING SYSTEM

Refer to Air Conditioning System Troubleshooting and Testing. 0017 00-1

COLLISION WARNING SYSTEM (CWS)

Refer to Collision Warning System (CWS) Troubleshooting 0018 00-1

Table 1. Engine Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. Engine Fails to Crank or Cranks Slowly.	1. Check for damaged or loose battery connections.	Tighten or repair battery connections as required (WP 0115 00).
	2. Check battery voltage. 22-26 volts are required.	If voltage is below 22 volts, service batteries (TM 9-6140-200-14).
	3. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 4 and read Active Flash Codes. b. If CEL comes on for up to five seconds and then turns off, perform step 4 and read Inactive Flash Codes. c. If CEL comes on, but is erratic or intermittent, refer to DDEC faults code system 10.4 (WP 0007 00).
	4. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system diagnostic troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
2. Engine Does Not Crank.	1. Check for damaged or loose battery connections.	Tighten or repair battery connections as required (WP 0115 00).
	2. Check battery voltage. 22-26 volts are required.	If voltage is below 22 volts, service batteries (see TM 9-6140-200-14).
	3. Check electrical connections at the starter motor.	Tighten or repair connections as required (WP 0056 00).
	4. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 5 and read Active Flash Codes. b. If CEL comes on for up to five seconds and then turns off, perform step 5 and read Inactive Flash Codes. c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code 10.4 (WP 0007 00).

Table 1. Engine Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
2. Engine Does Not Crank - Continued.	5. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system diagnostic troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
3. Engine Cranks, But Does Not Start.	1. Check position of fuel shutoff valve.	If closed, open valve (WP 0030 00).
	2. Check fuel lines and hoses for leaks and damage.	Tighten or replace fuel lines and hoses as necessary (WP 0030 00).
	3. Check for clogged fuel/water separator and clogged secondary fuel filter.	Service or replace fuel filters (WP 0031 00).
	4. Confirm fuel system is primed.	Using fuel/water separator primer pump, prime system (TM 9-2320-302-10).
	5. Check for clogged or restricted air cleaner element.	Service air cleaner (WP 0036 00).
	6. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 7 and read Active Flash Codes. b. If CEL comes on for up to five seconds and then turns off, perform step 7 and read Inactive Flash Codes. c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code 10.4 (WP 0007 00).
	7. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
4. Engine Stops, But Is Not Seized.	1. Check for clogged fuel/water separator and clogged secondary fuel filter.	Service or replace fuel filters (WP 0031 00).
	2. Check fuel lines and hoses for leaks and damage.	Tighten or replace fuel lines and hoses as necessary (WP 0030 00).
	3. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 4 and read Active Flash Codes. b. If CEL comes on for up to five seconds and then turns off, perform step 4 and read Inactive Flash Codes.

Table 1. Engine Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
4. Engine Stops, But Is Not Seized - Continued.		c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code 10.4 (WP 0007 00)
	4. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system diagnostic troubleshooting by referring to the section number that matches the flash code logged (WP 0007 00).
5. Erratic Engine Operation.	1. Check fuel lines and hoses for leaks and damage.	Tighten or replace fuel lines and hoses as necessary (WP 0030 00).
	2. Check for clogged fuel/water separator and clogged secondary fuel filter.	Service or replace fuel filters (WP 0031 00).
	3. Confirm fuel system is primed.	Using fuel/water separator primer pump, prime fuel system (TM 9-2320-302-10).
	4. Check for clogged or restricted air cleaner element.	Service air cleaner (WP 0036 00).
	5. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 6 and read Active Codes.
		b. If CEL comes on for up to five seconds and then turns off, perform step 6 and read Inactive Flash Codes.
		c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code, 10.4 (WP 0007 00).
	6. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
6. Excessive Exhaust Smoke.	1. Check for clogged or restricted air cleaner element.	Service air cleaner (WP 0036 00).
	2. Check for clogged fuel/water separator and clogged secondary fuel filter.	Service or replace fuel filters (WP 0031 00).
	3. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 4 and read Active Flash Codes.

Table 1. Engine Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
6. Excessive Exhaust Smoke- Continued.		b. If CEL comes on for five seconds and then turns off, perform step 4 and read Inactive Flash Codes. c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code 10.4 (WP 0007 00).
	4. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
7. Low Oil Pressure.	1. Check engine oil level.	Fill to proper level (TM 9-2320-302-10).
	2. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 3 and read Active Flash Codes. b. If CEL comes on for up to five seconds and then turns off, perform step 3 and read Inactive Flash Codes. c. If CEL comes on but is erratic or intermittent, refer to DDEC system fault code, 10.4 (WP 0007 00).
	3. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
8. High Oil Consumption.	1. Check for overfilled crankcase.	Drain oil to proper level (TM 9-2320-302-10).
	2. Check for oil in air reservoir tanks.	If oil is found in air reservoirs, replace air compressor assembly (WP 0029 00).
	3. Check for indications of oil at turbocharger outlet and inlet.	If oil is found, notify Direct Support Maintenance.
9. Engine Overheats.	1. Check coolant level.	Fill coolant to proper level (TM 9-2320-302-10).
	2. Check for loose or missing fan belts.	Adjust or replace fan belts as required (WP 0046 00).
	3. Check radiator clamps and hoses for leaks.	Replace or tighten radiator clamps and hoses as necessary (WP 0042 00).

Table 1. Engine Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
9. Engine Overheats - Continued.	4. Remove and test thermostats.	Replace failed thermostats (WP 0043 00).
	5. Visually check radiator for signs of clogged fins, leaks, and damage.	If radiator fins are clogged, remove obstructions. Replace leaking or damaged radiator (WP 0045 00).
	6. With ignition ON and engine OFF, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 6 and read Active Flash Codes. b. If CEL comes on for up to five seconds and then turns off, perform step 6 and read Inactive Flash Codes. c. If CEL comes on but is erratic or intermittent, refer to DDEC system fault code, 10.4 (WP 0007 00).
	7. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system diagnostic troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).

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DDEC ENGINE TROUBLESHOOTING 0007 00

INTRODUCTION

1. The DDEC Troubleshooting Manual is provided in its entirety as part of this work package. For ease of use, this manual retains its original format and page numbering.
2. A DDEC Engine Troubleshooting Index has been developed to assist the user in finding general information on DDEC troubleshooting and locating specific diagnostic flash codes.
3. Note that the flash codes in the index are electronically linked to the flash codes within the DDEC Troubleshooting Manual.

DDEC ENGINE TROUBLESHOOTING AND FLASH CODE INDEX

SECTION NUMBER	TITLE	PAGE NUMBER
	General Information	1
1	Introduction	1-1
2	(CHG) Operation	2-1
3	(CHG) ECM and Sensor Locations	3-1
4	Basic Knowledge Required	4-1
5	(CHG) Flash Codes vs. SAE Codes	5-1
6	(CHG) Testing/Service Tools/Tips	6-1
7	(CHG) DDEC ECM Software Features	7-1
8	(UPDATE) Connectors, Terminals, and Splicing	8-1
9	(CHG) Diagnosing a DDEC System Fault	9-1
10	(CHG) Intermittent Fault	10-1
11	Flash Code 11 – VSG Low	11-1
12	Flash Code 12 – VSG High	12-1
13	(CHG) Flash Code 13 – CLS Low	13-1
14	(CHG) Flash Code 14 – Temp Sensor High	14-1
15	(CHG) Flash Code 15 – Temp Sensor Low	15-1
16	(CHG) Flash Code 16 – CLS High	16-1
17	(CHG) Flash Code 17 – Throttle Valve High	17-1
18	(CHG) Flash Code 18 – Throttle Valve Low	18-1
19	Flash Code 19	19-1
20	Flash Code 20	20-1
21	Flash Code 21 – TPS High	21-1
22	Flash Code 22 – TPS Low	22-1
23	(CHG) Flash Code 23 – Fuel Temp Sensor High	23-1
24	(CHG) Flash Code 24 – Fuel Temp Sensor Low	24-1
25	Flash Code 25	25-1
26	Flash Code 26 – Auxiliary Input Active	26-1
27	(CHG) Flash Code 27 – Air Temp Sensor High	27-1
28	(CHG) Flash Code 28 – Air Temp Sensor Low	28-1
29	Flash Code 29	29-1
30	Flash Code 30	30-1

DDEC ENGINE TROUBLESHOOTING AND FLASH CODE INDEX - CONTINUED

SECTION NUMBER	TITLE	PAGE NUMBER
31	(CHG) Flash Code 31 – Engine Brake Fault Code	31-1
32	Flash Code 32 – CEL/SEL Fault	32-1
33	(CHG) Flash Code 33 – TBS High	33-1
34	(CHG) Flash Code 34 – TBS Low	34-1
35	Flash Code 35 – OPS High	35-1
36	Flash Code 36 – OPS Low	36-1
37	Flash Code 37 – FPS High	37-1
38	Flash Code 38 – FPS Low	38-1
39	Flash Code 39	39-1
40	Flash Code 40	40-1
41	(CHG) Flash Code 41 – Too Many SRS	41-1
42	(CHG) Flash Code 42 – Too Few SRS	42-1
43	Flash Code 43 – Coolant Level Low	43-1
44	Flash Code 44 – Temp High	44-1
45	Flash Code 45 – Oil Pressure Low	45-1
46	Flash Code 46 – Battery Voltage Low	46-1
47	(CHG) Flash Code 47 – Air/Fuel Pressure High	47-1
48	(CHG) Flash Code 48 – Air/Fuel Pressure Low	48-1
49	Flash Code 49	49-1
50	Flash Code 50	50-1
51	(CHG) Flash Code 51	51-1
52	(CHG) Flash Code 52 – ECM Fault	52-1
53	Flash Code 53 – ECM Memory Fault	53-1
54	Flash Code 54 – VSS Fault	54-1
55	(CHG) Flash Code 55 – J1939 Data Link Fault	55-1
56	(CHG) Flash Code 56 – J1587 Data Link Fault	56-1
57	(CHG) Flash Code 57 – J1922 Data Link Fault	57-1
58	(CHG) Flash Code 58	58-1
59	Flash Code 59	59-1
60	Flash Code 60	60-1
61	(CHG) Flash Code 61 – Injector Response Long	61-1
62	Flash Code 62 – Output Fault	62-1
63	Flash Code 63 – PWM Fault	63-1
64	(CHG) Flash Code 64	64-1
65	(CHG) Flash Code 65 – Throttle Valve Fault	65-1
66	(CHG) Flash Code 66 – Knock Sensor Fault	66-1
67	(CHG) Flash Code 67 – Map Sensor Fault	67-1

DDEC ENGINE TROUBLESHOOTING AND FLASH CODE INDEX - CONTINUED

SECTION NUMBER	TITLE	PAGE NUMBER
68	Flash Code 68 – Idle Validation Fault	68-1
69	Flash Code 69.	69-1
70	Flash Code 70.	70-1
71	(CHG) Flash Code 71 – Injector Response Short	71-1
72	Flash Code 72 – Vehicle Overspeed	72-1
73	Flash Code 73.	73-1
74	Flash Code 74.	74-1
75	Flash Code 75 – Battery Volt High	75-1
76	Flash Code 76 – Engine Overspeed/Brake	76-1
77	Flash Code 77 – Fuel Temp High	77-1
78	(CHG) Flash Code 78	78-1
79	Flash Code 79.	79-1
80	Flash Code 80.	80-1
81	(CHG) Flash Code 81	81-1
82	(CHG) Flash Code 82	82-1
83	(CHG) Flash Code 83	83-1
84	(CHG) Flash Code 84	84-1
85	Flash Code 85 – Engine Overspeed	85-1
86	Flash Code 86 – PGS Sensor High	86-1
87	Flash Code 87 – PGS Sensor Low	87-1
88	(CHG) Flash Code 88	88-1
89	Flash Code 89.	89-1
90	(CHG) Engine Sensor Harness	90-1
91	(CHG) Vehicle Harness	91-1
92	(CHG) Engine Wiring Schematics	92-1
93	(CHG) Vehicle Wiring Schematics	93-1
94	(CHG) DDEC Pro-link Operation	94-1

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ENGINE EXHAUST

Consider the following before servicing engines:

CAUTION:

Engine exhaust may be harmful to your health if inhaled.

Please note this caution and remember:

- ☐ Always start and operate the engine in a well ventilated area.
- ☐ If in an enclosed area, vent the exhaust to the outside.
- ☐ Do not modify or tamper with the exhaust system.

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GENERAL INFORMATION

Section	Page
ABSTRACT	3

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ABSTRACT

This manual provides instruction for troubleshooting the Detroit Diesel Electronic Controlled (DDEC®) engines, with two or three (multiple) ECMs.

Specifically covered in this manual are troubleshooting and repair steps that apply to the DDEC III and DDEC IV systems.

CAUTION:

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed. Proper service and repair are important to the safety of the service technician and the safe, reliable operation of the engine. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part number. Do not use a replacement part of lesser quality. The service procedures recommended and described in this manual are effective methods of performing repair. Some of these procedures require the use of specially designed tools. Accordingly, anyone who intends to use a replacement part, procedure or tool which is not recommended, must first determine that neither personal safety nor the safe operation of the engine will be jeopardized by the replacement part, procedure or tool selected. It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during repair, or the possibility that improper repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is impossible to warn personnel of the possible hazardous consequences that might result from failure to follow these instructions.

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1 INTRODUCTION

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1.1 INTRODUCTION

Detroit Diesel Corporation is the world leader in diesel engine electronics. DDC has made technological leaps in engine performance and fuel economy. Today, we build the most dependable electronically controlled diesel engine in the industry.

Our goal at Detroit Diesel is to be the most customer focused and most responsive engine manufacturer in the world.

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1.2 TROUBLESHOOTING INFORMATION

Troubleshooting of the DDEC III system and the DDEC IV system is identical. At the time of this printing, the available features are the same in both systems. The DDEC IV system allows for an increased processor speed and increased memory. DDEC III ECMs and DDEC IV ECMs are not interchangeable.

Instructions for repair in this manual are generic. For example, "Repair Open" is used to advise the technician that a particular wire has been determined to be broken. In some cases it may not be best to try and locate the open. It may be that the best repair technique is to replace a complete harness. The technician should make the determination of the proper repair, with the best interest of the customer in mind.

Instructions to "Contact Detroit Diesel Technical Service" indicate that at the time of this publication, all known troubleshooting checks have been included. Review any recent Service Information Bulletins (SIB) or Service Information letters before calling.

It is also suggested that other DDC outlets be contacted. e.g. if you are a dealer or user, contact your closest DDC Distributor.

Ensure you have the engine serial number when you call. The FAX number for Detroit Diesel Technical Service is 313-592-7888.

Instructions in this manual may suggest replacing a non DDC component. It may be required to contact the supplier of the component, e.g. truck manufacturer for a TPS concern, to obtain approval to replace the component.

Instructions to check terminals and connectors should include checking for proper contact tension. Using a mating terminal, a modest force should be required to remove a terminal from its mate. Replace terminals with poor tension.

After completing any repair, always clear fault codes that may have been generated during the troubleshooting process.

Important:

To ensure you receive updates to this manual should the need arise, you must fill out the Information Card in the front of this manual.

NOTE:
Be aware that troubleshooting in this manual is mostly concerned with DDEC related codes. Codes associated with other components, e.g. construction and industrial, EDM and AIM, can be found in the related publication. Refer to section 2.4.

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2 (CHG) OPERATION

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2.1 DDEC BENEFITS

CHANGES NEEDED. All Detroit Diesel On-Highway engines come standard with Detroit Diesel Electronic Controls (DDEC®). The state of the art Electronic Control Module (ECM) allows precise control of the engine management system that provides:

- ☐ Excellent engine performance
- ☐ Optimum fuel economy
- ☐ Emissions to meet current laws without after treatment
- ☐ Engine diagnostics
- ☐ Simple programming

2.2 FEATURES

The following features are part of the DDEC system:

- ☐ Engine Protection System
- ☐ Cruise Control
- ☐ Cruise Power
- ☐ Cruise Control Automatic Resume
- ☐ Progressive Engine Braking In Cruise Control
- ☐ Fan Controls
- ☐ Engine Fan Braking
- ☐ Progressive Shifting
- ☐ Vehicle Speed Limiting
- ☐ Vehicle Overspeed Diagnostics
- ☐ Vehicle ID Number
- ☐ Pressure Governor
- ☐ Starter Lockout
- ☐ Remote Throttle - PTO - Control
- ☐ High Idle Controls
- ☐ DDEC Ether Start
- ☐ Optimized Idle
- ☐ Idle Adjustment
- ☐ Idle Timer Shutdown
- ☐ Air Temperature Shutdown
- ☐ Auxiliary Engine Protection
- ☐ Customer Password
- ☐ Rating Security
- ☐ Maximum Security
- ☐ Low DDEC Voltage Light
- ☐ Low Coolant Light
- ☐ Low Oil Pressure Light
- ☐ High Oil Temperature Light
- ☐ High Coolant Temperature Light
- ☐ De-acceleration Light
- ☐ 12-volt or 24-volt ECM
- ☐ Communications Links SAE J1587, J1922, J1939

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2.3 DDEC SYSTEM--HOW IT WORKS

The major components of the DDEC system consist of the electronic control module (ECM), the electronic unit injectors (EUI) and the various system sensors. The purpose of the sensors is to provide information to the ECM regarding various engine performance characteristics. The information sent to the ECM is used to instantaneously regulate engine and vehicle performance.

2.3.1 Electronic Unit Injector

An electronic unit injector incorporates a solenoid operated poppet valve which performs the injection timing and metering functions. When the solenoid valve is closed, pressurization and fuel injection is initiated. Opening the solenoid valve releases injection pressure, ending injection. The duration of valve closure determines the quantity of fuel injected. See Figure 2-1.

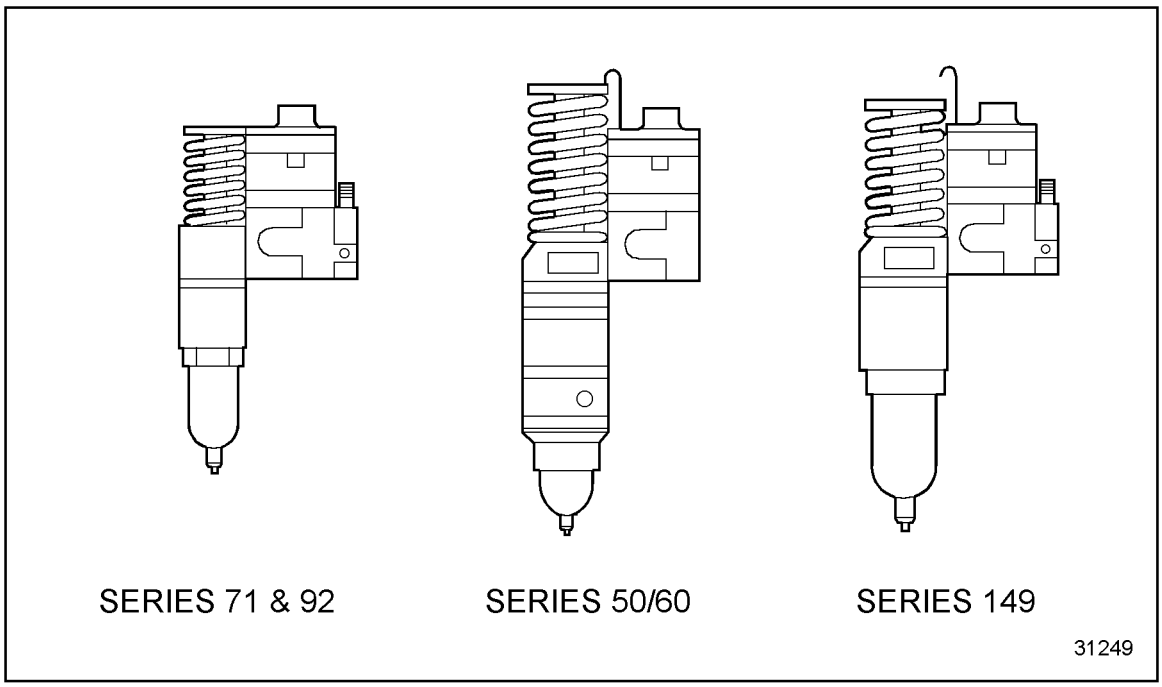

Figure 2-1 Electronic Unit Injector

2.3.2 Electrical Connectors

Provide water-tight connections for the harnesses between the sensors and the ECM.

2.3.3 Air Temperature Sensor

The air temperature sensor is located in the air intake manifold and monitors the air temperature entering the engine. The ECM adjusts the engine timing to reduce white smoke, improve cold starts, and provide engine protection. See Figure 2-2.

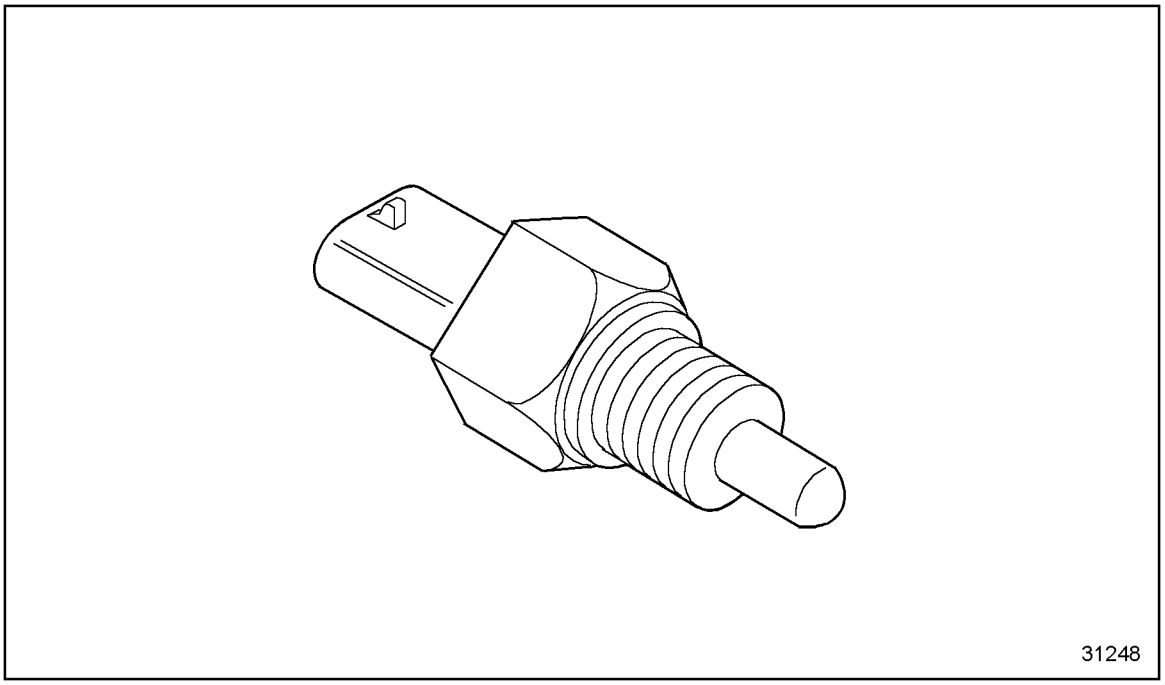

Figure 2-2 Air Temperature Sensor

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2.3.4 Coolant Temperature Sensor

The coolant temperature sensor is located on the right side of the engine. The engine protection feature will be triggered if the coolant temperature exceeds the specified limits. See Figure 2-3.

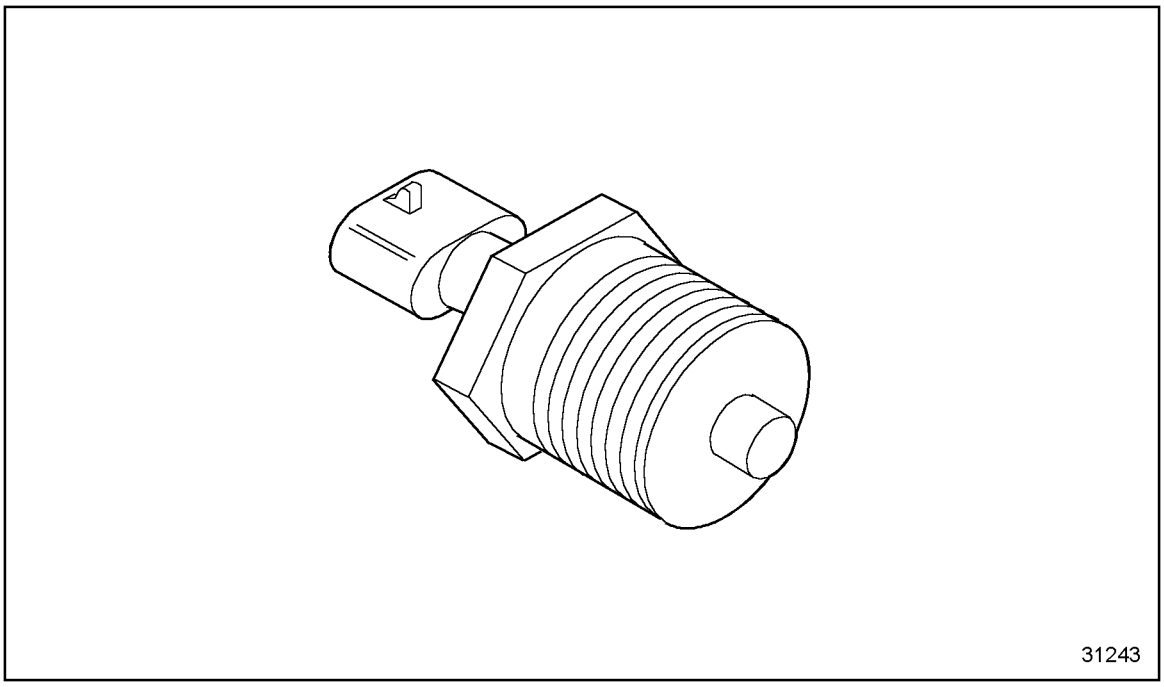

Figure 2-3 Coolant Temperature Sensor

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2.3.5 Fire Truck Pump Pressure Sensor

The fire truck pump pressure sensor is used to monitor water pressure for the Pressure Governor System in the DDEC system. The signal back to the ECM changes r/min which allows the fire truck water pump to maintain a steady water pressure during pumping operation in fire trucks. See Figure 2-4.

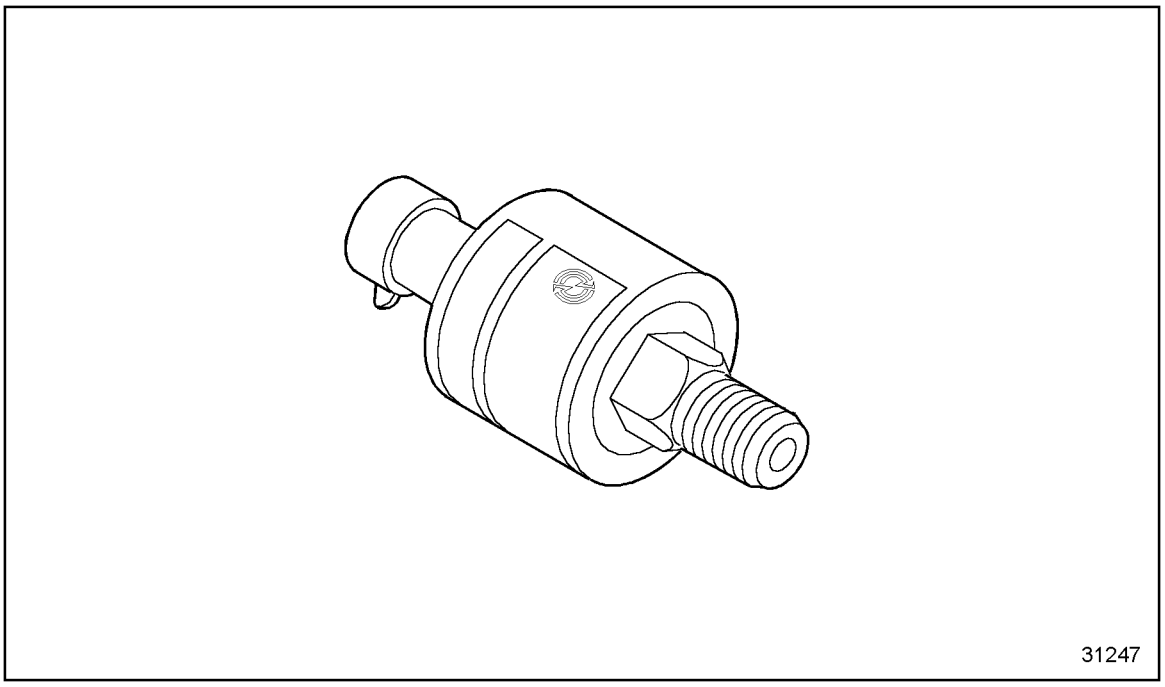

Figure 2-4 Fire Truck Pump Pressure Sensor

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2.3.6 The Synchronous Reference Sensor and Timing Reference Sensor

These sensors control the timing of the engine. The SRS sensor provides a "once per cam revolution" signal and the TRS sensor provides a "36 per crankshaft revolution" signal. Working together, these sensors tell the ECM which cylinder is at top-dead-center for cylinder firing. Precise monitoring of piston position allows for optimum injection timing, resulting in excellent fuel economy and performance with low emissions. See Figure 2-5 for the SRS and the TRS.

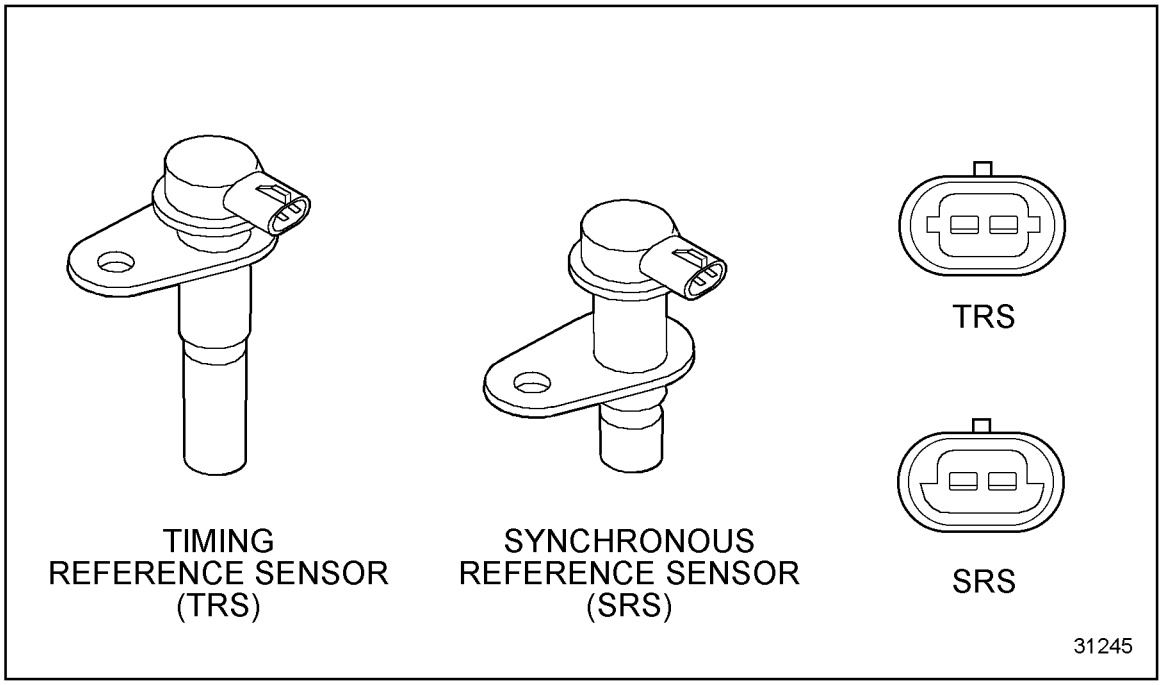

Figure 2-5 Timing Reference Sensor and Synchronous Reference Sensor

2.3.7 Oil and Fuel Temperature Sensors

The oil temperature sensor optimizes idle speed and injection timing to improve cold startability and reduce white smoke. This sensor will activate the engine protection system if the oil temperature is higher than normal.

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The fuel temperature sensor provides a signal to the ECM. The ECM utilizes the fuel temperature signal to adjust the fueling for changes in the fuel density as a function of temperature to maintain horsepower. See Figure 2-6.

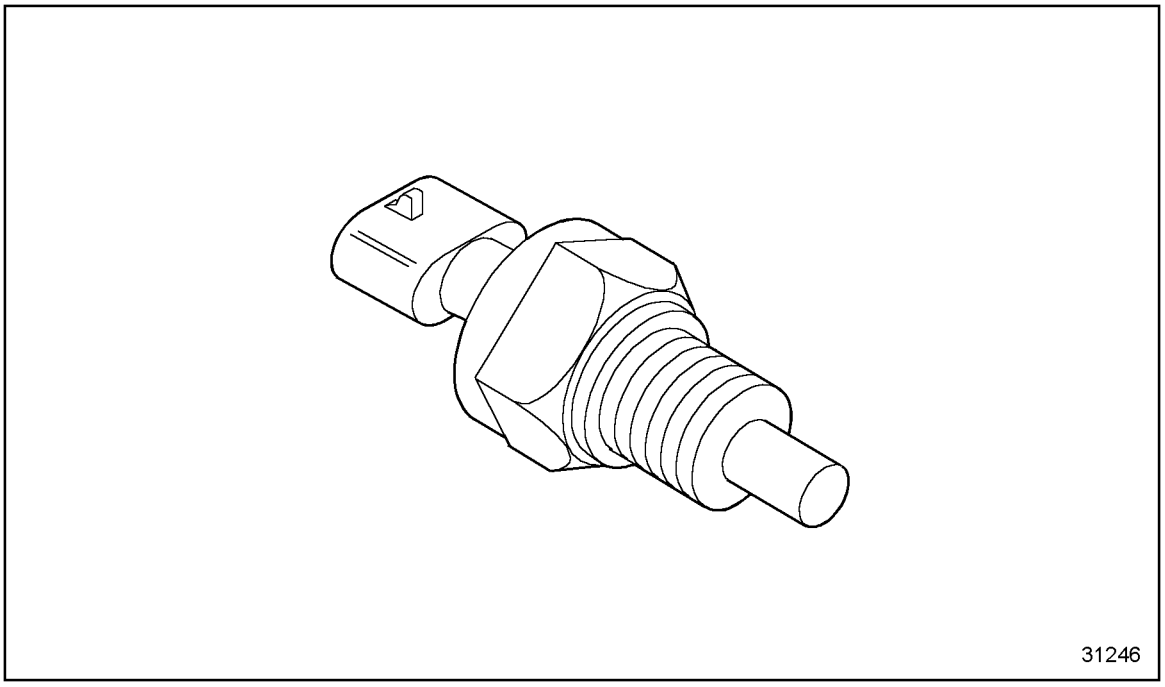

Figure 2-6 Oil and Fuel Temperature Sensors

2.3.8 Electronic Control Module

The ECM is the brain of the computer system, receiving electronic inputs from the operator as well as from the engine and vehicle mounted sensors. See Figure 2-7.

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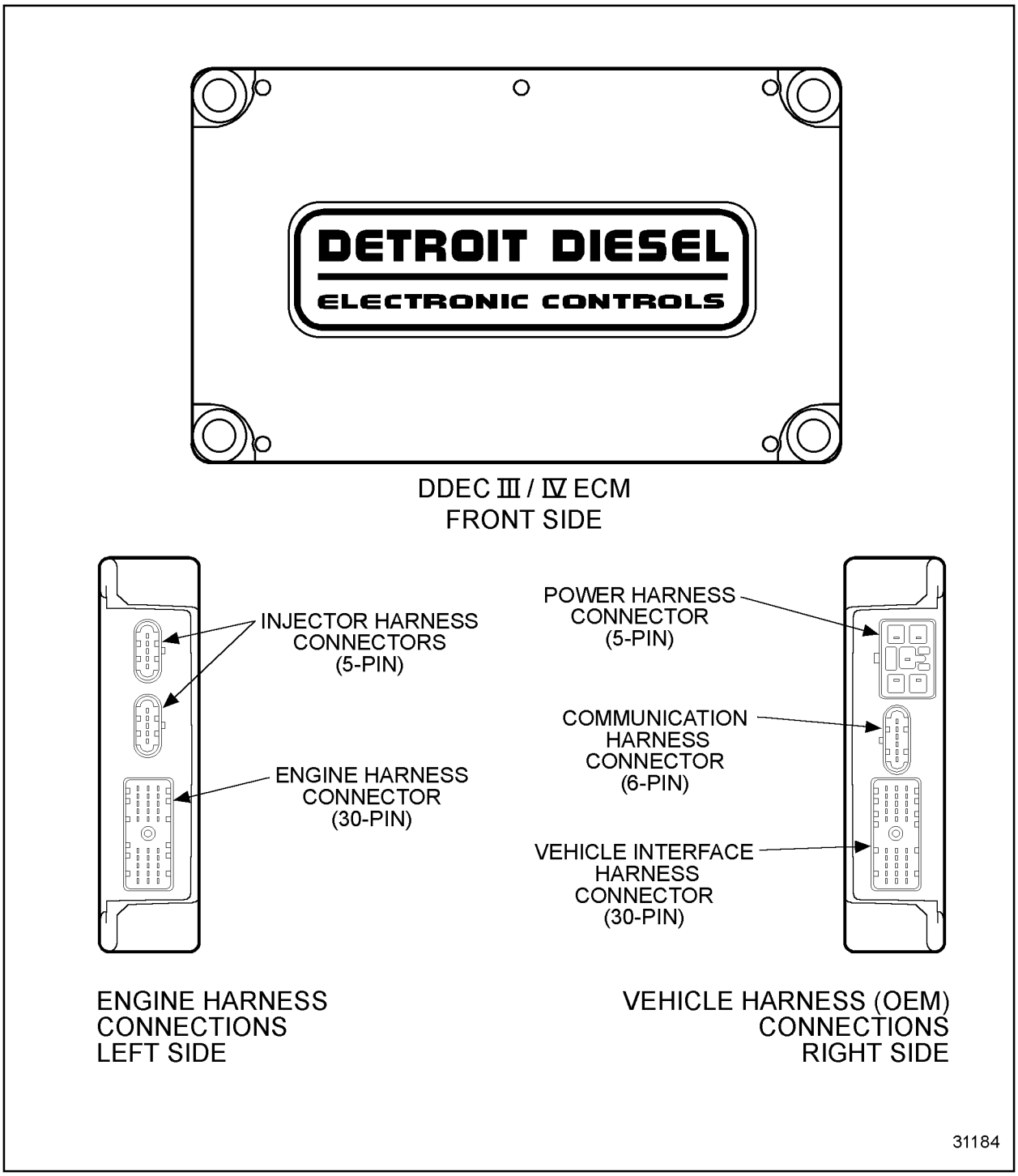

Figure 2-7 Electronic Control Module

2.3.9 Coolant Level Sensor

The engine protection feature will be triggered if the coolant level sensor detects a low coolant level. See Figure 2-8.

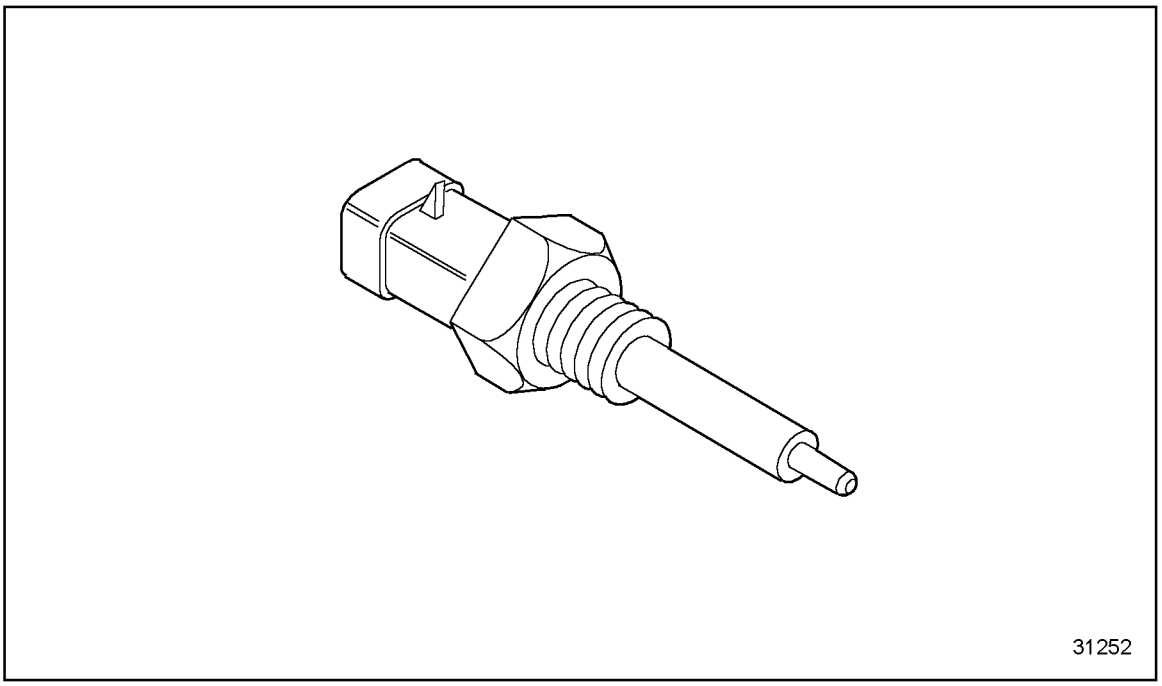

Figure 2-8 Coolant Level Sensor

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2.3.10 Throttle Position Sensor

The electronic foot pedal assembly instantaneously converts the operator's throttle input into a signal to the ECM. The throttle response is fast and accurate. This sensor is self-calibrated, and requires no maintenance. See Figure 2-9.

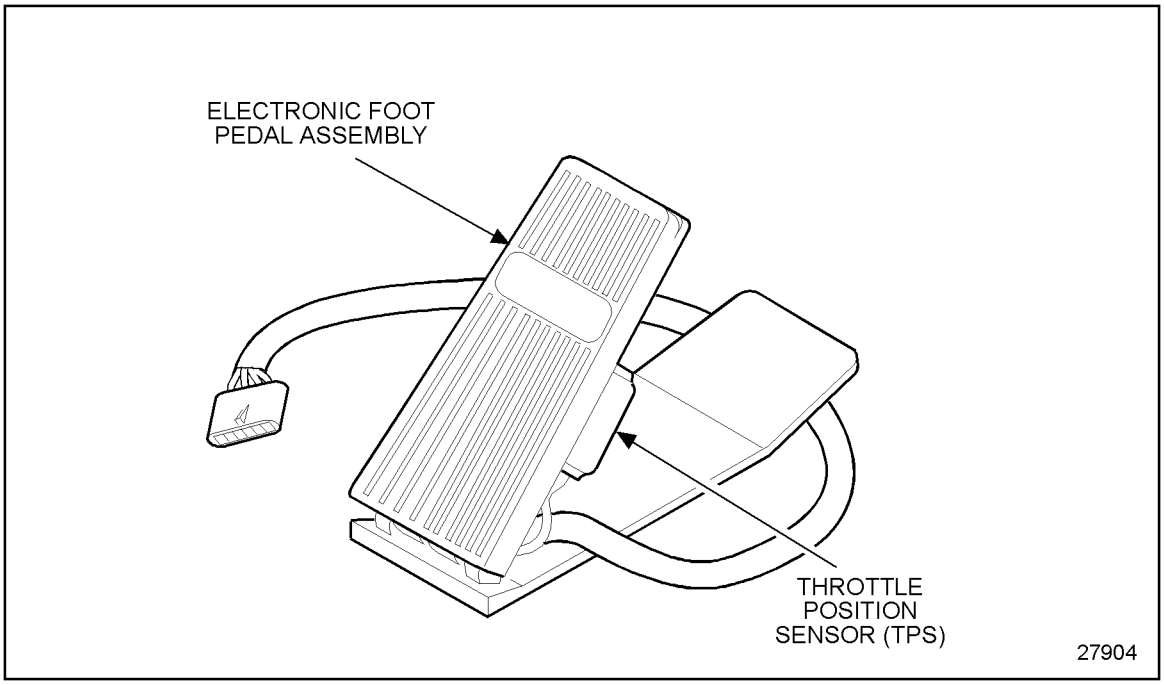

Figure 2-9 Throttle Position Sensor

2.3.11 Vehicle Speed Sensor

The vehicle speed sensor provides the ECM with the vehicle road speed for use with cruise control, vehicle speed limiting, and progressive shifting. See Figure 2-10.

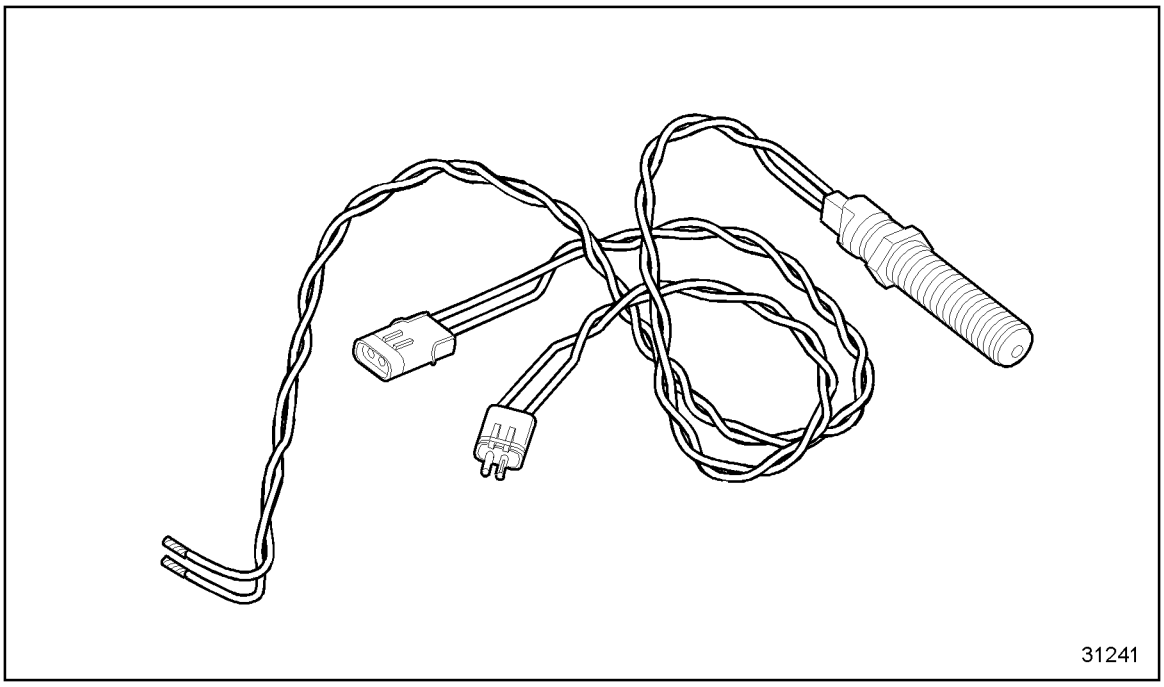

Figure 2-10 Vehicle Speed Sensor

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2.3.12 Turbo Boost Sensor

In monitoring turbocharger compressor discharge, the turbo boost sensor provides air pressure data to the ECM for smoke control during engine acceleration. See Figure 2-11.

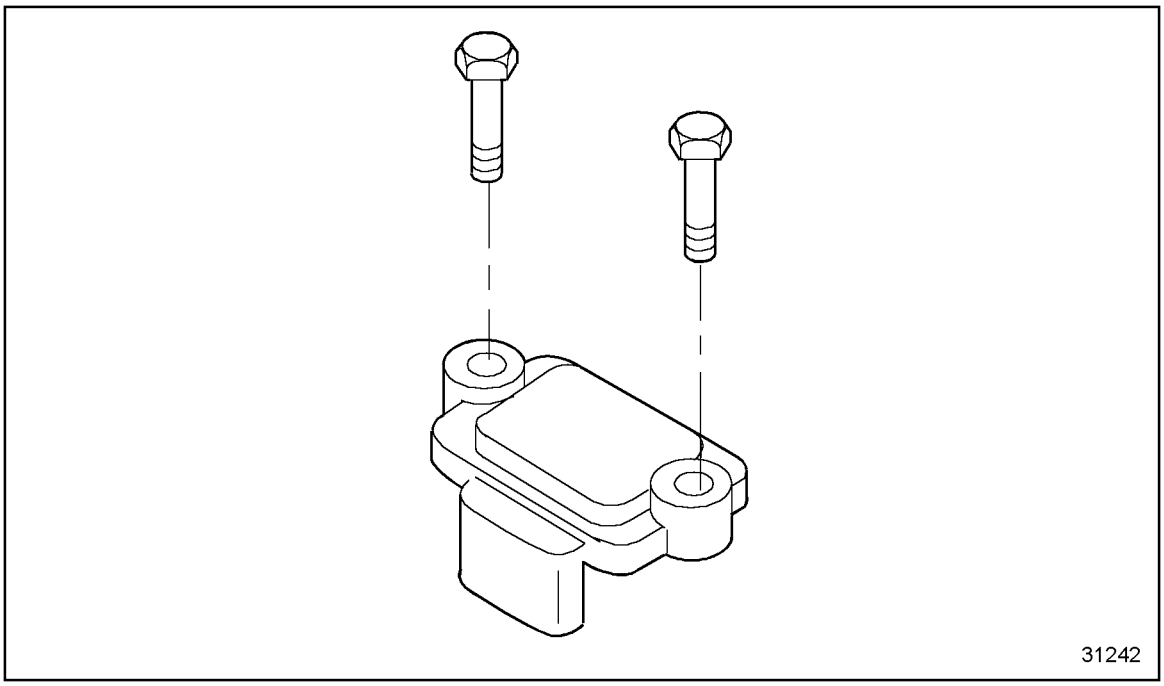

Figure 2-11 Turbo Boost Sensor

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2.3.13 Oil Pressure Sensor

The oil pressure sensor will activate the engine protection system when the oil pressure falls below a normal oil pressure at a given engine r/min. See Figure 2-12.

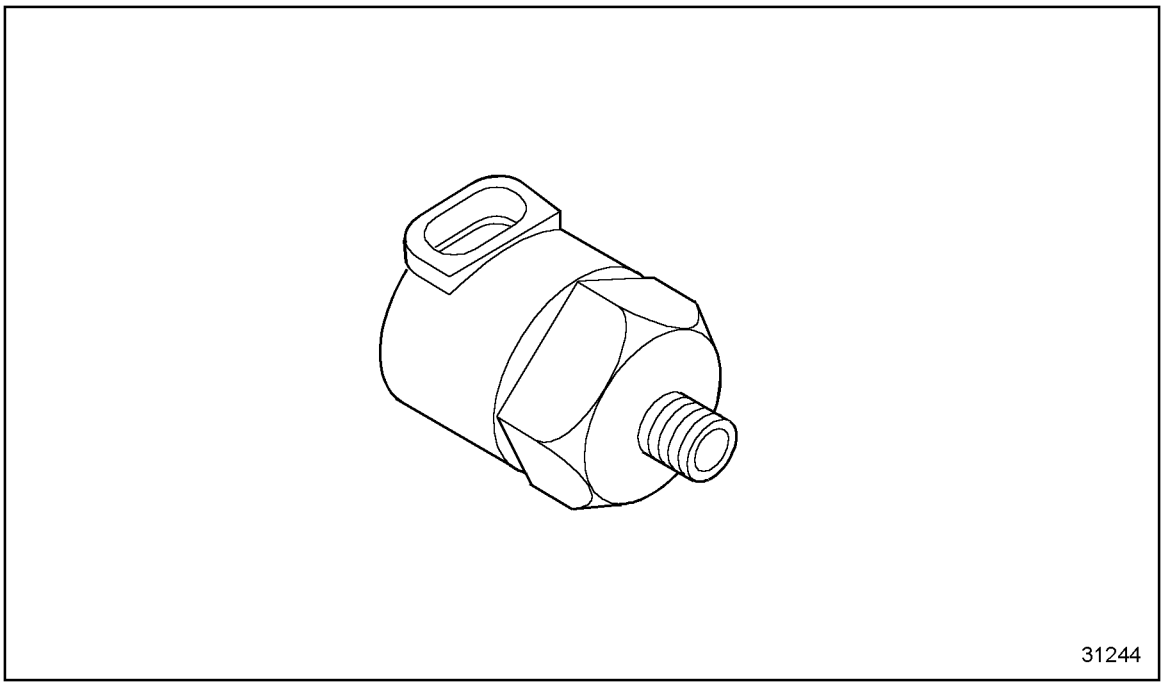

Figure 2-12 Oil Pressure Sensor

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2.3.14 Fuel Pressure Sensor

The fuel pressure sensor monitors fuel pressure to warn the operator of impending power loss. This feature is optional. It is not used in international applications. See Figure 2-13.

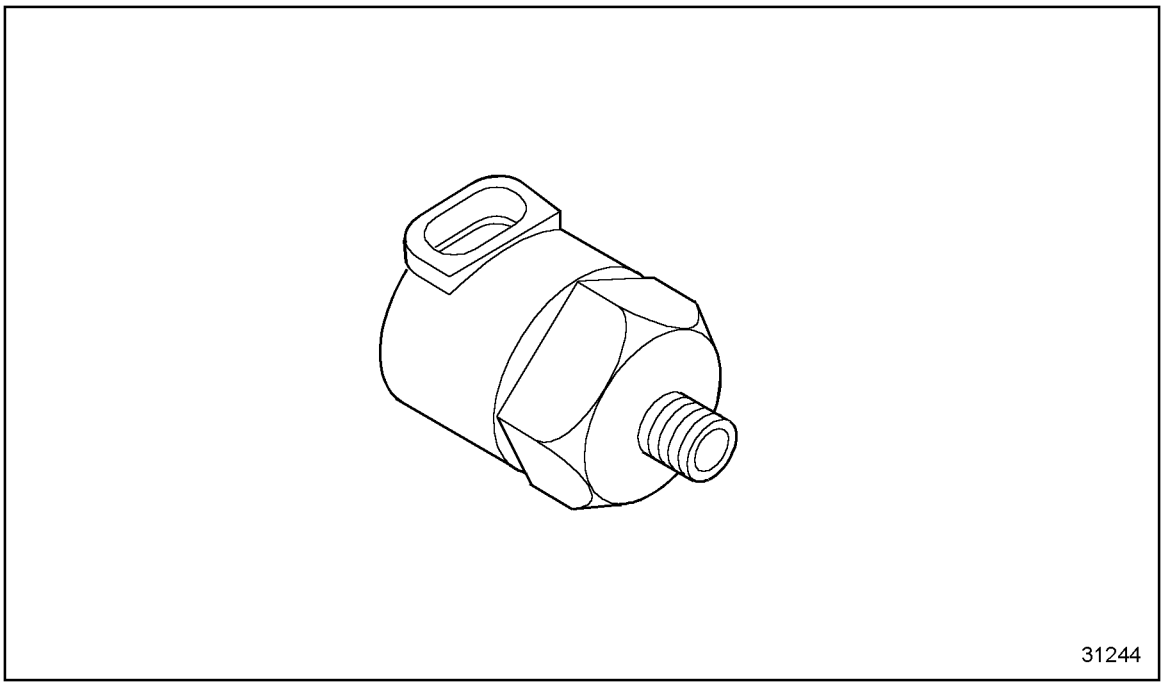

Figure 2-13 Fuel Pressure Sensor

2.4 DDEC RELATED PUBLICATIONS

The following manuals, listed in Table 2-1, should be used for reference when troubleshooting DDEC components.

Publication	Number
DDEC III Application and Installation manual	7SA800
Optimized Idle Installation and Troubleshooting	7SA734
Optimized Idle User Manual	6SE518
Optimized Idle Troubleshooting and Reprogramming	18SA366
Engine Synchro Shift (ESS) Troubleshooting Manual	6SE498
Construction and Industrial EDM and AIM Installation and Troubleshooting	7SA801
Construction and Industrial EDM and AIM User Manual	6SE710
DDC Ether Start	7SA727
Series 50G Application and Installation Engineering Guidelines, Bulletin 53	18SA365
DDEC III Automotive Code Chart, 3 color, 8.5 x 11	7SE444
DDEC III Codes, Reference Pamphlet	7SE414
DDEC II Troubleshooting Manual	6SE489
DDEC II Application and Installation manual	7SA707
Series 60 Driving Tips (includes VHS video)	25STV0161

Table 2-1 DDEC Related Publications

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3 (CHG) ECM AND SENSOR LOCATIONS

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3.1 ECM AND SENSOR LOCATIONS

For the DDEC system ECM see Figure 3-1.

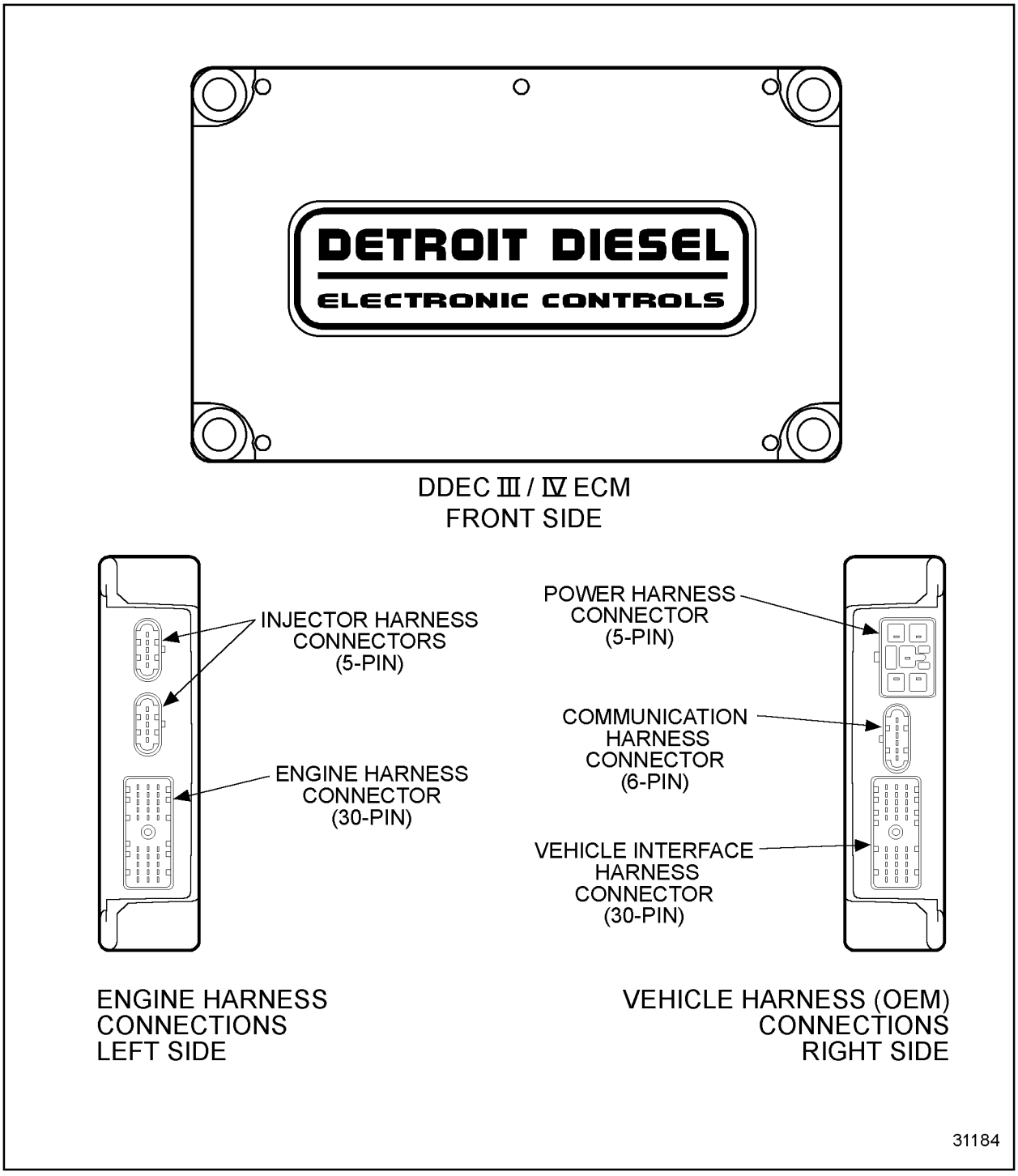

Figure 3-1 DDEC System ECM

For the Series 60® sensor locations, see Figure 3-2.

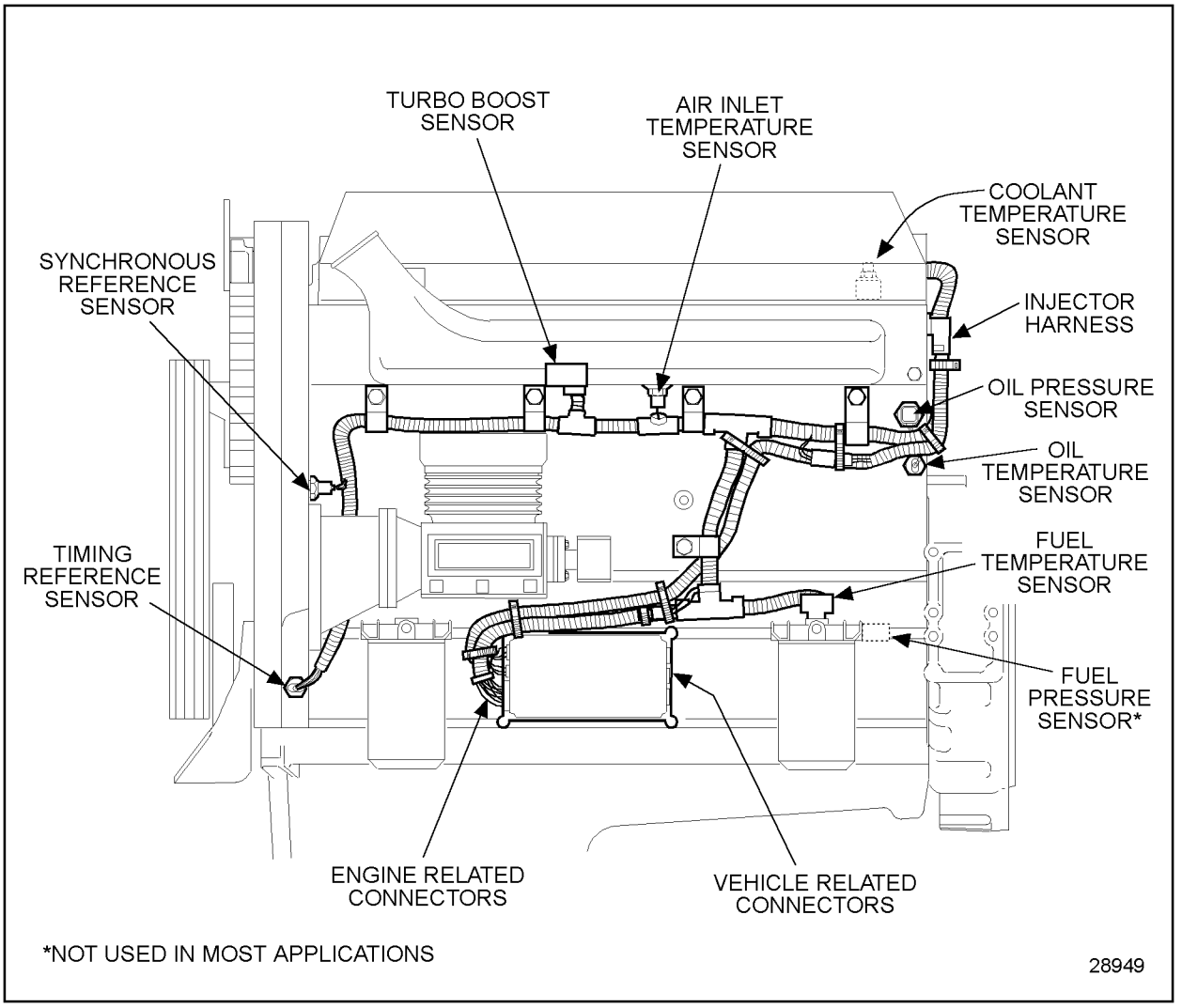

Figure 3-2 Series 60 Diesel ECM and Sensor Locations

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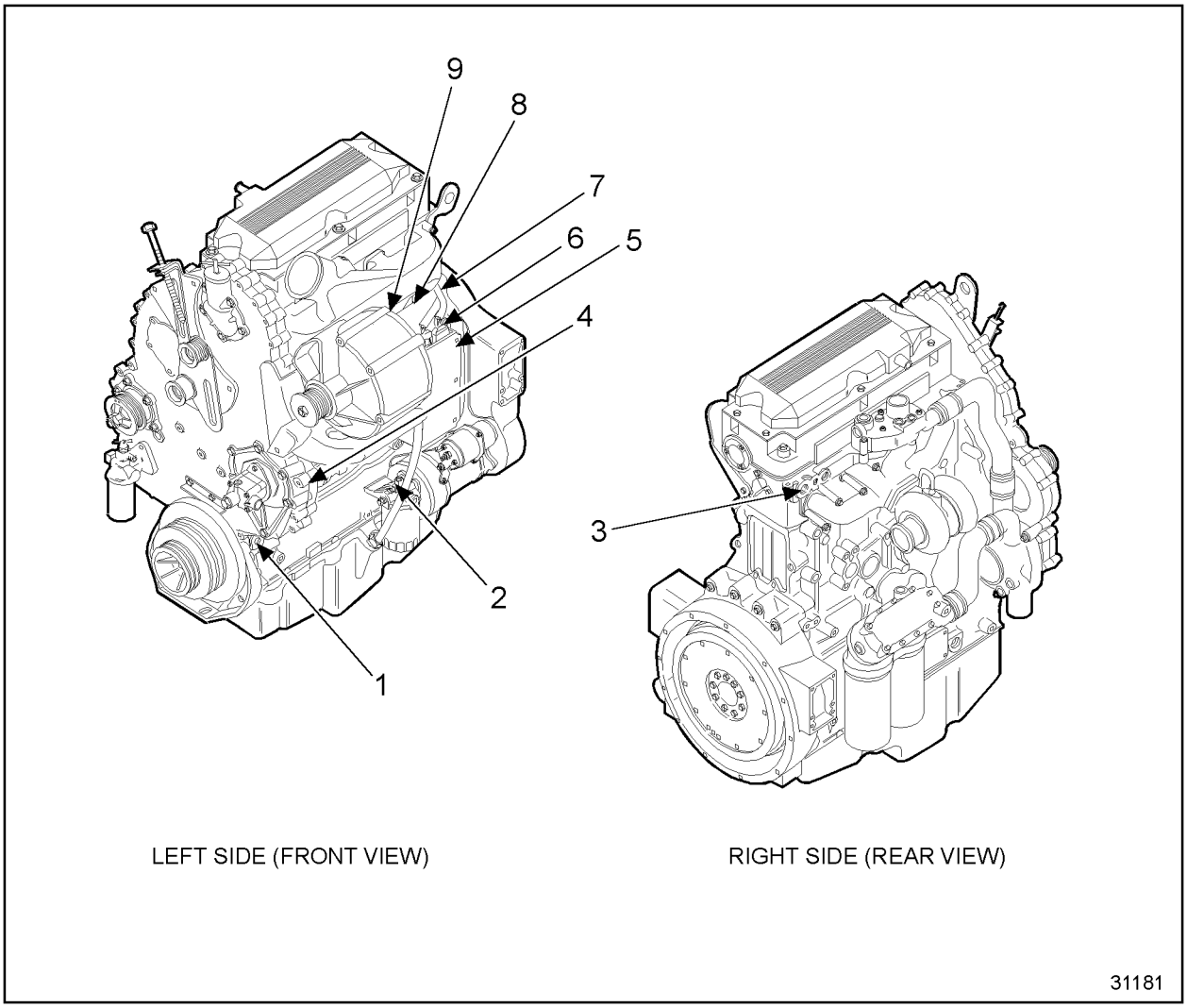
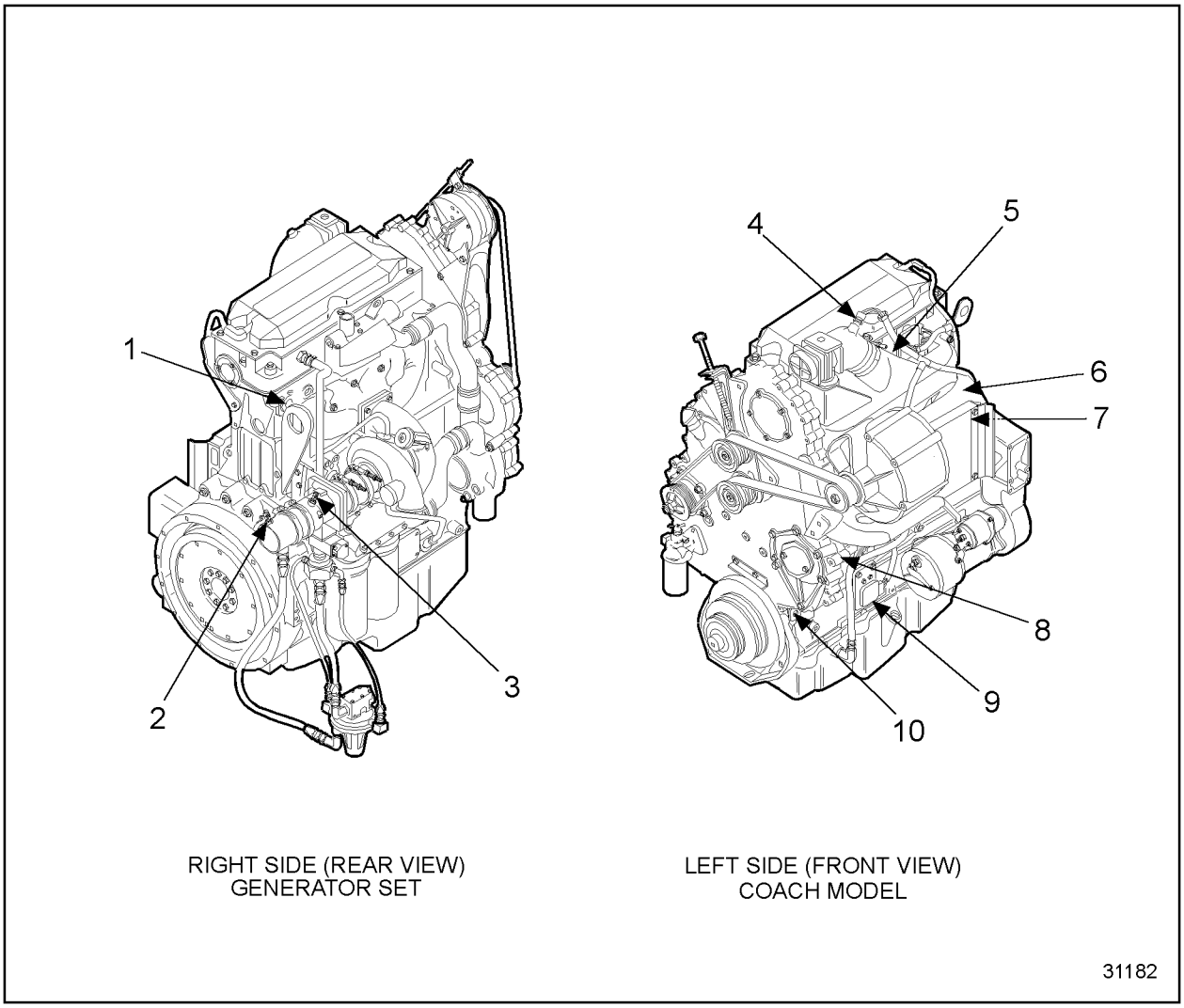
For the Series 50® diesel engine sensor locations, see Figure 3-3.



1.Timing Reference Sensor
2.Fuel Temperature Sensor
3.Coolant Temperature Sensor
4.Synchronous Reference Sensor
5.ECM
6.Oil Temperature Sensor
7.Oil Pressure Sensor
8.Turbo Boost Sensor
9.Air Inlet Temperature Sensor

Figure 3-3 Series 50 Diesel ECM and Sensor Locations

For the Series 50® gas engine sensor locations, see Figure 3-4.



1.Coolant Temperature Sensor
2.Air Temperature Sensor
3.Fuel Temperature Sensor
4.Manifold Air Pressure (MAP) Sensor
5.Knock Sensor
6.Oil Temperature Sensor
7.Oil Pressure Sensor
8.Synchronous Reference Sensor
9.SNEF Module
10.Timing Reference Sensor

Figure 3-4 Series 50 Gas ECM and Sensor Locations

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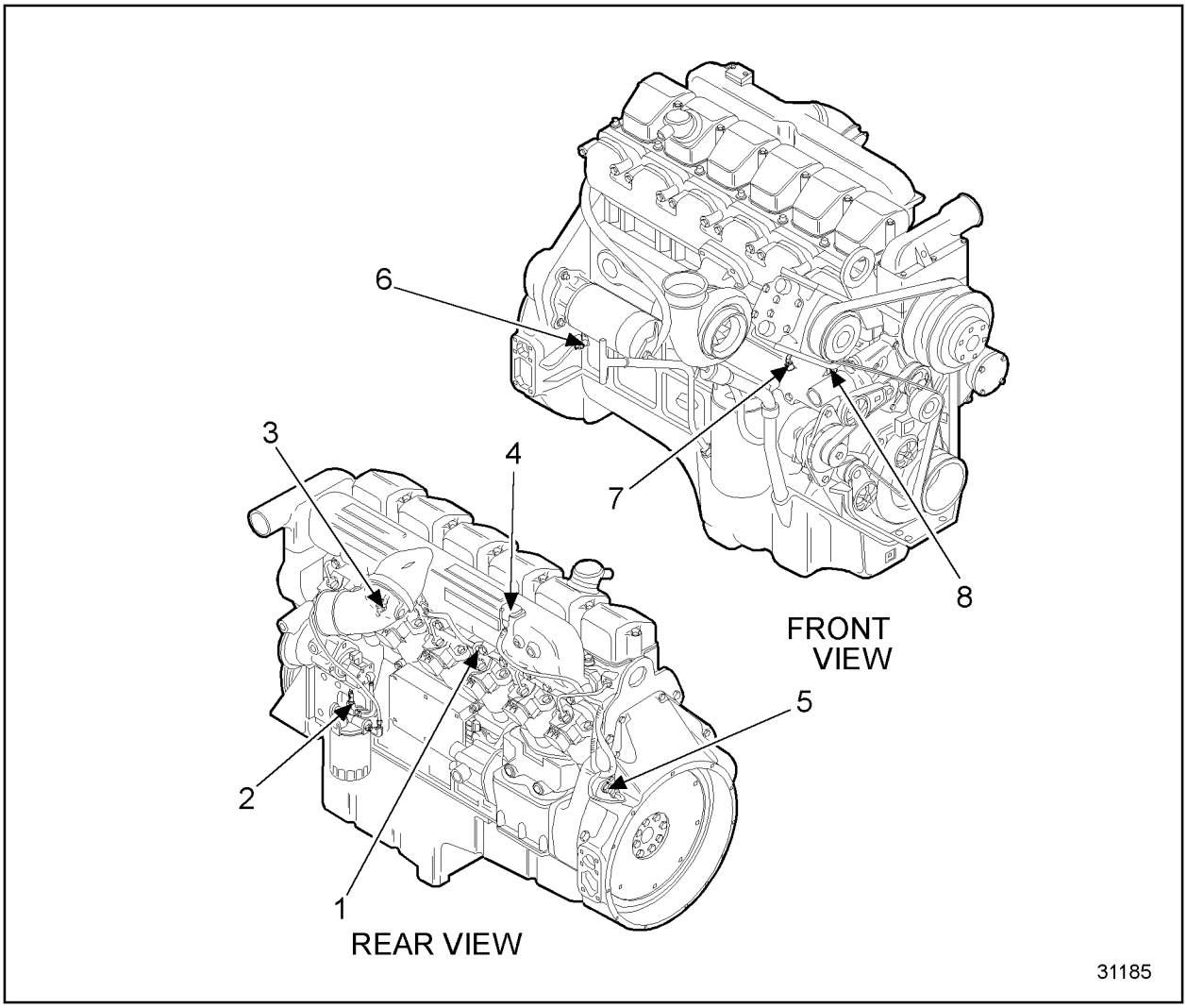
For the Series 55™ engine sensor locations, see Figure 3-5.



1.Coolant Temperature Sensor
2.Fuel Temperature Sensor
3.Air Inlet Temperature Sensor
4.Turbo Boost Sensor
5.Synchronous Reference Sensor
6.Timing Reference Sensor
7.Oil Temperature Sensor
8.Oil Pressure Sensor

Figure 3-5 Series 55 Engine Sensor Locations

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4 BASIC KNOWLEDGE REQUIRED

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4.1 DDEC DIAGNOSTIC CODE

Troubleshooting of the DDEC III system and the DDEC IV system is identical. At the time of this printing, the available features are the same in both systems. The DDEC IV system allows for an increased processor speed and increased memory. DDEC III ECMs and DDEC IV ECMs are not interchangeable.

A diagnostic code indicates a problem in a given circuit (i.e. diagnostic Code 14 indicates a problem in the oil or coolant temperature sensor circuit). This includes the oil or coolant temperature sensor, connector, harness, and Electronic Control Module (ECM). The procedure for finding the problem can be found in Flash Code 14, refer to section 14.3. Similar sections are provided for each code. Remember, diagnosis should always begin at the start of the section. For an oil or coolant temperature sensor problem, it will quickly lead you to section 14, but first you verify the code or symptom.

Since the self-diagnostics do not detect all possible faults, the absence of a code does not mean there are not problems in the system. If a DDEC problem is suspected, even in the absence of a code, refer to section 9.1, anyway. This section can lead you to other sections that can aid in the troubleshooting process - where DDEC problems may occur, but do not generate a code. Basic mechanical checks are not covered in this manual.

4.2 GENERAL DIAGNOSTIC INFORMATION

As a bulb and system check, the Check Engine Light (CEL) and Stop Engine Light (SEL) will come on for five seconds when the ignition switch is first turned on. If the unit is programmed for the cruise control feature, the "Cruise Active" light (if equipped) will also turn on for five seconds.

If the CEL comes on during vehicle operation, it indicates the self diagnostic system has detected a fault.

When the diagnostic request switch is held, the diagnostic system will flash the yellow or red light located on the dash of the vehicle. The light will be flashing the code(s) indicating the problem areas. If the SEL comes on during vehicle operation, it indicates the DDEC System has detected a potential engine damaging condition. The engine should be shut down immediately and checked for the problem.

Active codes will be flashed on the SEL in numerical flash code order. If there are no active codes, a code 25 will be flashed.

Inactive codes will be flashed on the CEL in most recent to least recent order. If there are no inactive codes, a Code 25 will be flashed.

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4.3 READING CODES WITH DIAGNOSTIC DATA READER

Flash codes are used for operator convenience to advise of an engine fault or sensor failure. SAE specific codes are read with the Diagnostic Data Reader (DDR). In some cases, one flash code may be used to cover more than one component fault. For this reason the DDR (or Diagnostic Data Link, DDL) must be used to identify the specific code.

The Diagnostic Code Menu selections are defined as follows.

- ☐ Active codes
- ☐ Inactive codes
- ☐ Clear codes

To read codes, start with the Menu Selection screen.

1. To call up active codes:
   [a] Select ENGINE and ENTER three times.
2. To call up inactive codes:
   [a] Select ENGINE and ENTER twice.
   [b] Select INACTIVE CODES and ENTER.
3. To clear codes:
   [a] Select ENGINE and push ENTER twice.
   [b] Go down and select CLEAR CODES and ENTER.
   [c] Left to YES, and ENTER.
   [d] Wait and then push FUNC three times.
   [e] Go to lines 1 and 2 of the Engine Data List, Active and Inactive Codes, and verify that both lines display NO.

4.3.1 Active Codes

Active codes are conditions that are presently occurring and causing the CEL to be illuminated. All current active codes will be displayed for the entire system, including single, dual and triple ECM applications. The display for each code is as follows:

Line 1: ## MID: XXX XXXXXXXX

Line 2: PID Description

Line 3: FMI Description

Line 4: ↑ A## PID: XXX FMI: XX ↓

Explanation:

##: Indicates the DDC diagnostic flash code number

MID: Message Identification Character

PID: Parameter Identification Character

FMI: Failure Mode Identifier

A##: Numerical count of active codes

↑↓: Indicates additional codes are stored in ECM memory

4.3.2 Inactive Codes

Inactive codes are faults that have occurred previously. All current inactive codes will be displayed for the entire system, including single, dual, and triple ECM applications. The display for each code is as follows:

SCREEN #1; SCREEN #2

Line 1: ## MID: XXX XXXXXX XX ; Line 5: 1st: Last:

Line 2: PID Description; Line 6: Total#:

Line 3: FMI Description; Line 7: Total Time:

Line 4: ↑ |## PID: XXX FMI: XX ↓; Line 8: Min/Max:

Explanation:

##: Indicates the DDC diagnostic flash code number

|##: Numerical Count of inactive codes

1st: First occurrence of the diagnostic code in engine hours

Last: Last occurrence of the diagnostic code in engine hours

Total#: Total number of occurrences

Total Time: Total engine seconds that the diagnostic code was active

Min/Max: Minimum/Maximum value recorded during diagnostic condition

4.3.3 Clear Codes

This feature allows diagnostic codes stored in the ECMs to be erased. An audit trail of when the codes were last erased will be displayed in engine hours.

Engine Hours of Last Clear Codes: XXXX

4.3.4 Message Identification Descriptions

MID: 128 ENGINE, Single ECM applications

MID: 175 ENGINE, R1 Dual ECM application - engine #2 with first receiver ECM

MID: 183 ENGINE, R2 Triple ECM application - engine #3 w/second receiver ECM

MID: 184 PING, Pilot Injection Natural Gas ECM application

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Diagnostic codes with Subsystem Identification Characters (SIDs) that reference Auxiliary Outputs # 1-8 (SIDs: 26, 40, 51, 52, 53, 54, 55, 56) will look up the parameter text description in a table to identify the function assigned to the auxiliary output channel.

Diagnostic codes with SIDs that reference PWM Outputs #1 through #4 (SIDs: 57, 58, 59 & 60) will look up the parameter text description in a table to identify the function assigned to the PWM output channel.

Injector Response Time Codes Long and Injector Response Time Codes Short will use a table of injector numbering to identify the appropriate engine cylinder number.

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4.4 ELECTRICAL CIRCUITS

Before using this manual, you should understand the theory of electricity and know the meaning of voltage and ohms. You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.

You should be able to use jumper wires to make circuit checks.

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4.5 USE OF DIGITAL VOLT-OHM METER

Before using this manual, you should be familiar with the digital volt-ohm meter (VOM). You should be able to measure voltage and resistance. You should be familiar with the controls of the meter and how to use it correctly.

For use of a typical digital volt-ohm meter, refer to section 4.5.1, refer to section 4.5.2, and refer to section 4.5.3.

4.5.1 Resistance Measurements

Perform the following steps to measure resistance:

1. Connect the red test lead to the V- Ω (Volt-Ohm) input connector and the black lead to the com input connector on the meter.
2. Set the function/range switch to the desired Ω position. If the magnitude of the resistance is not known, set the switch to the highest range, then reduce until a satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off the power to the circuit being tested. Turn off the ignition.
4. Connect the test leads to the circuit being measured. When measuring high resistance, be careful not to contact adjacent points, even if they are insulated. Some insulators have a relatively low insulation resistance which can affect the resulting measurement.
5. Read the resistance value on the digital display.

4.5.2 Continuity Checks

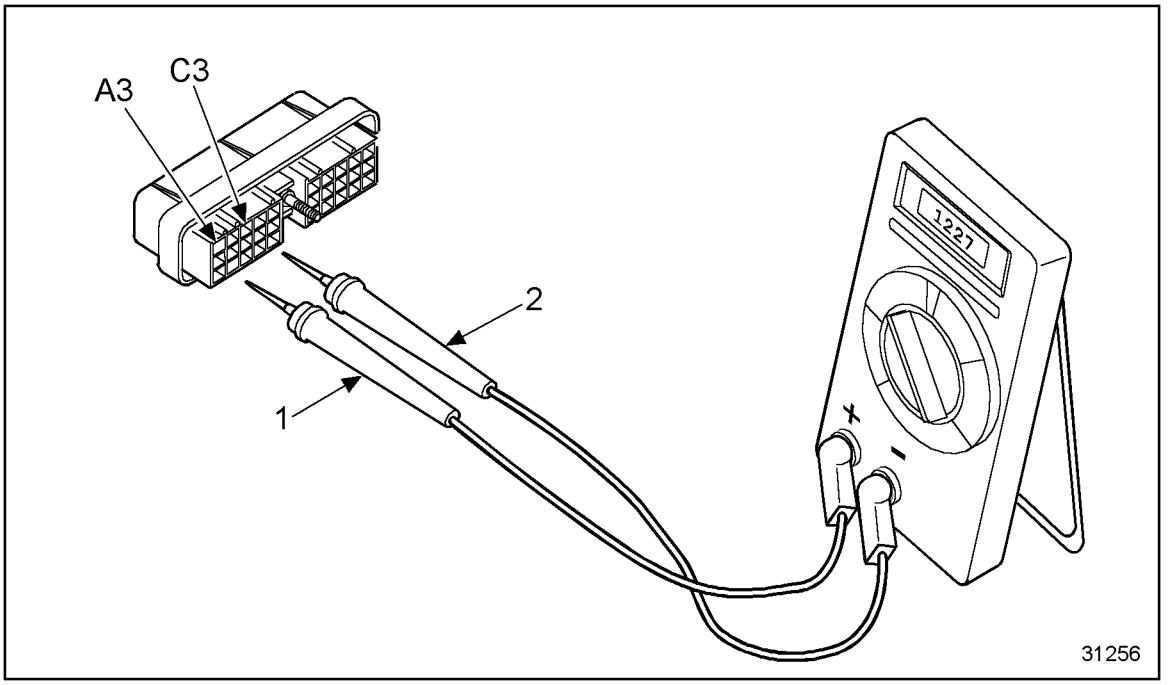
In addition to measuring the specific resistance value of a circuit, some meters will also register if a continuous electrical path exists. If a path exists, the circuit is said to have continuity. (This continuity check can be used in any section of this troubleshooting guide where the test is looking for greater than, less than, or equal to 5 ohms.) An open circuit (broken electrical path) would have ∞ resistance and would not have continuity. To utilize the continuity feature of certain meters:

1. Place the function/range switch in any Ω range.
2. Connect the red lead to the V- Ω connector and the black lead to the com connector on the meter. With the test leads separated or measuring an out-of-range resistance, the digital display will indicate OL (over limit) Some meters show "1 +, 1, or ↑."
3. Put one test probe at one end of the wire or circuit to be tested. Use the other test lead to trace the circuit. When continuity is established, an ohm (Ω) symbol will display in the upper left corner of the digital display. If contact in the wire is maintained long enough (about 1/4 second), the OL will disappear and the resistance value of the wire or circuit will display next to the symbol.
4. If your VOM does not work in the manner described above, you must know how your VOM operates in order to use this troubleshooting guide.

4.5.3 Voltage Measurements

Perform the following steps to measure voltage.

1. Connect the red test lead to the V- Ω connector and the black lead to the com input on the meter. If a DC-AC switch is present, ensure it is switched to the DC position.
2. Set the function range/switch to the desired volts position. If the magnitude of the voltage is not known, set the switch to a range that will be able to read most voltages seen on a vehicle. Typically, a 20V range will do. Then, reduce the range until a satisfactory reading is obtained.
3. Connect the test leads to the circuit being measured. In the DDEC system diagnostic procedures, voltage measurements are always given as being taken at pins, sockets, battery +, or ground. Following the voltage measurement point, the color test lead to be used is given in parenthesis (red is the V- Ω connection, and black is the com connection). Example: If the procedure displays, "Take voltage reading at socket A3 (red lead) to socket C3 (black lead)", see Figure 4-1 for the hook-up.



1.Red Lead 2.Black Lead

Figure 4-1 Voltage Measurement Hook-up

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4.6 IMPORTANT INFORMATION

The following items must be read and thoroughly understood before using this manual.

1. The engine and ignition should always be off before the harness connectors are disconnected or reconnected.
2. When disconnecting harness connectors, ensure the pulling force is applied to the connectors themselves and not the wires extending from them.

NOTICE:
To avoid damage to the harness connectors, ensure the pulling force is applied to the connections themselves and not the wires extending from them.

3. After harness connectors are reconnected to the DDEC system, the codes logged should be ignored and cleared.
4. In most all areas of repair/troubleshooting, a DDR will be required.
5. In diagnosing an intermittent problem, wiggling wires or harnesses may allow the fault to be repeated. This may allow a technician to better isolate the problem area.

4.7 EXPLANATION OF ABBREVIATIONS AND TERMS

The following abbreviations and terms listed in Table 4-1, will be used throughout the electrical flowcharts.

Abbreviations	Terms
A/C	Air Conditioning
ACG	Air Compressor Governor
A/D	Analog to Digital: The computer inside the ECM uses an A/D converter to convert a sensor voltage into a number with which the computer can work.
ASR	Anti-Skid Regulation: Data supplied by the ECM for use with ABS (anti-lock braking system).
ATI	Auxiliary Timed Input
ATS	Air Temperature Sensor: Monitors engine air temperature.
BAT	Battery
BOI	Beginning of Injection: The number of crank angle degrees, before top-dead-center (TDC), where the ECM is requesting the injectors be turned on.
BPS	Bypass Position Sensor
CAN	Controller Area Network: J 1939 high speed control data link.
CCM	Crankcase Monitor Sensor: Monitors crankcase pressure (currently on 149 engines only).
CCPS	Crankcase Pressure Sensor
CEL	* Check Engine Light: Typically mounted on the instrument panel. The CEL has two functions:1. It is used as a warning lamp to inform the operator of the vehicle that a fault has occurred and the unit should be taken in for service as soon as possible.2. It is used by the operator or technician to "flash out inactive trouble codes to help diagnose a problem.
CKT	Circuit
CLS	Coolant Level Sensor: Monitors coolant level at the radiator top tank or heat exchanger.
COM	Common
CPS	Coolant Pressure Sensor: Monitors coolant presssure.
CTS	Coolant Temperature Sensor: Monitors coolant temperature.
DDEC	Detroit Diesel Electronic Controls
DDEC III	Third generation Detroit Diesel Electronic Controls
DDEC IV	Fourth generation Detroit Diesel Electronic Controls

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Abbreviations	Terms
DDL	Diagnostic Data Link: The lines (wires) over which the ECM transmits information that can be read by a Diagnostic Data Reader.
DDL+	Data Link, positive side: J 1587 data link.
DDL-	Data Link, negative side: J 1587 data link.
DDR	Diagnostic Data Reader: The hand held tool used for troubleshooting the DDEC system. MPSI PRO-LINK 9000.
ECM	Electronic Control Module: The controller of DDEC system. It reads the engine and vehicle inputs, sensors and switches, calculates injector firing and duration, and fires injectors at appropriate times.
EEPROM	Electrically Erasable Programmable Read Only Memory.
EFC	Electronic Fire Commander
EFPA	Electronic Foot Pedal Assembly: Contains the throttle position sensor.
EOP	Engine Over-temperature Protection
ESH	Engine Sensor Harness
ESS	Engine Synchro Shift
EUI	Electronic Unit Injector
FEI	Fuel Economy Incentive
FPS	Fuel Pressure Sensor: Monitors fuel pressure.
FTS	Fuel Temperature Sensor: Monitors fuel temperature.
GND	Ground
INJ	Injector (fuel)
ISD	Idle Shutdown: Programmable feature of the DDEC system.
IVS	Idle Validation Switch: A switch used to establish the idle speed position.
LSG	Limiting Speed Governor.
MPG	Miles Per Gallon
N/A	Not Applicable.
OEM	Original Equipment Manufacturer
OI	Optimized Idle
OLS	Oil Level Sensor: Monitors oil level.
OPS	Oil Pressure Sensor: Monitors oil pressure.
OTS	Oil Temperature Sensor: Monitors oil temperature.
PGS	Pressure Governor System: Regulates engine speed to maintain a selected external pump pressure.

Abbreviations	Terms
PTO	Power Take-Off. Also, referred to as VSG (Variable Speed Governor).
PW	Pulsewidth
PWM	Pulsewidth Modulated: Modulated signal provided by the DDEC system.
RES/ACCEL	Resume/Accelerate Switch used for cruise control.
SEL	† Stop Engine Light: Typically mounted on the instrument panel. It has two functions:1.It is used as warning to the operator that a potential engine damaging condition has been detected. If the DDEC system is programmed for shutdown, the engine will shutdown on its own within 30 seconds. The engine should not be run until the condition is corrected.2.It is used by the operator or technician to "flash" out active trouble codes.
SEO	Stop Engine Override: Allows the stop engine condition to be overridden in case it is required.
SET/COAST	Set/Coast Switch: Used in cruise control.
SRS	Synchronous Reference Sensor: Indicates a specific cylinder in the firing order.
TBS	Turbocharger Boost Sensor: Monitors turbo boost.
TBD	To be determined.
TD	Tachometer Driver: An output from the ECM for electronic tachometers and or data loggers.
TPS	Throttle Position Sensor: Used to detect throttle request (a component of the EFPA). Also, referred to as LSG.
TRS	Timing Reference Sensor: Used to detect whenever any cylinder is about to be fired.
VIH	Vehicle Interface Harness (OEM Wiring)
VIN	Vehicle Identification Number
VSG	Variable Speed Governor. Also, referred to as PTO (Power Take-Off).
VSS	Vehicle Speed Sensor: Used to detect vehicle speed.
VSS OC	Vehicle Speed Sensor Open Collector: An ECM input which must be used in addition to the VSS positive input when certain types of vehicle speed sensors are used. Refer to the Application and Installation manual for installation.

* As a light bulb check and system check, the check engine light will come on for about 5 seconds when the ignition is turned on. If the CEL remains on, or comes back on, the self diagnostic system has detected a problem. If the problem goes away, the light will go out, but a trouble code will be stored in the ECM as an inactive code.

† As a light bulb check and system check, the stop engine light will come on for about 5 seconds when the ignition is turned on.

Table 4-1 Abbreviations and Terms

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5 (CHG) FLASH CODES VS SAE CODES

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5.1 READING THE DIAGNOSTIC CODES - FLASH METHOD

The following steps describe the flash method to interpret diagnostic codes:

NOTE:
If you are here to begin diagnosis of a problem and already know how to read codes, as well as understand active and inactive codes, refer to section 9.1.

1. Active versus Inactive codes:
   [a] Active codes are the codes which are currently keeping the "Check or Stop Engine" light on. Active codes are flashed via the Stop Engine Light (SEL).
   [b] Inactive codes are all the codes previously logged in the ECM. These codes can be cleared by using the DDR. Inactive codes are flashed via the Check Engine Light (CEL).

NOTE:
The Diagnostic Request Switch reads codes on the CEL and SEL when an DDR is not available. The following steps will enable you to obtain codes.

2. Turn vehicle ignition switch ON.
3. Depress and hold the diagnostic request switch.
   [a] As an example, observe Code 13 (active) and Code 21 (inactive) flashing out on the CEL and SEL; see Figure 5-1.
   [b] If input used is SEO/Diagnostic Request, press and release the switch.

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[c] If input used is Diagnostic Request, press and hold switch.

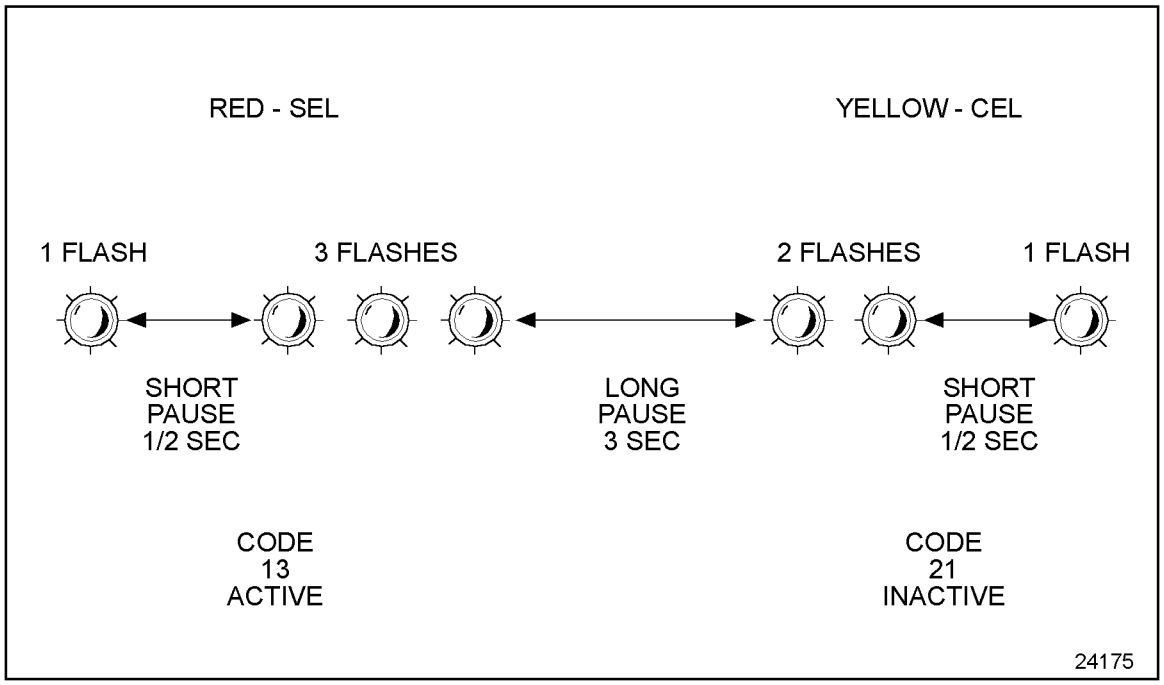

Figure 5-1 Flash Code Method

5.1.1 Clearing Codes

Fault codes can only be cleared using the DDR.

NOTE:
Removing the battery cables will not clear codes.

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5.2 READING CODES

For instructions for using the DDR or Pro-Link 9000 ®, (see Figure 5-2), refer to the Pro-Link Users Manual. For a list of Flash Codes and SAE Fault Codes, refer to section 5.3. Refer to flowchart.

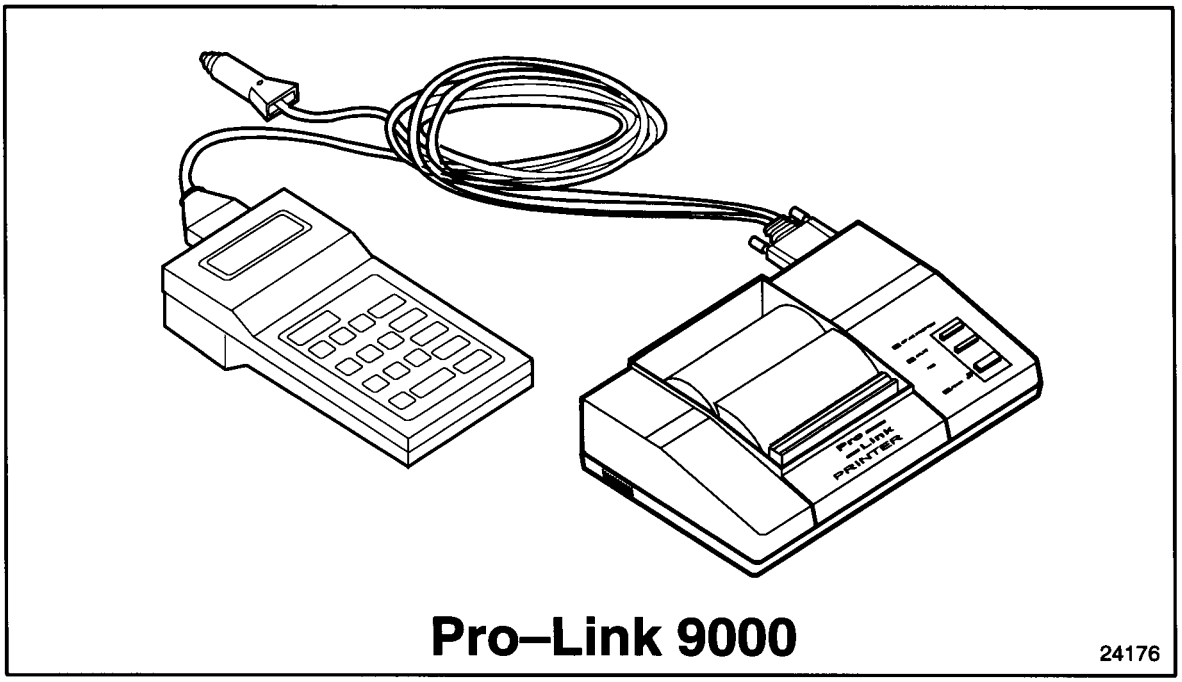

Figure 5-2 Pro-Link 9000

NOTE:
Active codes are flashed in ascending numerical flash code order. Inactive codes are flashed in most recent to least recent order.

5.3 DDEC DESCRIPTIONS

To read codes, use the diagnostic data reader or depress and hold the diagnostic request switch with the ignition ON, engine at idle or not running. Active codes will be flashed on the SEL. Inactive codes will be flashed on the CEL. The cycle will repeat until the operator releases the diagnostic request switch. Flash codes and descriptions are listed in Table 5-1.

Flash Codes	DDEC Description
11	VSG sensor input voltage low
12	VSG sensor input voltage high
13	Coolant level sensor input voltage low
14	Oil, coolant, or intercooler, temperature sensor input voltage high
15	Oil, coolant, or intercooler, temperature sensor input voltage low
16	Coolant level sensor input voltage high
17	Bypass or throttle, valve position sensor input voltage high
18	Bypass or throttle, valve position sensor input voltage low
21	TPS input voltage high
22	TPS input voltage low
23	Fuel temperature sensor input voltage high
24	Fuel temperature sensor input voltage low
25	No active codes
26	Auxiliary shutdown #1, or #2, input active
27	Air inlet or intake air, temperature sensor input voltage high
28	Air inlet or intake air, temperature sensor input voltage low
31	Auxiliary high side output open circuit or short to ground
32	CEL or SEL short to battery (+) or open circuit
33	Turbo boost sensor input voltage high
34	Turbo boost sensor input voltage low
35	Oil pressure sensor input voltage high
36	Oil pressure sensor input voltage low
37	Fuel pressure sensor input voltage high
38	Fuel pressure sensor input voltage low
41	Too many SRS (missing TRS)
42	Too many SRS (missing SRS)
43	Coolant level low
44	Oil, coolant, intercooler or intake air, temperature high
45	Oil pressure low

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Flash Codes	DDEC Description
46	ECM battery voltage low
47	Fuel, air inlet, or turbo boost, pressure high
48	Fuel or air inlet pressure low
52	ECM A/D conversion fault
53	ECM non volatile memory fault
54	Vehicle speed sensor fault
55	J1939 data link fault
56	J1587 data link fault
57	J1922 data link fault
58	Torque overload
61	Injector response time long
62	Auxiliary output short to battery (+) or open circuit, or mechanical fault
63	PWM drive short to battery (+) or open circuit
64	Turbo speed sensor input fault
65	Throttle valve position input fault
66	Engine knock sensor input fault
67	Coolant or air inlet, pressure sensor input voltage fault
68	TPS idle validation switch open circuit or short to ground
71	Injector response time short
72	Vehicle overspeed
73	Gas valve position input fault or ESS fault
74	Optimized idle safety loop short to ground
75	ECM battery voltage high
76	Engine overspeed with engine brake
77	Fuel temperature high
81	Oil level, crankcase pressure, dual fuel BOI, or exhaust temperature voltage high
82	Oil level, crankcase pressure, dual fuel BOI, or exhaust temperature voltage low
83	Oil level, crankcase pressure, exhaust temperature, or external pump pressure high
84	Oil level or crankcase pressure low
85	Engine overspeed
86	External pump or barometer pressure sensor input voltage high

Flash Codes	DDEC Description
87	External pump or barometer pressure sensor input voltage low
88	Coolant pressure low

Table 5-1 Flash Codes and Description

SAE faults and flash codes with descriptions are listed in Table 5-2.

SAE Faults	Flash Code	DDEC Description
p051 0	65	Throttle valve position above normal range
p051 1	65	Throttle valve position below normal range
p051 3	17	Throttle valve input voltage high
p051 4	18	Throttle valve input voltage low
p051 7	65	Throttle valve not responding
p052 0	44	Intercooler temperature high
p052 3	14	Intercooler sensor input voltage high
p052 4	15	Intercooler sensor input voltage low
p070 4	74	Optimized idle safety loop short to ground
p072 3	17	Bypass position sensor input voltage high
p072 4	18	Bypass position sensor input voltage low
p073 0	83	External pump pressure high
p073 3	86	Pump pressure sensor input voltage high
p073 4	87	Pump pressure sensor input voltage low
p084 0	72	Vehicle overspeed (fueled)
p084 11	72	Vehicle overspeed (absolute)
p084 12	54	Vehicle speed sensor failure
p091 3	21	Throttle position sensor input voltage high
p091 4	22	Throttle position sensor input voltage low
p092 0	58	Torque overload
p094 0	47	Fuel pressure high
p094 1	48	Fuel pressure low

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SAE Faults	Flash Code	DDEC Description
p094 3	37	Fuel pressure sensor input voltage high
p094 4	38	Fuel pressure sensor input voltage low
p098 0	83	Oil level high
p098 1	84	Oil level low
p098 3	81	Oil level sensor input voltage high
p098 4	82	Oil level sensor input voltage low
p100 1	45	Oil pressure low
p100 3	35	Oil pressure sensor input voltage high
p100 4	36	Oil pressure sensor input voltage low
p101 0	83	Crankcase pressure high
p101 1	84	Crankcase pressure low
p101 3	81	Crankcase pressure sensor input voltage high
p101 4	82	Crankcase pressure sensor input voltage low
p102 0	47	Turbo boost pressure high
p102 3	33	Turbo boost pressure sensor input voltage high
p102 4	34	Turbo boost pressure sensor input voltage low
p103 8	64	Turbo speed sensor input failure
p105 0	44	Intake air temperature high
p105 3	27	Intake air temperature sensor input voltage high
p105 4	28	Intake air temperature sensor input voltage low
p106 0	47	Air inlet pressure high
p106 1	48	Air inlet pressure low
p106 3	67	Air inlet pressure sensor input voltage high
p106 4	67	Air inlet pressure sensor input voltage low
p108 3	86	Barometer pressure sensor input voltage high
p108 4	87	Barometer pressure sensor input voltage low
p109 1	88	Coolant pressure low

SAE Faults	Flash Code	DDEC Description
p109 3	67	Coolant pressure sensor input voltage high
p109 4	67	Coolant pressure sensor input voltage low
p110 0	44	Coolant temperature high
p110 3	14	Coolant temperature sensor input voltage high
p110 4	15	Coolant temperature sensor input voltage low
p111 1	43	Coolant level low
p111 3	16	Coolant level sensor input voltage high
p111 4	13	Coolant level sensor input voltage low
p121 0	76	Engine overspeed with engine brake
p168 0	75	ECM battery voltage high
p168 1	46	ECM battery voltage low
p172 3	27	Air temperature sensor input voltage high
p172 4	28	Air temperature sensor input voltage low
p173 0	83	Exhaust temperature high
p173 3	83	Exhaust temperature sensor input voltage high
p173 4	83	Exhaust temperature sensor input voltage low
p174 0	77	Fuel temperature high
p174 3	23	Fuel temperature sensor input voltage high
p174 4	24	Fuel temperature sensor input voltage low
p175 0	44	Oil temperature high
p175 3	14	Oil temperature sensor input voltage high
p175 4	15	Oil temperature sensor input voltage low
p187 3	12	VSG sensor input voltage high
p187 4	11	VSG sensor input voltage low
p187 7	11	VSG switch system not responding
p190 0	85	Engine overspeed
p251 10	-	Clock module abnormal rate

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SAE Faults	Flash Code	DDEC Description
p251 13	-	Clock module fault
s001 0	61	Injector #1 response time long
s001 1	71	Injector #1 response time short
s002 0	61	Injector #2 response time long
s002 1	71	Injector #2 response time short
s003 0	61	Injector #3 response time long
s003 1	71	Injector #3 response time short
d004 0	61	Injector #4 response time long
s004 1	71	Injector #4 response time short
s005 0	61	Injector #5 response time long
s005 1	71	Injector #5 response time short
s006 0	61	Injector #6 response time long
s006 1	71	Injector #6 response time short
d007 0	61	Injector #7 response time long
s007 1	71	Injector #7 response time short
s008 0	61	Injector #8 response time long
s008 1	71	Injector #8 response time short
s009 0	61	Injector #9 response time long
s009 1	71	Injector #9 response time short
s010 0	61	Injector #10 response time long
s010 1	71	Injector #10 response time short
s011 0	61	Injector #11 response time long
s011 1	71	Injector #11 response time short
s012 0	61	Injector #12 response time long
s012 1	71	Injector #12 response time short
s013 0	61	Injector #13 response time long
s013 1	71	Injector #13 response time short
s014 0	61	Injector #14 response time long
s014 1	71	Injector #14 response time short
s015 0	61	Injector #15 response time long
s015 1	71	Injector #15 response time short
s016 0	61	Injector #16 response time long
s016 1	71	Injector #16 response time short
s020 3	81	Dual fuel BOI input voltage high
s020 4	82	Dual fuel BOI input voltage low
s021 0	41	Too many SRS (missing TRS)

SAE Faults	Flash Code	DDEC Description
s021 1	42	Too few SRS (missing SRS)
s025 11	26	Auxiliary engine shutdown #1 input active
s026 3	62	Auxiliary output #1 short to battery (+)
s026 4	62	Auxiliary output #1 open circuit
s026 7	62	Auxiliary output #1 mechanical system not responding properly
s040 3	62	Auxiliary output #2 short to battery (+)
s040 4	62	Auxiliary output #2 open circuit
s 040 7	62	Auxiliary output #2 mechanical system not responding properly
s047 0	61	Injector #17 response time long
s047 1	71	Injector #17 response time short
s048 0	61	Injector #18 response time long
s048 1	71	Injector #18 response time short
s049 0	61	Injector #19 response time long
s049 1	71	Injector #19 response time short
s050 0	61	Injector #20 response time long
s050 1	71	Injector #20 response time short
s051 3	31	Auxiliary output #3 open circuit
s051 4	31	Auxiliary output #3 short to ground
s052 3	31	Auxiliary output #4 open circuit
s052 4	31	Auxiliary output #4 short to ground
s053 3	62	Auxiliary output #5 short to battery (+)
s053 4	62	Auxiliary output #5 open circuit
s053 7	62	Auxiliary output #5 mechanical system not responding properly
s054 3	62	Auxiliary output #6 short to battery (+)
s054 4	62	Auxiliary output #6 open circuit
s054 7	62	Auxiliary output #6 mechanical system not responding properly
s055 3	62	Auxiliary output #7 short to battery (+)
s055 4	62	Auxiliary output #7 open circuit
s055 7	62	Auxiliary output #7 mechanical system not responding properly
s056 3	62	Auxiliary output #8 short to battery (+)
s056 4	62	Auxiliary output #8 open circuit
s056 7	62	Auxiliary output #8 mechanical system not responding properly

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SAE Faults	Flash Code	DDEC Description
s057 3	63	PWM driver #1 short to battery (+)
s057 4	63	PWM driver #1 open circuit
s058 3	63	PWM driver #2 short to battery (+)
s058 4	63	PWM driver #2 open circuit
s059 3	63	PWM driver #3 short to battery (+)
s059 4	63	PWM driver #3 open circuit
s060 3	63	PWM driver #4 short to battery (+)
s060 4	63	PWM driver #4 open circuit
s061 11	26	Auxiliary engine shutdown #2 input active
s072 0	61	#21 injector response time long
s072 1	71	#21 injector response time short
s073 0	61	#22 injector response time long
s073 1	71	#22 injector response time short
s074 0	61	#23 injector response time long
s074 1	71	#23 injector response time short
s075 0	61	#24 injector response time long
s075 1	71	#24 injector response time short
s076 0	66	Engine knock level above normal range
s076 3	66	Engine knock sensor input voltage high
s076 4	66	Engine knock sensor input voltage low
s076 7	66	Engine knock sensor torque reduction
s077 0	73	Gas valve position above normal range
s077 1	73	Gas valve position below normal range
s077 3	73	Gas valve position input voltage high
s077 4	73	Gas valve position input voltage low
s151 14	73	System Diagnostic Code #1 (ESS)
s226 11	73	Transmission Neutral Switch (ESS)
s227 4	73	Auxiliary analog input #1 voltage low (ESS)
s227 3	73	Auxiliary analog input #1 voltage high (ESS)
s227 2	73	Auxiliary analog input #1 data erratic, intermittent or incorrect (ESS)

SAE Faults	Flash Code	DDEC Description
s230 5	68	TPS idle validation switch open circuit
s230 6	68	TPS idle validation switch short to ground
s231 12	55	J1939 data link fault
s238 3	32	SEL short to battery (+)
s238 4	32	SEL open circuit
s239 3	32	CEL short to battery (+)
s239 4	32	CEL open circuit
s240 2	-	Fram checksum incorrect
s248 8	55	Proprietary data link fault (master)
s248 9	55	Proprietary data link fault (slave)
s249 12	57	J1922 data link fault
s250 12	56	J1587 data link fault
s253 2	53	Non volatile memory data incorrect
s253 12	53	Non volatile memory fault
s253 13	-	Incompatible calibration version
s254 0	-	External failed RAM
s254 1	-	Internal failed RAM
s254 6	-	Entered boot via switches
s254 12	52	ECM A/D conversion fail

Table 5-2 SAE Faults and Flash Codes

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6 (CHG) TESTING / SERVICE TOOLS / TIPS

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6.1 BASICS

CHANGES NEEDED. The following listed items should be checked prior to starting any troubleshooting:

- ☐ Ensure engine serial number on the ECM matches the serial number on the cylinder block.
- ☐ Walk around the vehicle. Look for obvious problems such as leaks (air or liquid).
- ☐ Inspect ECM for worn isolators, debris or bolts lodged between ECM and cylinder block.
- ☐ Broken wiring connectors.
- ☐ Fuel Supply - Full on.
- ☐ Fuel tank level.
- ☐ Vehicle damage.
- ☐ Investigate into any prior repairs, if applicable.
- ☐ Check for poor mating of the connector halves or terminals not fully seated in the connector body (backed out terminals).
- ☐ Look for improperly formed or damaged terminals. All connector terminals in the problem circuit should be carefully inspected to determine proper contact tension. Use a mating terminal to test the contact tension.
- ☐ Electrical system interference caused by a defective relay, ECM driven solenoid, or a switch causing an electrical surge. Look for problems with the charging system (alternator, etc.). In certain cases, the problem can be made to occur when the faulty component is operated as in the case of a relay.
- ☐ Verify alternator grounds are clean and making good contact. Disconnect the alternator belt to test.
- ☐ Wiggle wires and harnesses to try to make the problem active, or re-occur.

6.1.1 ECM Programming

The following label is attached to the ECM. See Figure 6-1.

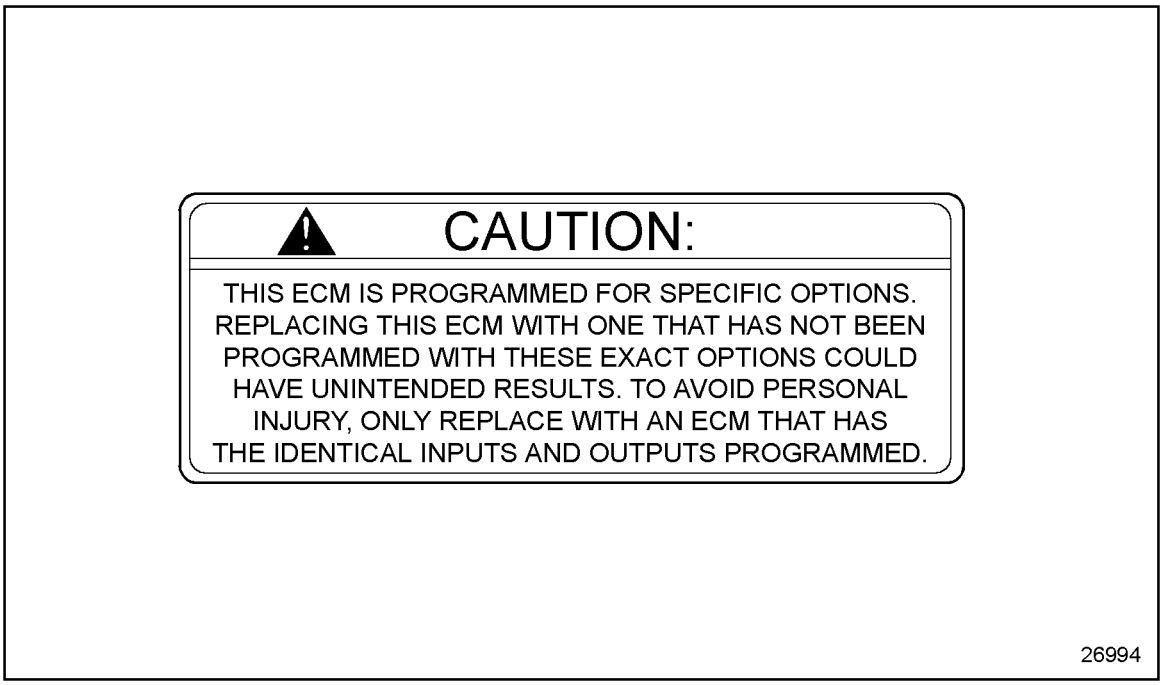

Figure 6-1 ECM Label

- ☐ Every DDEC system engine serial number has its own file in the DDC Mainframe.

NOTICE:
Failure to match the serial number on the engine with the ECM programming may result in incorrect calibration results and engine damage.

- ☐ ECM programming must be done to match the serial number you are currently working on. Failure to do so may result in incorrect calibration and engine damage.
- ☐ Programming a DDEC III ECM must be done with an engine file set up for the DDEC III system.
- ☐ Programming a DDEC IV ECM must be done with an engine file set up for the DDEC IV system.
- ☐ For a summary of features and how to change them, refer to section 7.

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6.2 OPERATOR INFORMATION

This section should serve as a guideline for the technician:

- ☐ Intermittent Problems - Talk to the operator/driver. Be specific!
- ☐ Develop your own Driver Questionnaire. Refer to section 6.2.1.

6.2.1 Driver Questionnaire

Ask the driver to answer the following questions before attempting to repair an intermittent problem, or a problem with symptoms but no diagnostic codes. Use this and the response guideline to these questions.

1. How often does the problem occur? Can you and the driver take the vehicle and demonstrate the problem in a short time?
2. Has the vehicle been to other shops for the same problem? If so, what was done there?
3. Did the radio, dash gages, or lights momentarily turn OFF when the problem occurred?
4. Does the problem occur only at specific operating conditions? If so, at what load? Is it light, medium, or heavy?
5. Does the problem occur at a specific engine operating temperature? If so, at what engine temperature?
6. Does the problem occur only when above or below specific outside temperatures? In what temperature range?
7. Does the problem occur during other conditions e.g. during or after rain, spray washing, snow?
8. Did the problem occur at a specific vehicle speed? If so, at what vehicle speed?
9. Does the problem occur at specific engine r/min? If so, at what engine r/min?

6.2.2 Questionnaire Response Guideline

The following are typical responses to the Driver Questionnaire:

1. If the problem is repeatable, take the vehicle for a drive with the DDR connected and note the conditions when the problem occurs. Be prepared to take snapshot data using the DDR. Ensure you operate the vehicle after correcting the problem and duplicate the operating conditions before releasing the unit, to verify the problem is corrected.
2. If the vehicle has been to other shops for the same problem, call the other shops and find out what has been done. Avoid replacing the same components again unless absolutely sure they are the problem! It is unlikely a component will fail again following a recent replacement.
3. If other vehicle devices are affected, this indicates there may be something wrong with the ignition wiring. Refer to section 91.2 for information on inspecting the ECM battery connections.

4. Operate the engine under similar load conditions. Check the fuel system for restrictions, primary filter, and fuel tanks for foreign objects blocking the fuel supply. Also, check the air system. Utilize the DDR snapshot feature.
5. Operate the engine at this temperature while attempting to duplicate the problem. Use the snapshot feature on the DDR.
6. If possible, troubleshoot the problem in this temperature range.
7. If the problem seems to occur during or after the engine is subjected to rain/spray washing, thoroughly inspect the connectors for moisture entry.
8. If the problem occurs at a specific vehicle speed, check the parameters affecting vehicle speed to verify they are programmed close to the vehicle speed where the problem occurs. Check Vehicle Speed and watch the DDR (snapshot) for changes to see if the pulse wheel (VSS signal) is loose.
9. If the problem occurs at a specific engine r/min, unplug the oil, coolant, and air temperature sensors, and note any changes to the problem. Gather this data and contact Detroit Diesel Technical Service.

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6.3 SERVICE TOOLS

Listed in Table 6-1 are the service tools required to perform troubleshooting procedures for the DDEC-equipped engine.

Tool Number	Tool Name
J 39299	Volt-Ohm Meter; see Figure 6-2.
J 38500	Pro-Link ® Diagnostic Data Reader; see Figure 6-3.
J 41005	DDEC III Vehicle Interface Module; see Figure 6-4.
J 38480	Pro-Link Printer; see Figure 6-5.
J 38852 or J 39848	Crimping Tools; see Figure 6-6
23516937	Digital Diesel Sensor Simulator; see Figure 6-7 (Optional Tool)
J 35751	Jumper Wire Kit

Table 6-1 Service Tools

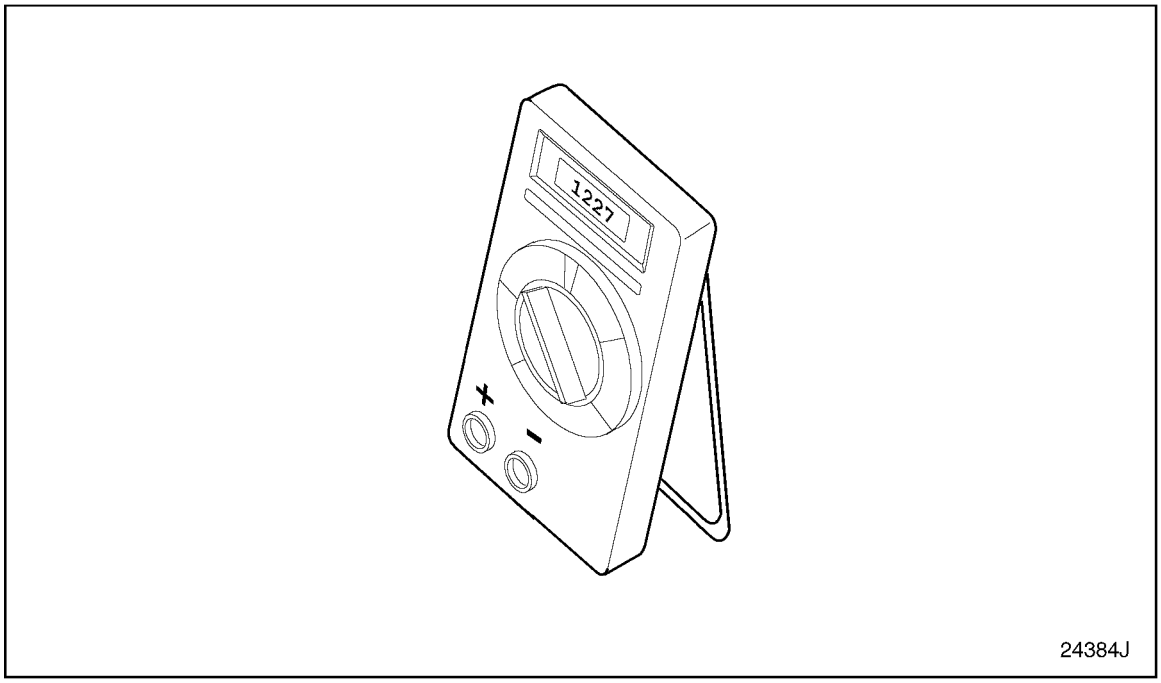

Figure 6-2 Volt-Ohm Meter, J 39299

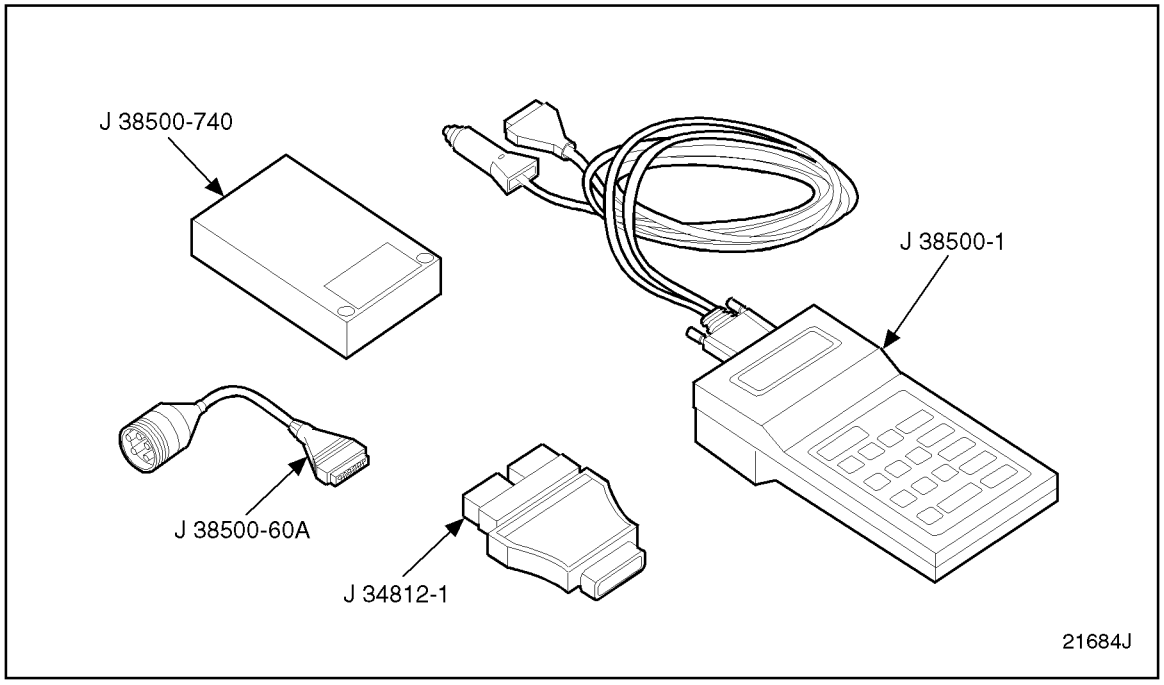

Figure 6-3 Pro-Link Diagnostic Data Reader, J 38500

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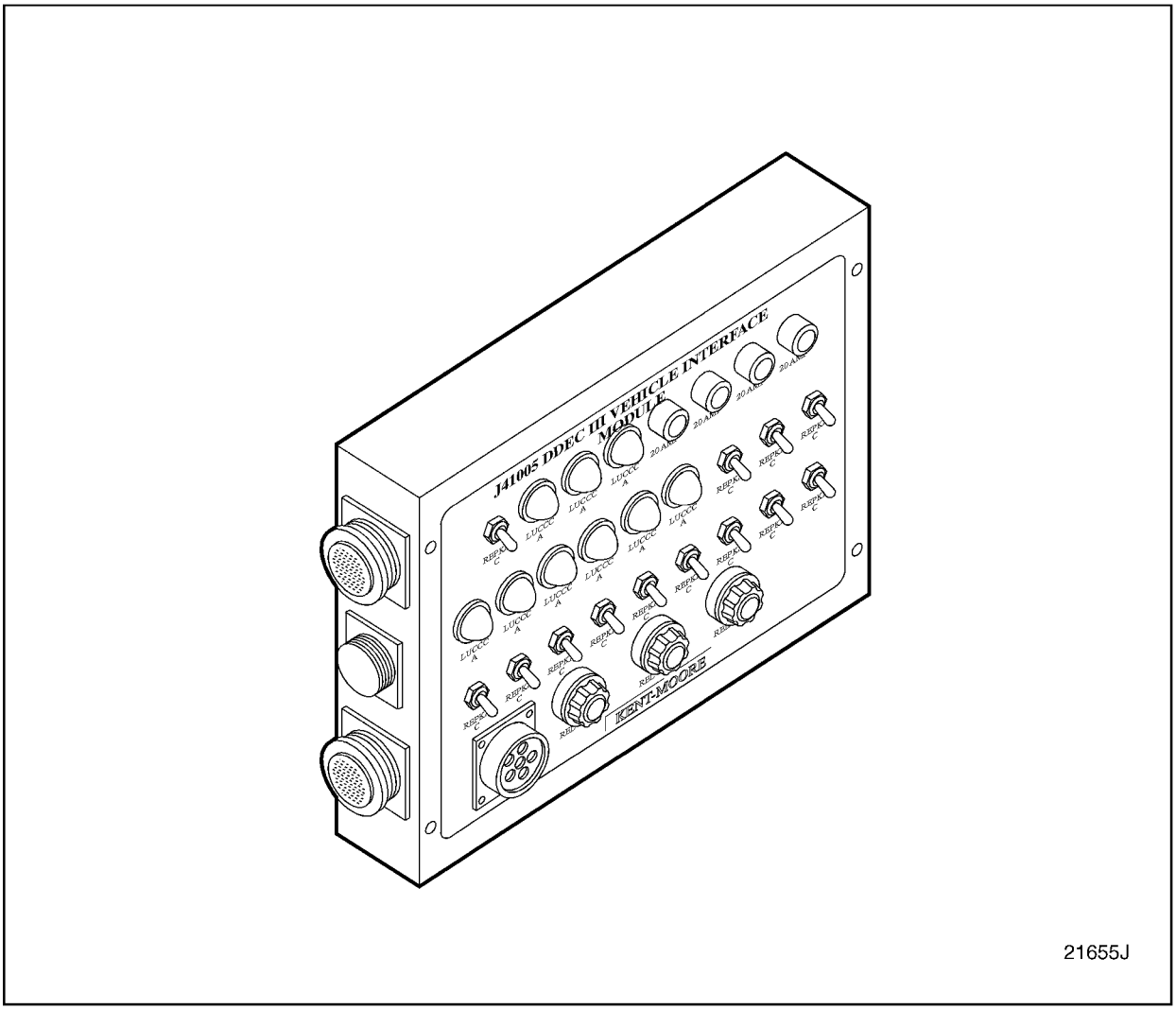

Figure 6-4 **DDEC III Vehicle Interface Module, J 41005 (Will Operate DDEC IV Also)**

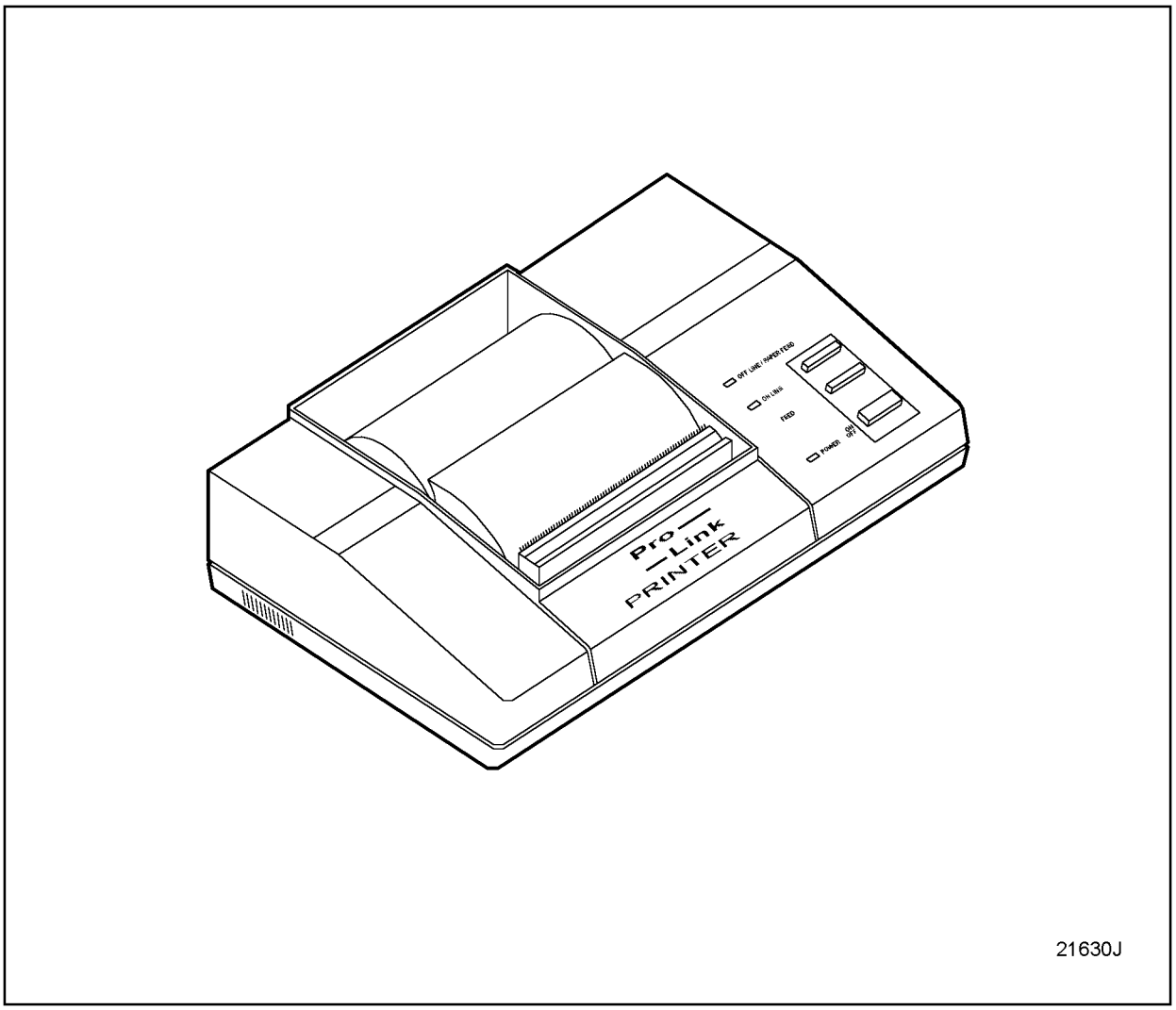

Figure 6-5 Pro-Link 9000 Printer, J 38480

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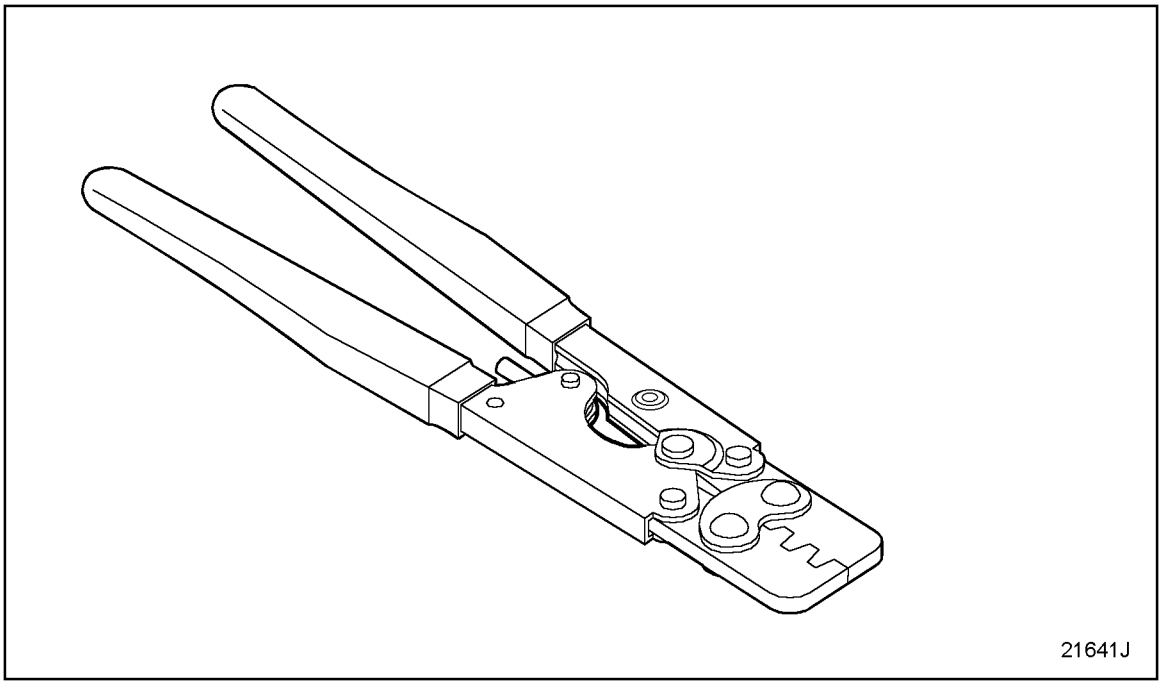

Figure 6-6 Crimping Tool, J 38852 or J 39848

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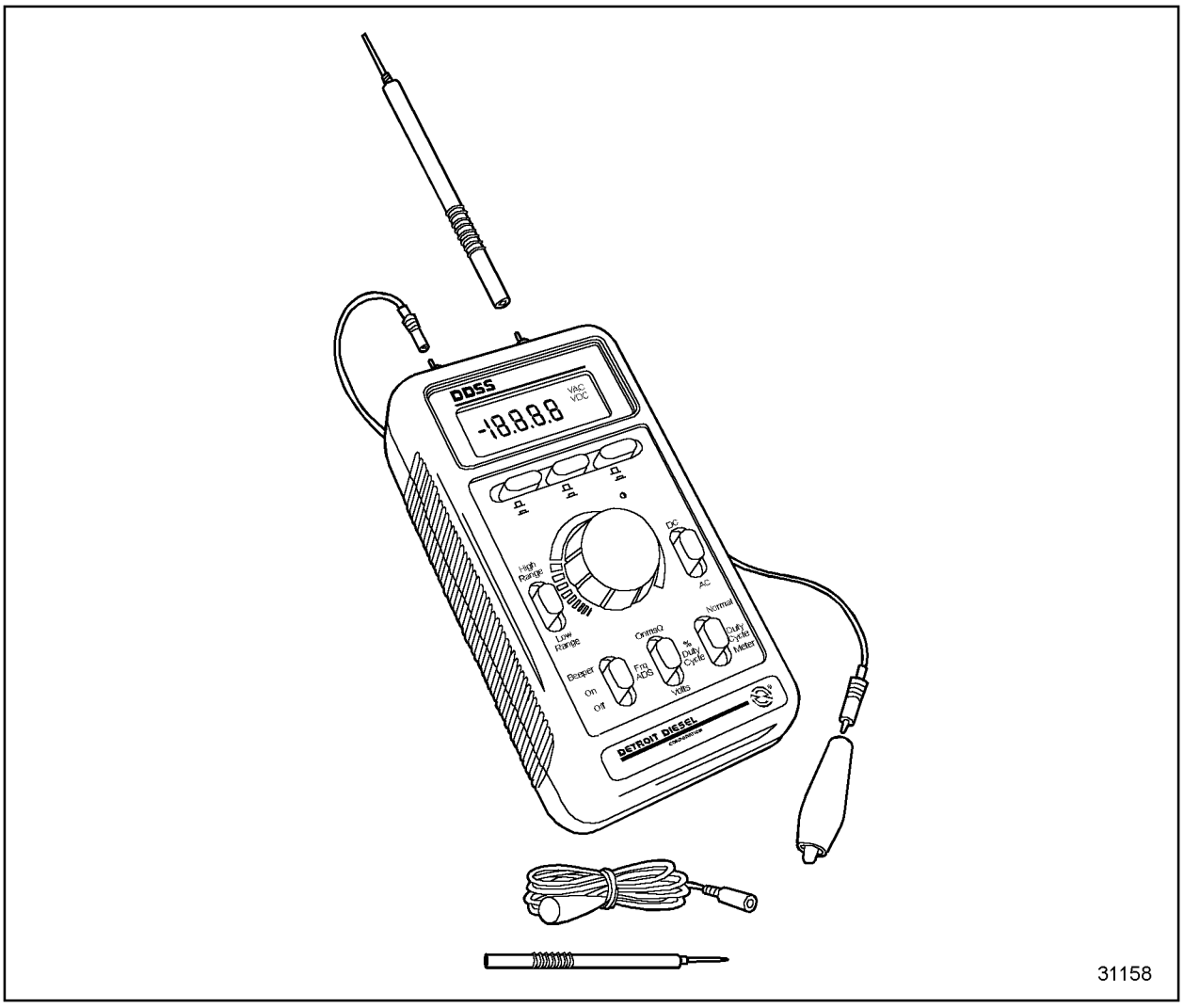

Figure 6-7 Digital Diesel Sensor Stimulator, P/N: 23516937

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7 (CHG) DDEC ECM SOFTWARE FEATURES

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7.1 DDEC ECM SOFTWARE FEATURES

This section is a brief description of DDEC system ECM software features and what is required to activate the feature (DDR, PC, etc.).

NOTE:
For a complete description of features, refer to publication 7SA800, *DDEC III Application and Installation* manual.

7.1.1 Air Compressor Governor System

The air compressor governor system can be set on the mainframe only. This system is similar to the pressure governor system, but for air compressor applications. 6N4C change adjusts the engine speed to compensate for air pressure loads. ECM Software 4.01 is required.

7.1.2 Cruise Control

Cruise control can be set with the DDR or programming station.

- Auto Resume
  - Yes or No. Will re-engage cruise if clutch switch is used to disable. Second press of clutch must be done within 3 seconds of the disengage and cruise will resume at the previously set speed.
- Minimum Cruise Speed
  - Can be set with the DDR or programming station. Normally 20 mph, newer ECM software may allow setting to as low as 10 mph.
- Maximum Cruise Speed
  - Can be set with the DDR or programming station. Limited to the calculated gear bound vehicle speed at rated engine r/min, or if progressive shift = yes, then max cruise speed is limited to high gear r/min. Also limited to vehicle speed limit (if set).
- Engine Brake Cruise
  - Can be set with the DDR or programming station. Refer to engine brake information. Refer to section 7.1.5.

7.1.3 Cruise Switch Variable Speed Governor

The cruise switch can be set with the DDR or programming station. Requires Vehicle Speed Sensor (VSS) set to Yes.

- Initial r/min= 1000 r/min default, initial r/min to ramp up to when set.
- R/min incr= 25 r/min default, r/min increase when res/accl switch is enabled.

7.1.4 Data Pages

Enable data pages on the mainframe (up to 7.00 ECM software). This is automatic with ECM software level 20.xx or higher.

7.1.5 Engine Brake (Jake Brake)

Enabling the engine brake is done on the mainframe. Once turned on, output cavities S3 and T3 are automatically configured to provide voltage to the brake solenoids when the ECM calibrated parameters are met allowing activation.

Also requires two inputs, engine brake low and engine brake med.

Several options are available (programming station or DDR set) relative to engine brake operations:

- Dynamic Fan Braking
  - Enables the cooling fan whenever the engine brake is in high mode. This feature is able to be configured with the programming station or DDR. (DDR software level 2.0 or higher.)
- Engine Brake / Service Brake
  - This feature forces the operator to, in addition to the normal requirements, press the service brake in order to initiate the engine brake(s). Can be set with the DDR or programming station.
- Engine Brake Minimum MPH
  - This feature allows the customer to set a minimum mph to allow the engine brake to activate. Can be set with the DDR or programming station.
- Engine Brake Cruise
  - Allows engine brakes to activate to programmed levels automatically based on vehicle speed increases. Initial speed is low. The speed of the increments is medium, then high. Level (high, med, low) is limited by dash position switch.
  - Can be set with the DDR or programming station.

7.1.6 Engine Protection Features

Engine protection features can be set with the DDR or programming station. Three features are available:

- Shutdown
- Rampdown
- Warning

7.1.7 Engine Synchro Shift

Engine Synchro Shift ™ (ESS) can be set with the programming station. ESS is a joint development between DDC and Rockwell.

The ESS system automatically synchronizes the transmission by matching the engine r/min speed to the road speed of the vehicle, eliminating the need to use the clutch pedal for shifting gears. Refer to publication number 6SE498, *Engine Synchro Shift (ESS) Troubleshooting Manual* .

Requires an ESS transmission type, two inputs (in gear and in neutral), and two outputs (high range solenoid and low range solenoid).

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7.1.8 Ether Start

Ether start can be set with the programming station only. Requires ECM software level to be greater than 3.00, and enable output for Ether Start. Refer to *Ether Start* manual, 7SA727.

7.1.9 Fan Controls

Fan type is set in the mainframe; None; Single; Dual; Two Speed; are the allowed types. The correct inputs (if any are needed or desired) and outputs must be configured to an available cavity with the programming station.

- Required Outputs: Configure to any output cavity
  - Fan control #1 for Single
  - Fan control #1 and Fan control #2 for Dual or Two-Speed types
- Inputs are optional: Configure to any input cavity with the programming station
  - Auxiliary Fan Control
  - Fan Override

7.1.10 Fuel Economy Incentive

Fuel Economy Incentive (FEI) can be set with the DDR or programming station.

FEI is a DDEC feature that allows vehicle owners to set driver goals of fuel economy while offering the driver an incentive which is a result of his/her good driving habits. The FEI will automatically allow a higher vehicle speed (speed increase is dependent on the customer selected settings) than is set in the road speed limiting area of the ECM. FEI was released with ECM software level 5.00.

There are four items relative to FEI:

- Minimum MPG (MIN MPG)
  - This would be defined as the customer's minimum fuel economy goal. Any fuel economy obtained by the driver greater than this figure would result in a allowed speed increase. Each increase of 0.1 mpg will provide the speed increase dictated by the Conversion factor (or Scaler MPH/MPG).
- Maximum MPH (MAX MPH)
  - This would be the absolute maximum speed increase to which the customer wants the vehicle limited. The value is an increase above the vehicle speed limit. The allowed values are 0 to 20. A value of 0 disables the FEI feature. A value of 1 to 20 enables the FEI feature.
- Conversion Factor (Scaler MPH/MPG)
  - The miles per hour you want to allow for each full mile per gallon above the minimum mpg. Example: a value of 10 will allow the driver to go 10 mph above the road speed limit for each full (1) mile per gallon above the minimum mpg. If the minimum mpg is 7.0, and the driver is getting 7.1 mpg, then the system will allow one additional mile per hour increase, etc. The unit will still be limited to the maximum MPH.
- Calculation Type (CALC TYPE)

- Two choices can be found under this item; FILTERED, or TRIP. This is what you want the FEI to use to base its calculations. Filtered bases the calculations on the fuel information, by periodic sampling of fuel consumption, recorded in the ECM. Trip bases the calculations on the *trip* portion of the fuel usage information.

FEI is only able to be set by the customer or service outlet and only with the DDR or programming station. Requires MPSI DDR version 5.0 or higher.

7.1.11 Fuel Pressure Sensor

Fuel pressure sensing is currently only configured for some industrial engines. It is not available on all series. The fuel pressure sensor used is the same as the oil pressure sensor.

7.1.12 Full Power Continuous Override

Full Power Continuous Override allows the operator to override the shutdown protection and maintain full power rather than ramp down to a reduced performance. This is set on the mainframe.

7.1.13 Function Lockout

Function Lockout was added to the release of 4.00 ECM and DDR software.

The purpose of this new option is to allow users to have a selected area or areas of the customer parameters password protected. For example, a customer can now function lockout the cruise control parameters with a user entered password, and still have the other areas accessible with the DDR with no (four zeros) password.

The function lockout parameters are able to be selected and customized to the customers request. The areas that are able to be protected by function lockout are:

- Idle Shutdown
- VSG Configuration
- Engine Protection
- Cruise Control
- Progressive Shift
- Engine Droop
- Engine/Vehicle Options
- Air Compressor
- ESS Transmission

When making changes with the DDR under the Reprogram Calibration section, you will already have entered a password to get past this step. If any of the functions in the selection list are function lockout protected, the DDR will ask for the function lockout password after that selection is made.

7.1.14 Half Engine Enable

Half engine enable can be set with the DDR for ECMs with 7.00 ECM software or higher. A current DDR is required. Half engine options are:

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- ☐ No half engine - (OFF)
- ☐ Half engine when cold air inlet temperature is less than 12.5°C (55°F), with parking brake set - (IF COLD)
- ☐ Half engine all the time, whenever park brake is set - (ON)
- ☐ N/A is displayed when changing half engine with the DDR or laptop is not allowed in the engine calibration. The engine may have half engine program as part of that engine calibration. View "Diagnostic Data List" to see if the engine is currently operating in half engine mode.

7.1.15 Idle Shutdown

Idle shutdown can be set with the DDR or programming station.

- ☐ Enabled: Yes/No
- ☐ Time: 01 - 99 minutes
- ☐ Enabled on VSG: Yes/No; this determines if you want the idle timer to shut the engine down during idle only
  - ☐ No
  - ☐ Yes (Idle and High Idle)
- ☐ Override:
  - ☐ Yes/No, will flash the CEL 90 seconds before shutdown to allow the driver to press the pedal that will cancel the idle shutdown, and run until the key is cycled or by pressing the pedal again.
  - ☐ Ambient Air Temp disallows override: Can be set with the DDR or programming station. (Override Temp Disable) Lower Limit = XX; Upper Limit =XX. (When upper and lower limits are set, the operator will only be able to override ISD if the calculated ambient air temperature is above or below these temperatures. Upper and lower limit both set to 167°F=disables the feature.
- ☐ Adding Ambient Temp Sensor: DDC offers an *actual* ambient temperature sensor.

NOTE:
If the override temperature disable function is wanted by a customer, it is recommended that this be added (Kit P/N: 23518521, with instructions 18SP397).

7.1.16 Idle Speed

Idle speed can be set on the mainframe for some industrial applications to a maximum of 1000 r/min. It is a fixed speed for on-highway engines.

7.1.17 Idle Speed Offset

The Idle Speed Offset is read by the DDR as Idle Adjust.

Idle speed offset can be adjusted from + 100 r/min, to - 25 r/min using the DDR. Maximum combined speed for automatic transmission applications is 700 r/min. (Some special applications allow 750 r/min.)

7.1.18 Injector Calibration Codes

Injector calibration codes can be set with the DDR or programming station only. Codes are password protected. Allowed range is 01 - 99.

7.1.19 Input Functions

DDEC has twelve digital input ports listed in Table 7-1, located on the Vehicle Interface Harness. These digital inputs can be configured for various functions, listed in Table 7-2. These functions can be ordered at the time of engine order. Any digital input function is able to be customized by programming the ECM with a the programming station.

Input Cavities	Input Cavities
E1#451	G2#543
F1#542	H2#524
G1#528	J2#531
H1#523	K2#583
J1#541	G3#545
F2#544	K3#979

Table 7-1 Input Cavities

Functions	Functions	Functions
None	Limiting Torque Curve	Trans Retarder Status
Engine Brake Low	Diagnostic Request	Dual Throttle (LSG)
Engine Brake Med	Alt Min VSG/Fast Idle	A/C Fan Status
Aux Shutdown #1	Service Brake Release	Aux CLS
Aux Shutdown #2	Clutch Released	Fan Control Override
Park Brake / ISD	Set Coast OFF DDEC II	VSG Station Change
Idle Validation	Set / Coast ON	VSG Station Complement
Pressure / RPM Mode	Resume/Accel OFF DDEC II	Air Load Switch
Throttle Inhibit	Resume / Accel ON	In Neutral Switch
RPM Sync (Marine)	Cruise Enable	In Gear Switch
RPM Freeze (Marine)	PGS System Enable	KD Brake
Rating Switch #1	SEO / DIAG Request	Gas Valve Diagnostic
Rating Switch #2	Engine Brake Disable	-

Table 7-2 Available Input Functions

7.1.20 Jake Brake (See Engine Brake)

For information on the Jake Brake®, refer to section 7.1.5.

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7.1.21 Optimized Idle Feature

The Optimized Idle ® feature can be set with the mainframe. Refer to the *Optimized Idle Installation and Troubleshooting Manual* , 7SA734, for all required information.

7.1.22 Output Functions

The DDEC system has three digital output ports located on the vehicle interface harness and three digital output ports located on a pigtail off the engine sensor harness. These digital outputs can be configured for various functions. The digital output cavities are listed in Table 7-3. These functions can be ordered at the time of engine order. The digital output functions available are listed in Table 7-4. Any digital output function can be customized by programming the ECM with the programming station.

Output Cavities	Output Cavities
VIH	ESH
A1 #988	W3 #563
A2 #555	X3 #564
F3 #499	Y3 #565

Table 7-3 Output Cavities

Functions	Functions	Functions
No Function	Fan Control #2	Turbo Recirc Valve
Low DDEC Volt	Deceleration Light	Optimized Idle Active
RPM Sync Active	Engine Brake Active	Low Range Solenoid (ESS)
PGS Active Light	VSG Active Indication	High Range Solenoid (ESS)
Vehicle Power Down	Oil Pressure Low Light	Shift Solenoid (Top2)
Starter Lockout	Oil Temp High Light	Shift Lockout (Top2)
Ext Brake Enable	Coolant Temp High Light	Gas Throttle Actuator
Trans Retarder Enable	Air Comp Solenoid	Fuel Supply Solenoid
Coolant Level Low Light	Crankcase Pressure High	KD Brake Solenoid
Cruise Active Light	Coolant Pressure Low	-
Fan Control #1	Ether Start	-

Table 7-4 Available Output Functions

7.1.23 Passwords

DDEC ECMs have the ability to have unique and separate passwords in the following areas:

- ☐ Update customer calibration (calibration change)
- ☐ Rating change

- ☐ Function lockout (4.00 or higher ECM software function)
- ☐ Injector calibration (Only the DDR will change this password)

7.1.23.1 Changing Passwords Using the Diagnostic Data Reader

DDR software level **must** be 2.00 or higher.

1. In the event a customer loses or forgets his/her password, contact a Detroit Diesel Regional Office, or the Detroit Diesel Technical Service Department with the engine serial number. These contacts can provide an alternate (backdoor) password. You should also ensure that there is not any "maximum" or "rating" security enabled on the mainframe for that unit.
2. Using the DDR select the Password Change option in the area that you need to change. Password changing for Customer Password can be found in the "ENGINE" section, under "Calibration Change". Changing the password for engine rating and function lockout is found under their respective headings under the "Reprogram Cal" menu. Changing the injector password is found in the "ENGINE" section, under "Fuel Injector Information".
3. Enter the alternate password as the current password. The alternate password is a six character alpha numeric code. Enter alpha characters with the DDR by using the up or down arrow keys, that scroll you through the alphabet. Use the side arrow keys to move the cursor to the next position, or to back up to correct an entry.
4. Once all six positions are filled press the enter key.
5. Enter the new password you wish to enter (maximum four positions). Press enter.
6. Depending on the area you are changing, you will get a message that the password is successfully changed, or prompt you to confirm that this is what you really want to do.
7. Turn the ignition off, unplug the DDR.

7.1.24 Pressure Governor System (Fire Truck)

The pressure governor system allows the engine speed to fluctuate to maintain a steady water pump outlet pressure.

NOTE:
This system can be set on the mainframe only (Fire Truck Applications 6N4C change).

The system requires the mainframe to be set to enable the feature. A pressure transducer is required.

NOTE:
The same transducer is used for DDEC II systems and III systems.

Control of the system can be done with switches/Mastermind for DDEC II systems or with Switches/Mastermind or Electronic Fire Commander (EFC) for DDEC III systems. Basic operation is the same for all systems.

The mastermind part number differs for DDEC II systems vs. DDEC III systems.

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7.1.25 Progressive Shift Configuration

Progressive shift configuration can be set with the DDR or programming station and can be used to force shifting. It is also useful to limit engine r/min in certain gears, to force shifting to a higher gear. Use Spec Manager to determine values to enter.

7.1.26 Rating Selections

Ratings can be selected with DDR or programming station. Selections are limited to ratings available within the 6N4D group.

7.1.27 Top 2 (Eaton)

Top 2 can be set with the programming station. Two outputs are required - shift solenoid and shift lockout. The transmission type is manual.

7.1.28 Transmission Type

Transmission type can be set with the programming station only. Choices at time of print (may be limited by the application code) are listed in Table 7-5.

Transmission	Transmission	Transmission
00 Manual	14 Other Automatic	20 Rockwell RSX9-R
01 Allison Hydraulic	15 GE Statex III	21 Rockwell RS10
03 Voith	16 Autoshift / J1939	22 Rockwell RSX10
04 Z-F Ecomat	17 Rockwell RS9	23 Reserved - RSX10-C
09 Allison Electronic	18 Rockwell RSX9-A	-
12 Allison WT	19 Rockwell RSX9-B	-

Table 7-5 Available Transmission Selections

7.1.29 Vehicle Overspeed Parameters

Vehicle overspeed parameters can be set with the DDR or programming station. Customer decided parameters log vehicle overspeed codes. The parameter is typically set for +3 mph and +5 mph greater than the current vehicle speed limit; e.g. vehicle speed limit 65. Maximum overspeed limit is 68 and maximum speed no fuel is 70. Setting both to zero disables the function.

NOTE:
Remember to review these figures if Fuel Economy Incentive is activated.

7.1.30 Vehicle Speed Limiting

Vehicle speed limiting can be set with the DDR or programming station. Requires VSS set to Yes.

Vehicle Speed Limit = Yes/No; Maximum speed = XX mph. Limited to the calculated gear bound vehicle speed at rated engine r/min, or if progressive shift = yes, then max cruise speed is limited to high gear r/min. (XX refers to customer selections.)

7.1.31 Variable Speed Governor or Limited Speed Governor Vehicle Speed Limiting Diagnostics

If low side diagnostics need to be enabled or disabled, this is set on the mainframe.

Low side diagnostics refers to throttle position sensor (TPS) or variable speed governor (VSG) "low volt" codes. This occurs when an ECM is configured to be looking for a signal at one of these items, but nothing is wired to it.

7.1.32 Vehicle Speed Sensor Anti-Tamper

Vehicle Speed Sensor (VSS) anti-tamper can be set with the DDR, or special ECM software available via parts.

Once set, VSS anti-tamper requires 5.0 level DDR or higher to disable.

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7.2 DDEC FEATURE SUMMARY

The "x" in a column indicates that this feature has always been available. The numbers indicate the software release that the feature was introduced. A number in the DDR column represents the ECM software release that made the feature available, or able to be changed with the tool listed in the comments column. Parameters that are configured in the Application Code Only are listed in Table 7-6.

Parameter Name	APPL Code 6N4C Only	Mainframe Only	Prog Station	DDR/DDL	Comments
Air Compressor Governor System	4	-	-	-	-
Air Temp Sensor	x	-	-	-	-
Air Temp Torque Reduction	3	-	-	-	-
Barometric Pressure Sensor	x	-	-	-	-
Coolant Level Sensor	x	-	-	-	-
Coolant Pressure Sensor	x	-	-	-	-
Crankcase Pressure Sensor	x	-	-	-	-
Cruise MIN r/min	x	-	-	-	Typically 1100 r/min
Disable EOP on VSG	x	-	-	-	Typically fire trucks only
Dual Fuel BOI	x	-	-	-	Methanol engines; replaces fuel pressure sensor
Enable Engine Brakes	x	-	-	-	May be Jakes, KD (S55) or DVB (S55) beginning w/R4
Engine Overtemp Protection	x	-	-	-	Engine power limiting based on high engine temps OTS, CTS, ICTS
Engine Protection Configuration	x	-	-	-	Temp limits F & amt of power/speed reduction
Engine Sync	x	-	-	-	-
Engine Sync Pulses	x	-	-	-	Typically 12
Fan Control Configuration	x	-	-	-	Includes activation temps
Fuel Pressure Sensor	x	-	-	-	-

Parameter Name	APPL Code 6N4C Only	Mainframe Only	Prog Station	DDR/DDL	Comments
Glow Plugs	x	-	-	-	Methanol engines
Idle Operation at Zero VSG	x	-	-	-	Typically set for on-highway applications
Intercooler Temp Sensor	x	-	-	-	-
LSG Low Side Diagnostics (Code 22)	x	-	-	-	-
LSG Override VSG	x	-	-	-	-
Oil Pressure Sensor	x	-	-	-	-
Oil Temp Sensor	x	-	-	-	-
Pressure Governor System	x	-	-	-	Fire truck applications
PWM Fan Control	3	-	-	-	Assigned to PWM4 w/R3; can be programmed for PWM2 or PWM4 w/R4*
PWM Fan Control Configuration	3	-	-	-	Includes duty cycle levels and temperatures
VSG	x	-	-	-	-
VSG Low Side Diagnostics (Code 11)	x	-	-	-	Typically not set for on-highway applications
VSG Operation at Higher Vehicle Speeds	5	-	-	-	Typically set to 3 mph
VSG Using Foot Pedal	x	-	-	-	Changes scale of r/min per count

* Typically PWM2 for S149; PWM4 for S50/S60

Table 7-6 Parameters That Are Configured in Application Code Only

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The parameters that are configured in the mainframe screens only are listed in Table 7-7.

Parameter Name	APPL Code 6N4C Only	Mainframe Only	Program Station	DDR/DDL	Comments
6N4C Group	-	x	-	-	-
6N4D Group	-	x	-	-	-
ATI Port	-	4	-	-	None or TURBO SPD or NAT GAS or VSG FREQ (Pin X-1)
Digital Torque Limiting	-	5	-	-	Utilizes selection of a predefined torque curve and/or speed
Fan Type (Digital Output)	-	x	-	-	-
Full Power Continuous Override	-	x	-	-	-
Hot Idle Speed	-	x	-	-	Some industrial only max 1400 r/min
Max Cold Idle Speed	-	3	-	-	Restricted for automatic trans to 700 r/min
Maximum Security	-	x	-	-	-
Override CCPS Faults	-	3	-	-	Intended for EMD
Override OPS Low Faults	-	3	-	-	Intended for EMD
Rating Security	-	x	-	-	-
Starter Lockout Speed Settings	-	5	-	-	Allows use of this output for other functions
VSG is Primary	-	x	-	-	-

Table 7-7 Parameters that are Configured in the Mainframe Screens Only

Parameters that can be configured by the OEM, programming station, and/or the DDR are listed in Table 7-8.

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Parameter Name	APPL Code 6N4C Only	Mainframe Only	Prog Station	DDR/DDL	Comments
ACG Integral Gain	-	4	4	-	Air Compressor Gov
ACG Pressure Increment	-	4	4	-	-
ACG Proportional Gain	-	4	4	-	-
Engine Sensor Harness Outputs (3)	-	x	x	-	-
Fan A/C Timer	-	5	5	-	Typically set to 180 seconds (3 minutes)
PGS Cavitation Time Out	-	x	x	-	-
PGS Engine Speed Increment	-	x	x	-	-
PGS Integral Gain	-	x	x	-	-
PGS Proportional Gain	-	x	x	-	-
PGS Pump Pressure Increment	-	x	x	-	-
Vehicle Interface Harness Inputs (12)	-	x	x	-	-
Vehicle Interface Harness Outputs (3)	-	x	x	-	-
ACG Delta Pressure to Load	-	4	4	4	Air Compressor Gov
ACG Delta Pressure to Unload	-	4	4	4	-
ACG Maximum Pressure - 1,2,3	-	4	4	4	-
ACG Minimum Pressure - 1.2.3	-	4	4	4	-
Auxiliary Stop 1 or 2 Protection Level	-	x	x	x	-
Coolant Level Protection Level	-	x	x	x	-

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Parameter Name	APPL Code 6N4C Only	Mainframe Only	Prog Station	DDR/DDL	Comments
Crankcase Pressure Protection Level	-	x	x	x	-
Cruise Auto Resume	-	x	x	x	-
Cruise Control Enable	-	x	x	x	-
Cruise Maximum Speed	-	x	x	x	-
Cruise Minimum Speed	-	x	x	x	-
Dynamic Fan Braking	-	x	2	2	-
Engine Brake Cruise	-	x	x	x	-
Engine Brake Increment	-	x	x	x	-
Engine Brake Low	-	x	x	x	-
Engine Brake-Svc Brake Activation	-	-	5	5	When set requires tap of svc brake to activate Jakes
Engine Brake - Minimum mph	-	-	5	5	Allows deactivation of Jakes below a vehicle speed
FEI - Calculation Type	-	5	5	5	Fuel Economy Incentive
FEI Conversion Factor, mph per mpg	-	5	5	5	-
FEI - Maximum mph	-	5	5	5	-
FEI - Minimum mpg	-	5	5	5	-
Feature Password Protection	-		5	4	(Function Lockout)
Half Engine Enable	-	-	-	7	Enable/disable Half engine idle, Off, If Cold, On, N/A
Idle Shutdown Override	-	x	x	x	-

Parameter Name	APPL Code 6N4C Only	Mainframe Only	Prog Station	DDR/DDL	Comments
Idle Speed Offset	-	-	-	x	Idle Adjust Normal +100 to -25 rpm
Idle Timer	-	x	x	x	-
Idle Timer Operates ON	-	x	x	x	Idle Gov only, or Idle and VSG Governor
Idle Timer Override Defeat, max temp	-	2	2	2	-
Idle Timer Override Defeat, min temp	-	2	2	2	-
Idle Timer Shutdown	-	x	x	x	-
Injector Calibration Codes	-	-	-	x	-
Intercooler Temp Protection Level	-	x	x	x	-
LSG Droop	-	x	x	x	-
Max Vehicle Overspeed with Fuel	-	x	x	x	-
Max Vehicle Overspeed w/o Fuel	-	x	x	x	-
Oil Pressure Protection Level	-	x	x	x	-
Oil Temp Protection Level	-	x	x	x	-
Progressive Shift Configuration	-	x	x	x	-
Rating Selection (Rating Override)	-	6N4M	x	x	-
Transmission Type (PWM #1)	-	x	x	x	-
Unit Number	-	-	-	4	-
Vehicle Speed Limiting	-	x	x	x	-
Vehicle Speed Max	-	x	x	x	-
Vehicle Speed Sensor	-	x	x	x	-

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Parameter Name	APPL Code 6N4C Only	Mainframe Only	Prog Station	DDR/DDL	Comments
VIN	-	-	x	x	-
VSG Alt Min RPM	-	x	x	x	-
VSG Cruise Init Speed	-	x	x	x	-
VSG Cruise RPM Increment	-	x	x	x	-
VSG Droop	-	x	x	x	-
VSG Maximum RPM	-	x	x	x	-
VSG Minimum RPM	-	x	x	x	-
VSG Using Cruise Switch	-	x	x	x	-
VSS Anti Tamper	-	-	7	5	-
VSS Axle Ratio	-	x	x	x	-
VSS Final Gear Ratio	-	x	x	x	-
VSS Number of Teeth	-	x	x	x	-
VSS Sensor Type	-	x	x	x	Typically tailshaft; also wheel or J1939
VSS Signal Type	-	2	2	2	Typically magnetic; also open-collector/switch
VSS Tire Revolutions	-	x	x	x	-

Table 7-8 Parameters that can be Configured by the OEM, Programming Station, and/or the DDR

DDEC Features, code 6N5, are listed in Table 7-9.

Parameter Name	Code	Mainframe Only	Program Station	DDR	Comments
No DDEC Feature	6N5-NONE	-	-	-	-
ECM Data Pages Only	6N5-0001	-	-	-	-
Optimized Idle Only	6N5-0002	-	-	-	-
Data Pages and Optimized Idle	6N5-0003	-	-	-	-

Table 7-9 6N5 - DDEC Features

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8 (UPDATE) CONNECTORS, TERMINALS, AND SPLICING

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8.1 CRIMP AND REMOVAL TOOLS

Crimp tools and connector removing tools can be purchased from Kent-Moore. The part and associated part numbers are listed in Table 8-1.

Connector	Tool	Part Number
Metri-Pack 150	Removing	J 35689
	Crimp	J 35123
Weather Pack	Removing	J 36400-5
	Crimp	J 35606
Metri-Pack 280	Removing (18 AWG)	J 33095
	Crimp (18 AWG)	J 38125-6
	Removing (12 AWG - Used for power harness)	J 33095
	Crimp (12 AWG - Used for power harness)	J 39848
Deutsch	Removing (12 AWG)	J 37451
	Removing (16-18 AWG)	J 34513
	Crimp	J 34182

Table 8-1 Crimp and Removal Tools

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8.2 METRI-PACK 150 CONNECTORS

Metri-Pack 150 series connectors are "pull-to-seat" connectors. Each wire must be pushed through the connector prior to crimping the terminal. Cable seals are inserted into the shell of the connector and hold many wires. Metri-Pack 150 connectors are listed in Table 8-2.

ECM Engine Harness		**ECM Vehicle Interface Harness**	
Connector	P/N: 12034400	Connector	P/N: 12034398
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: 12034413	Plug	P/N: 12034413
ECM Communication Harness Connector		**Temperature Sensor Harness**	
Connector	P/N: 12066317	Connector	P/N: 12162193
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: 12034413	Plug	P/N: Not Applicable
Pressure Sensor Harness		**Fire Truck Pressure Sensor (PGS)**	
Connector	P/N: 12047909	Connector	P/N: 12065287
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable
SRS Harness		**TRS Harness**	
Connector	P/N: 12162193	Connector	P/N: 12162197
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable
Injector (Gray)		**Injector (Black)**	
Connector	P/N: 12162830	Connector	P/N: 12040947
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	P/N: Not Applicable	Seal	P/N: Not Applicable
Plug	P/N: 12034413	Plug	P/N: 12034413

Table 8-2 Metri-Pack 150 Connector Part Numbers

8.2.1 Installation

Metri-Pack 150 connectors are of the "pull-to-seat" design. The cable is pushed through the seal and correct cavity of the connector before crimping the terminal to the cable. It should be stripped of insulation *after* it is placed through the seal and connector body. Use the following instructions for terminal installation:

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1. Position the cable through the seal and correct cavity of the connector. See Figure 8-1.

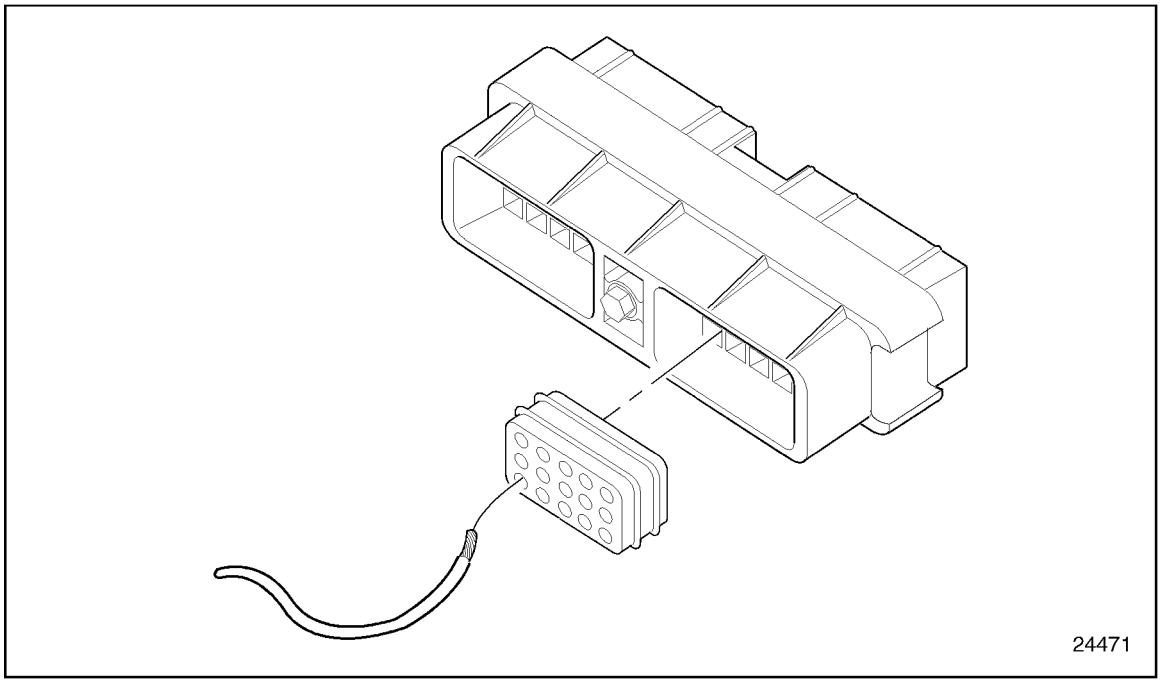

Figure 8-1 Inserting Wire in Connector

2. Strip the end of the cable using wire strippers to leave 5.0 ± 0.5 mm (0.2 ± 0.02 in.) of bare conductor.
3. Squeeze the handles of the crimping tool together firmly to cause the jaws to automatically open.
4. Hold the "wire side" facing you.
5. Push the terminal holder to the open position and insert the terminal until the wire attaching portion of the terminal rests on the 20-22 anvil. Be sure the wire core wings and

the insulation wings of the terminal are pointing toward the upper jaw of the crimping tool. See Figure 8-2.

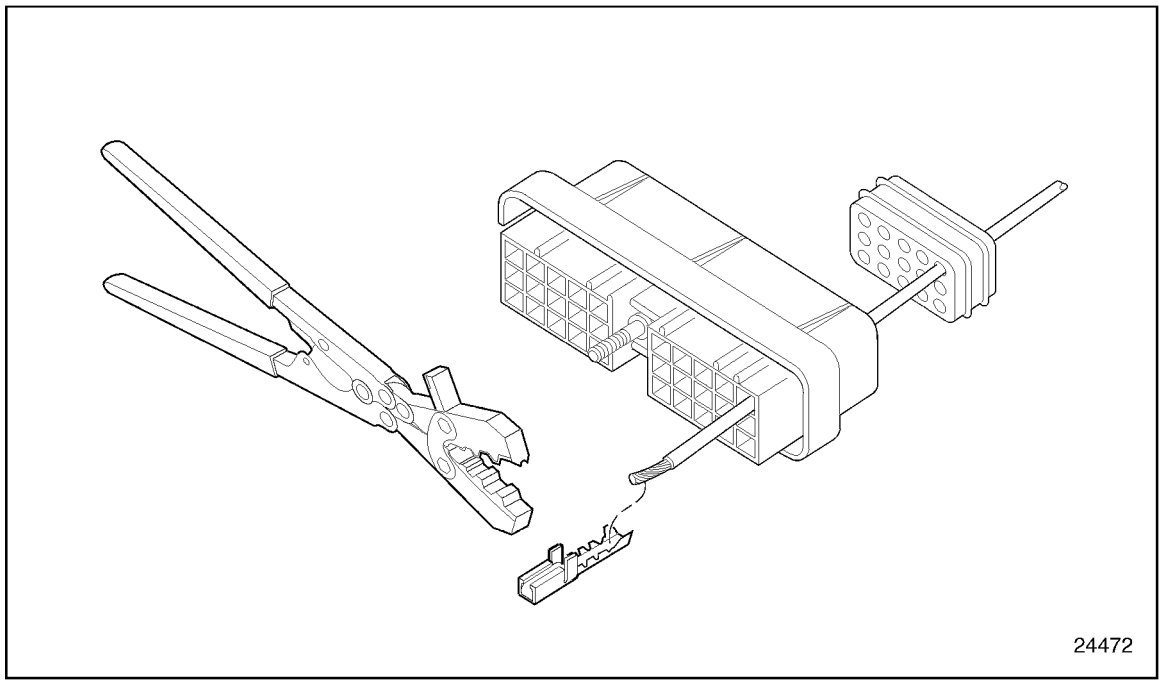

Figure 8-2 Terminal and Crimping Tool Position

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6. Insert the cable into the terminal until the stripped portion is positioned in the wire core wings, and the insulation portion ends just forward of the insulation wings. See Figure 8-3.

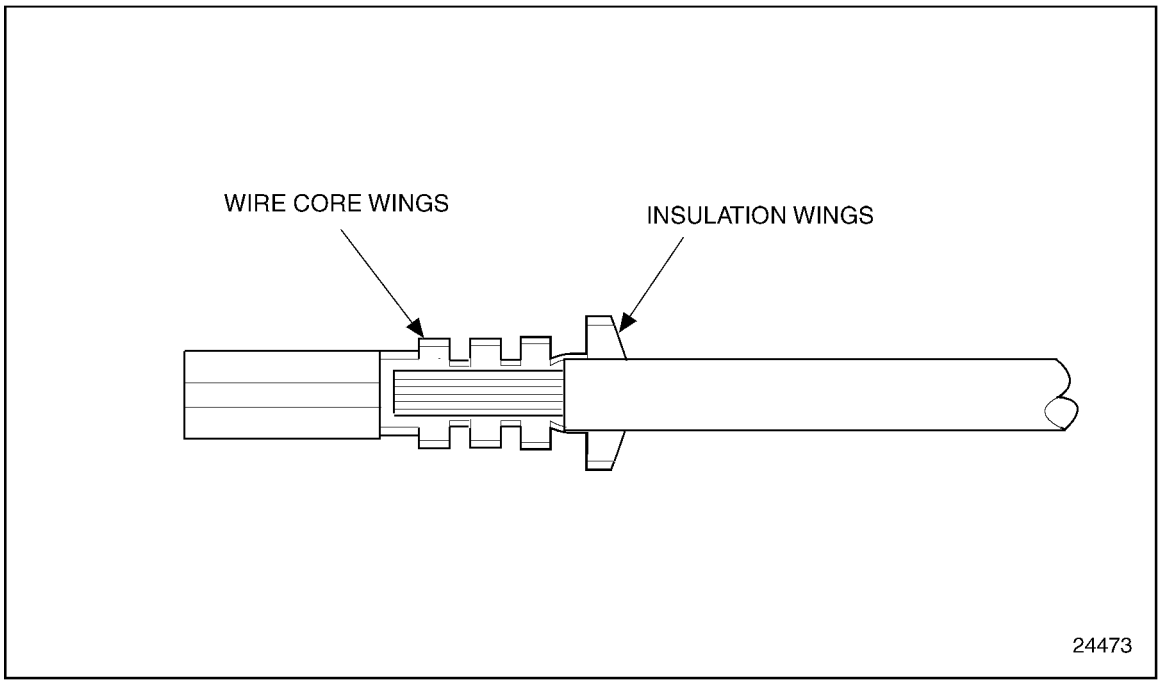

Figure 8-3 Cable to Terminal Alignment

7. Compress the handles of the crimping tool until the ratchet automatically releases and the crimp is complete.

NOTE:
For faster, more efficient crimping operation, a bracket or bench rest may be used to cradle one handle of the tool. The operator can apply the terminals by grasping and actuating only one handle of the tool. See Figure 8-4.

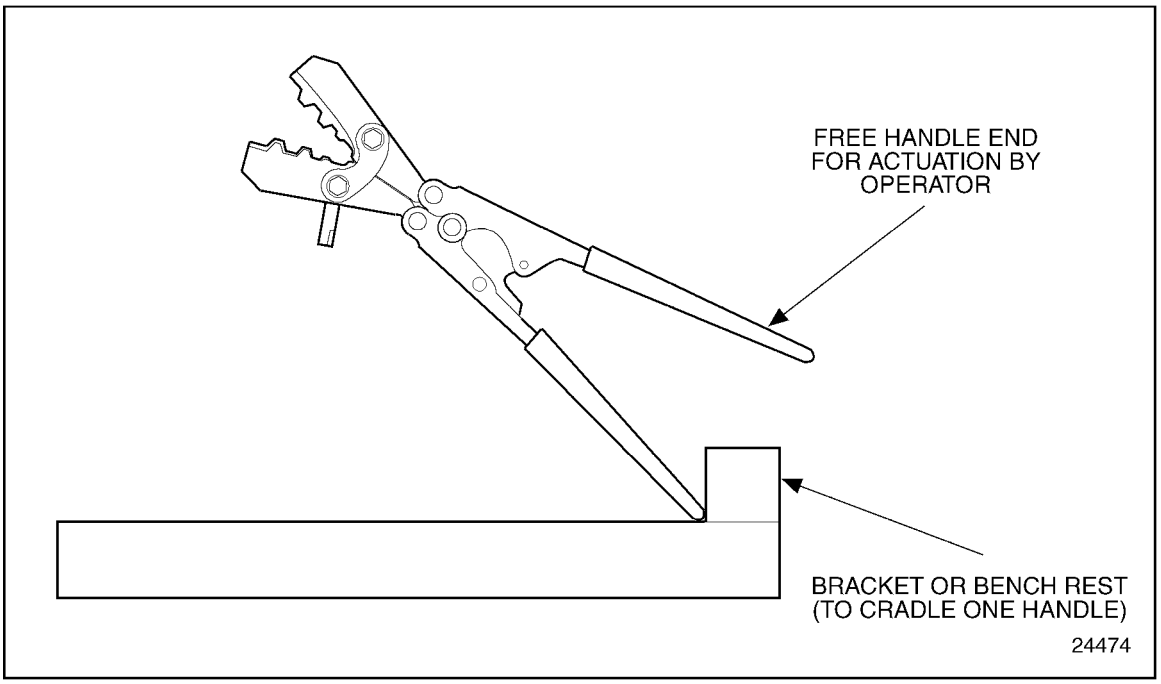

Figure 8-4 Crimping Operation

8. Release the crimping tool with the lock lever located between the handles, in case of jamming.
9. Align the locking tang of the terminal with the lettered side of the connector.

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10. Pull the cable back through the connector until a click is heard.See Figure 8-5. Position the seal into the connector.

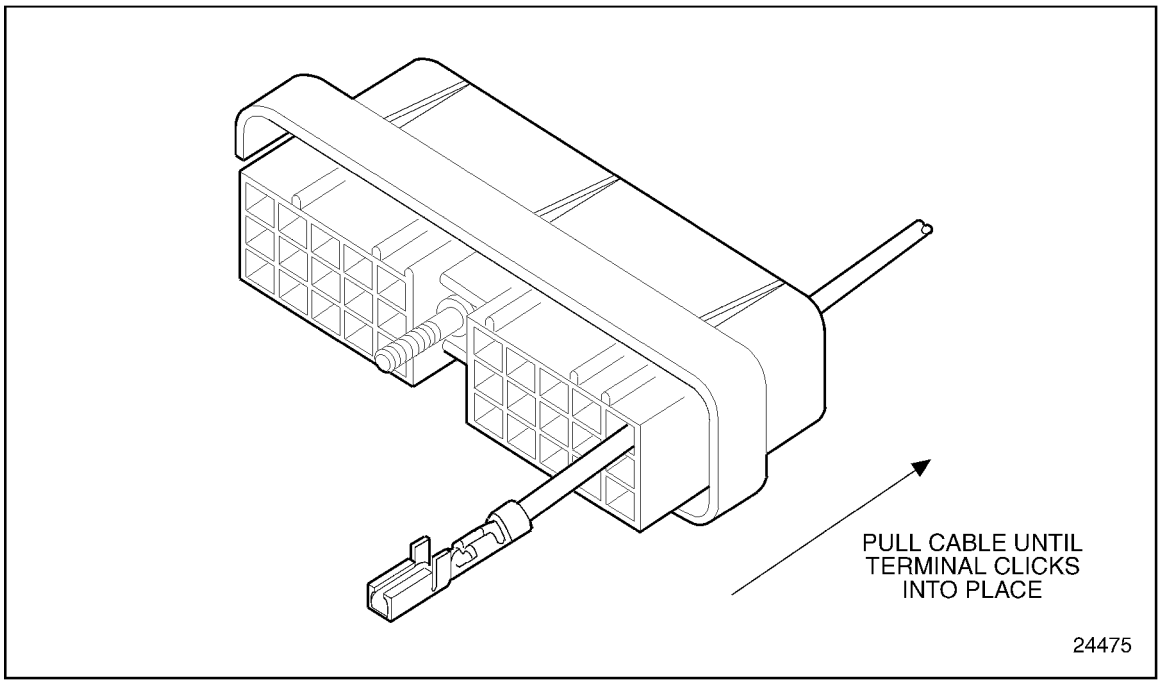

Figure 8-5 Pulling the Terminal to Seat

NOTE:
For ECM 30-pin connectors, put locking tang opposite lettered side.

8.2.2 Removal and Repair

A tang on the terminal locks into a tab molded into the plastic connector to retain the cable assembly. Remove Metri-Pack 150 terminals using the following instructions.

1. Insert the removal tool into the cavity of the connector, placing the tip of the tool between the locking tang of the terminal and the wall of the cavity. See Figure 8-6.

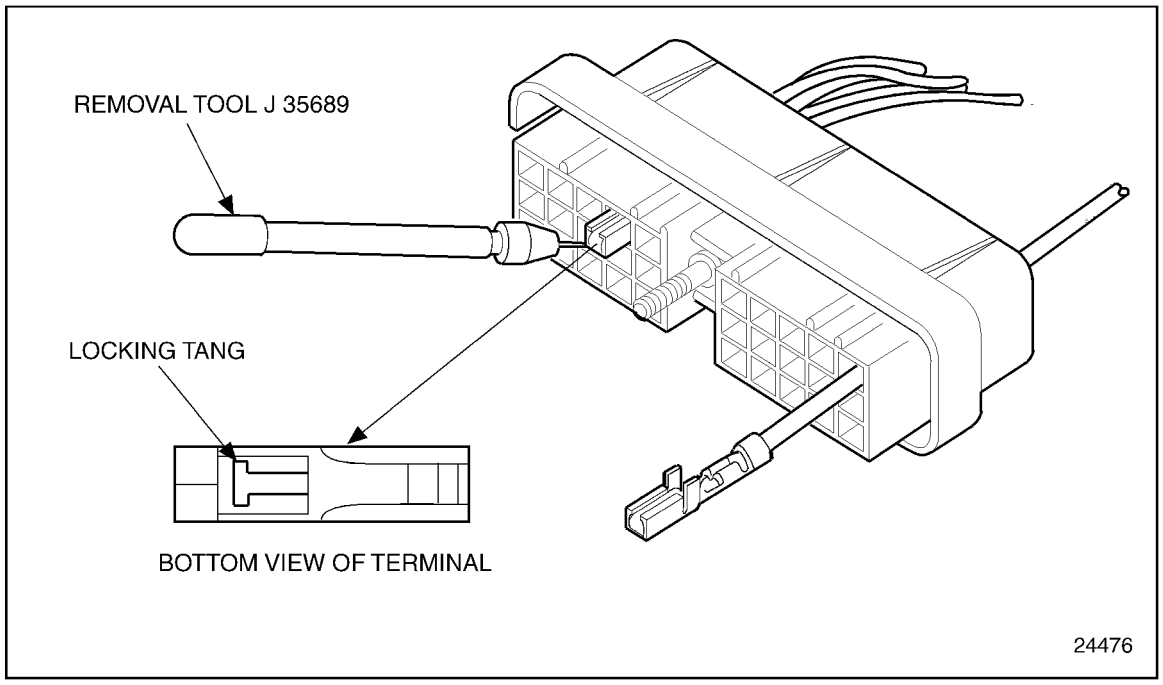

Figure 8-6 Terminal Removal

2. Depress the tang of the terminal to release it from the connector.
3. Push the cable forward through the terminal until the complete crimp is exposed.
4. Cut the cable immediately behind the damaged terminal to repair it.
5. Follow the installation instructions for crimping the terminal and inserting it into the connector.

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8.3 WEATHER PACK AND METRI-PACK 280 CONNECTORS

Weather Pack and Metri-Pack 280 series connectors are push-to-seat. The terminal is crimped onto each wire before it is inserted into the connector. A cable seal is crimped on each wire at the same time the terminal is crimped onto the wire. Weather Pack connectors use a secondary lock on both male and female connector bodies and the lock snaps into place over the cable seals after installation. Some Metri-Pack connectors have secondary locks as well. Weather Pack connectors and their associated part numbers are listed in Table 8-3. Metri-Pack 280 connectors and their associated part numbers are listed in Table 8-4.

Turbo Boost Pressure Sensor Harness		**Engine Brake Connector, Series 60**	
Connector	P/N: 12015384	Connector	P/N: 12010973 / 12162000
Terminal	P/N: 12089040	Terminal	P/N: 12048074 / 12045773
Seal	P/N: 12015323	-	-
Throttle Position Sensor Harness Side		**Throttle Position Sensor Sensor Side**	
Connector	P/N: 12015793	Connector	P/N: 12010717
Terminal	P/N: 12089188	Terminal	P/N: 12089040
Seal	P/N: 12015323	Seal	P/N: 12015323
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable
Ignition Connector Power Harness Side		**Ignition Connector Vehicle Interface Harness Side**	
Connector	P/N: 12034074	Connector	P/N: 12015378
Terminal	P/N: 12089040	Terminal	P/N: 12089188
Allison Interface Module		**Allison Interface Module Maximum Feature**	
Connector	P/N: 12015791	Connector	P/N: 12015799
Terminal	P/N: 12089188	Terminal	P/N: 12089188
Seal	P/N: 12015323	Seal	P/N: 12015323
		Plug	P/N: 12010300

Table 8-3 Weather Pack Connectors and Part Numbers

Coolant Level Sensor Connector		**Power Harness**	
Connector	P/N: 15300027	Connector	P/N: 12124634
Terminal	P/N: 12077411	Terminal	P/N: 12077413
Seal	P/N: 12015323	Seal	P/N: 12015193
Secondary Lock	P/N: 15300014	Secondary Lock	P/N: 12052816
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable

Table 8-4 Metri-Pack 280 Connectors and Part Numbers

8.3.1 Installation

Use the following instructions for terminal installation:

1. Insert the terminal into the locating hole of the crimping tool using the proper hole according to the gage of the cable to be used. See Figure 8-7.

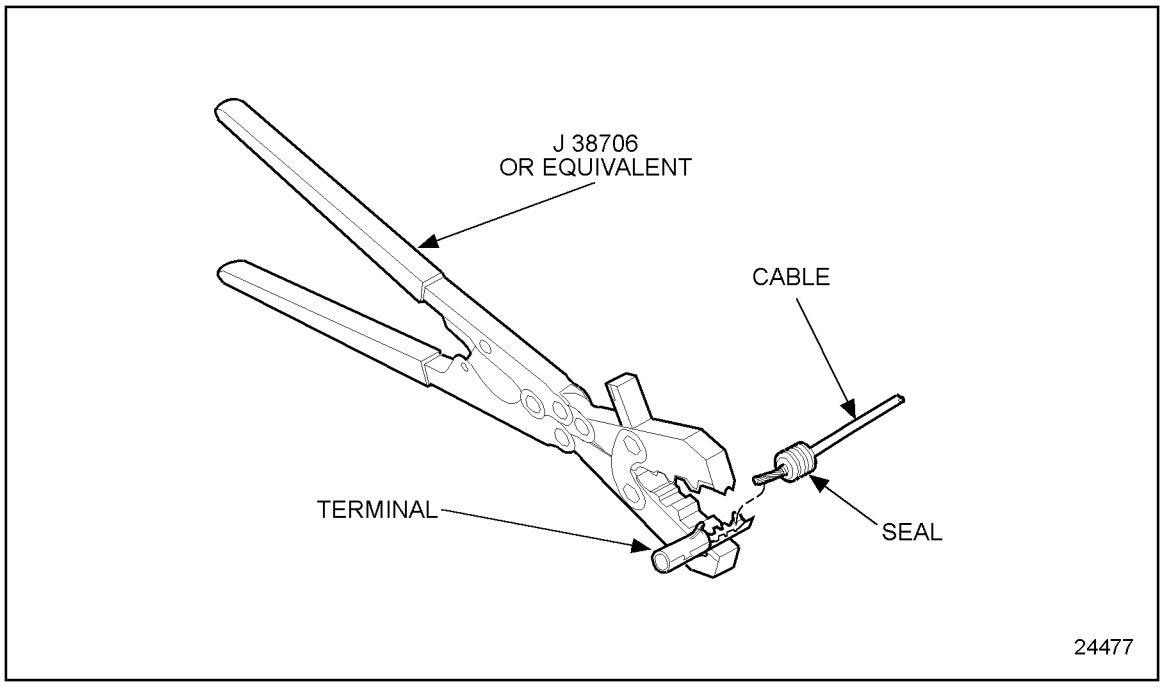

Figure 8-7 Terminal Position

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2. Insert the cable into the terminal until the stripped portion is positioned in the cable core wings, and the seal and insulated portion of the cable are in the insulation wings. See Figure 8-8.

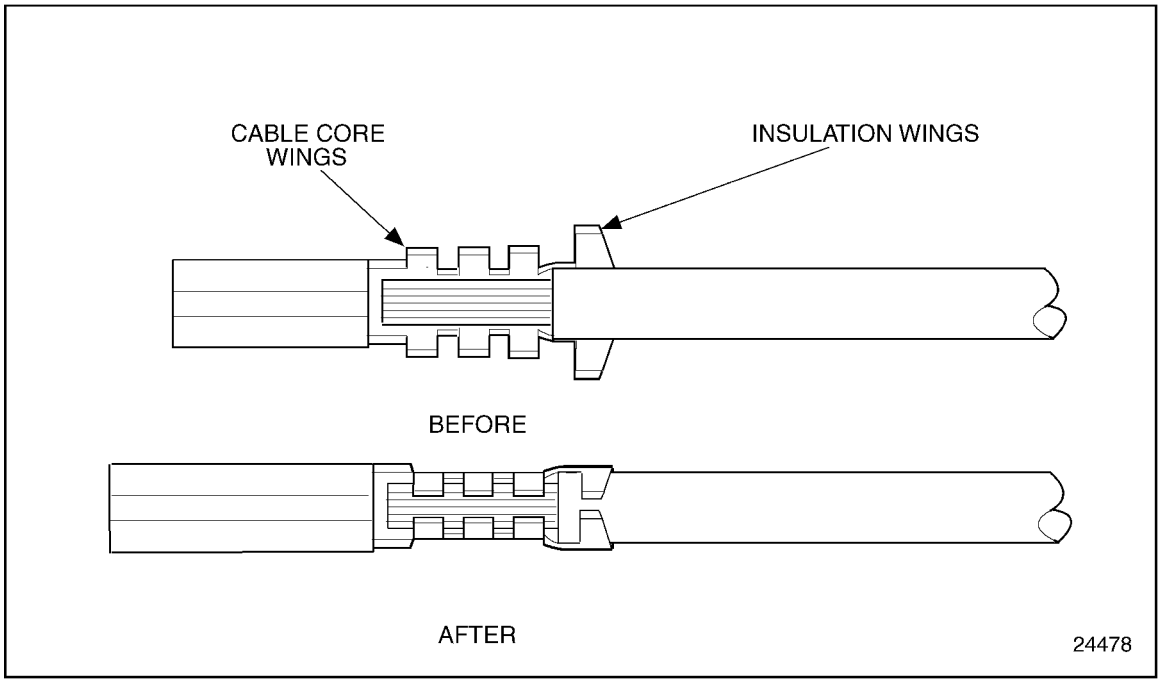

Figure 8-8 Cable and Terminal Position Before and After Crimping

3. Compress the handles of the crimping tool until the ratchet automatically releases and the crimp is complete. A properly crimped terminal is shown. See Figure 8-8.
4. Release the crimping tool with the lock lever located between the handles, in case of jamming.

5. Push the crimped terminal into the connector until it clicks into place. Gently tug on the cable to make sure it is secure. See Figure 8-9.

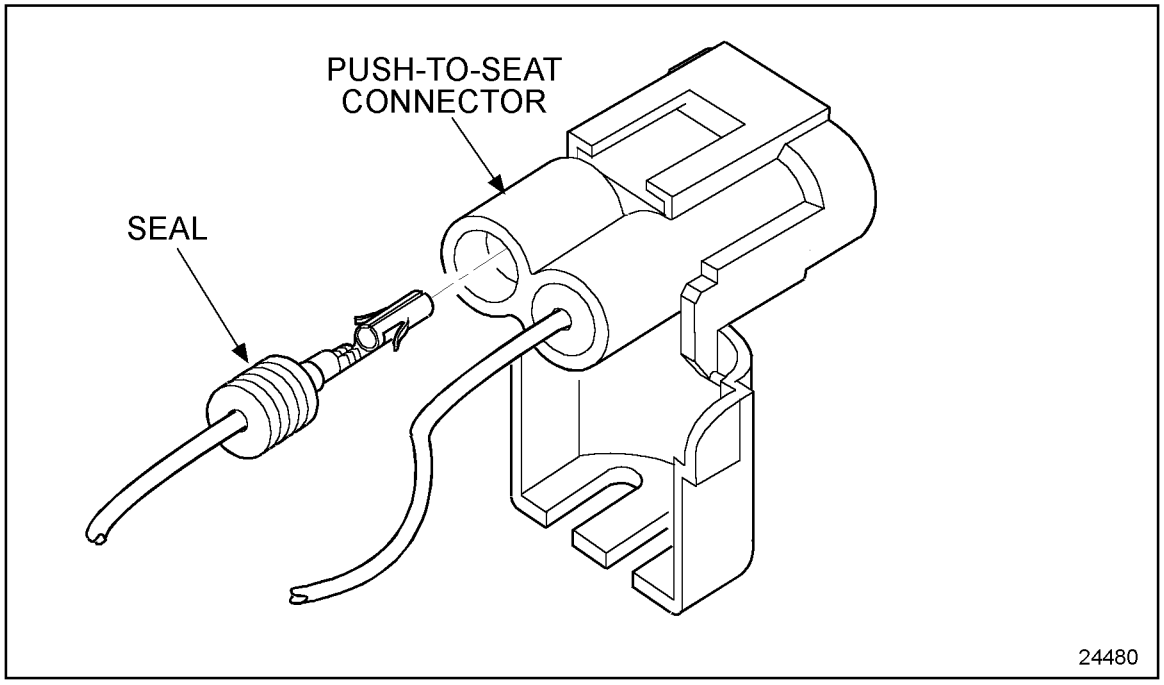

Figure 8-9 Inserting Terminal in Connector

8.3.2 Removal and Repair

Two locking tangs are used on the terminals to secure them to the connector body. Use the following instructions for removing terminals from the connector body.

1. Disengage the locking tang, securing the connector bodies to each other. Grasp one half of the connector in each hand and gently pull apart.

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2. Unlatch and open the secondary lock on the connector. See Figure 8-10.

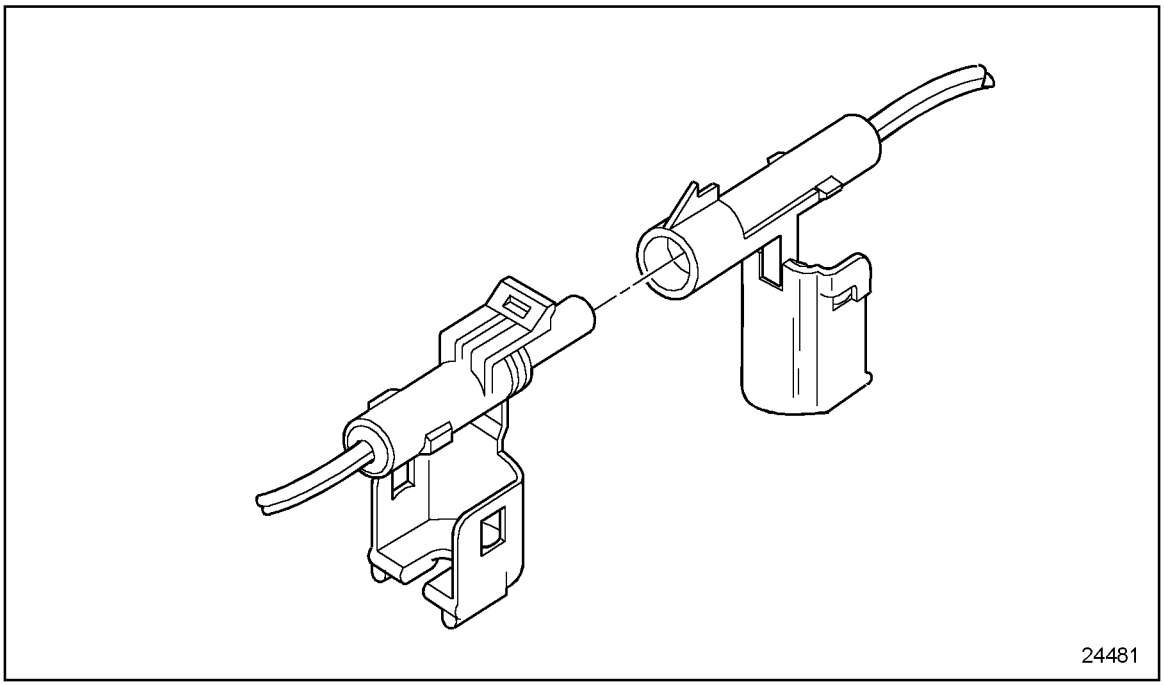

Figure 8-10 Unlatched Secondary Lock

3. Grasp the cable to be removed and push the terminal to the forward position.
4. Insert the removal tool straight into the front of the connector cavity until it resists on the cavity shoulder.

5. Grasp the cable and push it forward through the connector cavity into the tool while holding the tool securely in place. See Figure 8-11.

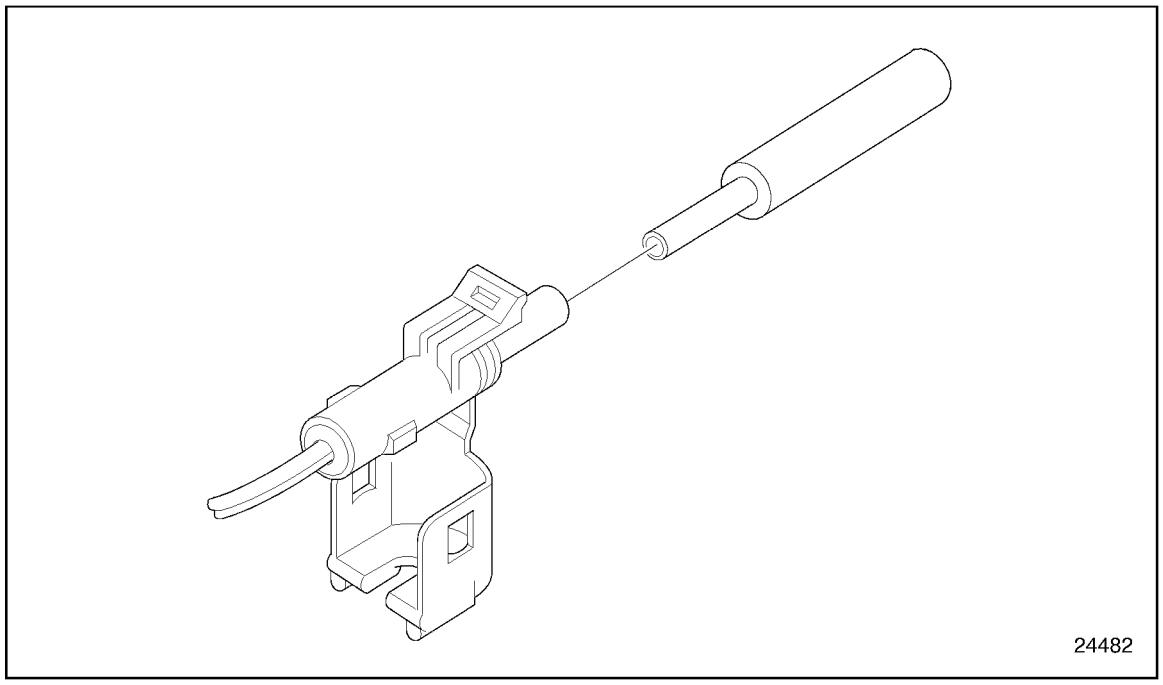

Figure 8-11 Removal Tool Procedure

6. The tool will press the locking tangs of the terminal. Pull the cable rearward (back through the connector). Remove the tool from the connector cavity.
7. Cut the wire immediately behind the cable seat and slip the new cable seal onto the wire.

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8. Strip the end of the cable using strippers to leave 5.0 ± 0.5 mm (0.2 ± 0.02 in.) of bare conductor. Position cable seal as shown. See Figure 8-12.

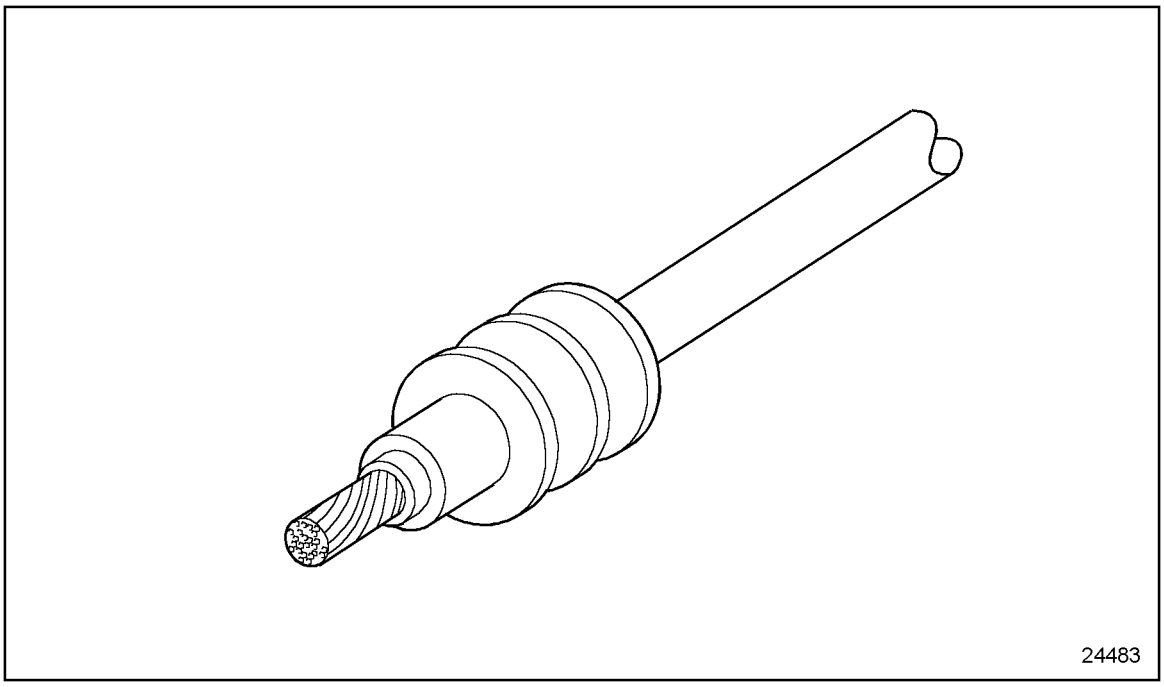

Figure 8-12 Proper Cable Seal Position

9. Crimp new terminal onto wire using the crimp tool. See Figure 8-13.

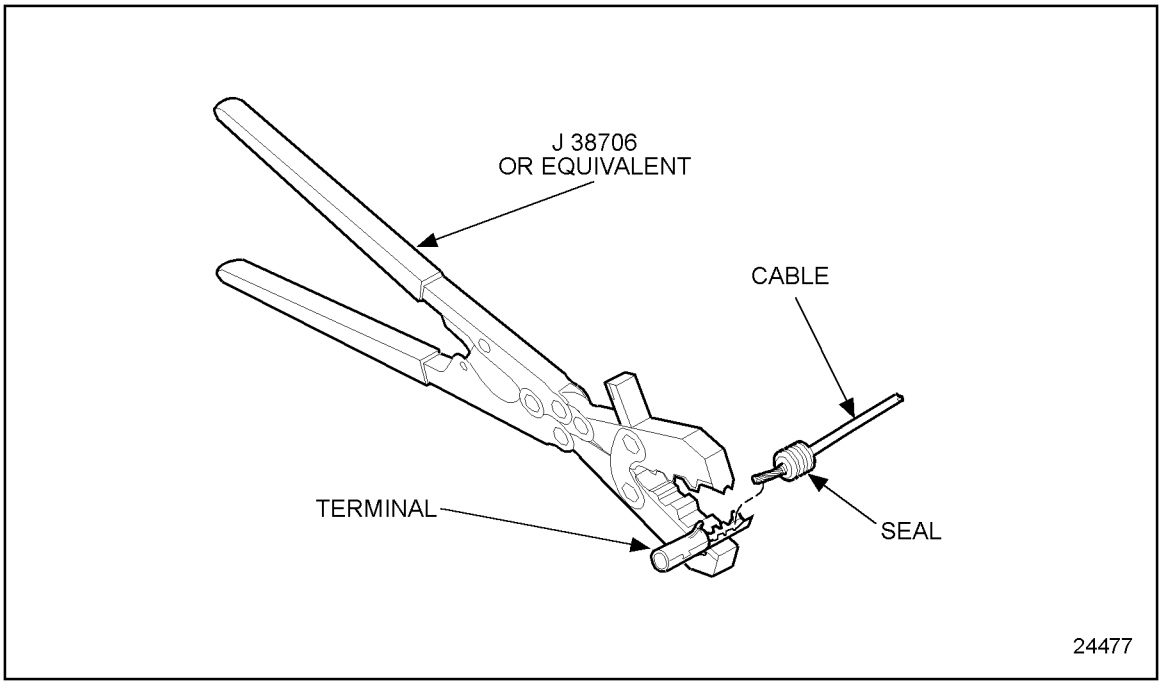

Figure 8-13 Crimping Procedure

8.4 DEUTSCH CONNECTORS

Deutsch connectors have cable seals molded into the connector. These connectors are push to seat connectors with cylindrical terminals. The diagnostic connector terminals are gold plated for clarity. Deutsch connectors and their associated part numbers are listed in Table 8-5.

Diagnostic Connector	
Connector	P/N: 23513052
Terminal	P/N: 23513053
Protective Cap	P/N: 23413054
Plug	P/N: 23507136
Engine Minder	
Connector	P/N: 23512222
Terminal	P/N: 23507132
Plug	P/N: 23507136
Mastermind - Power and Communication Link	
Connector	P/N: 23512221
Terminal	P/N: 23507132
Plug	P/N: 23507136
Mastermind - Inputs and Outputs	
Connector	P/N: 23512223
Terminal	P/N: 23507066
Plug	P/N: 23507136

Table 8-5 Deutsch Connectors and Part Numbers

8.4.1 Installation

Use the following instructions for installation:

1. Strip approximately $\frac{1}{4}$ in.(6 mm) of insulation from the cable.
2. Remove the lock clip, raise the wire gage selector, and rotate the knob to the number matching the gage wire that is being used.
3. Lower the selector and insert the lock clip.

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4. Position the contact so that the crimp barrel is 1/32 of an inch above the four indenters. See Figure 8-14. Crimp the cable.

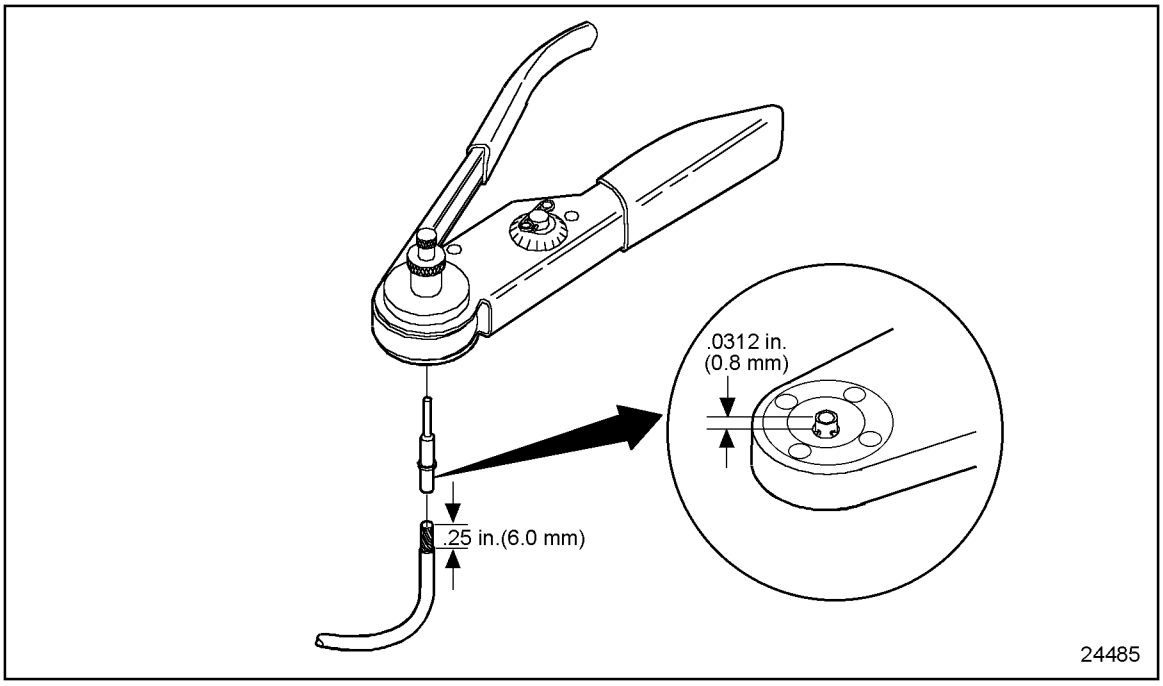

Figure 8-14 Setting Wire Gage Selector and Positioning the Contact

5. Grasp the contact approximately one inch behind the contact crimp barrel.

6. Hold the connector with the rear grommet facing you. See Figure 8-15.

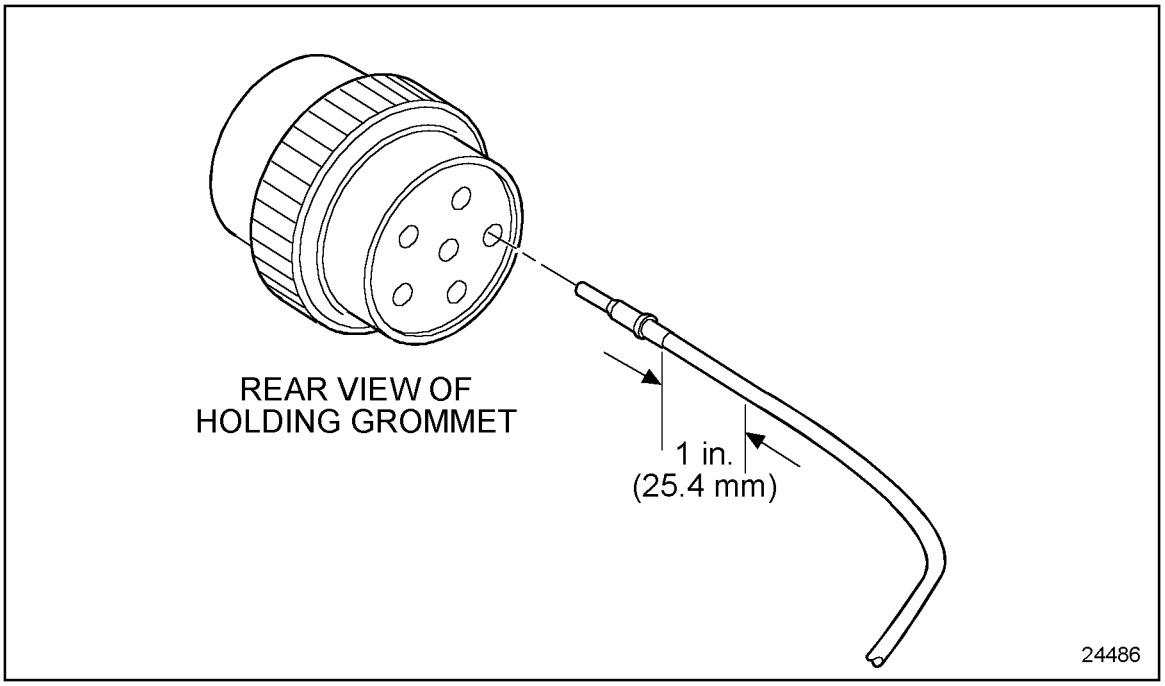

Figure 8-15 Pushing Contact Into Grommet

7. Push the contact into the grommet until a positive stop is felt. See Figure 8-15. A slight tug will confirm that it is properly locked into place. See Figure 8-16.

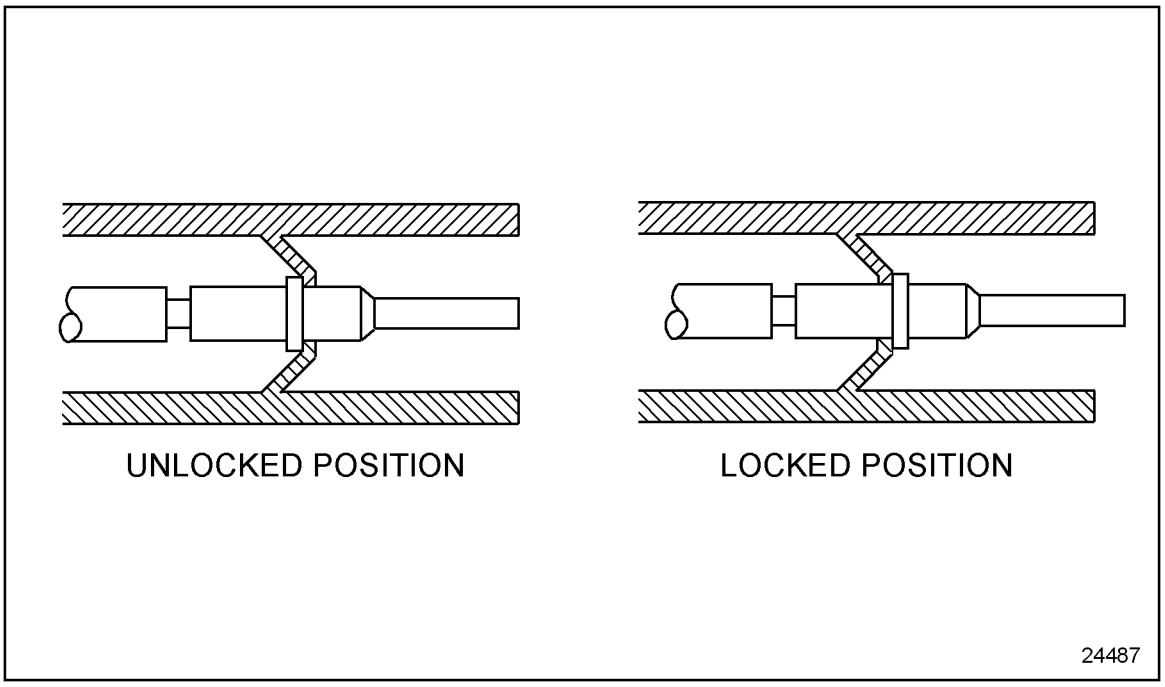

Figure 8-16 Locking Terminal Into Connector

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8.4.2 Removal

The appropriate size removal tool should be used when removing cables from connectors. The proper removal tool size is listed in Table 8-1.

1. With the rear insert toward you, snap the appropriate size remover tool over the cable of contact to be removed. See Figure 8-17.

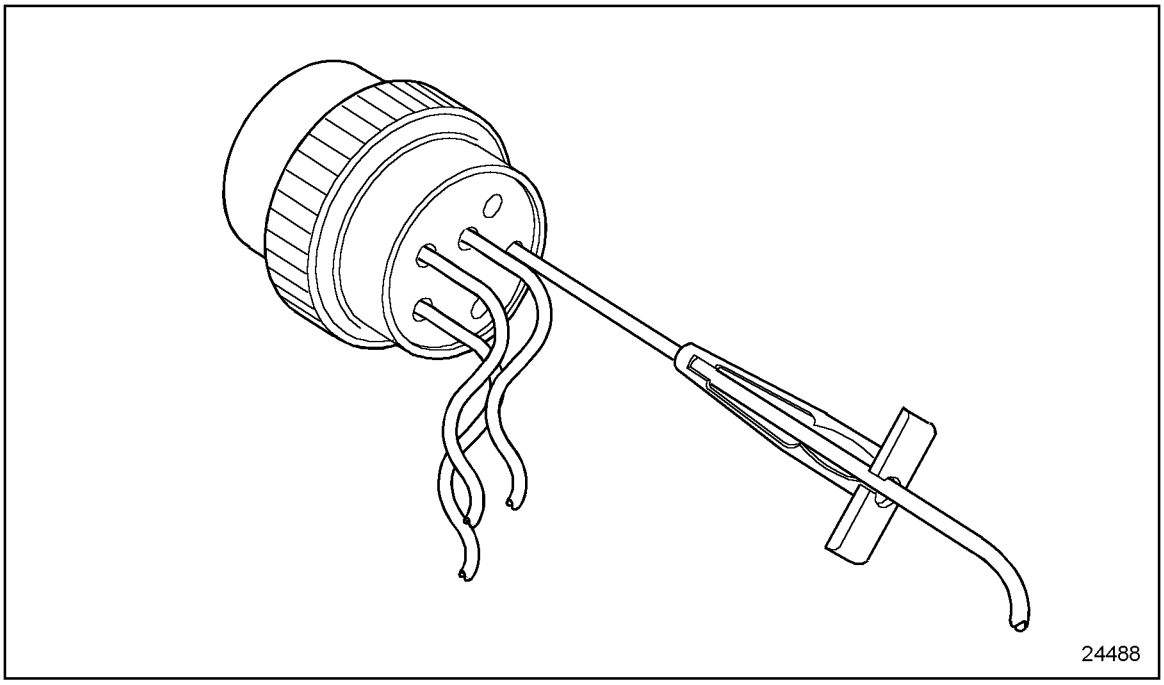

Figure 8-17 Removal Tool Position

2. Slide the tool along the cable into the insert cavity until it engages and resistance is felt. Do not twist or insert tool at an angle. See Figure 8-18.

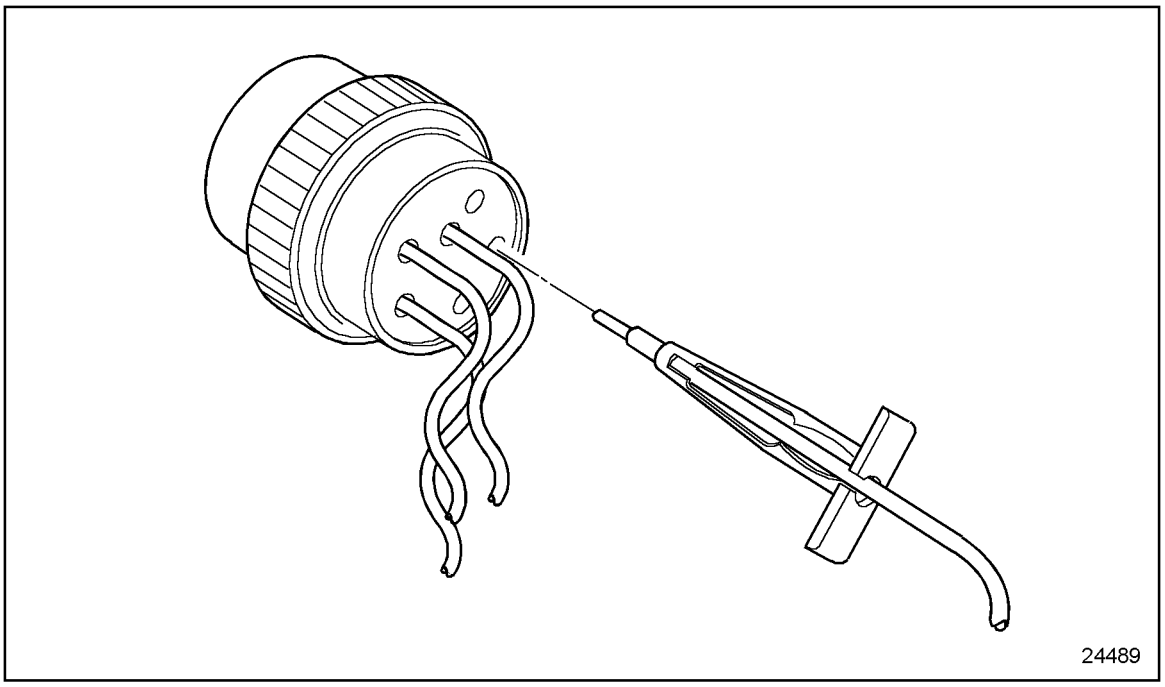

Figure 8-18 Removal Tool Insertion

3. Pull contact cable assembly out of the connector. Keep reverse tension on the cable and forward tension on the tool.

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8.5 SPLICING GUIDELINES

The following are guidelines which may be used for splices. The methods described are not the only acceptable methods. Any method should produce a high quality, tight splice with durable insulation which can be expected to last the life of the vehicle.

The selection of crimpers and splice connectors is optional. Select a high quality crimper equivalent to the Kent-Moore tool, J 38706, and commercially available splice clips.

8.5.1 Tools Required

The following is a list of tools required for splicing wires:

- ☐ Soldering iron
- ☐ Rosin core solder
- ☐ Wire strippers
- ☐ Heat shrink tubing
- ☐ Splice clips
- ☐ Crimp pliers

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8.6 STRAIGHT LEADS

To splice straight leads:

1. Locate broken wire.
2. Remove insulation as required; be sure exposed wire is clean and not corroded.
3. Slide a sleeve of shrink wrap on the wire long enough to cover the splice and overlap the wire insulation, about $\frac{1}{4}$ in. on both sides.
4. Insert one wire into splice clip (P/N: 0597428 or equivalent) and crimp.
5. Insert the other wire into splice and crimp. See Figure 8-19.

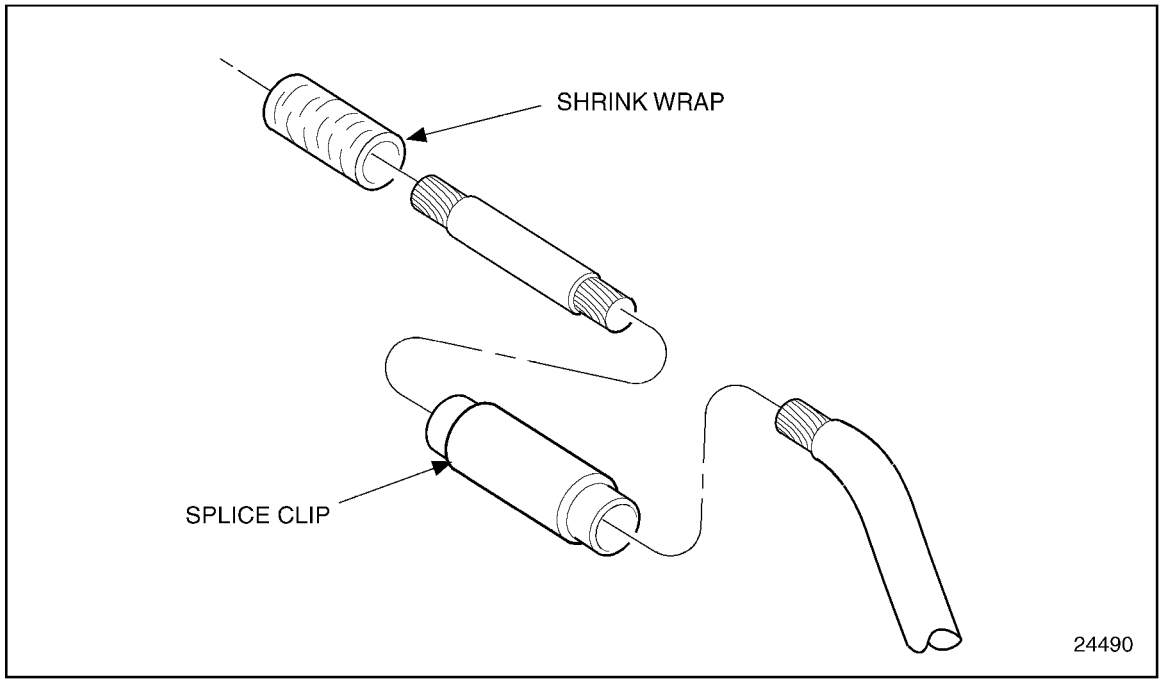

Figure 8-19 Spliced Wire

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8.7 SOLDER

Soldering splice connectors is optional. To solder splice connectors:

1. You *must* use rosin core solder.
2. Check the exposed wire before the splice is crimped in its connector. The exposed wire *must* be clean before the splice is crimped.
3. Use a suitable electronic soldering iron to heat the wires. Apply the solder to the heated wire (not to the soldering iron) allowing sufficient solder flow into the splice joint.
4. Pull on connection to assure crimping and soldering integrity.

8.8 SHRINK WRAP

Shrink wrap is required. Alpha FIT-300, Raychem TAT-125 or any equivalent heat shrink dual wall epoxy encapsulating adhesive polyolefin is required.

Alpha Wire Corp 711 Lidgerwood Ave, P.O. Box 711 Elizabeth; New Jersey 07207-0711; 1-800-52ALPHA

Raychem Corporation, Thermofit Div 300 Constitution Drive, Bldg. B; Menlo Park, CA 94025; 415-361-3860

To heat shrink wrap a splice:

1. Select the correct diameter to allow a tight wrap when heated. The heat shrink wrap *must* be long enough to overlap the wire insulation about $\frac{1}{4}$ in. on both sides of the splice.
2. Heat the shrink wrap with a heat gun; do not concentrate the heat in one location, but play the heat over the entire length of shrink wrap until the joint is complete.

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8.9 MULTIPLE BROKEN WIRES

To splice multiple broken wires:

1. Stagger the position of each splice as illustrated. See Figure 8-20.
2. You *must* stagger positions to prevent a large bulge in the harness and to prevent the wires from chafing against each other.

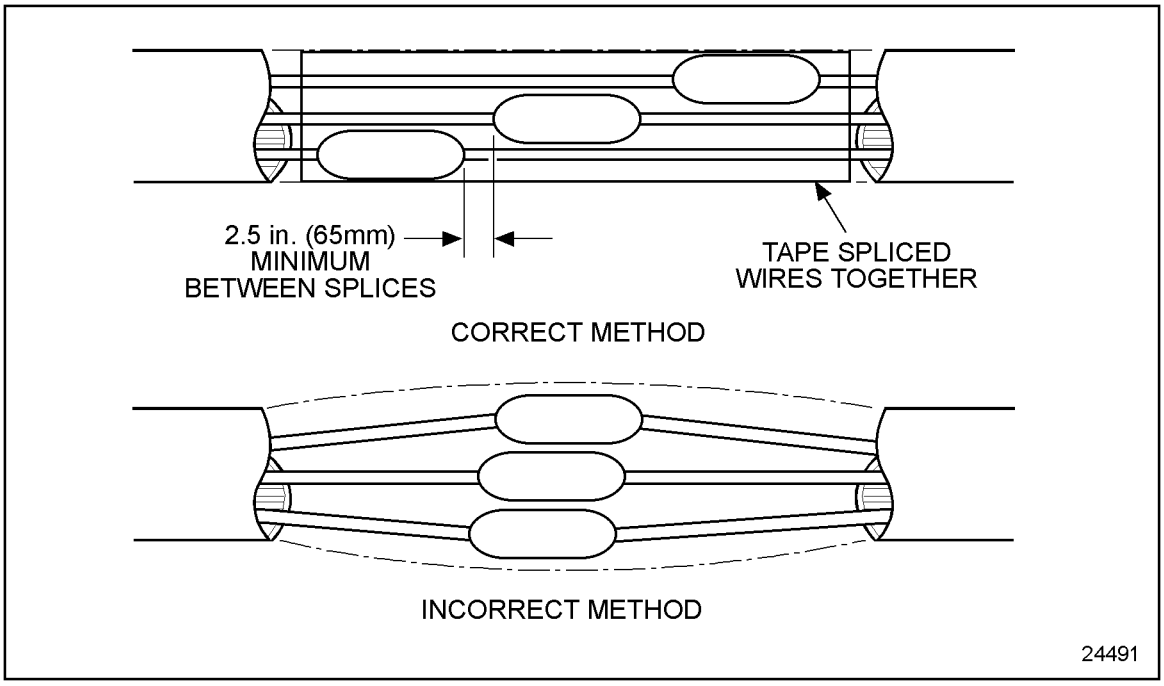

Figure 8-20 Multiple Splices

8.10 THREE-WIRE SPLICE

Three-way splice connectors are commercially available to accommodate three-wire splices. The technique is the same as a single butt splice connector. See Figure 8-21.

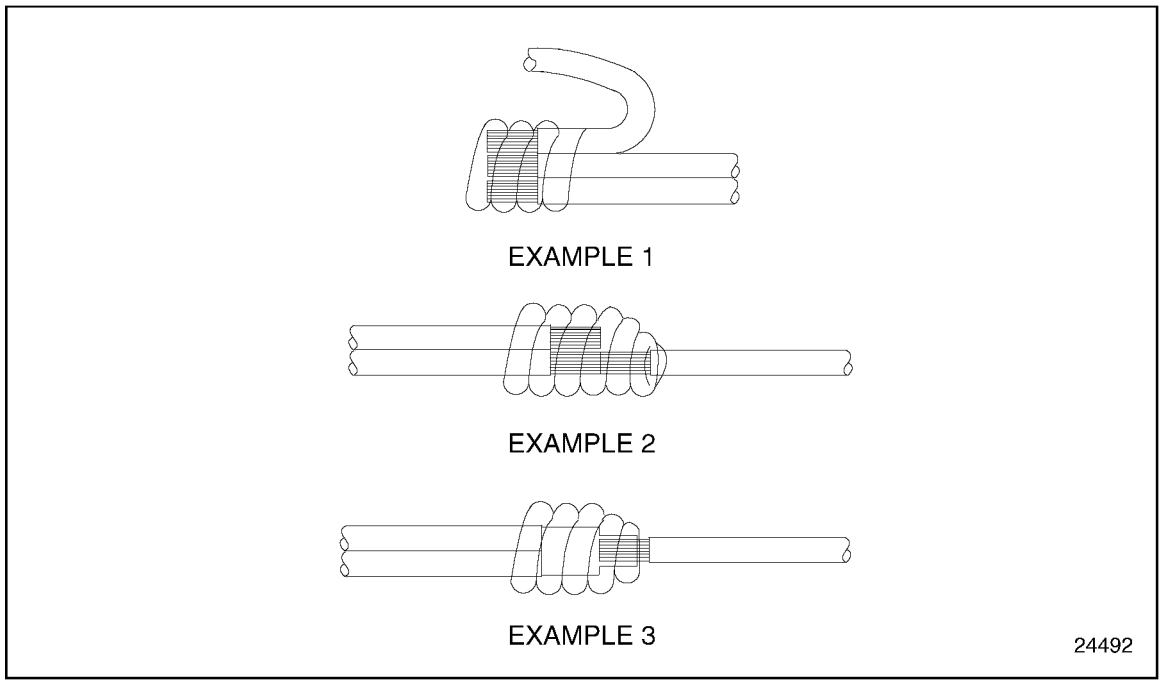

Figure 8-21 Three-Way Splice

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9 (CHG) DIAGNOSING A DDEC SYSTEM FAULT

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9.1 FIRST STEP FOR DIAGNOSING A FAULT WITHIN THE DDEC SYSTEM

The following procedure is the starting point for diagnosing DDEC codes using the Diagnostic Data Reader (DDR).

9.1.1 Check Engine Light

Perform the following steps to check the Check Engine Light (CEL):

1. Turn the ignition on while at the same time observing the Check/Stop Engine light (engine not running).
   [a] If the CEL comes on and stays on, refer to section 9.1.2.
   [b] If the CEL comes on for up to five seconds, and then turns off, refer to section 9.1.3.
   [c] If the CEL does come on, but the condition of light is erratic or intermittent, refer to section 10.4.
   [d] If the CEL does not come on, refer to section 10.4.

9.1.2 Read Active Codes

Perform the following steps to read the active codes.

1. Turn ignition on. Plug DDR into DDL connector. See Figure 9-1.

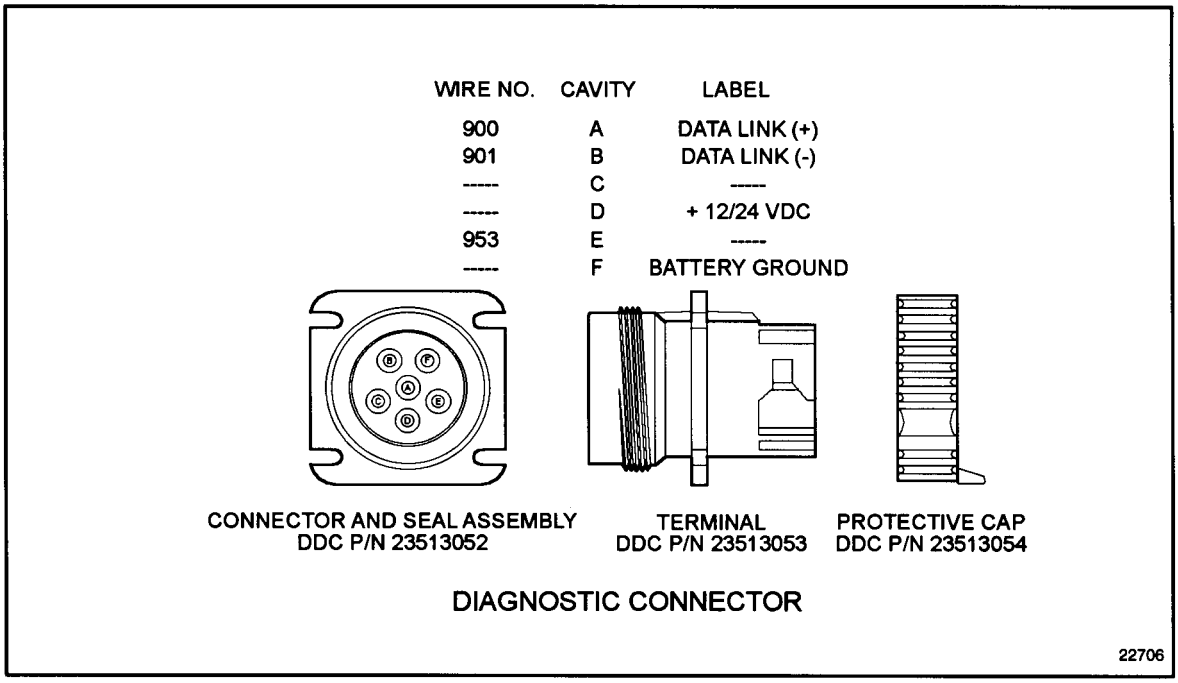

Figure 9-1 Diagnostic Connector

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2. Read active codes by selecting the DIAGNOSTIC CODE MENU (ACTIVE CODES) on the DDR.

   [a] If active codes are displayed on the DDR, follow the appropriate diagnostic procedures for the codes received. Refer to the section number that is the same as the Flash Code number.

   [b] If the DDR display is blank or random, refer to section 10.5.

   [c] If DDR displays NO DATA or DDEC Info not available, refer to section 10.8.

   [d] If the DDR display reads "No Active Codes", refer to section 10.8.

9.1.3 Read Inactive Codes

Perform the following steps to read inactive codes.

1. Plug DDR into the DDL connector.
2. Read inactive codes. (Select inactive codes on the DDR.)

   [a] If DDR displays no inactive codes, the problem may be intermittent. Refer to section 10.1.

   [b] If DDR display is blank or random, refer to section 10.5.

   [c] If DDR displays NO DATA or DDEC Info not available, refer to section 10.5.

   [d] If the DDR displays any inactive codes, clear the codes and refer to section 9.1.4.

9.1.4 Attempt to Make Codes Active

Perform the following steps to make codes active.

1. Start and run the engine for eight minutes. Warm the engine. Coolant/oil temperature must be greater than 140 ° F (60 ° C).
2. If required, perform road test with an assistant.

   [a] If CEL or SEL illuminate, read codes and refer to the section number that matches the flash code number logged.

   [b] If CEL or SEL do not illuminate and no codes log, return to service.

   [c] If CEL or SEL do not illuminate but symptom occurs, refer to section 10.1, and Diagnosis by Symptom.

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10 (CHG) INTERMITTENT FAULT

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10.1 INTERMITTENT CODE OR A SYMPTOM AND NO CODES

The following procedure will diagnose an intermittent code or symptom.

10.1.1 Diagnosis by Symptom

Perform the following steps to diagnose an intermittent code or symptom.

NOTE:
Do not use any other procedures (except for the suggestions listed in this manual) when trying to solve an intermittent problem. Use of any other procedures for this type of problem can result in the replacement of non-defective parts.

Many intermittent problems are caused by faulty electrical connectors or wiring. Diagnosis must include a careful inspection of the indicated circuit wiring and connectors. For example, an intermittent code 35 (Oil Pressure Sensor High Voltage) would indicate a problem in the following areas associated with the Oil Pressure Sensor.

- ☐ Wires #530 (signal line), #416 (+5 volt line), or #452 (ground line)
- ☐ The Oil Pressure Sensor connector or ECM connector
- ☐ An intermittent problem in the Oil Pressure Sensor (least likely)

Use the following checklist:

1. Check for poor mating of the connector halves or terminals not fully seated in the connector body (backed out terminals).
2. Look for improperly formed or damaged terminals. All connector terminals in the problem circuit should be carefully inspected to determine proper contact tension. Use a mating terminal to test the contact tension.
3. Electrical system interference caused by a defective relay, ECM driven solenoid, or a switch causing an electrical surge. Look for problems with the charging system (alternator, etc.). In certain cases, the problem can be made to occur when the faulty component is operated as in the case of a relay.
4. Verify alternator grounds are clean and making good contact. Disconnect the alternator belt to test.
5. Wiggle wires and harnesses to try to make the problem active, or re-occur.

10.1.2 Verify Repairs

Perform the following steps to verify repairs.

1. Clear codes.
2. Confirm the CEL does not come on (except for the five second ignition ON bulb check).
3. Run the engine for one minute.
4. If the CEL stays ON, refer to section 9.1.2.

10.2 ENGINE CRANKS BUT WILL NOT START

The following procedures will diagnose engine cranks but will not start.

10.2.1 Check Engine Light

Perform the following steps to check the CEL:

1. Turn ignition on while observing the Check/Stop Engine Light.
   [a] If the light comes on and stays on, refer to section 9.1.
   [b] If the light comes on for up to five seconds, and then goes off, refer to section 10.2.2.
   [c] If the lights are off, refer to section 10.2.14.

10.2.2 Fuel Check

Perform the following steps to check the fuel supply:

1. Disconnect the fuel return line.
2. Check for fuel flow while cranking the engine.
   [a] If fuel flow is okay, refer to section 10.2.3.
   [b] If fuel supply is not okay, refuel the vehicle. The system may need to be re-primed. Refer to the appropriate engine service manual.

10.2.3 White Smoke Check

Perform the following steps to check for white smoke:

1. Reconnect fuel return line.
2. Look for white smoke coming out of the exhaust stack while cranking the engine.
   [a] If white smoke is present, refer to section 10.2.4.
   [b] If white smoke is not present, refer to section 10.2.28.

10.2.4 Check Timing Reference Sensor Status

Perform the following steps to check the TRS status via a r/min readout:

1. Select engine speed and active codes on the DDR.
2. Crank the engine for ten seconds while observing DDR display. A battery voltage surge while cranking with electric starters may blank or reset the DDR.
   [a] If the display reads greater than or equal to 60 r/min, refer to section 10.2.9.
   [b] If the display reads less than 60 r/min or constantly reads 60 r/min, refer to section 10.2.5.

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[c] If code 41 is displayed, refer to section 41.3.1.

[d] If code 42 is displayed, refer to section 42.3.1.

10.2.5 Check Timing Reference Sensor

Perform the following steps to check the TRS:

1. Turn vehicle ignition OFF.
2. Disconnect engine harness connector at the ECM.
3. Measure resistance between sockets T1 and T2 at the engine harness connector.
   [a] If the resistance measurement is greater than 200 Ω, refer to section 41.3.3.
   [b] If the resistance measurement is less than 100 Ω, refer to section 41.3.2.
   [c] If the resistance measurement is between 100 and 200 Ω, refer to section 10.2.6.

10.2.6 Check Synchronous Reference Sensor / Timing Reference Sensor Mounting

Perform the following steps to check the SRS/TRS mounting and the bracket:

1. Inspect SRS/TRS mounting.
   [a] If the sensor and mount are secure, refer to section 10.2.7.
   [b] If the sensor and mount are not secure, tighten the bolt or replace if necessary. Refer to section 10.2.27.

10.2.7 Check Pulse Wheel

Perform the following steps to check the pulse wheel:

1. Inspect DDEC ® pulse wheel for loose wheel or chipped or missing teeth.
   [a] If the pulse wheel is damaged, repair or replace as necessary. Refer to section 10.2.27.
   [b] If the pulse wheel is not damaged, refer to section 10.2.8.

10.2.8 Check ECM Connectors

Perform the following steps to check the ECM connectors:

1. Turn vehicle ignition OFF.
2. Disconnect all connectors at the ECM.
3. Check terminals at all ECM connectors (both the ECM and harness side) for damaged, bent, corroded or unseated pins or sockets.
   [a] If the terminals and connectors are damaged, repair them. Refer to section 10.2.27.

[b] If the terminals and connectors are not damaged, replace the ECM. Refer to section 10.2.27. (Try a test ECM first.)

10.2.9 Check for Good Synchronous Reference Sensor Signal

Perform the following steps to check for a good SRS signal:

1. Select engine data list on DDR.
2. Crank engine while observing DDR display of SRS received. Battery voltage surges while cranking with electric starters may blank or reset the DDR.
   [a] If the SRS RECEIVED signal is YES, refer to section 10.2.11.
   [b] If the SRS RECEIVED signal is NO, refer to section 10.2.10.

10.2.10 Check Synchronous Reference Sensor

Perform the following steps to check the SRS:

1. Turn vehicle ignition OFF.
2. Disconnect engine harness connector at the ECM.
3. Measure resistance between sockets S1 and S2 at the engine harness connector.
   [a] If the resistance measurement is greater than 200 Ω, refer to section 41.3.3.
   [b] If the resistance measurement is less than 100 Ω, refer to section 41.3.2.
   [c] If the resistance measurement is between 100 and 200 Ω, refer to section 10.2.6.

10.2.11 Check for Open

Perform the following steps to check if the injector return wires are open:

1. Turn ignition OFF.
2. Disconnect the 5-way injector harness connector at the ECM.
3. Measure resistance between the injector return pin and all the power driver pins on both harness connectors.
   [a] If the resistance measurement is greater than 5 Ω on any reading, an open exists in one of the injector power driver or return wires. Repair the open. Refer to section 10.2.27.
   [b] If the resistance measurement is less than or equal to 5 Ω on any reading, refer to section 10.2.12.

10.2.12 Short to Ground

Perform the following steps to check if the injector lines are shorted to the ground:

1. Disconnect the 5-way injector harness connector at the ECM.

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2. Measure resistance between socket D of the 5-way power harness connector to the following sockets on the injector harness connector: A, B, C, D, E, G, H, J, K and L.

   [a] If the resistance measurement is greater than or equal to 10,000 Ω or open on all readings, refer to section 10.2.13.

   [b] If the resistance measurement is less than 10,000 Ω on any reading, there is a short to ground on the wire where resistance was less than 10,000 Ω. Repair the short and refer to section 10.2.27.

10.2.13 Injector Drive Pulses

Perform the following steps to check the injector drive pulses:

1. Turn ignition OFF.
2. Reconnect all ECM connectors. See Figure 10-1.
3. Remove rocker covers.
4. Disconnect return wire #619 or #620 from one injector.
5. Place a 6-volt test light across the previously disconnected injector return side and a good ground.
6. Crank engine and note the test light to see if it lights (flashes).
7. Reconnect the return wire.
8. Repeat the above procedure with all other injectors until all have been tested or until one test fails.

   [a] If all tests pass, the problem does not appear to be in the DDEC system.

   [b] If all tests do not pass and the test light is flashing for one or more tests, check for proper parts (e.g. bull gear) then try a test ECM. Refer to section 10.2.27.

[c] If all tests do not pass and the test light is not flashing for one or more tests, refer to section 10.2.8.

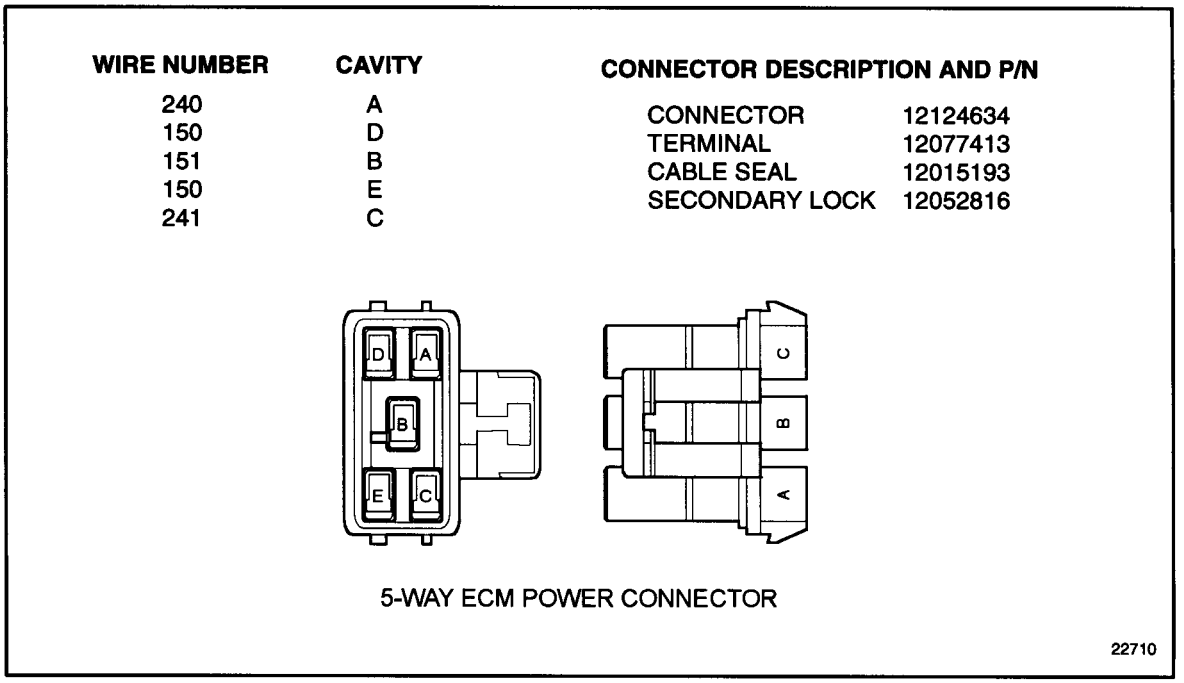

Figure 10-1 5-Way ECM Power Harness Connector

10.2.14 Check DDEC Fuses

Perform the following steps to check the DDEC fuses:

1. Check both ECM power fuses or circuit breakers.
   [a] If both fuses are okay, refer to section 10.2.15.
   [b] If either fuse is not okay, refer to section 10.2.25.

10.2.15 Battery Volts Check

Perform the following steps to check for battery volts at the 5-way connector:

NOTE:
A high resistance in these wires may prevent engine starting but measure correct voltage. Proper resistance based on wire length and size is listed in Table 46-2.

1. Turn ignition OFF.
2. Disconnect the 5-way power harness connector at the ECM. See Figure 10-2.
3. Measure voltage from socket A (red lead) of 5-way power harness connector to a good ground.

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4. Measure voltage from socket C (red lead) of 5-way power harness connector to a good ground.

   [a] If the voltage measurement is greater than 11.5 volts on all readings, refer to section 10.2.18.

   [b] If the voltage measurement is less than 11.5 volts on any readings, refer to section 10.2.16.

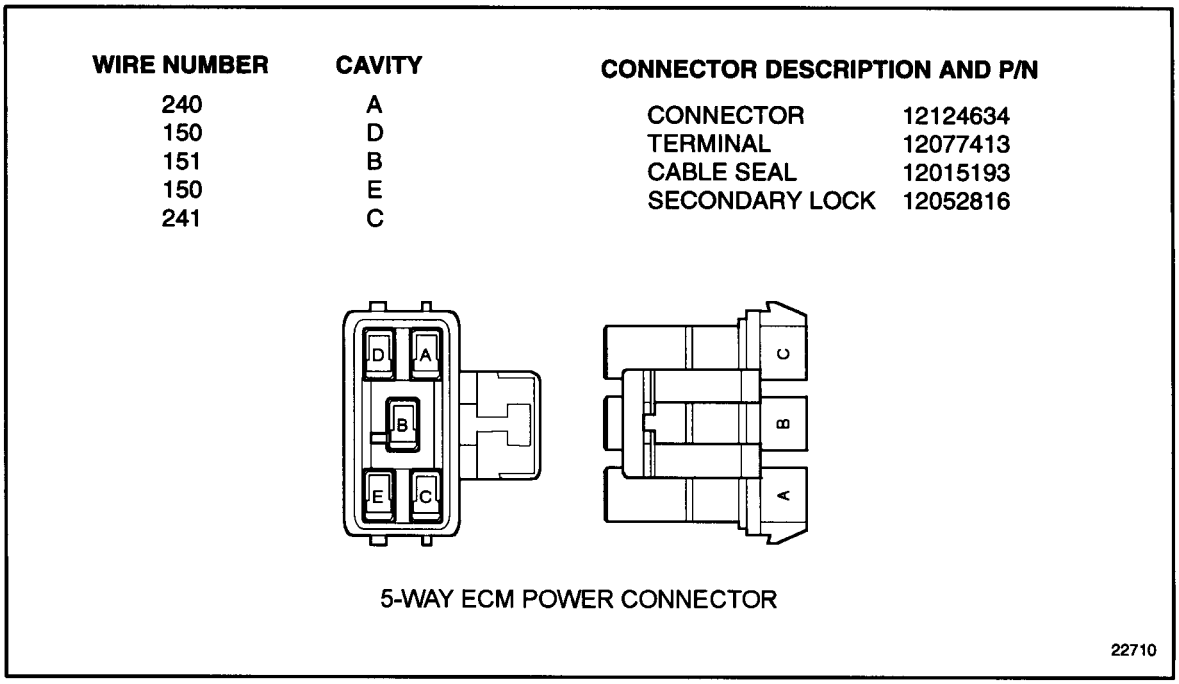

Figure 10-2 5-Way ECM Power Harness Connector

10.2.16 ECM Power Line Check

Perform the following steps to check if the ECM power lines are open:

1. Measure voltage between battery side of one ECM fuse or circuit breaker (red lead) and a good ground (black lead).
2. Measure voltage at other ECM fuse or circuit breaker. Note that battery side does not contain #240 or #241 wires. See Figure 10-3.

   [a] If the voltage measurement is less than 11.5 volts on any reading, refer to section 10.2.17.

[b] If the voltage measurement is greater than 11.5 volts on all readings, an open exists in either power wire (#240 or #241). Repair the open; refer to section 10.2.27.

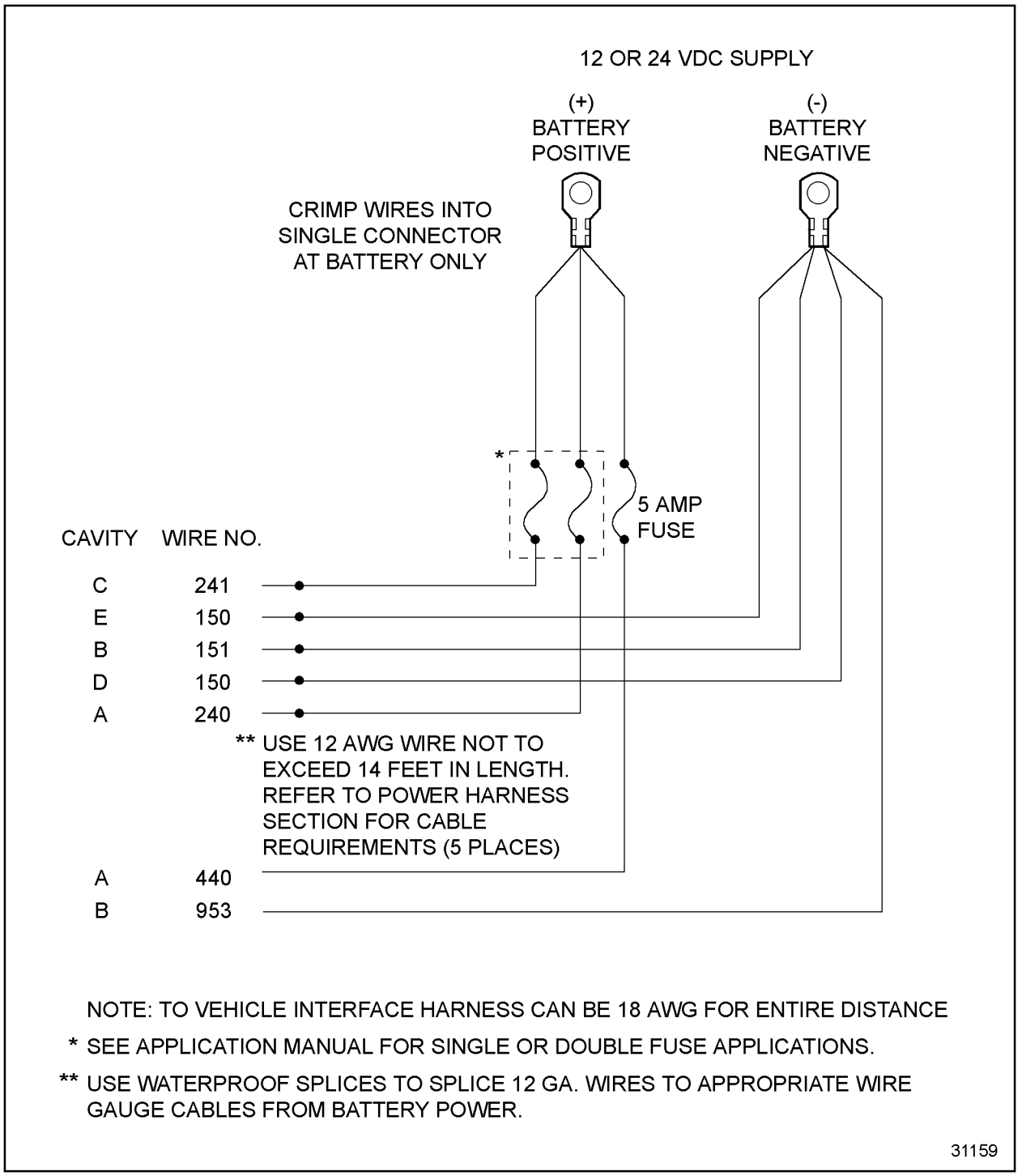

Figure 10-3 Power Harness Diagram

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10.2.17 Check Battery

Perform the following steps to check the battery:

1. Connect all connectors.
2. Turn ignition ON.
3. Measure voltage at battery (+) terminal (red lead) to the battery (-) terminal (black lead).
   [a] If the voltage reading is less than 11.5 volts, service the discharged battery. Refer to section 10.2.27.
   [b] If the voltage reading is greater than or equal to 11.5 volts, an open or short to ground exists in the battery (+) line. Repair the open. Refer to section 10.2.27.

10.2.18 Check Volts at Ignition Wire

Perform the following steps to check for +12 or +24 volts at the ignition wire:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM. For vehicle harness schematic, see Figure 10-4.
3. Turn ignition ON.
4. Measure voltage between socket B3 on the vehicle harness connector (red lead) and a good ground (black lead).
   [a] If the voltage measurement is greater than or equal to 11.5 volts, refer to section 10.2.19.

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[b] If the voltage measurement is less than 11.5 volts, refer to section 10.2.20.

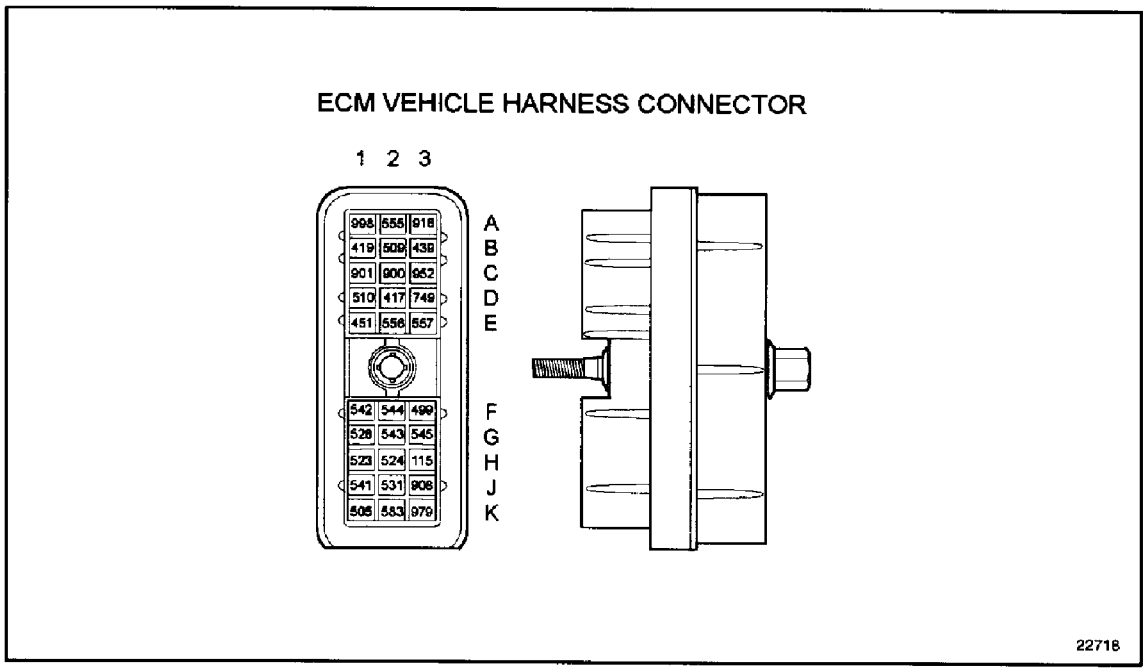

Figure 10-4 ECM Vehicle Harness Connector

10.2.19 Ground Wire Check

Perform the following steps to check for a good ground wire:

1. Measure voltage between socket B3 on the vehicle harness connector (red lead) and sockets D and E of the 5-way power harness connector. For 5-way ECM power harness schematic, see Figure 10-5.

   [a] If the voltage measurement is greater than or equal to 11.5 volts, refer to section 10.2.8.

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[b] If the voltage measurement is less than 11.5 volts, the ECM ground wire (ck#150) is open or has a poor connection. Repair open; refer to section 10.2.27.

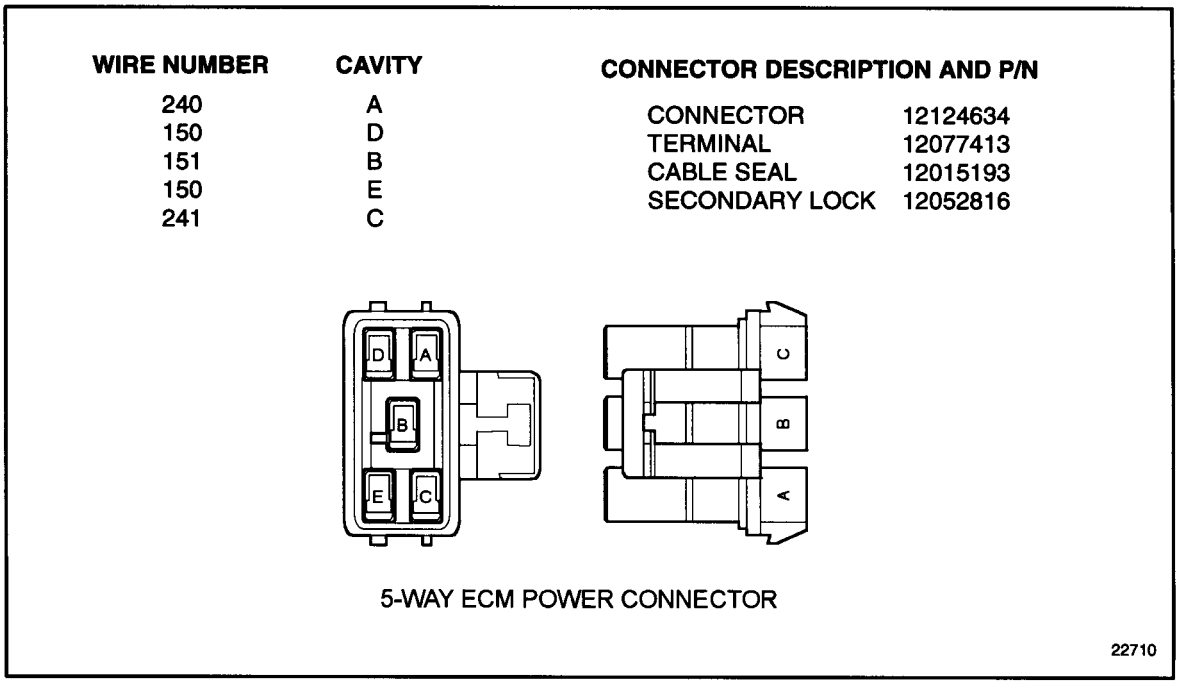

Figure 10-5 5-Way ECM Power Harness Connector

10.2.20 Check Ignition Fuse

Perform the following steps to check the ignition fuse:

1. Turn ignition OFF.
2. Check 5-amp ignition fuse or circuit breaker.
   [a] If both the fuse and circuit breaker are okay, refer to section 10.2.21.
   [b] If the fuse or circuit breaker are not okay, refer to section 10.2.22.

10.2.21 Check for Open

Perform the following steps to check if the ignition wire is open:

1. Measure voltage between battery side (hot side) of the 5-amp ignition fuse (red lead) and a good ground (black lead).
   [a] If the voltage measurement is less than 11.5 volts, refer to section 10.2.24.
   [b] If the voltage measurement is greater than or equal to 11.5 volts, the ignition line (circuit #439) is open. Repair the open; refer to section 10.2.27.

10.2.22 Check for Ground

Perform the following steps to check if the ignition wire is shorted to ground:

1. Replace blown fuse or reset open circuit breaker.
2. Turn ignition ON for ten seconds.
3. Run engine for one minute.
4. Turn ignition OFF.
5. Check 5-amp ignition fuse or circuit breaker again.
   [a] If both the fuse and circuit breaker are okay, refer to section 10.2.23.
   [b] If the fuse and circuit breaker are not okay, the ignition line (circuit #439) is shorted to ground. Repair the short; refer to section 10.2.27.

10.2.23 Check Fuse or Circuit Breaker

Perform the following steps to check if the ignition fuse or breaker is okay:

1. Reconnect all harness connectors at the ECM.
2. Start the engine.
3. Run engine for one minute.
4. Turn ignition OFF.
5. Check 5-amp ignition fuse or circuit breaker again. For 5-way ECM power harness schematic, see Figure 10-6.
   [a] If both the fuse and circuit breaker are okay, no short is currently present. Be warned of an intermittent short that could shut down the engine or blow a fuse due to reverse voltage at the battery. Refer to section 10.2.27.

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[b] If the fuse or circuit breaker are not okay, refer to section 10.2.8.

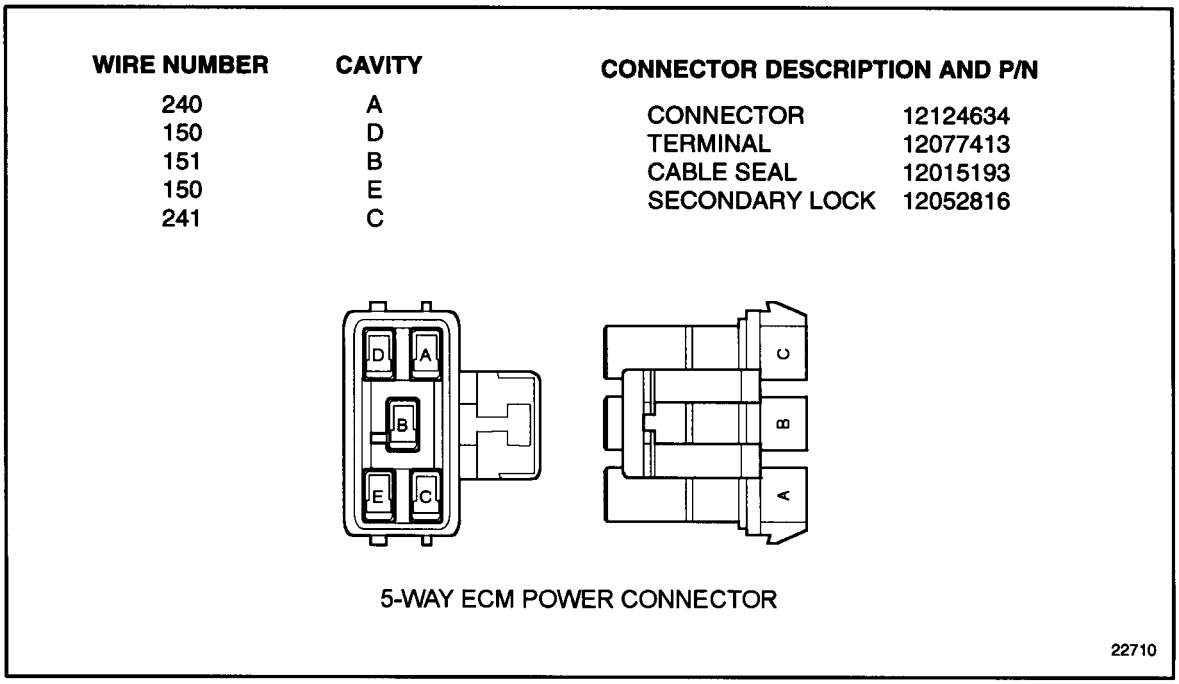

Figure 10-6 5-Way ECM Power Harness Connector

10.2.24 Check Battery

Perform the following steps to check the battery:

1. Disconnect the battery cables at the battery.
2. Measure voltage at the battery (+) terminal (red lead) to the battery (-) terminal (black lead).
   [a] If the voltage measurement is less than 11.5 volts, service the discharged battery. Refer to section 10.2.27.
   [b] If the voltage measurement is greater than or equal to 11.5 volts, an open or short to ground exists in unfused ignition line. Repair the open. Refer to section 10.2.27.

10.2.25 Check for Blown Fuses

Perform the following steps to check for blown fuses:

1. Turn ignition OFF.
2. Disconnect the 5-way power harness connector at the ECM.
3. Replace blown fuse(s) or reset the circuit breaker(s).
4. Wait ten seconds.
5. Check whether fuse(s) or circuit breaker(s) have blown or opened up again.

[a] If the fuse and circuit breaker are okay, refer to section 10.2.23.

[b] If the fuse or circuit breaker are not okay, refer to section 10.2.26.

10.2.26 Check for Short to Ground

Perform the following steps to check for a short to ground:

1. Disconnect the batteries.
2. Measure resistance between #240 and a good ground (black lead).
3. Measure resistance between #241 and a good ground (black lead).
   [a] If the resistance measurement is greater than or equal to 10,000 Ω on all readings, refer to section 10.2.8.
   [b] If the resistance measurement is less than 10,000 Ω on any readings, a short to ground exists. Repair the short. Refer to section 10.2.27.

10.2.27 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop the engine.
7. Read inactive codes.
   [a] If the engine starts and no codes are displayed, troubleshooting is complete.
   [b] If the engine does not start, refer to section 10.2.1.
   [c] If the engine starts and codes display, refer to section 9.1.

10.2.28 Check Fuel Filters

Perform the following steps to check fuel filters:

1. Turn ignition OFF.
2. Check primary and secondary fuel filters to be sure they are not clogged and they are filled with clean fuel.
   [a] If the fuel filters are clean, refer to section 10.2.4.
   [b] If the fuel filters are not clean, replace the filters. Prime the system if required. Refer to section 10.2.27.

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NOTE:
For information concerning Fuel Filters, refer to section 29.4.11 in the appropriate service manual. For information concerning Fuel Filter Replacement, refer to section 18 in the appropriate service manual.

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10.3 ERRATIC PERFORMANCE AND NO CODES

The following troubleshooting chart resolves erratic performance and no codes displayed. For troubleshooting procedures, refer to the appropriate engine service manual.

10.3.1 Erratic Performance and No Codes

Check the following symptoms to determine possible fault, listed in Table 10-1.

Symptom	Possible Fault
Cannot get full power.	Plugged fuel filters. Hose not connected to Turbo Boost Sensor. Verify injector calibration(s) are correct.
Cannot get full throttle.	Mis-calibrated Throttle Position Sensor.
Runs rough; misses and occasionally stalls.	Improper gapping of Timing Reference and Synchronous Reference Sensor. Fuel leaks. Loose battery power, ignition or ground wires Injector failure. Vehicle speed sensor failure. Injector harness failure.
Engine idles high after warm-up or hangs.	Incorrect calibration of Throttle Position Sensor. TPS linkage or pedal problem. VSG signal wire shorted to voltage source.
Low road speed.	Determine road speed specifications for vehicle manufacturer data. If road speed is less than specified and all mechanical checks are correct, then cruise control calibration is suspected.
Vehicle surges or bucks.	VSS may be supplying incorrect data to the ECM.

Table 10-1 Troubleshooting Erratic Performance and No Code

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10.4 CHECK ENGINE LIGHT AND STOP ENGINE LIGHT FAULT

The following steps will troubleshoot a fault with the check engine or stop engine lights. These lights are used to alert the operator of engine faults; flash any trouble codes stored in the ECM; and illuminate for five seconds and then go out during a start sequence, as a bulb check.

10.4.1 Determine Fault

Perform the following to determine fault:

1. If the CEL or SEL is always on, refer to section 10.4.2.
2. If the CEL or SEL never lights, refer to section 10.4.5.

10.4.2 Display ECM Light Status

Perform the following steps to display light status:

1. While the light is lit, plug in the DDR (ignition ON).
2. Select switch light status.
3. View the displayed status for the problem light.
   [a] If status reads OFF, refer to section 10.4.4.
   [b] If status reads ON, refer to section 10.4.3.

10.4.3 Determine Reason for ECM Request

Perform the following steps to determine the reason the ECM is requesting the light to be ON:

1. Verify the diagnostic request is not ON.
   [a] If the diagnostic request is ON, refer to section 10.10.
   [b] If the diagnostic request is not ON, refer to section 9.1, (troubleshoot code).

10.4.4 Check for Grounded Wire

Perform the following steps to check for a grounded wire:

1. Turn ignition OFF.
2. Unplug VIH 30-pin connector.
3. Turn ignition ON.
   [a] If the light stays on, drive (#509 or #419) wire is shorted to the ground. Repair or replace the wire. Refer to section 10.4.9.
   [b] If the light goes off, clean the connectors of the VIH 30-pin and assemble again. Then, refer to section 10.4.9.

10.4.5 Activate Light With Diagnostic Data Reader

Perform the following steps to activate the light with the DDR:

1. Turn ignition ON.
2. Plug in DDR.
3. Select Activate Outputs.
4. Activate affected light; watch status.
   [a] If the light stays off. Refer to section 10.4.6.
   [b] If the light illuminates, the problem no longer exists. Refer to *DDEC III Application and Installation* manual, 7SA800, to review the light operation.

10.4.6 Check Bulb

Perform the following steps to check the bulb:

1. Turn ignition OFF.
2. Refer to OEM recommendations for checking bulb.
   [a] If the bulb is bad, replace the bulb and refer to section 10.4.9.
   [b] If the bulb is okay, refer to section 10.4.7.

10.4.7 Check for Voltage Supply

Perform the following steps to check the voltage supply:

1. Disconnect the power supply to the light.
2. Turn ignition ON.
3. Measure voltage between the removed connection and battery ground.
   [a] If the voltage is correct based on the system of the vehicle (12/24V), refer to section 10.4.8.
   [b] If the voltage is too low to expect the bulb to light, refer to the OEM recommendations to resolve the problem. Refer to section 10.4.9.

10.4.8 Check for Open Output Wire

Perform the following steps to check for an open output wire:

1. Measure the resistance between the ground side of the connector of the light and the battery ground.
   [a] If the measured resistance is 45,000 to 48,000 Ω, clean the connections. Refer to section 10.4.9.

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[b] If the measured resistance is less than 45,000 Ω or greater than 48,000 Ω, the wire is shorted to voltage, or is opened. Repair wire. Refer to section 10.4.9.

10.4.9 Verify Repairs

Perform the following steps to verify repairs.

1. Ensure all removed connections are installed.
2. Turn ignition ON.
   [a] If the light comes on for five seconds, then goes out, troubleshooting is complete.
   [b] If the light comes on and stays on, refer to section 10.4.1.
   [c] If the light does not turn on, all troubleshooting is complete. Review this section and contact Detroit Diesel Technical Service.

10.5 NO DATA TO DIAGNOSTIC DATA READER

Before using this procedure, all basic mechanical checks and physical inspections should have been performed with no problem found. Also the diagnosis of the DDEC system in Section 9 referred you to this section.

10.5.1 Read Codes on the Check Engine Light

Perform the following steps to read the codes on the CEL or SEL:

1. Unplug the DDR.
2. Ignition should be ON; engine not running.
3. Enable diagnostic request switch.
4. Read codes flashing on the CEL and SEL.
   [a] If codes are flashing out, refer to section 10.5.4.

NOTE:
If you wish to bypass diagnosis of a potential data line of the DDR problem for now, diagnose the active code by referring to the section that matches the code number.

   [b] If CEL and SEL are not flashing out codes, refer to section 10.5.2.

10.5.2 Check Diagnostic Request Circuit

Perform the following steps to check the diagnostic request circuit:

1. Ensure ignition is ON.
2. Plug in DDR.
3. Select Calibration Configuration.
4. Determine port assigned to Diagnostic Request on the ECM input switches.
5. Go to switch light status.
6. Depress and hold the diagnostic request switch.
7. Read status of diagnostic request.
   [a] If the switch reads OFF, the diagnostic request circuit (#528) is open or the ground is poor or open. Repair the open wire or the bad ground. Refer to section 10.5.8.
   [b] If the switch reads ON, refer to section 10.5.3.

10.5.3 Check ECM Connectors

Follow this procedure to check the ECM connectors:

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1. Check the terminals at the vehicle harness and 5-way power harness connectors (both ECM and harness side) for damage: bent, corroded and unseated pins or sockets. See Figure 10-7.

   [a] If terminals and connectors are okay, replace the ECM. Refer to section 10.5.8.

   [b] If the terminals and connectors are damaged, repair them. Refer to section 10.5.8.

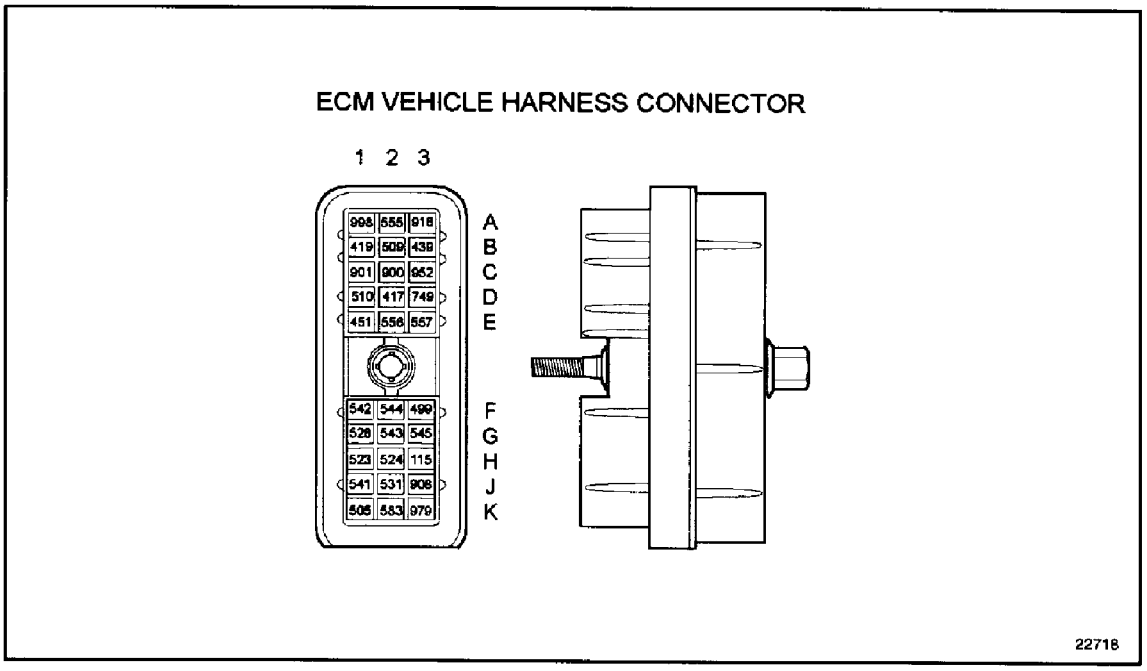

Figure 10-7 ECM Vehicle Harness Connector

10.5.4 Check for Open

Perform the following steps to check for an open:

1. Turn ignition OFF.
2. Place a jumper wire across pins A (#900) and B (#901) of the DDL connector. Unplug the vehicle harness connector and measure resistance between sockets C1 and C2.
3. Turn ignition ON, and again measure resistance between sockets C1 and C2. See Figure 10-8.

   [a] If both readings are greater than 5 Ω , one or both data wires (circuit #900 or #901) are open. Repair the open and refer to section 10.5.8.

[b] If either reading is less than 5 Ω, refer to section 10.5.5.

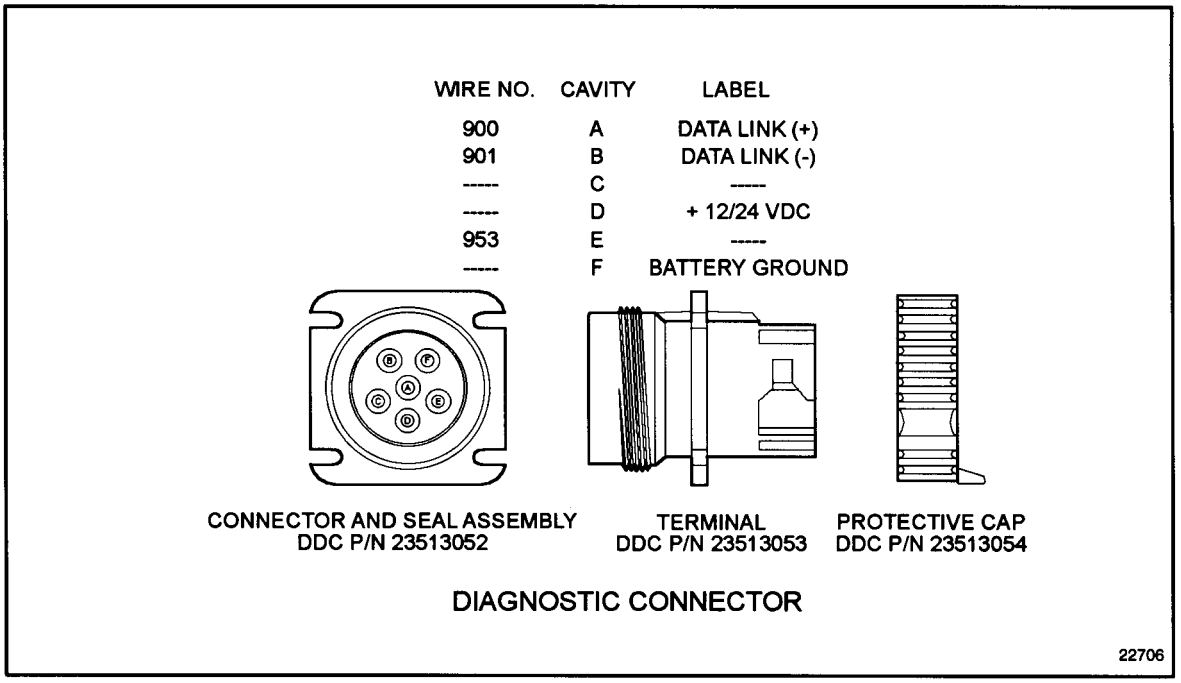

Figure 10-8 Diagnostic Connector

10.5.5 Check for Short

Perform the following steps to check for a short:

1. Remove the jumper wire from the DDL connector.
2. Measure resistance between sockets C1 (#901) and C2 (#900) of the vehicle harness connector.
   [a] If the resistance measurement is less than 5 Ω, two data wires (circuit #900 or #901) are shorted together. Repair the short and refer to section 10.5.8.
   [b] If the measured resistance is greater than 5 Ω, refer to section 10.5.6.

10.5.6 Check for Short to Ignition and Ground

Perform the following steps to check for a short to ignition and ground:

1. Remove all jumpers for the DDL connector.
2. Measure resistance between sockets A (#900) and C (ignition switch), A (#900) and E (ground), B (#901) and E (ground), and B (#901) and C (ignition switch) of the DDL connector.
   [a] If the measured resistance is less than 5 Ω on any reading, a short exists between the data wires and ignition or ground. Repair the short and refer to section 10.5.8.
   [b] If the measured resistance is greater than 5 Ω, refer to section 10.5.7.

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10.5.7 Check Diagnostic Data Reader on Another Engine

Follow this procedure to check the DDR on another engine:

1. Connect the DDR to another engine and read any parameter in the menu.
   [a] If the procedure worked okay, refer to section 10.5.8.
   [b] If the procedure did not work, the DDR is probably defective. Refer to the DDR instruction manual for repair.

10.5.8 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Turn ignition OFF.
6. Turn ignition ON.
7. Note status of CEL.
8. Start and run the engine for one minute.
9. Read inactive codes.
   [a] If the DDR display reads NO DATA BEING RECEIVED FROM DATA LINK or DDEC SYSTEM NOT RESPONDING, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 10.5.1.
   [b] If the engine starts and no codes are read on the DDR, repairs are complete.
   [c] If the engine starts and code displays, refer to section 9.1.

10.6 DIAGNOSTIC REQUEST SWITCH INOPERATIVE

Before using this procedure, all basic mechanical checks and physical inspections should have been performed with no problem found. Also the diagnosis of the DDEC system in Section 9 referred you to this section.

10.6.1 Check Diagnostic Request Circuit

Perform the following steps to check the diagnostic request circuit:

1. Turn ignition ON; engine not running.
2. Plug in DDR.
3. Select Switch/Light Status.
4. Depress and hold diagnostic request switch.
5. Observe the Diagnostic Request Status on the DDR.
   [a] If the display reads ON, refer to section 10.6.2.
   [b] If the display reads OFF, the diagnostic request line (#528) is open, or is not being grounded when the switch is depressed. Check the #528 wire and ground for diagnostic request switch. Repair the problem; refer to section 10.6.4.
   [c] If no diagnostic request on the DDR input list, the ECM is not configured for diagnostic request operation. Refer to the *DDEC Application and Installation* manual, 7SA800.

10.6.2 Check Stop Engine Light and Check Engine Light Bulbs

Perform the following steps to check the SEL and CEL bulbs:

1. Turn ignition OFF.
2. Remove CEL and SEL bulbs. Check to see if either is burned out or damaged.
   [a] If the bulbs are okay, refer to section 10.6.3.
   [b] If the bulbs are defective, replace the bulbs. Refer to section 10.6.4.

10.6.3 Check 12 / 24V Ignition Line

Perform the following steps to check the 12/24V ignition line:

1. Turn ignition ON.
2. Disconnect vehicle harness connector at ECM.
3. Measure voltage at cavity B3 (#439).
   [a] If voltage measurement is less than 11.5V, the 5 amp fuse or circuit breaker is blown, and the ignition line could be open or shorted to ground.

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[b] If the voltage measurement is greater than 11.5V, the circuit #419 or #509 is open. Repair the open. Refer to section 10.6.4.

10.6.4 Verify Repairs

Perform the following steps to verify repairs:

1. Reconnect all connectors.
2. Turn ignition ON.
3. Press diagnostic request switch.

   [a] If codes flash, the system is working. Repairs are complete. If any other problems exist, refer to section 9.1.

   [b] If the system does not function, all system diagnostics are complete. Review this section to find the error. Refer to section 10.6.1.

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10.7 CRUISE CONTROL INOPERATIVE

Before using this procedure, all basic mechanical checks and physical inspections should have been performed with no problem found. Also the diagnosis of the DDEC system in Section 9 referred you to this section.

10.7.1 Determine Type of Cruise Control System

Perform the following to determine the type of cruise control system:

1. Check that this is a DDEC cruise control system.
2. Turn ignition ON.
3. Plug DDR into DDL connector.
4. Select calibration configuration (cruise control).
5. Is cruise control enabled?
   [a] If cruise control is enabled, refer to section 10.7.3.
   [b] If cruise is not enabled, refer to *DDEC III Installation and Application* manual, 7SA800, for requirements of installing cruise control.

10.7.2 Check ECM Connectors

Perform the following to check the ECM connectors:

1. Disconnect the vehicle harness connector at the ECM.
2. Check the terminals at the ECM vehicle harness connector (both ECM and harness side) for damaged, corroded, or unseated pin or sockets.
   [a] If terminals and connectors are not damaged, reprogram the ECM. Refer to section 10.7.16.
   [b] If the terminals or connectors are damaged, repair them. Refer to section 10.7.16.

10.7.3 Check Pin Assignments

Perform the following to check pin assignments:

1. Turn ignition ON.
2. Plug in the DDR.
3. Select calibration configuration (ECM Ins/Outs).
4. Write/print pin assignments.

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[a] An example listed in Table 10-2 shows pins, wires and functions. Refer to section 10.7.4.

Pin	Wire	Function
J1	#541	set/coast on
F2	#544	cruise enable
G2	#543	svc brk rel
J2	#531	clutch rel
G3	#545	res/accel on

Table 10-2 Pin Assignments

[b] If the functions are not assigned, reprogram the ECM. Refer to section 10.7.16.

10.7.4 Checking Out of Cruise Control Switch and Wiring

To speed up the checking out of cruise control switches, quick check tables have been developed. These tests are to be run with the ignition ON, and the engine not running. A DDR must be plugged into the connector. All three quick check tables must be gone through to completely check out the cruise control wiring and switches.

For Example: Listed in Table 10-3, step 2, you would do the following:

1. Ignition ON; engine not running; DDR plugged in.
2. Turn the cruise enable switch to ON.
3. Select switch/light status on the DDR.
4. Note the DDR display; if ON, check out brake and clutch switch as listed in Table 10-4.

Step	Cruise Enable Switch	Set / Coast Switch	Res / Accel Switch	DDR Readout Being Looked At	DDR Display	Okay	Go To
1.	Off	Off	Off	Cruise Enable	OffOn	YesNo	Refer to step 2 Refer to section 10.7.5
2.	On	Off	Off	Cruise Enable	OffOn	NoYes	Refer to section 10.7.6Listed in Table 10-4, step 1

Table 10-3 Cruise Control Quick Check Table I, Check Out Cruise Enable Switch and Wiring (Ignition ON Not Running)

Step	Cruise Enable Switch	Brake Pedal	Clutch Pedal	DDR Readout Being Looked At	DDR Display	Okay	Go To
1.	On	Released	Released	Service Brake Release	On Off	Yes No	Refer to step 2 Refer to section 10.7.7
2.	On	Depressed	Released	Service Brake Release	On Off	No Yes	Refer to section 10.7.8 Refer to step 3
3.	On	Released	Released	Clutch Release	On Off	Yes No	Refer to step 4 Refer to section 10.7.9
4.	On	Released	Depressed	Clutch Release	On Off	No Yes	Refer to section 10.7.10Listed in Table 10-5, step 1

Table 10-4 Cruise Control Quick Check Table II, Check Out Brake and Clutch Switch and Wiring (Ignition ON Not Running)

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Step	Cruise Enable Switch	Set / Coast Switch	Res / Accel Switch	DDR Readout Being Looked At	DDR Display	Okay	Go To
1.	On	Off	Off	Set/Coast On	Off On	Yes No	Refer to step 2 Refer to section 10.7.11
2.	On	On	Off	Set/Coast On	Off On	No Yes	Refer to section 10.7.12 Refer to step 3
3.	On	Off	Off	Res/Ac-celOn	Off On	Yes No	Refer to step 4 Refer to section 10.7.13
4.	On	Off	On	Res/Accel On	Off On	No Yes	Refer to section 10.7.14Refer to section 10.7.15

Table 10-5 Cruise Control Quick Check Table III, Check Out Set/Coast and Resume/Accel Switches and Wiring (Ignition ON Not Running)

10.7.5 Check for Short at the Cruise Enable Circuit

Perform the following steps to check for a short at the cruise enable circuit:

1. Turn ignition ON.
2. Turn cruise engage switch to off.
3. Disconnect the vehicle harness connector at the ECM.
4. Measure resistance between the cruise enable cavity (i.e. F2) on the vehicle harness connector and a good ground.

   [a] If the resistance measurement is less than or equal to 10,000 Ω, reconnect the vehicle harness. Turn the ignition on. Then run steps listed in Table 10-4; and listed in Table 10-5. If any DDR display received is not okay, refer to the indicated step. If all steps listed in Table 10-4 and listed in Table 10-5, pass, then the cruise engage wire is shorted to the ground. Repair the short, or replace the switch. Refer to section 10.7.16.

   [b] If the resistance measurement is greater than 10,000 Ω, refer to section 10.7.2.

10.7.6 Check for Open at the Cruise Enable Circuit

Perform the following steps to check for an open at the cruise enable circuit:

1. Turn ignition ON.
2. Disconnect the vehicle harness connector at the ECM.
3. Turn cruise enable switch to ON.
4. Measure resistance between the cruise enable cavity (i.e. F2) on the vehicle harness connector and a good ground.
   [a] If the resistance measurement is greater than 5 Ω, or open, the cruise engage switch is bad, circuit #953 is open or the cruise enable wire is open. Repair the open or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is less than or equal to 5 Ω, refer to section 10.7.2.

10.7.7 Check for Open or Miswired Brake Switch

Perform the following steps to check for an open or miswired brake switch:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Ensure the service brake is not engaged.
4. Measure resistance between the service brake cavity (i.e. G2) on the vehicle harness connector and a good ground.
   [a] If the resistance measurement is greater than 5 Ω, or open, the brake switch is miswired or faulty, circuit #953 is open or the ground is bad. Repair the open, rewire or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is less than or equal to 5 Ω, refer to section 10.7.2.

10.7.8 Check for Short at the Brake Switch or Circuit

Perform the following steps to check for a short at the brake switch or circuit:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Engage the service brake.
4. Measure resistance between the service brake cavity (i.e. G2) on the vehicle harness connector and a good ground.
   [a] If the resistance measurement is less than or equal to 10,000 Ω, the brake switch is miswired or the service brake circuit is shorted to ground. Rewire, repair the short or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is greater than 10,000 Ω, or open, refer to section 10.7.2.

10.7.9 Check for Open or Miswired Clutch Switch

Perform the following steps to check for an open or miswired clutch switch:

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1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Ensure the clutch is not engaged.
4. Measure resistance between the clutch cavity (i.e. J2) on the vehicle harness connector and a good ground.
   [a] If the resistance measurement is greater than 5 Ω, or open, the clutch switch is miswired or faulty, circuit #953 is open, or there is a bad battery ground. Rewire, repair the short or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is less than or equal to 5 Ω, refer to section 10.7.2.

10.7.10 Check for Short at the Clutch Service/Circuit

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Engage the clutch.
4. Measure resistance between the clutch cavity (i.e. J2) on the vehicle harness connector and a good ground.
   [a] If the resistance measurement is less than or equal to 100 Ω, the clutch switch is miswired or faulty, or the clutch circuit is shorted to ground. Rewire, repair the short or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is greater than 100 Ω, or open, refer to section 10.7.2.

10.7.11 Check for Short at the Set/Coast Circuit

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Measure resistance between the set/coast cavity (i.e. J2) and a good ground.
   [a] If the resistance measurement is less than or equal to 100 Ω, the set/coast switch is shorted, or a short to ground exists in the set/coast circuit (i.e. #541). Repair the short or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is greater than 100 Ω, refer to section 10.7.2.

10.7.12 Check for Open at the Set/Coast Circuit

Perform the following steps to check for an open:

1. Turn ignition OFF.

2. Disconnect the vehicle harness connector at the ECM.
3. Find a means to press and hold the set/coast switch.
4. Measure resistance between the set/coast cavity (i.e. J1) and a good ground.
   [a] If the resistance measurement is greater than 5 Ω, or open, the set/coast switch is open or miswired, circuit #953 is open, or there is a bad battery ground. Rewire, repair the short or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is less than or equal to 5 Ω, refer to section 10.7.2.

10.7.13 Check for Short at the Res/Accel Circuit

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Measure resistance between the Res/Accel cavity (i.e. G3) and a good ground.
   [a] If the resistance measurement is less than or equal to 100 Ω, the Res/Accel switch is shorted, or a short to ground exists in the Res/Accel circuit (i.e. #541). Repair the short or replace the switch. Refer to section 10.7.16.
   [b] If the resistance measurement is greater than 100 Ω, refer to section 10.7.2.

10.7.14 Check for Open at the Res/Accel Circuit

Perform the following steps to check for an open:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Find a means to press and hold the Res/Accel switch.
4. Measure resistance between the Res/Accel cavity (i.e. G3) and a good ground.
   [a] If the resistance measurement is greater than 5 Ω, or open, the Res/Accel switch is open or miswired, circuit #953 is open or the battery ground is bad. Repair the short, replace the switch, or rewire. Refer to section 10.7.16.
   [b] If the resistance measurement is less than or equal to 5 Ω, refer to section 10.7.2.

10.7.15 Verify Problem Still Exists

Perform the following steps to verify the problem still exists:

1. If you were referred to this step, you have completed the switch checkout process without detecting a fault.
2. Take the vehicle for a road test and check the cruise control operation.

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[a] If the cruise control operates correctly, the problem no longer exists. If any other problems exist, refer to section 9.1.

[b] If the cruise control does not operate correctly, check the vehicle speed sensor. Refer to section 54.1.

10.7.16 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Road test the vehicle.

   [a] If the cruise control operates correctly, troubleshooting is complete.

   [b] If the cruise control does not operate correctly, all system diagnostics are complete. Review this section from the start to find the error. Refer to section 10.7.1.

10.8 FAN OPERATIONAL CONCERN (ON/OFF TYPE)

This section covers only the DDEC controlled fan operation, (fan type single, dual or two-speed). If the function is assigned, see description of DDEC fan control logic, listed in Table 10-6.

Cavity	Wire#	Function	Output/Input
X#	#	Fan Control 1	Output - Required
X#	#	Aux. Fan Control	Input - Optional
X#	#	Fan Override	Input - Optional

Table 10-6 DDEC Fan Control Logic Description

10.8.1 Digital Fan Operation

Items used in digital fan operation include:

1. The ECM provides ground (output Fan Control 1) and should be wired such that when this cavity grounds, the fan should turn off. When the circuit goes open, the fan should turn on.
2. When Aux. Fan Control is configured (input), this wire must be connected to battery ground, or the fan will always be on. Typically, this is used with an air conditioning pressure switch. High pressure opens this circuit, and turns the fan on for a minimum time that can be set with the programming station on later ECM software versions.
3. Fan Override - Grounding this wire will turn the fan on. This would normally be an OEM supplied switch on the dash.

Other than these items, the ECMs fan control output opens, turning the fan on due to engine temperatures that are above the programmed limits. Once a fan output turns the fan on for whatever reason, all fan off temperatures must be met before the fan will turn off.

Temperatures for most highway applications are listed in Table 10-7.

Fan Control	Actual Fan Status	Coolant Temp	Oil Temp	Air Temp
Fan Control - 1	Fan ON	96 ° C / 204 ° F	110 ° C / 230 ° F	66 ° C / 150 ° F
Fan Control - 2	Fan ON	98 ° C / 208 ° F	113 ° C / 235 ° F	N/A
Fan Control -	Fan OFF	92 ° C / 197 ° F	104 ° C / 219 ° F	49 ° C / 120 ° F

Table 10-7 Highway Application Temperatures

These temperature limits are only changeable in the base calibration.

10.8.2 Check Output Status

Perform the following steps to troubleshoot a fan operation problem:

1. Start engine.

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2. Ensure the air conditioning of the vehicle is OFF.
3. Run engine for at least three minutes.
4. Plug in DDR.
5. Select switch / light status.
6. Check the status of the Fan Control #1 while noting the actual fan status as listed in Table 10-8.

	Status	Status	Status	Status
Fan Control #1	ON	OFF	ON	OFF
Actual Fan State	OFF	ON	ON	OFF
	Refer to section 10.8.3.	Refer to section 10.8.4.	Refer to section 10.8.6	Refer to section 10.8.7

Table 10-8 Troubleshooting Fan

10.8.3 Fan Information

The steps that led to this procedure do not indicate a problem with the fan control logic in the ECM. The fan operation is normal if the steps that you checked led you to this section.

The fan status is correct according to what the ECM is requesting.

If you believe the fan state should be different, review the DDEC application and installation manual for information on fan control configuration.

10.8.4 Check Input Status

Read the status of the inputs used for fan operation listed in Table 10-9. (Note both together.)

	Status	Status	Status
Aux. Fan Control	OFF	ON	ON
Fan Override	OFF	ON	OFF
	Refer to section 10.8.5	Refer to section 10.8.8	Refer to section 10.8.3

Table 10-9 Input Status

10.8.5 Check for Input Open

Perform the following steps to check for an open:

1. Turn ignition OFF.
2. Disconnect vehicle 30-pin connector at the ECM.
3. Turn ignition ON.

4. Measure resistance between auxiliary fan control wire and a good ground.
   [a] If the measured resistance is greater than 1,000 Ω, an open exists in the auxiliary fan control wire, or auxiliary fan control is configured and not wired, or the switch is bad. Repair open or replace the switch if an auxiliary fan control is used. If this feature is not to be used, disable the auxiliary fan control with the programming station. Refer to section 10.8.10.
   [b] If the measured resistance is less than or equal to 1,000 Ω, refer to section 10.8.9.

Perform the following steps to troubleshoot fan always on. The steps that led to this procedure do not indicate a problem with the fan control logic in the ECM. The fan operation is normal if the steps that you checked led you to this section.

10.8.6 Check for Output Open

Perform the following steps to check for an output open:

1. With ignition off, locate OEM supplied wire used for Fan Control #1.
2. Determine where the wire terminates. (e.g. fan solenoid, relay, data module, etc.)
3. Disconnect the Fan Control #1 wire at the solenoid/relay.
4. Turn ignition ON.
5. Measure resistance between the fan control #1 wire and a good ground, battery (-).
   [a] If the measured resistance is greater than 48,000 Ω or open, an open exists in the FC#1 wire. Repair the open. Refer to section 10.8.10.
   [b] If the measured resistance is less than or equal to 48,000 Ω, refer to section 10.8.9.

10.8.7 Check for Output Short

Perform the following steps to check for an output short:

1. With ignition off, locate OEM supplied wire used for Fan Control #1.
2. Determine where the wire terminates. (e.g. fan solenoid, relay, data module, etc.)
3. Disconnect the Fan Control #1 wire at the solenoid/relay.
4. Measure resistance between the fan control #1 wire and a good ground, battery (-).
   [a] If the measured resistance is greater than 1,000 Ω or open, refer to section 10.8.9.
   [b] If the measured resistance is less than or equal to 1,000 Ω, the output wire is shorted to ground, keeping the fan off. Repair the short or replace the wire. Refer to section 10.8.10.

10.8.8 Check Override Request

Perform the following steps to check the fan override switch:

1. Is the fan override switch on?

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[a] If the fan override is on, and the fan override is requesting fan on, this is normal.

[b] If the fan override is not on, the fan override wire is shorted to ground, repair the short or re-configure the input if this is an error in programming. Refer to section 10.8.10.

10.8.9 Check Connectors

Perform the following steps to check the connectors:

1. Check connectors for damaged, bent, or corroded terminals.

   [a] If the pins and terminals are not damaged, the problem may be due to the solenoid, ECM, or OEM device that operates the fan. Contact the OEM for further information or instructions. The ECM and wiring between the ECM and device appear to be operating correctly and in good repair. The ECM is requesting the fan operation correctly and the checks indicate the ECM and wire between the ECM and OEM device is okay.

   [b] If the pins or terminals are damaged, repair or replace them. Refer to section 10.8.10.

10.8.10 Verify Repairs

Perform the following steps to verify repairs:

1. Connect any removed connectors.
2. Start engine.
3. Operate engine under conditions that brought you to this section.
4. Check fan operation.

   [a] If the fan operates correctly, troubleshooting is complete.

   [b] If the fan does not operate correctly, review this section from the first step to find the error.

10.9 FAN OPERATIONAL CONCERN (VARIABLE SPEED TYPE)

The DDEC system via a PWM (Pulsewidth Modulation) signal will go to a high voltage (7-8 volts on a 12-volt system) on a cold engine for a low speed, and to a low voltage (0.8 - 1.0 volts on a 12-volt system) for a high speed.

Fan speed is ramped up as temperatures increase, as listed in Table 10-10. Calibrations can vary. The table is provided only as a guide.

Coolant Temperature	Speed
up to 197°F	Low speed
about 203°F	Medium speed
208°F and above	High speed

Table 10-10 Fan Speed vs Temperature

10.9.1 Verify Correct DDEC Configuration

Perform the following steps to verify the configuration:

1. Turn ignition ON.
2. Plug in DDR.
3. Select "View Calibration" (ECM Ins/Outs).
4. Review PWM functions to determine correct pin assignment for PWM fan.
   [a] If the cavity is assigned to PWM Fan, refer to section 10.9.2.
   [b] If the cavity is not programmed, reprogram the ECM and refer to section 10.9.7.

10.9.2 Check for Signal

Perform the following steps to check for signal:

1. Start and run the engine at idle.
2. Plug in DDR.
3. Review engine data list and watch the pulsewidth modulation number x wire = # of fan assignment (normally PWM#4).
4. Verify coolant, oil and air temperatures are cooler, less than 150 ° F. Verify the air conditioning input is grounded (On).
   [a] If the PWM value is 80 to 90% and the fan is at Low Speed, refer to section 10.9.3.
   [b] If the PWM value is 80 to 90% and the fan is at High Speed, refer to section 10.9.4.

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10.9.3 Check Signal Engine Hot

Perform the following steps to check the signal status:

1. Start engine and warm up. Road test (until coolant temp is about 200 ° F).
2. View DDR data list display, Coolant Temp/PWM # (normally #4).
   [a] If PWM % decreases as the temperature increases, all checks appear normal. If this is an intermittent high speed operation, check A/C Freon pressure switch or wiring for an intermittent open. Refer to section 10.9.7.
   [b] If PWM % decreases as the temperature increases, but the fan speed stays low, refer to section 10.9.5.

10.9.4 Check for Open

Perform the following steps to check for an open:

1. Turn ignition OFF.
2. Unplug PWM wire at the fan control valve.
3. Install a jumper between the PWM wire and the battery (-).
4. Unplug the engine harness connector.
5. Measure resistance between the PWM cavity and the battery (-).
   [a] If the measured resistance is greater than 1,000 Ω, the wire is open. Repair the open and refer to section 10.9.7.
   [b] If the measured resistance is less than 1,000 Ω, the valve or wiring (voltage supply) to the valve is defective. Replace.

10.9.5 Check for Short

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Unplug the engine harness connector.
3. Measure resistance between the PWM cavity and several ground sources (battery, chassis, etc.).
   [a] If the measured resistance is greater than 1,000 Ω, refer to section 10.9.6.
   [b] If the measured resistance is less than 1,000 Ω at any time, the wiring is shorting. Replace the wire and refer to section 10.9.7.

10.9.6 Check Connectors

Perform the following steps to check the connectors:

1. Check for damaged, bent or corroded connectors, pins, and terminals.

[a] If the connectors, pins, and terminals are not damaged, contact the OEM or fan valve supplier for instructions on further troubleshooting. If the ECM and wiring to the component appear to be okay, the problems could be with the control valve or battery and wiring.

[b] If the connectors, pins or terminals are damaged, repair or replace them and refer to section 10.9.7.

10.9.7 Verify Repairs

Perform the following steps to verify repairs:

1. Connect all removed connectors, etc.
2. Start and run the engine from cold to hot, while watching the fan speed operation.
   [a] If the operation is normal, troubleshooting is complete.
   [b] If the operation is not normal, all system diagnostics are complete. Review this section to find the error. Refer to section 10.9.1.

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10.10 ENGINE BRAKE INOPERATIVE

The following procedure will troubleshoot DDEC controlled Engine Brake Inoperative.

10.10.1 Engine Brake Inoperative

Perform the following steps to troubleshoot the inoperative engine brake:

1. Turn ignition ON.
2. Plug in DDR.
3. View Diagnostic Data List to see if the correct application is programmed into the ECM.
4. Next to Engine Brake, the display should read ON or OFF. If it reads N/A, the DDC mainframe must be changed and the ECM must be reprogrammed after the change is made.
5. If the ECM is correctly configured, go to the view calibration area with the DDR and check to ensure that the two required inputs (Engine Brake Low and Engine Brake Medium) are configured.
6. If the inputs are not configured, or incorrectly configured, this must be corrected using the DDEC reprogramming station.
7. If the inputs are configured correctly, print or write down the inputs and outputs for future reference. Refer to section 10.10.2. Refer to the appropriate Application and Installation manual for engine brake operation.

10.10.2 Check Switches

Perform the following steps to troubleshoot the switches:

1. Turn ignition ON.
2. Plug in DDR.
3. Select Switch Light status - Inputs.
4. View DDR display of Eng Brk Low and Eng Brk Med.

NOTE:
Set brake dash switch position on low.

[a] If Eng Brake Low is ON and Eng Brake Med is OFF, refer to section 10.10.3.

[b] If Eng Brake Low is ON and Eng Brake Med is ON, medium and low inputs are shorted to each other. Repair. Refer to section 10.10.9.

[c] If Eng Brake Low is OFF and Eng Brake Med is ON, input wires are reversed. Correct and refer to section 10.10.9.

[d] If Eng Brake Low is OFF and Eng Brake Med is OFF, refer to section 10.10.4.

5. Turn brake enable dash switch on.

10.10.3 View Diagnostic Data Reader Display

Perform the following steps to troubleshoot the inoperative engine brake:

1. View DDR display.

NOTE:
Set brake dash switch position on medium.

[a] If Eng Brake Low is OFF and Eng Brake Med is ON, refer to section 10.9.5.

[b] If Eng Brake Low is ON and Eng Brake Med is ON, medium and low inputs are shorted to each other. Repair. Refer to section 10.10.9.

[c] If Eng Brake Low is ON and Eng Brake Med is OFF, input wires are reversed. Correct and refer to section 10.10.9.

[d] If Eng Brake Low is OFF and Eng Brake Med is OFF, refer to section 10.10.4.

10.10.4 Check for Open

Perform the following steps to check for an open:

1. Turn ignition OFF.
2. Turn engine brake switch to low.
3. Measure resistance between the engine brake low switch and a good ground (ECM side).
4. Set switch to Med. Measure resistance between medium input and a good ground.

[a] If the measured resistance is less than 10,000 Ω, either the switch is bad or the wire from the switch to the battery ground is bad. Replace the switch or repair the open.

[b] If the measured resistance is greater than 10,000 Ω, or open, an open exists in the input wire. Repair the open. Refer to section 10.10.9.

10.10.5 View Calibration - Engine Configuration

Perform the following steps to view calibration - engine configuration:

1. Go to View Cal-Eng Configuration. Check status of Eng Brk Serv Brk and Eng Brk mph. If Eng Brk Serv Brk indicates YES, or Eng Brk Min mph has number other than "0", check with the operator to ensure he or she understands how these functions operate.

[a] If the Eng Brk Serv Brk indicates YES, the application of service brake is required for engine brake operation.

[b] If the Eng Brk Min mph has a number other than "0", the brakes will not operate below this mph.

NOTE:
These two functions may work separately or together.

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[c] If the Eng Brk Svc Brk indicate No, and Eng Brk Min mph indicate 0, refer to section 10.10.6.

10.10.6 Check Engine Brake Operation

Perform the following steps listed in Table 10-11 to check out the brake and clutch switch, and the wiring.

NOTE:
If table below leads to section 10.11, troubleshoot clutch and brake inputs. Then check operation of engine brake. If engine brake is still inoperative, refer to section 10.10.7.

1. Turn ignition ON. Engine must not be running.
2. Plug in DDR. Select switch/light status.

Step	Brake Pedal	Clutch Pedal	DDR Readout Looked At	DDR Display	Status OK	
1.	Released	Released	Service Brake (Release)	On Off	Yes No	refer to Step 2 refer to section 10.11
2.	Depressed	Released	Service Brake Release	On Off	No Yes	refer to section 10.11 refer to Step 3
3.	Released	Released	Clutch Release	On Off	Yes No	refer to Step 4 refer to section 10.11
4.	Released	Depressed	Clutch Release	On Off	No Yes	refer to section 10.11refer to section 10.10.7

Table 10-11 Engine Brake Operation

10.10.7 Check Brake Solenoids

Perform the following steps to troubleshoot the brake solenoids:

1. Check engine brake solenoids. Refer to OEM guidelines.
   [a] If solenoids are okay, refer to section 10.10.8.
   [b] If solenoids are bad, repair or replace the solenoids. Refer to section 10.10.9.

10.10.8 Verify Conditions

Perform the following steps to verify conditions:

1. Verify proper conditions are being met to enable engine brake:
   [a] TPS % = 0 %
   [b] Pulse width = 0 (or less)
   [c] Engine speed >850 r/min
   [d] Clutch release (input) = ON (if configured)
   [e] Engine brake disable (input) = OFF (Auto Trans)
2. Are the conditions listed in 1a through 1e met?
   [a] If conditions are not met, correct the problem (i.e. TPS). Refer to section 10.10.9.
   [b] If the conditions are met, reprogram the ECM. Contact the OEM for possible TPS repair. Then, refer to section 10.10.9.

10.10.9 Verify Repairs

Perform the following steps to verify repairs:

1. Reinstall all connectors.
2. Test drive vehicle to see if the problem is corrected.
   [a] If engine brakes operate correctly, troubleshooting is complete.
   [b] If engine brakes do not operate, all system diagnostic checks are complete. Review this section to find the error. Refer to section 10.10.1, or contact Detroit Diesel Technical Service for possible ECM replacement.

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10.11 MISCELLANEOUS DIGITAL INPUT FAULT

The following procedure will cover miscellaneous input switch faults. All faults function in the same manner, allowing the same troubleshooting process to be used regardless of the function.

There are 12 digital input cavities, listed in Table 10-12, available on a DDEC ECM. Any available function can be assigned (programmed with the Programming Station) to any of the available cavities.

When a digital input wire is switched to battery ground (usually #953), it is a request to the ECM to activate the function assigned to that wire. Additional conditions may need to be met for the feature to activate. Refer to the appropriate Application and Installation Manual for these conditions.

Input Cavities	Input Cavities
E1 #451	G2 #543
F1 #542	H2 #524
G1 #528	J2 #531
H1 #523	K2 #583
J1 #541	G3 #545
F2 #544	K3 #979

Table 10-12 Input Cavities

Available functions are listed in Table 10-13.

Functions	Functions	Functions
None	Limiting Torque Curve	Trans Retarder Status
Engine Brake Low	Diagnostic Request	Dual Throttle (LSG)
Engine Brake Med	Alt Min VSG/Fast Idle	A/C Fan Status
Aux Shutdown #1	Service Brake Release	Aux CLS
Aux Shutdown #2	Clutch Released	Fan Control Override
Park Brake / ISD	Set Coast OFF DDEC II	VSG Station Change
Idle Validation	Set / Coast ON	VSG Station Complement
Pressure / RPM Mode	Resume/Accel OFF DDEC II	Air Load Switch
Throttle Inhibit	Resume / Accel ON	In Neutral Switch
RPM Sync (Marine)	Cruise Enable	In Gear Switch
RPM Freeze (Marine)	PGS System Enable	KD Brake
Rating Switch #1	SEO / DIAG Request	Gas Valve Diagnostic
Rating Switch #2	Engine Brake Disable	-

Table 10-13 Available Input Functions

The following procedure will troubleshoot an input fault.

10.11.1 Verify Switch Status

Follow these steps to verify the switch status.

1. Turn ignition ON.
2. Plug in DDR.
3. Select switch light status.
4. Operate the engine or vehicle that would allow the feature to activate (e.g. activate switch, set brake, etc.).
5. Observe the status when the feature is active (or supposed to be active). See Figure 10-9.
   [a] The feature always reads OFF. Refer to section 10.11.2.
   [b] The feature switches from OFF to ON. Refer to section 10.11.3.
   [c] The feature always reads ON. This indicates the input wire is shorted to ground or the switch is faulty. Repair wire or replace switch. Refer to section 10.11.4.

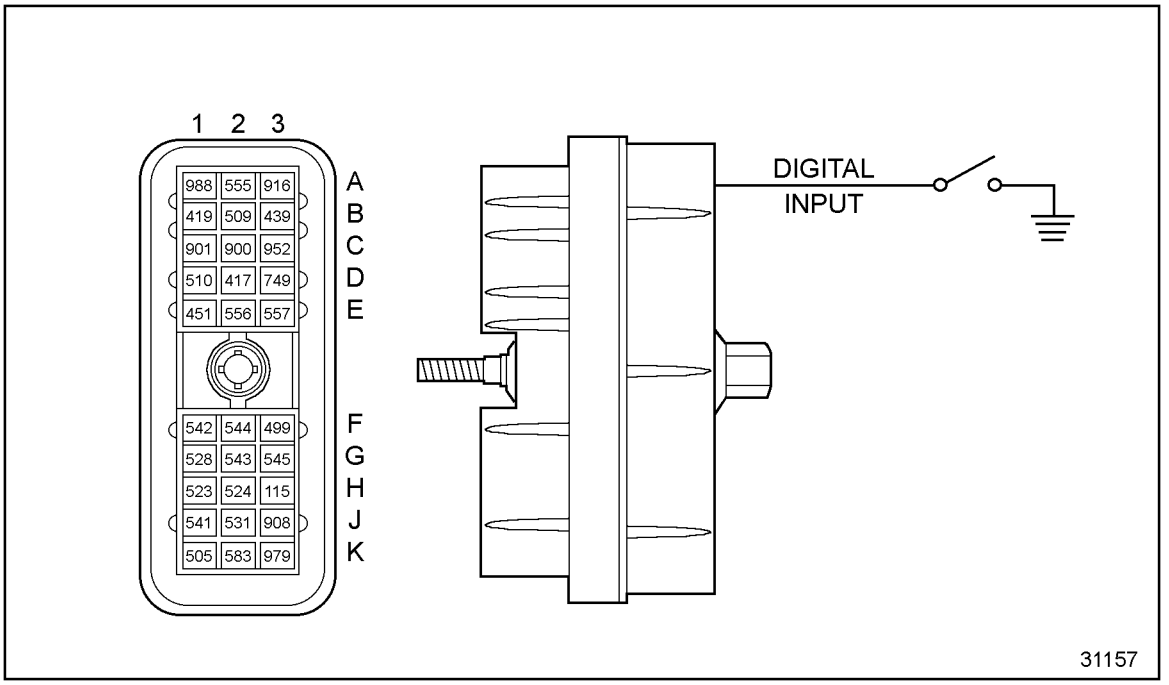

Figure 10-9 ECM Vehicle Harness Connector

10.11.2 Check for Open

Perform the following steps to check for an open:

1. Turn ignition OFF.
2. Unplug the vehicle interface harness connector at the ECM.

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3. Operate switch. Enable the feature.
4. Measure the resistance between the input cavity affected and the battery ground.
   [a] If the measured resistance is greater than 10,000 Ω, the input wire or ground wire is open, or the switch is bad. Repair the open or replace the switch. Refer to section 10.11.4.
   [b] If the measured resistance is less than 10,000 Ω, refer to section 10.11.3.

10.11.3 Review the Operation of the Feature

Perform the following steps to check the operation of the feature:

1. The step that led you here indicates the input, wire, and switch, are operating correctly. Review the intended operation of the feature to determine if any other conditions need to be met for the feature to operate. (e.g. appropriate Application and Installation manual for the engine). Refer to section 2.4, for a list of related troubleshooting publications.
2. To verify the repairs to the feature, refer to section 10.11.4.

10.11.4 Verify Repairs

Perform the following steps to verify repairs.

1. Hook up all connectors that were previously removed.
2. Operate the engine or vehicle.
3. Activate the feature.
   [a] If the input feature operates correctly, troubleshooting is complete.
   [b] If the input feature is not operating, contact Detroit Diesel Technical Service.

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10.12 MISCELLANEOUS DIGITAL OUTPUT FAULT

This section is designed to diagnose an output fault (feature not functioning). Since all outputs operate in the same manner, this troubleshooting section can be used regardless of the function assigned.

10.12.1 DDEC ECM

The DDEC ECM has six available digital output cavities. Three are located at the engine harness connector and three at the vehicle harness connector. Output functions (features) are assigned (programmed with the programming station) to any available cavity. The ECM switches the cavity to battery (-) to allow the function to activate. Some output activation is dependent on other parameters being met. (e.g. minimum, r/min, etc.) Perform the following steps to check the DDR for codes. Available output cavities are listed in Table 10-14.

Additional outputs could be added at a later date. Available functions are listed in Table 10-15.

Output Cavities	Output Cavities
VIH	ESH
A1 #988	W3 #563
A2 #555	X3 #564
F3 #499	Y3 #565

Table 10-14 Output Cavities

Functions	Functions	Functions
No Function	Fan Control #2	Turbo Recirc Valve
Low DDEC Volt	Deceleration Light	Optimized Idle Active
RPM Sync Active	Engine Brake Active	Low Range Solenoid (ESS)
PGS Active Light	VSG Active Indication	High Range Solenoid (ESS)
Vehicle Power Down	Oil Pressure Low Light	Shift Solenoid (Top2)
Starter Lockout	Oil Temp High Light	Shift Lockout (Top2)
Ext Brake Enable	Coolant Temp High Light	Gas Throttle Actuator
Trans Retarder Enable	Air Comp Solenoid	Fuel Supply Solenoid
Coolant Level Low Light	Crankcase Pressure High	KD Brake Solenoid
Cruise Active Light	Coolant Pressure Low	-
Fan Control #1	Ether Start	-

Table 10-15 Available Output Functions

10.12.2 Activate Output

Perform the following steps to attempt activation to troubleshoot an output fault.

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1. Turn ignition ON.
2. Plug in DDR. Select ACTIVATE OUTPUTS.
3. Activate output associated with the fault.

NOTE:
Service any other codes first.

[a] If the feature operates (e.g. light illuminates or solenoid activates, etc.) review the Application and Installation manual for the operation of the designated feature. Operation is dependent on other parameters. Refer to section 10.12.6.

[b] If the feature does not operate or cannot be activated, refer to section 10.12.3.

10.12.3 Check for Open

Perform the following steps to check for open:

1. Turn ignition OFF.
2. Locate device end of output wire (e.g. light) and disconnect wire.
3. Turn ignition ON.
4. Measure resistance between the disconnected wire and battery (-).

   [a] If the measured resistance is less than 46,000-48,000 Ω, refer to section 10.12.4.

   [b] If the measured resistance is greater than 48,000 Ω, the wire is open. Refer to section 10.12.6.

10.12.4 Check for Voltage

Perform the following steps to check the voltage:

1. Measure voltage between the disconnected wire and a good ground.

   [a] If voltage measurement is less than 2 volts, refer to section 10.12.5.

   [b] If voltage measurement is greater than 2 volts, the output is shorted to a voltage source. Replace the wire and refer to section 10.12.6.

10.12.5 Check for Resistance

Perform the following steps to check for resistance at the ECM:

1. Turn ignition OFF.
2. Disconnect 30-pin connector that houses the wire/function you are checking (e.g. X3-engine harness connector, A1-VIH).
3. Measure resistance between the pin on the ECM and the ECM case.

[a] If the measured resistance is 46,000 to 48,000 Ω, contact the OEM or the hardware of the supplier of the features. For further troubleshooting, all output wiring and ECM operation appear to be operating correctly.

[b] If greater than 48,000 Ω, try a test ECM. Refer to section 10.12.6.

10.12.6 Verify Repairs

Perform the following steps to verify repairs.

1. Connect all connectors.
2. Test the vehicle and attempt to operate the feature.
   [a] If the feature works correctly, troubleshooting is complete.
   [b] If the feature still does not work correctly, review this section to find the error. Refer to section 10.12.2.

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10.13 FIRE TRUCK PRESSURE GOVERNOR FAULT

The following procedure will troubleshoot fire truck pressure governor fault.

10.13.1 Pressure Governor Operation

The Pressure Sensor Governor (PSG) System is a DDEC feature, programmed to allow the engine speed to change in order to maintain a steady water pump pressure (pressure mode) or hold a steady engine speed (RPM Mode).

10.13.2 Verify Correct Pressure Sensor Governor Configuration

Perform the following steps to verify the PSG configuration. Refer to the Application and Installation manual for the appropriate engine model to ensure correct inputs and outputs are configured. Required In / Outs are listed in Table 10-16.

1. Turn ignition ON.
2. Plug in DDR.
3. View H_2 O governor enabled (engine configuration).
4. View In / Outs. Verify correct configuration.
   [a] If the system is enabled and the in/outs are correctly configured, refer to section 10.13.3.
   [b] If the problem was found, correct the settings and retest. Refer to the *DDEC III Application And Installation* manual, 7SA800 and refer to section 10.13.10.3.

Inputs	Outputs
PGS Mode, (Press / RPM)	PGS Active
PGS Enable	Cruise Active
Res / Accel	-
Set / Coast	-

Table 10-16 Required In / Outs

10.13.3 Identify Problem

Use the following procedure to identify the problem with the PSG:

- ☐ Does not operate; refer to section 10.13.4.
- ☐ No pressure mode, refer to section 10.13.6.
- ☐ No increase function refer to section 10.13.7.
- ☐ No decrease function refer to section 10.13.8.
- ☐ EFC Fault Information refer to section 10.13.9.

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10.13.4 Check System Ground

Perform the following steps to check the system ground:

1. Start engine.
2. Turn ON pump control switch.
3. Verify all interlocks are set (parking brake, transmission neutral, etc.).
4. Plug in DDR. Select Switch/Light status.
5. Observe the displays and PGS ENABLE.
   [a] If PGS ENABLE reads OFF, the PGS ENABLE input (circuit #543) is not grounded. Check circuit #543 for an open between battery ground or a short to a voltage source. Repair fault and retest. Refer to section 10.13.5.
   [b] If PGS ENABLE reads ON, refer to section 10.13.7.

10.13.5 Check Sensor Wiring

Perform the following steps to identify the problem:

1. Compare pressure sensor harness wiring to the diagram.
   [a] If the wiring is correct, refer to section 10.13.9. If the EFC tests okay, refer to section 10.13.6.
   [b] If the wiring is incorrect, correct the wiring and retest.

10.13.6 Verify Mode Selector Operation

Perform the following steps to identify the problem:

1. Start engine.
2. Turn ON pump control switch.
3. Verify all interlocks are set (parking brake, transmission neutral, etc.).
4. Plug in DDR. Select Switch/Light status.
5. Observe the displays and PGS MODE.
   [a] If DDR displays ON when Pressure Mode is selected, the mode selector (circuit #523) is functioning properly. Check for possible intermittent open or short to voltage source. Check for faulty pressure transducer. Refer to section 10.13.5. See Figure 10-10.

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[b] If the DDR displays OFF when Pressure Mode is selected, the mode selector wire (circuit #523) or switch is open or shorted to a voltage source. Repair the fault and retest. If the EFC tests okay, refer to section 10.13.9.

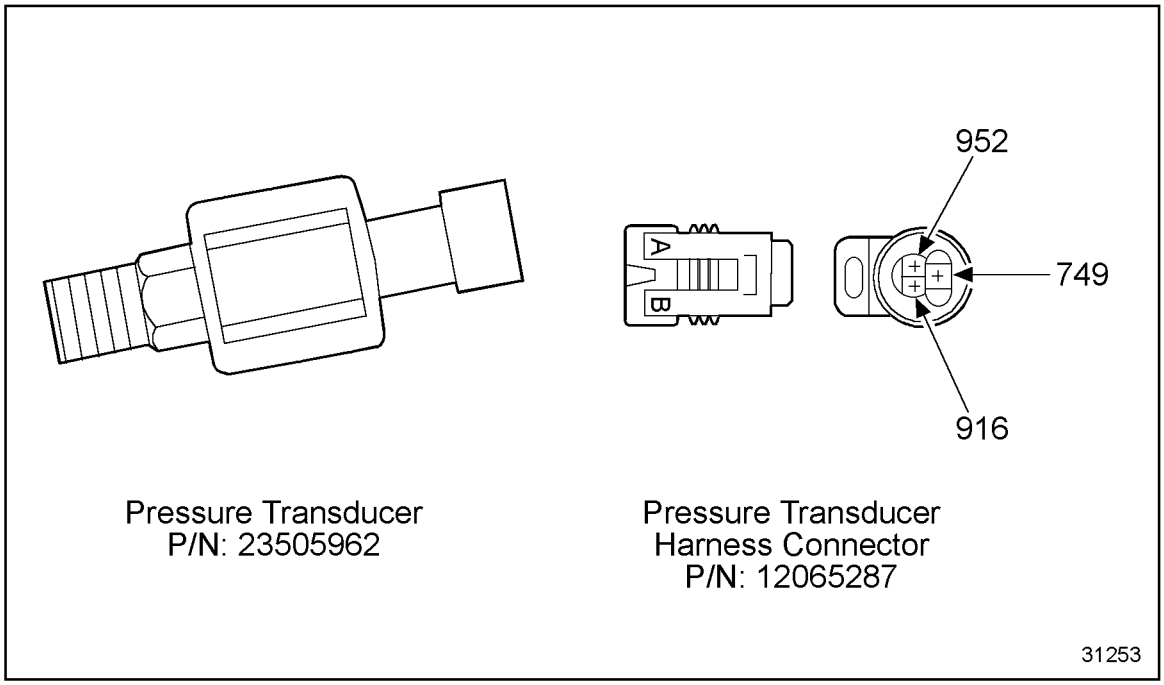

Figure 10-10 Pressure Transducer and Harness Connector

10.13.7 Check Resume / Accel Switch

Perform the following steps to identify the problem:

1. Start engine.
2. Turn ON pump control switch.
3. Verify all interlocks are set (parking brake, transmission neutral, etc.).
4. Plug in DDR. Select Switch/Light status.
5. Observe the displays and Res/Accel, while depressing the increase switch.

   [a] If DDR displays OFF to ON when increase is depressed, check the EFC. Refer to section 10.13.9.

   [b] If the DDR displays OFF when increase is depressed, circuit #541 is open or shorted to a voltage source. Repair the fault and retest.

10.13.8 Check Set / Coast Switch

Perform the following steps to identify the problem:

1. Start engine.

2. Turn ON pump control switch.
3. Verify all interlocks are set (parking brake, transmission neutral, etc.)
4. Plug in DDR. Select Switch/Light status.
5. Observe the displays and Set/Coast, while depressing the decrease switch.
   [a] If DDR displays OFF to ON when Set/Coast decrease is depressed, check the EFC. Refer to section 10.13.9.
   [b] If the DDR displays OFF when decrease is depressed, circuit #541 is open or shorted to a voltage source. Repair the fault and retest.

10.13.9 Electronic Fire Commander

The Detroit Diesel Electronic Fire Command ™ (EFC) is designed to support Detroit Diesel engines in the fire fighting market. It combines a Pressure Sensor Governor (PSG) controller, a system monitor, and a display for vital engine operating parameters into one compact, durable package. It also provides complete control and monitoring of the DDEC engine control system on a fire truck when pumping.

10.13.9.1 Pressure Sensor Governor Operating Modes

The EFC commands the Detroit Diesel PSG system to operate in one of two modes. The RPM Mode controls the engine speed to a constant number of revolutions per minute, and the Pressure Mode varies the engine speed to maintain a constant pump discharge pressure. The operating mode of the PSG can be changed from RPM Mode to Pressure Mode and back by pressing the MODE button. When the unit is first turned on, the RPM Mode is active. Pressing MODE switch engages the Pressure Mode and another press brings the system back to RPM Mode. The PSG system utilizes the engine speed or pump pressure that is current at the time the button is pressed.

In the Pressure Mode, the PSG system operates like cruise control for the water pump pressure, and maintains the pressure at a chosen setting. Engine speed is constantly adjusted to maintain the desired pump discharge pressure. A pressure sensor in the output side of the fire pump is used to measure and feed this pressure back to the DDEC Electronic Control Module (ECM).

The RPM Mode keeps the engine speed constant even when the load varies within the engine's operating capability. The pump output pressure may vary in this mode, but the engine speed does not. The driver/engineer uses the EFC to choose which of these two modes the PSG uses. The EFC also allows the driver/engineer to finely adjust the pressure setting or the engine speed setting to match prevailing conditions.

10.13.9.2 Setting the Revolutions Per Minute Mode

Perform the following steps to set the RPM Mode:

1. Start engine and ensure the EFC is ON.
2. Ensure the conditions are met for the Throttle Ready lamp to be ON. (These are usually interlocks necessary to allow increased throttle operation.)

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3. The RPM Mode lamp should be lit, indicating the system is in RPM Mode.
4. Engine speed can be adjusted using the following buttons:
   - ☐ Press the PRESET button to command the engine to go to the preset speed.
   - ☐ Press the INC button to increase engine speed in 25 RPM increments each time the button is pressed.
   - ☐ Press and hold the INC button to increase the speed at a faster rate equivalent to 2 increments per second.
   - ☐ Press the DEC button to decrease engine speed in 25 RPM increments.
   - ☐ Press and hold the DEC button to decrease the speed at a faster rate equivalent to 2 increments per second.
   - ☐ Press the IDLE button to immediately return the engine to the normal idle speed.

10.13.9.3 Setting the Pressure Mode

Perform the following steps to set the Pressure Mode:

1. Start engine and adjust the system to run in the RPM Mode as described in the previous sections.
2. Ensure conditions are met for the PUMP ENGAGED and OKAY TO PUMP and THROTTLE READY lamps to be on. (This usually requires that required safety interlocks for engine speed increase and pump operation are met.)
3. Press the MODE button and the PRESSURE lamp will illuminate.
4. Pump discharge pressure can now be adjusted with the following buttons.
   - ☐ Press the PRESET button to command the engine to go to the preset pump pressure.
   - ☐ Press the INC button to increase discharge pressure in 4 PSI increments each time the button is pressed.
   - ☐ Press and hold the INC button to increase the pressure at a faster rate equivalent to 2 increments per second.
   - ☐ Press the DEC button to decrease discharge pressure in 4 PSI increments.
   - ☐ Press and hold the DEC button to decrease the pressure at a faster rate equivalent to 2 increments per second.
   - ☐ Press the IDLE button to return the engine immediately to the normal idle speed.

10.13.9.4 Cavitation

If the water pump discharge pressure falls below 30 psi and the engine r/min rises a minimum of 400 r/min above the current setpoint for more than five seconds, the system considers cavitation to have occurred. It takes the following actions:

- ☐ The engine will return to idle.
- ☐ The current engine speed and discharge pressure setpoints will be cleared.
- ☐ The check engine light will illuminate and a cavitation code will be logged.

10.13.9.5 Engine Parameter Display

Engine r/min, oil pressure, temperature, and system voltage are displayed continuously while the EFC is in operation. In addition, any diagnostic code accompanying a Check Engine or Stop Engine condition will be displayed on the Information Center message display. An audible alarm will also be activated with the code.

10.13.10 Programming the Electronic Fire Commander

Programming the EFC is simply a matter of selecting items from a menu:

- To enter the programming menu, press and hold the MODE and MENU buttons at the same time until "Press Idle to Exit" is displayed on the information center, then release both buttons.
- Moving through the menu is accomplished by pressing the MENU button.
- Changing a selection in the menu is performed by using the INC and DEC switches.
- Exiting the programming menu is accomplished in one of two ways.
  - Press IDLE to exit the menu and save changes.
  - Press MODE to exit the menu without saving changes.

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10.13.10.1 Programming Menu Options

As you scroll through the menu by repeatedly pressing the MENU button, the following items, listed in Table 10-17, will appear sequentially in the Information Center display.

Item	Explanation
RPM Preset Point	preset engine speed
Pressure Set (PSI)	preset PSI
Engine Hour meter	information only
Pump Hour meter	information only
Engine degrees	oil or coolant
Pump Pressure (PSI)	pressure reading, if active
DDEC Software Version	ECM revision level
EFC Software Version	EFC revision level
Fire Commander I/O Test	test switches and outputs
Press Test Lights	tests display panel
Set Time Clock	set clock
Units of Measure	English/Metric
Welcome Message	enable/disable
Codes Currently Active	information
Connector Data	displays connection information
Save? [Idle Y]	exit and save options

Table 10-17 Information Center Menu

10.13.10.2 Additional Information

Engine r/mi

- ☐ The Information Center displays DDEC ECM diagnostic codes and limited engine information as well as PGS status.
- ☐ The Information Center display can be used as an aid to troubleshooting the Pressure Governor System and the Electronic Fire Commander.
- ☐ The Fire Commander I/O Test checks the outputs as well as the switches. It automatically runs through a test and displays the results for your information in troubleshooting.
- ☐ The connector data displays the cavities of inputs and outputs necessary for correct system operation.
- ☐ The interlock lamps show which interlock circuits have been closed and if that part of the system is ready for operation.

10.13.10.3 Troubleshooting the Electronic Fire Commander

This section lists some of the common troubles encountered during the installation and check out of the Electronic Fire Commander. These conditions are listed and the suggested actions follow each one. The Electronic Fire Commander wiring is listed in Table 10-18, listed in Table 10-19, listed in Table 10-20.

1. Condition: The EFC will not light up.
   - ☐ Check if the necessary switches are turned on.
   - ☐ Check if there is a 12 VDC between pins #1 and #2 at the EFC 4-pin connector.
2. Condition: The throttle will not increase in RPM Mode.
   - ☐ Check if the THROTTLE READY lamp is on. The EFC will not respond in RPM mode unless the OEM safety interlock requirements that enable the throttle are met.
   - ☐ Press the PRESET and then the INC switches. Does the EFC indicate it is increasing RPM on the data display?
   - ☐ Check the switch and outputs in the Menu I/O test.
   - ☐ Re-initialize the EFC. (Remove power to the EFC; wait ten seconds and then power the unit and try again.)

NOTE:
The EFC performs a "self-test" when it is powered up. This is indicated on the EFC by a momentary lighting of all the display segments.

3. Condition: The throttle will not increase in Pressure Mode.
   - ☐ Check that all three lamps: PUMP ENGAGED, OKAY TO PUMP, and THROTTLE READY are on.
   - ☐ Press the INC and then the PRESET buttons to increase pump pressure.
   - ☐ Check for a pump discharge pressure reading in the Menu.
   - ☐ Re-initialize the EFC.
4. Condition: The Engine Data Display is showing all zeroes.
   - ☐ Check that the connections at pins #3 and #4 of the EFC 4-pin connector are secure.
   - ☐ Check there is continuity on the 900 and 901 circuits from the ECM connector to the EFC connector.
5. Condition: The THROTTLE READY lamp will not turn on.
   - ☐ Check that the parking brake is on.
   - ☐ Check that the transmission is in neutral, or the hand throttle (PTO) is engaged.
   - ☐ Check for 12 VDC at pin #2 of the EFC 12-pin connector.
6. Condition: The PUMP ENGAGED and OKAY TO PUMP lamps do not turn on.
   - ☐ Check that all OEM safety requirements for pump operation are fulfilled.
   - ☐ Is the parking brake on?
   - ☐ Is the transmission in the proper range for pump operation?
   - ☐ Is the hand throttle (PTO) engaged?
   - ☐ Is there an OK to PUMP indication in the cab?
   - ☐ Check for 12 VDC at pin #10 of the EFC 12-pin connector.
7. Condition: The mode will not change from RPM to Pressure.

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- ☐ Check: Are the PUMP ENGAGED and OKAY TO PUMP lamps on?
- ☐ Does the MODE switch pass in the menu I/O test?

8. Condition: The PRESET switch doesn't work.
   - ☐ Check that the proper lamps are on for the mode you want to operate.
   - ☐ Is there a valid preset programmed into the menu? If not, refer to section 10.13.10 and complete the steps given there.

☐ Does the PRESET switch pass the menu I/O test?

Connector 1:	Deutsch DT06-4S		
Cavity	**Circuit Description**	**DDC#**	**EFC Input/Output**
1	DDEC Accessory Power	439	(+) System Power
2	DDEC Accessory Ground	953	(-) System Ground
3	DDEC 1708 Data Link (+)	900	J1587 Serial Link
4	DDEC 1708 Data Link (-)	901	J1587 Serial Link

Table 10-18 Electronic Fire Commander Wiring

Connector 2:	DT06-12S		
Cavity	**Circuit Description**	**DDC#**	**EFC Input/Output**
1	DDEC PGS Mode Select	523	Output (ground) to DDEC
2	OEM Interlock from OEM	-	Input (+12 VDC)
3	Cavity plug	-	No connection
4	DDEC PGS Mode	499	Input (ground) from DDEC
5	DDEC PGS Enable	-	Output (ground) to DDEC
6	DDEC PGS Increase	-	Output (ground) to DDEC
7	DDEC PGS Decrease	-	Output (ground) to DDEC
8	DDEC PGS Active	-	Input (ground) from DDEC
9	Alarm	-	Output (ground) to DDEC
10	PTO Engaged	-	Input (+12 VDC) from OEM
11	Cavity Plug	-	No connection
12	Low fuel	-	Input (ground) from DDEC

Table 10-19 Electronic Fire Commander Wiring

	Pressure Sensor Connector:		
Circuit	**Cavity**	**Wire Color**	**Description**
916	B	Red/Black	Sensor Supply 5 VDC
749	C	Yellow	Fire Pump Pressure
952	A	Black	Sensor Return

Table 10-20 Electronic Fire Commander Wiring

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10.14 OPTIMIZED IDLE FEATURE DOES NOT FUNCTION

The following procedure will troubleshoot Optimized Idle not functioning.

CAUTION:

To avoid personal injury from the engine starting accidently, do not replace the ECM with an ECM that is not programmed with Optimized Idle.

CAUTION:

To avoid personal injury from the engine starting while working in the engine compartment, remove the starter relay from the relay holder before performing any service or troubleshooting to the Optimized Idle system.

10.14.1 Check Diagnostic Data Reader for Codes

Perform the following steps to check the DDR for codes.

1. Plug DDR into connector.
2. Turn ignition ON.
3. Check the active and inactive codes for any Optimized Idle codes.
4. Turn ignition OFF.

NOTE:
Service any code first.

[a] If an Optimized Idle code 62, 63, or 74 is logged, go to the appropriate flash code section, based on Optimized Idle code logged.

[b] If an Optimized Idle code 62, 63 or 74 is not logged, refer to section 10.14.2.

10.14.2 Heater and Air Conditioning Fans Do Not Function

Perform the following steps to troubleshoot the heater and A/C fans.

1. Check the heater and A/C blower fuse.
2. Turn ignition ON.
3. Plug in DDR.

4. Check the vehicle power down relay switch. Select switch light status (VEH PWR DOWN).
   [a] If the output status reads ON, check the relay and relay connections for proper operation. Refer to section 10.14.3.
   [b] If the output status does not read ON, install a test ECM. Refer to section 10.14.11.

10.14.3 Check Optimized Idle Active Light

The Optimized Idle active light should flash when all of the following occur:

1. Engine idling.
2. The transmission is in NEUTRAL and high-range, if equipped.
3. The hood is closed and the park brake is set.
4. The cruise switch is turned ON.
   [a] If the active light is not flashing, refer to section 10.14.4.
   [b] If the light is flashing, after the engine shuts down, turn the thermostat on. When the light flashes, if the alarm turns ON and the engine starts, the system is OK.
   [c] If the light is flashing, after the engine shuts down, turn the thermostat on. When the light flashes, if the alarm does not turn ON and the engine does not start, refer to section 10.14.10.

10.14.4 Check Idle Condition

Perform the following steps to troubleshoot Optimized Idle:

1. Check idle condition.
2. Verify the engine is at idle and not running on VSG. Optimized idle will not function if the engine is running on VSG, unless the idle timer is enabled on VSG.
   [a] If the engine is not at idle, turn off the ISD on the VSG. Refer to section 10.14.11.
   [b] If the engine is at idle, refer to section 10.14.5.

10.14.5 Check Idle Shutdown Enabled

Perform the following steps to troubleshoot Optimized Idle:

1. Check for idle shutdown enabled.
2. Using the DDR, view the calibration.
   [a] If idle shutdown is not enabled, enable the idle shutdown and set a shutdown time. Refer to section 10.14.11.
   [b] If the idle shutdown is enabled, refer to section 10.14.6.

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10.14.6 Check Input Status

Perform the following steps to troubleshoot Optimized Idle:

1. Check for input status.
2. Using the DDR, check the park brake input status with the hood closed, the transmission in NEUTRAL (and high-range if equipped) and the park brake set.
   [a] If the park brake status is ON, refer to section 10.14.9.
   [b] If the park brake status is not ON, refer to section 10.14.7.

10.14.7 Check Hood Switch

Perform the following steps to troubleshoot the hood switch:

1. Check hood switch.
2. Measure the resistance across the hood switch contacts with the hood closed. See Figure 10-11.
   [a] If the resistance measures less than 100 Ω , refer to section 10.14.8.

[b] If the resistance measures greater than 100 Ω, replace or adjust the hood switch. Refer to section 10.14.11.

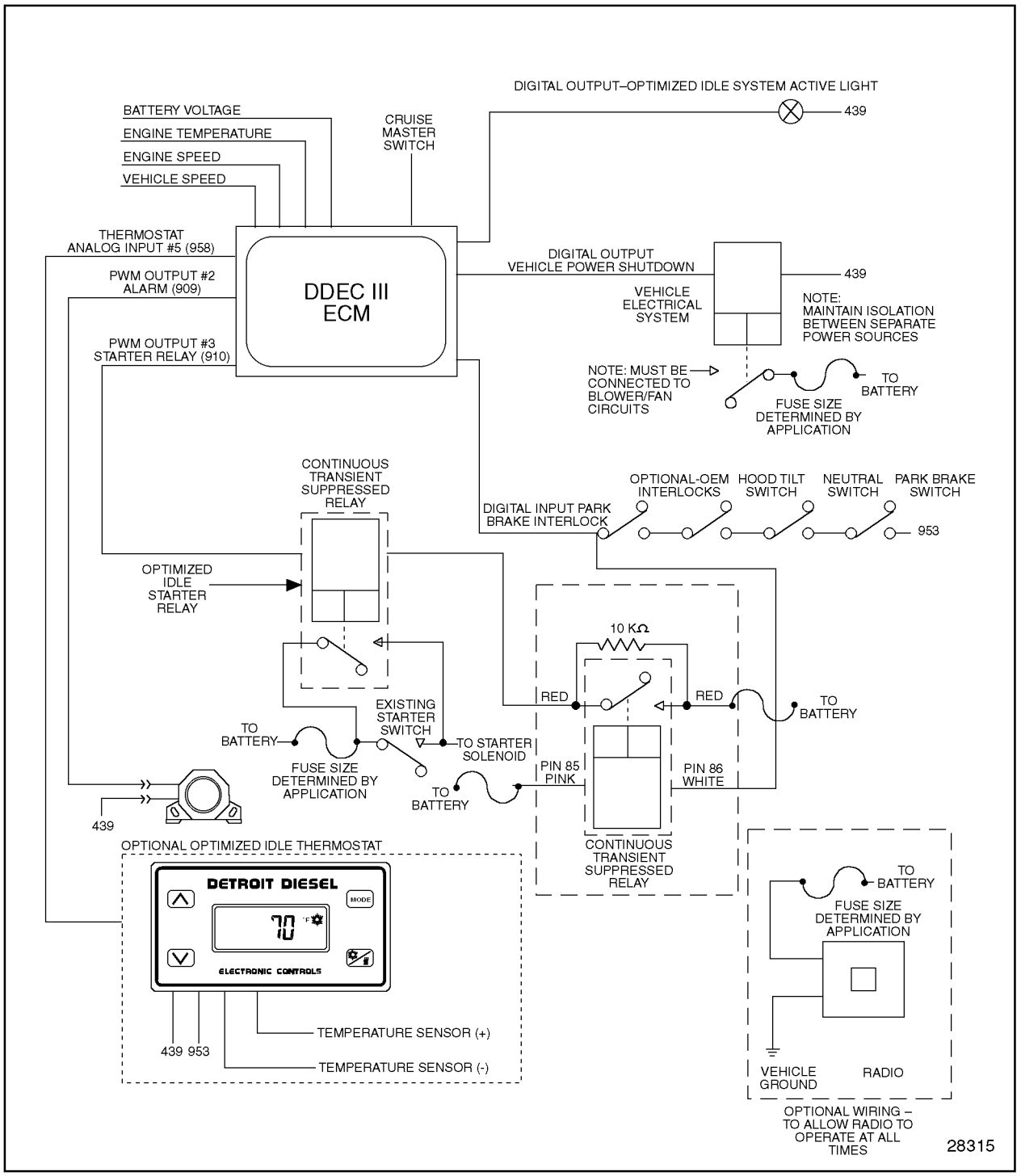

Figure 10-11 Optimized Idle Schematic

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10.14.8 Check Park Brake Switch

Perform the following steps to troubleshoot the park brake switch and other OEM interlock devices.

1. Check the park brake switch and other OEM interlock devices (e.g. high-range switch).
2. Measure resistance across the park brake switch contacts with the park brake set.
   [a] If the measured resistance is less than 100 Ω, the 953 ground wire is open somewhere between the ECM and the battery. Repair the open. Refer to section 10.14.11.
   [b] If the measured resistance is more than 100 Ω, replace the park brake switch or other OEM interlock devices. Refer to section 10.14.11.

10.14.9 Check the Thermostat

Perform the following steps to check the thermostat operation:

1. Turn ignition ON.
2. Plug in the DDR.
3. Select switch light status OPIDL T-STAT.
   [a] If the display reads ON with the thermostat enabled and the alarm is turned ON and the reader shows the switch status for the starter as ON after the alarm turns OFF, check the relay and starter solenoid connections. Refer to section 10.14.11.
   [b] If the display reads ON with the thermostat enabled and the alarm is turned ON and the reader does not show the switch status for the starter as ON after the alarm turns OFF, refer to section 10.14.10.
   [c] If the display reads ON with the thermostat enabled and the alarm OFF, replace the alarm. Refer to section 10.14.11.
   [d] If the display does not read ON with the thermostat enabled, the thermostat input wire #958 is open between the thermostat and the ECM. Repair the open. Refer to section 10.14.11.

10.14.10 Oil Temperature Sensor Connection Check

Perform the following steps to troubleshoot the OTS connection:

1. Check the OTS connection.
   [a] If the OTS connector is plugged into the oil temperature sensor, reprogram the ECM. Refer to section 10.14.11.
   [b] If the OTS connector is not plugged into the OTS, plug in the OTS connector. Refer to section 10.14.11.

10.14.11 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Close the hood; set the park brake; put the transmission in NEUTRAL and the high-range, if equipped.
4. Start the engine.
5. Turn the cruise master switch to the ON position. If it was on before the vehicle started, turn the switch to OFF and then to ON.
6. Wait for the engine to shut down. After the idle timer expires, the engine will either shutdown or continue to run to charge the battery or keep the oil temperature between 60°F (16°C) and 104°F (40°C).
7. Turn the thermostat on, if installed. Change the set point and heating/cooling mode until the thermostat requires the engine to start. The icons will flash. If the thermostat is not installed, wait for the lube oil temperature to fall below 60°F (16°C).
8. The alarm will sound and the engine will start. Vehicle power (blower fans) will turn on approximately 30 seconds after the engine starts, due to the thermostat.
   [a] If Optimized Idle operates properly, troubleshooting is complete.
   [b] If Optimized Idle does not operate properly, troubleshooting is complete. Review this section from the first step to find the error. Refer to section 10.14.1.

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10.15 TRANSMISSION INTERFACE FAULT

Numerous transmissions utilize the DDEC ECM to receive signals that are used to determine shift points, and/or other information.

10.15.1 Transmission Fault

Transmissions that currently utilize data links:

- ☐ J1587 - Allison World Transmissions
- ☐ J1939 Eaton, Allison
- ☐ J1922 Ceemat
- ☐ Advanced Interface
  - ☐ ESS ™, Rockwell - Refer to ESS Troubleshooting Manual
  - ☐ Top2, Eaton - Refer to MISC Output Troubleshooting
- ☐ PWM Signal Type - DDEC provides a PWM signal that is used by the transmission or its components

10.15.2 Verify Transmission Type

Perform the following steps to check the transmission type.

1. Turn ignition ON.
2. Plug in DDR.
3. Check transmission origination.

   [a] If a manual transmission, Allison hydraulic, Allison Electronic, Voith, ZF, refer to section 10.15.3.

   [b] If a J 1939/autoshift, Allison WT, Rockwell RXX-X, refer to the troubleshooting guide of the transmission manufacturer to troubleshoot the fault.

   [c] If the transmission type does not match the transmission correctly, reprogram and refer to section 10.15.4.

10.15.3 Review PWM #1 Signal

Perform the following steps to check the DDR for codes.

1. Perform road test with assistant.
2. Plug in DDR.
3. Watch PWM #1 signal.

   [a] If the PWM varies with the load changes, Alison Electric, Voith or ZF, the signal is normal. Review the wiring or transmission.

   [b] If the PWM signal is 0% or 100% when the signal is for Allison Hydraulic with load changes, the program is normal. Review the transmission, wiring or relay. Refer to section 10.15.4.

10.15.4 Verify Repairs

Perform the following steps to verify repairs. Start with the Menu Selection. An assistant is needed for the following procedure.

1. Perform road test.

   [a] If the problem is resolved, troubleshooting is complete.

   [b] If the problem still exists, contact the OEM or transmission supplier. The steps that led you here do not indicate a problem with the PWM #2 output or output wire. Verify the correct configuration. Refer to the *DDEC Application and Installation* manual, 7SA800, for the appropriate engine.

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11 FLASH CODE 11 - VSG LOW

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11.1 DESCRIPTION OF FLASH CODE 11

Flash Code 11 indicates that the Variable Speed Governor (VSG) input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage. This diagnostic condition is typically:

- Open sensor signal circuit (No VSG throttle control installed.)
- Open sensor +5 volt supply circuit
- Sensor signal is shorted to the sensor return circuit or to ground
- Sensor +5 volt supply is shorted to sensor return circuit or to ground (This condition will result in numerous sensor codes.)

11.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 11

The SAE J 1587 equivalent code for Flash Code 11 is p 187 4, Variable Speed Governor (VSG) input low.

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11.3 TROUBLESHOOTING FLASH CODE 11

The following procedure will troubleshoot Flash Code 11.

11.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in DDR.
3. Read active codes.
   [a] If code 187/4 is logged and there are no VSG controls used, call DDC with the engine serial number to determine if re-calibration is necessary.
   [b] If code 187/4 was logged and there are VSG controls used primarily, refer to section 11.3.2.
   [c] If flash codes 100/4 and 91/4 were logged, refer to section 91.2.

11.3.2 Sensor Wiring Check

Perform the following steps to check the sensor and wiring:

1. Turn ignition OFF.
2. Disconnect VSG throttle sensor connector.
3. Install a jumper wire between sockets B (#510 signal) and C (5V-#916) of the VSG harness connector. See Figure 11-1.

NOTE:
Cavities of throttle controls may vary depending on the OEM.

4. Turn ignition ON.
5. Enable VSG throttle. Refer to OEM guidelines.
6. Read DDR for active codes.
   [a] If active code 187/3 and any other codes are logged, refer to section 11.3.3.

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[b] If active code 187/4 and any other codes are logged, refer to section 11.3.6.

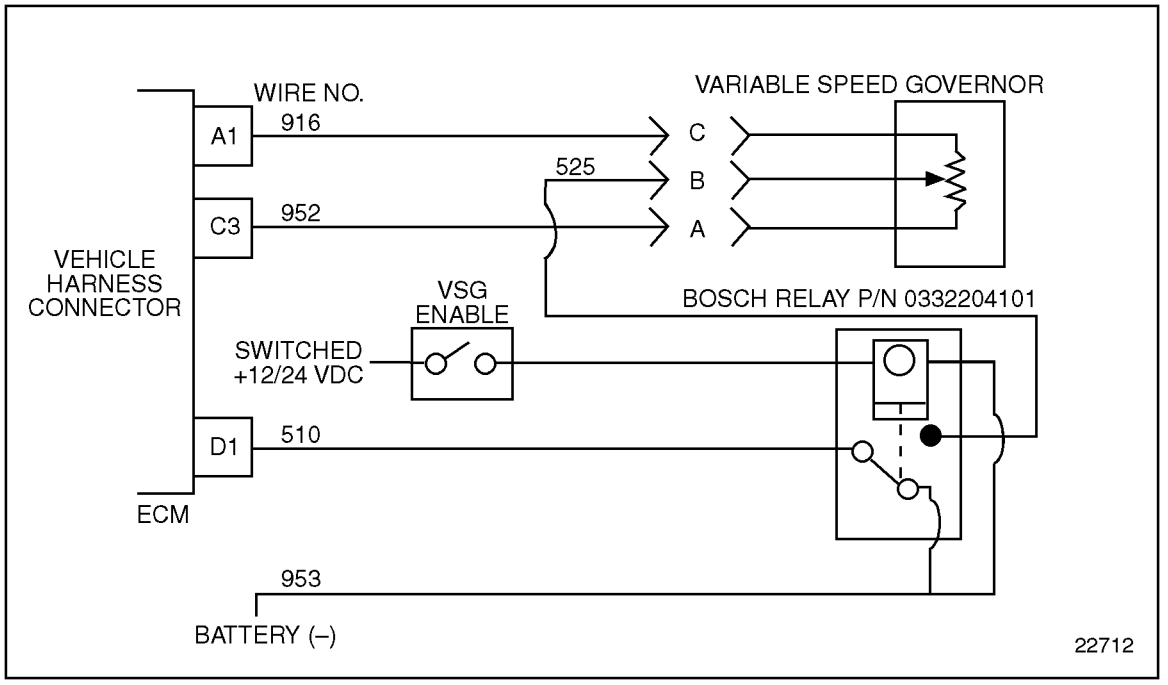

Figure 11-1 Variable Speed Governor Circuit

11.3.3 Check Hand Throttle Sensor Adjustment

Perform the following steps to check the hand throttle sensor:

1. Remove jumper and reconnect hand throttle sensor.
2. Turn ignition ON.
3. Plug in DDR.
4. Select VSG COUNTS on the DDR.
5. Enable VSG. Set to idle position.
6. Read counts.

   [a] If the count value set at idle (minimum throttle) is greater than 48 counts, refer to section 11.3.5.

   [b] If the count value set at idle (minimum throttle) is less than 48 counts, refer to section 11.3.4.

11.3.4 Adjust Hand Throttle Sensor

Perform the following steps to adjust the hand throttle sensor:

1. Turn ignition OFF.

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2. If a variable hand throttle sensor is installed, adjust idle position (low-speed) stops on the hand throttle sensor.
3. If fixed resistors are installed, replace with new resistors. (Minimum counts MUST be greater than 48.)
4. Turn ignition ON.
5. Read VSG counts with throttle at low-speed position.
   [a] If the idle count reading is greater than 48 counts, refer to section 11.3.12.
   [b] If the idle count reading is less than 48 counts, refer to section 11.3.5.

11.3.5 Check Hand Throttle Sensor Connectors

Perform the following steps to check the hand throttle sensor connectors.

1. Turn ignition OFF.
2. Inspect the terminals at the hand throttle sensor connectors (sensor side and harness side) for bent, corroded and unseated pins or sockets. See Figure 11-2.
   [a] If the terminals and connectors are not damaged, replace hand throttle sensor. Refer to section 11.3.12.
   [b] If the terminals and connectors are damaged, repair as necessary. Refer to section 11.3.12.

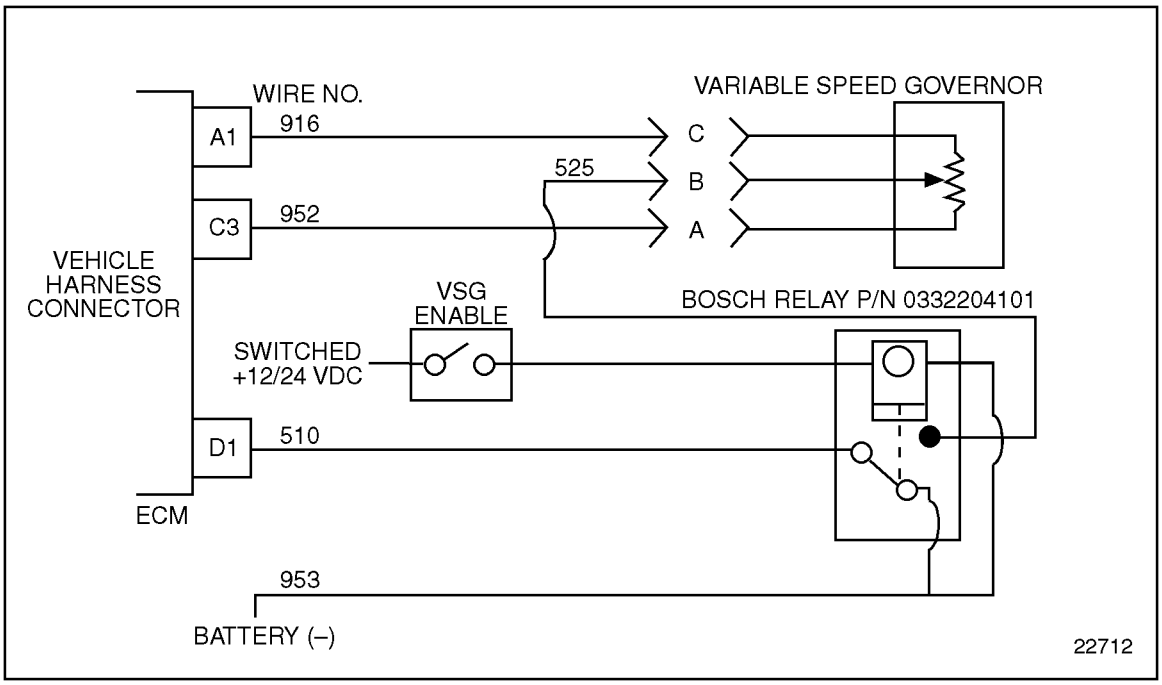

Figure 11-2 Variable Speed Governor Circuit

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11.3.6 Check for +5 volts

Perform the following steps to check for +5 volts:

1. Turn ignition ON.
2. Enable VSG. Refer to OEM guidelines.
3. Measure voltage on the hand throttle sensor harness connector, socket C (5V #916, red lead) to socket A (return #952, black lead). See Figure 11-3.
   [a] If the voltage reading is between 4 to 6 volts, refer to section 11.3.7.
   [b] If the voltage reading is greater than 6 volts, refer to section 12.1.
   [c] If the voltage reading is less than 4 volts, refer to section 11.3.10.

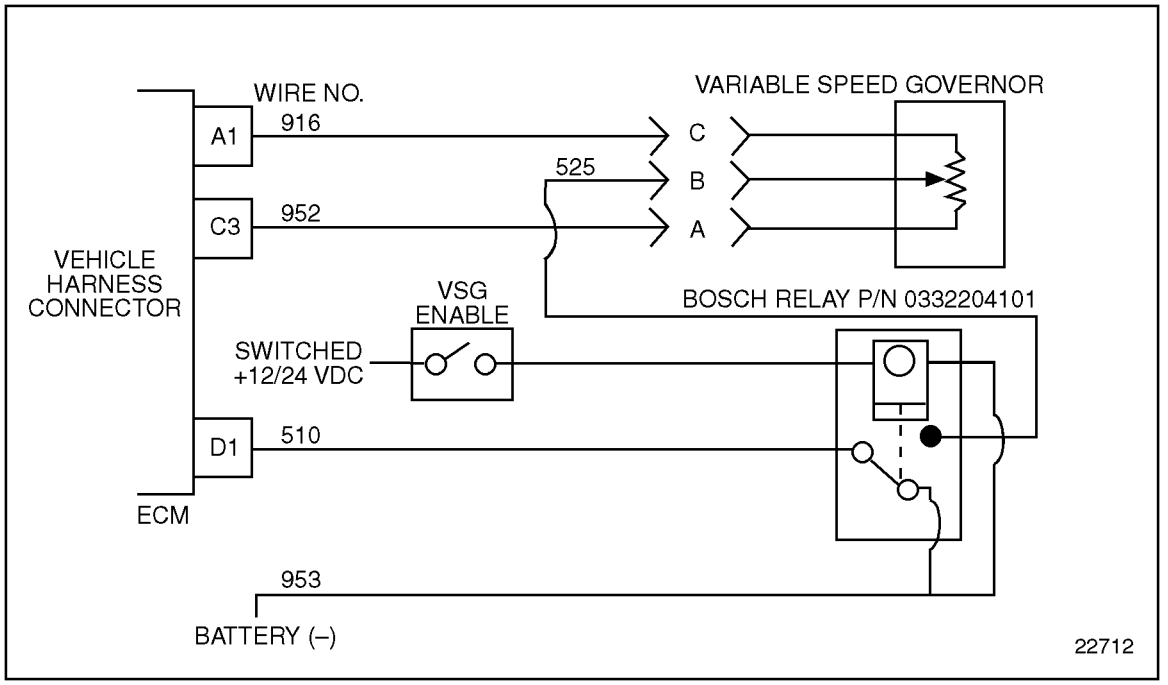

Figure 11-3 Variable Speed Governor Circuit

11.3.7 Check for Short

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Enable VSG. Refer to OEM guidelines.
4. Measure resistance between sockets A (return #952) and B (signal #525) on the hand throttle sensor harness connector. For VSG circuit, see Figure 11-4.
   [a] If the resistance is greater than 1,000 Ω or open, refer to section 11.3.8.

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[b] If the resistance is less than or equal to 1,000 Ω, the signal line #525 is shorted to the return line. Repair the short. Refer to section 11.3.12.

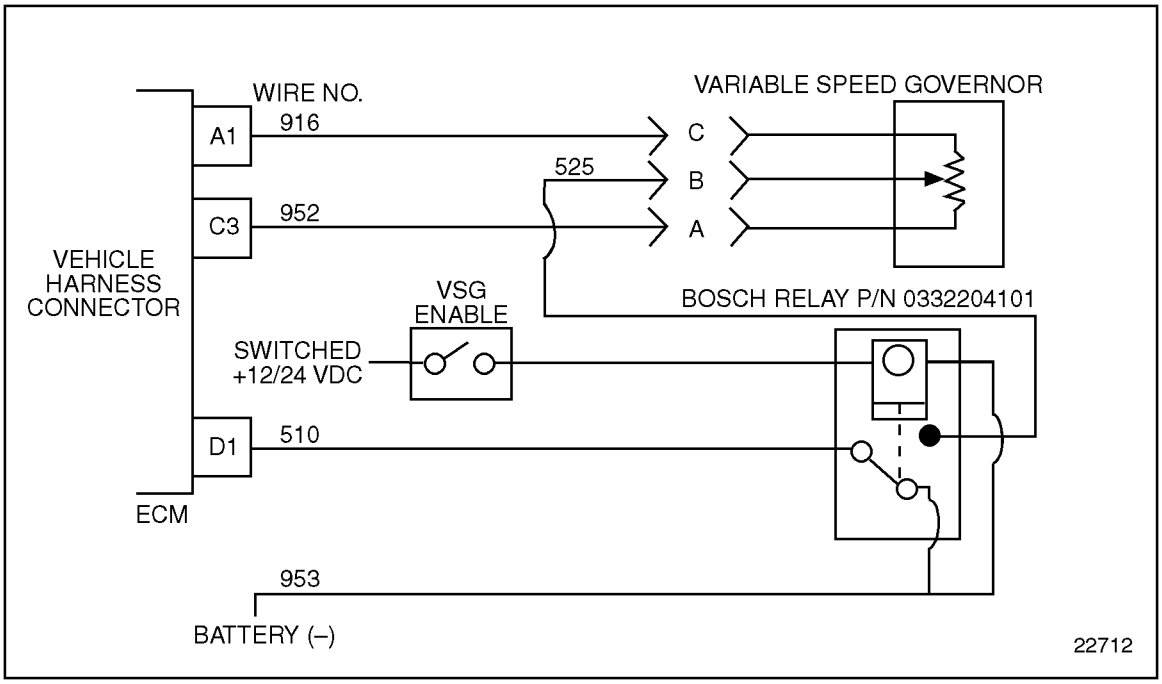

Figure 11-4 Variable Speed Governor Circuit

11.3.8 Check for Open Signal

Perform the following steps to check for open signal:

1. Install a jumper wire between sockets A and B of the hand throttle sensor harness connector. See Figure 11-4.
2. Enable VSG. Refer to OEM guidelines.
3. Measure resistance between sockets D1 (#510) and C3 (#952) on the vehicle harness connector.
   [a] If the resistance is less than or equal to 5 Ω, refer to section 11.3.9.
   [b] If the resistance is greater than 5 Ω or open and the signal line (#510) or return line (#952) is open, repair the open. Refer to section 11.3.12.

11.3.9 Check ECM Connectors

Perform the following steps to check for signal open:

1. Check terminals at the ECM vehicle harness connector (both the ECM and harness side) for bent, corroded, and unseated pins or sockets. See Figure 11-5.
   [a] If the terminals and connectors are damaged, repair the terminals, connectors, or both. Refer to section 11.3.12.

[b] If the terminals and connectors are not damaged, contact DDC Technical Service. Refer to section 11.3.12.

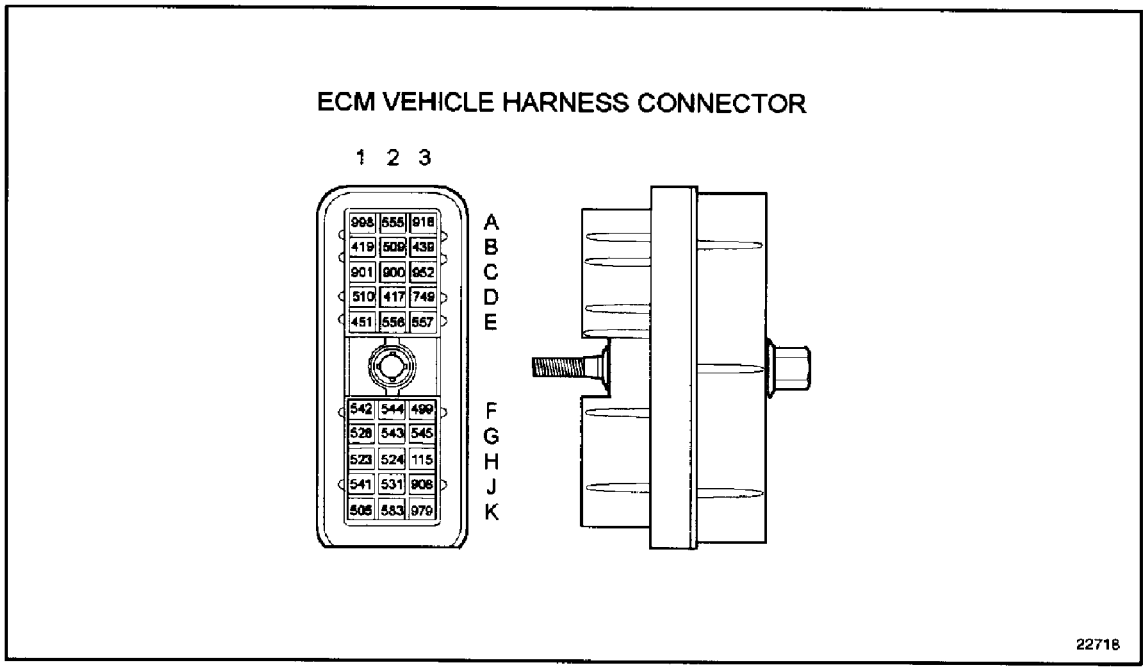

Figure 11-5 Electronic Control Module Vehicle Harness Connector

11.3.10 Check for Short to 5 Volt

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Disconnect the connector at the hand throttle sensor.
4. Measure resistance between sockets A and C on the hand throttle sensor harness connector. See Figure 11-6.

   [a] If the resistance measurement is greater than 1,000 Ω, refer to section 11.3.11.

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[b] If the resistance measurement is less than or equal to 1,000 Ω, the vehicle +5 volt line (#916) is shorted to the return line (#952). Repair short. Refer to section 11.3.12.

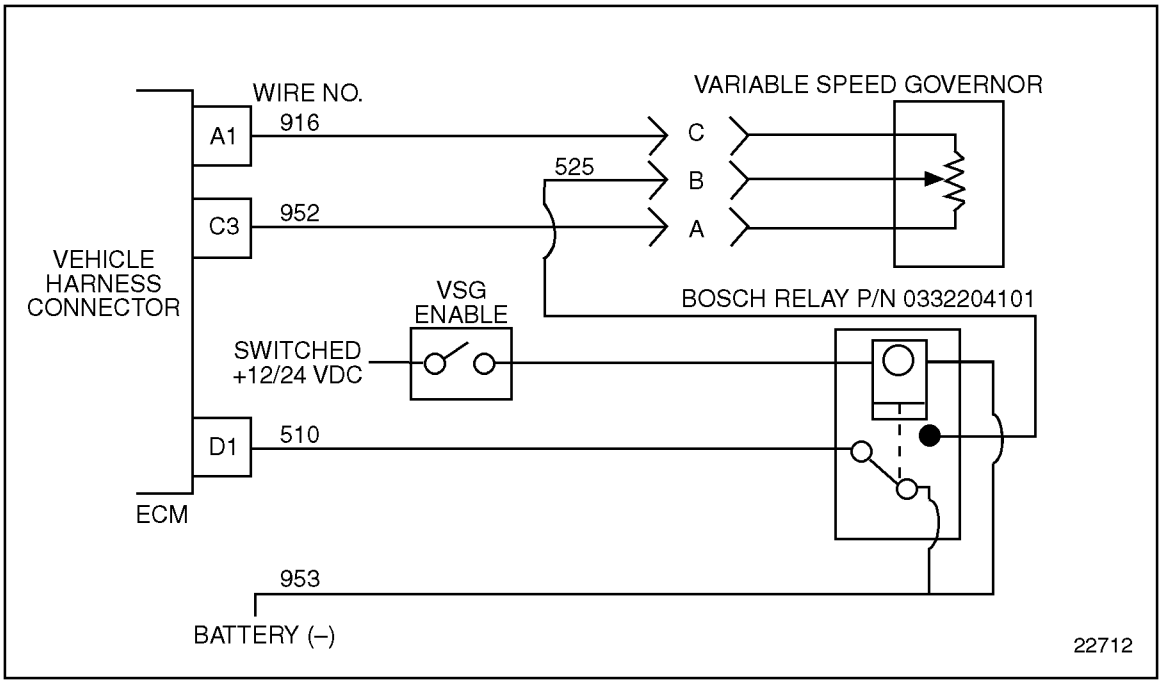

Figure 11-6 Variable Speed Governor Circuit

11.3.11 Check for Open +5 Volt Line

Perform the following steps to check for an open +5 volt line.

1. Install a jumper wire between sockets A and C of the hand throttle sensor harness connector. See Figure 11-6.
2. Measure resistance between sockets A3 (#916) and C3 (#952) on the vehicle connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 11.3.9.
   [b] If the resistance measurement is greater than 5 Ω, or open, the vehicle +5 volt line (#916) is open. Repair open. Refer to section 11.3.12.

11.3.12 Verify Repair

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.

6. Stop engine.
7. Check for logged codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 187/4 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 187/4 is logged, and other codes are logged, systems diagnostics are complete. Please review this section from the first step to find the error. Refer to section 11.3.1.

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12 FLASH CODE 12 - VSG HIGH

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12.1 DESCRIPTION OF FLASH CODE 12

Flash Code 12 indicates that the Variable Speed Governor (VSG) input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage. This diagnostic condition is typically:

- ☐ Open sensor return circuit
- ☐ Sensor signal circuit is shorted to the sensor +5 volt supply
- ☐ Throttle sensor not adjusted properly at full throttle

12.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 12

The SAE J1587 equivalent code for Flash Code 12 is p 187 3, Variable Speed Governor (VSG) input high.

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12.3 TROUBLESHOOTING FLASH CODE 12

The following procedure will troubleshoot Flash Code 12.

12.3.1 Multiple Code Check

Perform the following steps to check for multiple codes:

1. Turn ignition ON. (For VSG circuit, see Figure 12-1.)
2. Plug in DDR.
   [a] If active code 187/3 and any other codes except 91/3 or 100/3 are logged, refer to section 12.3.2.
   [b] If active code 187/3 and codes 91/3 or 100/3 are logged, refer to section 91.2.

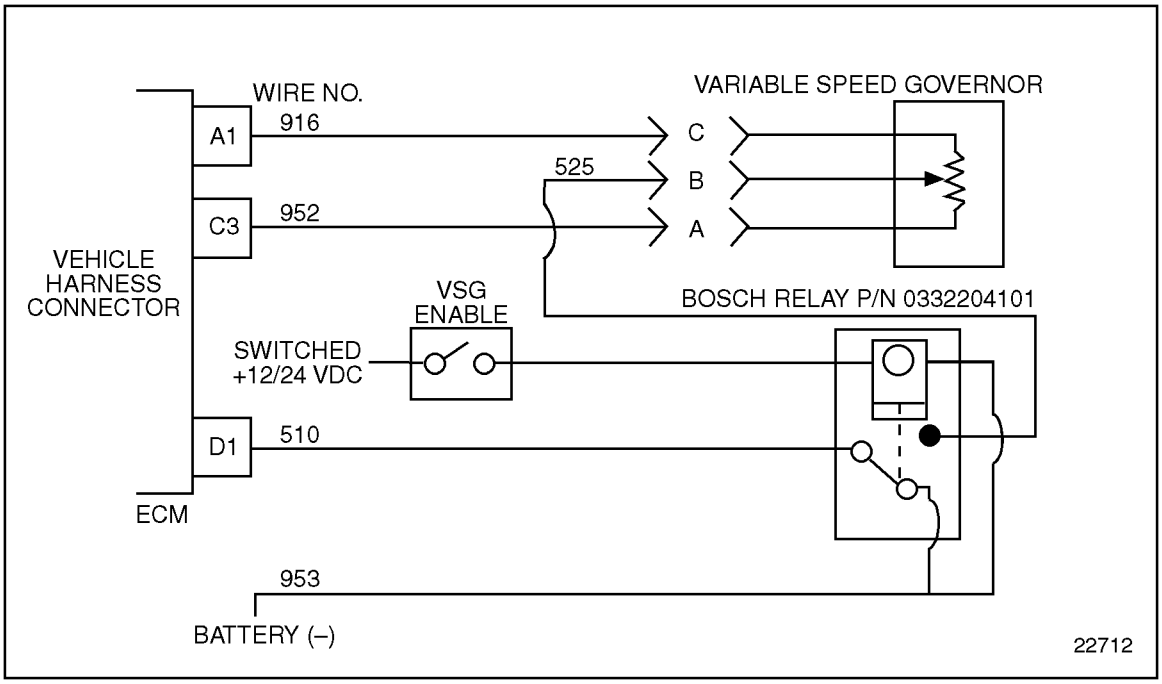

Figure 12-1 Variable Speed Governor Circuit

12.3.2 Sensor Check

Perform the following steps to check the sensor:

1. Turn ignition OFF.
2. Unplug the VSG throttle connector. (For VSG circuit, see Figure 12-1.)
3. Turn ignition ON.
4. Read active codes.

[a] If active code 187/4 is logged, and code 187/3 only occurs when the throttle is moved at or near full throttle (when connected), refer to section 12.3.3.

[b] If active code 187/3 is logged, and the code appears when the throttle is not at or near full throttle (when connected), refer to section 12.3.4.

12.3.3 Check Calibration

Perform these additional steps to check the calibration of the sensor:

1. Plug in the VSG throttle connector.
2. Turn ignition ON.
3. Plug in DDR.
4. Display VSG counts.
5. Dial throttle to Full Throttle.
   [a] If the VSG counts are greater than 968, adjust the maximum throttle travel. If not adjustable, replace the throttle control.
   [b] If the VSG counts are less than 968, refer to section 12.3.4.

12.3.4 Return Circuit Check

Perform these steps to check the return circuit:

1. Place the transmission in neutral.
2. Turn ignition OFF.
3. Install a jumper wire between pin A (return #952) and pin B (signal #510/525) of the VSG throttle harness connector.
4. Disconnect the vehicle harness connector at the ECM.
5. Enable VSG control. (This may require the ignition be turned on.)
6. Measure resistance between sockets C3 (#952) and D1 (#510) on the vehicle harness connector. See Figure 12-2.
   [a] If the resistance is less than or equal to 5 Ω, refer to section 12.3.5.

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[b] If the resistance is greater than 5 Ω , the return line (#952) is open, repair the open. Refer to section 12.3.8.

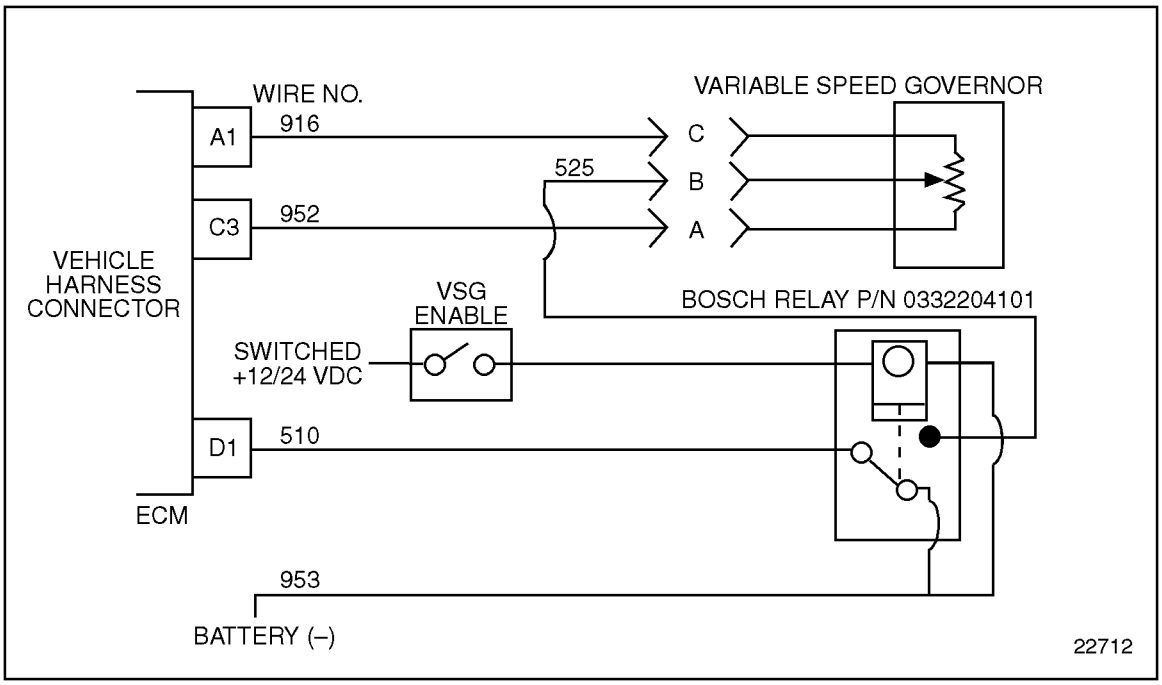

Figure 12-2 Typical Variable Speed Governor Circuit

12.3.5 Variable Speed Governor Throttle Connector Check

Perform these steps to check the VSG throttle connectors:

1. Inspect terminals at the VSG connectors (sensor side and harness side) for bent, corroded and unseated pins or sockets.

   [a] If the VSG connector terminals are damaged, repair terminals and/or connectors. Refer to section 12.3.8.

   [b] If the VSG connector terminals are in good condition with no signs of damage, refer to section 12.3.6.

12.3.6 Check for Short to Battery (+)

Perform these steps to check for short to battery (+).

1. Turn ignition OFF.
2. Unplug VSG connector.
3. Turn ignition ON.
4. Measure voltage between B (signal #525/#510) and battery ground. See Figure 12-3.

   [a] If measured voltage is less than or equal to 0.2 volts, refer to section 12.3.7.

[b] If measured voltage is greater than 0.2 volts, signal wire is shorted to 12/24 volt source. Repair or replace #510/#525 circuit. Refer to section 12.3.8.

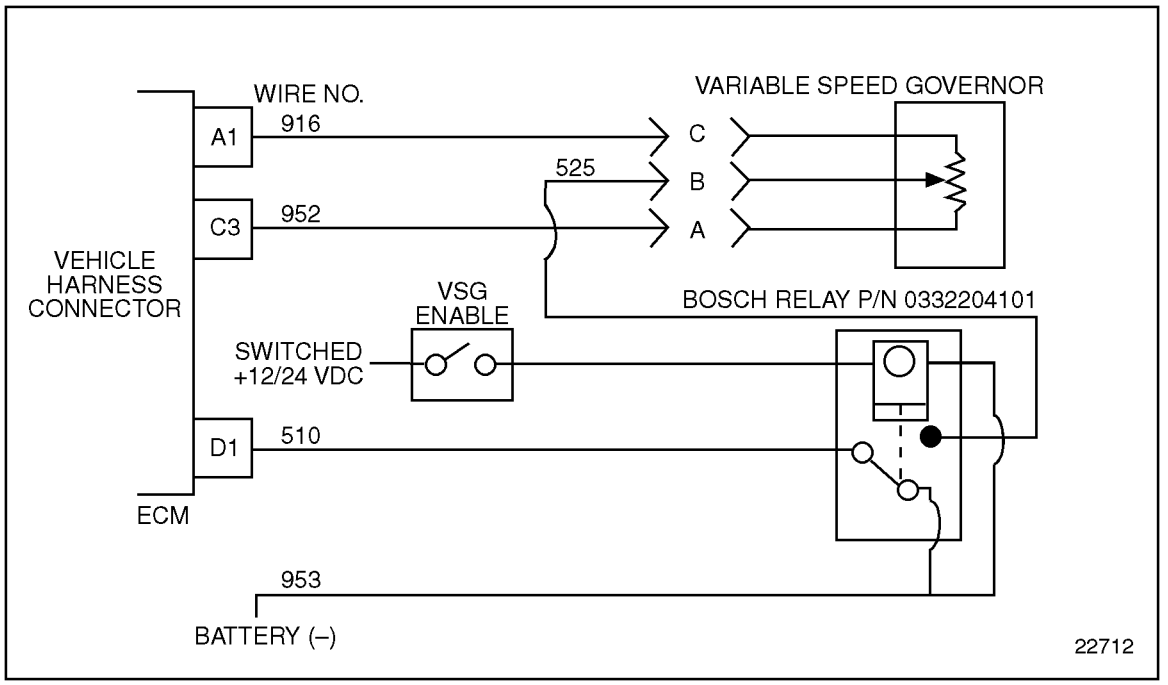

Figure 12-3 Variable Speed Governor Circuit

12.3.7 Check for Short

To check for short, perform the following:

1. Turn ignition OFF.
2. Unplug vehicle 30-pin connector and the VSG connector.
3. Turn ignition ON.
4. Enable VSG. Refer to OEM guidelines.
5. Measure resistance between A3 (#916) and D1 (#510). See Figure 12-4.
   [a] If resistance is greater than 5 Ω, check ECM connector. Refer to section 12.3.8.

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[b] If resistance is less than 5 Ω, wire #916 (5-volt supply) is shorted to #510/#525 (signal). Repair short or replace wire. Refer to section 12.3.8 to verify repairs.

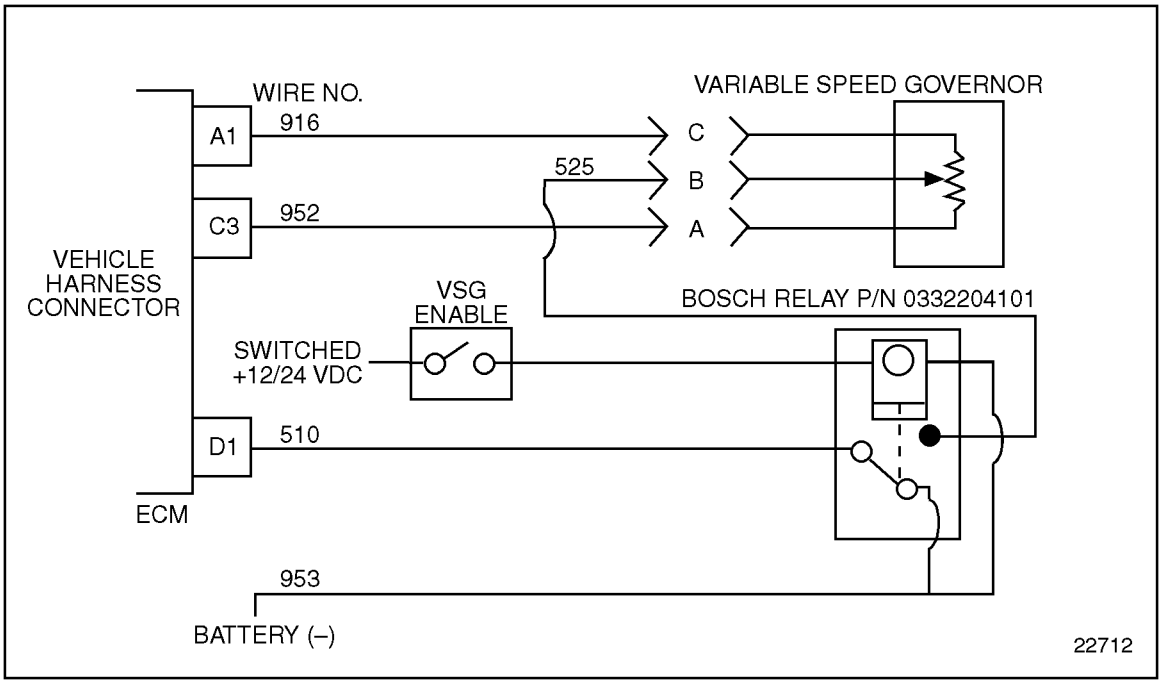

Figure 12-4 Variable Speed Governor Circuit

12.3.8 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Set parking brake, transmission in Neutral.
4. Turn ignition ON.
5. Clear codes.
6. Start and run the engine for one minute.
7. Stop engine.
8. Check DDR for codes.
   [a] If no codes are displayed, no further troubleshooting is required.
   [b] If code 187/3 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 187/3 is logged, and other codes are logged, refer to section 12.3.1.

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13 (CHG) FLASH CODE 13 - CLS LOW

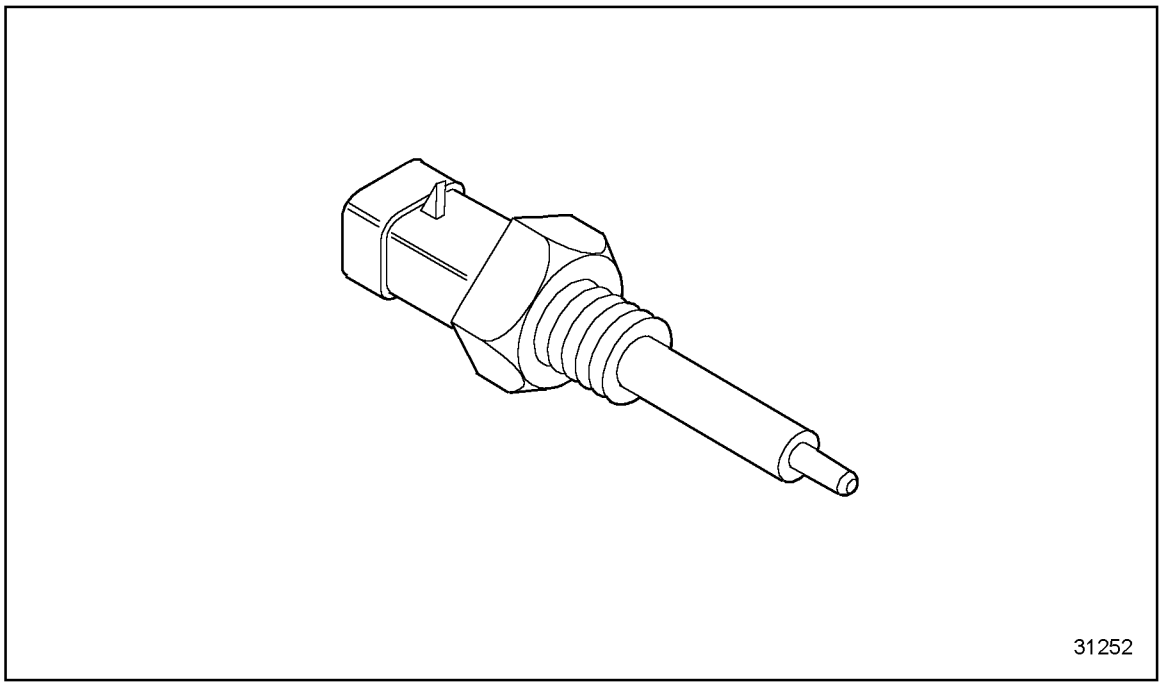

Figure 13-1 Coolant Level Sensor

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13.1 DESCRIPTION OF FLASH CODE 13

Flash Code 13 indicates that the Coolant Level Sensor (CLS) input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage. See Figure 13-1. This diagnostic condition is typically:

- Sensor signal is shorted to the sensor return circuit or to ground
- Deteriorated coolant

13.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 13

The SAE J1587 equivalent code for Flash Code 13 is p 111 4, coolant level circuit low.

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13.3 TROUBLESHOOTING FLASH CODE 13

The following procedure will troubleshoot Flash Code 13.

13.3.1 Sensor Check

Perform the following steps to check the sensor.

1. Turn vehicle ignition OFF.
2. Disconnect Coolant Level Sensor (CLS).
3. Turn ignition ON.
4. Start engine.
5. Read logged codes.
6. Stop engine.
   [a] If code P111/3 is logged, refer to section 13.3.2.
   [b] If code P111/4 is logged, refer to section 13.3.3.

13.3.2 Check Coolant Level Sensor Connector

Perform the following steps to check the CLS connector.

1. Inspect terminals at the CLS connector for bent, corroded and unseated pins or sockets. Ensure wires are not reversed at the CLS. See Figure 13-2.
   [a] If terminals and connectors are damaged, repair both. Refer to section 13.3.4.

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[b] If terminals and connectors are not damaged, replace the CLS. Refer to section 13.3.4.

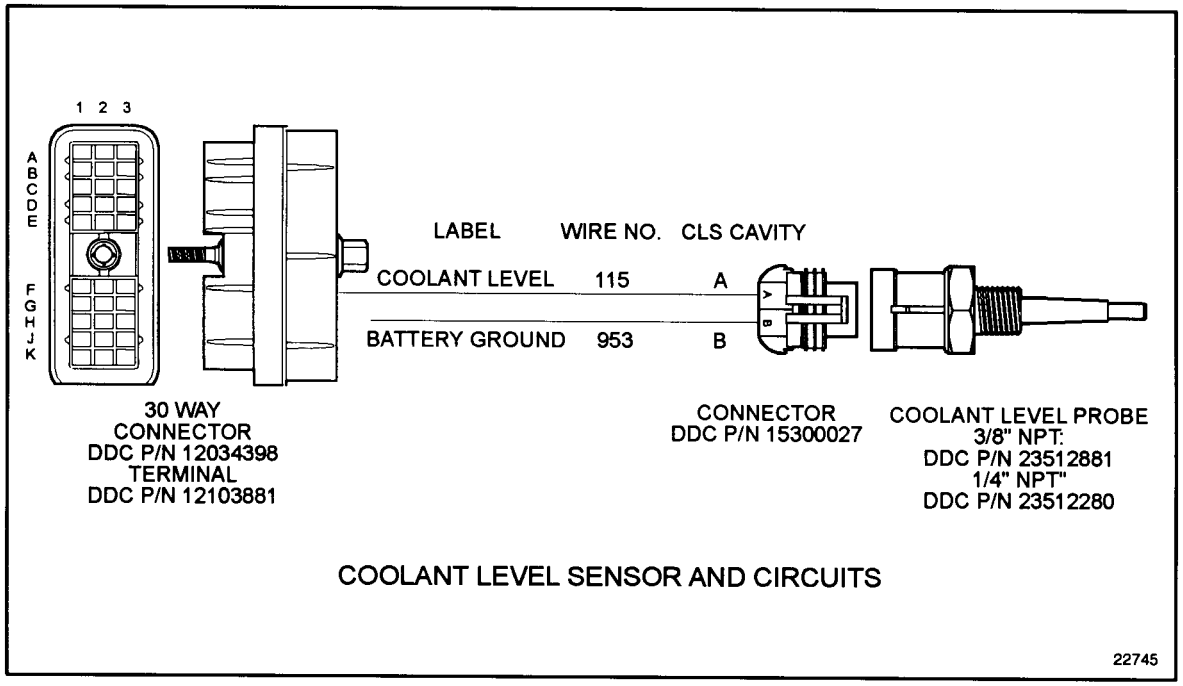

Figure 13-2 Coolant Level Sensor and Circuits

13.3.3 Check for Short

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Measure resistance between sockets A and B on the CLS harness connector. Also measure resistance between socket A and battery ground; and socket A and chassis ground. See Figure 13-2.
   [a] If the resistance is greater than 10,000 Ω or open, refer to section 13.3.2.
   [b] If the resistance is less than or equal to 10,000 Ω, the signal wire (#115) is shorted to the ground (#953), or to chassis ground. Repair short; refer to section 13.3.4.

13.3.4 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear DDR codes.

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5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are displayed, troubleshooting is complete.
   [b] If code 111/4 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 111/4 is logged, refer to section 13.3.5.

13.3.5 Code 111/4 Logged

Perform the following steps to troubleshoot Code 111/4.

1. Remove CLS.
2. Plug opening.
3. Locate sensor probe in clean water.
4. Start and run the engine for one minute.
5. Check DDR for codes.
   [a] If code 111/4 is logged, all system diagnostics are complete. Review this section to find the error. Refer to section 13.3.1.
   [b] If code 111/4 is not logged, reprogram the ECM and replace the coolant with new. Repeat the test. Refer to section 13.3.4.

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14 (CHG) FLASH CODE 14 - TEMP SENSOR HIGH

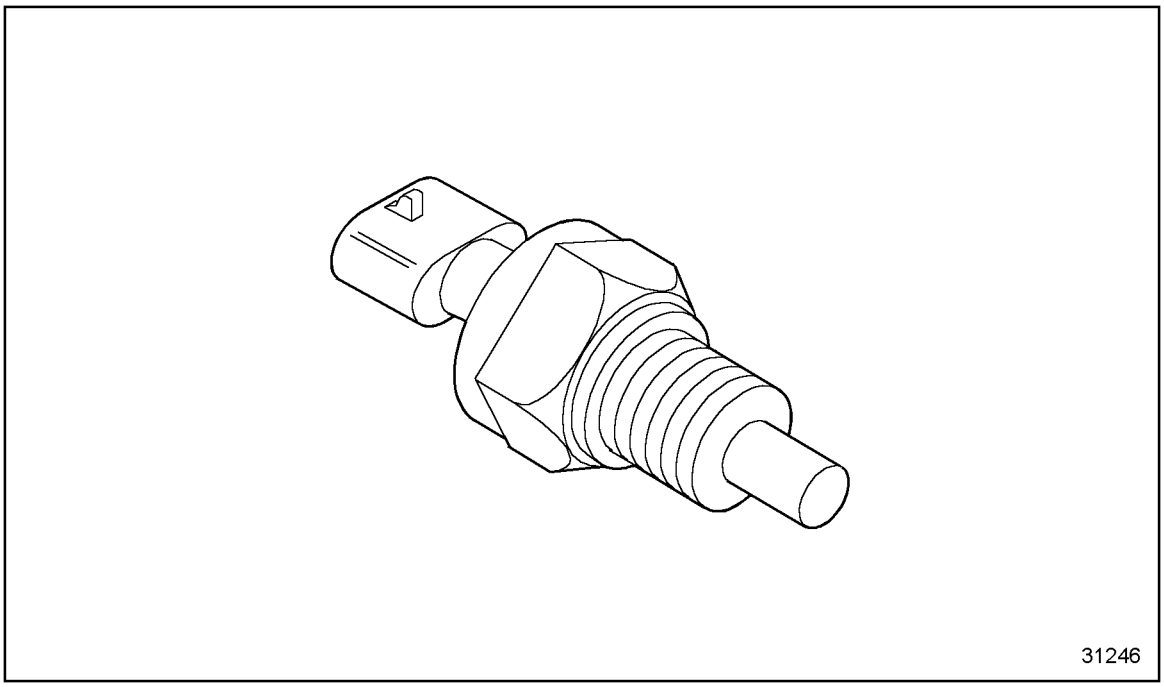

Figure 14-1 Coolant Temperature Sensor (Oil Temperature Sensor similar)

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14.1 DESCRIPTION OF FLASH CODE 14

Flash Code 14 indicates that the engine Coolant Temperature Sensor (CTS) or Oil Temperature Sensor (OTS), See Figure 14-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

NOTE:
This code will only be logged during warm engine operation.

This diagnostic condition is typically:

- ☐ Open sensor signal circuit
- ☐ Open sensor return circuit

14.2 SAE J1587 EQUIVALENT CODES FOR FLASH CODE 14

The SAE J1587 equivalent codes for Flash Code 14 are:

- p 110 3 - coolant temperature circuit high
- p 175 3 - oil temperature circuit high

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14.3 TROUBLESHOOTING FLASH CODE 14

The following procedure will troubleshoot Flash Code 14.

14.3.1 Code Check

Perform the following steps to check for codes.

1. Turn vehicle ignition ON.
2. Plug in diagnostic data reader (DDR) and determine which code is logged.
   [a] If codes PID 110-FMI 3 is logged, refer to section 14.3.2.
   [b] If codes PID 175-FMI 3 is logged, refer to section 14.3.3.

14.3.2 Coolant Temperature Sensor Check

Perform the following steps to check the coolant temperature sensor (CTS).

1. Turn vehicle ignition OFF.
2. Disconnect CTS and install a jumper between the CTS connector sockets A and B. See Figure 14-2.
3. Turn vehicle ignition ON.
4. Read active codes.
   [a] If code 110/4 or any other codes except 110/3 are logged, refer to section 14.3.8.

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[b] If code 110/3 is logged and any codes except code 110/4 are logged, refer to section 14.3.4.

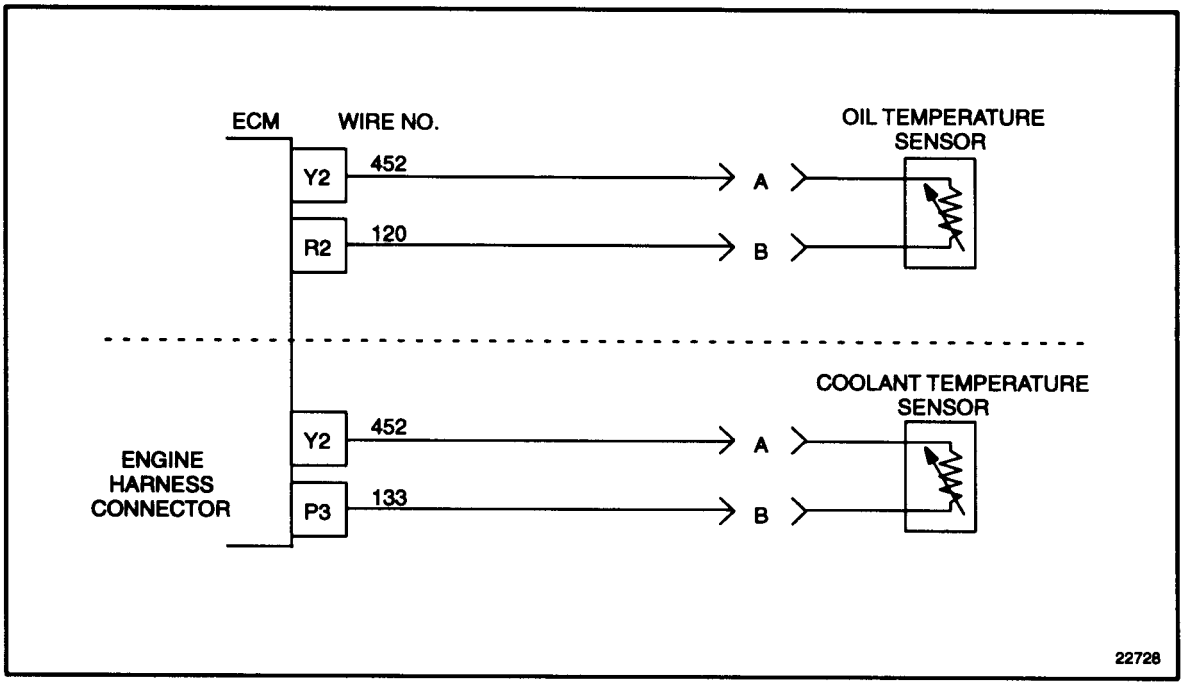

Figure 14-2 Temperature Sensor Circuits

14.3.3 Oil Temperature Sensor Check

Perform the following steps to check the oil temperature sensor (OTS).

1. Turn vehicle ignition OFF.
2. Disconnect OTS and install a jumper between OTS connector sockets A and B. See Figure 14-3.
3. Turn ignition ON.
4. Read active codes.

   [a] If code 175/4 is logged, refer to section 14.3.9.

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[b] If code 175/3 is logged and any codes except code 175/4 are logged, refer to section 14.3.5.

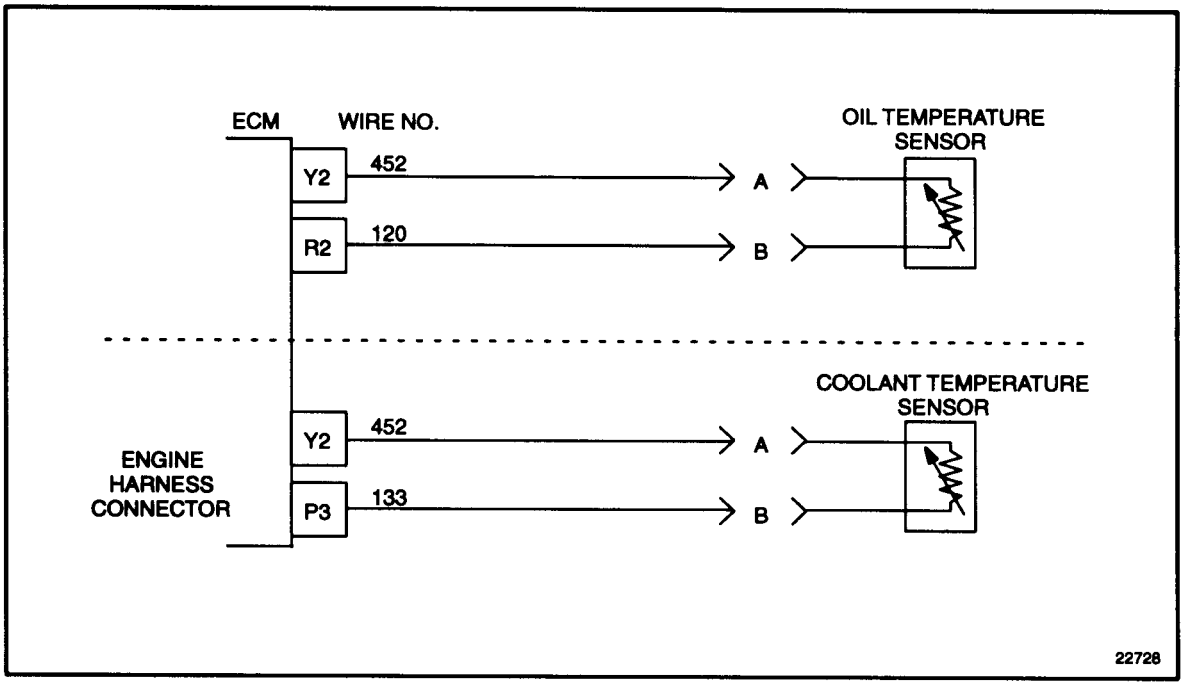

Figure 14-3 Temperature Sensor Circuits

14.3.4 Check for Signal Short to +5 Volt Line

Perform the following steps to check for a short to the +5 volt line.

1. Turn ignition OFF.
2. Remove jumper wire.
3. Disconnect the engine harness connector at the ECM.
4. Measure resistance between sockets P3 #133 and W1 #416 on the engine harness connector. See Figure 14-4.

   [a] If the resistance measurement is greater than 5 Ω or open, refer to section 14.3.6.

[b] If the resistance measurement is less than or equal to 5 Ω, the signal line (#133) is shorted to the engine +5 volt line (#416). Repair the short and refer to section 14.3.11.

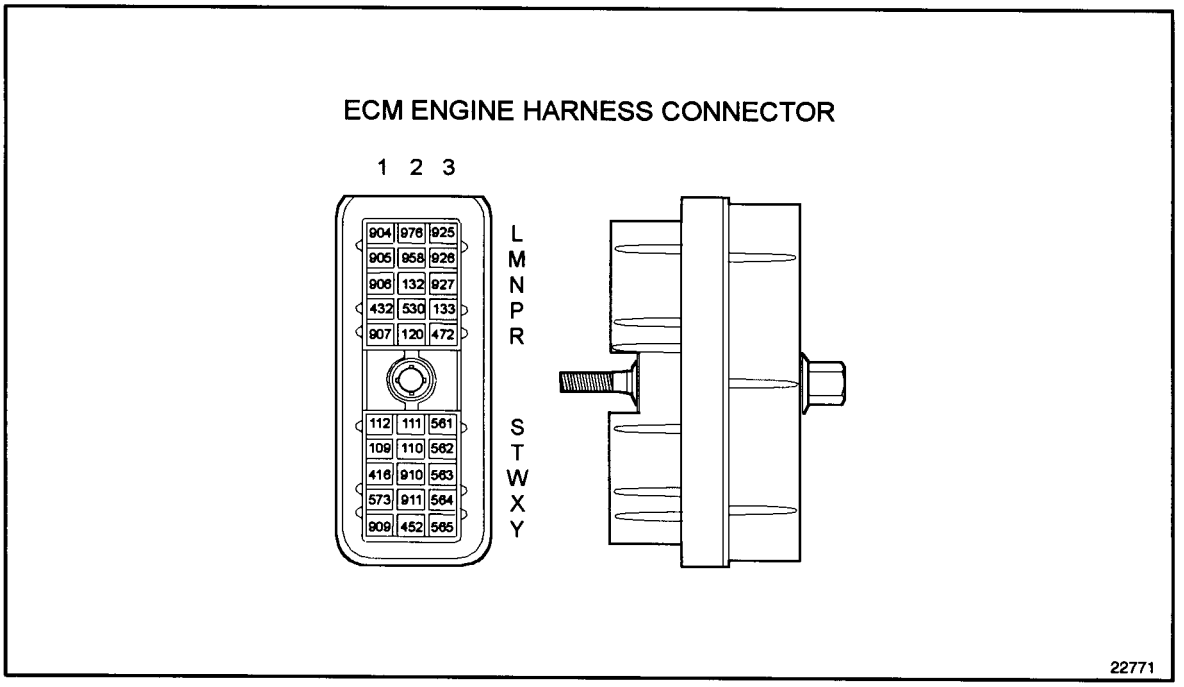

Figure 14-4 ECM Engine Harness Connector

14.3.5 Check for Signal Short to +5 Volt Line

Perform the following steps to check for a short to the +5 volt line.

1. Turn vehicle ignition OFF.
2. Remove jumper wire.
3. Disconnect the engine harness connector at the ECM.
4. Measure resistance between sockets R2 #120 and W1 #416 on the engine harness connector. See Figure 14-4.

   [a] If the resistance measurement is greater than or equal to 5 Ω, refer to section 14.3.7.

   [b] If the resistance measurement is less than 5 Ω, the signal line (#120) is shorted to the engine +5 volt line (#416). Repair the short and refer to section 14.3.11.

14.3.6 Check Coolant Temperature Sensor Connectors

Perform the following steps to check the CTS connectors.

1. Check terminals at the CTS connector (both sensor and harness side) for damage; bent, corroded and unseated pins or sockets. See Figure 14-5.

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[a] If terminals and connectors are in good condition, replace the CTS. Refer to section 14.3.11.

[b] If the terminals and connectors are damaged, repair them. Refer to section 14.3.11.

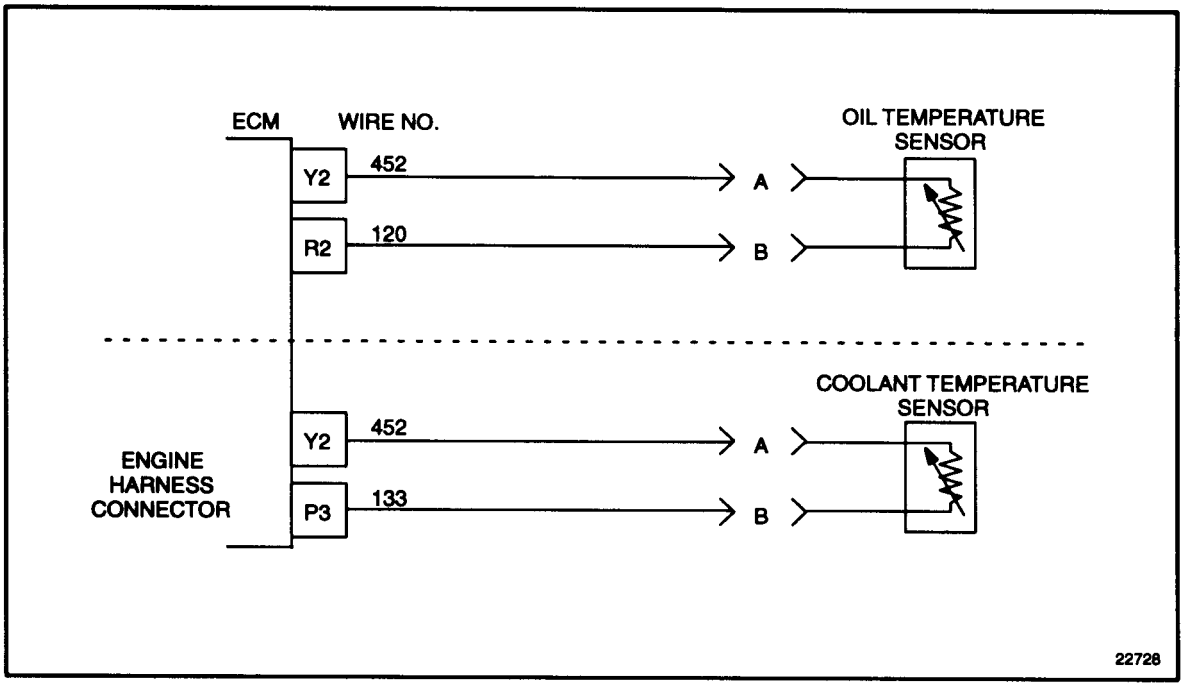

Figure 14-5 Temperature Sensor Circuits

14.3.7 Check Oil Temperature Sensor Connectors

Perform the following steps to check the OTS connectors.

1. Check terminals at the OTS connector (both sensor and harness side) for damage: bent, corroded and unseated pins or sockets. See Figure 14-6.

   [a] If terminals or connectors are damaged, repair them. Refer to section 14.3.11.

[b] If terminals and connectors are not damaged, replace the OTS. Refer to section 14.3.11.

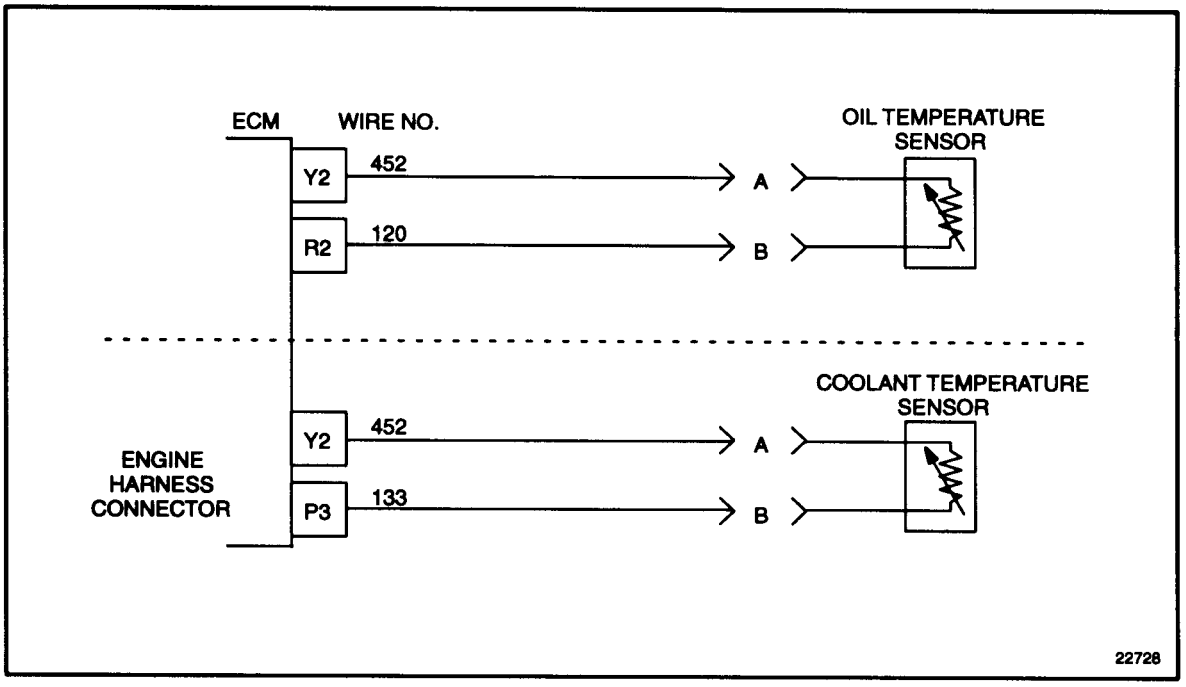

Figure 14-6 Temperature Sensor Circuits

14.3.8 Open Line Check

Perform the following steps to check for an open line.

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM. Leave the jumper wire between A and B of the Temperature Sensor Connector.
3. Measure resistance between sockets P3 (#133) and Y2 (#452) on the engine harness connector. See Figure 14-7.

   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 14.3.10.

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[b] If the resistance measurement is greater than 5 Ω or open, the signal line (#133) or return line (#452) is open. Repair the open. Refer to section 14.3.11.

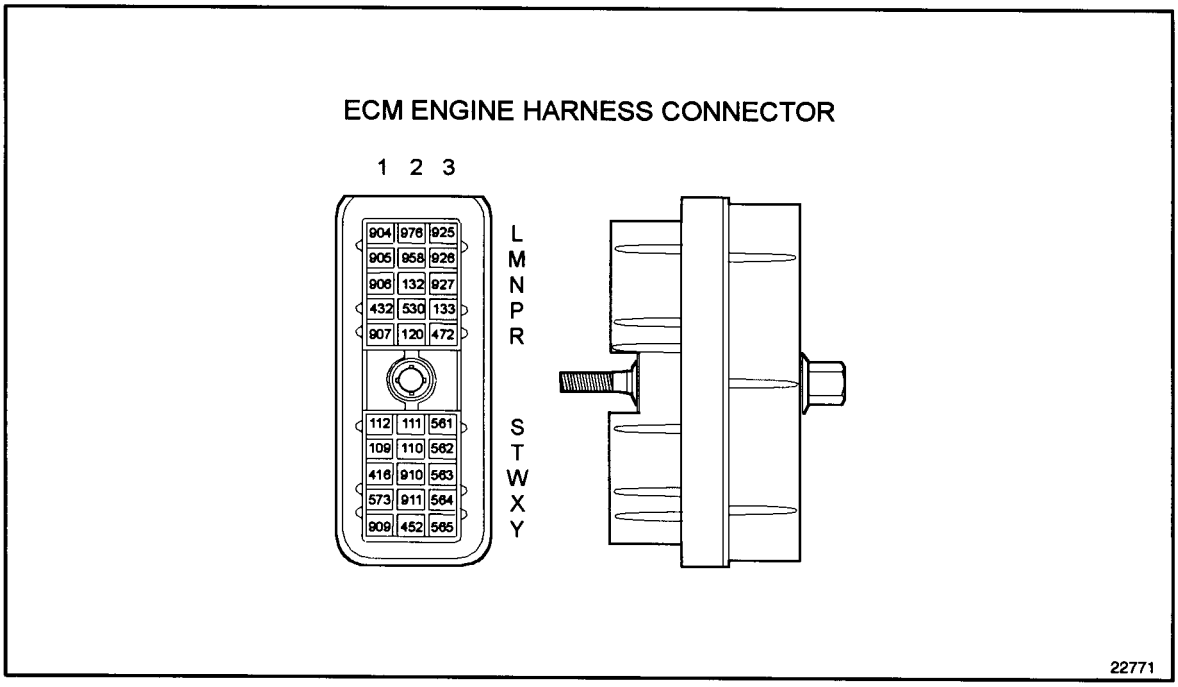

Figure 14-7 ECM Engine Harness Connector

14.3.9 Open Line Check

Perform the following steps to check for an open line.

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM. Leave the jumper wire between A and B of the Temperature Sensor Connector.
3. Measure resistance between sockets R2 (#120) and Y2 (#452) on the engine harness connector. See Figure 14-7.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 14.3.10.
   [b] If the resistance measurement is greater than 5 Ω or open, the signal line (#120) or return line (#452) is open. Repair the open. Refer to section 14.3.11.

14.3.10 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connector (both ECM and harness side) for damage: bent, corroded and unseated pins or sockets. See Figure 14-8.
   [a] If terminals or connectors are damaged, repair them. Refer to section 14.3.11.

[b] If terminals and connectors are not damaged, replace the CTS/OTS.

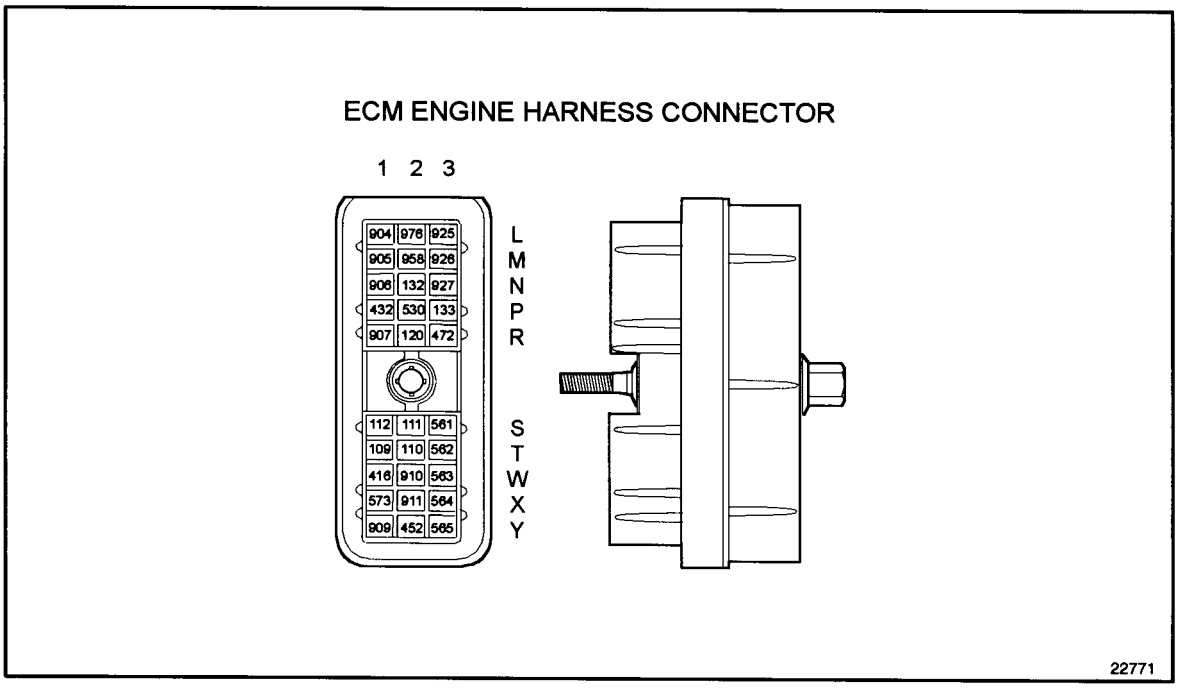

Figure 14-8 ECM Engine Harness Connector

14.3.11 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn vehicle ignition ON.
4. Clear codes.
5. Start and run the engine for eight minutes.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 110/3 or 175/3 and any other codes are logged, all system diagnostics are complete. Review this section to find the error. Refer to section 14.3.1.
   [c] If any codes except code 110/3 or 175/3 are logged, refer to section 9.1.

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15 (CHG) FLASH CODE 15 - TEMP SENSOR LOW

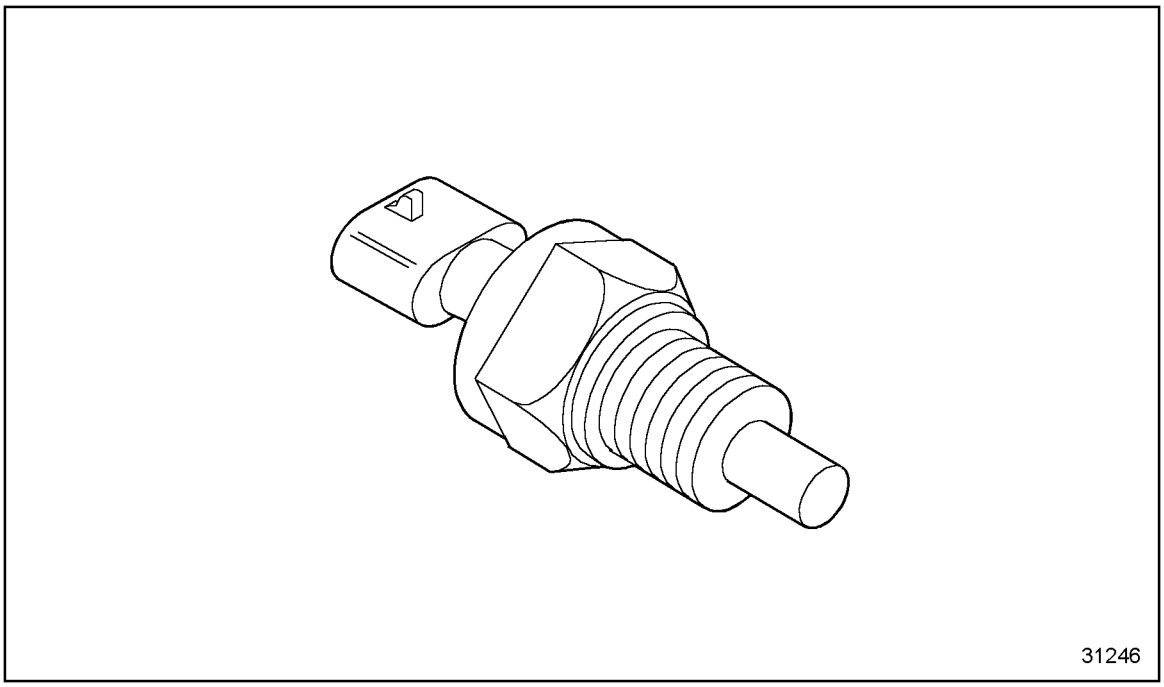

Figure 15-1 Coolant Temperature Sensor (Oil Temperature Sensor similar)

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15.1 DESCRIPTION OF FLASH CODE 15

Flash Code 15 indicates that the Coolant Temperature Sensor (CTS), or Oil Temperature Sensor (OTS), see Figure 15-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- Sensor signal is shorted to the sensor return circuit or to ground

15.2 SAE J1587 EQUIVALENT CODES FOR FLASH CODE 15

The SAE J1587 equivalent codes for Flash Code 15 are:

- p 110 4 - coolant temperature circuit low
- p 175 4 - oil temperature circuit low

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15.3 TROUBLESHOOTING FLASH CODE 15

The following procedure will troubleshoot Flash Code 15.

15.3.1 Code Check

Perform the following steps to check for codes.

1. Turn vehicle ignition ON.
2. Plug in diagnostic data reader (DDR) and determine which code is logged.
   [a] If codes PID 110-FMI 4 are logged, refer to section 15.3.2.
   [b] If codes PID 175-FMI 4 are logged, refer to section 15.3.3.

15.3.2 Coolant Temperature Sensor Check

Perform the following steps to check the coolant temperature sensor (CTS).

1. Turn vehicle ignition OFF.
2. Disconnect (unplug) CTS connector.
3. Start and run the engine for eight minutes.
4. Read active codes with engine still running.
   [a] If code 110/4 or any other codes are logged, refer to section 15.3.4.
   [b] If any codes except code 110/4 are logged, refer to section 15.3.6.

15.3.3 Oil Temperature Sensor Check

Perform the following steps to check the oil temperature sensor (OTS).

1. Turn vehicle ignition OFF.
2. Disconnect OTS connector. See Figure 15-2.
3. Start and run the engine for eight minutes.
4. Read active codes with engine running.
   [a] If code 175/4 is logged, refer to section 15.3.7.

[b] If any codes except code 175/4 are logged, refer to section 15.3.5.

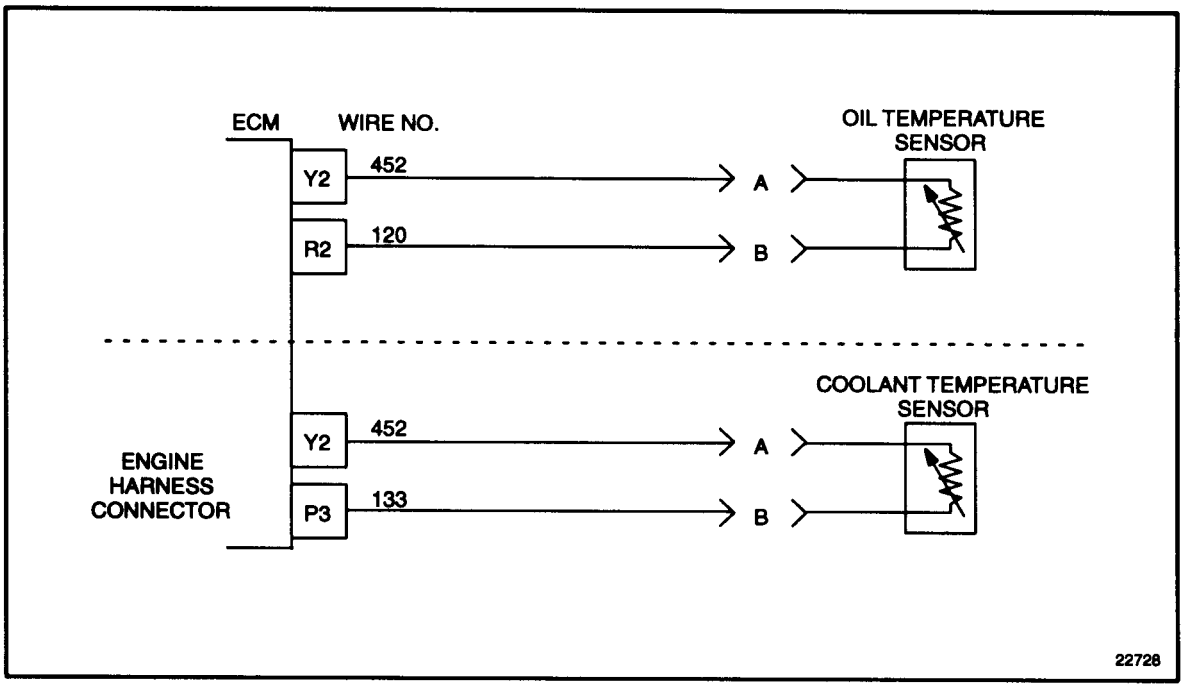

Figure 15-2 Temperature Sensor Circuits

15.3.4 Check Coolant Temperature Sensor Connectors

Perform the following steps to check the CTS connectors.

1. Check terminals at the CTS connector (both sensor and harness side) for damage; bent, corroded and unseated pins or sockets. See Figure 15-3.

   [a] If terminals and connectors are in good condition, replace the CTS. Refer to section 15.3.10.

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[b] If the terminals and connectors are damaged, repair them. Refer to section 15.3.10.

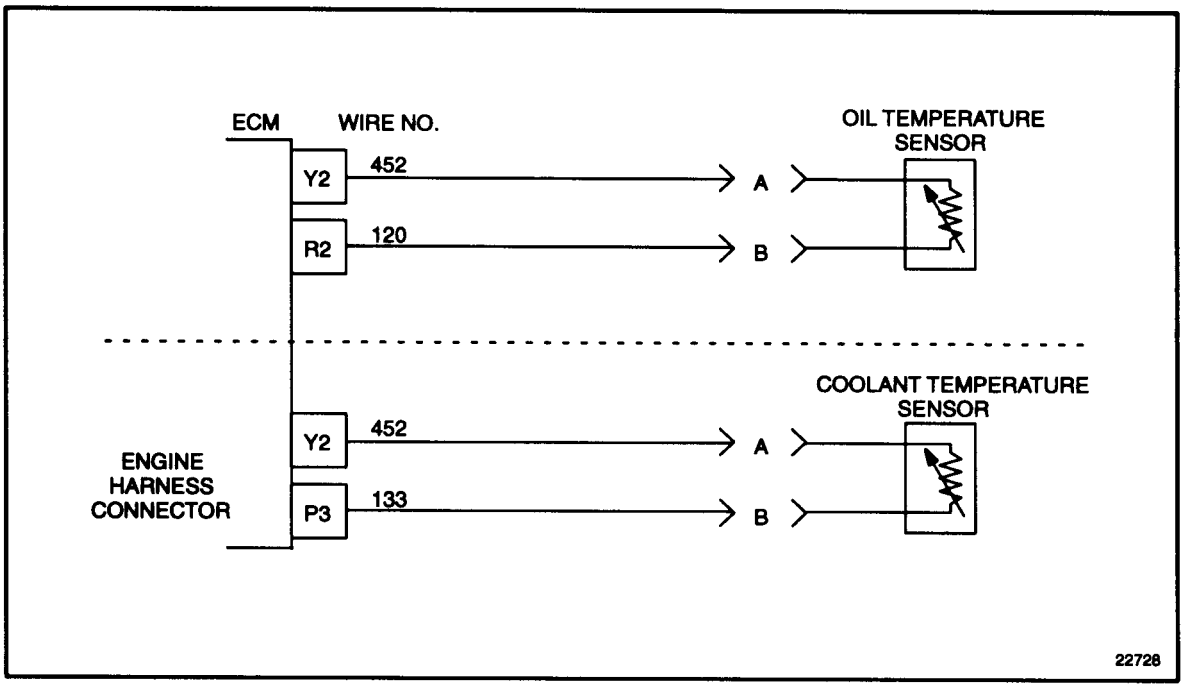

Figure 15-3 Temperature Sensor Circuits

15.3.5 Check Oil Temperature Sensor Connectors

Perform the following steps to check the OTS connectors.

1. Check terminals at the OTS connector (both sensor and harness side) for damage: bent, corroded and unseated pins or sockets. See Figure 15-4.

   [a] If terminals or connectors are damaged, repair them. Refer to section 15.3.10.

[b] If terminals and connectors are not damaged, replace the OTS. Refer to section 15.3.10.

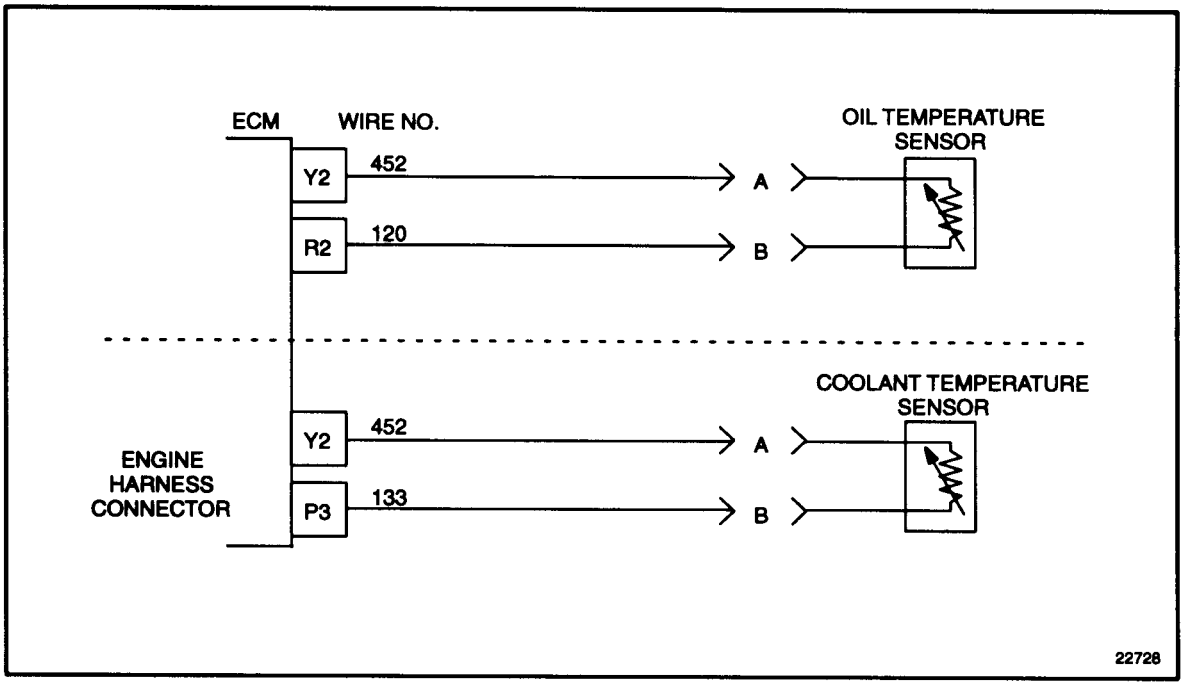

Figure 15-4 Temperature Sensor Circuits

15.3.6 Check for Short

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Measure resistance between sockets P3 (#133) and Y2 (#452) on the engine harness connector. See Figure 15-5.
4. Measure resistance between socket P3 and a good ground.

   [a] If the resistance measurement between sockets P3 and Y2, or P3 and battery ground, is less than or equal to 5 Ω, the signal line (#133) is shorted to the return line (#452) or battery ground. Repair the short. Refer to section 15.3.10.

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[b] If the resistance measurement between sockets P3 and Y2 is greater than 5 Ω or open, and the resistance measurement between sockets P3 and a good ground is greater than or equal to 5 Ω or open, refer to section 15.3.8.

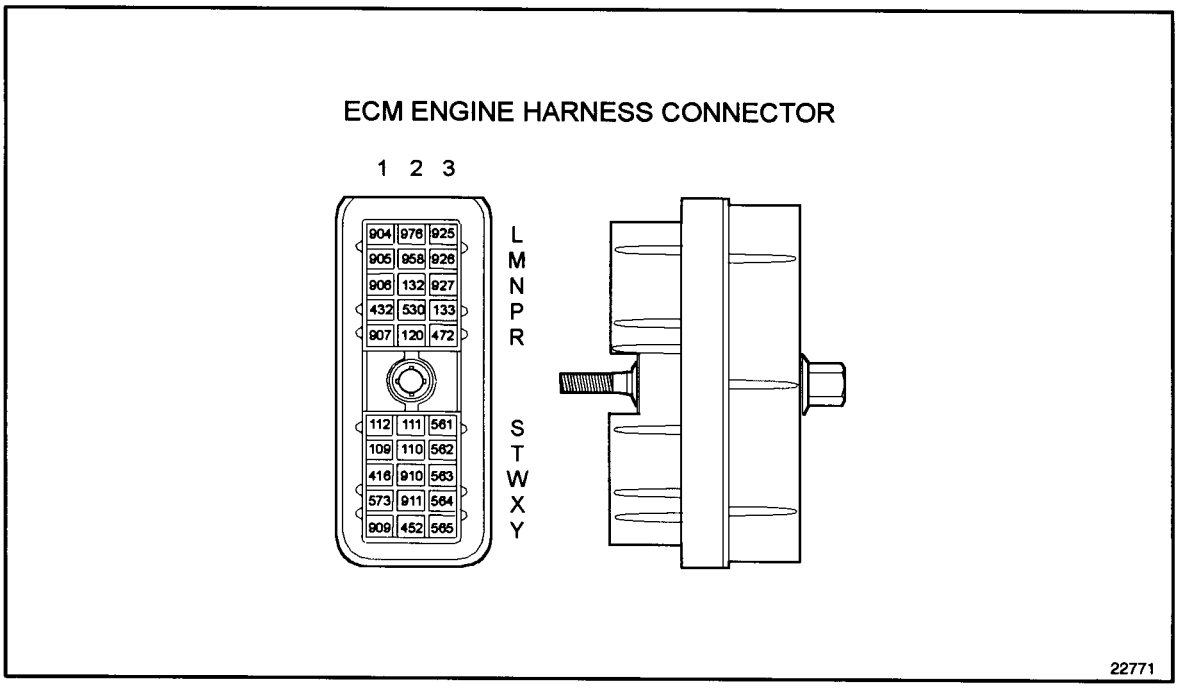

Figure 15-5 ECM Engine Harness Connector

15.3.7 Check for Short

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Measure resistance between sockets R2, (#120) and Y2 (#452) on the engine harness connector. See Figure 15-6.
4. Measure resistance between socket R2 and a good ground.

   [a] If the resistance measurement between sockets R2 and Y2, or R2 and battery (-) is less than or equal to 5 Ω, the signal line (#120) is shorted to the return line (#452) or battery ground. Repair the short. Refer to section 15.3.10.

[b] If the resistance measurement between socket R2 and Y2 is greater than 5 Ω or open, and the resistance measurement between socket R2 and a good ground is greater than or equal to 5 Ω or open, refer to section 15.3.9.

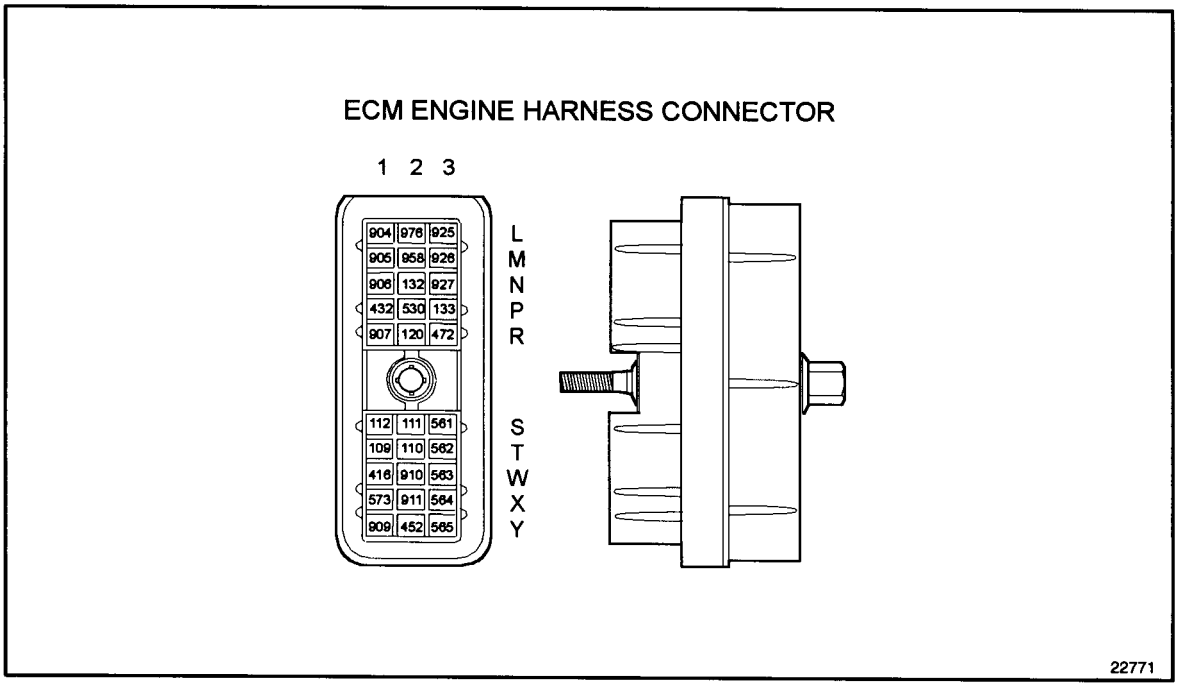

Figure 15-6 ECM Engine Harness Connector

15.3.8 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connector (both ECM and harness side) for damage: bent, corroded and unseated pins or sockets. Check terminals P3 and Y2 of the ECM connector. See Figure 15-7.

   [a] If terminals or connectors are damaged, repair them. Refer to section 15.3.10.

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[b] If terminals and connectors are not damaged, reprogram the ECM. Refer to section 15.3.10.

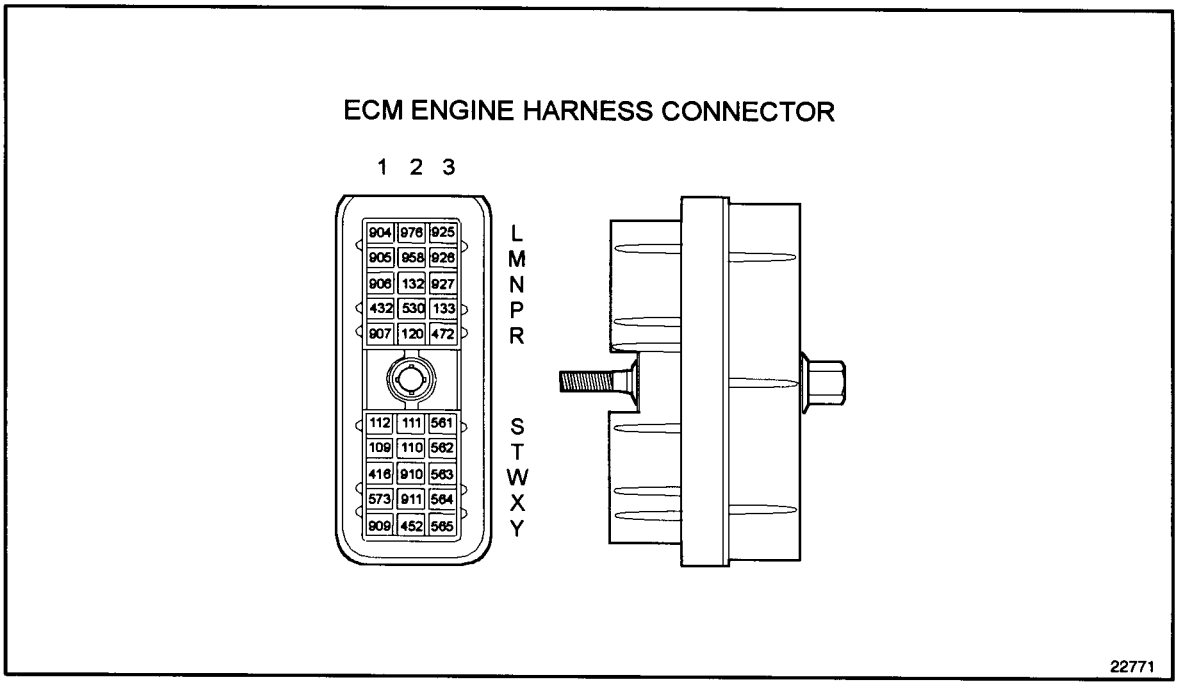

Figure 15-7 ECM Engine Harness Connector

15.3.9 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connector (both sensor and harness side) for damage: bent, corroded and unseated pins or sockets. Check terminals R2 and Y2 of the ECM connector. See Figure 15-8.

   [a] If terminals or connectors are damaged, repair them. Refer to section 15.3.10.

[b] If terminals and connectors are not damaged, reprogram the ECM. Contact Detroit Diesel Technical Service Group. Refer to section 15.3.10.

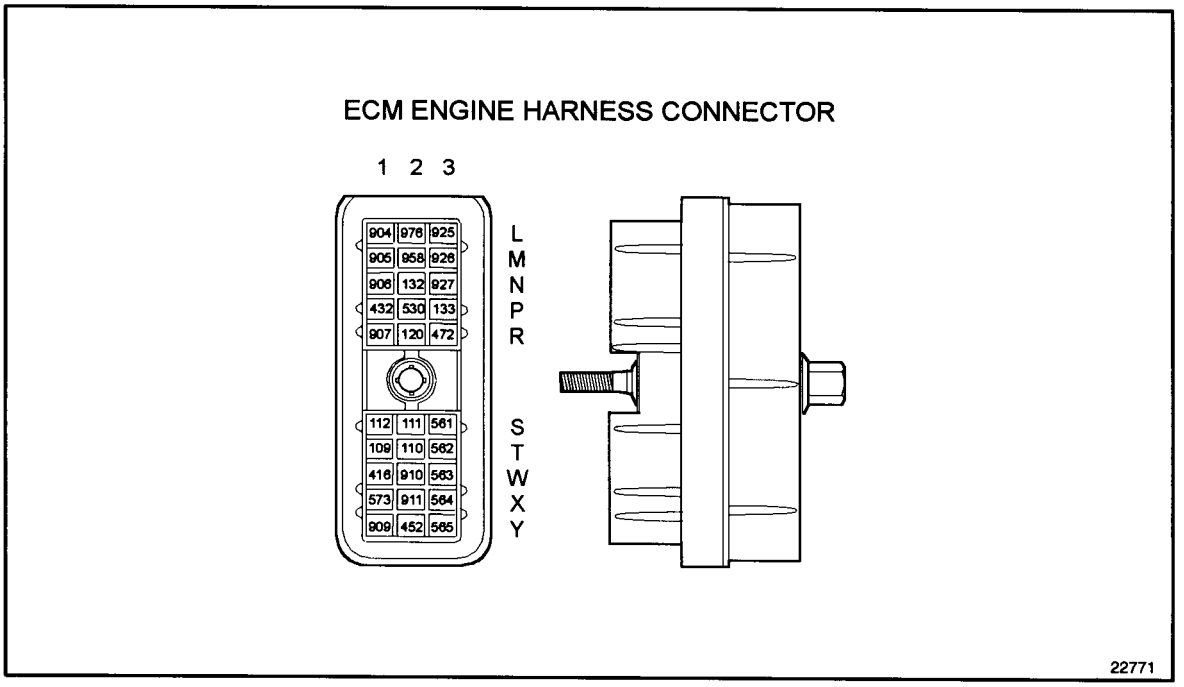

Figure 15-8 ECM Engine Harness Connector

15.3.10 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn vehicle ignition ON.
4. Clear codes
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 110 or 175/4 and any other codes are logged, all system diagnostics are complete. Review this section to find the error. Refer to section 15.3.1.
   [c] If any codes except code 110 or 175/4 are logged, refer to section 9.1.

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16 (CHG) FLASH CODE 16 - CLS HIGH

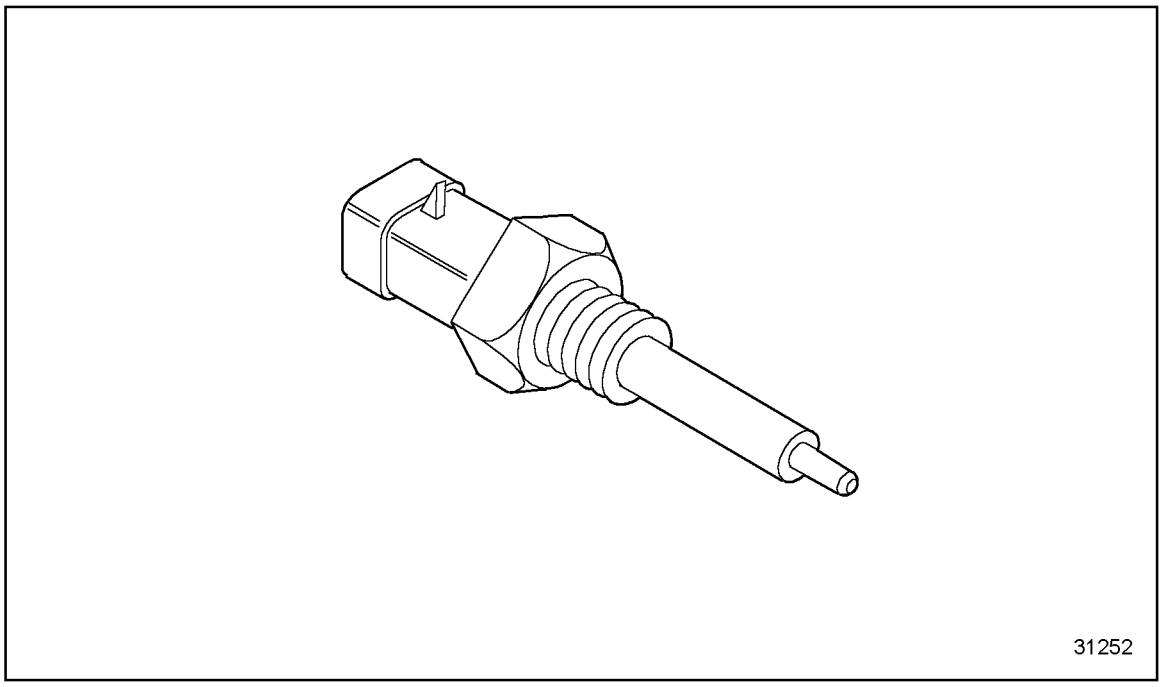

Figure 16-1 Coolant Level Sensor

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16.1 DESCRIPTION OF FLASH CODE 16

Flash Code 16 indicates that the engine Coolant Level Sensor (CLS), see Figure 16-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- ☐ Open sensor signal circuit
- ☐ Open sensor ground circuit

16.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 16

The SAE J1587 equivalent code for Flash Code 16 is p 111 3, coolant level circuit high.

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16.3 TROUBLESHOOTING FLASH CODE 16

The following procedure will troubleshoot Flash Code 16.

16.3.1 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition OFF.
2. Disconnect Coolant Level Sensor (CLS) connector and install a jumper between sockets A and B of the CLS harness connector.
3. Attempt to start and run engine at idle.
4. Read DDR for active codes.
   [a] If active code 111/3 and any other codes except code 111/4 are logged, refer to section 16.3.2.
   [b] If active code 111/4 and any other codes are logged, refer to section 16.3.4.
5. Stop engine.

16.3.2 Signal Circuit Check

Perform the following steps to check the signal circuit.

1. Turn ignition OFF.
2. Disconnect the CLS.
3. Disconnect the vehicle harness connector.
4. Measure resistance between socket H3 (#115) on the vehicle harness connector and A (#115 signal) of the CLS connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 16.3.3.
   [b] If the resistance measurement is greater than 5 Ω, or the signal line #115 is open, repair the open. Refer to section 16.3.7.

16.3.3 Ground Circuit Check

Perform the following steps to check the ground circuit.

1. Measure resistance between cavity B (battery ground) of the CLS connector and battery ground.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 16.3.4.
   [b] If the resistance measurement is greater than 5 Ω, or open, the ground circuit is open. Repair and refer to section 16.3.7.

16.3.4 Signal Short to Ignition Check

Perform the following steps to check for a signal short to ignition.

1. Disconnect the vehicle harness connector at the ECM.
2. Remove the jumper wire at the CLS harness connector.
3. Turn ignition ON.
4. Measure voltage at cavity A (#115 signal) of the CLS connector and battery ground. See Figure 16-2.
   [a] If the voltage measurement is less than or equal to 6 volts, refer to section 16.3.5.
   [b] If the voltage measurement is greater than 6 volts, the CLS signal line (#115) is shorted to the 12/24 volt DC line. Repair the short or replace the #115 wire. Refer to section 16.3.7.

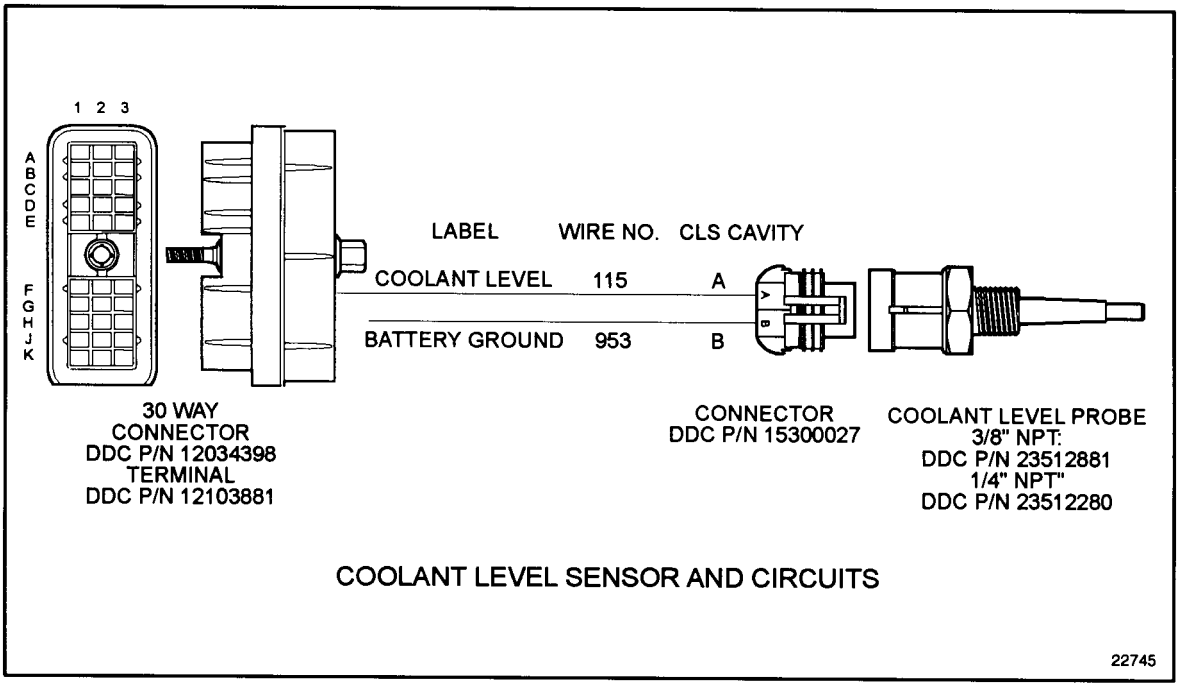

Figure 16-2 Coolant Level Sensor and Circuits

16.3.5 ECM Connectors Check

Perform the following steps to check the ECM connectors.

1. Inspect terminals at the vehicle harness connector (both the sensor and harness side) for bent, corroded and unseated pins or sockets. Check terminal and pin H3 at the ECM and all terminals and pins in the CLS connector. See Figure 16-3.
   [a] If terminals and connectors are not damaged, replace the CLS. Refer to section 16.3.7. If this is a repeated failure of the CLS, refer to section 16.3.6.

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[b] If terminals and connectors are damaged, repair both. Refer to section 16.3.7.

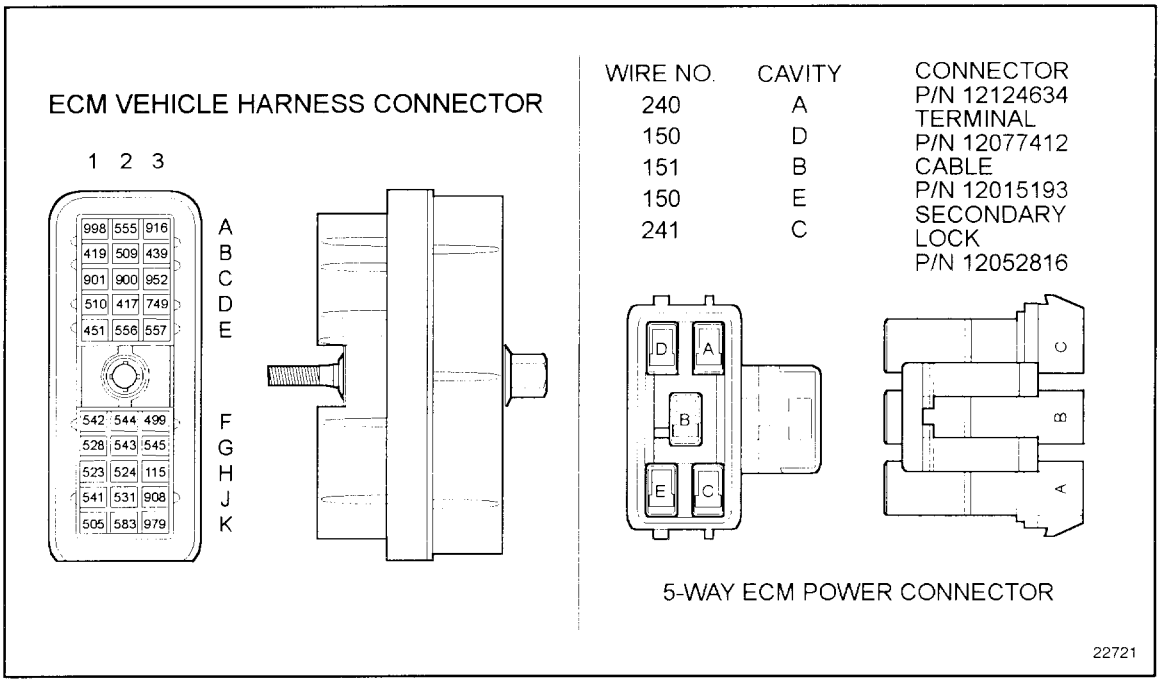

Figure 16-3 Vehicle Harness Connector

16.3.6 Alternator Ground Check

Perform the following steps to check the alternator ground.

1. Connect all connectors.
2. Remove alternator belt or disable alternator from charging.
3. Start and run the engine.
4. Read logged codes.
   [a] If no codes are logged, repair the alternator ground circuit. Refer to section 16.3.7.
   [b] If codes are logged, replace CLS. Refer to section 16.3.7.

16.3.7 Verify Repairs

Perform the following steps to verify the repairs.

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear DDR codes.
5. Start and run the engine for one minute.

6. Stop the engine.
7. Check DDR for codes.
   [a] If no codes are displayed, troubleshooting is complete.
   [b] If code 111/3 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 111/3 is logged, and other codes are logged, refer to section 16.3.1, and perform tasks.

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17 (CHG) FLASH CODE 17 - THROTTLE VALVE HIGH

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17.1 DESCRIPTION OF FLASH CODE 17

Flash Code 17 is currently used for gas fueled engines only. This code indicates that the Throttle Plate Input Voltage has exceeded 95% of the sensor supply voltage (normally >4.75 volts). Typically, the problem is an open sensor return, a short to the sensor supply or throttle body power is low.

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17.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 17

The SAE J1587 equivalent code for Flash Code 17 is p 051/3, throttle plate input voltage high.

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17.3 TROUBLESHOOTING FLASH CODE 17

The following procedure will troubleshoot Flash Code 17.

17.3.1 Check Actuator

Perform the following steps to check the actuator.

1. Unplug throttle actuator connector.
2. Turn ignition ON.
3. Plug in DDR.
   [a] If code p 051/3 is logged, refer to section 17.3.3.
   [b] If code p 051/4 is logged, refer to section 17.3.5.

17.3.2 Check Connectors

Perform the following steps to check the connectors.

1. Turn ignition OFF.
2. Check connectors, ECM side and throttle actuator side, for damaged, bent or broken pins.
   [a] If the connectors are not damaged, replace the actuator. Refer to section 17.3.6.
   [b] If the connectors are damaged, bent or have broken pins, repair or replace the connectors or pins; refer to section 17.3.6.

17.3.3 Check Sensor

Perform the following steps to check the sensor.

1. Turn ignition OFF.
2. Unplug the engine sensor harness.
3. Measure resistance between W1 and R1. See Figure 17-1.
   [a] If the resistance measurement is less than or equal to 1,000 Ω, the wires are shorted to each other. Repair the short or replace the engine sensor harness. Refer to section 17.3.6.

[b] If the resistance measurement is greater than 1,000 Ω, refer to section 17.3.4.

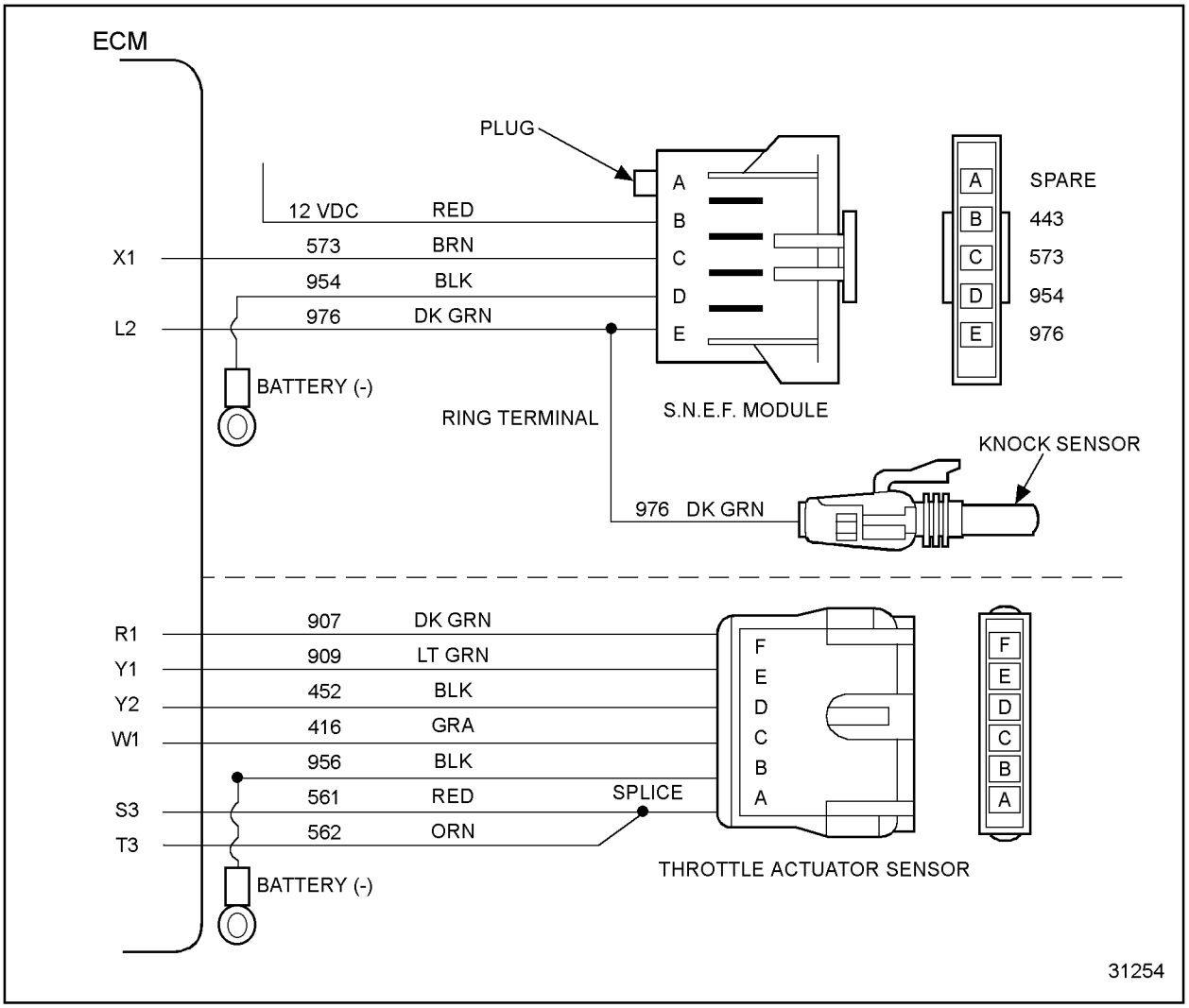

Figure 17-1 Gas Engine Sensor Harness

17.3.4 Check for Voltage

Perform the following steps to check for voltage.

1. Reconnect the engine sensor harness.
2. Measure voltage between cavity R1 and battery (-), ground.

   [a] If the voltage measurement is greater than 4.5 volts, the wire is shorted to the voltage supply. Replace the #907 wire, or replace the harness. Refer to section 17.3.6.

   [b] If the voltage is less than 4.5 volts, refer to section 17.3.5.

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17.3.5 Check for Open

Perform the following steps to check for open.

1. Turn ignition OFF. Disconnect engine sensor harness.
2. Place a jumper wire between cavity F and D of the throttle actuator connector.
3. Measure resistance between R1 (#907) and Y2 (#452).
   [a] If the measured resistance is greater than 1,000 Ω, the return line (#452) is open. Repair the open and refer to section 17.3.6.
   [b] If the measured resistance is less than 1,000 Ω, refer to section 17.3.2.

17.3.6 Verify Repairs

Perform the following steps to verify repairs.

1. Plug in all connectors.
2. Clear the codes.
3. Start and run the engine.
4. Operate at idle and rated speed.
5. Turn ignition OFF.
6. Plug in DDR and read the codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If any codes are logged, review this section to find the error. Then, contact Detroit Diesel Technical Services.

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18 (CHG) FLASH CODE 18 - THROTTLE VALVE LOW

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18.1 DESCRIPTION OF FLASH CODE 18

Flash Code 17 is currently used for gas fueled engines only. This code indicates that the Throttle Valve Plate Input Voltage has dropped below the 5% sensor supply voltage (normally < 0.25 volts). Typically, the problem is an open signal or an open sensor supply.

18.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 18

The SAE J1587 equivalent code for Flash Code 18 is p 051/4, throttle plate input voltage low.

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18.3 TROUBLESHOOTING FLASH CODE 18

The following procedure will troubleshoot Flash Code 18.

18.3.1 Check Actuator

Perform the following steps to check the actuator.

1. Unplug throttle actuator harness connector.
2. Install a jumper wire between cavity F and C.
3. Turn ignition ON.
4. Plug in DDR. Read the codes.
   [a] If code p 051/3 and any other codes are logged, refer to section 18.3.2.
   [b] If code p 051/4 is logged, refer to section 18.3.3.

18.3.2 Check Connectors

Perform the following steps to check the connectors.

1. Turn ignition OFF.
2. Remove jumper wire.
3. Check connectors, both ECM and throttle actuator side, for bent, broken, or loose connections.
   [a] If the connectors are not damaged, replace the actuator and refer to section 18.3.7.
   [b] If the connectors are damaged, bent or have broken pins, repair or replace them. Refer to section 18.3.7.

18.3.3 Check for Open

Perform the following steps to check for open.

1. Turn ignition OFF.
2. Move jumper wire from cavity F and C to cavity F and D.
3. Remove engine harness connector.
4. Measure resistance between Y2 (#452) and R1 (#907). See Figure 18-1.
   [a] If the measured resistance is greater than 1,000 Ω , wire #907 is open. Repair the open or replace the harness and refer to section 18.3.7.

[b] If the measured resistance is less than 1,000 Ω , refer to section 18.3.4.

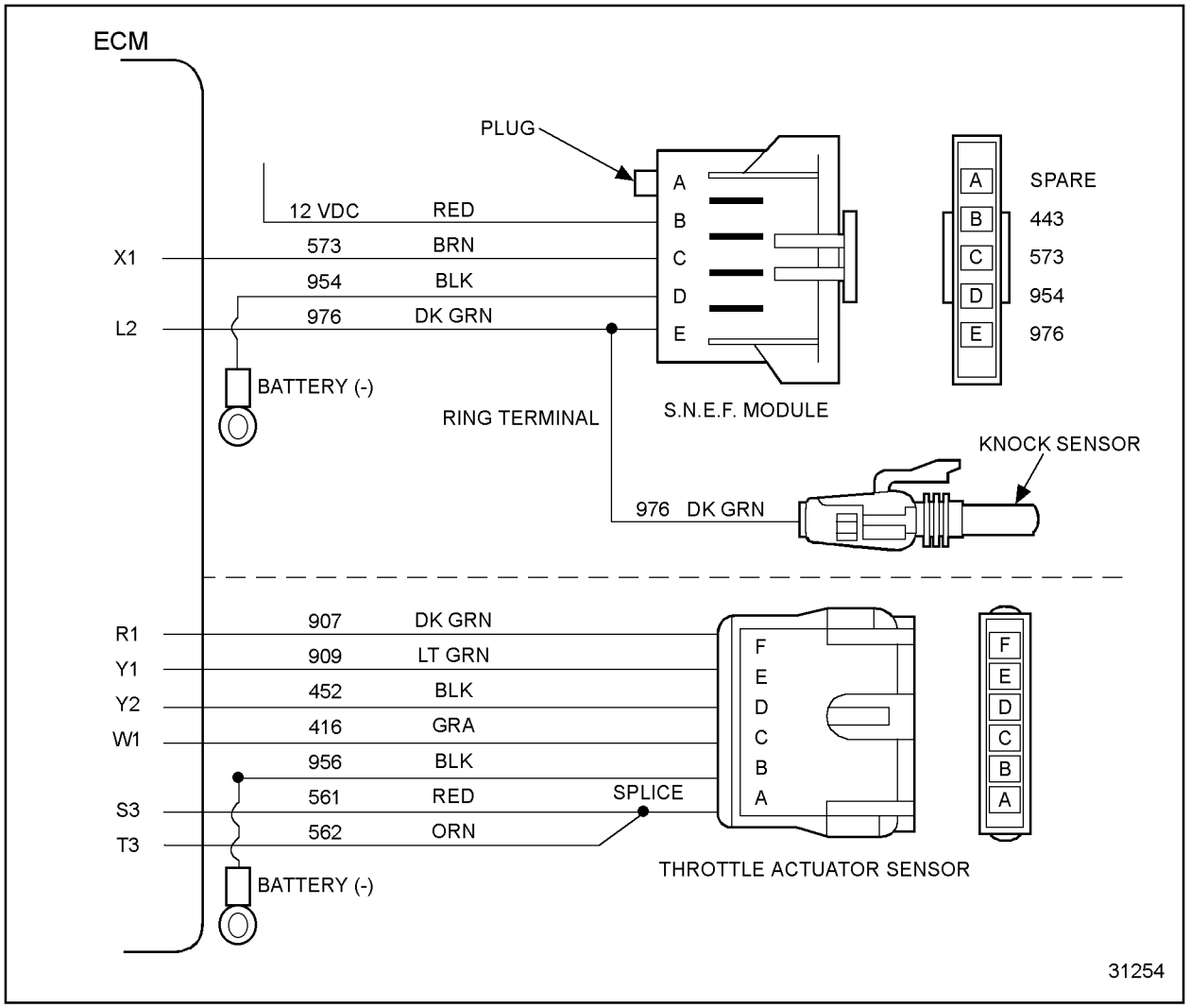

Figure 18-1 Gas Engine Sensor Harness

18.3.4 Check for Short to Return

Perform the following steps to check for a short to the return line.

1. Remove jumper.
2. Measure resistance between Y2 (#452) and R1 (#907), and Y2 (#452) and W1 (#416).

   [a] If either measured resistance is less than 1,000 Ω, those wires are shorted to each other. Replace the harness and refer to section 18.3.7.

   [b] If both measured resistance are greater than 1,000 Ω, refer to section 18.3.5.

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18.3.5 Check for Short to Battery (-)

Perform the following steps to check for a short to the battery (-).

1. Measure resistance between R1 (#907) and battery ground, and W1 (#416) and battery ground.
   [a] If either measured resistance is less than 1,000 Ω, then that wire is shorted to the battery (-). Replace the harness and refer to section 18.3.7.
   [b] If the measured resistance is greater than 1,000 Ω, refer to section 18.3.6.

18.3.6 Check for 5 Volt Open

Perform the following steps to check for a 5 volt open.

1. Plug in the 30-pin connector for the engine sensor harness.
2. Turn ignition ON.
3. Measure voltage between cavity D (#452) and C (#416) of the actuator connector.
   [a] If the measurement is less than 4.5 volts, wire #416 is open. Repair the open or replace the harness. Refer to section 18.3.7.
   [b] If the measurement is between 4.5 and 5.5 volts, refer to section 18.3.2.

18.3.7 Verify Repairs

Perform the following steps to verify repairs.

1. Plug all connectors in.
2. Start and run the engine.
3. Plug in the DDR and read the codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code p 051/4 is logged, please review this section from the first step to find the error. Refer to section 18.3.1. Then, contact Detroit Diesel Technical Services.

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19 FLASH CODE 19

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19.1 DESCRIPTION OF FLASH CODE 19

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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20 FLASH CODE 20

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20.1 DESCRIPTION OF FLASH CODE 20

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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21 FLASH CODE 21 - TPS HIGH

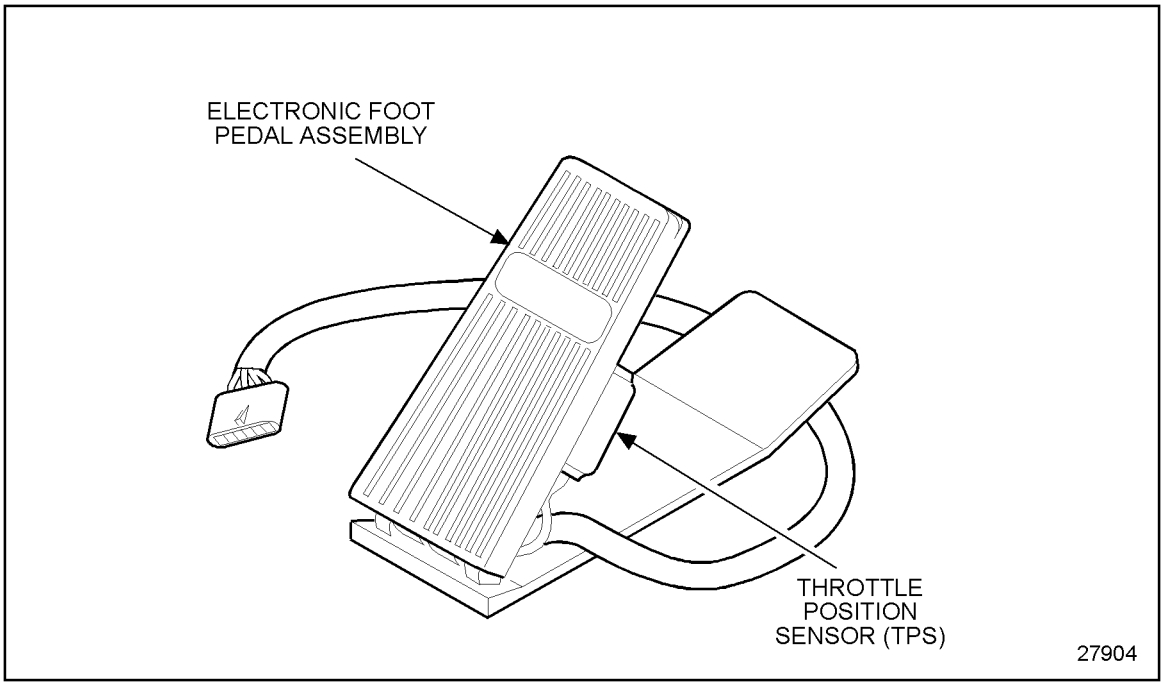

Figure 21-1 Throttle Position Sensor

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21.1 DESCRIPTION OF FLASH CODE 21

Flash Code 21 indicates that the Throttle Position Sensor (TPS), see Figure 21-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- Open sensor return circuit
- Sensor signal circuit is shorted to the sensor +5 volt supply

21.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 21

The SAE J1587 equivalent code for Flash Code 21 is p 091 3, TPS circuit high.

21.2.1 General Throttle Information (Limiting Speed Governor)

The correct TPS counts for DDEC III engines at idle should be 64 - 205 counts.

1. Typical DDEC III foot pedals today, at idle, provide 102 - 205 counts.
2. DDEC II foot pedals can be used on DDEC III engines. The counts from the DDEC II style pedal may go as low as 64 counts at idle, but this is still acceptable.
3. The DDEC system will log a TPS low volt code (PID 091, FMI 4, Flash Code 22) if the TPS counts go below 48.
4. The DDEC system will log a TPS high volt code (PID 091, FMI 3, Flash Code 21) if the TPS counts go above 968 counts.
5. In order to go from 0% to 100% throttle, the counts have to increase 546 above the idle count, or 100 counts, whichever is greater.
6. If an idle validation switch (IVS) is configured, to go from 0% to 100% throttle, the counts have to increase 546 above the counts at which the IVS opens or 100 counts, whichever is greater.
7. If 0% throttle is attained with the foot off the pedal, and if 100% throttle is attained with the pedal to the floor, then the pedal should not be considered a factor for low power complaints.

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21.3 TROUBLESHOOTING FLASH CODE 21

The following procedure will troubleshoot Flash Code 21.

21.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn ignition ON.
2. Plug in DDR.
3. Read active codes.
   [a] If active code 91/3 and no other active codes are logged, refer to section 21.3.2.
   [b] If any or all of the following codes are logged, 91/3, 91/4, 187/3, 100/3, refer to section 91.2.
   [c] If any codes except 91/3 are logged, refer to section 21.3.3.

21.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition OFF.
2. Unplug the TPS connector.
3. Turn ignition ON.
4. Read for active codes.
   [a] If active code 91/3 and any other codes are logged, refer to section 21.3.7.
   [b] If code 91/4 is logged, refer to section 21.3.3.

21.3.3 Return Circuit Check

Perform the following steps to check the return circuit.

1. Turn ignition OFF.
2. Install a jumper wire between pin A (return #952) and pin B (signal #417) of the TPS harness connector.
3. Disconnect the vehicle harness connector at the ECM.
4. Measure resistance between sockets C3 and D2 on the vehicle harness connector. For Throttle Position Sensor schematic, See figure 21-2.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 21.3.4.

[b] If the resistance measurement is greater than 5 Ω, and the return line #952 is open, repair the open and refer to section 21.3.10.

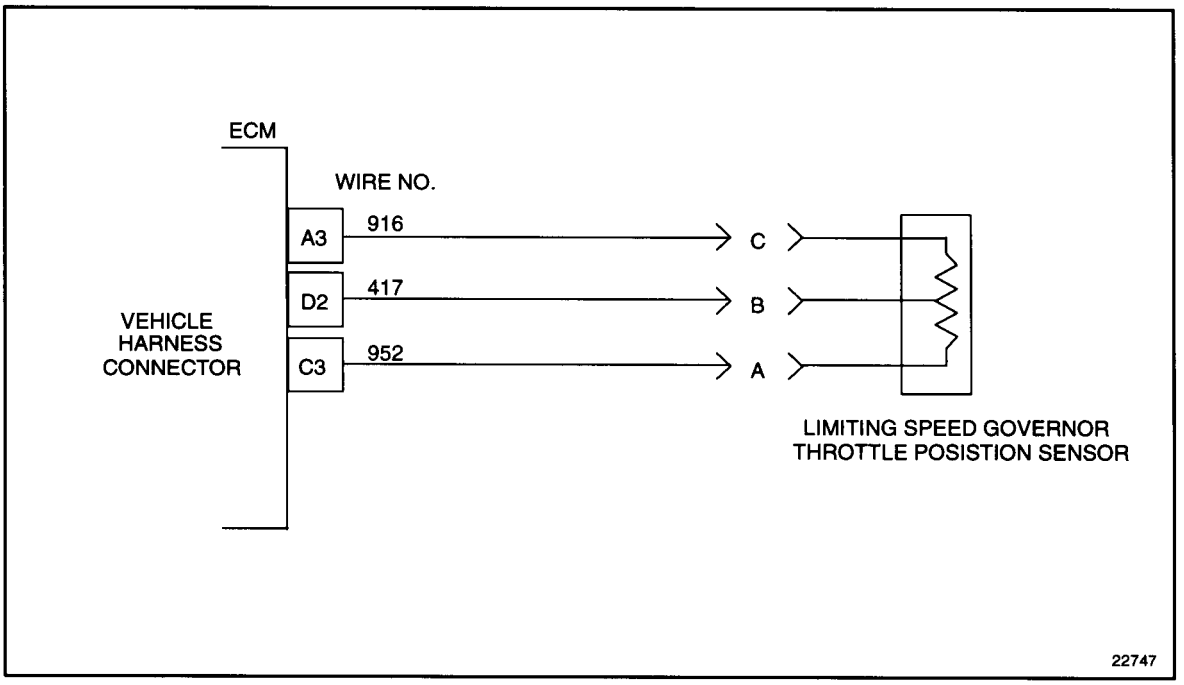

Figure 21-2 Throttle Position Sensor

21.3.4 Check Throttle Position Sensor Adjustment

Perform the following steps to check for TPS adjustment.

1. Reconnect vehicle harness connector and plug in the TPS.
2. Hook up DDR to the DDL connector and select Throttle Sensor Display.
3. Measure Throttle Counts at both no throttle and full throttle. Take several readings.
   [a] If TPS counts are ever greater than 968 counts, refer to section 21.3.5.
   [b] If TPS counts stay less than 968 counts, refer to section 21.3.6.

21.3.5 Throttle Position Sensor Adjustment

Perform the following steps to attempt TPS adjustment.

1. Check for pedal or linkage interferences.
2. Loosen the TPS screws and attempt to adjust for the correct throttle reading (64 - 205 counts). Do not attempt to adjust by bending the pedal mechanism.
3. Recheck counts at idle and at full throttle.
   [a] If the throttle counts are not correct, refer to section 21.3.6.
   [b] If the throttle counts are now correct, refer to section 21.3.10.

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21.3.6 Check Throttle Position Sensor Connectors

Perform the following steps to check the TPS connectors.

1. Check terminals at the TPS connector (both sensor and harness side) for bent, corroded and unseated pins or sockets. See Figure 21-3.
   [a] If the terminals or connectors are damaged, repair both and refer to section 21.3.10.
   [b] If the terminals or connectors are not damaged, replace the TPS; refer to section 21.3.10.

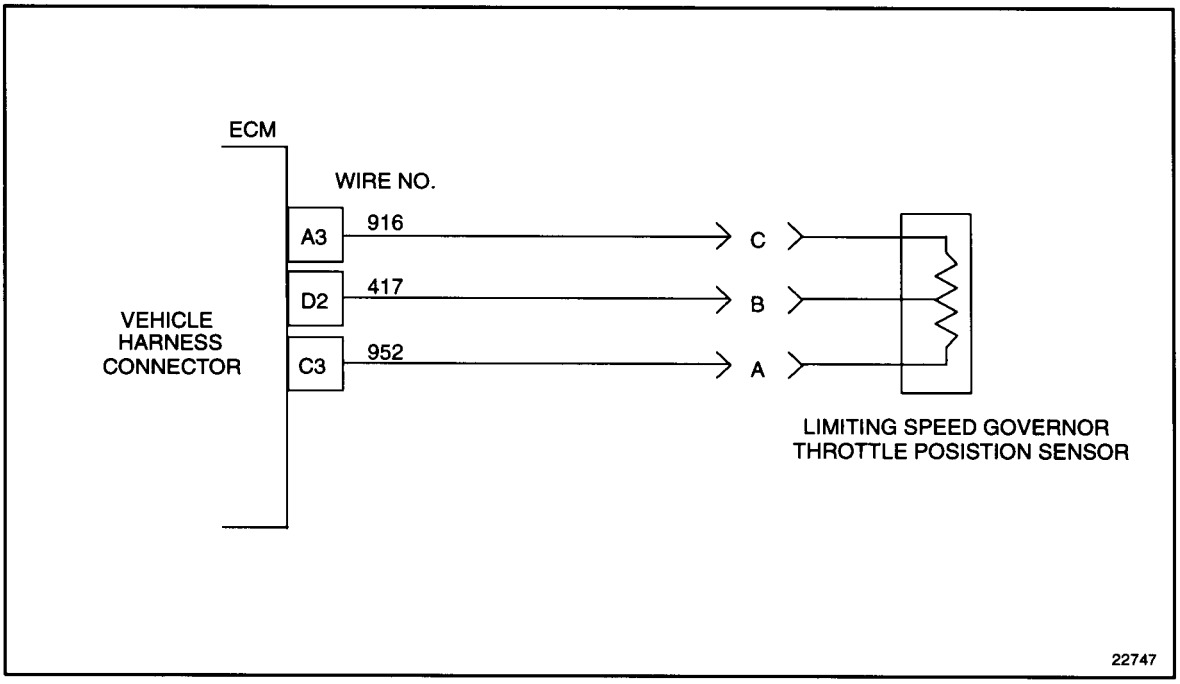

Figure 21-3 Throttle Position Sensor

21.3.7 Check for Short

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM. Unplug the TPS connector.
3. Read resistance between sockets D2 and A3 on the vehicle harness connector. For ECM vehicle harness connector, see Figure 21-4.
   [a] If the resistance is greater than 100 Ω or open, refer to section 21.3.8.

[b] If the resistance is less than or equal to 100 Ω, the signal line (#417) is shorted to the vehicle +5 volt line (#916). Repair the short and refer to section 21.3.10.

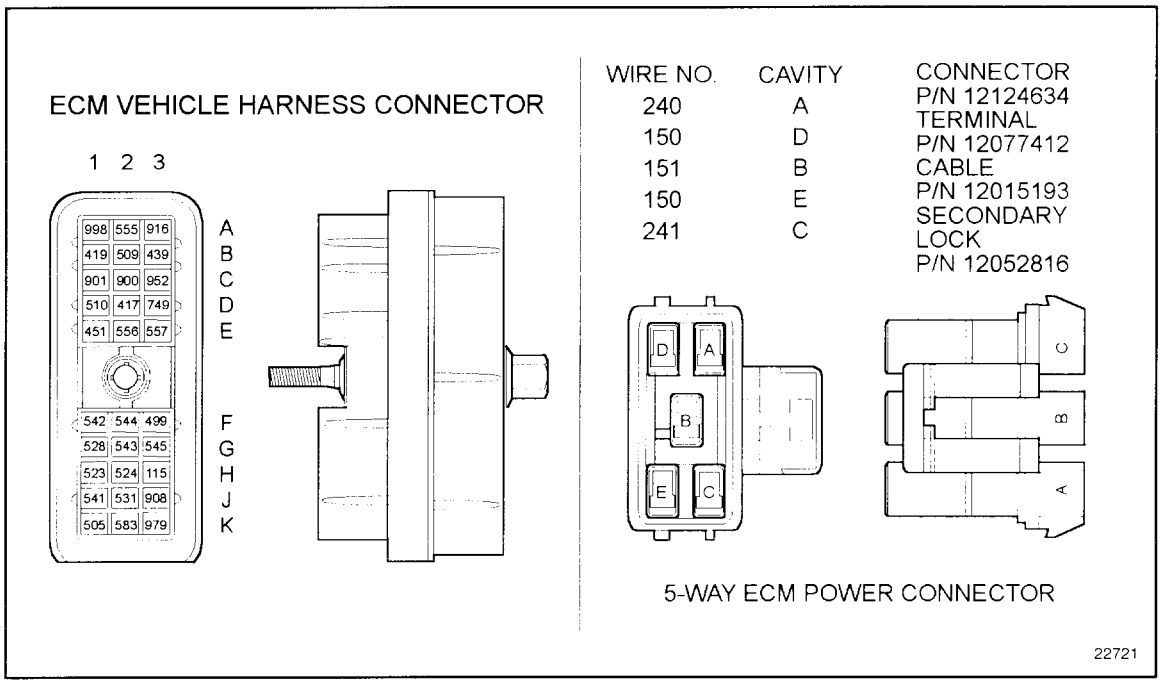

Figure 21-4 ECM Vehicle Harness Connector

21.3.8 Check for Short to Battery

Perform the following steps to check for a short to the battery.

1. Remove both fuses to the ECM.
2. Disconnect the 5-way power harness and vehicle harness connectors at the ECM.
3. Measure resistance between socket D2 on the vehicle harness connector and the 5-way power connector sockets A and C. See Figure 21-5.

   [a] If the resistance is greater than 100 Ω, refer to section 21.3.9.

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[b] If the resistance is less than or equal to 100 Ω, a short exists between sockets where less than 100 Ω resistance was read. Repair short and reinsert fuses. Refer to section 21.3.10.

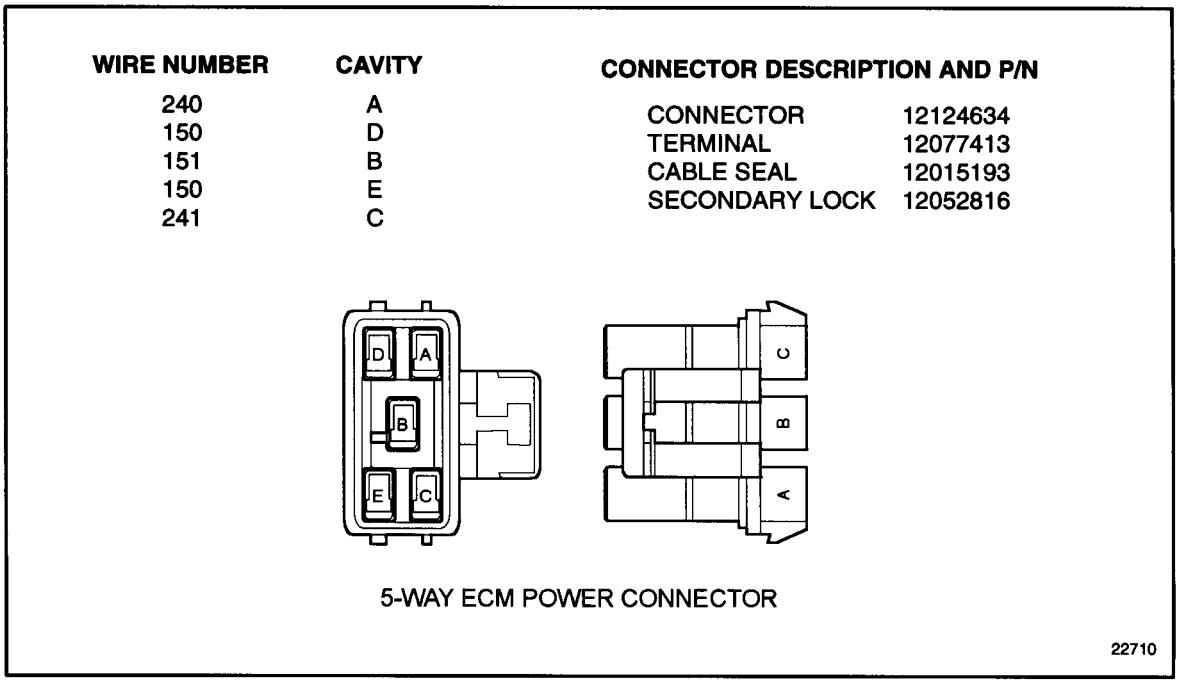

Figure 21-5 5-Way ECM Power Connector

21.3.9 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM harness connector (both ECM and harness side) for bent, corroded and unseated pins or sockets. See Figure 21-6.

   [a] If terminals and connectors are damaged, repair them. Refer to section 21.3.10.

[b] If terminals and connectors are not damaged, refer to section 21.3.1, to review this section. If review leads back here, install a test ECM or contact Detroit Diesel Technical Service.

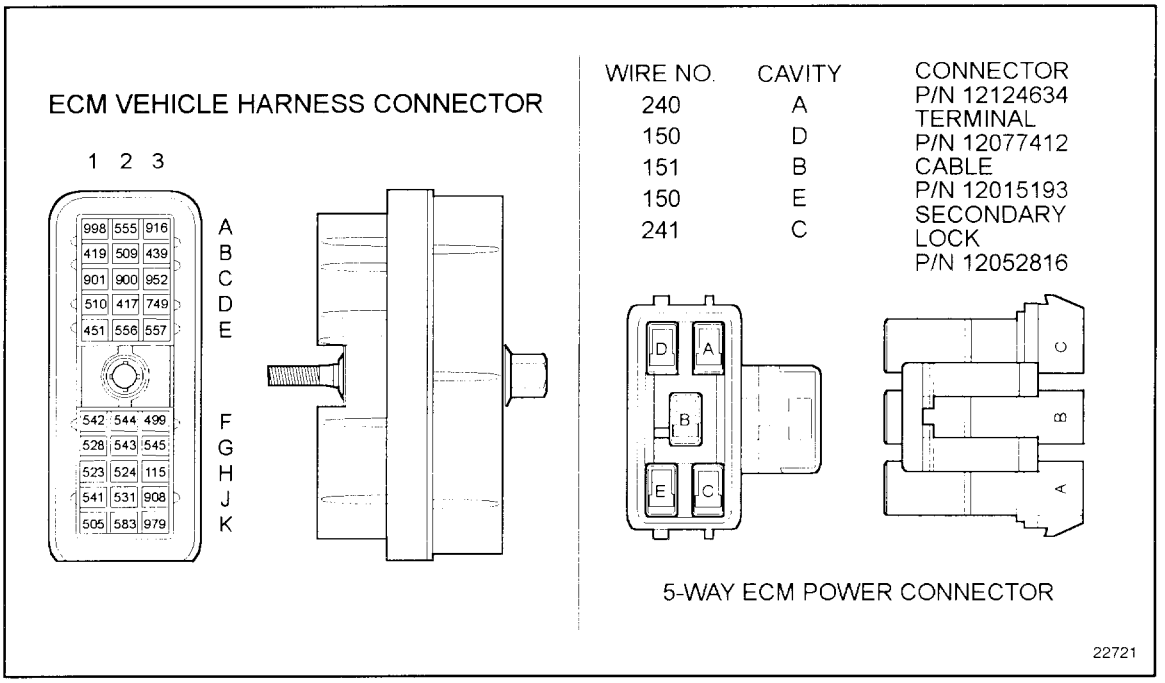

Figure 21-6 ECM Vehicle Harness Connector

21.3.10 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear DDR codes.
5. Start and run the engine for one minute. Check idle position and full throttle.
6. Stop engine.
7. Check DDR for codes.

   [a] If no codes are displayed, troubleshooting is complete.

   [b] If code 91/3 is not logged, and other codes are logged, refer to section 9.1.

   [c] If code 91/3 is logged, and other codes are logged, all system diagnostics are complete. If a problem still exists, review this section from the first step to troubleshoot the error, refer to section 21.3.1.

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22 FLASH CODE 22 - TPS LOW

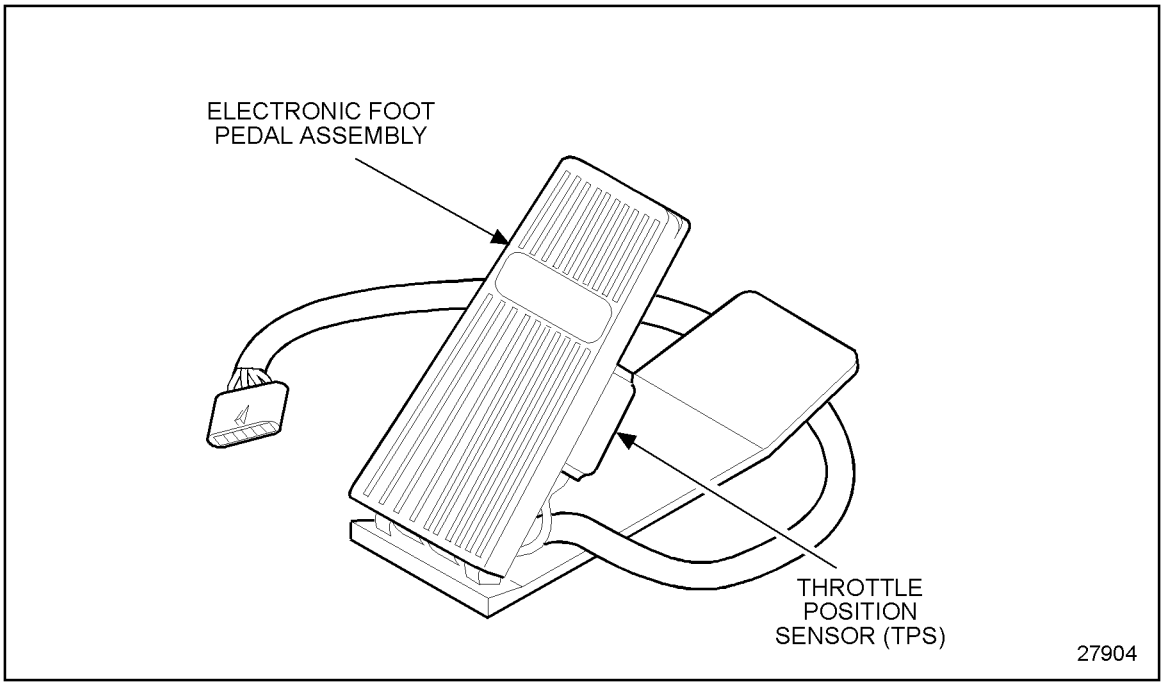

Figure 22-1 Throttle Position Sensor

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22.1 DESCRIPTION OF FLASH CODE 22

Flash Code 22 indicates that the Throttle Position Sensor (TPS), see Figure 22-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- ☐ Open sensor signal circuit
- ☐ Open sensor +5 volt supply circuit
- ☐ Sensor signal is shorted to sensor return circuit or to ground

22.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 22

The SAE J1587 equivalent code for Flash Code 22 is p 091 4, Throttle Position Sensor (TPS) circuit low.

22.2.1 General Throttle Information (Limiting Speed Governor)

The correct TPS counts for DDEC III engines at idle should be 64 - 205 counts.

1. Typical DDEC III foot pedals today, at idle, provide 102 - 205 counts.
2. DDEC II foot pedals can be used on DDEC III engines. The counts from the DDEC II style pedal may go as low as 64 counts at idle, but this is still acceptable.
3. The DDEC system will log a TPS low volt code (PID 091, FMI 4, Flash Code 22) if the TPS counts go below 48.
4. The DDEC system will log a TPS high volt code (PID 091, FMI 3, Flash Code 21) if the TPS counts go above 968 counts.
5. In order to go from 0% to 100% throttle, the counts have to increase 546 above the idle count, or 100 counts, whichever is greater.
6. If an idle validation switch (IVS) is configured, to go from 0% to 100% throttle, the counts have to increase 546 above the counts at which the IVS opens or 100 counts, whichever is greater.
7. If 0% throttle is attained with the foot off the pedal, and if 100% throttle is attained with the pedal to the floor, then the pedal should not be considered a factor for low power complaints.

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22.3 TROUBLESHOOTING FLASH CODE 22

The following procedure will troubleshoot Flash Code 22.

22.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn ignition ON.
2. Plug in DDR.
3. Read active codes.
   [a] If active code 91/4 and no other active codes are logged, refer to section 22.3.2.
   [b] If code 91/4 and any or all of the following codes are logged, 91/3, 187/4, or 100/4, refer to section 91.2.
   [c] If codes other than the above are logged, refer to section 9.1.

22.3.2 Check for Device

Perform the following steps to check for device.

1. If there is a throttle (LSG) wired to use the 417 (LSG) circuit, refer to section 22.3.3.
2. If there is no throttle (LSG) wired to use the 417 (LSG) circuit, contact Detroit Diesel Technical Service, for possible change to the calibration.
   [a] If required, reprogram the ECM after the mainframe is changed and refer to section 22.3.15.

22.3.3 Sensor Check

Perform the following steps to check the sensor:

1. Turn ignition OFF.
2. Disconnect the TPS connector.
3. Install a jumper wire between sockets B (signal #417) and C (5V supply #916); see Figure 22-2.
4. Turn ignition ON.
5. Read active codes.
   [a] If code 91/4 and any other codes are logged, refer to section 22.3.7.

[b] If code 91/3 and any other codes are logged, refer to section 22.3.4.

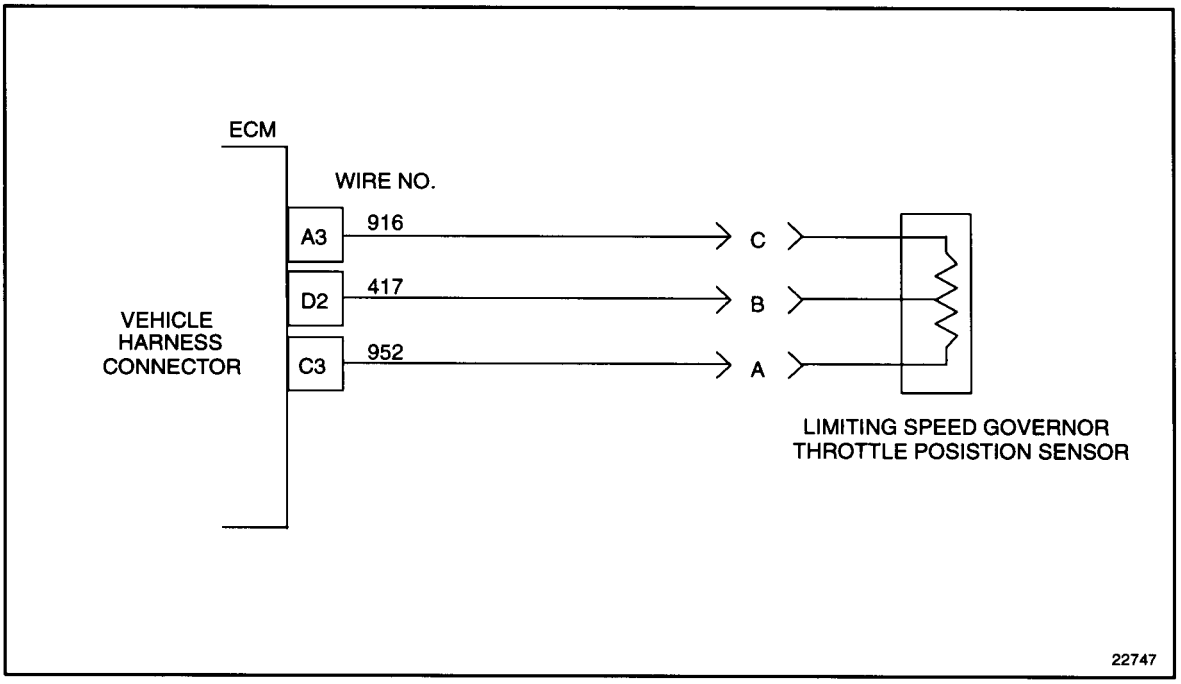

Figure 22-2 Throttle Position Sensor

22.3.4 Check Throttle Position Sensor Adjustment

Perform the following steps to check the TPS adjustment:

1. Remove jumper and reconnect TPS.
2. Hook DDR to the DDL connector and select TPS - Counts.
3. Read Throttle Counts at both no throttle and full throttle positions. Take several readings.
   [a] If at any time counts go lower than 49 counts, refer to section 22.3.5.
   [b] If counts never go lower than 49 counts, refer to section 22.3.6.

22.3.5 Attempt Throttle Position Sensor Adjustment

Perform the following steps to attempt a TPS adjustment:

1. Check for pedal or linkage interferences.
2. Loosen the TPS screws and attempt to adjust for the correct throttle reading (normal range - 64-205 counts). Do not attempt to adjust by bending the pedal mechanism.
3. Recheck counts at idle and at full throttle.
   [a] If the throttle count has been corrected, refer to section 22.3.15.
   [b] If the problem could not be corrected, refer to section 22.3.6.

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22.3.6 Check Throttle Position Sensor Connectors

Perform the following steps to check the TPS connectors:

1. Check terminals at the TPS connector (both sensor and harness side) for bent, corroded, and unseated pins or sockets.
   [a] If the terminals or the connectors are damaged, repair them. Refer to section 22.3.15.
   [b] If the terminals and connectors are not damaged, replace the TPS and refer to section 22.3.15.

22.3.7 Check for +5 Volts

Perform the following steps to check for +5 volts:

1. Remove jumper wire.
2. Turn ignition ON.
3. Measure voltage on TPS harness connector, socket C (5V supply #916) (red lead) to socket A (return #952) (black lead).
   [a] If measured voltage is greater than 6 volts, refer to section 22.3.13.
   [b] If measured voltage is less than 4 volts, refer to section 22.3.11.
   [c] If measured voltage is between 4 and 6 volts, refer to section 22.3.8.

22.3.8 Check for Short

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Measure resistance between sockets A (return #952) and B (signal #417) at the TPS harness connector. See Figure 22-3.
4. Measure resistance between socket B (signal #417) and a good ground (battery ground and chassis ground).
   [a] If resistance measurement is less than or equal to 100 Ω, the signal line #417 is shorted to the return line #952 or battery ground. Repair short. Refer to section 22.3.15.

[b] If resistance measurement on both readings is greater than 100 Ω or open, refer to section 22.3.9.

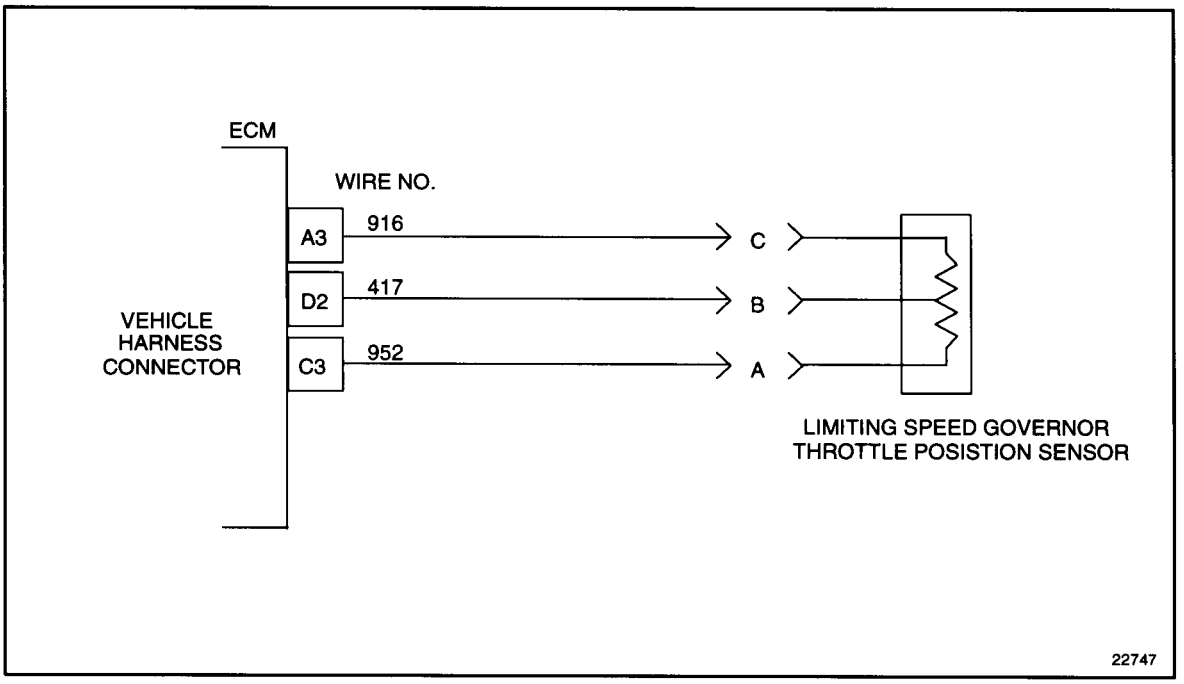

Figure 22-3 Throttle Position Sensor

22.3.9 Check for Signal Open

Perform the following steps to check for signal open:

1. Install a jumper wire between sockets A (return #952) and B (signal #417) of the TPS harness connector.
2. Measure resistance between sockets D2 and C3 on the vehicle connector.
   [a] If the resistance is less than or equal to 5 Ω, refer to section 22.3.10.
   [b] If the resistance is greater than 5 Ω or open, the signal line (#417) or return line (#952) are open, repair the open. Refer to section 22.3.15.

22.3.10 Check ECM Connectors

Perform the following steps to check the ECM connectors:

1. Check terminals at the ECM harness connector (both ECM and harness side) for bent, corroded, and unseated pins or sockets. See Figure 22-4.
   [a] If terminals and connectors are damaged, repair them. Refer to section 22.3.15.

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[b] If terminals and connectors are not damaged, call Detroit Diesel Technical Service for assistance.

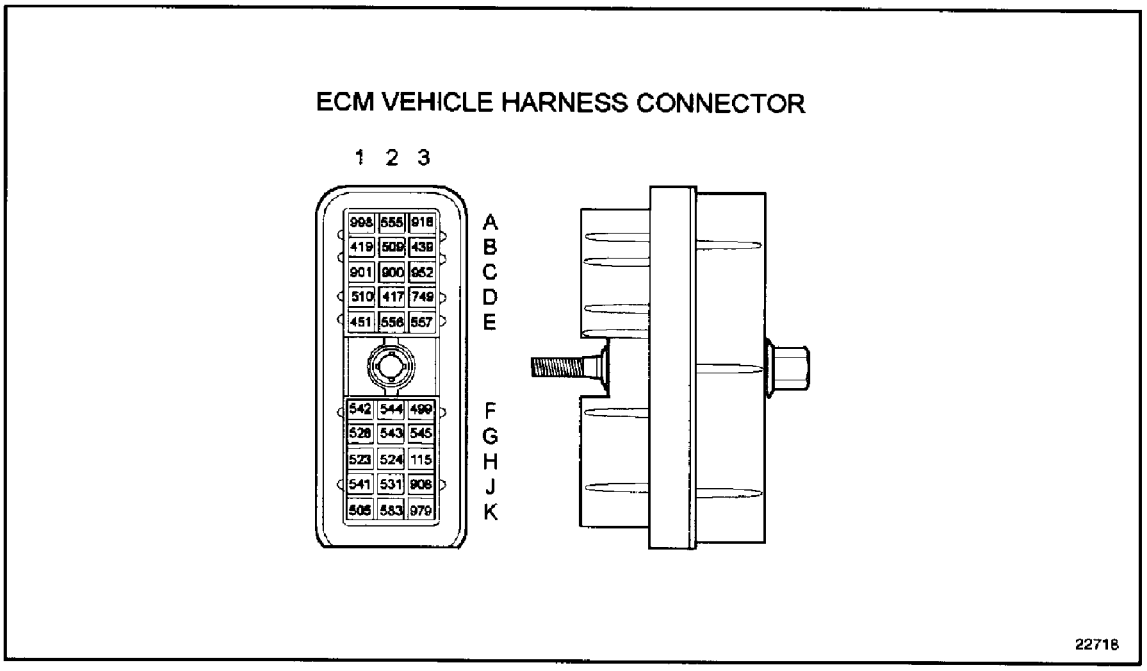

Figure 22-4 ECM Vehicle Harness Connector

22.3.11 Check for Short

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Measure resistance between sockets A (return #952) and C (5V #916) on the TPS harness connector. See Figure 22-5.

   [a] If resistance between sockets A and C is greater than 1,000 Ω or open, refer to section 22.3.12.

[b] If resistance between sockets A and C is less than or equal to 1,000 Ω or open, the 5V wire (#916) is shorted to the return (#952). Repair the short and refer to section 22.3.15.

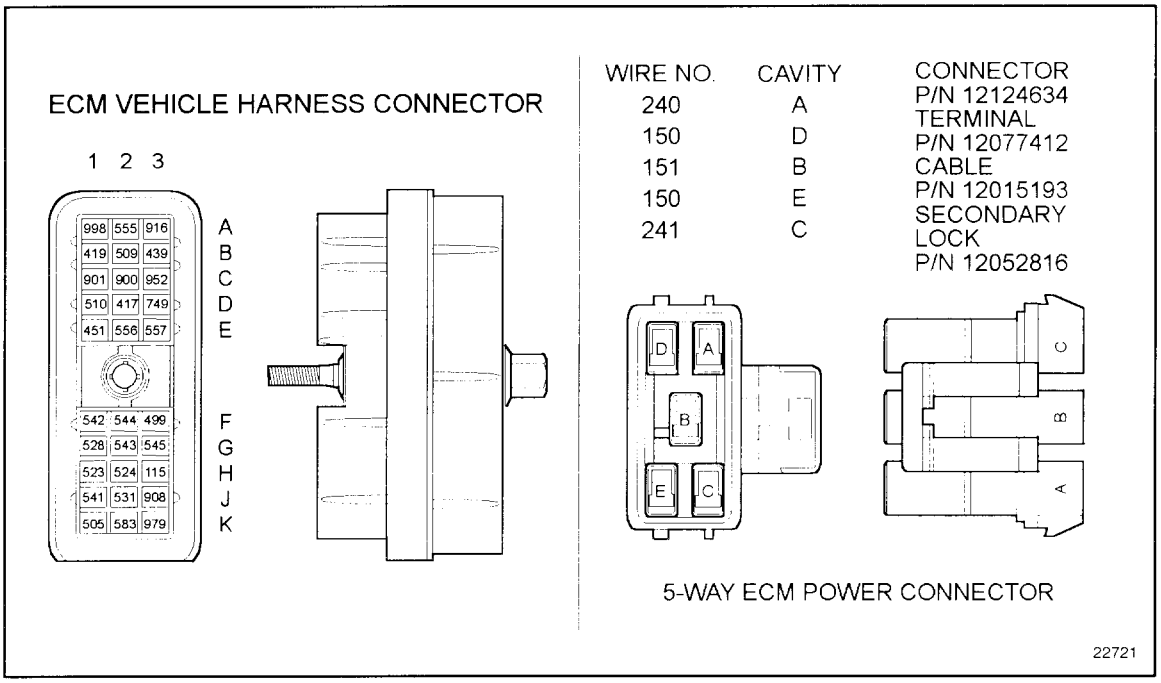

Figure 22-5 ECM Vehicle Harness Connector

22.3.12 Check for Open +5 Volt Line

Perform the following steps to check for an open +5 volt line:

1. Install a jumper wire between sockets A (return #952) and C (5V #916) on the TPS harness connector.
2. Measure resistance between sockets A3 and C3 on the vehicle harness connector. See Figure 22-6.

   [a] If resistance between sockets A3 and C3 is less than or equal to 5 Ω or open, refer to section 22.3.10.

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[b] If resistance between sockets A3 and C3 is greater than or equal to 5 Ω or open, the vehicle +5 volt line (#916) is open. Repair the open. Refer to section 22.3.15.

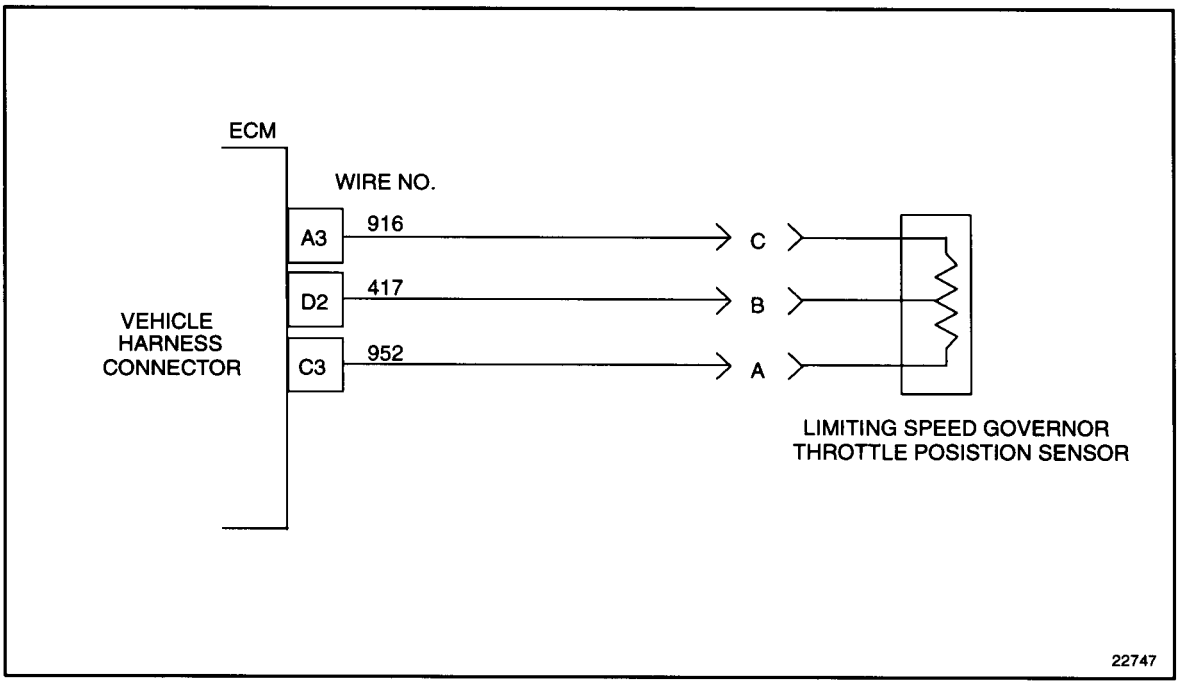

Figure 22-6 Throttle Position Sensor

22.3.13 Check for Short to Battery +

Perform the following steps to check for a short to the battery +:

1. Turn ignition OFF.
2. Remove both fuses to ECM.
3. Disconnect the 5-way power connector at the ECM.
4. Measure resistance between socket D2 on the vehicle harness connector and the 5-way power connector sockets A and C. See Figure 22-7.

   [a] If measured resistance is greater than 100 Ω or open, refer to section 22.3.14.

[b] If measured resistance is less than or equal to 100 Ω, a short exists between sockets where resistance was measured. Repair short and reinsert fuses; refer to section 22.3.15.

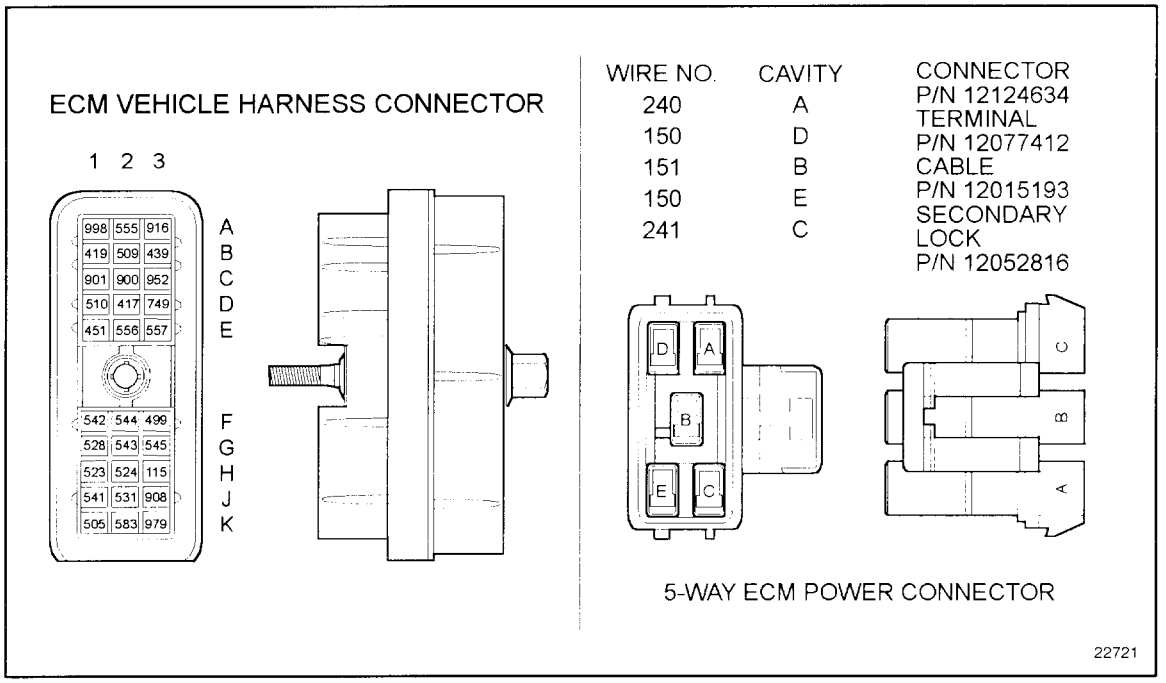

Figure 22-7 ECM Vehicle Harness Connector

22.3.14 Check for Outside DDEC Battery +

Perform the following steps to check for outside DDEC battery +:

1. Turn ignition OFF.
2. Remove ECM 5-pin power connector.
3. Remove ECM vehicle harness connector.
4. Turn ignition ON.
5. Measure voltage A3 (red lead) to battery ground.
6. Measure voltage C3 (red lead) to battery ground.

   [a] If measured voltage is less than 0.2 volts, refer to section 22.3.10.

   [b] If measured voltage is greater than 0.2 volts, outside power is spliced/shorted into either line #952 or line #916. Remove the splice/short. Refer to section 22.3.15.

22.3.15 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.

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2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes with DDR.
5. Start and run the engine for one minute at all throttle positions.
6. Stop engine.
7. Read active codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 91/4 and any other codes are logged, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 22.3.1.
   [c] If code 91/4 is not logged, but other codes are logged, refer to section 9.1.

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23 (CHG) FLASH CODE 23 - FUEL TEMP SENSOR HIGH

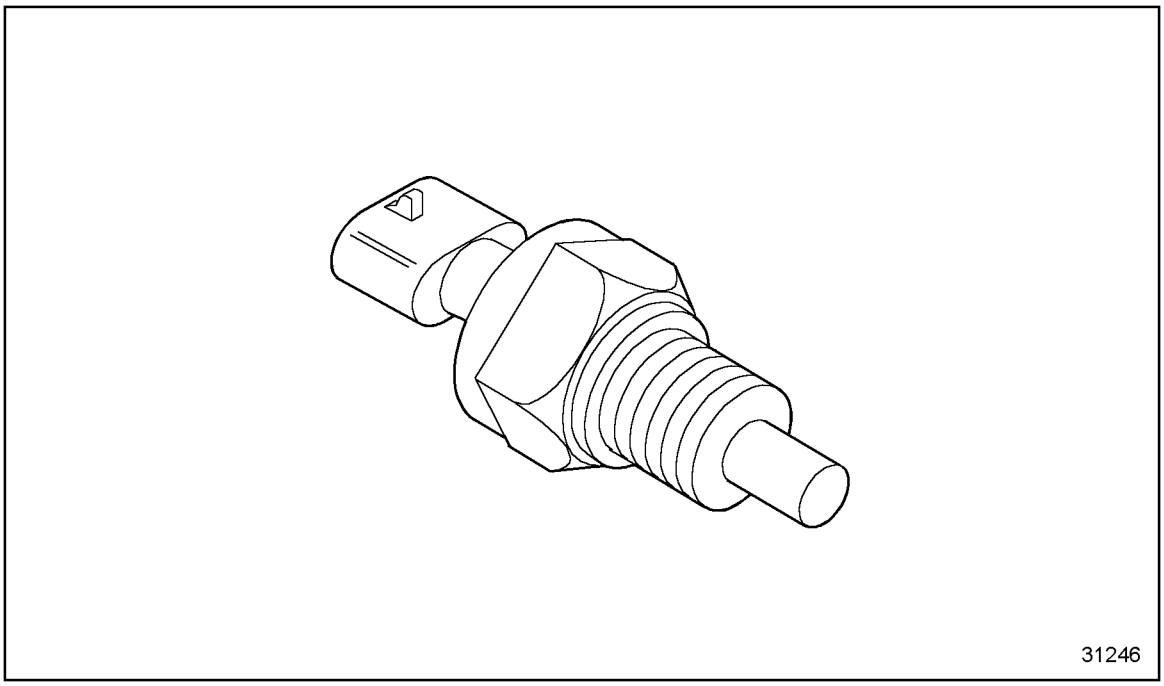

Figure 23-1 Fuel Temperature Sensor

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23.1 DESCRIPTION OF FLASH CODE 23

Flash Code 23 indicates that the engine Fuel Temperature Sensor (FTS), see Figure 23-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

NOTE:
This code will only be logged during warm engine operation.

This diagnostic condition is typically:

- Open sensor signal circuit
- Open sensor circuit return
- Sensor signal circuit is shorted to the sensor +5 volt supply

23.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 23

The SAE J1587 equivalent code for Flash Code 23 is p 174 3, fuel temperature circuit high.

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23.3 TROUBLESHOOTING FLASH CODE 23

The following procedure will troubleshoot Flash Code 23.

23.3.1 Sensor Check

Perform the following steps to check the sensor:

1. Turn ignition OFF.
2. Disconnect the FTS connector.
3. Install a jumper wire between sockets A and B of the FTS harness connector. see Figure 23-2.
4. Turn ignition ON.
5. Read active codes.
   [a] If code 174/4 and any other codes except code 174/3 are logged, refer to section 23.3.2.
   [b] If any code except 174/4 is logged, refer to section 23.3.4.

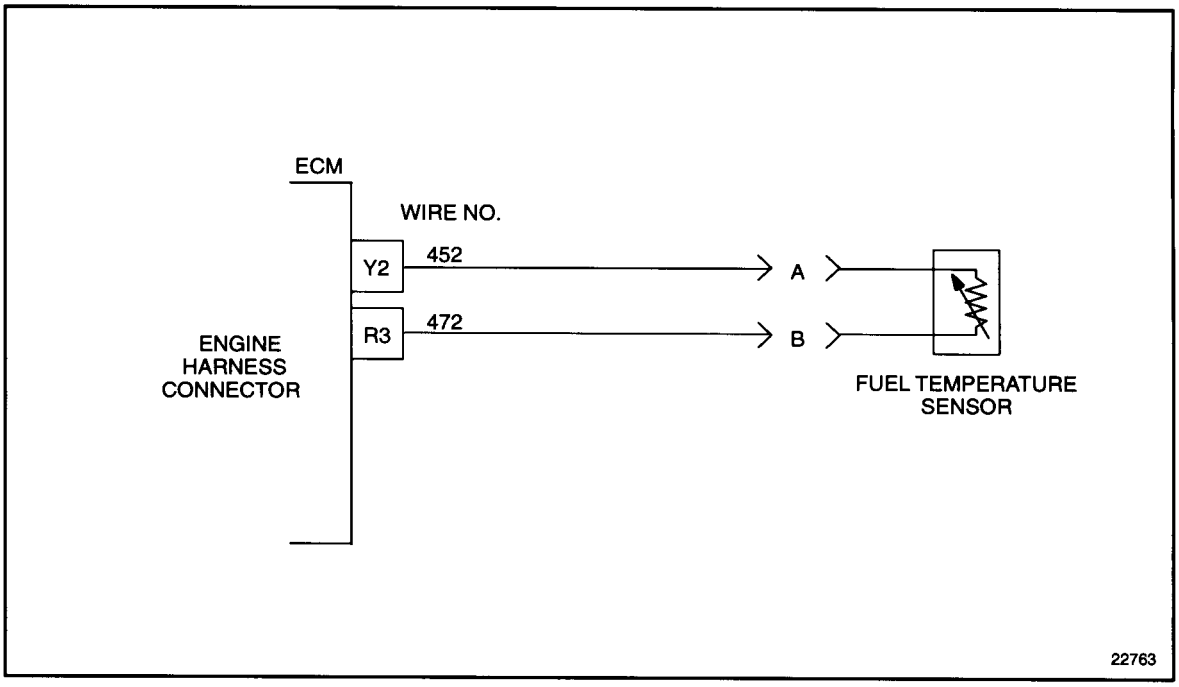

Figure 23-2 Fuel Temperature Sensor

23.3.2 Check for Short to +5 Volt Line

Perform the following steps to check for a short to the +5 volt line.

1. Turn ignition OFF.
2. Remove jumper wire.

3. Disconnect the engine harness connector at the ECM.
4. Measure resistance between sockets R3 and W1 on the engine harness connector. See Figure 23-3.
   [a] If the measured resistance is greater than 100 Ω or open, refer to section 23.3.3.
   [b] If the measured resistance is less than or equal to 100 Ω, the signal line #472 is shorted to the engine +5 volt line #416. Repair the short; refer to section 23.3.6.

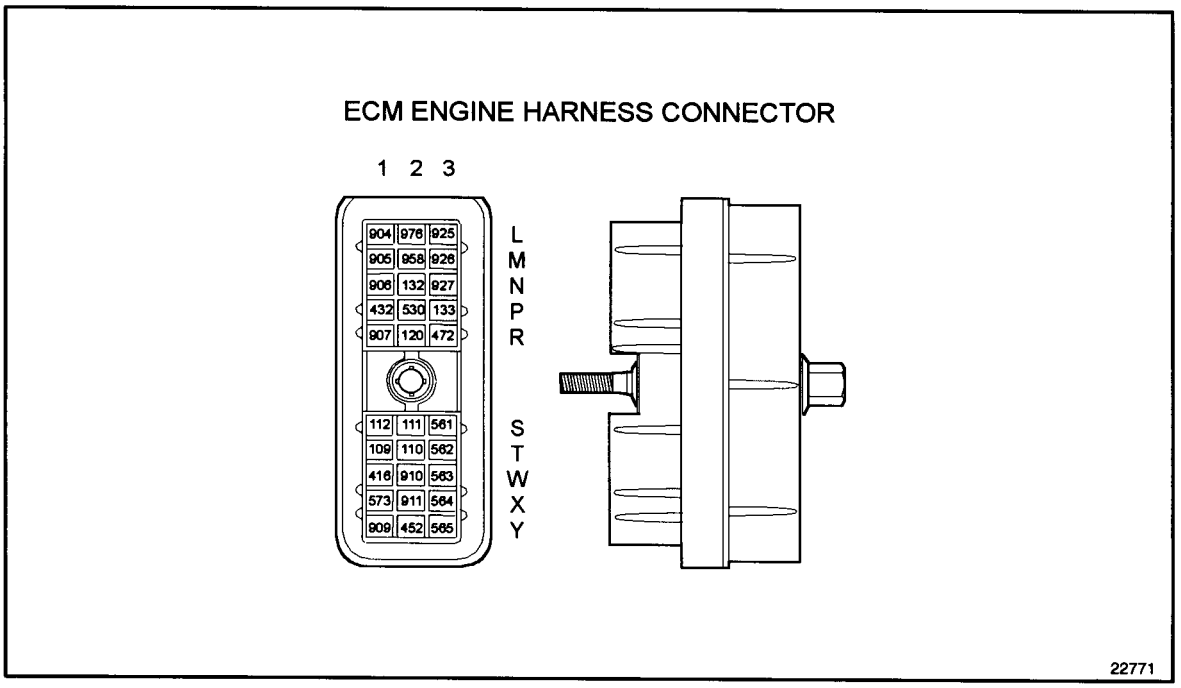

Figure 23-3 ECM Engine Harness Connector

23.3.3 Check Fuel Temperature Sensor Connectors

Perform the following steps to check the FTS connectors:

1. Check terminals at the FTS harness connector (both sensor and harness side) for bent, corroded, and unseated pins or sockets. See Figure 23-4.
   [a] If terminals and connectors are damaged, repair them. Refer to section 23.3.6.

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[b] If terminals and connectors are not damaged, replace the FTS. Refer to section 23.3.6.

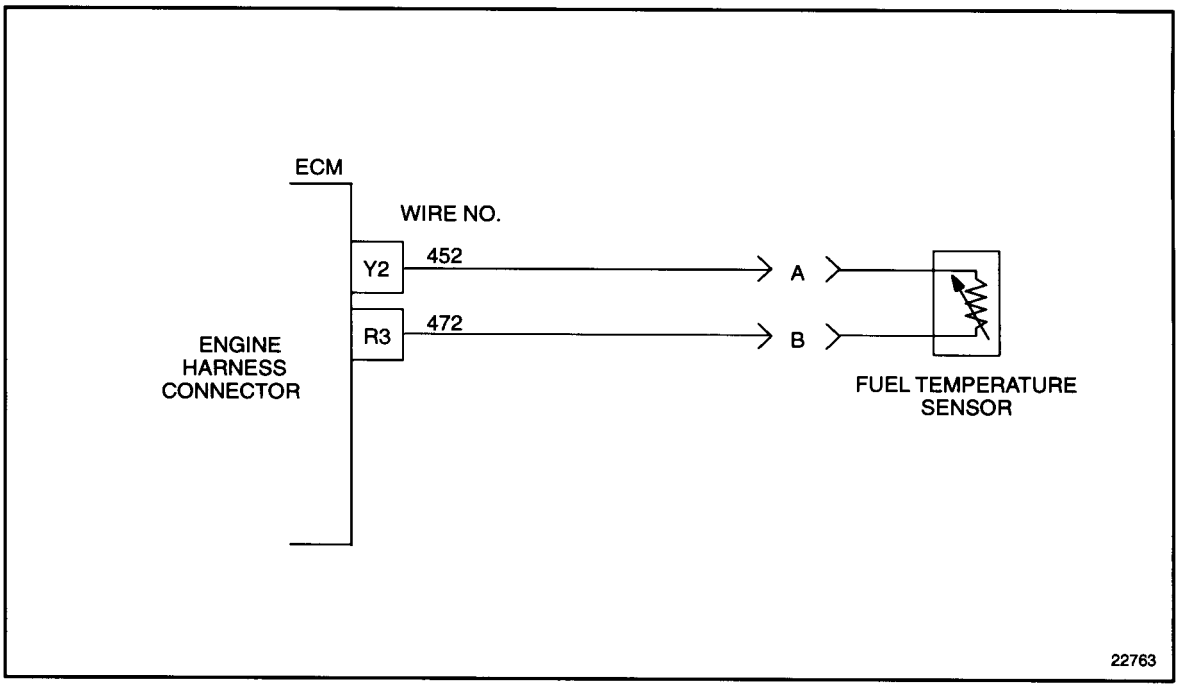

Figure 23-4 Fuel Temperature Sensor

23.3.4 Open Line Check

Perform the following steps to check for an open line.

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM. The jumper wire is still in place at the FTS connector.
3. Measure resistance between sockets R3 and Y2 on the engine harness connector. See Figure 23-5.

   [a] If the measured resistance is greater than 5 Ω or open, the signal line #472 or return line #452 is open. Repair the open; refer to section 23.3.6.

[b] If the measured resistance is less than or equal to 5 Ω, refer to section 23.3.5.

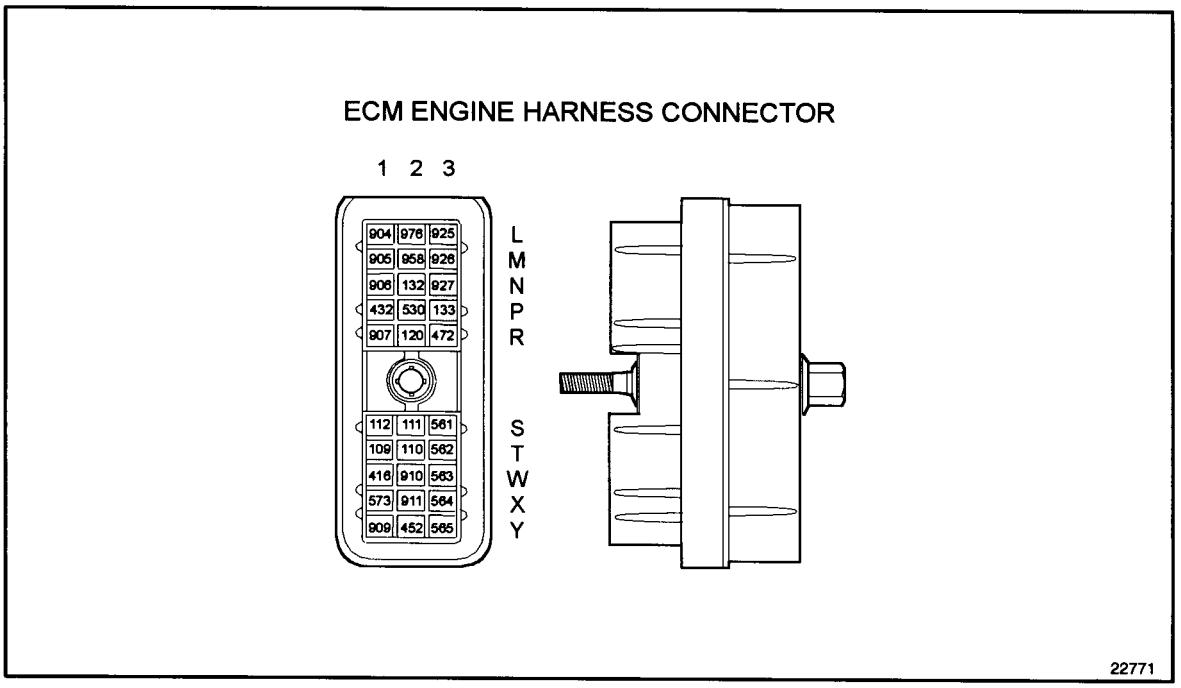

Figure 23-5 ECM Engine Harness Connector

23.3.5 Check ECM Connectors

Perform the following steps to check the ECM connectors:

1. Check terminals at the ECM harness connector (both ECM and harness side) for bent, corroded, and unseated pins or sockets. See Figure 23-6.

   [a] If terminals and connectors are damaged, repair them. Refer to section 23.3.6.

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[b] If terminals and connectors are not damaged, install a test ECM. Refer to section 23.3.6.

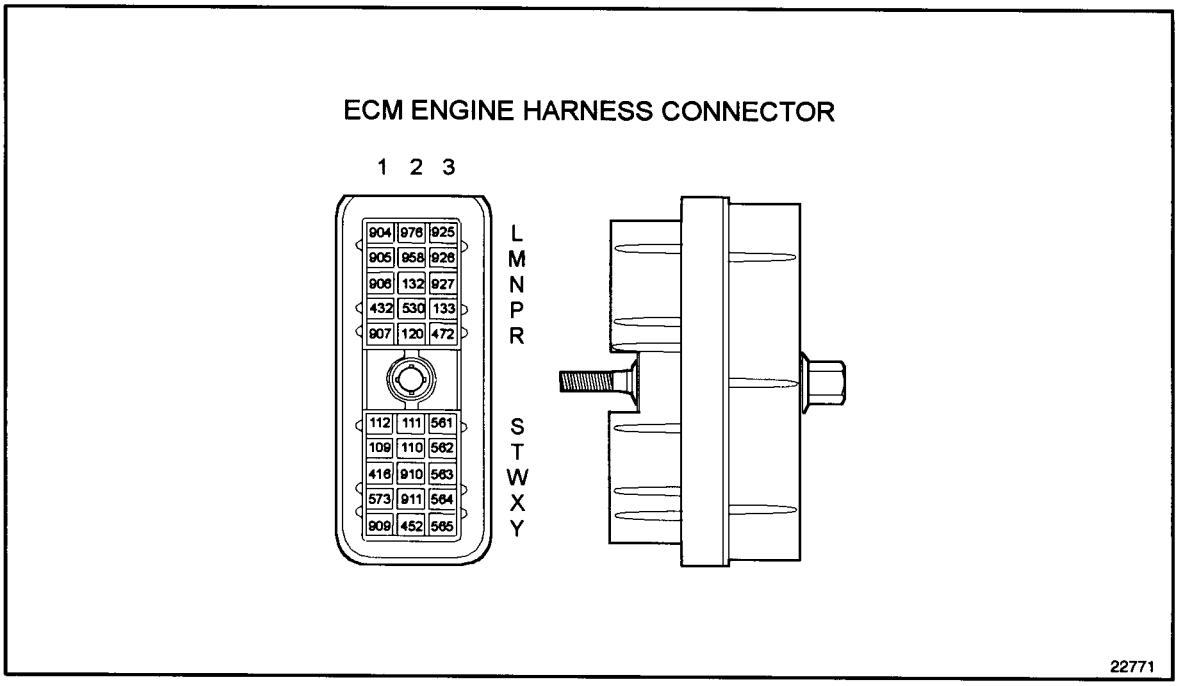

Figure 23-6 ECM Engine Harness Connector

23.3.6 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes with DDR.
5. Start and run the engine for eight minutes.
6. Stop engine.
7. Read codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 174/3 and any other codes are logged, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 23.3.1.
   [c] If code 173/4 is not logged, but other codes are logged, refer to section 9.1.

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24 (CHG) FLASH CODE 24 - FUEL TEMP SENSOR LOW

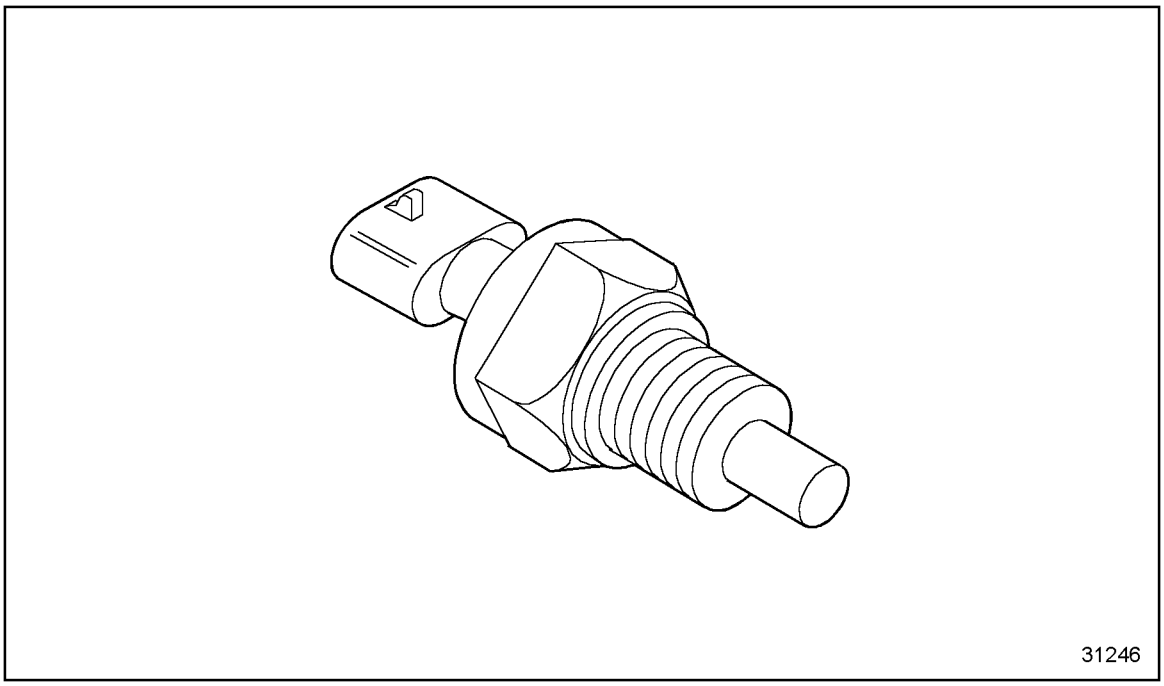

Figure 24-1 Fuel Temperature Sensor

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24.1 DESCRIPTION OF FLASH CODE 24

Flash Code 24 indicates that the engine Fuel Temperature Sensor (FTS), see Figure 24-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- Sensor signal circuit is shorted to sensor return circuit or to ground

24.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 24

The SAE J1587 equivalent code for Flash Code 24 is p 174 4, fuel temperature circuit low.

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24.3 TROUBLESHOOTING FLASH CODE 24

The following procedure will troubleshoot Flash Code 24.

24.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn ignition ON.
2. Plug in DDR.
3. Read active codes.
   [a] If active code 174/4 and no other active codes are logged, refer to section 24.3.2.
   [b] If any or all of the following codes are logged, 110/3, 175/3, 174/3, or 102/3, refer to section 91.2.
   [c] If codes other than the above are logged, refer to section 24.3.2.

24.3.2 Sensor Check

Perform the following steps to check the sensor:

1. Turn ignition OFF.
2. Disconnect the FTS connector.
3. Start and run engine for eight minutes.
4. Read active codes with engine still running.
   [a] If code 174/4 and any other codes are logged, refer to section 24.3.4.
   [b] If code 174/3 and any other codes except 174/4 are logged, refer to section 24.3.3.

24.3.3 Check Fuel Temperature Sensor Connectors

Perform the following steps to check the FTS connectors:

1. Check terminals at the FTS connector (both sensor and harness side) for bent, corroded, and unseated pins or sockets. See Figure 24-2.
   [a] If terminals and connectors are damaged, repair them. Refer to section 24.3.6.

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[b] If terminals and connectors are not damaged, replace the FTS. Refer to section 24.3.6.

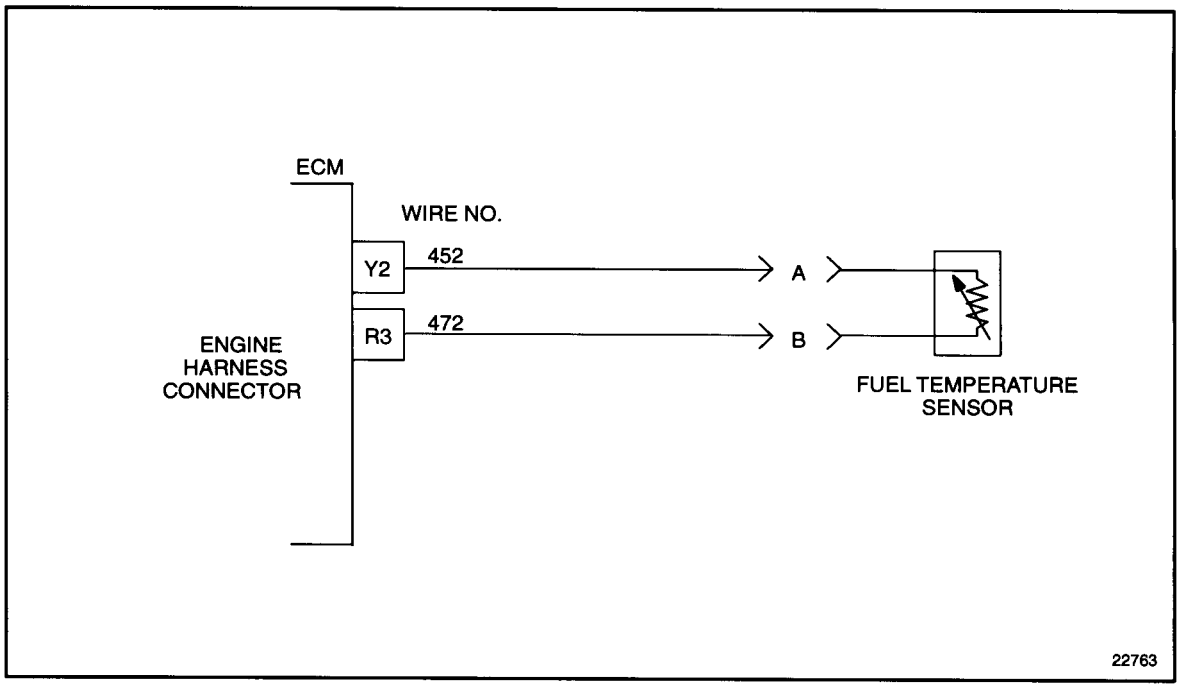

Figure 24-2 Fuel Temperature Sensor

24.3.4 Check for Short

Perform the following steps to check for a short:

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Measure resistance between sockets R3 and Y2 on the engine harness connector. See Figure 24-3.
4. Measure resistance between socket R3 and a good ground (battery ground and chassis ground).

   [a] If resistance between sockets R3 and Y2, or R3 and battery ground, is less than or equal to 10,000 Ω, the signal line (#472) is shorted to the return line (#452) or battery ground. Repair short. Refer to section 24.3.6.

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[b] If resistance between sockets R3 and Y2 is greater than 10,000 Ω or open, and resistance between socket B and a good ground is greater than 10,000 Ω or open, refer to section 24.3.5.

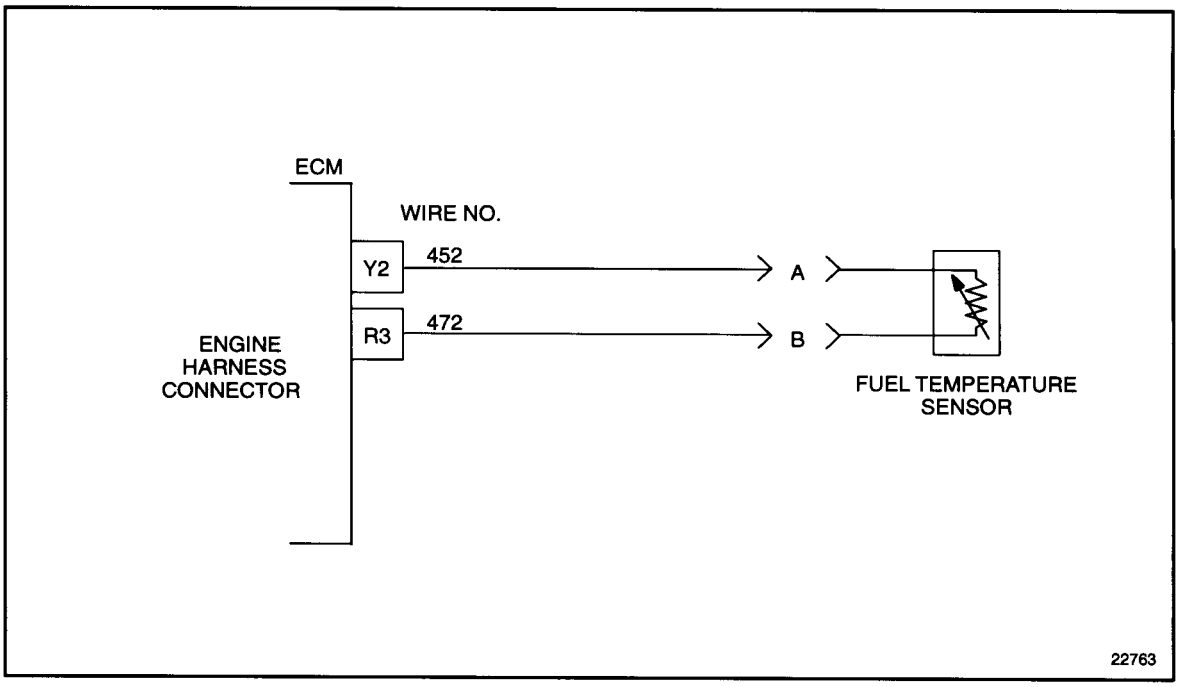

Figure 24-3 Engine Harness Connector

24.3.5 Check ECM Connectors

Perform the following steps to check the ECM connectors:

1. Check terminals at the ECM harness connector (both ECM and harness side) for bent, corroded, and unseated pins or sockets. See Figure 24-4.

   [a] If terminals and connectors are damaged, repair them. Refer to section 24.3.6.

[b] If terminals and connectors are not damaged, contact Detroit Diesel Technical Service. Refer to section 24.3.6.

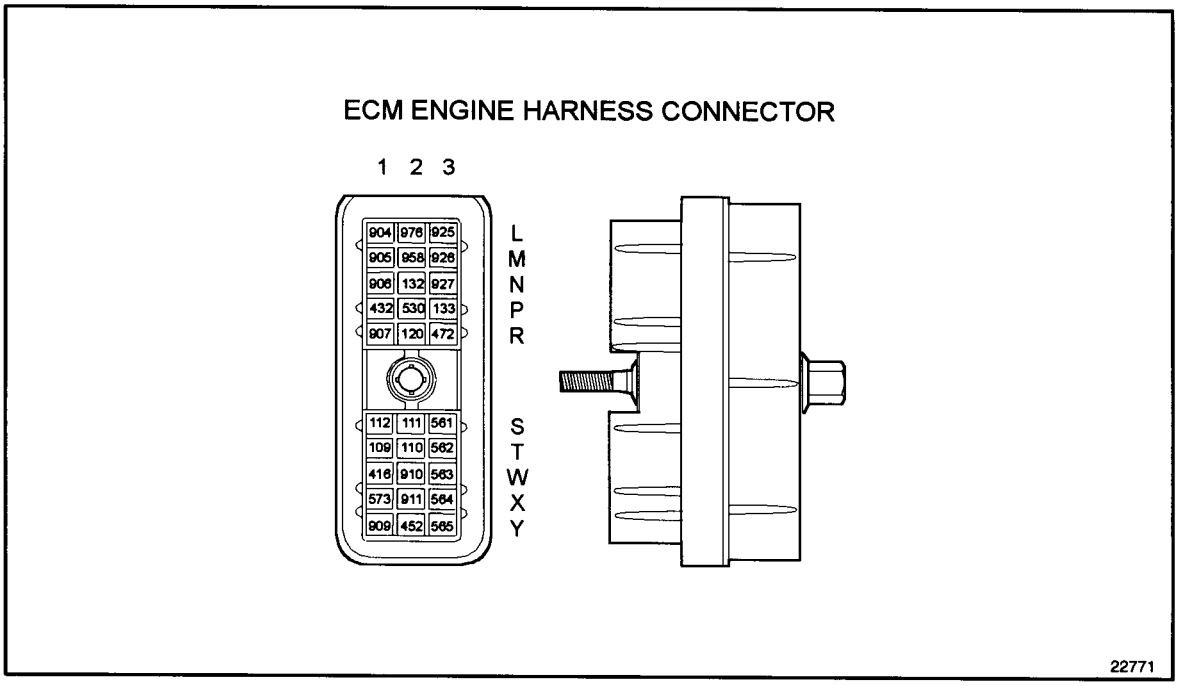

Figure 24-4 ECM Engine Harness Connector

24.3.6 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes with DDR.
5. Start and run the engine for eight minutes.
6. Stop engine.
7. Read active codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 174/4 and any other codes are logged, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 24.3.1.
   [c] If code 174/4 is not logged, but other codes are logged, refer to section 9.1.

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25 FLASH CODE 25

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25.1 DESCRIPTION OF FLASH CODE 25

Code 25 will be flashed to indicate that the DDEC system has no active or inactive codes. No troubleshooting is required.

If using the DDR, the description will read:

No Active Codes or No Inactive Codes

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26 FLASH CODE 26 - AUXILIARY INPUT ACTIVE

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26.1 DESCRIPTION OF FLASH CODE 26

Flash Code 26 indicates that the Auxiliary Engine Shutdown #1 switch input to the ECM is active. The active switch input represents a low (grounded) external input circuit to the ECM.

Indicates that the Auxiliary Engine Shutdown #2 switch input to the ECM is active. The active switch input represents a low (grounded) external input circuit to the ECM.

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26.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 26

The SAE J1587 equivalent codes for Flash Code 26 are:

- s 025 11 - auxiliary shutdown #1 active
- s 061 11 - auxiliary shutdown #2 active

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26.3 TROUBLESHOOTING FLASH CODE 26

The following procedure will troubleshoot Flash Code 26.

26.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn ignition ON. Start and run the engine.
2. Plug in DDR.
3. Read active codes.
   [a] If codes s 25-11 or s 61-11 are logged, refer to section 26.3.2.
   [b] If codes s 25-11 and s 61-11 are not logged, refer to section 9.1.

26.3.2 Check Calibration Configuration

Perform the following steps to check the calibration configuration:

1. Select ECM input/output configuration.
2. Determine cavity and wire number that is causing code to be logged.
3. Select switch/light status.
4. Determine status of that wire/cavity.
   [a] If the switch reads OFF, refer to section 26.3.3.
   [b] If the switch reads ON, the OEM supplied switch/relay is grounding the wire or a short to ground exists. Determine OEM supplied device or repair the short. Refer to section 26.3.4.
   [c] If no OEM device is used, remove the wire from the connector and plug, or use programming station to disable the function.

26.3.3 Confirm Switch Status

Perform the following steps to confirm switch status:

1. Start and run the engine for one minute.
2. Again, read switch status.
   [a] If the switch reads OFF, the condition no longer exists. Contact the OEM to learn which item is wired to this cavity. Refer to section 26.3.4.
   [b] If the switch reads ON, the OEM supplied device is grounding this wire. Contact the OEM for repair procedure. Refer to section 26.3.4.

26.3.4 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition ON.
2. Clear codes with DDR.
3. Note status of CEL/SEL.
4. If CEL/SEL not on, start and run the engine for one minute.
5. Read active and inactive codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If codes 25 or 61-11 and any other codes are logged, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 26.3.1.
   [c] If codes 25 or 61-11 are not logged, but other codes are logged, refer to section 9.1.

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27 (CHG) FLASH CODE 27 - AIR TEMP SENSOR HIGH

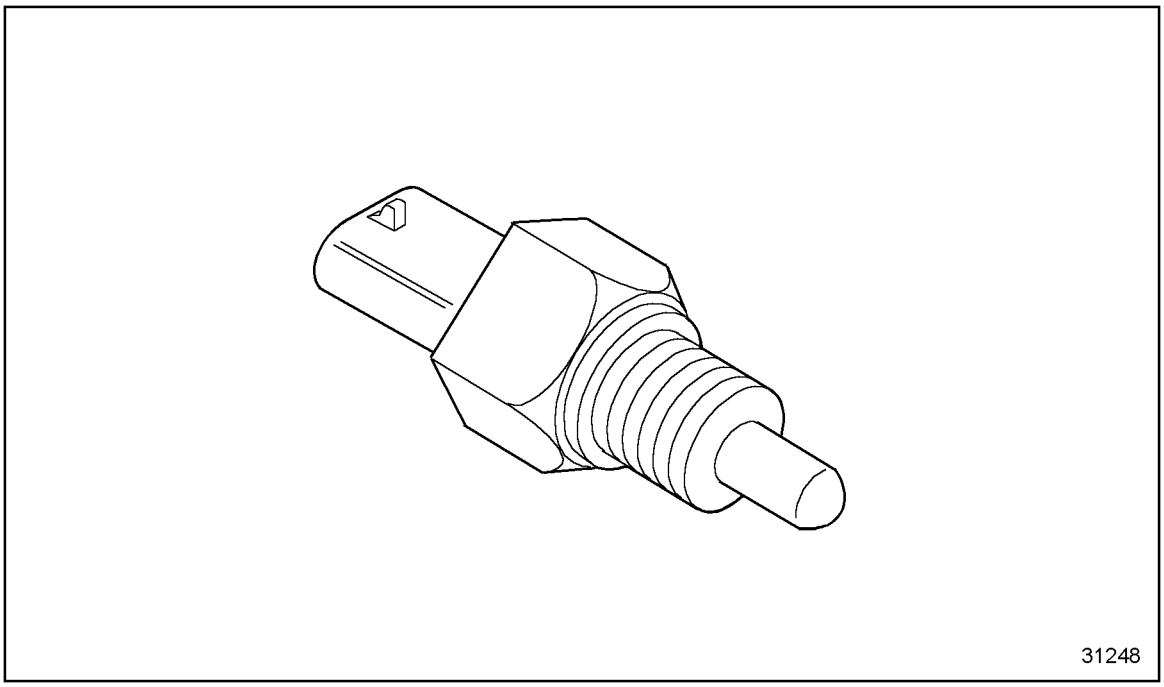

Figure 27-1 Air Temperature Sensor

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27.1 DESCRIPTION OF FLASH CODE 27

Flash Code 27 indicates that the engine Air Temperature Sensor (ATS), see Figure 27-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

NOTE:
This code will only be logged during warm engine operation.

This diagnostic condition is typically:

- Open sensor signal circuit
- Open sensor return circuit

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27.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 27

The SAE J1587 equivalent code for Flash Code 27 is p 172 3, air temperature circuit high.

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27.3 TROUBLESHOOTING FLASH CODE 27

The following procedure will troubleshoot Flash Code 27.

27.3.1 Sensor Check

Perform the following steps to check the sensor.

1. Turn vehicle ignition OFF.
2. Disconnect ATS connector.
3. Install a jumper wire between sockets A and B of the ATS harness connector. See Figure 27-2.
4. Turn ignition ON.
5. Start and run engine for one minute (ensure oil temp is greater than 140 ° F).
6. Read active codes.
   [a] If code 172/4 or any other codes except 172/3 are logged, refer to section 27.3.2.
   [b] If any codes except code 172/4 are logged, refer to section 27.3.4.

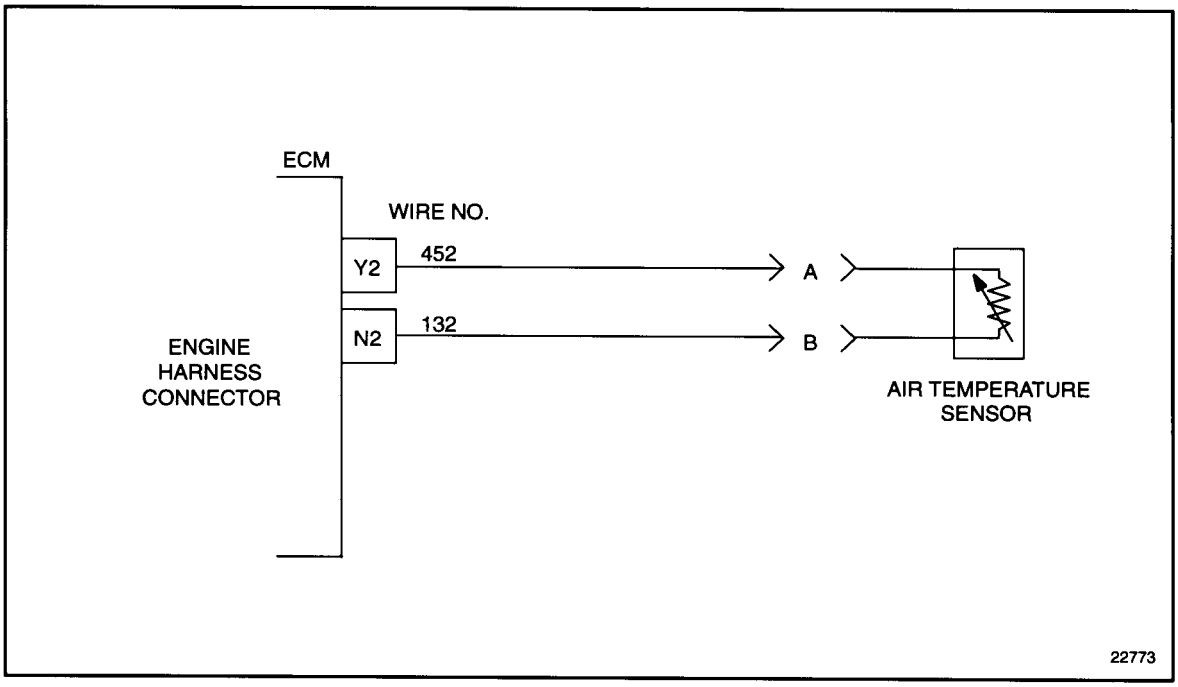

Figure 27-2 Air Temperature Sensor

27.3.2 Check for Short to +5 Volt Line

Perform the following steps to check for a short to the +5 volt line.

1. Turn ignition/engine OFF.

2. Remove jumper wire.
3. Disconnect the engine harness connector at the ECM.
4. Measure resistance between sockets N2 and W1 on the engine harness connector. See Figure 27-3.
   [a] If the resistance measurement is less than or equal to 10 Ω, the signal line #132 is shorted to the engine +5 volt line (#416). Repair the short and refer to section 27.3.6.
   [b] If the resistance measurement between sockets N2 and W1 is greater than 10 Ω or open, refer to section 27.3.3.

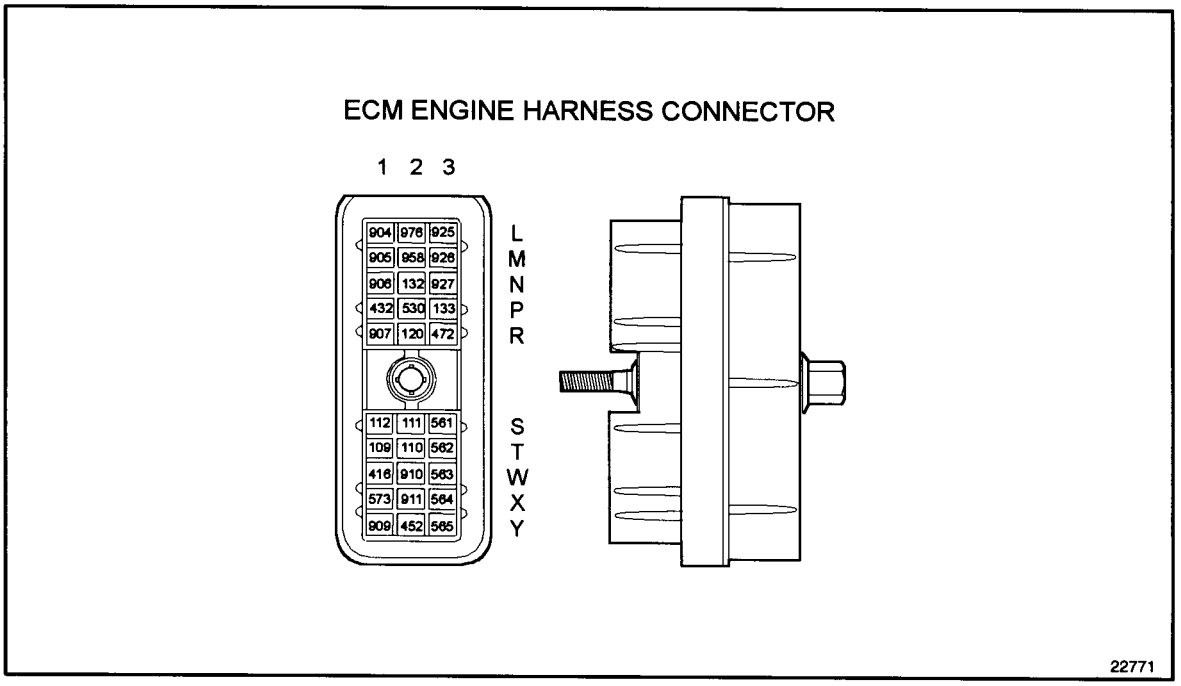

Figure 27-3 ECM Engine Harness Connector

27.3.3 Check Air Temperature Sensor Connectors

Perform the following steps to check the ATS connectors.

1. Check terminals at the ATS connector (both sensor and harness side) for damage; bent, corroded and unseated pins or sockets. See Figure 27-4.
   [a] If terminals or connectors are damaged, repair them. Refer to section 27.3.6.

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[b] If terminals and connectors are not damaged, replace the ATS. Refer to section 27.3.6.

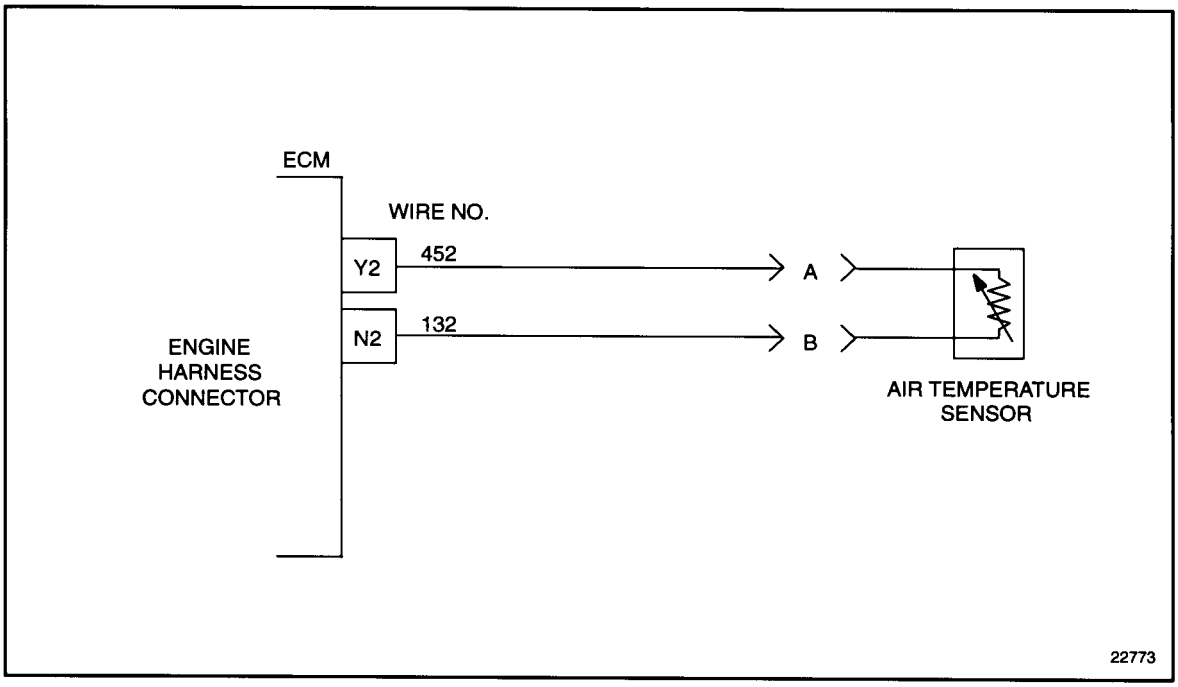

Figure 27-4 Air Temperature Sensor

27.3.4 Open Line Check

Perform the following steps to check for an open line.

1. Turn ignition OFF.
2. Disconnect the engine harness connector at the ECM. (Jumper still in place.)
3. Measure resistance between sockets N2 and Y2 on the engine harness connector. See Figure 27-5.

   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 27.3.5.

[b] If the resistance measurement between sockets N2 and W1 is greater than 5 Ω or open, the signal line #132 or return line #452 is open. Repair the open. Refer to section 27.3.6.

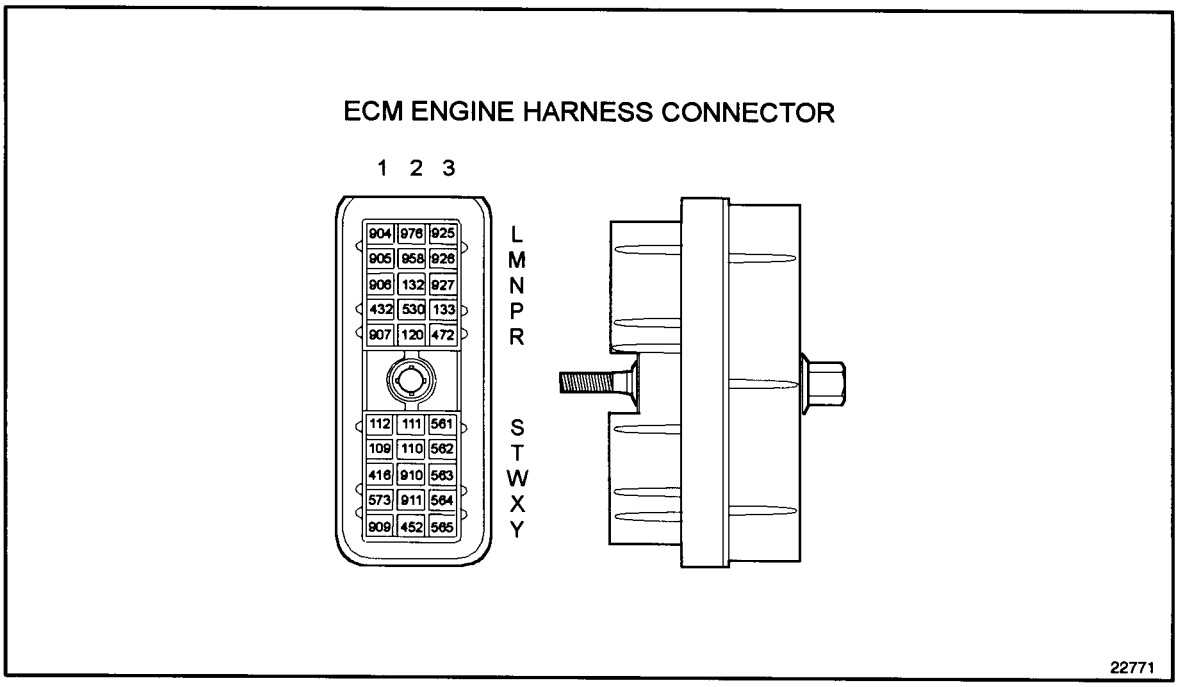

Figure 27-5 ECM Engine Harness Connector

27.3.5 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connector (both ECM and harness side) for damage: bent, corroded and unseated pins or sockets. See Figure 27-6.

   [a] If terminals or connectors are damaged, repair them. Refer to section 27.3.6.

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[b] If terminals and connectors are not damaged, contact Detroit Diesel Technical Service. **Refer to section** 27.3.6.

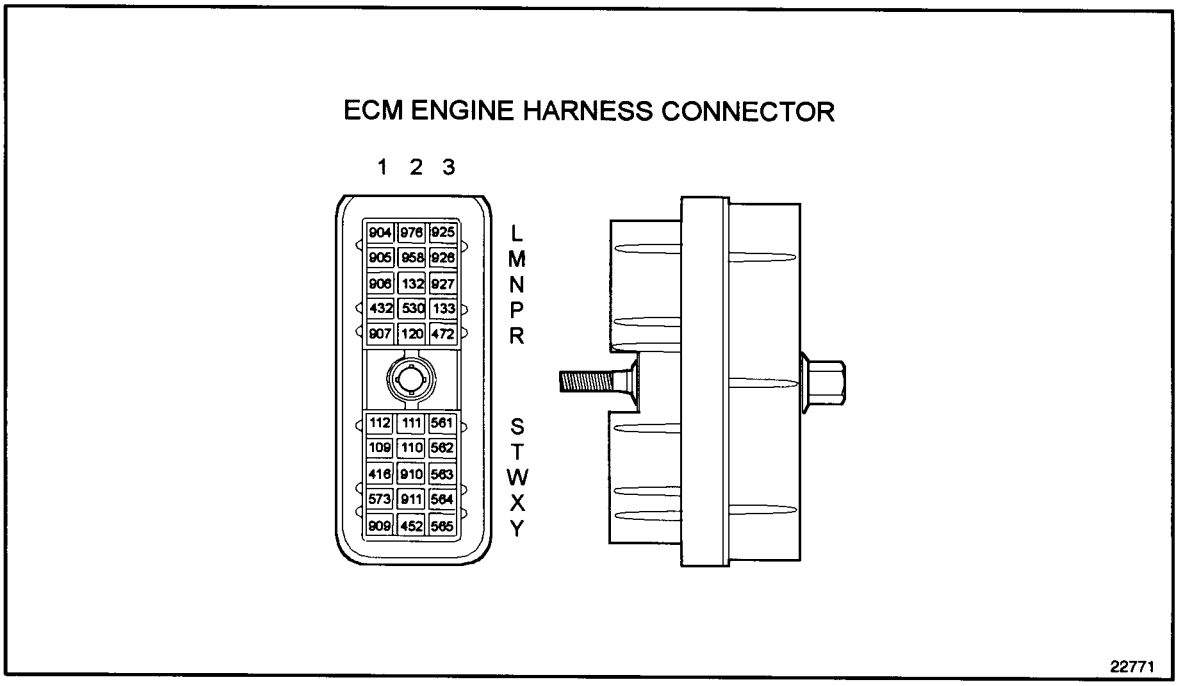

Figure 27-6 ECM Engine Harness Connector

27.3.6 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn vehicle ignition ON.
4. Clear codes.
5. Start and run the engine for eight minutes.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 172/3 and any other codes are logged, all system diagnostics are complete. Review this section to find the error. Refer to section 27.3.1.
   [c] If any codes except code 172/3 are logged, refer to section 9.1.

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28 (CHG) FLASH CODE 28 - AIR TEMP SENSOR LOW

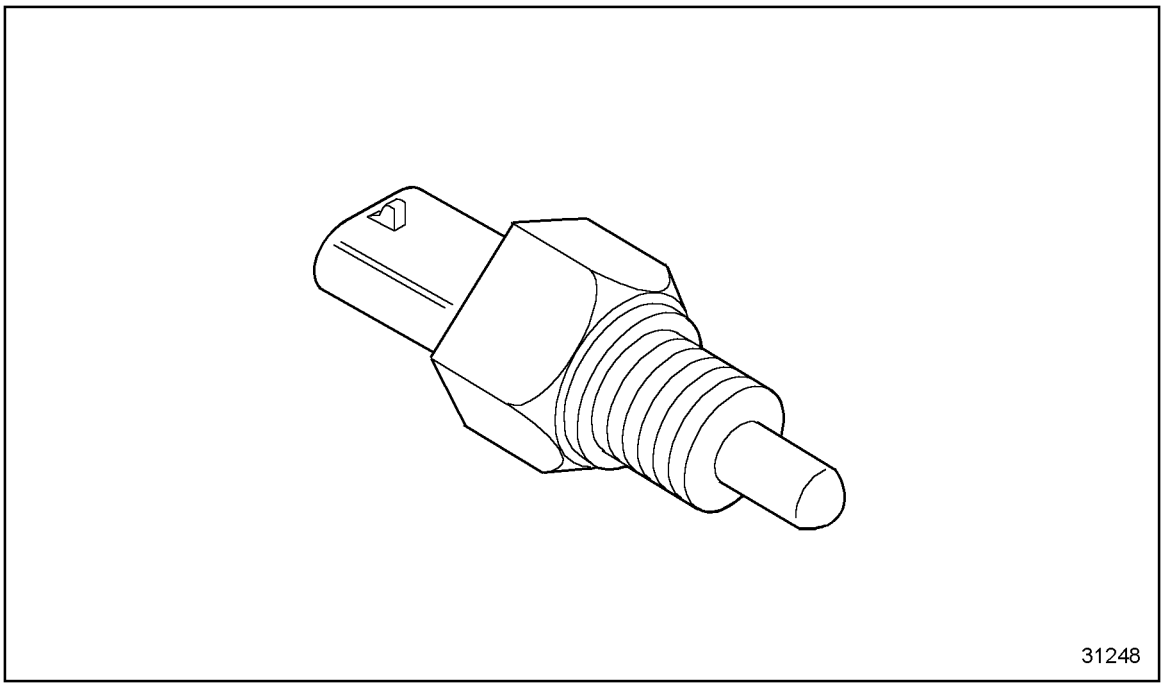

Figure 28-1 Air Temperature Sensor

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28.1 DESCRIROMPTION OF FLASH CODE 28

Flash Code 28 indicates that the engine Air Temperature Sensor (ATS), see Figure 28-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- Sensor signal circuit is shorted to sensor return
- Sensor signal circuit is shorted to ground

28.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 28

The SAE J1587 equivalent code for Flash Code 28 is p 172 4, air temperature circuit low.

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28.3 TROUBLESHOOTING FLASH CODE 28

The following procedure will troubleshoot Flash Code 28.

28.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in DDR.
3. Read active codes.
   [a] If code 172/4 was logged and there are no other codes logged, refer to section 28.3.2.
   [b] If code 172/4 and any of the following codes 110/3, 175/3, 174/3, 72/3 or 102/3 were logged, refer to section 90.1.
   [c] If code 172/4 and any code except the following were logged 110/3, 175/3, 174/3, 72/3 or 102/3, refer to section 28.3.2.

28.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn vehicle ignition OFF.
2. Disconnect the ATS connector. See Figure 28-2.

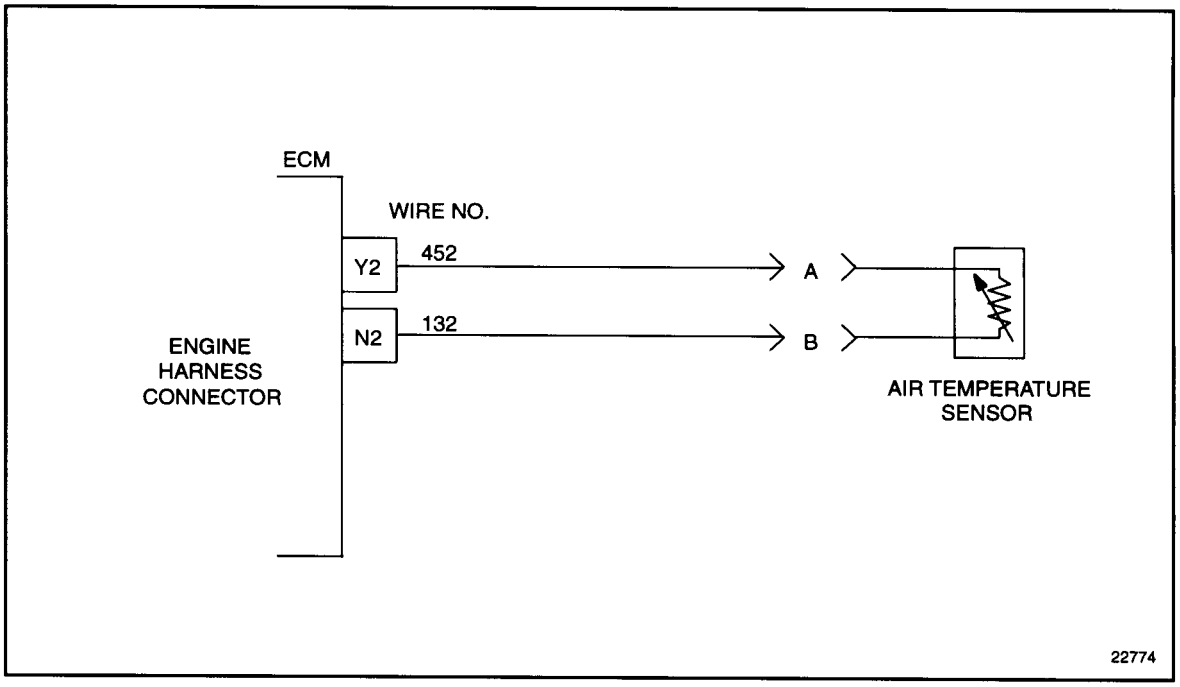

Figure 28-2 Engine Harness to Air Temperature Sensor Connector

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3. Start engine and run until Check Engine light comes on, or for eight minutes.
4. With engine still running, read active codes.
   [a] If code 172/4 and any other codes were logged, refer to section 28.3.4.
   [b] If flash 172/3 and any other codes except 172/4 were logged, refer to section 28.3.3.

28.3.3 Check Air Temperature Sensor Connectors

Perform the following steps to check the ATS connector.

1. Check terminals at the ATS connector (both sensor and harness side) for damage; bent, corroded and unseated pins or sockets.
   [a] If terminals and connectors are not damaged, replace ATS. Refer to section 28.3.6.
   [b] If terminals and connectors are damaged, repair/replace wires and refer to section 28.3.6.

28.3.4 Check for Short

Perform the following steps to check for a short.

1. Turn the ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Measure resistance between sockets N2 and Y2 on the engine harness connector. See Figure 28-3.
4. Measure resistance between socket N2 and a good ground.
   [a] If the resistance measurement between sockets N2 and Y2 and between socket N2 and a good ground is greater than 10 Ω or open, refer to section 28.3.5.

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[b] If the resistance measurement between sockets N2 and Y2, or N2 and battery negative, is less than or equal to 10 Ω, the signal line #132 is shorted to the return line #452 or battery ground. Repair short. Refer to section 28.3.6.

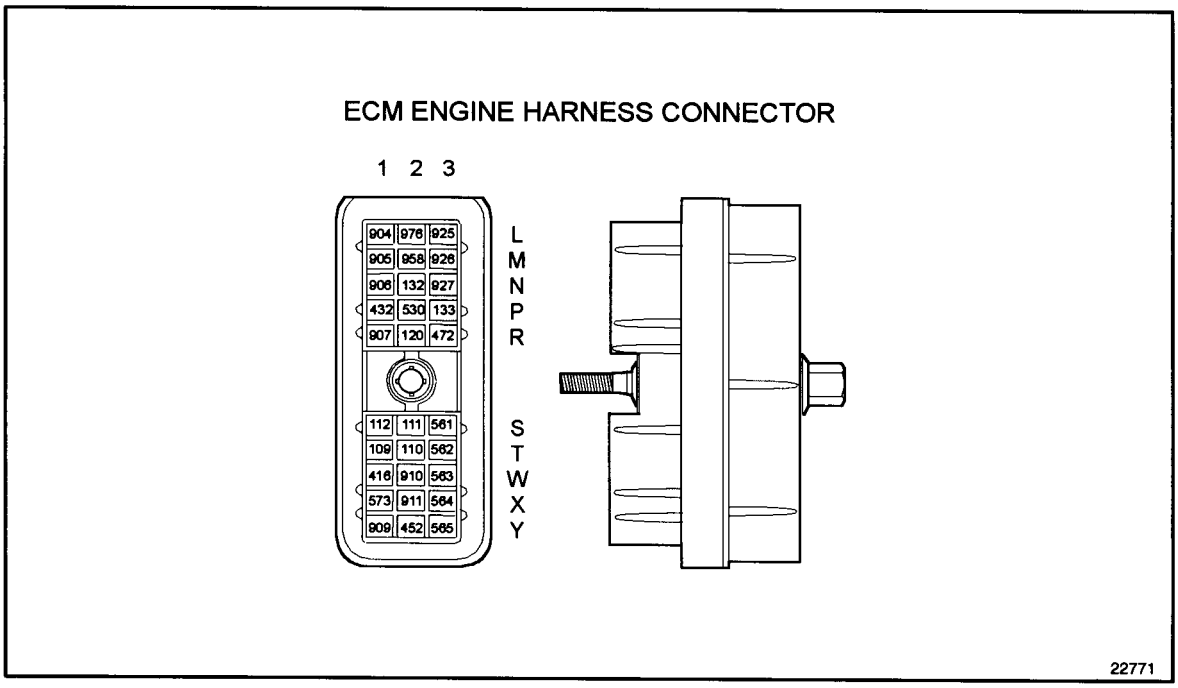

Figure 28-3 ECM Engine Harness Connector

28.3.5 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM harness connector (both ECM and harness side) for damage; bent, corroded and unseated pins or sockets, especially N2 and Y2 of the ECM connector.

   [a] If terminals or connectors are not damaged, contact Detroit Diesel Technical Services and refer to section 28.3.6.

   [b] If terminals and connectors are damaged, repair them. Refer to section 28.3.6

28.3.6 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for eight minutes.

6. Stop engine.
7. Read inactive codes.
   [a] If no codes are displayed, troubleshooting is complete.
   [b] If code 172/4 is logged with any other codes, all system diagnostics are complete. Review this section from the first step to find the error.
   [c] If code 172/4 is not logged, but other codes are logged, refer to section 9.1.

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29 FLASH CODE 29

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29.1 DESCRIPTION OF FLASH CODE 29

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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30 FLASH CODE 30

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30.1 DESCRIPTION OF FLASH CODE 30

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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31 (CHG) FLASH CODE 31 - ENGINE BRAKE FAULT CODE

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31.1 DESCRIPTION OF FLASH CODE 31

Flash Code 31 indicates the engine brake low or medium circuit has an open or is shorted to battery ground.

This diagnostic condition is typically:

- ☐ Output circuit open
- ☐ Output wire is shorted to ground

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31.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 31

The SAE J1587 equivalent code for Flash Code 31 is s 051 3/4 or s 052 3/4.

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31.3 TROUBLESHOOTING FLASH CODE 31

The following procedure will troubleshoot Flash Code 31.

31.3.1 Check Configuration

Perform the following steps to check configuration.

1. If the unit has engine brakes, refer to section 31.3.2.
2. If the unit does not have engine brakes, the ECM is configured for engine brakes and shouldn't be. Contact DDC with the engine serial number to have the data changed. Reprogram the ECM after the change. Refer to section 31.3.10.

31.3.2 Determine Failure Mode

Perform the following steps to determine failure mode.

1. Turn vehicle ignition ON.
2. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL) connector.
3. Read SAE code (051 or 052).
   [a] If the reading is FMI=3, there is an open. Refer to section 31.3.3.
   [b] If the reading is FMI=4, there is a short to ground. Refer to section 31.3.7.

31.3.3 Determine Engine Type

Perform the following steps to determine engine type.

1. Is this a Series 55 engine?
   [a] If yes, reprogram the ECM. Then, refer to section 31.3.10.
   [b] If no, refer to section 31.3.4.

31.3.4 Check for Open

Perform the following steps to check for open.

1. Turn vehicle ignition OFF.
2. Disconnect 2-pin connector pigtail from engine brake harness.
3. Disconnect 30-pin engine harness connector.
4. Install a jumper wire between pins #561 and #562, ECM side.
5. Measure resistance between S3 (#561) and T3 (#562) of the engine harness connector.
   [a] If measured resistance is less than 50 Ω , refer to section 31.3.5.

[b] If measured resistance is greater than 50 Ω , one or both wires are open. Repair open. Refer to section 31.3.10.

31.3.5 Check for Open (Inside Valve Cover)

Perform the following steps to check for open in the inside valve cover.

1. Reconnect the engine harness connector. See Figure 31-1.
2. Relocate the jumper to pins A and B of the brake harness connector (brake side).
3. Remove rocker cover.
4. Disconnect the two #621 leads and the one #622 lead from the brake solenoids.
5. Measure resistance between both #621 wires and #622 wire.

   [a] If measured resistance is greater than 50 Ω or open, an open exists in one of the wires where the check was made. Repair open or replace the injector harness. Refer to section 31.3.10.

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[b] If measured resistance is less than 50 Ω, refer to section 31.3.6.

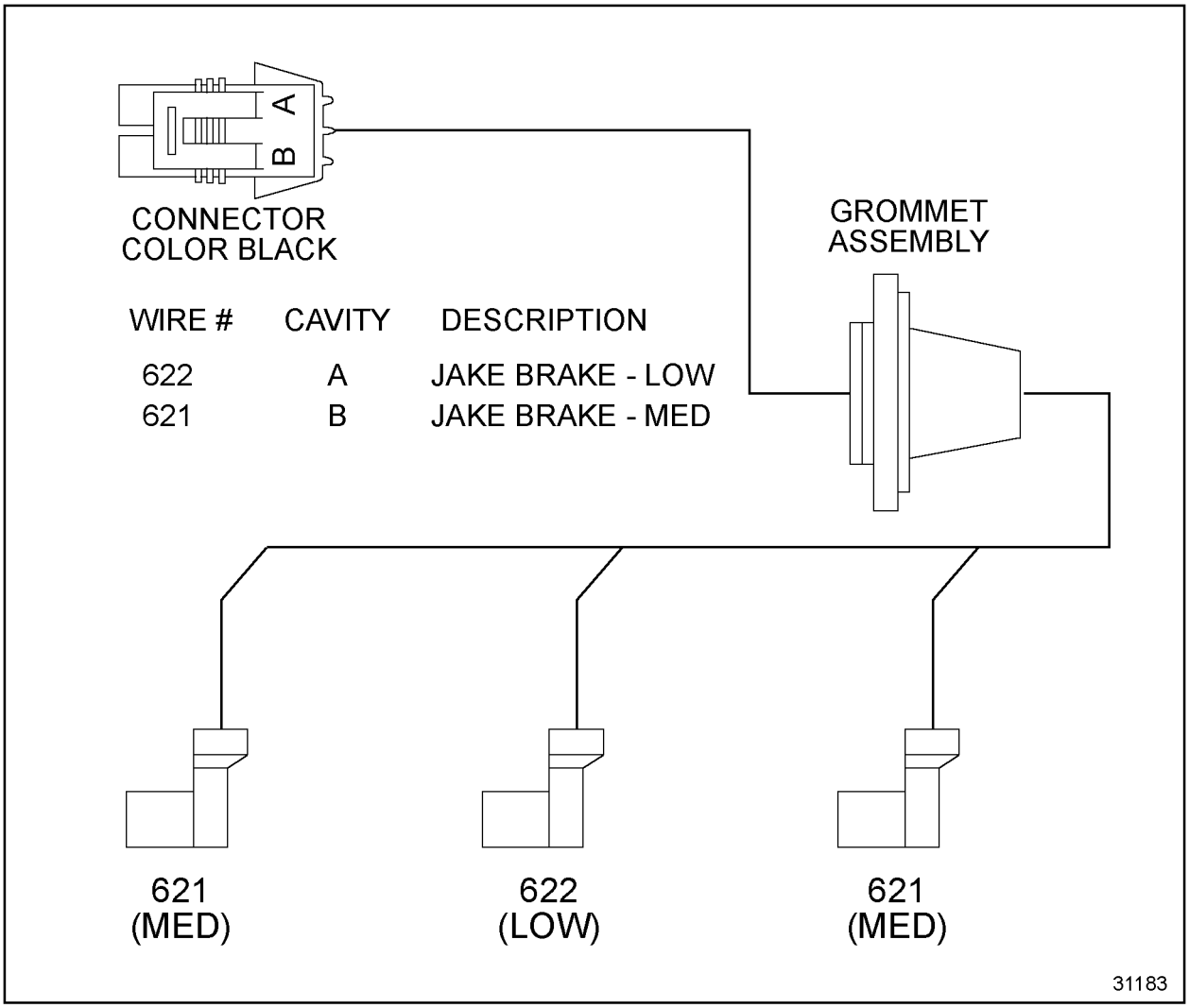

Figure 31-1 Engine Brake Harness Schematic

31.3.6 Check for Cylinder Block Ground

Perform the following steps to check for cylinder block ground.

1. If the cylinder block is connected to the battery ground, refer to section 31.3.9.
2. If the cylinder block is not connected to the battery ground, install a ground strap from the cylinder block to the battery negative (-). Refer to section 31.3.10.

31.3.7 Check for Short

Perform the following steps to check for a short.

1. Turn vehicle ignition OFF.

2. Unplug the engine harness connector.
3. Measure resistance between S3 (#561) and a battery ground, and S3 (#561) and the engine block. Repeat this check between T3 (#562) and battery ground, and T3 (#562) and the engine block.
   [a] If resistance for all measurements is greater than 5 Ω or open, refer to section 31.3.8.
   [b] If any measured resistance is less than 5 Ω, the wire where the measurement was read is shorted to ground or to the engine. Repair short or replace the wire. Refer to section 31.3.10.

31.3.8 Check for Short

Perform the following steps to check for a short between wires.

1. Measure resistance between S3 (#561) and T3 (#562).
   [a] If measured resistance is less than 10 Ω, the S3 and T3 wires are shorted to each other. Repair short. Refer to section 31.3.10.
   [b] If measured resistance is greater than 10 Ω, refer to section 31.3.9.

31.3.9 Check Brake Solenoids

Perform the following steps to check for brake solenoids.

1. Check brake solenoids. Refer to OEM guidelines.
   [a] If the solenoids are in good condition, contact Detroit Diesel Technical Service. Refer to section 31.3.10.
   [b] If the solenoids are damaged, repair or replace them. Refer to section 31.3.10.

31.3.10 Verify Repairs

Perform the following steps to verify repairs.

1. Connect any connectors removed for troubleshooting.
2. Start and run the engine. (Operate the engine brake.)
   [a] If no lights come on, and no codes are logged, the repairs are complete. No further troubleshooting is required.
   [b] If Check Engine Light displays with codes s 051 3/4 or 052 3/4, review this section to find the error. Refer to section 31.3.1.

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32 FLASH CODE 32 - CEL / SEL FAULT

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32.1 DESCRIPTION OF FLASH CODE 32

Flash Code 32 indicates that the wire for the SEL or CEL is open or shorted to Battery +.

This diagnostic condition is typically:

- ☐ Open/broken output wire
- ☐ Shorted output wire

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32.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 32

The SAE J1587 equivalent code for Flash Code 32 is:

- s 238/3 SEL short to battery
- s 238/4 SEL open circuit
- s 239/3 CEL short to battery
- s 239/4 CEL open circuit

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32.3 TROUBLESHOOTING FLASH CODE 32

The following procedure will troubleshoot Flash Code 32.

32.3.1 Determine Failure Mode Identifier (3 or 4)

Perform the following steps to determine FMI.

1. Turn ignition ON.
2. Plug in diagnostic data reader (DDR) into the diagnostic data link (DDL).
3. Read codes.
   [a] If code 238/4 or 239/4 is logged, reprogram the ECM. Refer to section 32.3.3.
   [b] If code 238/3 or 239/3 is logged, refer to section 32.3.2.

32.3.2 Check for Short to Battery

Perform the following steps to determine failure.

1. Turn vehicle ignition OFF.
2. Disconnect vehicle harness connector.
3. Turn ignition ON.
4. Remove CEL bulb and SEL bulb.
5. Measure voltage between B2 (#509) and a good ground. See Figure 32-1.

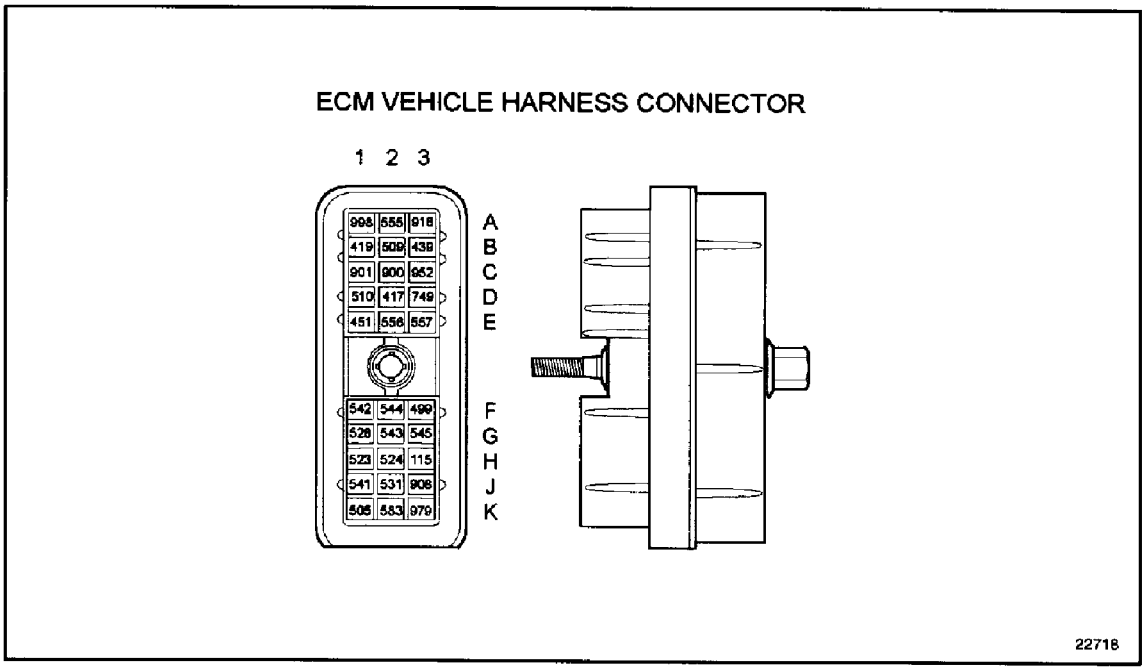

Figure 32-1 ECM Vehicle Harness Connector

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6. Measure voltage between B1 and a good ground.
   [a] If either measurement was greater than 0.5 volts, the wire that had the reading is shorted to some voltage source. Replace the wire(s). Refer to section 32.3.3.
   [b] If no measurement was greater than 0.5 volts, contact Detroit Diesel Technical Service.

32.3.3 Verify Repairs

Perform the following steps to verify repairs.

1. Connect all connectors.
2. Start and run the engine.
3. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL). Read codes.
   [a] If active code 32 is logged, review this section to find the error. Refer to section 32.1.
   [b] If code 32 is not logged, troubleshooting is complete.

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33 (CHG) FLASH CODE 33 - TBS HIGH

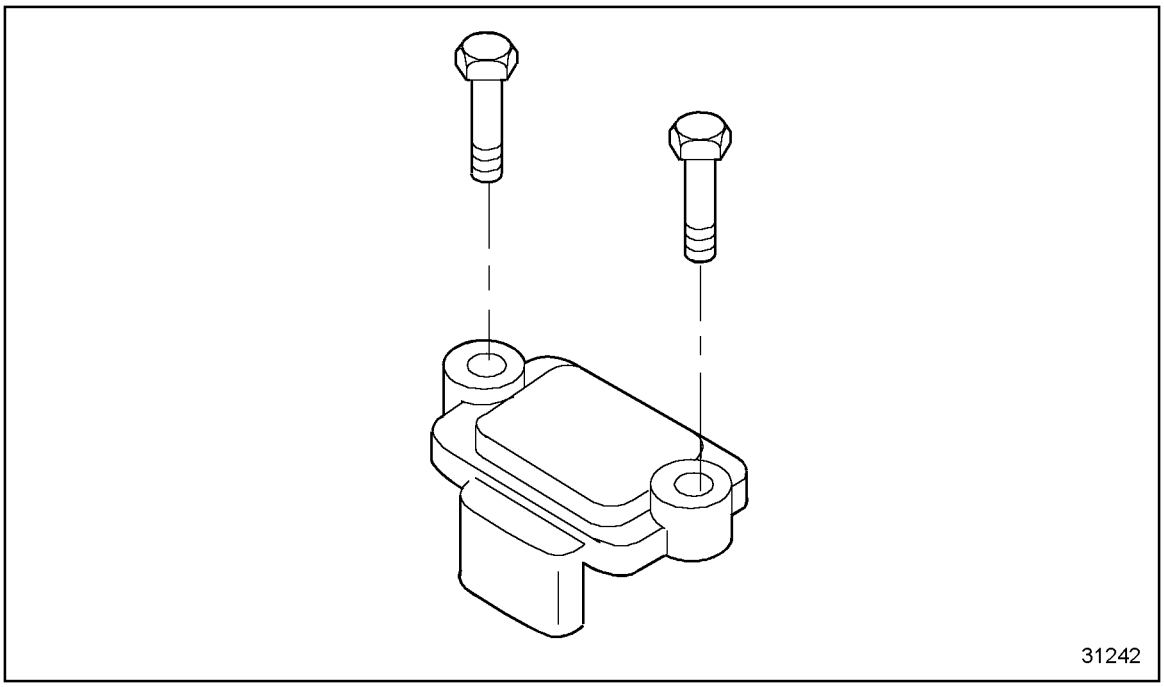

Figure 33-1 Turbo Boost Sensor

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33.1 DESCRIPTION OF FLASH CODE 33

Flash Code 33 indicates that the engine Turbo Boost Sensor (TBS), see Figure 33-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- Open sensor return circuit
- Sensor signal circuit is shorted to the sensor +5 volt supply

33.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 33

The SAE J1587 equivalent code for Flash Code 33 is p 102 3.

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33.3 TROUBLESHOOTING FLASH CODE 33

The following procedure will troubleshoot Flash Code 33.

33.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL).
2. Turn vehicle ignition switch ON.
3. Read active codes.
   [a] If code 102/3 and no other codes were logged, refer to section 33.3.2.
   [b] If any of the following codes are also present: 72/3 or 4, 73/3 or 4, 94/3 or 4, 100/3 or 4, 101/3 or 4, 110/3 or 4, 174/3 or 4, 175/3 or 4, refer to section 90.1.

33.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn vehicle ignition OFF.
2. Disconnect the TBS connector. See Figure 33-2.
3. Start and run the engine at idle.
4. Read active codes logged.
   [a] If active code 102/3 and any other codes are logged, refer to section 33.3.5.

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[b] If active code 102/4 and any other codes except 102/3 are logged, refer to section 33.3.3.

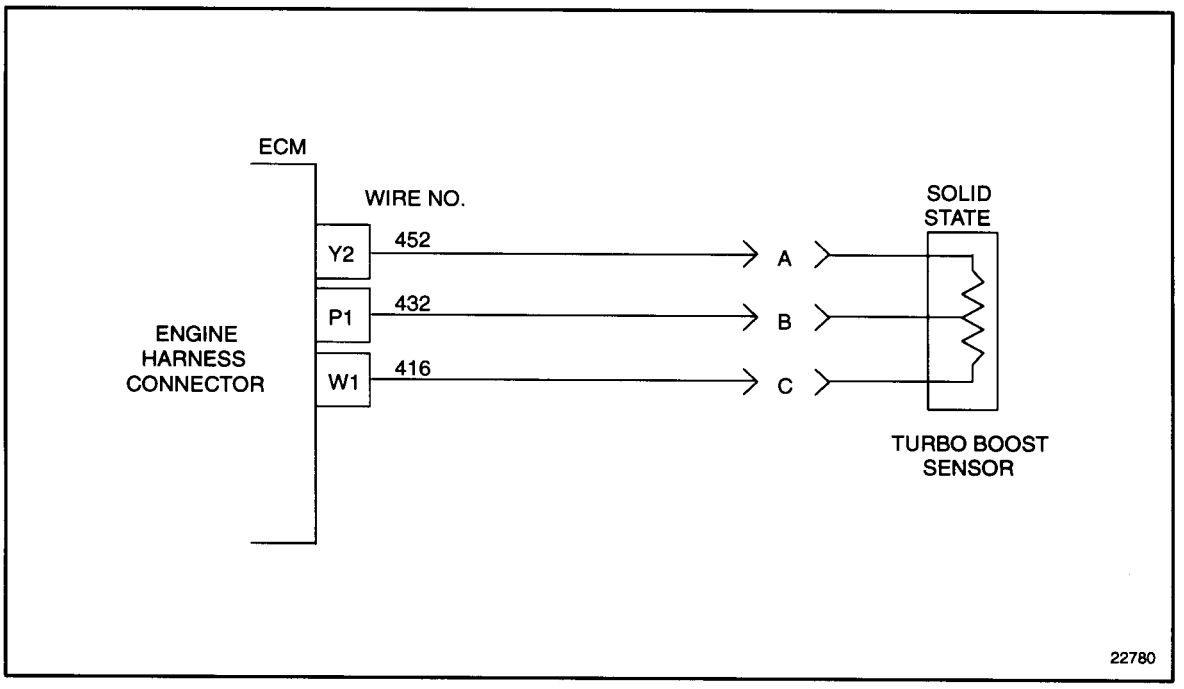

Figure 33-2 Turbo Boost Sensor

33.3.3 Return Circuit Check

Perform the following steps to check the return circuit.

1. Turn ignition switch OFF.
2. Install a jumper wire between pin A and pin B of the TBS harness connector. See Figure 33-3.
3. Disconnect the engine harness connector at the ECM. See Figure 33-4.
4. Measure resistance between sockets P1 and Y2 on the engine harness connector.

   [a] If resistance measurement is less than or equal to 5 Ω, refer to section 33.3.4.

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[b] If resistance measurement is greater than 5 Ω, the return line #452 is open. Repair the open. Refer to section 33.3.8.

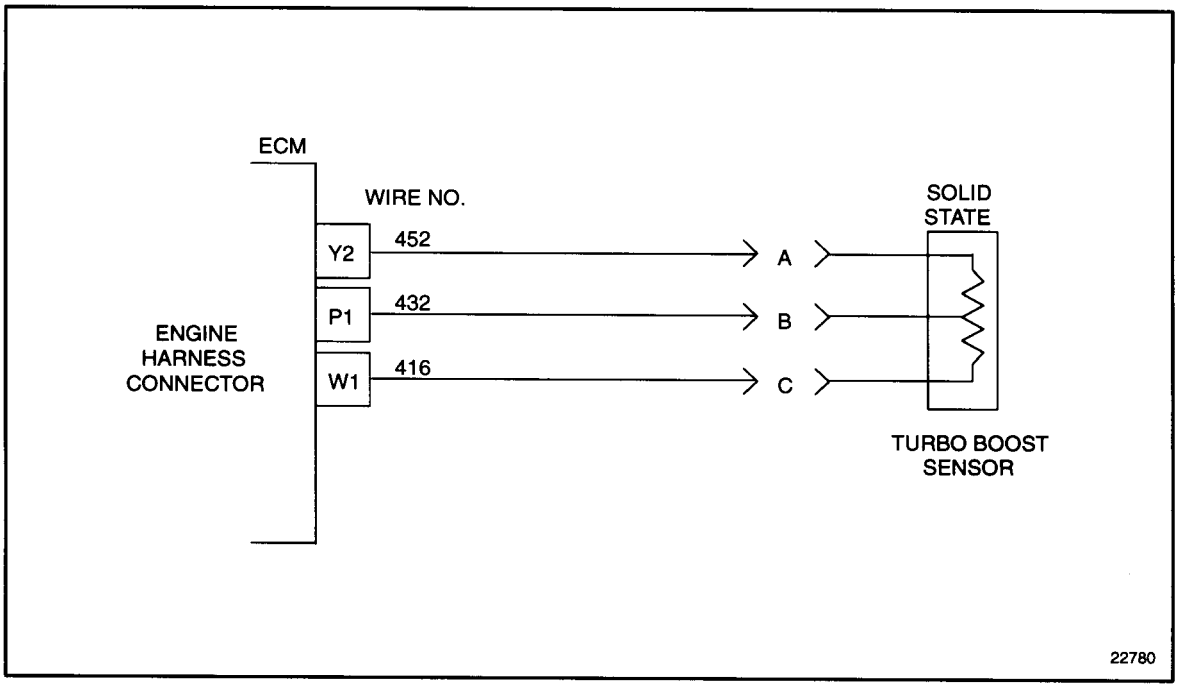

Figure 33-3 Turbo Boost Sensor

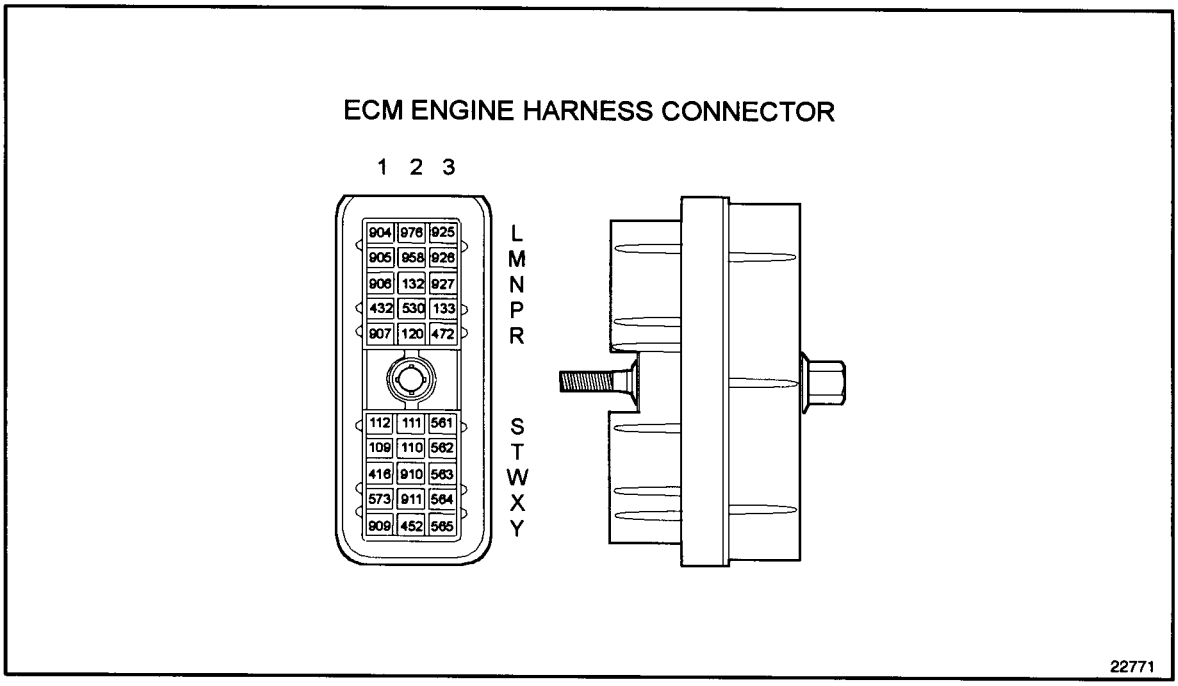

Figure 33-4 ECM Engine Harness Connector

33.3.4 Check Turbo Boost Sensor Connectors

Perform the following steps to check the TBS connectors.

1. Check terminals at the TBS connector (both sensor and harness side) for damage: bent, corroded, and unseated pins or sockets. See Figure 33-5.
   [a] If the terminals and connectors are damaged, repair them. Refer to section 33.3.8.
   [b] If the terminals and connectors are not damaged, replace the TBS. Refer to section 33.3.8.

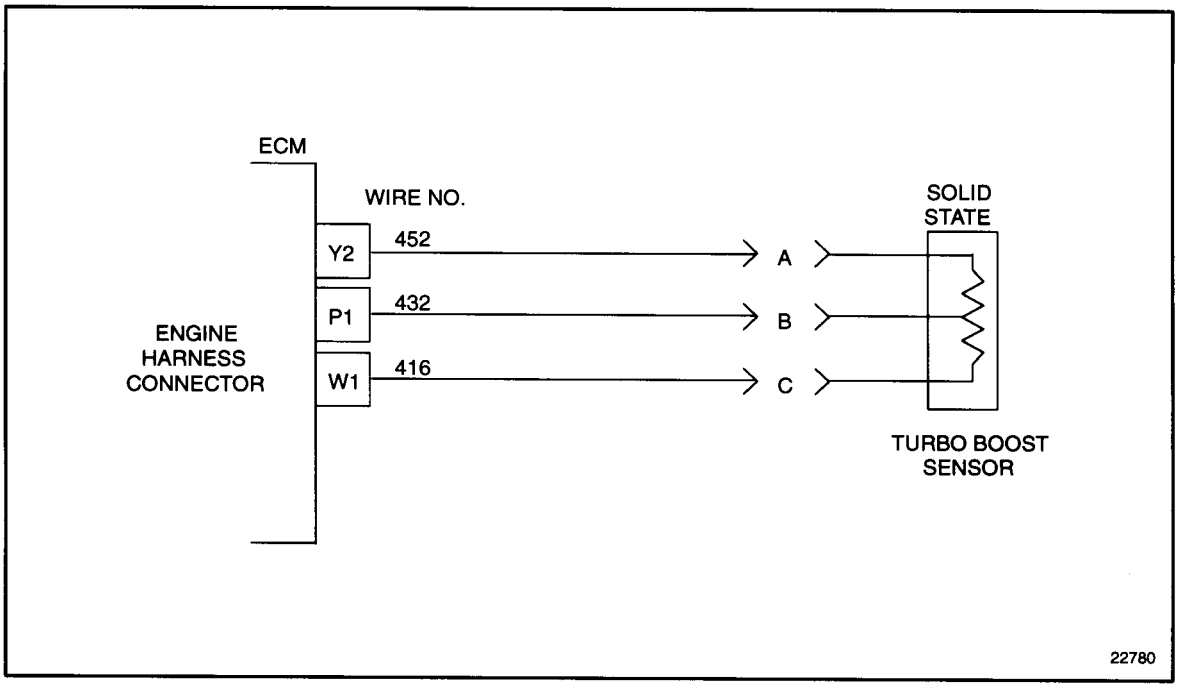

Figure 33-5 Turbo Boost Sensor

33.3.5 Check for Short to +5 Volt Line

Perform the following steps to check for a short to the +5 volt line:

1. Turn vehicle ignition OFF.
2. Disconnect engine harness connector from the ECM.
3. Measure resistance between sockets P1 and W1 on the engine harness connector. See Figure 33-6.
   [a] If measured resistance is less than or equal to 10,000 Ω, the signal line #432 is shorted to the engine +5 volt line #416. Repair short. Refer to section 33.3.8.

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[b] If measured resistance is greater than 10,000 Ω, or open, refer to section 33.3.6.

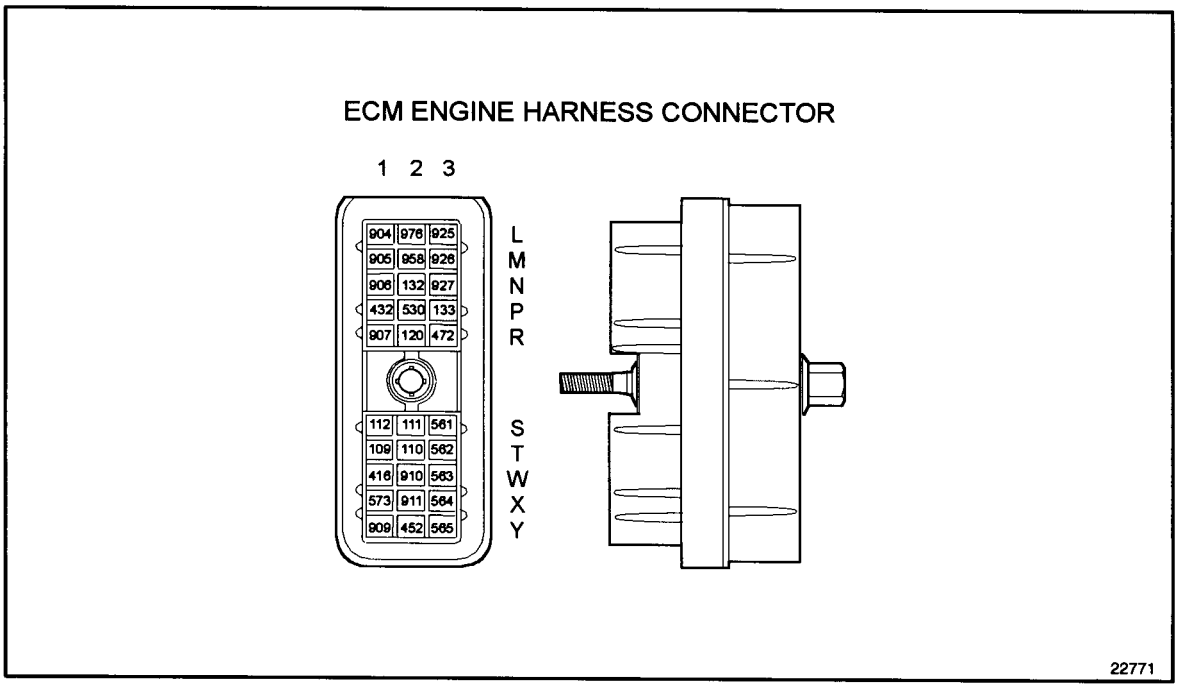

Figure 33-6 ECM Engine Harness Connector

33.3.6 Check for Short to Battery

Perform the following steps to check for a short to the battery (+):

1. Remove both fuses to the ECM.
2. Disconnect the vehicle harness and 5-way power connector harness at the ECM. See Figure 33-7.
3. Measure resistance between sockets P1 of the engine harness connector and B3 on the vehicle harness connector.
4. Measure resistance between socket P1 on the engine harness connector and the 5-way power harness connector sockets A and C.

   [a] If the resistance measurement is less than or equal to 100 Ω, a short exists between sockets where the measurement was taken. Repair short and reinsert fuses, or reset breakers. Refer to section 33.3.8.

[b] If the resistance measurement is greater than 100 Ω, or open, refer to section 33.3.7.

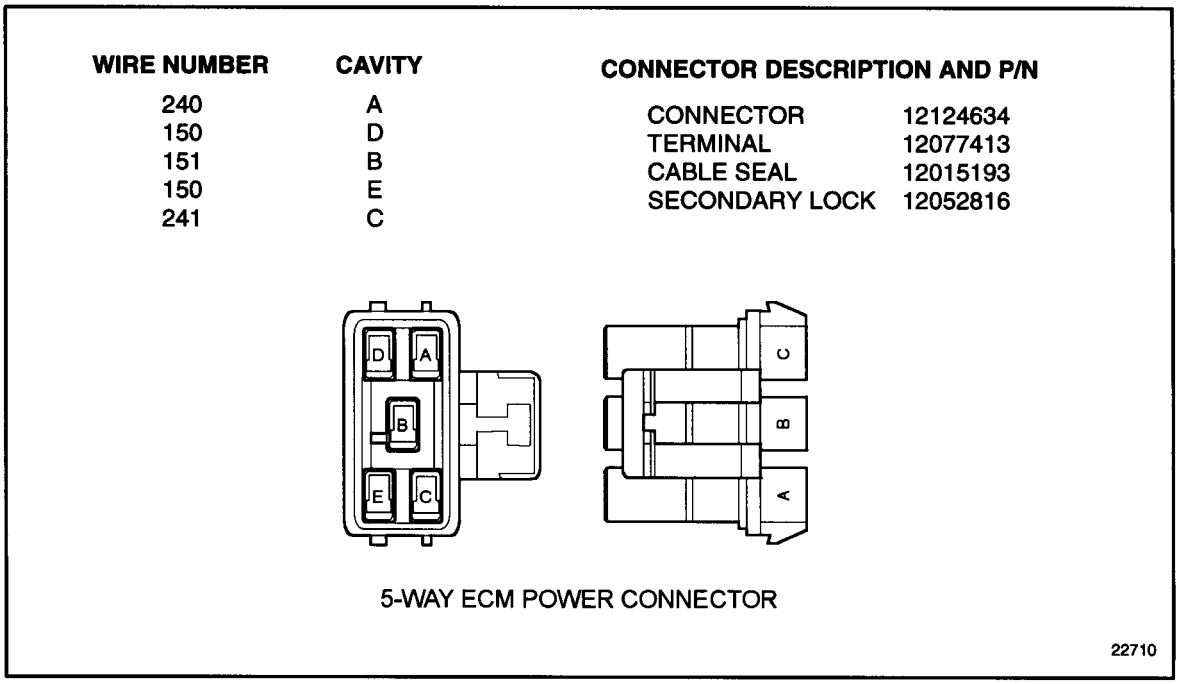

Figure 33-7 5-Way ECM Power Connector

33.3.7 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connector (both the ECM and harness side) for damage: bent, corroded, and unseated pins or sockets.
   [a] If terminals and connectors are damaged, repair both. Refer to section 33.3.8.
   [b] If terminals and connectors are not damaged, reprogram the ECM. Refer to section 33.3.8.

33.3.8 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition switch OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.

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[a] If no codes are logged, troubleshooting is complete.

[b] If code 102/3 is not logged, and other codes are logged, refer to section 9.1.

[c] If code 102/3 is logged, and other codes are logged, refer to section 33.3.1.

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34 (CHG) FLASH CODE 34 - TBS LOW

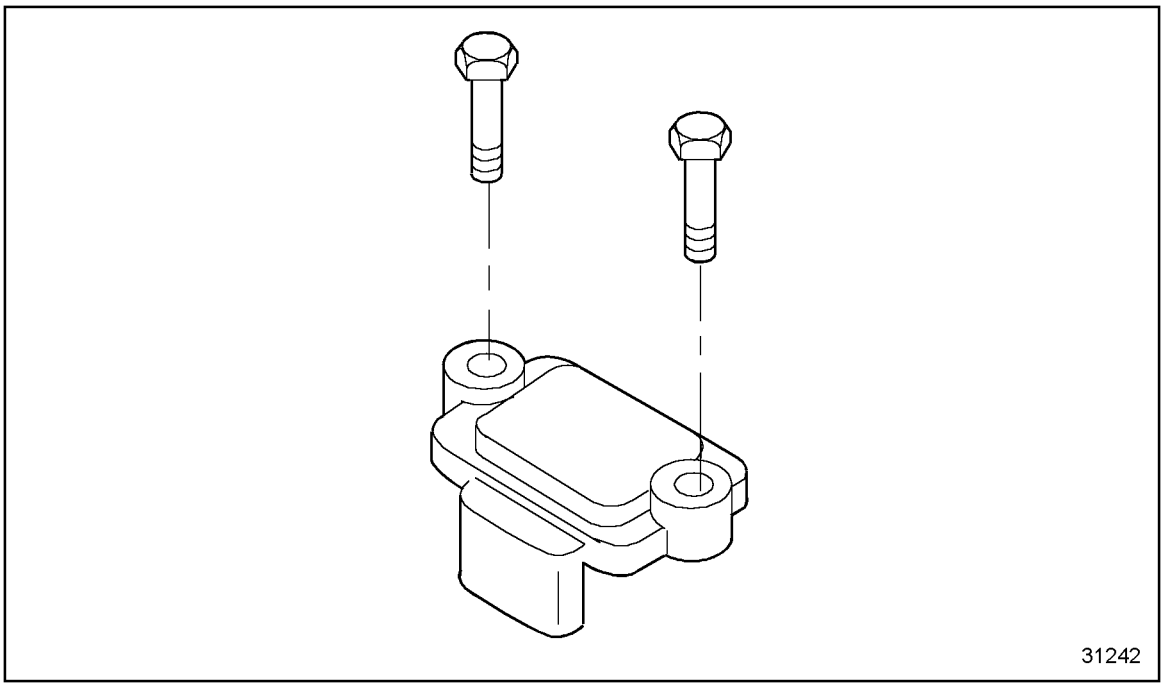

Figure 34-1 Turbo Boost Sensor

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34.1 DESCRIPTION OF FLASH CODE 34

Flash Code 34 indicates that the engine Turbo Boost Sensor (TBS), see Figure 34-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- ☐ Open sensor signal circuit
- ☐ Open sensor +5 volt supply circuit
- ☐ Sensor signal is shorted to sensor return circuit or to ground
- ☐ Sensor +5 volt supply is shorted to the sensor return circuit or ground

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34.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 34

The SAE J1587 equivalent code for Flash Code 34 is p 102 4.

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34.3 TROUBLESHOOTING FLASH CODE 34

The following procedure will troubleshoot Flash Code 34.

34.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL) connector.
2. Turn vehicle ignition switch ON.
3. Read active codes.
   [a] If code 102/4 was logged and there are no other logged codes, refer to section 34.3.2.
   [b] If code 102/4 and any of the following codes 72/3 or 4, 73/3 or 4, 94/3 or 4, 100/3 or 4, 101/3 or 4, 110/3 or 4, 174/3 or 4, 175/3 or 4, were logged, refer to section 90.1.
   [c] If code 102/4 was logged and none of the following codes 72/3 or 4, 73/3 or 4, 94/3 or 4, 100/3 or 4, 101/3 or 4, 110/3 or 4, 174/3 or 4, 175/3 or 4, were logged, refer to section 34.3.2.

34.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn vehicle ignition OFF.
2. Disconnect TBS connector.
3. Install a jumper wire between sockets B and C of the TBS harness connector. See Figure 34-2.
4. Turn ignition ON.
5. Start engine and run until either the Check Engine Light is on, or until the engine has been running at least one minute at greater than 1000 r/min.
6. Read logged codes.
   [a] If active code 102/4 and any other codes are logged, refer to section 34.3.4.

[b] If active code 102/3 and any other codes except 102/4 are logged, refer to section 34.3.3.

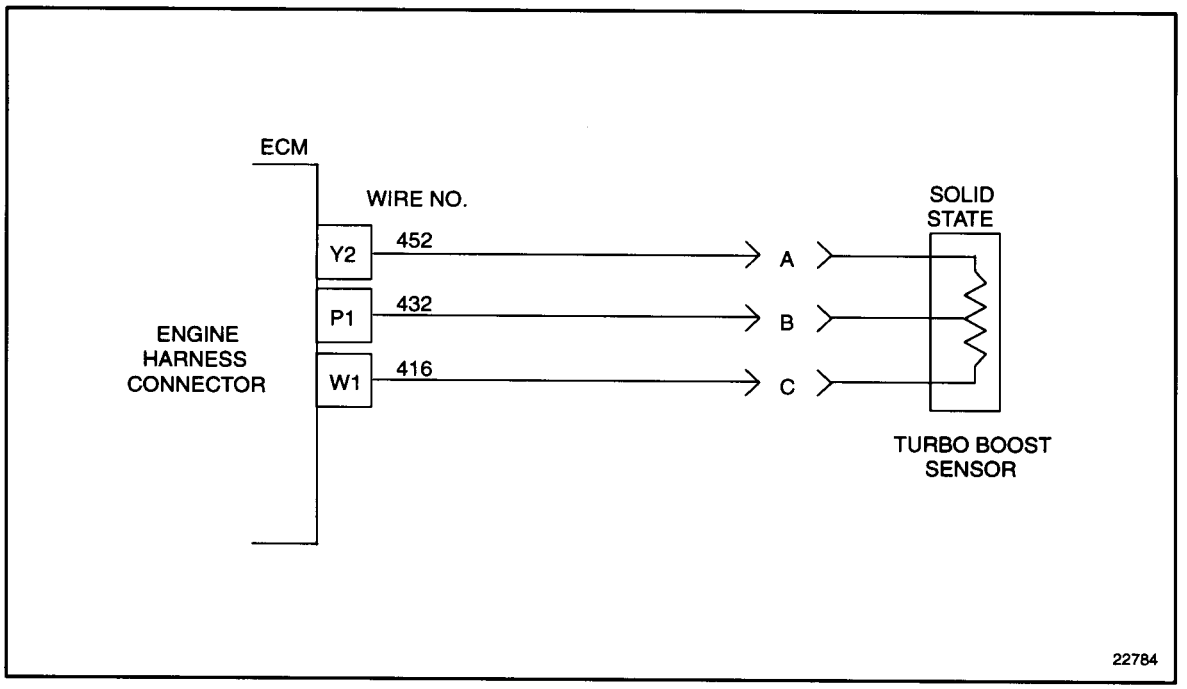

Figure 34-2 Turbo Boost Sensor Schematic

34.3.3 Check Turbo Boost Sensor Connectors

Perform the following steps to check the TBS connector.

1. Check terminals at the TBS connectors (both the TBS and harness side) for damage: bent, corroded and unseated pins or sockets.
   [a] If the terminals and connectors are damaged, repair them. Refer to section 34.3.11.
   [b] If the terminals and connectors are not damaged, replace the TBS. Refer to section 34.3.11.

34.3.4 Check for +5 Volt

Perform the following steps to check for +5 volt.

1. Remove jumper.
2. Turn ignition ON.
3. Measure voltage on TBS harness connector, pin C (red lead) to pin A (black lead).
   [a] If the voltage measurement is greater than 6 volts, refer to section 34.3.10.
   [b] If the voltage measurement is between 4 and 6 volts, refer to section 34.3.5.
   [c] If the voltage measurement is less than 4 volts, refer to section 34.3.8.

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34.3.5 Check for Signal Open

Perform the following steps to check for signal open.

1. Turn vehicle ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Install a jumper wire between pins A and B of the TBS harness connector. See Figure 34-3.
4. Measure resistance between sockets P1 and Y2 on the engine harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 34.3.6.
   [b] If the resistance measurement is greater than 5 Ω, or open, and the signal line (#432) is open, repair the open. Refer to section 34.3.11.

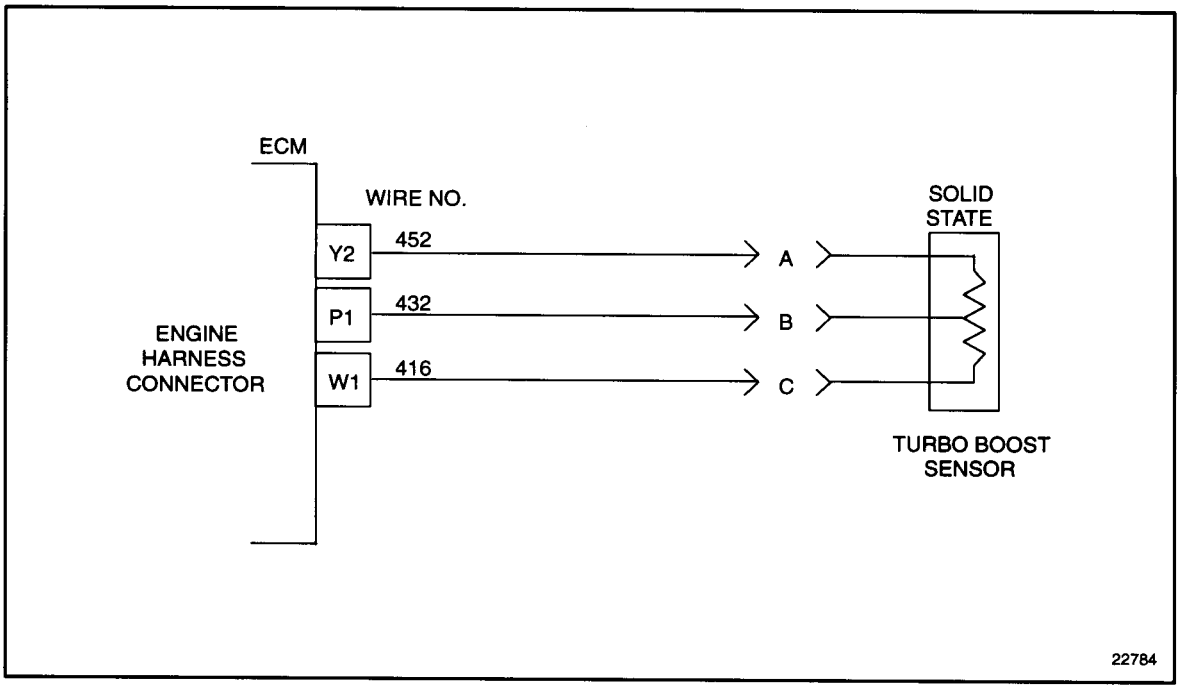

Figure 34-3 Turbo Boost Sensor Schematic

34.3.6 Check for Short

Perform the following steps to check for short.

1. Remove jumper.
2. Measure resistance between pins A and B on the TBS harness connector.
   [a] If measured resistance between pins A and B is greater than 100 Ω, or open, go to step 3
   [b] If measured resistance between pins A and B is less than 100 Ω, the signal line (#432) is shorted to the return line (#452). Repair the short. Refer to section 34.3.11.

3. Also measure resistance between socket B and a good ground.

   [a] If measured resistance between socket B and a good ground is greater than 100 Ω, or open, refer to section 34.3.7.

   [b] If measured resistance between socket B and a good ground is less than 100 Ω, the signal line (#432) is shorted to the battery ground. Repair the short and refer to section 34.3.11.

34.3.7 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM harness connector (both ECM and harness side) for damage: bent, corroded, and unseated pins or sockets. See Figure 34-4.

   [a] If terminals and connectors are damaged, repair them and refer to section 34.3.11.

   [b] If terminals and connectors are not damaged, install a test ECM. Refer to section 34.3.11.

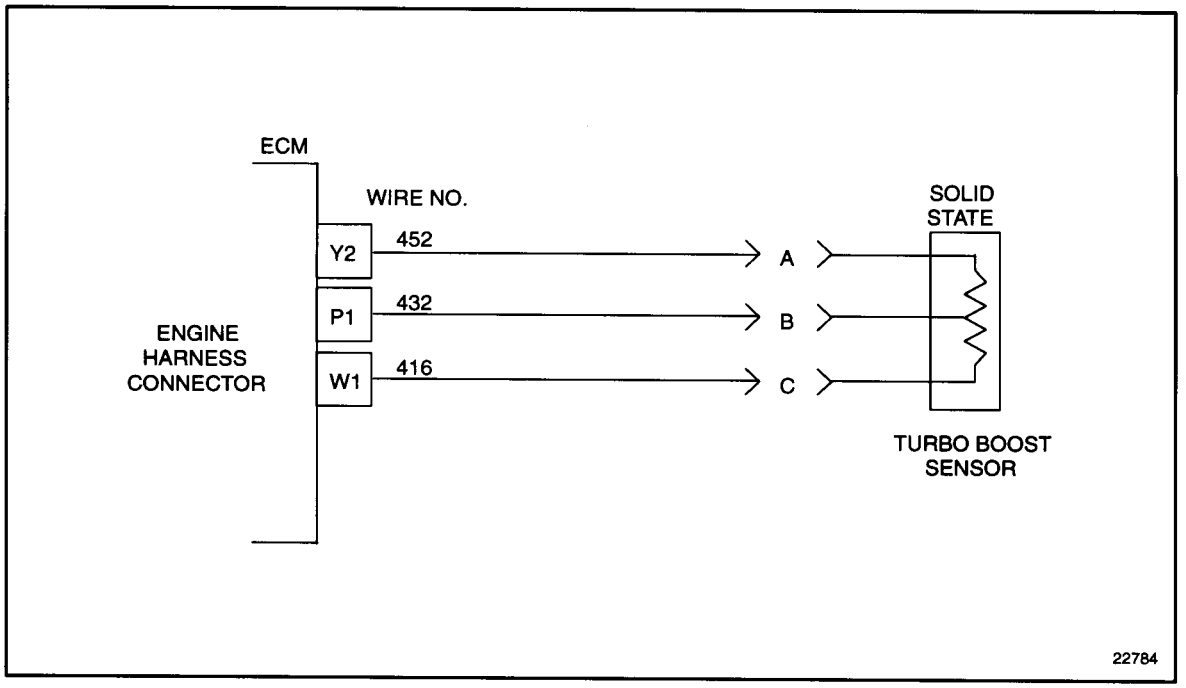

Figure 34-4 Engine Harness Connector to Turbo Boost Sensor

34.3.8 Check for Open +5 Volt Line

Perform the following steps to check for open +5 volt line.

1. Turn vehicle ignition OFF.
2. Disconnect the engine harness connectors at the ECM.
3. Install a jumper wire between pins A and C of the TBS harness connector. See Figure 34-5.

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4. Read resistance between sockets W1 and Y2 on the engine harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 34.3.9.
   [b] If the resistance measurement is greater than 5 Ω, or open, the vehicle +5 volt line (#416) is open. Repair open. Refer to section 34.3.11.

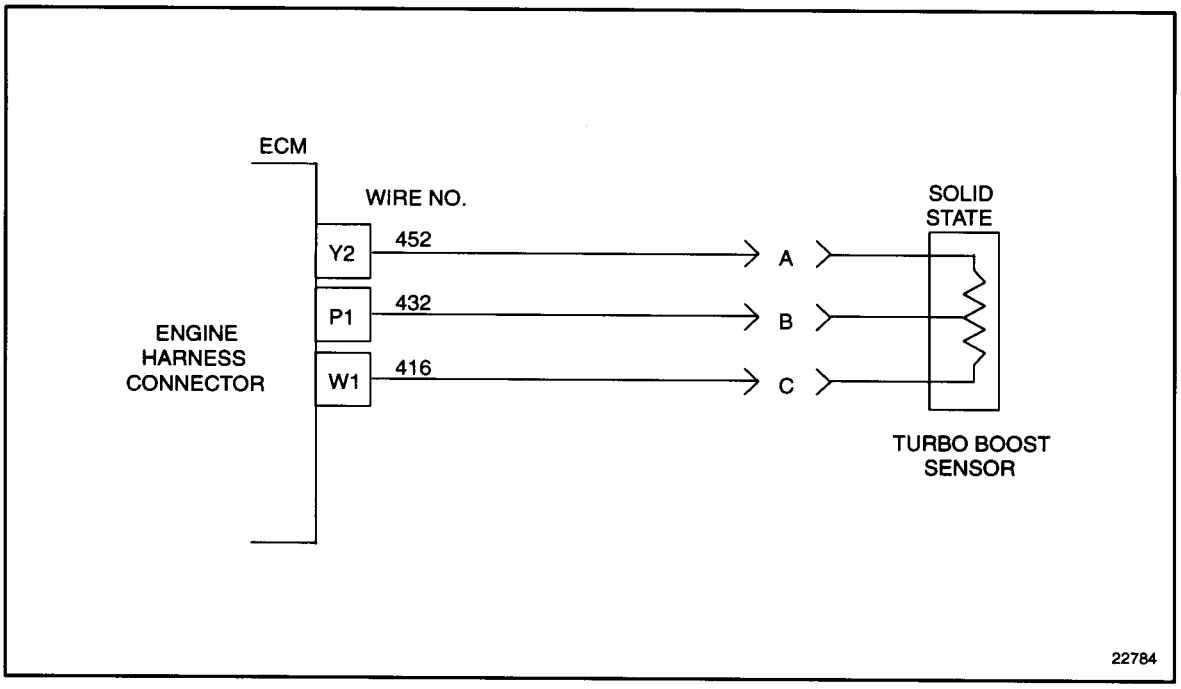

Figure 34-5 5-Way ECM Power Connector

34.3.9 Check for Short

Perform the following steps to check for short.

1. Remove jumper.
2. Measure resistance between pins A and C on the TBS harness connector. See Figure 34-6.
   [a] If measured resistance between pins A and C is greater than 100 Ω, or open, go to step 3
   [b] If measured resistance between pins A and C is less than 100 Ω, the 5 volt supply (#416) is shorted to the return line (#452). Repair the short. Refer to section 34.3.11.
3. Also measure resistance between socket C and a good ground.
   [a] If measured resistance between socket C and a good ground is greater than 100 Ω, or open, refer to section 34.3.7.

[b] If measured resistance between socket C and a good ground is less than 100 Ω, the 5 volt supply (#416) is shorted to the battery ground. Repair the short and refer to section 34.3.11.

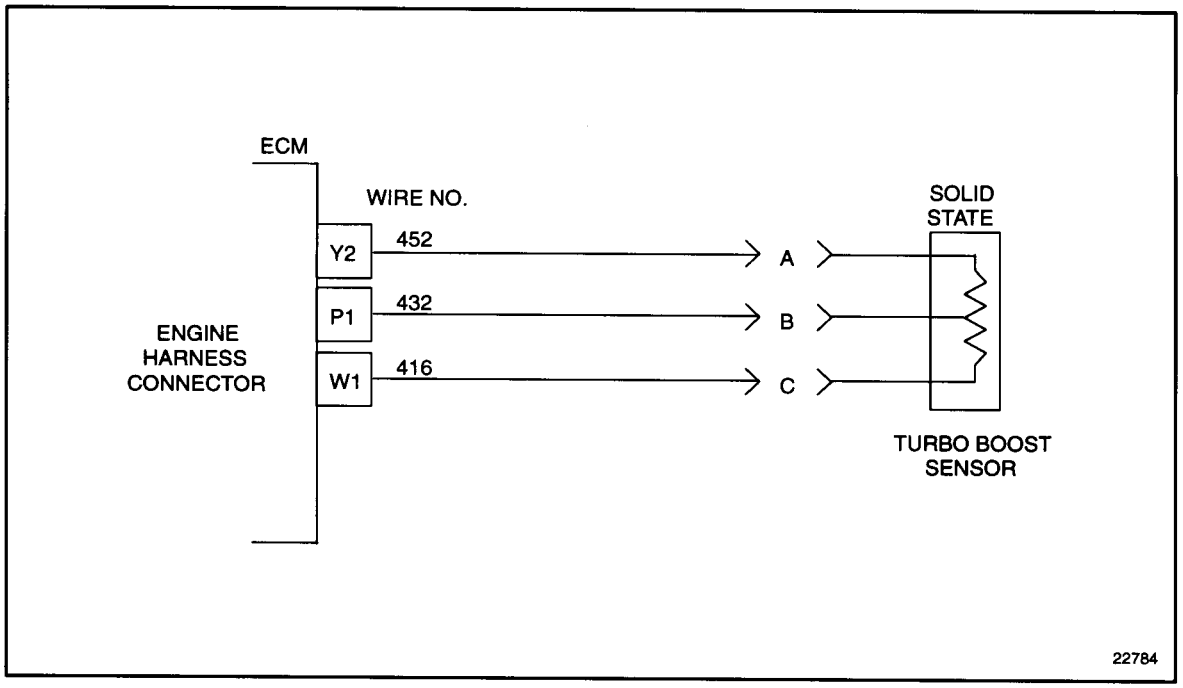

Figure 34-6 Turbo Boost Sensor Schematic

34.3.10 Check for Short to Battery +

Perform the following steps to check for short to battery +.

1. Turn vehicle ignition OFF.
2. Remove both fuses to the ECM.
3. Disconnect the engine harness, vehicle harness, and 5-way power connectors at the ECM.
4. Measure resistance between socket W1 on the engine harness connector and socket B3 of the vehicle harness connector, and between W1 and the 5-way power harness sockets A and C. See Figure 34-7.

   [a] If measured resistance is less than or equal to 100 Ω, a short exists between sockets where less than 100 Ω was measured. Repair short and reinsert fuses. Refer to section 34.3.11.

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[b] If the resistance measurement is greater than 100 Ω, or open, refer to section 34.3.7.

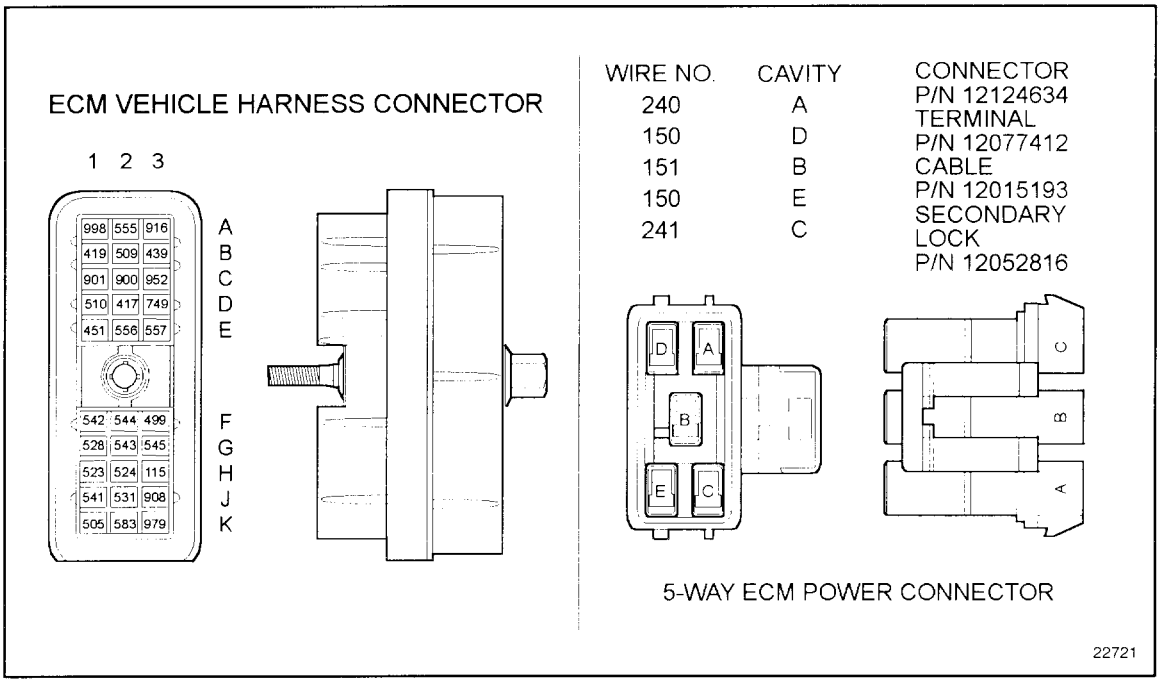

Figure 34-7 ECM Vehicle Harness Connector

34.3.11 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.

   [a] If no codes are logged, no further troubleshooting is required.

   [b] If code 102/4 and any other codes are logged, all system diagnostics are complete. Please review this section from the first step to find the error. Refer to section 34.3.1.

   [c] If code 102/4 is not logged and any other codes are logged, refer to section 9.1.

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35 FLASH CODE 35 - OPS HIGH

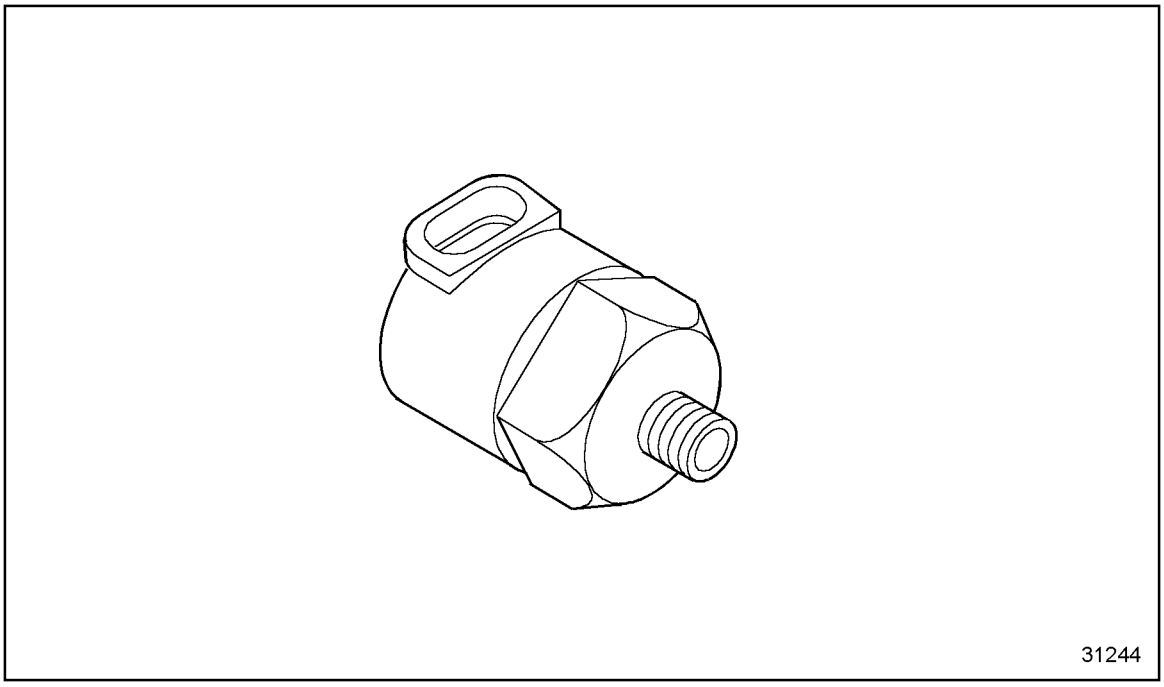

Figure 35-1 Oil Pressure Sensor

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35.1 DESCRIPTION OF FLASH CODE 35

Flash Code 35 indicates that the engine Oil Pressure Sensor (OPS), see Figure 35-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- ☐ Open sensor return circuit
- ☐ Sensor signal circuit is shorted to the sensor +5 volt supply
- ☐ Failed/damaged sensor

35.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 35

The SAE J1587 equivalent code for Flash Code 35 is p 100 3, oil pressure circuit high.

NOTE:
Code 35 is logged if oil pressure is high, engine is warm, and engine is at idle.

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35.3 TROUBLESHOOTING FLASH CODE 35

The following procedure will troubleshoot Flash Code 35.

35.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL).
3. Turn vehicle ignition to OFF.
4. Read active codes.
   [a] If code 100/3 and no other codes were logged, refer to section 35.3.2.
   [b] If code 100/3 and any of the following codes were logged: 73/3 or 4, 94/3 or 4, 100/4, 101/3 or 4, 102/3 or 4, 110/3 or 4, 174/3 or 4, 175/3 or 4, refer to section 90.1.

35.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition switch OFF.
2. Disconnect OPS connector.
3. Turn ignition ON.
4. Start and run the engine.
5. Select engine temperature (COOLANT TEMP or OIL TEMP) on the DDR.
6. Warm up engine until engine temperature reading is greater than 60°C (140°F).
7. After warm-up, let engine run at idle.
8. Read active codes.
   [a] If active code 100/3 and any other codes were logged, refer to section 35.3.5.
   [b] If code 100/4 and any other codes except 100/3 were logged, refer to section 35.3.3.

35.3.3 Return Circuit Check

Perform the following steps to check the return circuit.

1. Turn vehicle ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Install a jumper wire between pin A and pin B of the OPS harness connector. See Figure 35-2.
4. Measure resistance between sockets P2 and Y2 on the engine harness connector.

[a] If resistance measurement is less than or equal to 5 Ω, refer to section 35.3.4.

[b] If resistance measurement is greater than 5 Ω, the return line (#452) is open. Repair the open and refer to section 35.3.8.

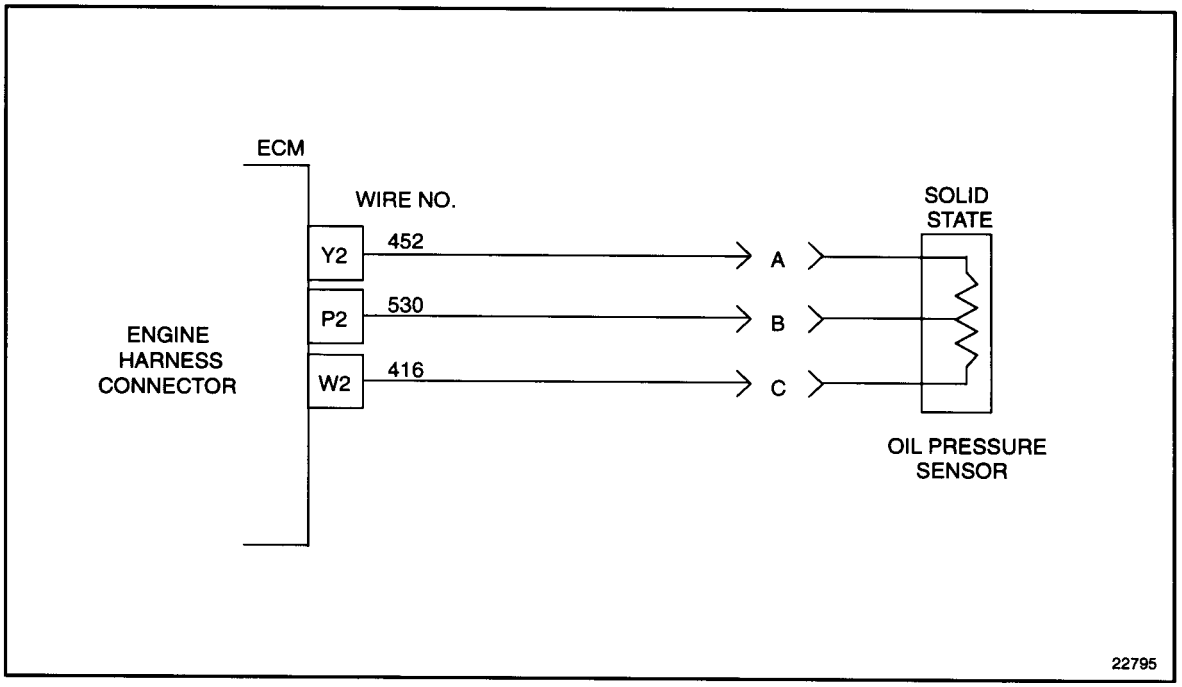

Figure 35-2 Engine Harness Connector to Oil Pressure Sensor

35.3.4 Check Oil Pressure Sensor Connectors

Perform the following steps to check the OPS connectors.

1. Check terminals at the OPS connectors (both the sensor and harness side) for damage: bent, corroded and unseated pins or sockets.

   [a] If the terminals and connectors are damaged, repair them and refer to section 35.3.8.

   [b] If the terminals and connectors are not damaged, replace the OPS. Refer to section 35.3.8.

35.3.5 Check for Signal Short to 5 Volt

Perform the following steps to check for signal open.

1. Turn vehicle ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Measure resistance between sockets P2 and W1 on the engine harness connector. See Figure 35-3.

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[a] If the resistance measurement is less than or equal to 100 Ω, the signal line (#530) is shorted to the engine +5 volt line (#416). Repair the short and refer to section 35.3.8.

[b] If the resistance measurement is greater than 100 Ω, or open, refer to section 35.3.6.

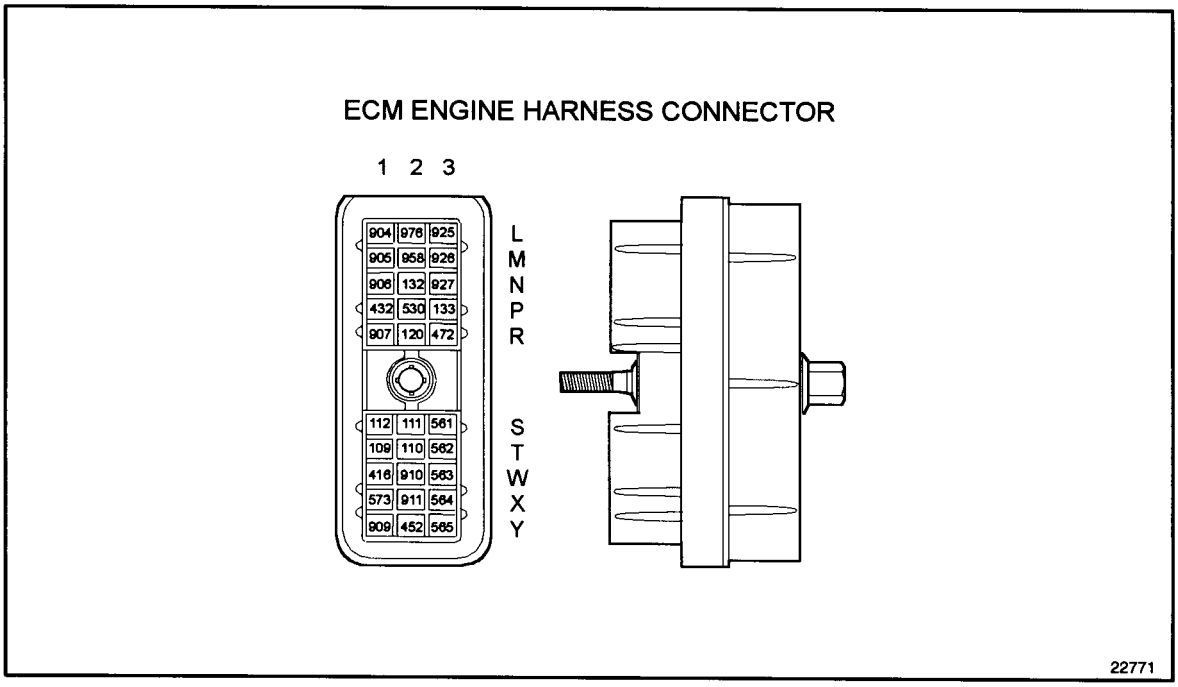

Figure 35-3 ECM Engine Harness Connector

35.3.6 Check for Short to Battery (+)

Perform the following steps to check for a short to battery (+).

1. Remove both fuses to the ECM.
2. Disconnect the vehicle harness and 5-way power connectors at the ECM. See Figure 35-4.
3. Measure resistance between socket P2 on the engine harness connector and socket B3 of the vehicle harness connector, and between P2 and the 5-way power harness sockets A and C.

   [a] If resistance measurement is greater than 100 Ω, or open, refer to section 35.3.7.

[b] If resistance measurement is less than or equal to 100 Ω, a short exists between sockets where less than 100 Ω resistance was read. Repair short and reinsert fuses. Refer to section 35.3.8.

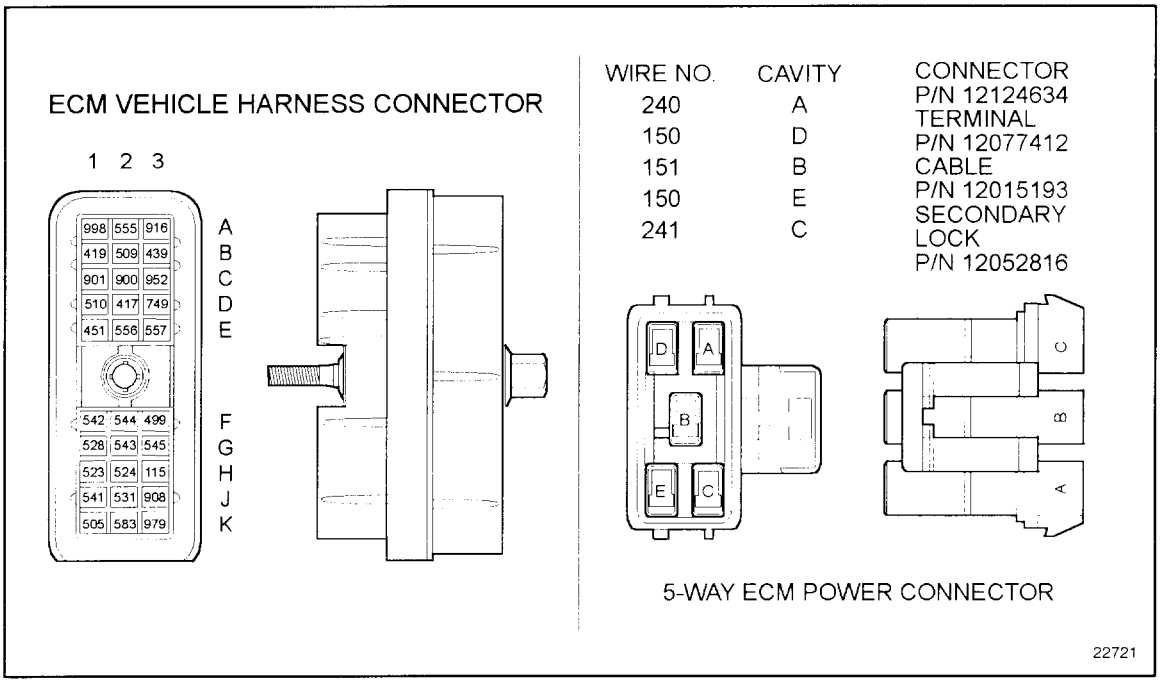

Figure 35-4 ECM Vehicle Harness Connector

35.3.7 Check ECM Connector

Perform the following steps to check the ECM connector:

1. Inspect the terminals at the ECM connector (ECM and harness side) for damage: bent, corroded, and unseated pins or sockets.

   [a] If the terminals and connector are damaged, repair both and refer to section 35.3.8.

   [b] If the terminals and connector are not damaged, refer to section 35.3.4.

35.3.8 Verify Repairs

Perform the following steps to verify repairs:

1. Turn ignition switch OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.

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7. Check codes with DDR.

   [a] If no codes are logged, no further troubleshooting is required.

   [b] If code 100/3 is not logged, but other codes are logged, refer to section 9.1.

   [c] If code 100/3 is logged, all system diagnostics are complete. Contact Detroit Diesel Technical Service.

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36 FLASH CODE 36 - OPS LOW

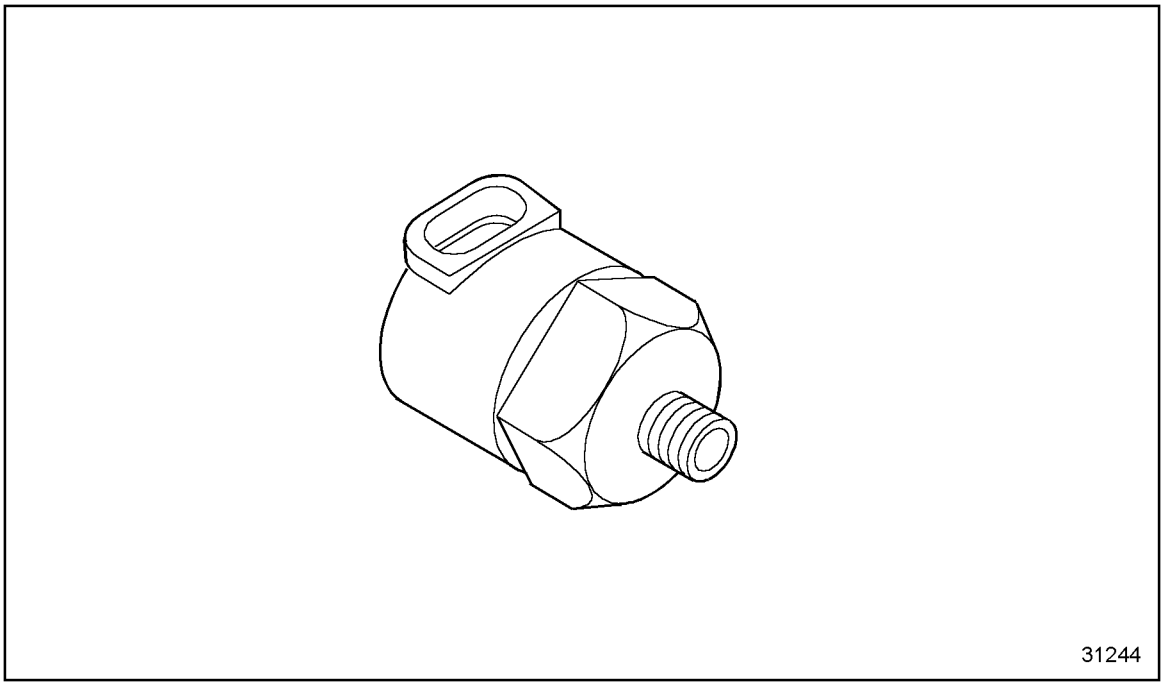

Figure 36-1 Oil Pressure Sensor

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36.1 DESCRIPTION OF FLASH CODE 36

Flash Code 36 indicates that the engine Oil Pressure Sensor (OPS), see Figure 36-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- ☐ Open sensor signal circuit
- ☐ Open sensor +5 volt supply circuit
- ☐ Sensor signal is shorted to sensor return circuit or to ground
- ☐ Sensor +5 volt supply is shorted to the sensor return circuit

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36.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 36

The SAE J1587 equivalent code for Flash Code 36 is p 100 4, oil pressure circuit low.

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36.3 TROUBLESHOOTING FLASH CODE 36

The following procedure will troubleshoot Flash Code 36.

36.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL).
2. Turn vehicle ignition switch ON.
3. Turn vehicle ignition OFF.
4. Read active codes.
   [a] If code 100/4 and no other codes were logged, refer to section 36.3.2.
   [b] If code 100/4 was logged and none of the following codes were logged: 110/3 or 4, 174/3 or 4, 175/3 or 4, 101/3 or 4, 102/3 or 4, 73/3 or 4, 94/3 or 4, 100/3, refer to section 36.3.2.
   [c] If code 100/4 and any of the following codes were logged: 110/3 or 4, 174/3 or 4, 175/3 or 4, 101/3 or 4, 102/3 or 4, 73/3 or 4, 94/3 or 4, 100/3, refer to section 90.1.

36.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition switch OFF.
2. Disconnect OPS connector and install a jumper wire between sockets B and C of the OPS harness connector. See Figure 36-2.
3. Turn ignition ON.
4. Read active codes.
5. If active codes 100/3 or 4 were logged, proceed with the following:
   [a] If active code 100/4 and any other codes were logged, refer to section 36.3.4.
   [b] If code 100/3 and any other codes except 100/4 were logged, refer to section 36.3.3.
6. If active codes 100/3 or 4 were not logged, warm up engine until either codes are logged or the engine temperature (COOLANT TEMP or OIL TEMP or DDR) has been greater than 60°C (140°F) for one minute.
   [a] If active code 100/4 and any other codes were logged, refer to section 36.3.4.

[b] If code 100/3 and any other codes except 100/4 were logged, refer to section 36.3.3.

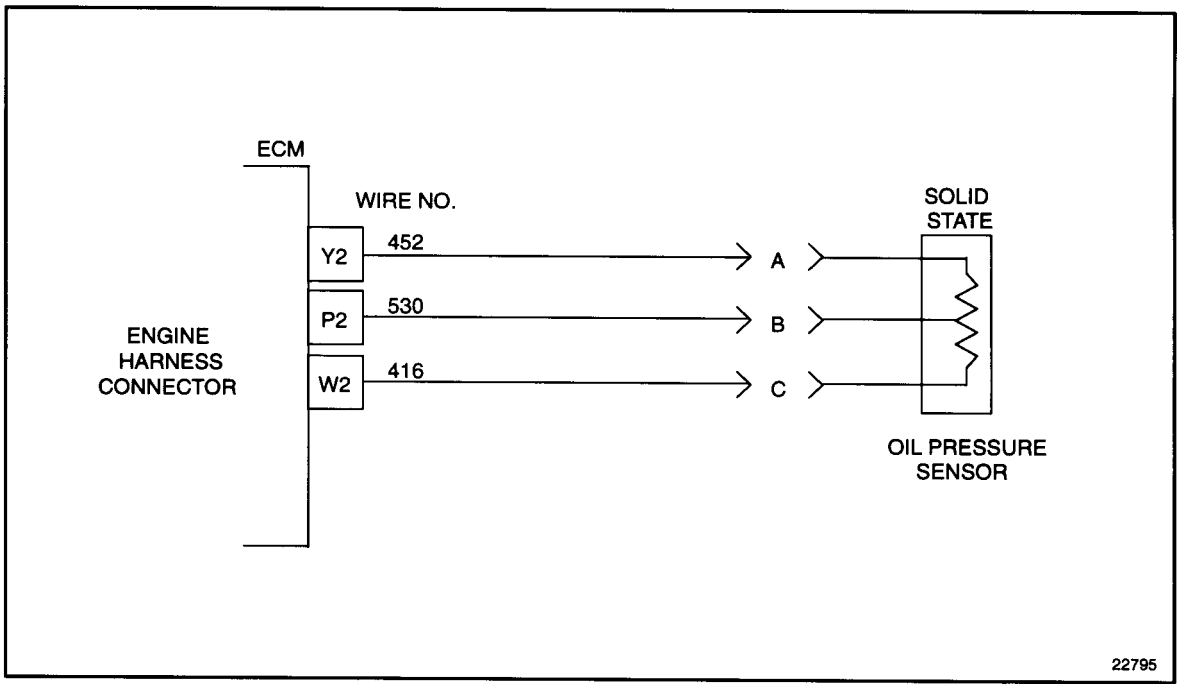

Figure 36-2 Engine Harness Connector to Oil Pressure Sensor

36.3.3 Check Oil Pressure Sensor Connectors

Perform the following steps to check the OPS connectors.

1. Turn ignition OFF.
2. Check terminals at the OPS connectors (both the sensor and harness side) for damage: bent, corroded and unseated pins or sockets.
   [a] If the terminals and connectors are damaged, repair them and refer to section 36.3.12.
   [b] If the terminals and connectors are not damaged, replace the OPS. Refer to section 36.3.12.

36.3.4 Check for +5 Volts

Perform the following steps to check for +5 volts.

1. Turn vehicle ignition OFF.
2. Remove jumper wire.
3. Turn ignition ON.
4. Measure voltage on OPS harness connector, socket C (red lead) to socket A (black lead).
   [a] If the voltage measurement is less than 4 volts, refer to section 36.3.8.
   [b] If the voltage measurement is greater than 6 volts, refer to section 36.3.10.

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[c] If the voltage measurement is between 4 and 6 volts, refer to section 36.3.5.

36.3.5 Check for Signal Open

Perform the following steps to check for signal open.

1. Turn the ignition OFF.
2. Disconnect the engine harness connector at the ECM. See Figure 36-3.
3. Install a jumper wire between sockets A and B of the OPS harness connector.
4. Measure resistance between sockets P2 and Y2 on the engine harness connectors.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 36.3.11.
   [b] If the resistance measurement is greater than 5 Ω or open, the signal line (#530) is open. Repair the open and refer to section 36.3.12.

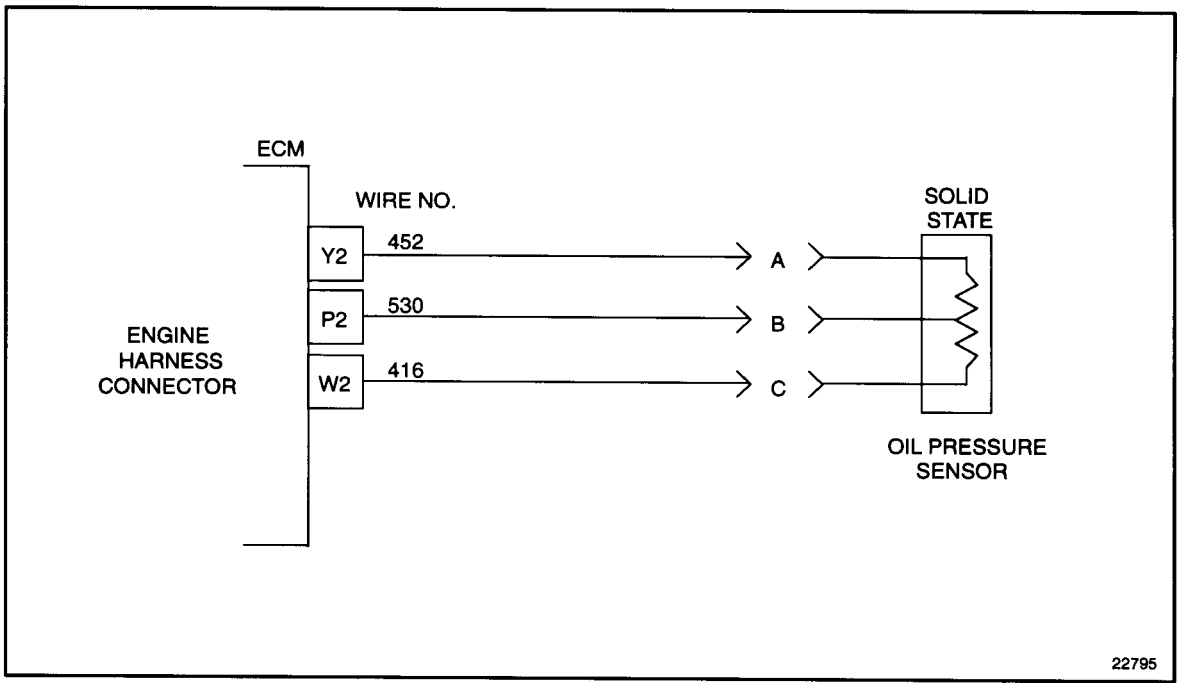

Figure 36-3 Engine Harness Connector to Oil Pressure Sensor

36.3.6 Check for Short

Perform the following steps to check for a short.

1. Remove jumper wire.
2. Measure resistance between socket P2 and a good ground. Also measure resistance between P2 and Y2.
   [a] If both resistance measurements are greater than 100 Ω or open, replace OPS. Refer to section 36.3.12.

[b] If either resistance measurement is less than 100 Ω, the signal line (#530) is shorted to the return line (#452) or battery ground. Repair short and refer to section 36.3.12.

36.3.7 Check ECM Connectors

Perform the following steps to check ECM connectors.

1. Check terminals at the ECM harness connector (both ECM and harness side) for damage: bent, corroded and unseated pins or sockets. Check W1, P2 and Y2 terminals and pins at ECM.
   [a] If the terminals and connectors are damaged, repair them and refer to section 36.3.12.
   [b] If the terminals and connectors are not damaged, reprogram the ECM. Refer to section 36.3.12.

36.3.8 Check for Open +5 Volt Line

Perform the following steps to check for open +5 volt line.

1. Turn ignition OFF.
2. Disconnect the engine harness connectors at the ECM.
3. Install a jumper wire between pins A and C of the OPS connector.
4. Measure resistance between sockets W1 and Y2 on the engine harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 36.3.9.
   [b] If the resistance measurement is greater than 5 Ω or open, the engine +5 volt line (#416) is open. Repair the open and refer to section 36.3.12.

36.3.9 Check for Short

Perform the following steps to check for a short.

1. Remove jumper wire.
2. Measure resistance between sockets A and C on the OPS harness connector. Also measure resistance between socket C and a good ground.
   [a] If either resistance measurement is less than or equal to 100 Ω, the engine +5 volt line (#416) is shorted to the return line (#452) or battery ground. Repair the short and refer to section 36.3.12.
   [b] If the resistance measurement is greater than 100 Ω or open, replace OPS and refer to section 36.3.12.

36.3.10 Check for Short to Battery +

Perform the following steps to check for a short to battery.

1. Remove both fuses to the ECM.

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2. Disconnect the vehicle harness and 5-way power connectors at the ECM. See Figure 36-4.
3. Measure resistance between socket W1 on the engine harness connector and socket B3 of the vehicle harness connector, and between W1 and the 5-way power harness sockets A and C.

   [a] If resistance measurement is greater than 100 Ω, or open, replace OPS. Refer to section 36.3.12.

   [b] If resistance measurement is less than or equal to 100 Ω, a short exists between sockets where less than 100 Ω resistance was read. Repair short and reinsert fuses. Refer to section 36.3.12.

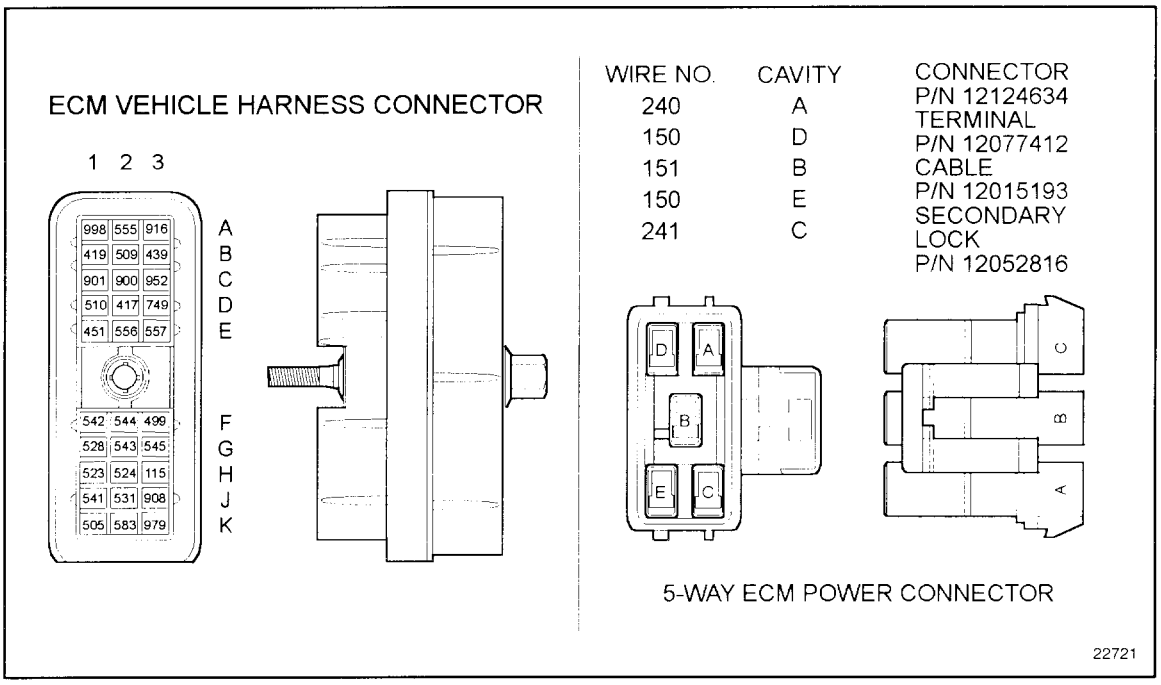

Figure 36-4 ECM Vehicle Harness Connector

36.3.11 Check for Short to Ground

Perform the following steps to check for a short to ground.

1. Turn vehicle ignition OFF.
2. Remove jumper wire.
3. Measure resistance between sockets P2 and Y2 on the engine harness connector. See Figure 36-5.

   [a] If resistance measurement is greater than 100 Ω, or open, refer to section 36.3.6.

[b] If resistance measurement is less than or equal to 100 Ω, the signal line (#530) and return line (#452) are shorted together. Repair the short. Refer to section 36.3.12.

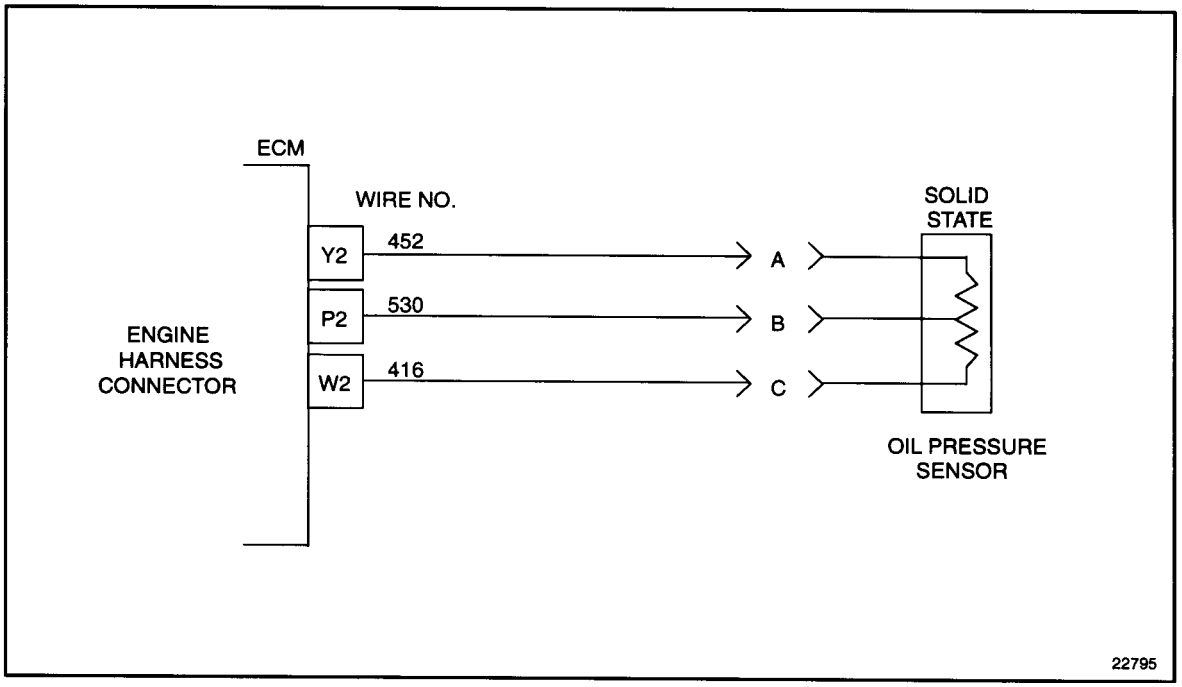

Figure 36-5 Engine Harness Connector to Oil Pressure Sensor

36.3.12 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition switch OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 100/4 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 100/4 is logged, and other codes are logged, all system diagnostics are complete. Please review this section from the first step to find the error. Refer to section 36.3.1.

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37 FLASH CODE 37 - FPS HIGH

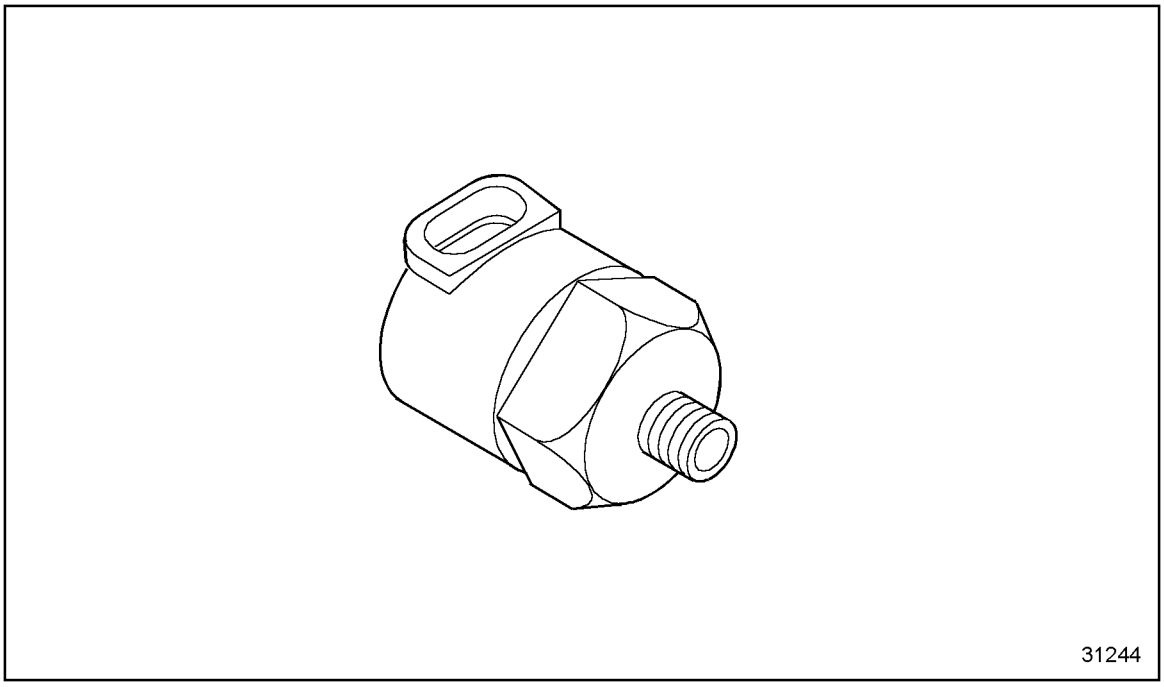

Figure 37-1 Fuel Pressure Sensor

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37.1 DESCRIPTION OF FLASH CODE 37

Flash Code 37 indicates that the engine Fuel Pressure Sensor (FPS), see Figure 37-1, input to the ECM has exceeded 95% (normally >4.75 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- Open sensor return circuit
- Sensor signal circuit is shorted to the sensor +5 volt supply

NOTE:
Require fuel pressure >60 psi.

37.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 37

The SAE J1587 equivalent code for Flash Code 37 is p 094 3.

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37.3 TROUBLESHOOTING FLASH CODE 37

The following procedure will troubleshoot Flash Code 37.

37.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn ignition ON.
2. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL).
3. Read active codes.
   [a] If active code 94/3 was logged, and no other codes were logged, refer to section 37.3.2.
   [b] If active code 94/3 and any or all of the following codes were logged, 110/3 or 4, 174/3 or 4, 175/3 or 4, 101/3 or 4, 102/3 or 4, 100/3 or 4, 94/4, 73/3 or 4, refer to section 90.1.

37.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition switch OFF.
2. Disconnect FPS connector. See Figure 37-2.
3. Turn ignition ON.
4. Start and run engine.
5. Select Engine Temperature (COOLANT TEMP & OIL) on DDR.
6. Warm up engine until engine temperature reading is greater than 60°C (140°F).
7. Leave engine running at idle after warm-up. Run for five minutes.
8. Read active codes.
   [a] If active code 94/3 and any other codes were logged, refer to section 37.3.5.

[b] If active code 94/4 and any other codes except 94/3 were logged, refer to section 37.3.3.

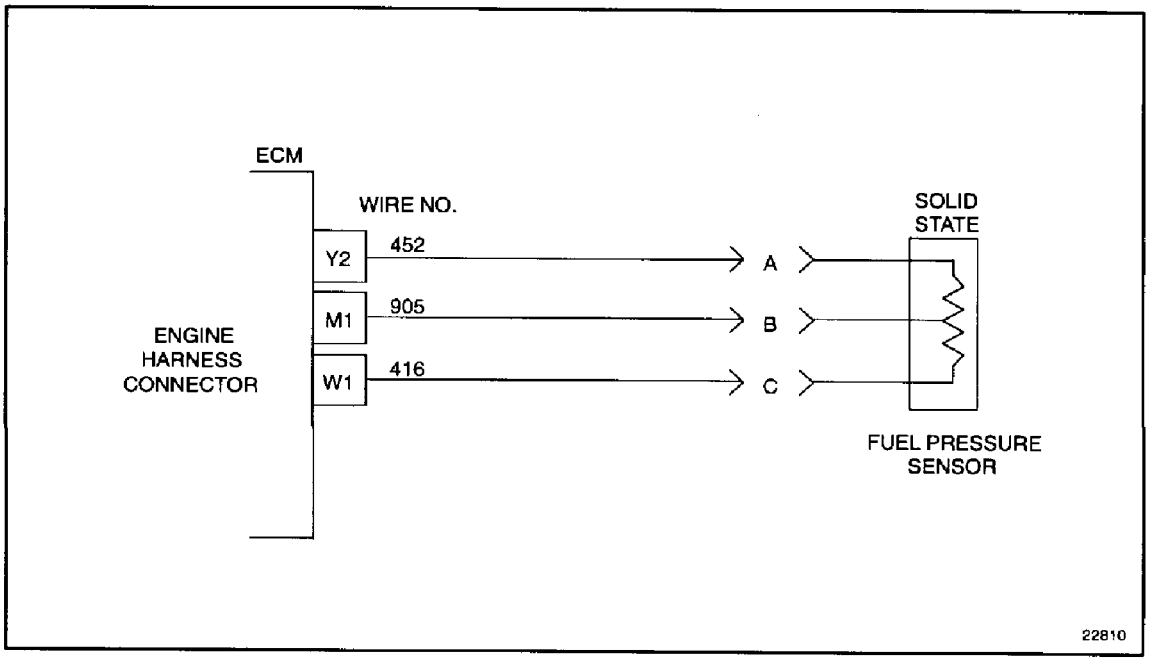

Figure 37-2 Engine Harness Connector to Fuel Pressure Sensor

37.3.3 Return Circuit Check

Perform the following steps to check the return circuit.

1. Turn vehicle ignition OFF.
2. Disconnect the engine harness connector at the ECM.
3. Install a jumper wire between pins A and B of the FPS harness connector.
4. Measure resistance between sockets M1 and Y2 on the engine harness connectors.
   [a] If resistance measurement is less than or equal to 5 Ω, refer to section 37.3.4.
   [b] If resistance measurement is greater than 5 Ω, or open, the return line (#452) is open. Repair the open and refer to section 37.3.9.

37.3.4 Check Fuel Pressure Sensor Connectors

Perform the following steps to check the FPS connectors.

1. Inspect terminals at the FPS connectors (both the sensor and harness side) for damage: bent, corroded, and unseated pins or sockets.
   [a] If the terminals and connectors are damaged, repair them and refer to section 37.3.9.

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[b] If the terminals and connectors are not damaged, replace the FPS and refer to section 37.3.9.

37.3.5 Check for Short

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Disconnect the engine harness connectors at the ECM.
3. Measure resistance between sockets W1 and M1 on the engine harness connector.
   [a] If the resistance measurement is greater than 100 Ω or open, refer to section 37.3.6.
   [b] If the resistance measurement is less than or equal to 100 Ω, the signal line (#905) is shorted to the engine +5 volt line (#416). Repair the short and refer to section 37.3.9.

37.3.6 Check for Short to Battery +

Perform the following steps to check for a short to battery.

1. Remove both fuses to the ECM.
2. Disconnect the vehicle harness and 5-way power connectors at the ECM. See Figure 37-3.
3. Measure resistance between socket M1 on the engine harness connector and socket B3 of the vehicle harness connector, and between M1 and the 5-way power harness sockets A and C.
   [a] If the resistance measurement is greater than 1,000 Ω or open, refer to section 37.3.8.

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[b] If the resistance measurement is less than or equal to 1,000 Ω, a short exists between sockets where less than 1,000 Ω was measured. Repair short and reinsert fuses. Refer to section 37.3.9.

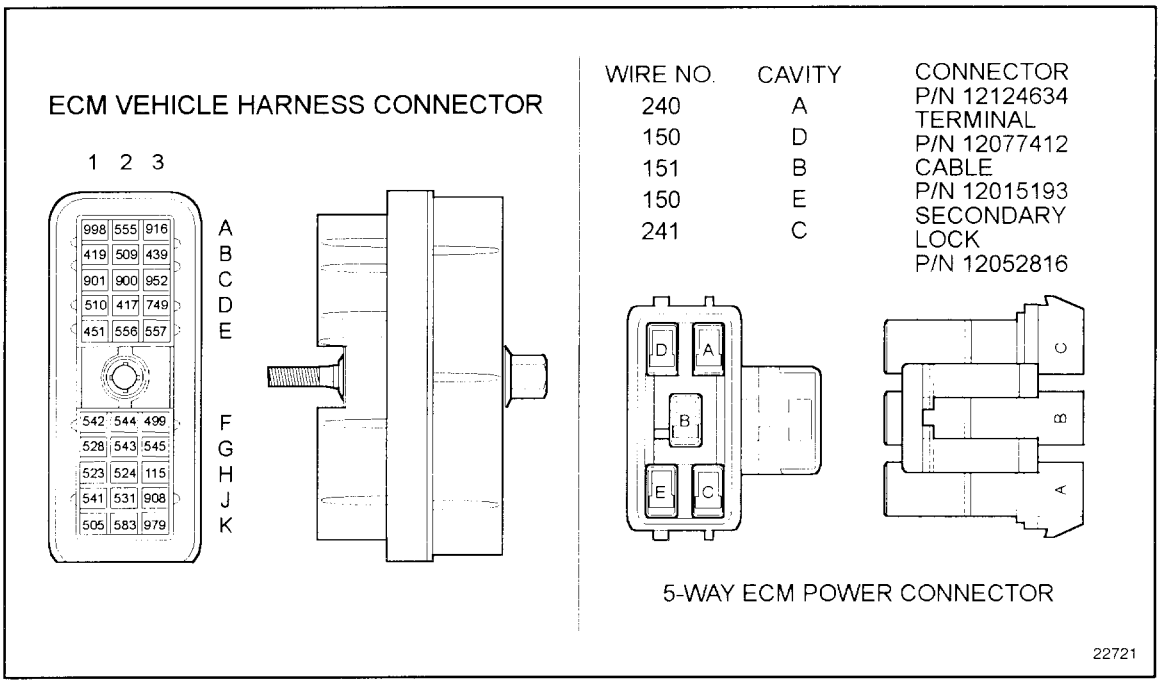

Figure 37-3 ECM Vehicle Harness Connector

37.3.7 Final Check

Perform the following steps to do a final check.

1. Reconnect all connectors.
2. Turn vehicle ignition ON.
3. Clear codes.
4. Start and run the engine for one minute.
5. Stop engine.
6. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If active code 94/3 is logged, reprogram the ECM. Refer to section 37.3.9.
   [c] If any codes except code 94/3 are logged, refer to section 9.1.

37.3.8 Check ECM Connector

Perform the following steps to check the ECM connector.

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1. Inspect terminals at the ECM connector (both the ECM and harness side) for damage: bent, corroded, and unseated pins or sockets.
   [a] If terminals and connectors are damaged, repair them. Refer to section 37.3.9.
   [b] If terminals and connectors are not damaged, replace the FPS. Refer to section 37.3.7.

37.3.9 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition switch OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, no further troubleshooting is required.
   [b] If code 94/3 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 94/3 is logged, and other codes are logged, all system diagnostics are complete. Please review this section from the first step to find the error. Refer to section 37.3.1.

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38 FLASH CODE 38 - FPS LOW

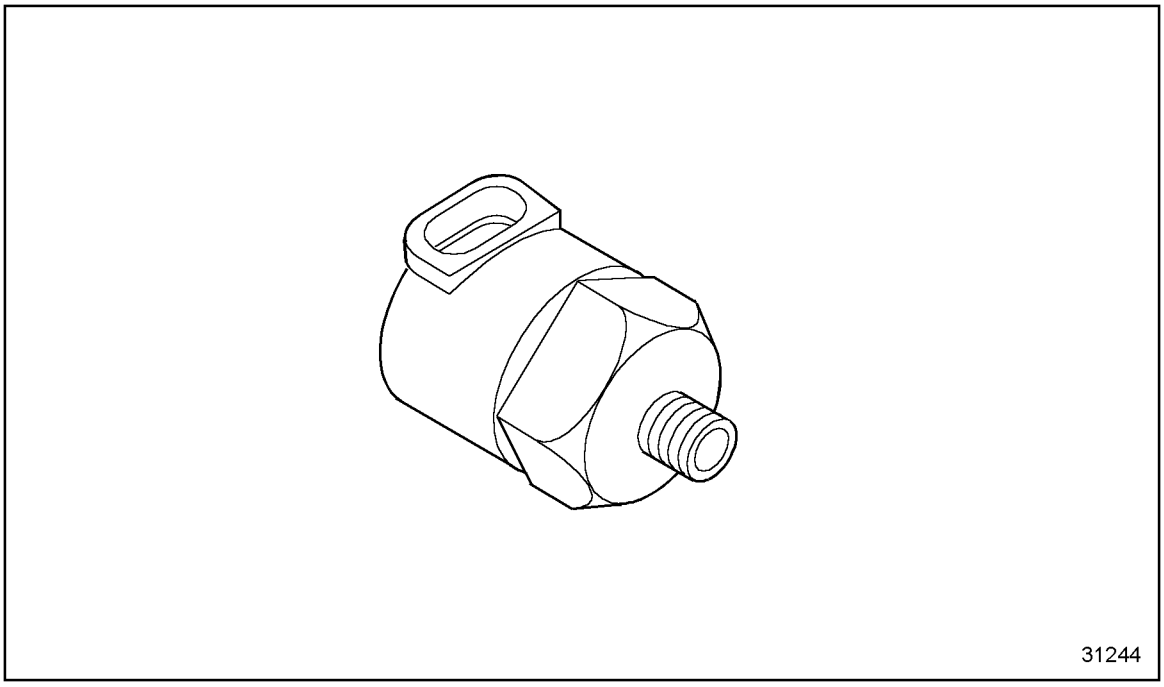

Figure 38-1 Fuel Pressure Sensor

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38.1 DESCRIPTION OF FLASH CODE 38

Flash Code 38 indicates that the engine Fuel Pressure Sensor (FPS), see Figure 38-1, input to the ECM has dropped below 5% (normally < 0.25 volts) of the sensor supply voltage.

This diagnostic condition is typically:

- ☐ Open sensor signal circuit
- ☐ Open sensor +5 volt supply circuit
- ☐ Sensor signal is shorted to sensor return circuit or to ground
- ☐ Sensor +5 volt supply is shorted to the sensor return circuit

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38.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 38

The SAE J1587 equivalent code for Flash Code 38 is p 094 4.

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38.3 TROUBLESHOOTING FLASH CODE 38

The following procedure will troubleshoot Flash Code 38.

38.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug the diagnostic data reader (DDR) into the diagnostic data link (DDL).
3. Read active codes.
   [a] If active code 94/4 and no other codes were logged, refer to section 38.3.2.
   [b] If active code 94/4 and any or all of the following codes were logged, 94/3, 100/3 or 4, 101/3 or 4, 110/3 or 4, 174/3 or 4, 175/3 or 4, refer to section 90.1.
   [c] If active code 94/4 and codes other than the following codes were logged, 94/3, 100/3 or 4, 101/3 or 4, 110/3 or 4, 174/3 or 4, 175/3 or 4, refer to section 38.3.2.

38.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition switch OFF.
2. Disconnect FPS connector and install a jumper wire between sockets B and C of the FPS harness connector. See Figure 38-2.
3. Turn ignition ON.
4. Read logged codes.
5. If active codes 94/3 or 4 are not logged, start and run the engine until either these active codes display or engine temperature (COOLANT TEMP & OIL on DDR) has been greater than 60°C (140°F) for more than one minute.
   [a] If active code 94/4 and any other codes are logged, refer to section 38.3.4.

[b] If active code 94/3 and any other codes except code 94/4 are logged, check to ensure ECM and FPS connectors are wired properly. Refer to section 38.3.3.

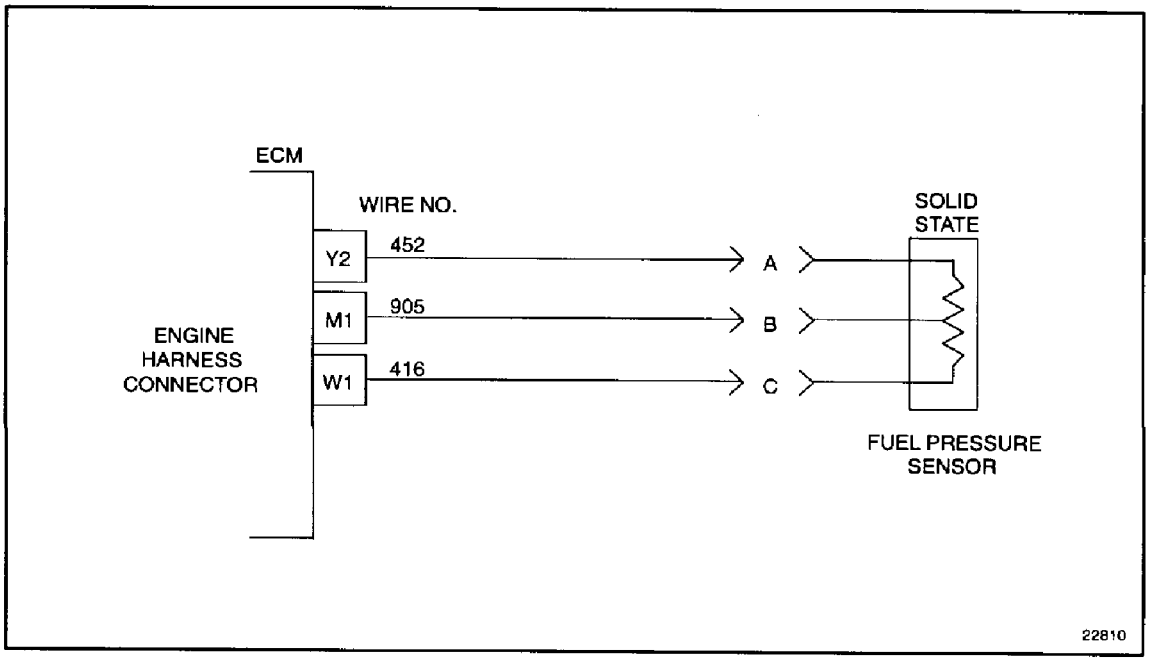

Figure 38-2 Engine Harness Connector to Fuel Pressure Sensor

38.3.3 Check Fuel Pressure Sensor Connectors

Perform the following steps to check the FPS connectors.

1. Inspect terminals at the FPS connectors (both the sensor and harness side) for damage: bent, corroded, and unseated pins or sockets.
   [a] If the terminals and connectors are damaged, repair them and refer to section 38.3.12.
   [b] If the terminals and connectors are not damaged, replace the FPS and refer to section 38.3.12.

38.3.4 Check for +5 Volts

Perform the following steps to check for +5 volts.

1. Turn vehicle ignition OFF.
2. Remove jumper wire.
3. Turn ignition ON.
4. Measure voltage on FPS harness connector, socket C to socket A. See Figure 38-3.
   [a] If the voltage measurement is greater than 6 volts, refer to section 38.3.9.
   [b] If the voltage measurement is less than 4 volts, refer to section 38.3.7.

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[c] If the voltage measurement is between 4 and 6 volts, refer to section 38.3.5.

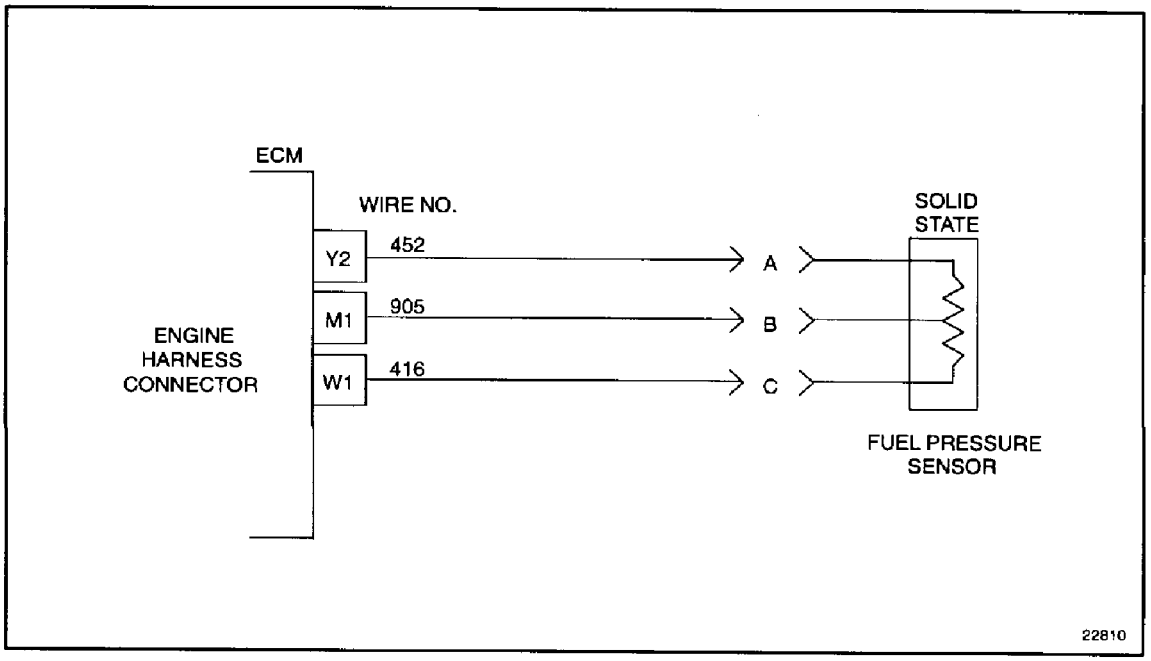

Figure 38-3 Engine Harness Connector to Fuel Pressure Sensor

38.3.5 Check for Signal Open

Perform the following steps to check for signal open.

1. Turn vehicle ignition OFF.
2. Disconnect engine harness connector at the ECM.
3. Install a jumper wire between pins A and B of the FPS harness connector.
4. Measure resistance between sockets M1 and Y2 on the engine harness connector.
   [a] If resistance measurement is less than or equal to 5 Ω refer to section 38.3.10.
   [b] If the resistance measurement is greater than 5 Ω or open, the signal line (#905) or return line (#452) is open. Repair the open and refer to section 38.3.12.

38.3.6 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM harness connector (both ECM and harness side) for damage: bent, corroded, and unseated pins or sockets. Check W1, M1 and Y2 terminals at ECM.
   [a] If terminals and connectors are damaged, repair them. Refer to section 38.3.12.
   [b] If terminals and connectors are not damaged, install a test ECM. Refer to section 38.3.12.

38.3.7 Check for Open +5 Volt Line

Perform the following steps to check for open +5 volt line.

1. Turn vehicle ignition OFF.
2. Disconnect the engine harness connectors at the ECM.
3. Install a jumper wire between sockets A and C of the FPS harness connector. See Figure 38-4.
4. Measure resistance between sockets W1 and Y2 on the engine harness connector.
   [a] If resistance measurement is less than or equal to 5 Ω refer to section 38.3.8.
   [b] If the resistance measurement is greater than 5 Ω or open, the engine +5 volt line (#416) is open. Repair the open and refer to section 38.3.12.

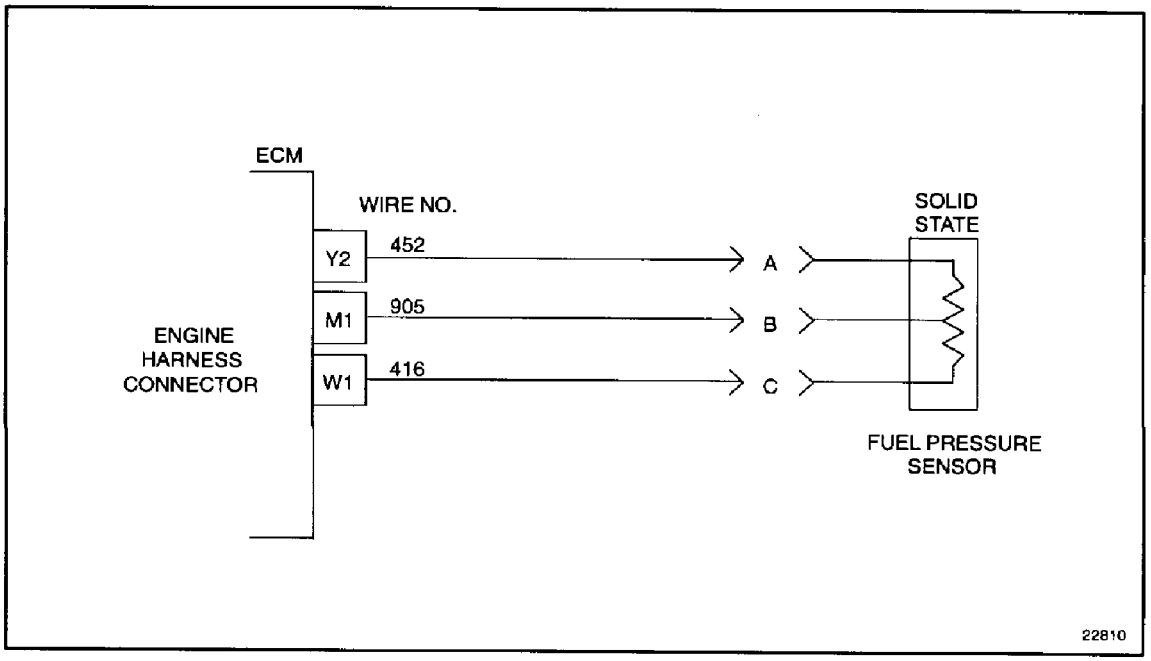

Figure 38-4 Engine Harness Connector to Fuel Pressure Sensor

38.3.8 Check for Short

Perform the following steps to check for a short.

1. Remove jumper wire.
2. Measure resistance between sockets A and C of the FPS harness connector.
   [a] If the resistance measurement is greater than 100 Ω or open, refer to section 38.3.11.
   [b] If the resistance measurement is less than or equal to 100 Ω, the return line (#452) is shorted to the engine +5 volt line (#416). Repair the short and refer to section 38.3.12.

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38.3.9 Check for Short to Battery +

Perform the following steps to check for a short to battery.

1. Remove both fuses to the ECM.
2. Disconnect the vehicle harness and 5-way power connectors at the ECM. See Figure 38-5.
3. Measure resistance between socket W1 on the engine harness connector and socket B3 of the vehicle harness connector, and between W1 and the 5-way power harness sockets A and C.

   [a] If the resistance measurement is greater than 1,000 Ω or open, refer to section 38.3.11.

   [b] If the resistance measurement is less than or equal to 1,000 Ω, a short exists between sockets where less than 1,000 Ω was measured. Repair short and reinsert fuses. Refer to section 38.3.12.

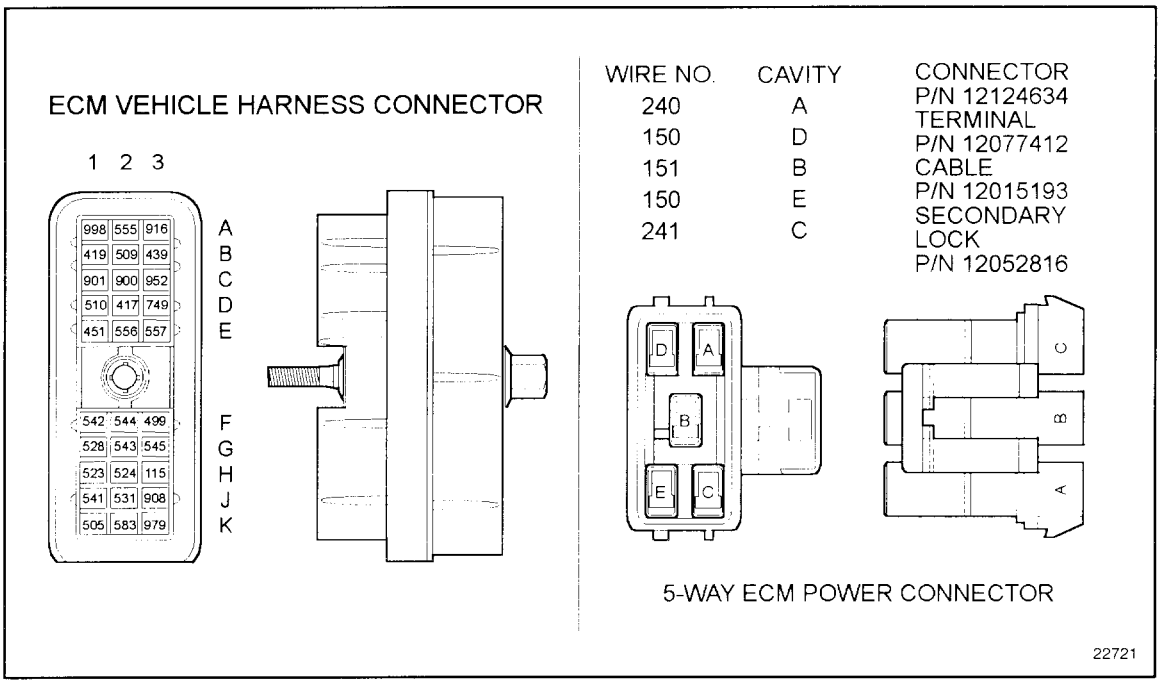

Figure 38-5 ECM Vehicle Harness Connector

38.3.10 Check for Short to Ground

Perform the following steps to check for a short to ground.

1. Turn ignition switch OFF.
2. Remove jumper wires.
3. Measure resistance between sockets M1 and Y2 on the engine harness connector. Also measure resistance between socket M1 and a good ground.

[a] If both resistance measurements are greater than 100 Ω or open, refer to section 38.3.11.

[b] If either resistance measurement is less than or equal to 100 Ω, the signal line (#905) and return line (#452) are shorted together, or the signal line (#905) is shorted to battery ground. Repair the short. Refer to section 38.3.12.

38.3.11 Replace Fuel Pressure Sensor

Perform the following steps to replace the FPS.

1. Turn ignition switch OFF.
2. Replace FPS.
3. Reconnect all connectors.
4. Turn ignition ON.
5. Clear codes.
6. Start and run the engine for one minute.
   [a] If check engine light comes on, refer to section 38.3.6.
   [b] If check engine light does not come on, refer to section 38.3.12.

38.3.12 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition switch OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 94/4 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 94/4 is logged, and other codes are logged, all system diagnostics are complete. Please review this section from the first step to find the error. Refer to section 38.3.1.

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39 FLASH CODE 39

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39.1 DESCRIPTION OF FLASH CODE 39

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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40 FLASH CODE 40

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40.1 DESCRIPTION OF FLASH CODE 40

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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41 (CHG) FLASH CODE 41 - TOO MANY SRS

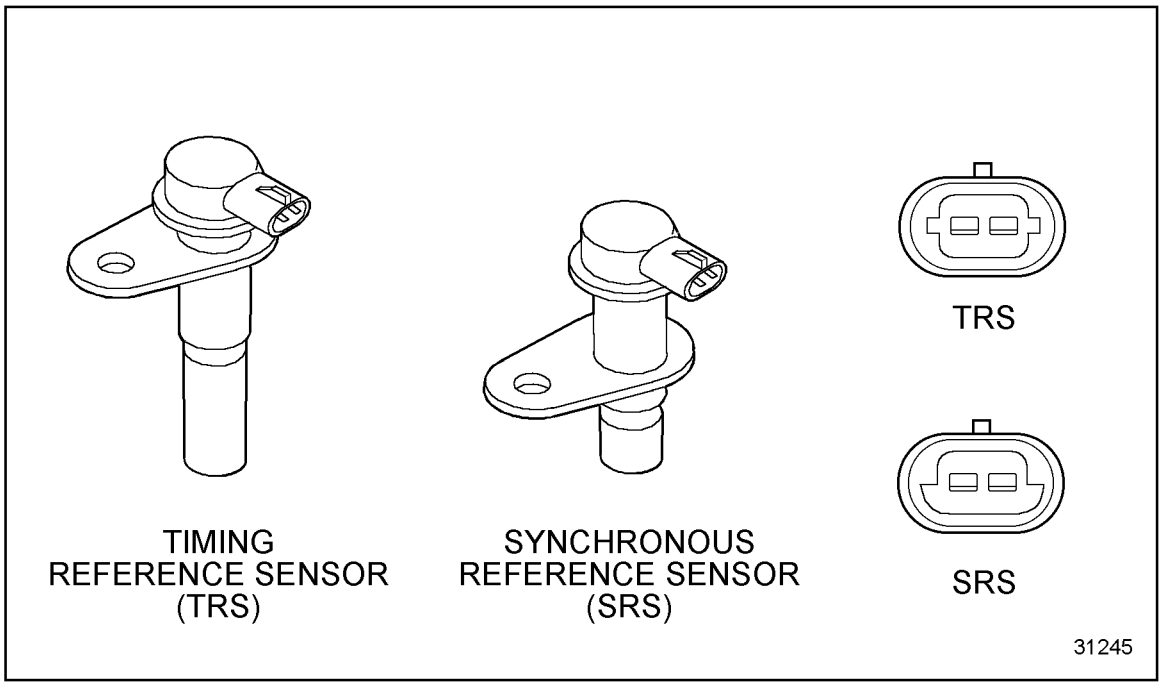

Figure 41-1 Synchronous Reference Sensor and Timing Reference Sensor

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41.1 DESCRIPTION OF FLASH CODE 41

Flash Code 41 indicates that the ECM has detected extra Synchronous Reference Sensor pulses, or the ECM has detected missing Timing Reference Sensor pulses, see Figure 41-1.

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41.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 41

The SAE J1587 equivalent code for Flash Code 41 is s 021 0.

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41.3 TROUBLESHOOTING FLASH CODE 41

The following procedure will troubleshoot Flash Code 41.

41.3.1 Check for Signal Open

Perform the following steps to check for signal open.

1. Turn ignition OFF.
2. Disconnect engine harness connector at the ECM. See Figure 41-2.
3. Read resistance between sockets T1 and T2 on the engine harness connector.
   [a] If the resistance reading is less than or equal to 200 Ω, refer to section 41.3.2.
   [b] If the resistance reading is greater than 200 Ω or open, refer to section 41.3.3.

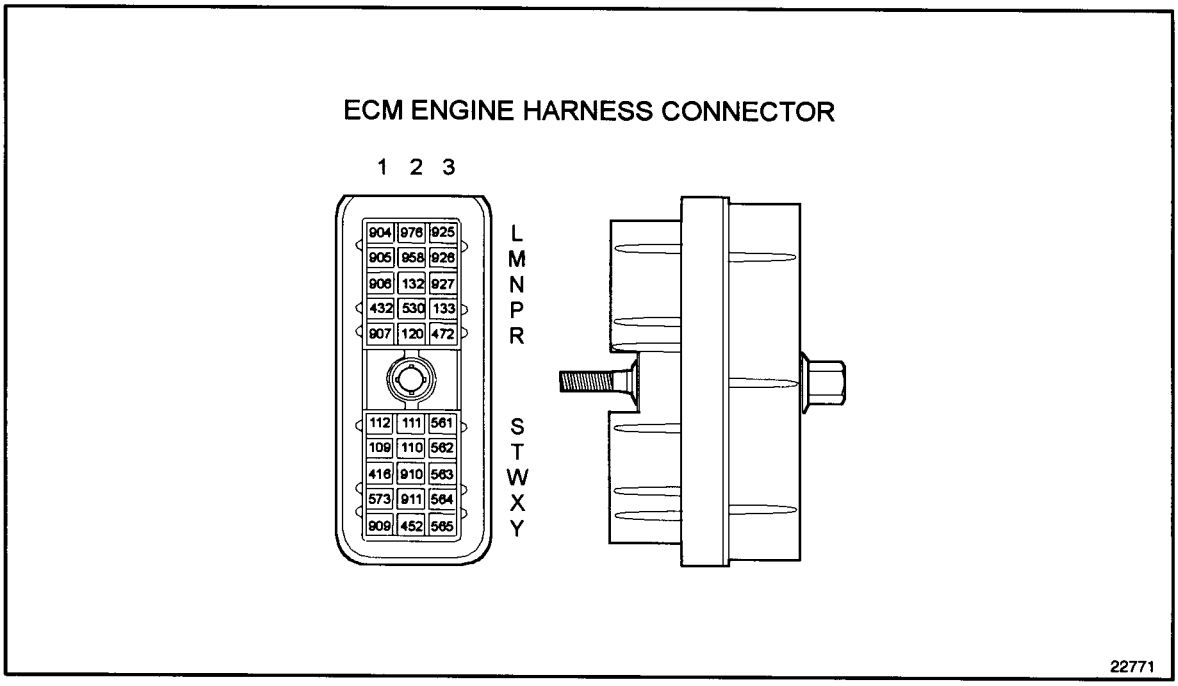

Figure 41-2 Engine Harness Connector

41.3.2 Check for Short

Perform the following steps to check for a short.

1. Disconnect the TRS connector.
2. Measure resistance between sockets T1 and T2 on the engine harness connector. See Figure 41-3.
3. Measure resistance between socket T1 and ground, and between socket T2 and ground.
   [a] If the resistance measurement is greater than 10,000 Ω or open, refer to section 41.3.4.

[b] If the resistance measurement is less than or equal to 10,000 Ω, a short exists between #110 and #109 or where less than 10,000 Ω resistance was read. Repair the short. Refer to section 41.3.15.

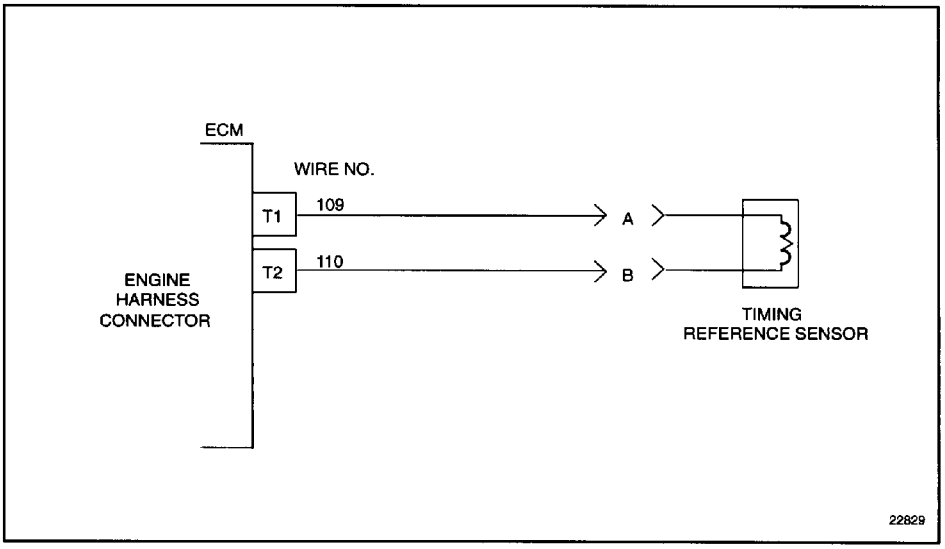

Figure 41-3 Engine Harness Connector to Timing Reference Sensor

41.3.3 Open Timing Reference Sensor Line Check

Perform the following steps to check the open TRS line.

1. Disconnect the TRS connector.
2. Install a jumper wire between sockets A and B of the TRS harness connector.
3. Measure resistance between sockets T1 and T2 on the engine harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 41.3.4.
   [b] If the resistance measurement is greater than 5 Ω, or open, the signal line #110 or return line #109 is open. Repair the open. Refer to section 41.3.15.

41.3.4 Check Timing Reference Sensor Resistance

Perform the following steps to check TRS resistance.

1. Measure resistance of TRS across sensor connector pins A and B. See Figure 41-4.
   [a] If the resistance measurement is greater than 200 Ω, refer to section 41.3.12.
   [b] If the resistance measurement is less than 100 Ω, refer to section 41.3.12.

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[c] If the resistance measurement is between 100 and 200 Ω, refer to section 41.3.5.

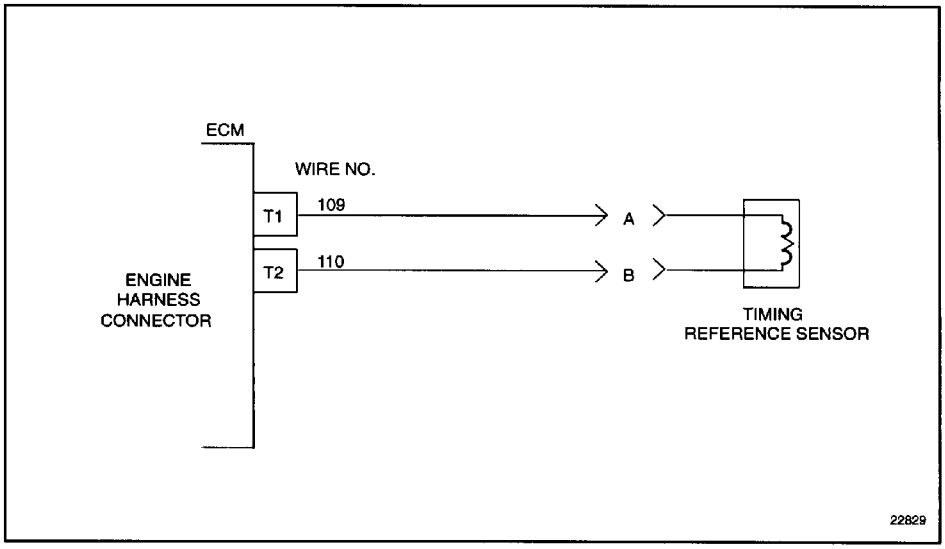

Figure 41-4 Engine Harness Connector to Timing Reference Sensor

41.3.5 Check Timing Reference Sensor / Synchronous Reference Sensor Gap

Perform the following steps to check the TRS/SRS gap.

1. Bar the engine until the TRS is over a TRS tooth of the pulse wheel.
2. Check the gap between TRS and the tooth of the pulse wheel (0.020 to 0.040 in.). A depth micrometer can be used.
   [a] If the gap setting is correct, refer to section 41.3.6.
   [b] If the gap setting is not correct, adjust the TRS/SRS until the gap setting is correct. If the problem returns, the pulse wheel may be loose or bad or damaged. Refer to section 41.3.15.

41.3.6 Synchronous Reference Sensor Code Check

Perform the following steps to check for SRS code.

1. Check for SRS code.
   [a] If code 21/1 is not logged, refer to section 41.3.7.
   [b] If code 21/1 is logged, refer to section 41.3.8.

41.3.7 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connectors (both the ECM and harness side) for damage: bent, corroded, and unseated pins or sockets.
   [a] If terminals and connectors are damaged, repair them. Refer to section 41.3.15.
   [b] If terminals and connectors are not damaged, install a test ECM. Refer to section 41.3.15.

41.3.8 Synchronous Reference Sensor Resistance Check

Perform the following steps to check SRS resistance.

1. Measure resistance between sockets S1 and S2 on the engine harness connector. See Figure 41-5.
   [a] If measured resistance is greater than 200 Ω , or open, refer to section 41.3.10.
   [b] If measured resistance is less than 200 Ω , or open, refer to section 41.3.9.

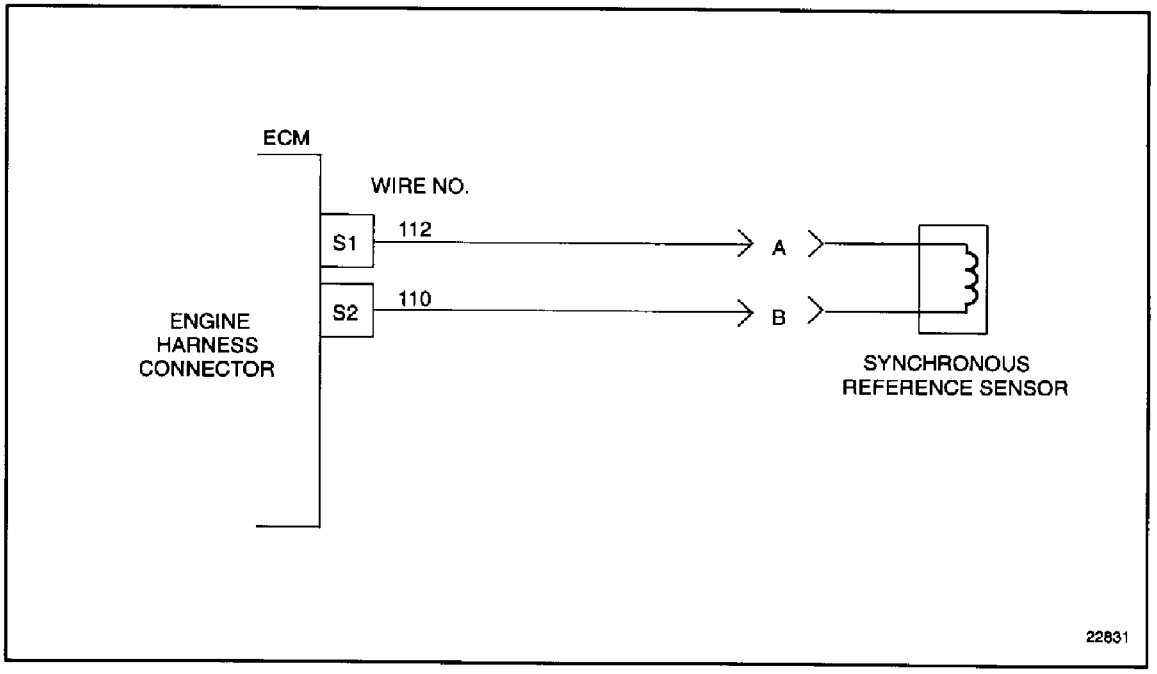

Figure 41-5 Engine Harness Connector to Synchronous Reference Sensor

41.3.9 Check for Short

Perform the following steps to check for a short.

1. Disconnect the SRS connector.
2. Measure resistance between sockets S1 and S2 on the engine harness connector.
   [a] If measured resistance is greater than 10,000 Ω, or open, refer to section 41.3.11.

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[b] If measured resistance is less than or equal to 10,000 Ω, the signal line #111 is shorted to the return line #112. Repair the short. Refer to section 41.3.15.

41.3.10 Open Synchronous Reference Sensor Line Check

Perform the following steps to check for an open SRS line.

1. Disconnect the SRS connector.
2. Install a jumper wire between sockets A and B of the SRS harness connectors.
3. Measure resistance between sockets S1 and S2 on the engine harness connector.
   [a] If measured resistance is less than or equal to 5 Ω, refer to section 41.3.11.
   [b] If measured resistance is greater than 5 Ω, or open, the signal line #111 or return line #112 is open. Repair the open and refer to section 41.3.15.

41.3.11 Synchronous Reference Sensor Test

Perform the following steps to test the SRS.

1. Measure resistance of SRS across the sensor connector pins A and B.
   [a] If measured resistance is less than or equal to 100 Ω, refer to section 41.3.13.
   [b] If measured resistance is greater than 200 Ω, refer to section 41.3.13.
   [c] If measured resistance is between 100 and 200 Ω, refer to section 41.3.7.

41.3.12 Check Timing Reference Sensor Connectors

Perform the following steps to check TRS connectors.

1. Check terminals at the TRS (both the TRS and harness side) for damage: bent, corroded, and unseated pins or sockets. See Figure 41-6.
   [a] If terminals and connectors are damaged, repair them. Refer to section 41.3.15.

[b] If terminals and connectors are not damaged, replace the TRS. Refer to section 41.3.14.

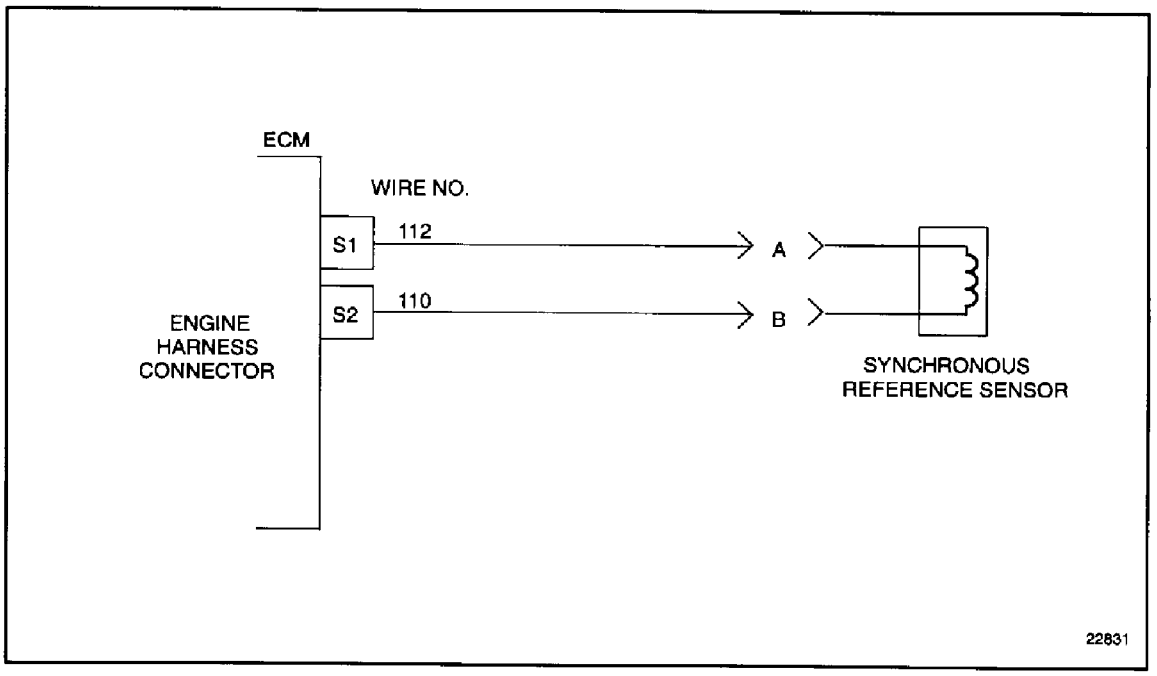

Figure 41-6 Engine Harness Connector to Synchronous Reference Sensor

41.3.13 Check Synchronous Reference Sensor Connectors

Perform the following steps to check the SRS connectors.

1. Check terminals at the SRS (both the SRS and harness side) for damage: bent, corroded, and unseated pins or sockets, or bad contacts.
   [a] If terminals and connectors are damaged, repair them. Refer to section 41.3.15.
   [b] If terminals and connectors are not damaged, replace the SRS. Refer to section 41.3.14.

41.3.14 Verify Synchronous Reference Sensor / Timing Reference Sensor

Perform the following steps to verify operation of the SRS/TRS.

1. Reconnect all connectors.
2. Turn vehicle ignition ON.
3. Clear codes.
4. Start and run the engine for one minute.
5. Stop engine.
6. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.

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[b] If code 21/0 and any other codes are logged, and the SRS was not replaced, refer to section 41.3.6.

[c] If any codes except code 21/0 are logged, refer to section 9.1.

41.3.15 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn vehicle ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.

   [a] If no codes are logged, troubleshooting is complete.

   [b] If code 21/0 and any other codes are logged, all system diagnostics are complete. Review this section to find the error. Refer to section 41.3.1 or contact Detroit Diesel Technical Service.

   [c] If any codes except code 21/0 are logged, refer to section 9.1.

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42 (CHG) FLASH CODE 42 - TOO FEW SRS

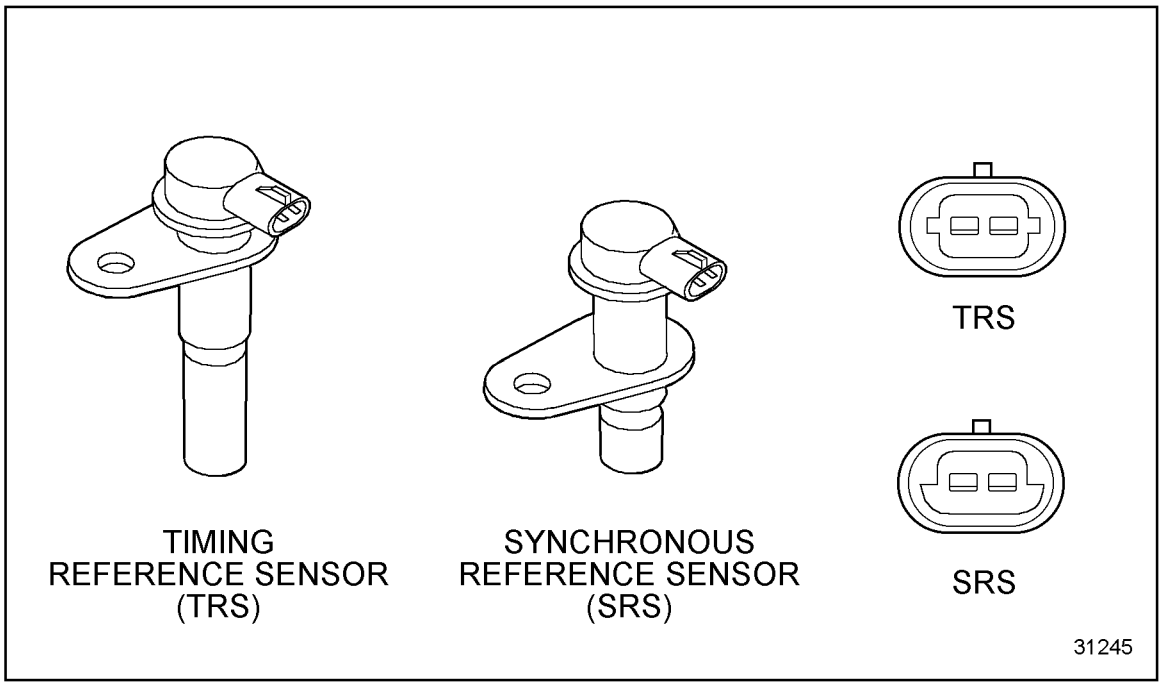

Figure 42-1 Synchronous Reference Sensor and Timing Reference Sensor

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42.1 DESCRIPTION OF FLASH CODE 42

Flash Code 42 indicates that the ECM has detected missing Synchronous Reference Sensor (SRS) pulses, or the ECM has detected extra Timing Reference Sensor (TRS) pulses, see Figure 42-1.

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42.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 42

The SAE J1587 equivalent code for Flash Code 42 is s 021 1.

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42.3 TROUBLESHOOTING FLASH CODE 42

The following procedure will troubleshoot Flash Code 42.

42.3.1 Resistance Check

Perform the following steps to check resistance.

1. Turn vehicle ignition OFF.
2. Disconnect engine harness connector at ECM.
3. Measure resistance between sockets S1 and S2 on the engine harness connector. See Figure 42-2.
   [a] If the resistance measurement is less than or equal to 200 Ω, refer to section 42.3.2.
   [b] If the resistance measurement is greater than 200 Ω or open, refer to section 42.3.3.

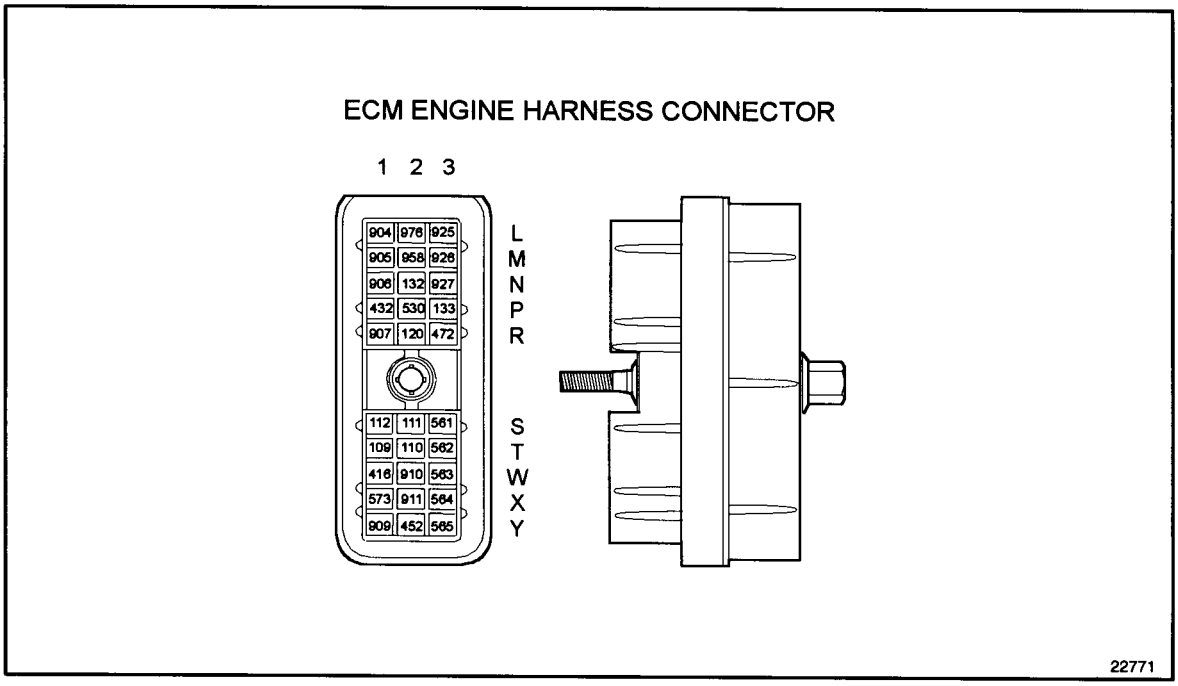

Figure 42-2 ECM Engine Harness Connector

42.3.2 Check for Short

Perform the following steps to check for a short.

1. Disconnect the SRS Connector.
2. Measure resistance between sockets S1 and S2 on the engine harness connector. See Figure 42-3.
3. Measure resistance between socket S1 and ground, and between socket S2 and ground.

[a] If the resistance measurement is less than or equal to 10,000 Ω, a short exists. Repair the short. Refer to section 42.3.16.

[b] If the resistance measurement is greater than 10,000 Ω, or open, refer to section 42.3.4.

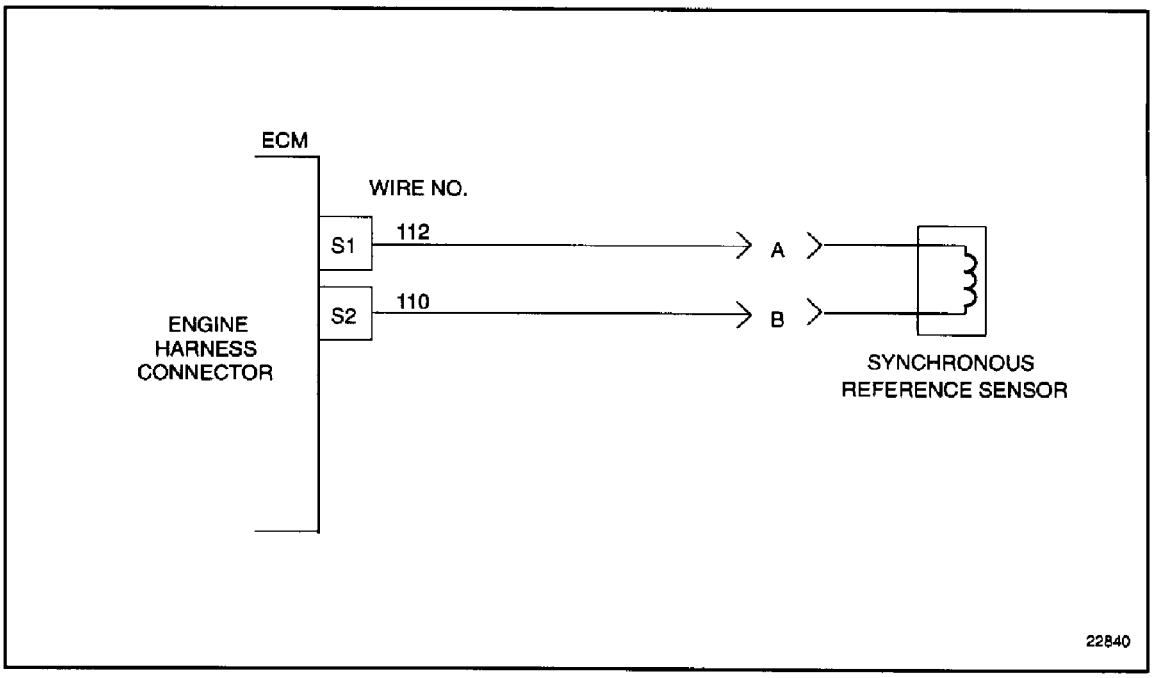

Figure 42-3 Engine Harness Connector to Synchronous Reference Sensor

42.3.3 Open Synchronous Reference Sensor Line Check

Perform the following steps to check for an open SRS line.

1. Disconnect the SRS connector.
2. Install a jumper wire between sockets A and B of the SRS harness connector. See Figure 42-4.
3. Measure resistance between sockets S1 and S2 on the engine harness connector.

   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 42.3.4.

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[b] If the resistance measurement is greater than 5 Ω or open, the signal line (#111) or return line (#112) is open. Repair the open. Refer to section 42.3.16.

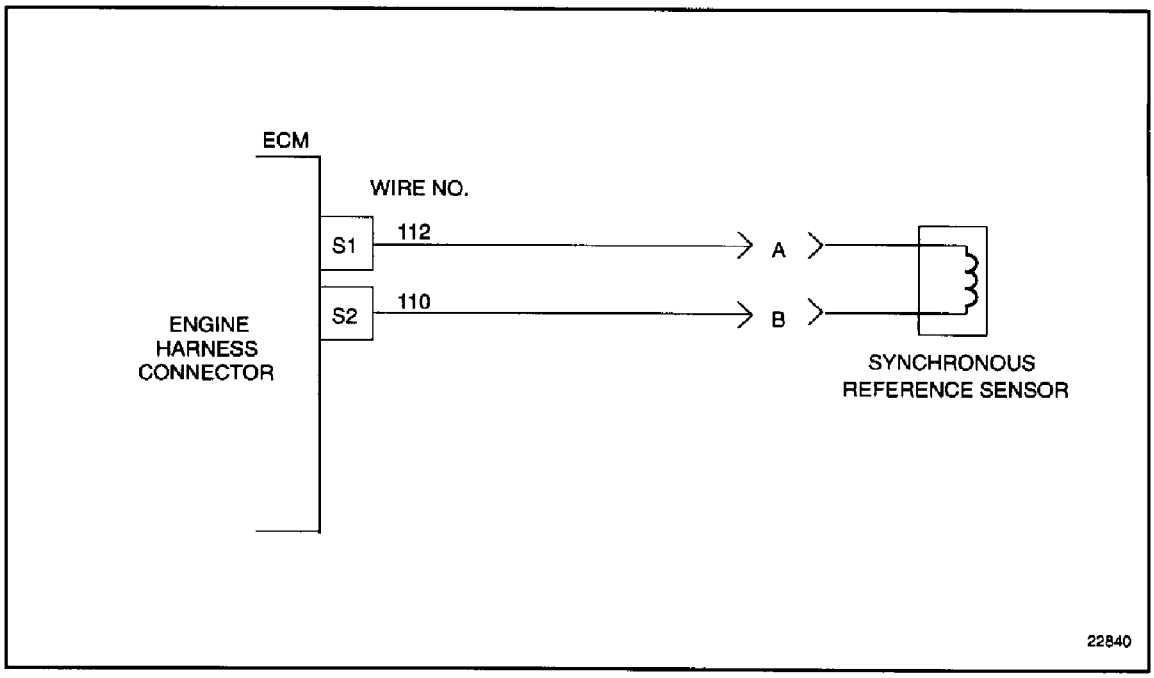

Figure 42-4 Engine Harness Connector to Synchronous Sensor

42.3.4 Synchronous Reference Sensor Test

Perform the following steps to test the SRS.

1. Measure resistance of SRS across the sensor connector pins A and B.
   [a] If the resistance measurement is less than or equal to 100 Ω, refer to section 42.3.12.
   [b] If the resistance measurement is greater than 200 Ω, refer to section 42.3.12.
   [c] If the resistance measurement is between 100 and 200 Ω, refer to section 42.3.5.

42.3.5 Check Synchronous Reference Sensor Gap

Perform the following steps to check the SRS gap.

1. Bar engine until SRS is over the SRS pin.
2. Check the gap between SRS and the pin.
   [a] If the gap setting is correct (0.020 - 0.040 in.), refer to section 42.3.6. A depth micrometer can be used.
   [b] If the gap setting is not correct, adjust the SRS until the gap setting is correct. If the problem returns, the pulse wheel may be loose or bad. Refer to section 42.3.16.

42.3.6 Check for Timing Reference Sensor Code

Perform the following steps to check for TRS code.

1. Check for TRS code.
   [a] If code 21/0 is not logged, refer to section 42.3.7.
   [b] If code 21/0 is logged, refer to section 42.3.8.

42.3.7 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connectors (both the ECM and harness side) for damage: bent, corroded, and unseated pins or sockets. See Figure 42-5.
   [a] If terminals and connectors are damaged, repair them. Refer to section 42.3.16.
   [b] If terminals and connectors are not damaged, refer to section 42.3.15.

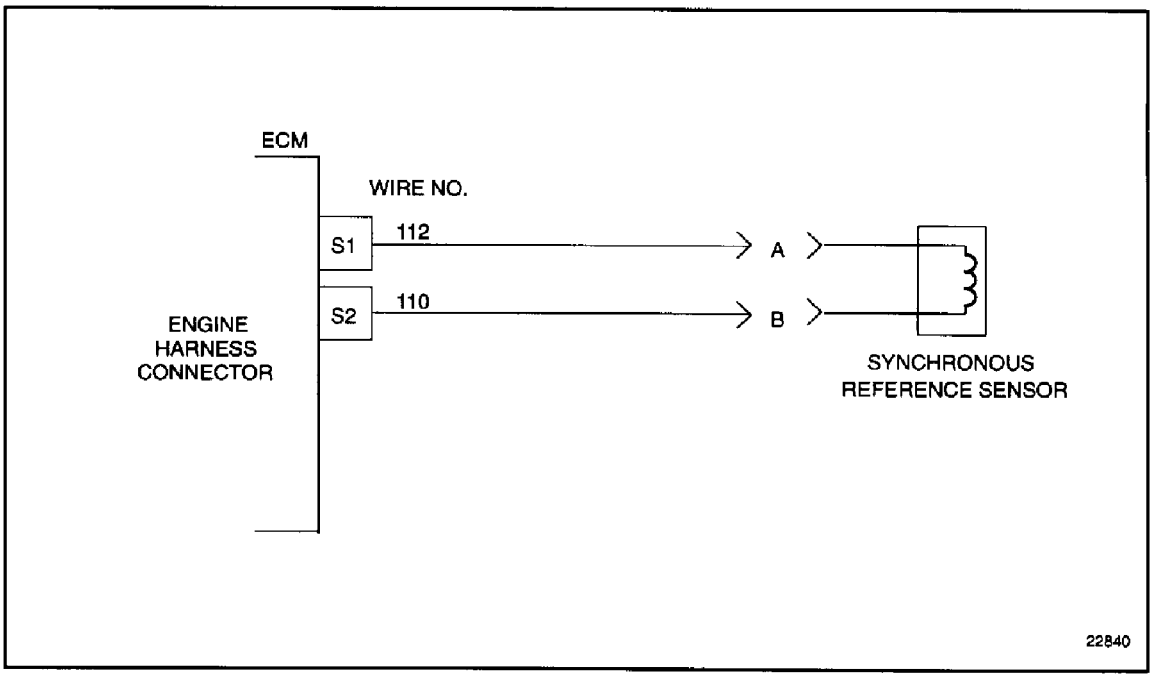

Figure 42-5 Engine Harness Connector to Synchronous Sensor

42.3.8 Timing Reference Sensor Resistance Check

Perform the following steps to check TRS resistance.

1. Remove the engine harness connector.
2. Measure resistance between sockets T1 and T2 on the engine harness connector. See Figure 42-6.

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[a] If the resistance measurement is greater than 200 Ω, refer to section 42.3.10.

[b] If the resistance measurement is less than or equal to 200 Ω, refer to section 42.3.9.

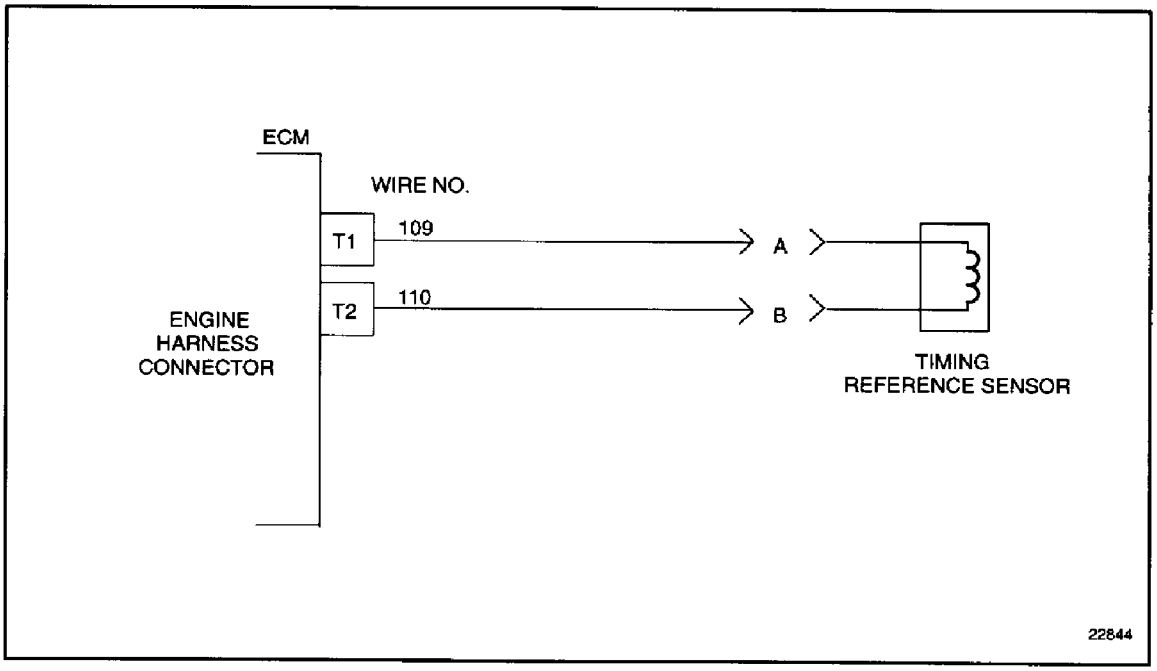

Figure 42-6 Engine Harness Connector to Timing Reference Sensor

42.3.9 Check for Short

Perform the following steps to check for a short.

1. Disconnect the TRS connector.
2. Measure resistance between sockets T1 and T2 on the engine harness connector.
   [a] If measured resistance is greater than 10,000 Ω, or open, refer to section 42.3.11.
   [b] If measured resistance is less than or equal to 10,000 Ω, the signal line (#110) is shorted to the return line (#109). Repair the short. Refer to section 42.3.16.

42.3.10 Open Timing Reference Sensor Line Check

Perform the following steps to check for an open TRS line.

1. Disconnect the TRS connector.
2. Install a jumper wire between sockets A and B of the TRS harness connector. See Figure 42-7.
3. Measure resistance between sockets T1 and T2 on the engine harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 42.3.11.

[b] If the resistance measurement is greater than 5 Ω, or open, the signal line (#110) or return line (#109) is open. Repair the open. Refer to section 42.3.16.

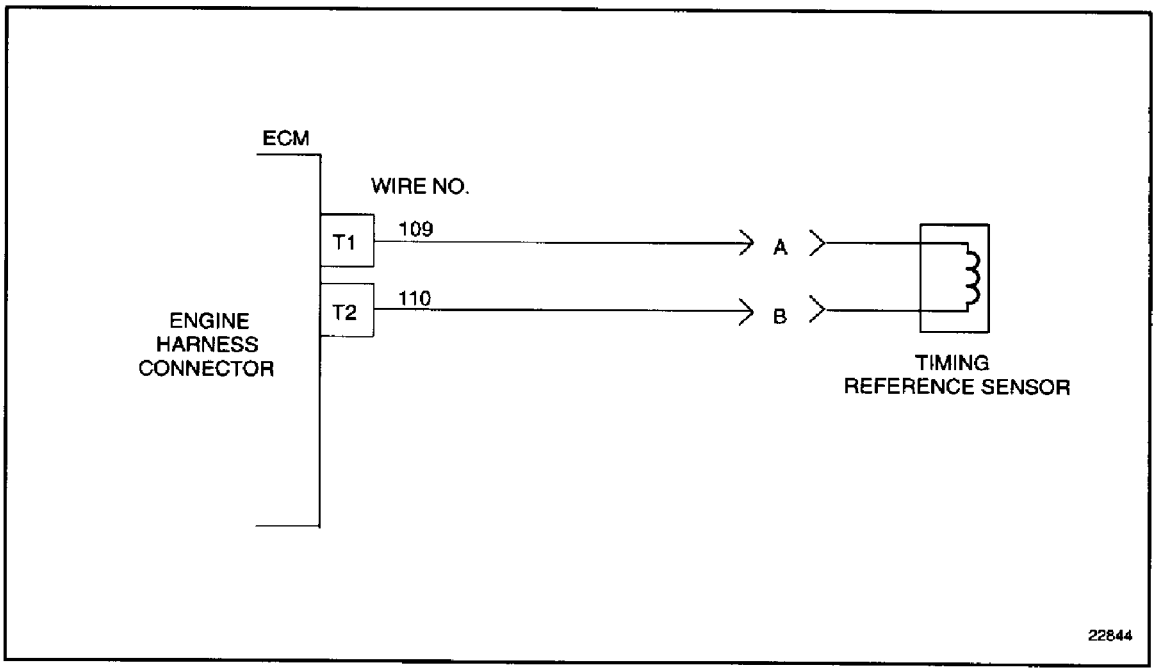

Figure 42-7 Engine Harness Connector to Timing Reference Sensor

42.3.11 Timing Reference Sensor Test

Perform the following steps to test the TRS.

1. Measure resistance of TRS across the sensor connector pins A and B.
   [a] If the resistance measurement is greater than 200 Ω, refer to section 42.3.13.
   [b] If the resistance measurement is less than 100 Ω, refer to section 42.3.13.
   [c] If the resistance measurement is between 100 and 200 Ω, refer to section 42.3.7.

42.3.12 Check Synchronous Reference Sensor Connectors

Perform the following steps to check the SRS connectors.

1. Check terminals at the SRS (both the SRS and harness side) for damage: bent, corroded, and unseated pins or sockets, or a bad contact. See Figure 42-8.
   [a] If terminals and connectors are damaged, repair them. Refer to section 42.3.16.

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[b] If terminals and connectors are not damaged, replace the SRS. Refer to section 42.3.14.

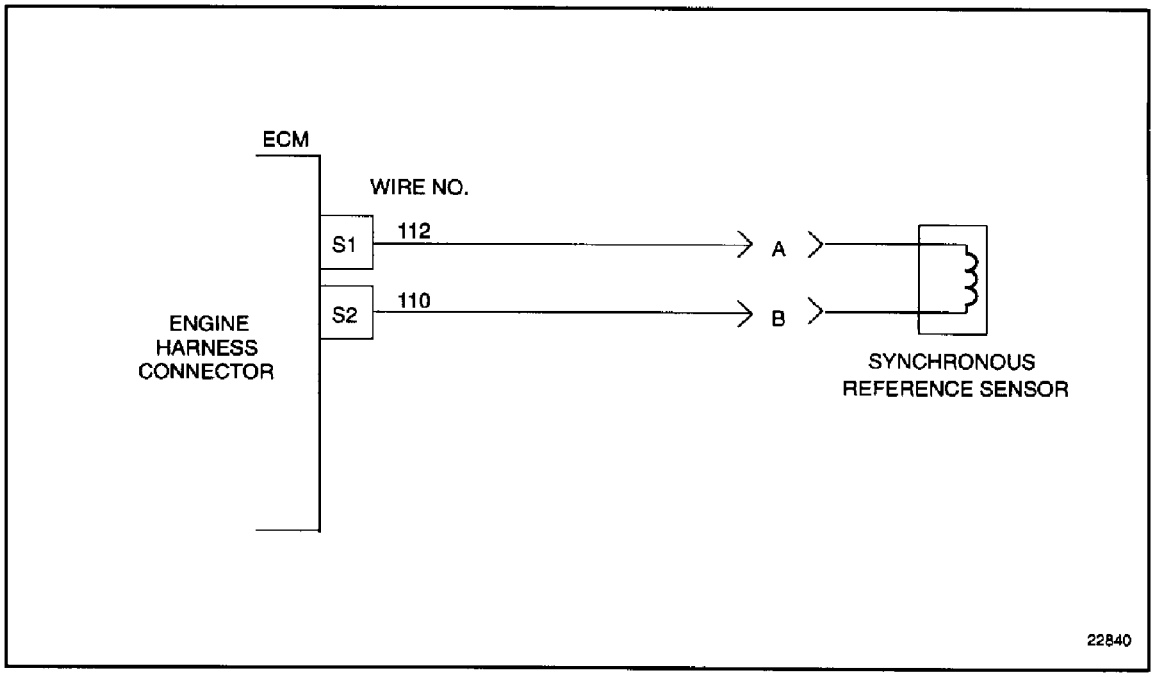

Figure 42-8 Engine Harness Connector to Synchronous Reference Sensor

42.3.13 Check Timing Reference Sensor Connectors

Perform the following steps to check the TRS connectors.

1. Check terminals at the TRS (both the TRS and harness end) for damage: bent, corroded, and unseated pins or sockets or bad contacts. See Figure 42-9.

   [a] If terminals and connectors are damaged, repair them. Refer to section 42.3.16.

[b] If terminals and connectors are not damaged, replace the TRS. Refer to section 42.3.14.

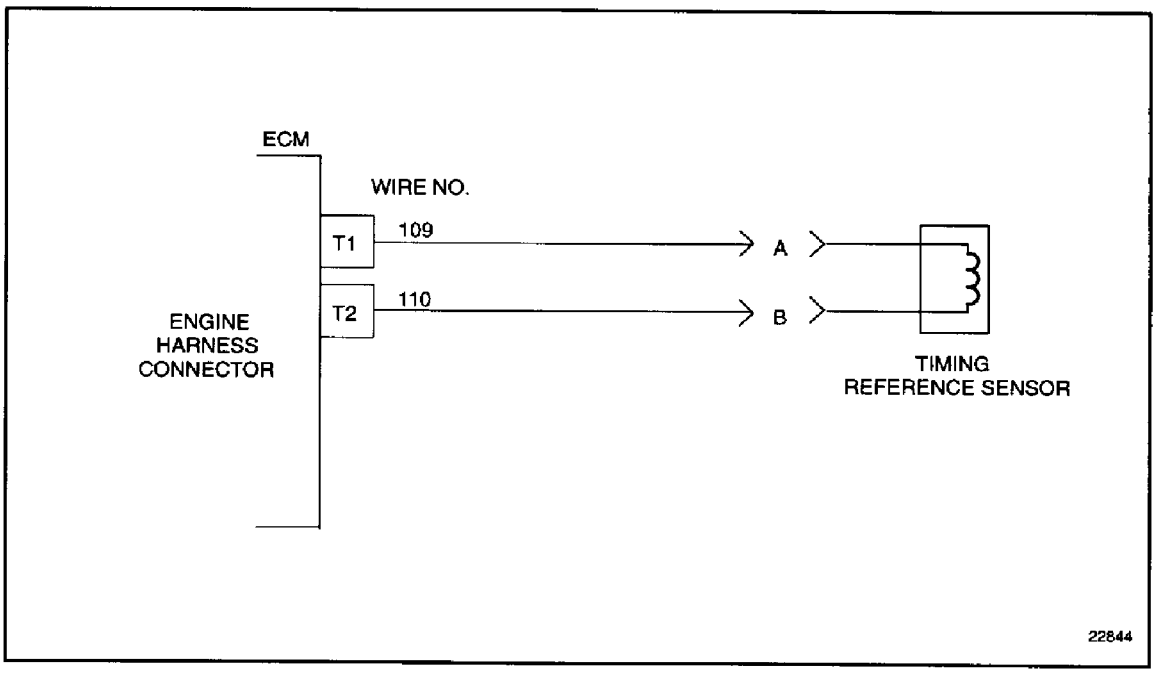

Figure 42-9 Engine Harness Connector to Timing Reference Sensor

42.3.14 Verify Synchronous Reference Sensor / Timing Reference Sensor

Perform the following steps to verify operation of the SRS/TRS.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Clear codes.
4. Start and run the engine for one minute.
5. Stop engine.
6. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If any codes except code 21/1 are logged, refer to section 9.1.
   [c] If code 21/1 and any other codes are logged, and the TRS was not replaced, refer to section 42.3.6.
   [d] If code 21/1 and any other codes are logged, and the TRS was replaced, refer to section 42.3.15.

42.3.15 Verify Cranking Voltage

Perform the following steps to verify cranking voltage.

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1. Turn vehicle ignition OFF.
2. Connect all connectors.
3. Connect 12 volt from a fully charged battery to the 5-pin power connector. See Figure 42-10.
4. Connect to ECM.
5. Start engine.
   [a] If engine starts, check the battery. If a voltage equalizer is installed, check the operation of the equalizer. If the equalizer is not working, refer to section 42.3.16.
   [b] If the engine does not start, replace the ECM. Refer to section 42.3.16.

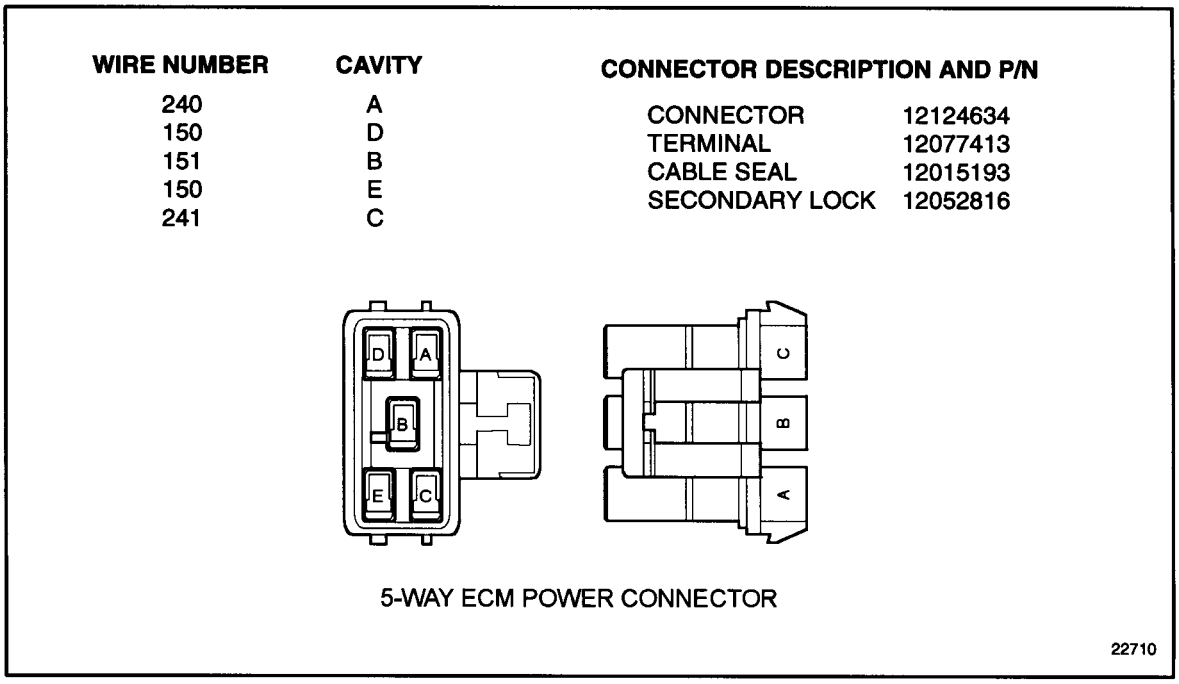

Figure 42-10 5-Way ECM Engine Power Connector

42.3.16 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn vehicle ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.

[a] If no codes are logged, troubleshooting is complete.

[b] If code 21/1 and any other codes are logged, all system diagnostics are complete. Review this section to find the error. Refer to section 42.3.1.

[c] If any codes except code 21/1 are logged, refer to section 9.1.

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43 FLASH CODE 43 - COOLANT LEVEL LOW

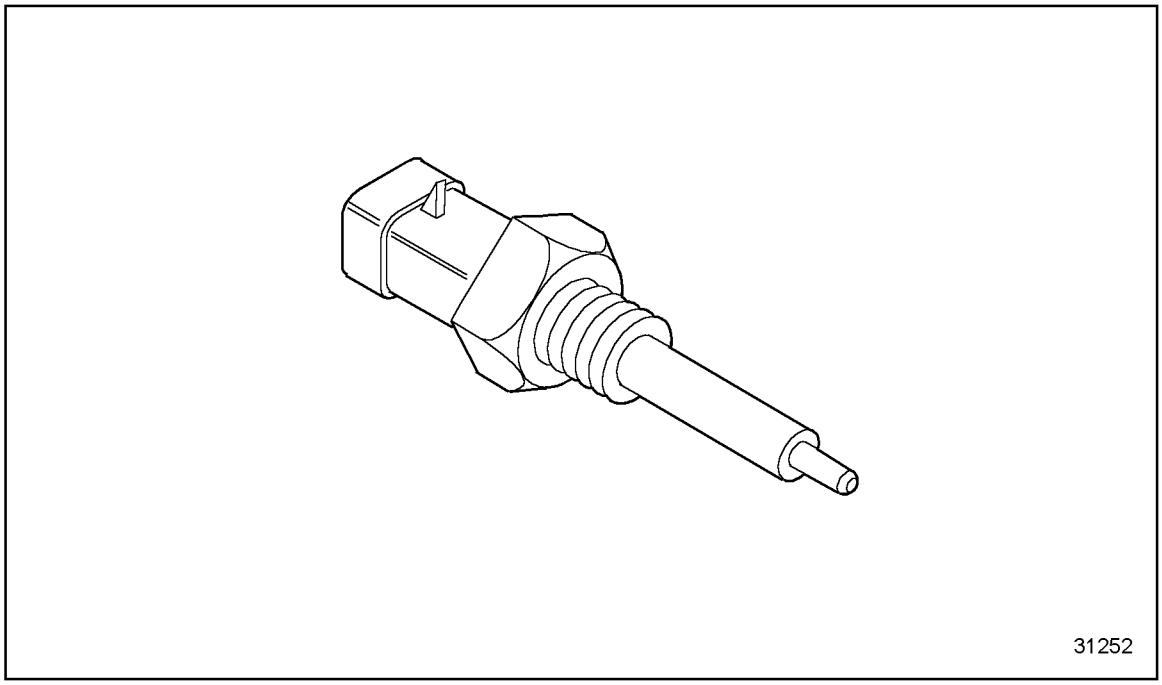

Figure 43-1 Coolant Level Sensor

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43.1 DESCRIPTION OF FLASH CODE 43

Flash Code 43 indicates that the ECM has detected that the engine coolant level has dropped below the recommended safe operating range, see Figure 43-1.

There is a significant difference between the coolant level sensors used in Detroit Diesel Electronic Controls (DDEC) II and DDEC III applications.

- Externally, the sensors physically look the same.
- The sensor used for the DDEC II system has a black colored connector.
- The sensor used for the DDEC III system has an off-white colored connector.

A coolant level module must be used with all coolant level sensors for DDEC II applications. All DDEC III applications, except Volvo, do not require a coolant level module.

43.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 43

The SAE J1587 equivalent code for Flash Code 43 is p 111 1.

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43.3 TROUBLESHOOTING FLASH CODE 43

The following procedure will troubleshoot Flash Code 43.

43.3.1 Coolant Level Low

Perform the following steps to diagnose the coolant level low.

1. Turn ignition ON; plug in DDR.
2. Read active codes.
   [a] If code 111-1 is logged, there is an indication of a low coolant level condition. Add coolant to ensure coolant level probe is immersed in coolant.
   [b] If code 111-1 remains active, refer to section 43.3.2.

43.3.2 Replace Coolant Level Sensor

Using the sensor tester may be of assistance. Use Tool J 37164.

NOTE:
When replacing the coolant level sensor, the CLS could be an OEM supplied part.

1. Turn ignition OFF; replace CLS.
2. Turn ignition ON.
3. Read active codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If codes are logged, refer to section 43.3.3.

43.3.3 Clean and Check Alternator Grounds

Perform the following steps to check the alternator ground.

1. If the grounds are clean and good, troubleshooting is complete.
2. If the grounds are damaged, repair the ground circuit and verify repairs. Refer to section 43.3.4.

43.3.4 Verify Repairs

Perform the following steps to verify repairs

1. Turn ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear DDR codes.

5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 111/1, and any other codes are logged, refer to section 43.3.1, and repeat the procedure, or contact Detroit Diesel Technical Service.
   [c] If any code other than 111/1 is logged, refer to section 9.1.

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44 FLASH CODE 44 - TEMP HIGH

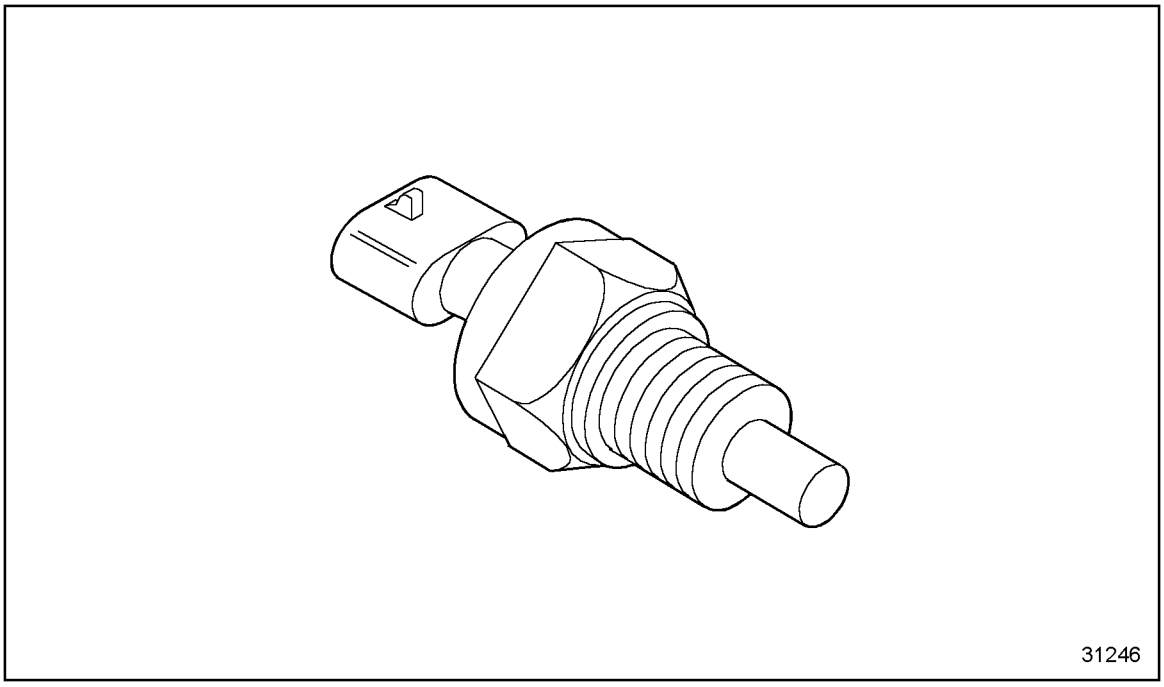

Figure 44-1 Coolant Temperature Sensor (Oil Temperature Sensor similar)

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44.1 DESCRIPTION OF FLASH CODE 44

Flash Code 44 indicates that the ECM has detected that the engine coolant temperature has exceeded the recommended safe operating range. See Figure 44-1, for the sensor.

It also indicates that the ECM has detected that the engine oil temperature has exceeded the recommended safe operating range. This normally occurs due to a mechanical fault.

44.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 44

The SAE J1587 equivalent code for Flash Code 44 is p 110 0, coolant temperature high.

The SAE J1587 equivalent code for Flash Code 44 is p 175 0, oil temperature high.

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44.3 TROUBLESHOOTING FLASH CODE 44

Perform the following steps to troubleshoot Flash Code 44.

44.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR).
3. Read active codes.
   [a] If active codes other than 110/0 or 175/0 are logged, service them first.
   [b] If active codes 110/0 or 175/0 are logged, and no other codes are logged, oil or coolant temperature was higher than it should have been. Inspect for damage. Plug in the reader and determine if code is coolant or oil temperature high.
   [c] If active code 110/0 is logged, and the duration of this code is less than 20 seconds, or if it has multiple occurrences which average less than 20 seconds each, contact Detroit Diesel Technical Service.

NOTE:
For information concerning high temperature levels, refer to section 4.1 in the service manual.

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45 FLASH CODE 45 - OIL PRESSURE LOW

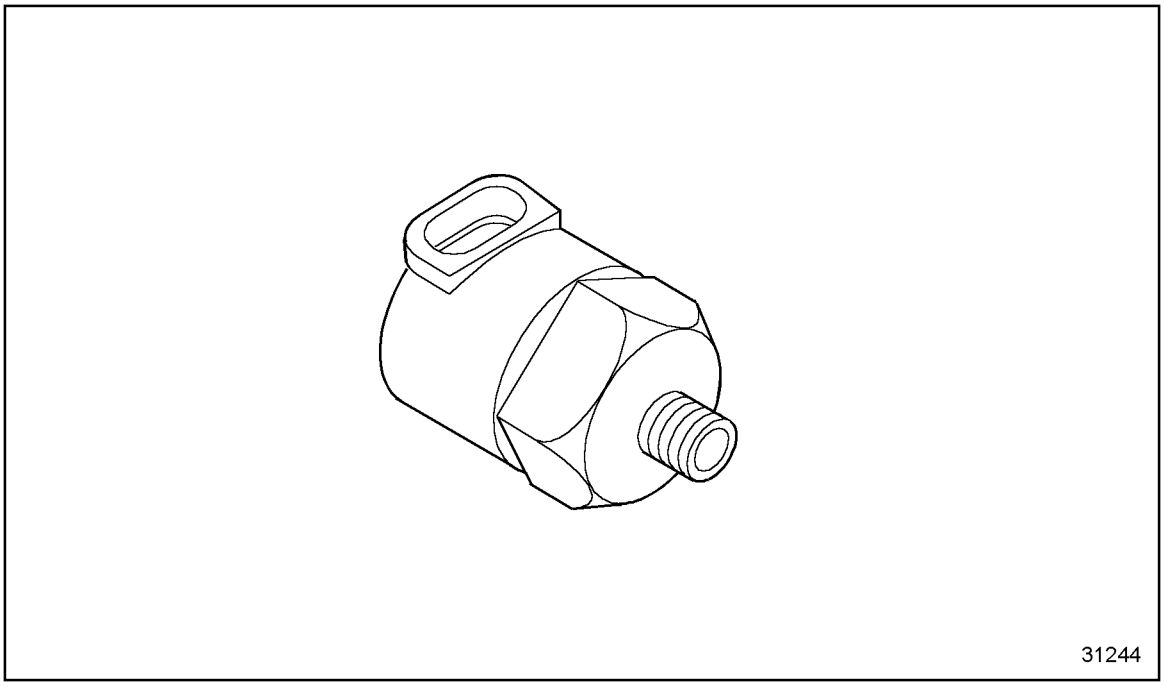

Figure 45-1 Oil Pressure Sensor

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45.1 DESCRIPTION OF FLASH CODE 45

Flash Code 45 indicates that the ECM has detected that the engine oil pressure has dropped below the recommended safe operating range. See Figure 45-1 for the engine oil pressure sensor.

Conditions: ECM looks for a minimum pressure vs. speed. This can vary for each engine type.

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45.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 45

The SAE J1587 equivalent code for Flash Code 45 is p 100 1, oil pressure low.

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45.3 TROUBLESHOOTING FLASH CODE 45

Perform the following steps to troubleshoot Flash Code 45.

45.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR)
3. Read active codes.
   [a] If codes other than 110/1 are logged, service them first.
   [b] If code 110/1 is logged, and no other codes are logged, there was an engine running condition at which oil pressure was lower than it should have been.

NOTE:
For information concerning low oil pressure level, refer to section 3.1 in the engine service manual.

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46 FLASH CODE 46 - BATTERY VOLTAGE LOW

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46.1 DESCRIPTION OF FLASH CODE 46

Flash Code 46 indicates that the DDEC system has detected that the main battery supply voltage to the ECM has dropped below the recommended operating range.

The DDEC system will operate on 12 or 24 volts.

- ☐ Normal operating voltage of the DDEC system is 11 to 32 volts DC, measured at the ECM.
- ☐ Operating the ECM between 6 and 11 volts may result in degraded engine operation. (Transient operation in this range during engine starting is considered normal for 12-volt systems.)
- ☐ Operating the ECM over 32 volts will cause damage.
- ☐ Reversing polarity will cause damage to the ECM if the power harness is not properly fused.

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46.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 46

The SAE J1587 equivalent code for Flash Code 46 is p 168 1.

The power harness supplies 12 or 24 volts to the ECM. The system must be sourced directly from the battery.

NOTE:
Connection to reverse polarity will damage the system if not properly fused.

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46.3 TROUBLESHOOTING FLASH CODE 46

The following procedure will troubleshoot Flash Code 46.

46.3.1 Battery Check

Perform the following steps to check the battery.

1. Start and run the engine for one minute.
2. Measure voltage on battery + terminal (red lead) to battery - terminal (black lead). Recommended fuse applications are listed in Table 46-1. Power harness length criteria is listed in Table 46-2.

   [a] If the engine does not start, inspect the battery and charging/starting system, and proceed if okay. Refer to section 9.1.

   [b] If the engine does start and the voltage measurement is less than or equal to 10.0 volts, service the discharged battery and charging/starting system.

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[c] If the engine does start and the voltage measurement is greater than 10.0 volts, refer to section 46.3.2.

Number of Cylinders	Dual Fuse or Circuit Breaker Size	Single Fuse or Circuit Breaker Size
6	2 @ 15 amp	1 @ 30 amp
8	2 @ 20 amp	1 @ 40 amp
12	4 @ 15 amp	2 @ 30 amp
16	4 @ 20 amp	2 @ 40 amp
20	4 @ 15 amp2 @ 20 amp	2 @ 30 amp1 @ 40 amp

Table 46-1 Fuse Size Recommendations

Length from ECM to Battery or Bus Bar (ft) *	Minimum Wire Size (Ga) *	Total Resistance of Maximum Length (m Ω) *	Length from ECM to Battery or Bus Bar (m) †	Minimum Wire Size (Ga) †	Total Resistance of Maximum Length (m Ω) †
0 to 28 ‡	12	24.8	0 to 6 ‡	2.5	22.8
28 to 44 ‡	10	24.57	6 to 10 ‡	4	23.55
44 to 70 ‡	8	24.58	10 to 14 ‡	6	21.98
70 to 110 ‡	6	24.7	14 to 26 ‡	10	23.66
110 to 178 ‡	4	25.0	26 to 40 ‡	16	23.2
0 to 14 §	12	24.8	0 to 3 §	2.5	22.8
14 to 22 §	10	24.57	3 to 5 §	4	23.55
22 to 35 §	8	24.58	5 to 7 §	6	21.98
35 to 55 §	6	24.7	7 to 13 §	10	23.66
55 to 89 §	4	25.0	13 to 20 §	16	23.2

* United States

†International

‡ Dual Fuse

§ Single Fuse

Table 46-2 Maximum Resistance vs Power Harness Length

46.3.2 Voltage Check at ECM

Perform the following steps to check voltage at the ECM.

1. Keep engine running.
2. Select ECM INPUT VOLT on DDR.
3. Observe ECM voltage reading on DDR.

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[a] If the voltage measurement is less than or equal to 10.0 volts, refer to section 46.3.3.

[b] If the voltage measurement is greater than 10.0 volts, refer to section 46.3.5.

46.3.3 Voltage Check at ECM Via Volt-Ohm Meter

Perform the following steps to check voltage at the ECM.

1. Turn the vehicle ignition OFF.
2. Disconnect 5-way power harness connector at the ECM.
3. Measure voltage from socket A and C (red lead) of 5-way power harness connector and a good battery ground (black lead). Don't use line (#151) as a ground reference. For 5-way ECM power harness connector, see Figure 46-1. For power harness schematic, see Figure 46-2.

   [a] If the voltage measurement is less than or equal to 11.5 volts, refer to section 46.3.4.

   [b] If the voltage measurement is greater than 11.5 volts, refer to section 46.3.5.

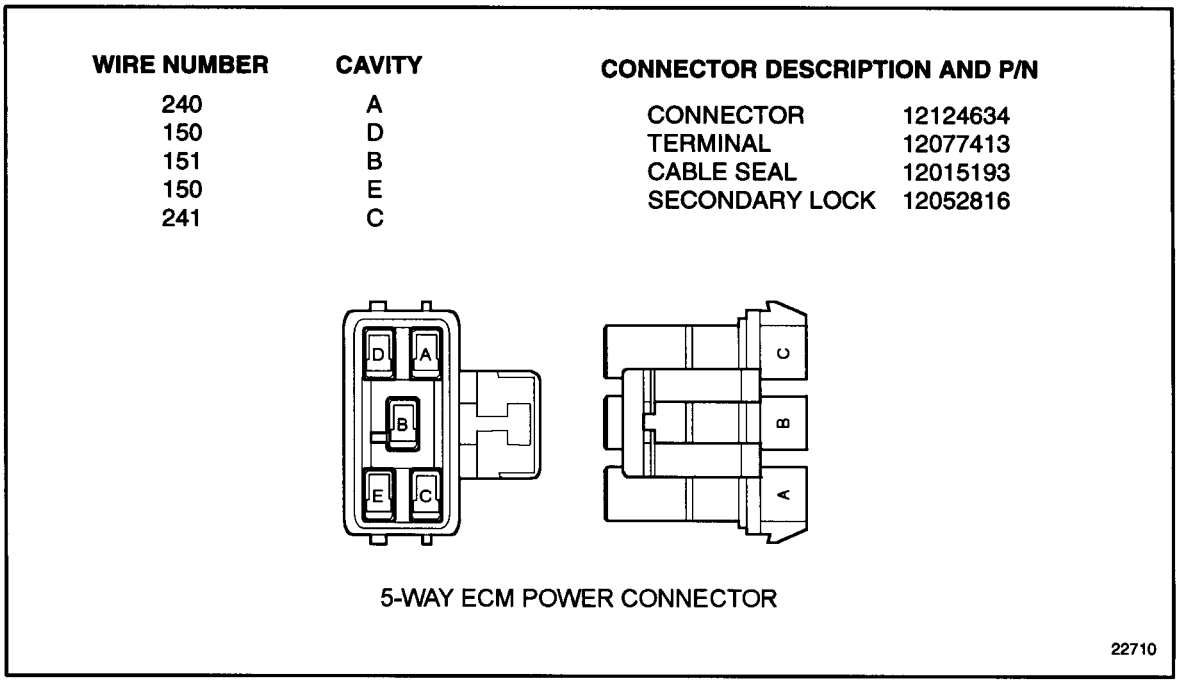

Figure 46-1 5-Way ECM Power Connector

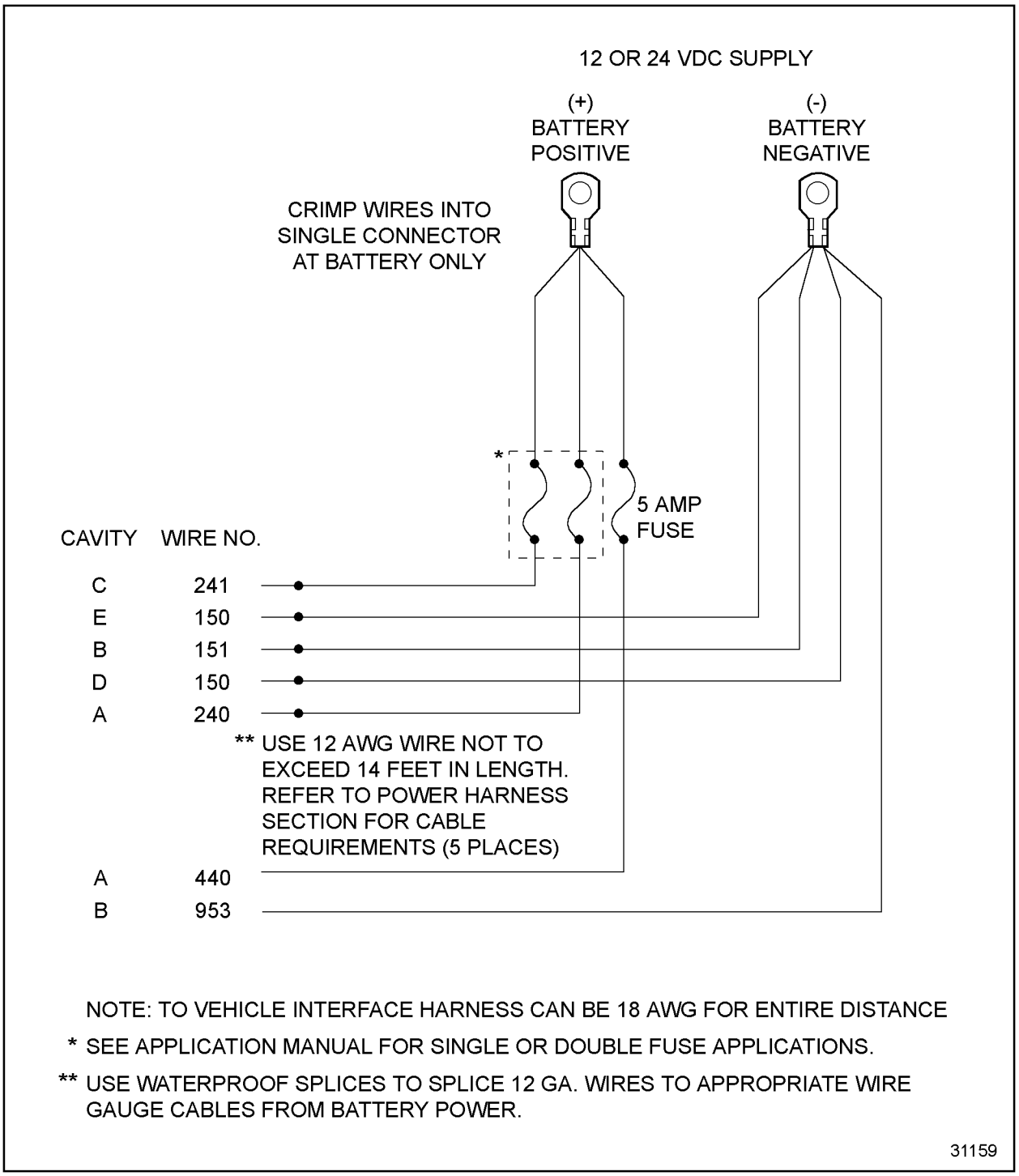

Figure 46-2 Power Harness

46.3.4 Check for Bad Battery + Line

Perform the following steps to check for a bad battery + line.

1. Remove fuse(s) to the ECM.

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2. Measure voltage at socket A of one fuseholder (red lead) to a good ground (black lead). For 5-way ECM power harness, see Figure 46-3.
3. Repeat voltage measurement at other fuseholder.
   [a] If the voltage measurement is greater than 11.5 volts on both readings, the battery + line between the fuseholder and ECM has an open, or the ECM power connector has a corroded connection. Repair the problem. Refer to section 46.3.8.
   [b] If the voltage measurement is less than or equal to 11.5 volts on either reading, the battery + line near the battery is open, or a corroded connection exists at battery + terminal. Repair the problem. Refer to section 46.3.8.

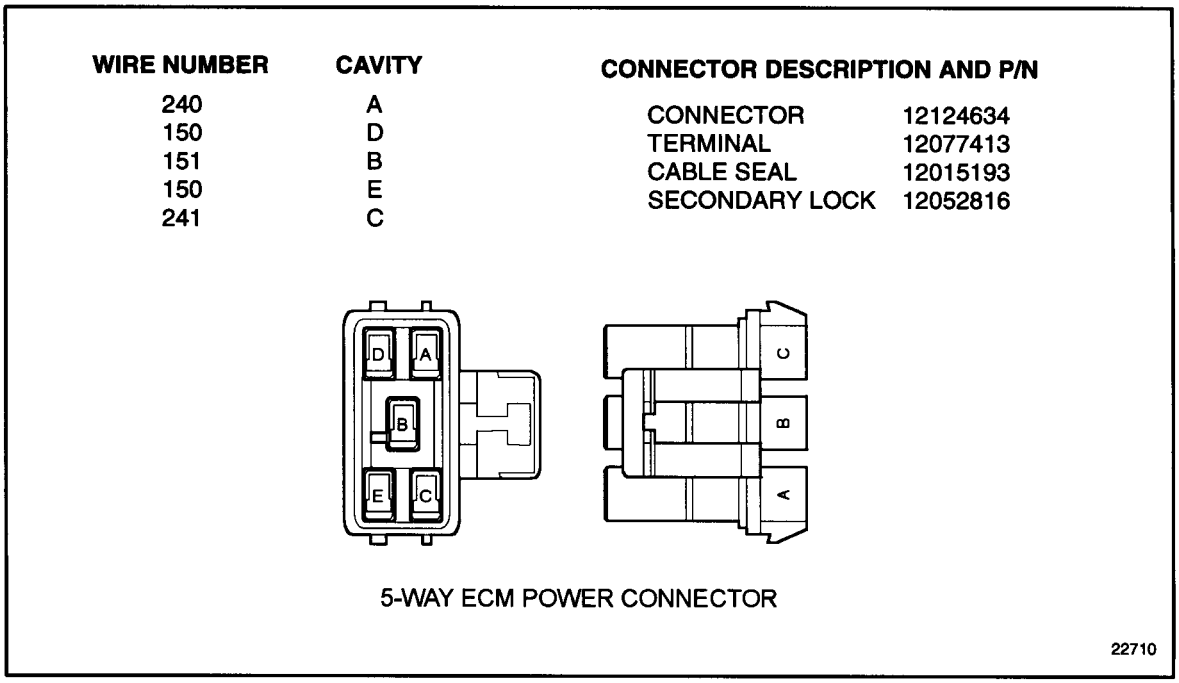

Figure 46-3 5-Way ECM Power Harness

46.3.5 Ground Check at ECM

Perform the following steps to check the ground at the ECM.

1. Disconnect the 5-way power harness connectors at the ECM. For 5-way ECM power harness, see Figure 46-3.
2. Measure voltage on socket A (red lead) to socket D (black lead) and socket C of 5-way power harness connector (red lead) to socket E, (black lead).
   [a] If voltage measurement is greater than 11.5 volts on either reading, refer to section 46.3.6.
   [b] If the voltage measurement is less than or equal to 11.5 volts on either reading, the ground wire (#150) is open or has a corroded connection. Repair ground wire, and refer to section 46.3.8.

46.3.6 Check ECM Connectors

Perform the following steps to check ECM connectors.

1. Check terminals at the ECM 5-way power harness connector (both ECM and harness side) for damage; bent, corroded, and unseated pins or sockets.
   [a] If terminals and connector are damaged, repair them. Refer to section 46.3.8.
   [b] If terminals and connector are not damaged, verify the power and ground are wired directly to the battery. Refer to section 46.3.7.

46.3.7 Code Check

Perform the following steps to check for codes.

1. Install the vehicle interface module.
2. Turn ignition ON; plug in DDR.
3. Check for codes.
   [a] If code reoccurs, install test ECM, then refer to section 46.3.8.
   [b] If code does not reoccur, check power harness wires for breaks, abrasions, etc. Then refer to section 46.3.8.

46.3.8 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes with DDR.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are displayed, troubleshooting is complete.
   [b] If code 168/1 is not logged, and other codes are logged, refer to section 9.1.
   [c] If code 168/1 is logged, and other codes are logged, all system diagnostics are complete. To troubleshoot the error, refer to section 46.3.1.

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47 (CHG) FLASH CODE 47 - AIR / FUEL PRESSURE HIGH

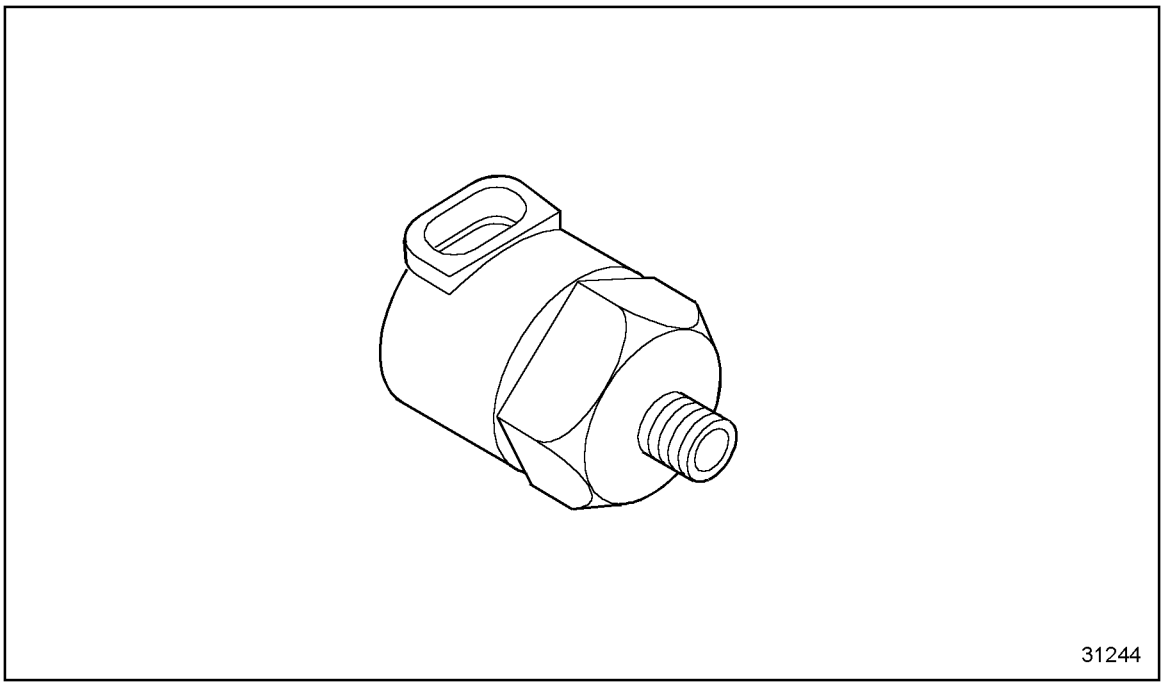

Figure 47-1 Fuel Pressure Sensor

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47.1 DESCRIPTION OF FLASH CODE 47

Flash Code 47 indicates that the ECM has detected that the fuel pressure, air inlet pressure, or turbo boost pressure has exceeded a programmed operating range. This normally occurs due to a mechanical fault in the air system or fuel system of the engine. See Figure 47-1, for the fuel pressure sensor.

NOTE:
Not all engines use a fuel pressure sensor.

For gas engines, code 47 indicates that the air inlet pressure has exceeded a calibration limit programmed in the ECM.

For diesel engines, code 47 indicates that the turbo boost pressure has exceeded a calibration limit programmed in the ECM.

47.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 47

The SAE J1587 equivalent code for Flash Code 47 is p 094/0, fuel pressure high.

The SAE J1587 equivalent code for Flash Code 47 is p 106/0, air inlet pressure high (Gas-fueled engines).

The SAE J1587 equivalent code for Flash Code 47 is p 102/0, turbo boost pressure high (Diesel-fueled engines).

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47.3 TROUBLESHOOTING FLASH CODE 47

This code is a mechanical fault. Check for reasons for high fuel pressure. Refer to appropriate service manual, section 5.

This (Gas-fueled engine) code is a mechanical fault. Check for reasons for high air inlet pressure. Refer to appropriate service manual, section 6.

This (Diesel-fueled engine) code is a mechanical fault. Check for reasons for high turbo boost pressure, e.g. wastegate bypassed. Refer to appropriate service manual, section 6.

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48 (CHG) FLASH CODE 48 - AIR / FUEL PRESSURE LOW

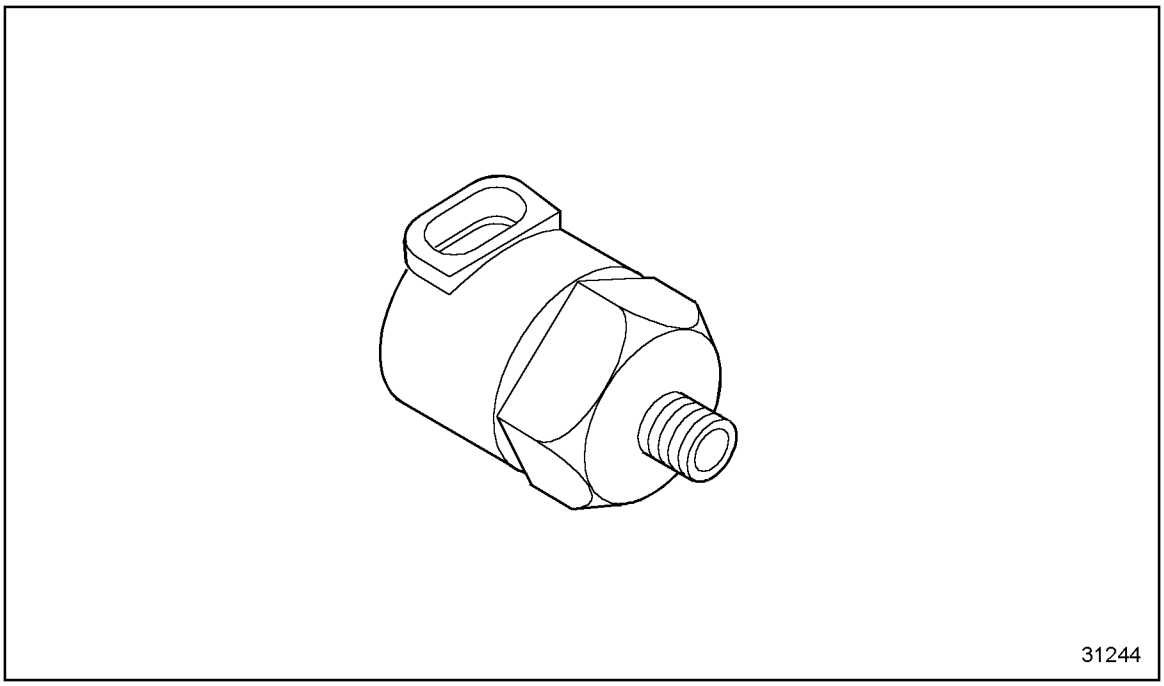

Figure 48-1 Fuel Pressure Sensor

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48.1 DESCRIPTION OF FLASH CODE 48

Flash Code 48 indicates that the ECM has detected that the Fuel Pressure has dropped below a programmed limit. This condition is normally associated with a restriction in the fuel supply system:

- ☐ Plugged fuel filter
- ☐ Low fuel supply

NOTE:
Not all engines use a fuel pressure sensor, see Figure 48-1.

For gas engines, code 48 indicates that the air inlet pressure has dropped below a calibration limit.

48.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 48

The SAE J1587 equivalent code for Flash Code 48 is p 094/1, fuel pressure high.

The SAE J1587 equivalent code for Flash Code 48 is p 106/1, air inlet pressure low. (Gas-fueled engines)

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48.3 TROUBLESHOOTING FLASH CODE 48

This code is a mechanical fault. Check for reasons for low fuel pressure. Refer to appropriate service manual, section 5.

This (Gas-fueled engine) code is a mechanical fault. Check for reasons for low air inlet pressure. Refer to appropriate service manual, section 6.

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49 FLASH CODE 49

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49.1 DESCRIPTION OF FLASH CODE 49

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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50 FLASH CODE 50

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50.1 DESCRIPTION OF FLASH CODE 50

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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51 (CHG) FLASH CODE 51

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51.1 DESCRIPTION OF FLASH CODE 51

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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52 (CHG) FLASH CODE 52 - ECM FAULT

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52.1 DESCRIPTION OF FLASH CODE 52

Flash Code 52 indicates that the DDEC system ECMs internal Analog to Digital (A/D) Convertor device has malfunctioned. Intermittent diagnostic conditions of this type can be caused by faulty external electrical system.

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52.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 52

The SAE J1587 equivalent code for Flash Code 52 is s 254 12.

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52.3 TROUBLESHOOTING FLASH CODE 52

The following procedure will troubleshoot Flash Code 52.

52.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR).
3. Read active codes.
   [a] If active codes other than 254/12 are logged, service them first.
   [b] If active code 254/12 is logged, and no other codes are logged, hook up test ECM. If code clears, replace the ECM. If code is not cleared, contact Detroit Diesel Technical Service.

NOTE:
For information concerning ECM replacement, refer to section 2.9 in the service manual.

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53 FLASH CODE 53 - ECM MEMORY FAULT

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53.1 DESCRIPTION OF FLASH CODE 53

Flash Code 53 indicates that the ECM was unable to read a valid copy of an engine data record (calibration, faults, or accumulators) stored in nonvolatile memory.

Flash Code 53 also indicates that the ECM was unable to update an engine data record (calibration, faults, or accumulators) stored in nonvolatile memory.

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53.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 53

The SAE J1587 equivalent code for Flash Code 53 is s 253 12, EEPROM write fail.

The SAE J1587 equivalent code for Flash Code 53 is s 253 2, nonvolatile checksum incorrect.

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53.3 TROUBLESHOOTING FLASH CODE 53

The following procedure will troubleshoot Flash Code 53.

NOTE:
Inactive code 53 should be cleared with the DDR and the unit returned to service if ECM SW is greater than or equal to 7.00.

53.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR).
3. Read active codes.
   [a] If codes other than 253/12 or 253/2 are logged, service them first.
   [b] If codes 253/12 or 253/2 are logged, and no other codes are logged, reprogram the ECM. Refer to section 53.3.2.

53.3.2 Test for Codes

Perform the following steps to test for codes.

1. Start and run the engine.
2. Read active codes with DDR.
   [a] If active code 253/2 is logged, and no other codes are logged, install a test ECM. Refer to section 53.3.3.

NOTE:
It is recommended that a "Test" ECM be tried first to determine the need to replace the ECM. For information concerning ECM replacement, refer to section 2.9 in the service manual.

   [b] If no codes are logged, troubleshooting is complete.

53.3.3 Verify Repairs

Perform the following steps to verify repairs.

1. Start and run the engine.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If codes are logged, contact Detroit Diesel Technical Service.

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54 FLASH CODE 54 - VSS FAULT

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54.1 DESCRIPTION OF FLASH CODE 54

Flash Code 54 indicates that during engine operation the vehicle speed that is measured by the Vehicle Speed Sensor (VSS) is less than the expected value for the current engine speed/conditions.

This diagnostic condition is typically:

- Open sensor signal circuit
- Conditions
  - Code is logged (without anti-tamper) when the mph >1500 and PW >15° and vehicle speed < 3 mph.
  - If code is logged (with or without anti-tamper) mph will be limited.

NOTE:
Code will not be logged for the first five hours of ECMs life (total engine hours).

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54.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 54

The SAE J1587 equivalent code for Flash Code 54 is p 084 12.

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54.3 TROUBLESHOOTING FLASH CODE 54

The following procedure will troubleshoot Flash Code 54.

54.3.1 Test Drive Vehicle

Take the vehicle for a test drive with an assistant.

1. View DDR; select vehicle speed.
   [a] If mph reads 0 (zero), or stays steady with the vehicle in motion, refer to section 54.3.2.
   [b] If speed appears correct, refer to section 54.3.11.

54.3.2 Speed Sensor Identification

Identify the speed sensor type - type one or type two.

1. The type one sensor is a magnetic pickup and may be located in one of the following locations: transmission tail shaft, wheel rim, mechanical speedometer cable. If you have a type one sensor, refer to section 54.3.3. (Verify with DDR signal type - magnetic.)
2. The type two sensor communicates with square wave input and output signals and requires the ECM to be configured correctly. Refer to section 54.3.12. (Verify with DDR signal type - switched.)

54.3.3 Check Vehicle Speed Sensor Circuit

Perform the following steps to check the vehicle speed sensor.

1. With ignition off, disconnect the vehicle harness connector.
2. Measure resistance of VSS circuit across vehicle harness connector pins, E2 to E3. See Figure 54-1.
   [a] If the resistance measurement is less than 50 Ω, refer to section 54.3.4.
   [b] If the resistance measurement is greater than 3,000 Ω or open, refer to section 54.3.6.

[c] If the resistance measurement is between 50 and 3,000 Ω, refer to section 54.3.7.

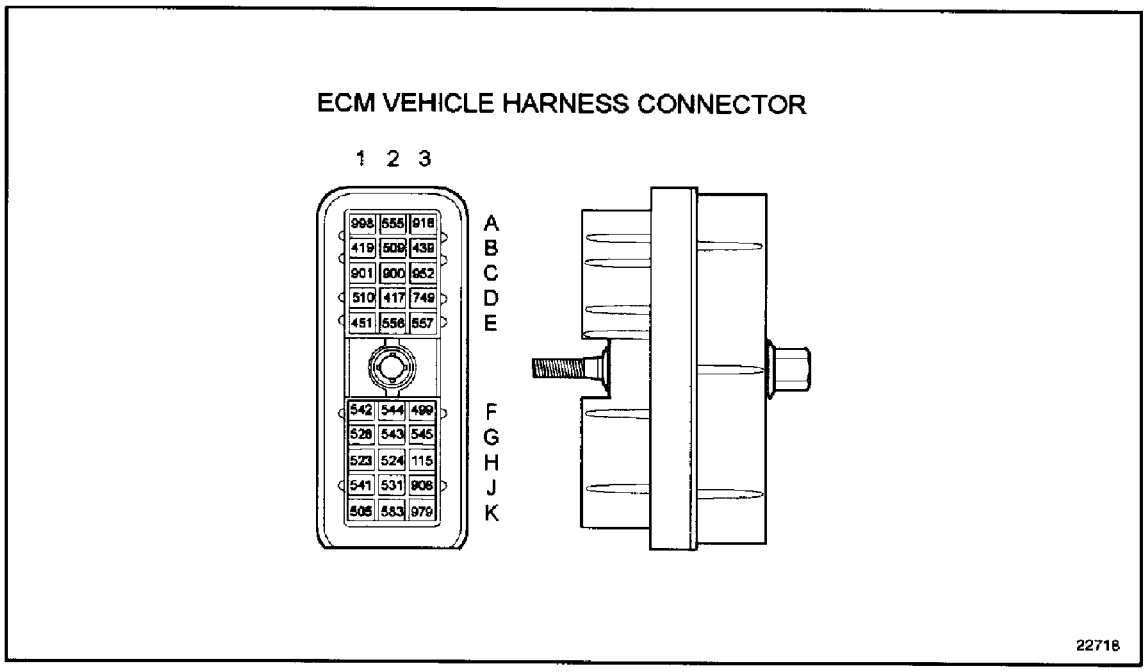

Figure 54-1 ECM Vehicle Harness Connector

54.3.4 Check for Short

Perform the following steps to check for short.

1. Disconnect VSS connector.
2. Measure resistance between vehicle harness connector terminals E2 and E3. See Figure 54-1.
   [a] If the resistance measurement is less than or equal to 1,000 Ω, the signal wire #556 or return wire #557, are shorted together. Repair the short; refer to section 54.3.13.
   [b] If the resistance measurement is greater than 1,000 Ω or open, refer to section 54.3.5.

54.3.5 Check Vehicle Speed Sensor

Perform the following steps to check the vehicle speed sensor.

1. Measure resistance of VSS across vehicle speed sensor connector pins. See Figure 54-1.
   [a] If the resistance measurement is less than 50 Ω, refer to section 54.3.8.
   [b] If the resistance measurement is greater than 3,000 Ω or open, refer to section 54.3.8.
   [c] If the resistance measurement is between 50 and 3,000 Ω, refer to section 54.3.10.

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54.3.6 Check for Open

Perform the following steps to check for open.

1. Disconnect the ECM vehicle harness connector and VSS connector.
2. Install a jumper wire between sockets A and B of the VSS harness connector.
3. Measure resistance between sockets E2 and E3 on the ECM vehicle harness connector. See Figure 54-2.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 54.3.5.
   [b] If the resistance measurement is greater than 5 Ω or open, the VSS signal line #556 or return line #557 is open. Repair open and refer to section 54.3.13.

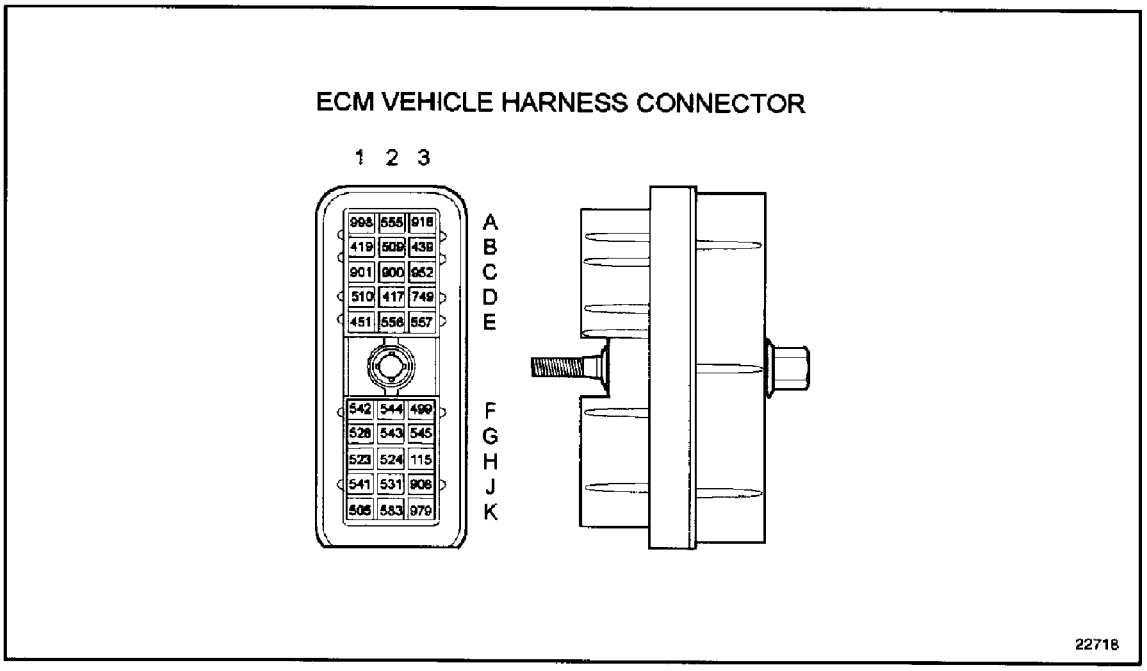

Figure 54-2 ECM Vehicle Harness Connector

54.3.7 Check for Short to Ground

Perform the following steps to check for short to ground.

1. Turn ignition OFF.
2. Remove jumper wire.
3. Measure resistance between sockets E2 and E3 and a good ground. See Figure 54-3.
   [a] If the resistance measurement is greater than 1,000 Ω or open, refer to section 54.3.9.

[b] If the resistance measurement is less than or equal to 1,000 Ω, the signal wire #556 or return wire #557, is shorted to ground, or wired to an unauthorized device. Repair the short; refer to section 54.3.13.

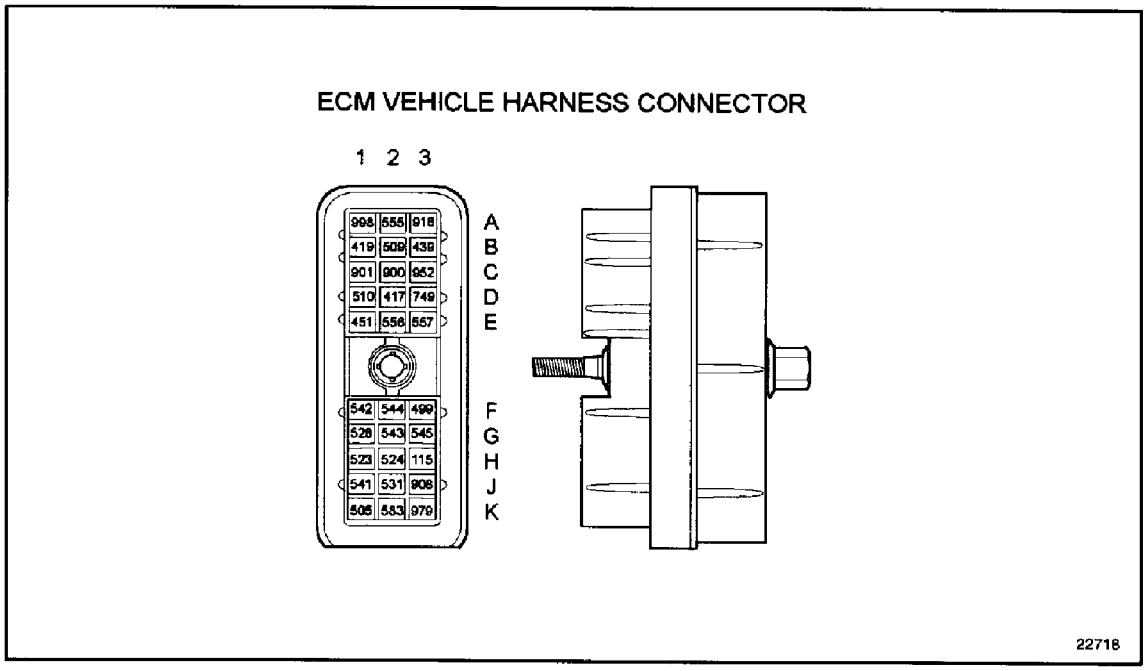

Figure 54-3 ECM Vehicle Harness Connector

54.3.8 Check Vehicle Speed Sensor Connectors

Perform the following steps to check the VSS connectors.

1. Check terminals at the VSS connectors (both sensor side and harness side) for bent, corroded, and unseated pins or sockets.

   [a] If the terminals and connectors are not damaged, replace the VSS. Refer to section 54.3.13.

   [b] If the terminals and connectors are damaged, repair them. Refer to section 54.3.13.

54.3.9 Check for Short to Power

Perform the following steps to check for short to power.

1. Turn ignition ON.
2. Measure voltage at the ECM vehicle harness connector between socket E3 (#557) and a good ground. Also measure voltage between socket E2 (#556) and a good ground. See Figure 54-4.

   [a] If both voltage measurements are less than 0.2 volts, refer to section 54.3.10.

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[b] If either voltage measurement is greater than or equal to 0.2 volts, the VSS signal (#556) or VSS return line (#557) is shorted to the battery or some other source of voltage. Repair the short; refer to section 54.3.13.

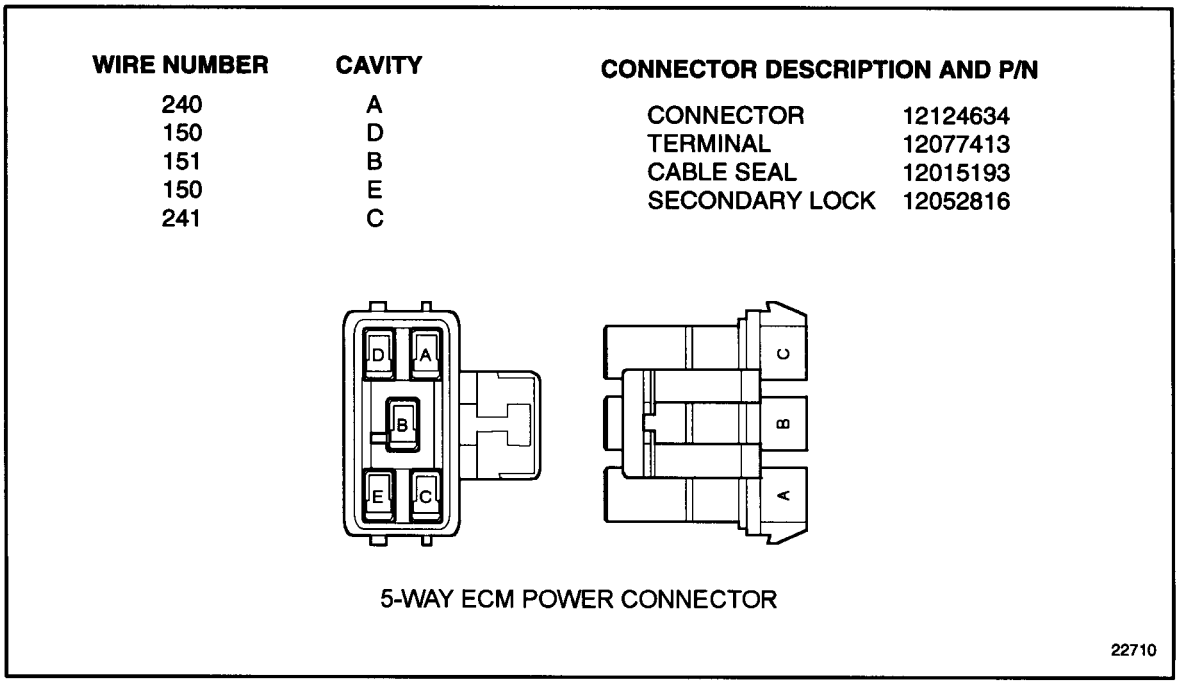

Figure 54-4 5-Way ECM Power Connector

54.3.10 Check ECM Connectors

Perform the following steps to check ECM connectors.

1. Check the terminals at the ECM engine harness connectors for bent, corroded, and unseated pins or sockets, on both the ECM and harness sides. See Figure 54-5.

   [a] If the terminals and connectors are not damaged, refer to section 54.3.11.

[b] If the terminals and connectors are damaged, repair them. Refer to section 54.3.13.

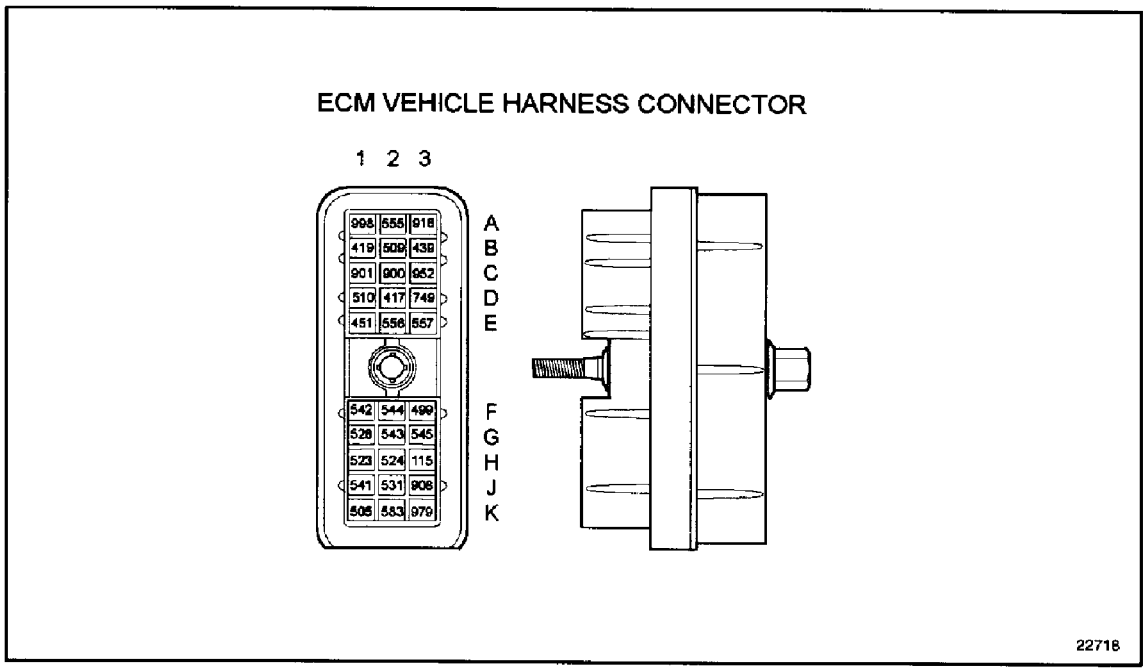

Figure 54-5 ECM Vehicle Harness Connector

54.3.11 Vehicle Speed Mechanical Checks

Perform the following vehicle speed mechanical checks.

1. Check for plugged fuel filters.
2. Check if any metal or debris is lodged between the VSS and the pulse wheel.
3. Check if the sensor is loose.
4. Ensure the VSS pulse wheel is in fixed position relative to magnetic pickup.
5. Check for proper air gap between magnetic pickup and pulse wheel.
   [a] If all mechanical checks are okay, contact Detroit Diesel Technical Service for review if anti-tamper = yes.
   [b] If all mechanical checks are not okay, repair the mechanical failure. Refer to section 54.3.13.

54.3.12 Check for Short to Ground

Perform the following steps to check for short to ground.

1. Turn ignition OFF.
2. Disconnect the ECM vehicle harness connector.
3. Measure resistance between sockets E2 and a good ground. See Figure 54-6.

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[a] If the resistance measurement is greater than 10,000 Ω or open, contact the component supplier for instructions. The wiring is okay, but the device may be defective. Refer to section 54.3.13.

[b] If the resistance measurement is less than or equal to 100 Ω, the VSS signal line (#556) is shorted to ground, Repair the short; refer to section 54.3.13.

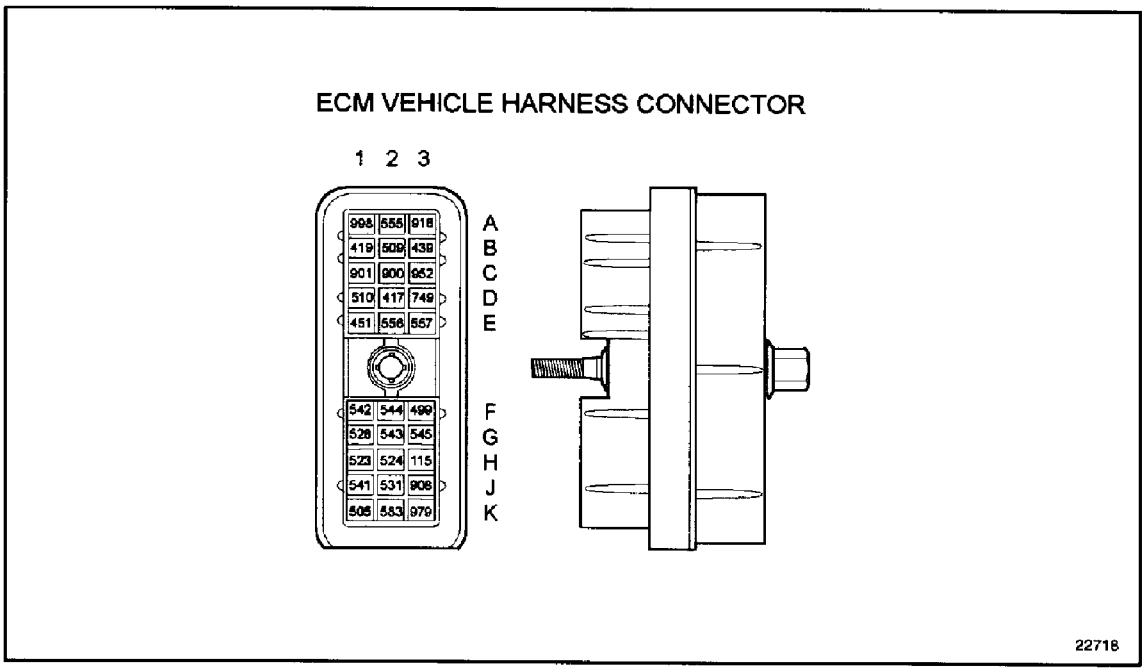

Figure 54-6 ECM Vehicle Harness Connector

54.3.13 Verify Repairs

Perform the following steps to verify repairs.

1. Turn the ignition OFF.
2. Reconnect all the connectors.
3. Turn the ignition ON.
4. Clear DDR codes.
5. Perform a road test with an assistant. Ensure the vehicle is loaded.
6. Stop the engine.
7. Check DDR for codes.

   [a] If no codes are logged, no further troubleshooting is required.

   [b] If code 84/12 is not logged, and other codes are logged, refer to section 9.1.

   [c] If code 84/12 is logged, and any other codes are logged, all system diagnostics are complete. To troubleshoot the error, refer to section 54.3.2 and perform tasks.

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55 (CHG) FLASH CODE 55 - J1939 DATA LINK FAULT

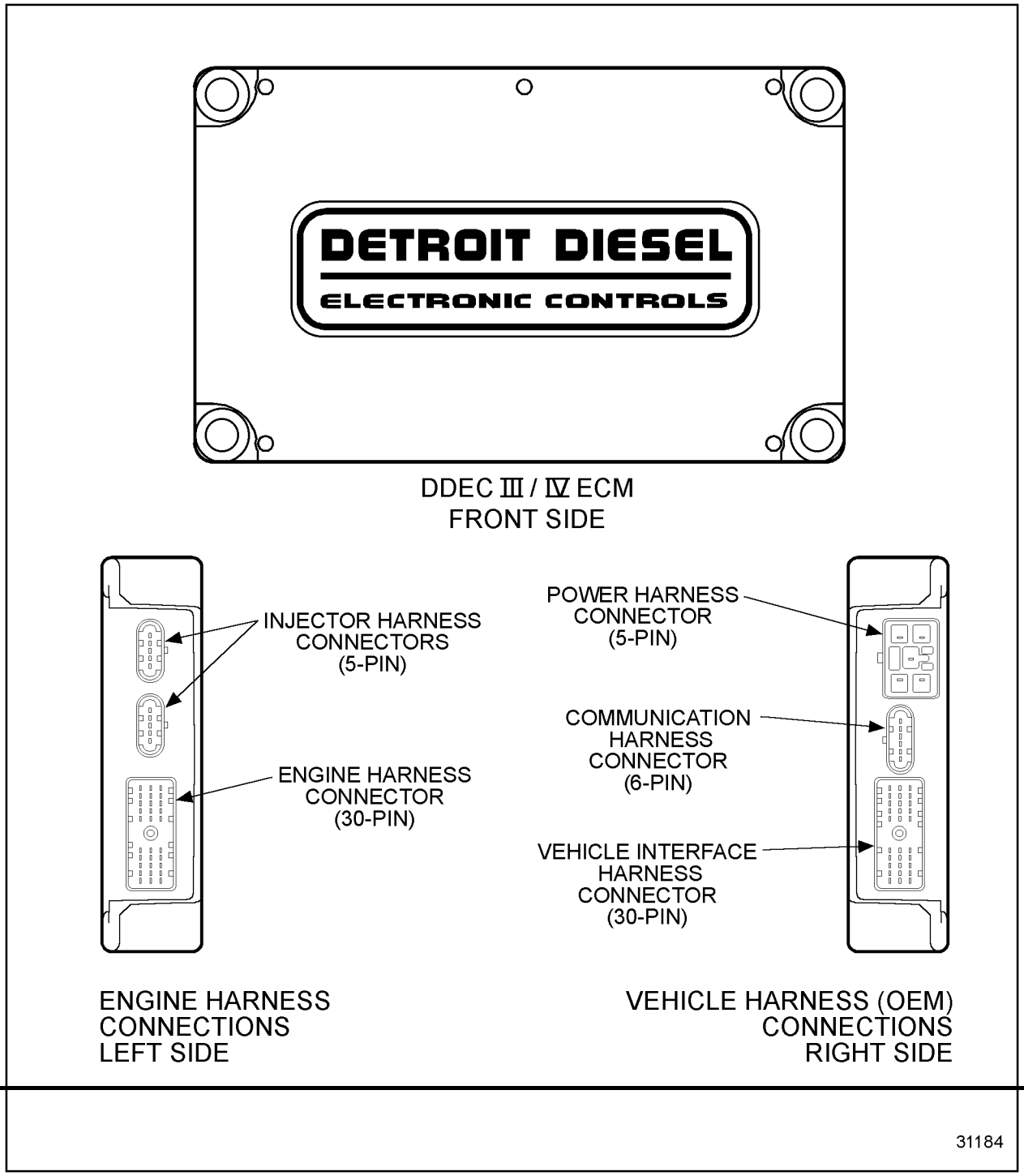

Fig. re 55-1 ECM

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55.1 DESCRIPTION OF FLASH CODE 55

Flash Code 55 indicates the ECM, see Figure 55-1, has detected a fault in the J1939 Data Link.

- ☐ Incorrect programming
- ☐ Wiring fault, J1939 data link wires

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55.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 55

The SAE J1587 equivalent code for Flash Code 55 is s 231/12.

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55.3 TROUBLESHOOTING FLASH CODE 55

The following procedure will troubleshoot Flash Code 55.

55.3.1 Check J1939 Data Link

Perform the following steps to check for J1939 data link fault.

1. Is this a J1939 transmission/engine application?
   [a] If yes, contact Detroit Diesel Technical Service.
   [b] If no, use programming station and go to "update customer calibration" and select transmission to manual, or correct transmission. Save changes. Refer to section 55.3.2.

55.3.2 Verify Repairs

Perform the following steps to verify repairs.

1. Start engine.
2. Plug in DDR.
3. Read codes.
   [a] If active code 231/12 is not logged, troubleshooting is complete.
   [b] If active code 231/12 is logged, contact Detroit Diesel Technical Service. Check DDR software level. Update DDR software if current level is 1.2.

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56 (CHG) FLASH CODE 56 - J1587 DATA LINK FAULT

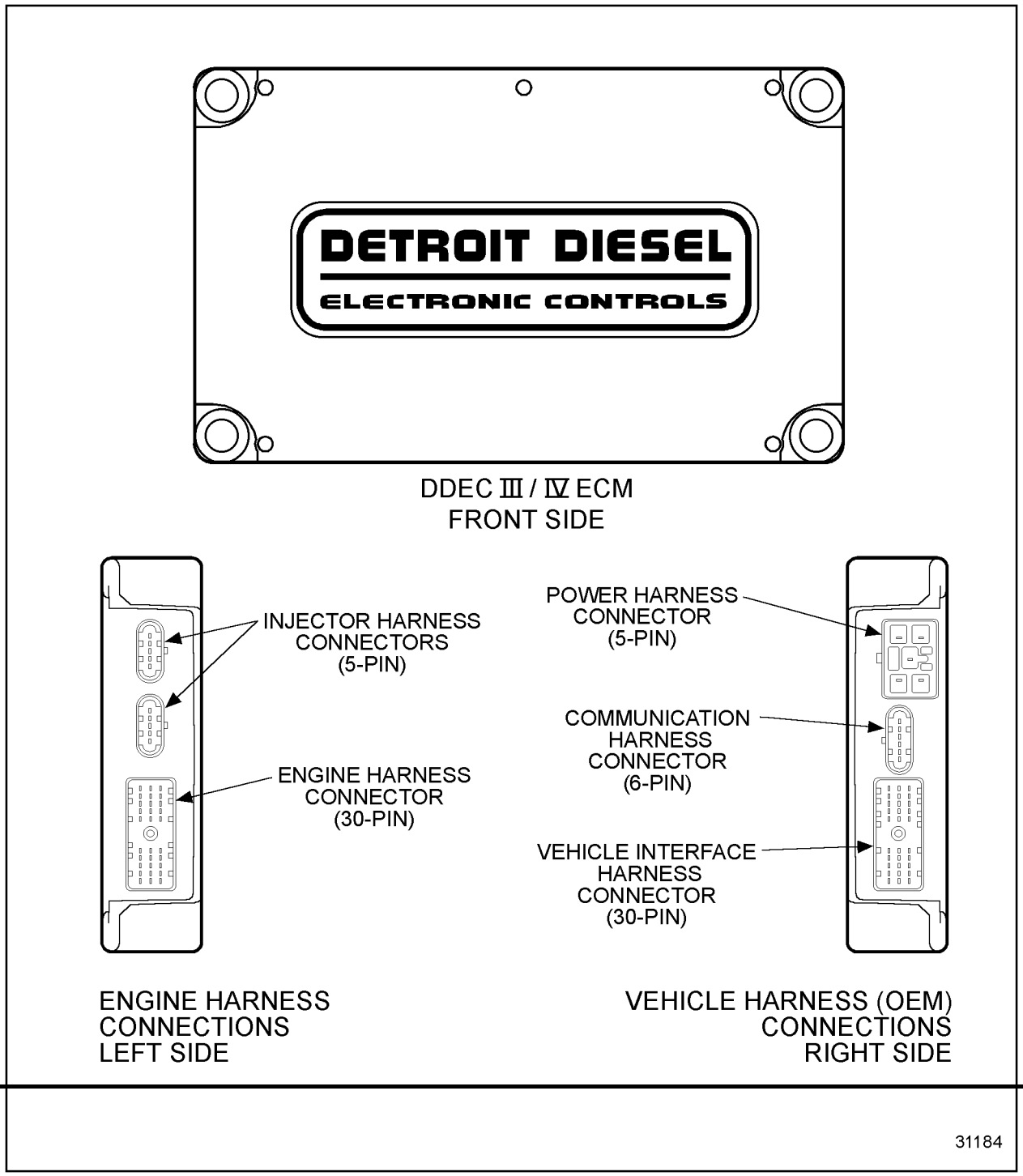

Figure 56-1 ECM

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56.1 DESCRIPTION OF FLASH CODE 56

Flash Code 56 indicates that the J1587 (diagnostic) data link is no longer allowing the ECM, see Figure 56-1, to transmit data.

This diagnostic condition is typically:

- ☐ Either or both of the data link circuits are open at some point in the network.
- ☐ Either or both of the data link circuits are shorted to ground at some point in the network.
- ☐ Either or both of the data link circuits are shorted to battery (+) at some point in the network.
- ☐ The pair of data link circuits are shorted together.

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56.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 56

The SAE J1587 equivalent code for Flash Code 56 is s 250 12.

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56.3 TROUBLESHOOTING FLASH CODE 56

The following procedure will troubleshoot Flash Code 56.

56.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR).
3. Visually check the DDR for codes.
   [a] If codes other than 250/12 are logged, service them first.
   [b] If code 250/12 is logged, and no other codes are logged, Refer to section 56.3.2.
   [c] If no data is logged, refer to section 9.1.

56.3.2 Clear Codes

Perform the following steps to clear codes.

1. Clear codes.
2. Start and run the engine.
3. Observe CEL/code.
   [a] If CEL is on with code 250/12 logged, refer to section 56.3.3.
   [b] If no CEL code is logged, refer to section 56.3.5.

56.3.3 Check for Devices of Original Equipment Manufacturer

Perform the following steps to check for OEM devices.

1. Turn vehicle ignition OFF.
2. Determine if any OEM equipment utilizes the J1587 data link. (ABS, ProDriver ®, satellite systems, etc.
   [a] If any OEM devices are installed, refer to section 56.3.4. Refer to step 1
   [b] If no OEM devices are installed, refer to section 56.3.4. Refer to step 2[a]

56.3.4 Disconnect Nodes (Data Link Devices)

Perform the following steps to disconnect the nodes.

1. Disconnect OEM installed devices, one at a time e.g. ABS, satellite systems, etc. Verify ABS switch is not in "Test" mode.

[a] If the disconnect does not solve the problem, continue the procedure. Refer to step 2[a]

[b] If the disconnect solved the problem, go to 4b.

2. Connect vehicle interface module, J 41005.
3. Start and run the engine.
4. Observe CEL codes.

[a] If CEL or codes displayed, and the CEL is on with code 250/12 logged, replace the ECM with a test ECM. Refer to section 56.3.5.

[b] If no CEL or codes are displayed, contact OEM for instructions on how to proceed. Refer to section 56.3.5.

56.3.5 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.
3. Start and run the engine.

[a] If the CEL or codes are displayed, and if code 250/12 is logged, all system diagnostics are complete. Review this section to find the error.

[b] If the CEL or codes are not displayed, troubleshooting is complete.

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57 (CHG) FLASH CODE 57 - J1922 DATA LINK FAULT

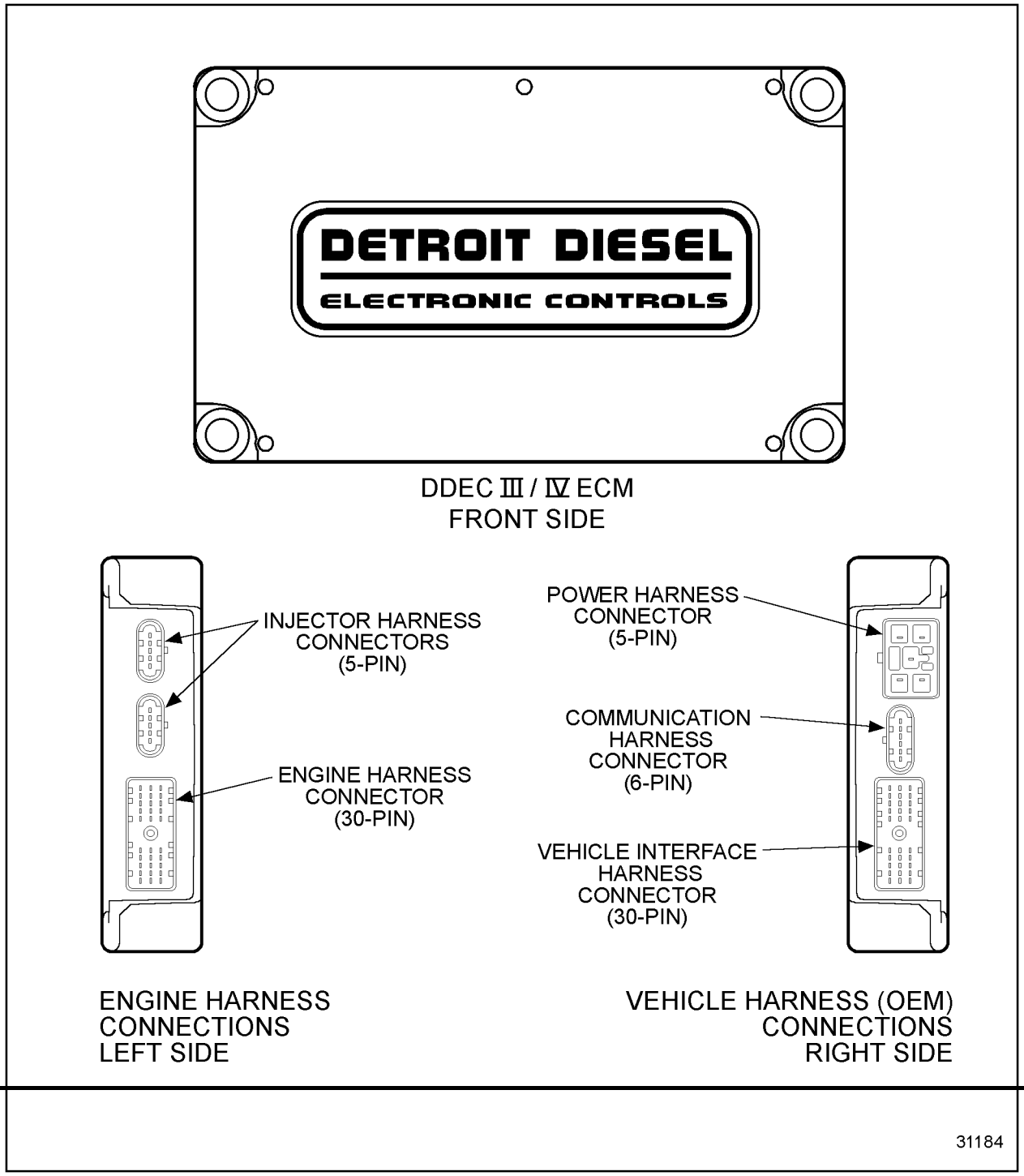

Fig. re 57-1 ECM

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57.1 DESCRIPTION OF FLASH CODE 57

Flash Code 57 indicates that the J 1922 (Low Speed Powertrain) data link is no longer allowing the ECM, see Figure 57-1, to transmit data.

This diagnostic condition is typically:

- ☐ Either or both of the data link circuits are open at some point in the network.
- ☐ Either or both of the data link circuits are shorted to ground at some point in the network.
- ☐ Either or both of the data link circuits are shorted to battery (+) at some point in the network.
- ☐ The pair of data link circuits are shorted together.

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57.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 57

The SAE J1587 equivalent code for Flash Code 57 is s 249 12.

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57.3 TROUBLESHOOTING FLASH CODE 57

The following procedure will troubleshoot Flash Code 57.

57.3.1 Code Check

Perform the following steps to check for codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR).
3. Visually check the DDR for codes.
   [a] If code 249/12 is logged, refer to section 57.3.2.
   [b] If no codes are logged, refer to section 9.1.
   [c] If code 254/12 is logged, and no other codes are logged, replace the ECM. Refer to section 9.1.

57.3.2 Verify Codes

Perform the following steps to verify codes.

1. Clear codes with DDR.
2. Start and run the engine for one minute.
3. Check CEL for codes.
   [a] If CEL is on with code 249/12 displayed, refer to section 57.3.3.
   [b] If CEL is not on and no codes are displayed, refer to section 57.3.5.

57.3.3 Check for OEM Devices

Perform the following steps to check for OEM devices.

1. Turn vehicle ignition OFF.
2. Determine if any OEM equipment utilizes the J 1922 data link. See Figure 57-2.
   [a] If no OEM devices are installed, refer to section 57.3.4. Refer to step 2

[b] If OEM devices are installed, refer to section 57.3.4. Refer to step 1

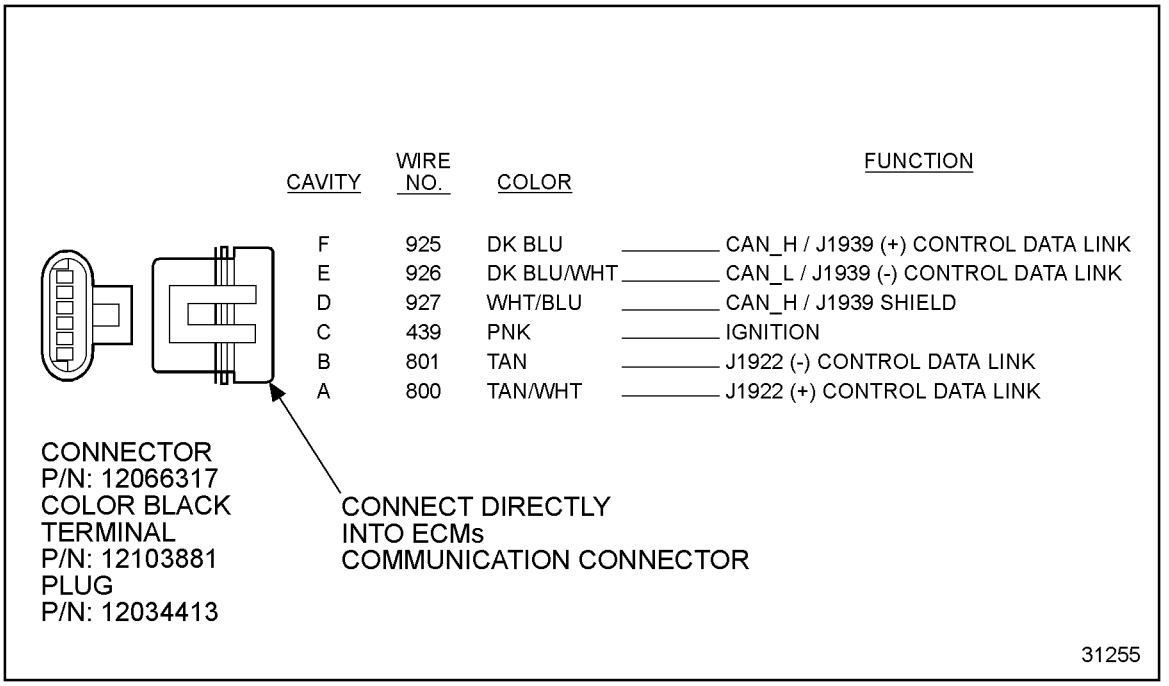

Figure 57-2 Communication Harness

57.3.4 Disconnect Nodes

Perform the following steps to disconnect nodes.

1. Start and run engine with OEM installed devices disconnected.
   [a] If the disconnect does not solve the problem, continue the procedure. Refer to step 2
   [b] If the disconnect solved the problem, Refer to step 44[a].
2. Connect vehicle interface module using J 41005.
3. Start and run engine.
4. Observe CEL codes.
   [a] If no CEL or codes are displayed, contact OEM for instructions on how to proceed. Refer to section 57.3.5. Fault is in node/wiring.
   [b] If CEL is on with code 249/12 logged, install a test ECM. Refer to section 57.3.5.

57.3.5 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition OFF.
2. Reconnect all connectors.

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3. Turn ignition ON.
4. Clear codes with DDR.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for codes.
   [a] If no codes are displayed, troubleshooting is complete.
   [b] If CEL is on with code 249/12 logged, all system diagnostics are complete. To troubleshoot the error, refer to section 57.3.1.

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58 (CHG) FLASH CODE 58

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58.1 DESCRIPTION OF FLASH CODE 58

Flash Code 58 indicates a torque overload.

This code is not covered in this manual. If changes occur, notification will be sent from DDC.

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58.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 58

The SAE J1587 equivalent code for Flash Code 58 is p 092/0.

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59 FLASH CODE 59

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59.1 DESCRIPTION OF FLASH CODE 59

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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60 FLASH CODE 60

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60.1 DESCRIPTION OF FLASH CODE 60

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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61 (CHG) FLASH CODE 61 - INJECTOR RESPONSE LONG

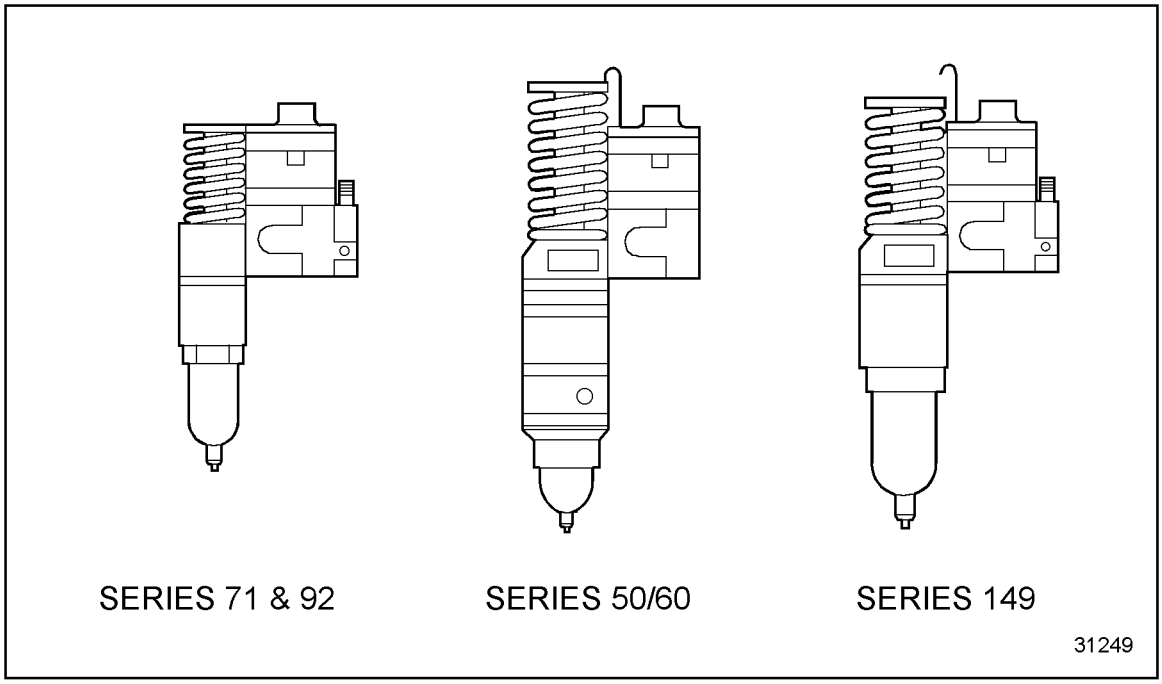

Figure 61-1 Injectors

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61.1 DESCRIPTION OF FLASH CODE 61

Flash Code 61 indicates that the time it takes from when the DDEC III ECM requests an injector, see Figure 61-1, be turned on to when the injector solenoid valve actually closes is longer than the high limit of the expected range. Engine oil temperature must be greater than 87°F (30°C).

This diagnostic condition is typically:

- ☐ Bad injector harness and or connection (high resistance)
- ☐ Poor vehicle grounds
- ☐ Sticky solenoid valve

NOTE:
The injector diagnostic SID (Subsystem Identifier) indicates which cylinder number has an injector with a long response time. The injector number describes the cylinder and or bank which has the injector with a long response time. The DDR will display the injector text description.

Injector response times generally increase with low battery supply voltage and decrease with high battery supply voltage. Although injector response times vary from injector to injector at a given r/min, each individual injector response time should remain relatively consistent from one firing to the next. Wide variations in response time (typically +/- 0.2 msec) for one injector at a steady engine r/min may indicate an electrical problem (faulty alternator or voltage regulator, poor or broken ground cables, etc.).

61.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 61

The SAE J1587 equivalent code for Flash Code 61 is s 001 0, or s 002 0, or s 003 0, or s 004 0, or s 005 0 or s 006 0 (six cylinder engine).

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61.3 TROUBLESHOOTING FLASH CODE 61

The following procedure will troubleshoot Flash Code 61.

61.3.1 Test Alternator Ground

Perform the following steps to test alternator ground.

1. Disable the alternator by removing the alternator belt.
2. Start and run the engine; warm to greater than 87°F (30°C).
3. Does the code return?
   [a] If Flash Code 61 does not return, repair or replace the alternator grounds and refer to section 61.3.5.
   [b] If the code(s) return, refer to section 61.3.2.

61.3.2 Determine Cylinders With Fault

The injector location that is logging the codes is listed in Table 61-1.

	#1	#2	#3	#4	#5	#6	
	(SID 1)	(SID 2)	(SID 3)	(SID 4)	(SID 5)	(SID 6)	
S55/60	1	5	3	6	2	4	cyl #
S50	1	3	4	2	-	-	cyl #

Table 61-1 Determine Cylinders With Fault

1. Disconnect the 5-pin injector harness connector at the ECM for those injectors logging the codes.
2. Establish a good ECM case ground by measuring the resistance across two points on the ECM. The resistance should measure less than or equal to 1 Ω.
3. Once a good case ground is established, keep one of the measurement probes in place and move the other probe to one of the five exposed male injector terminals on the ECM.
4. Measure the resistance. Repeat this procedure at each of the five terminals.
   [a] If any terminals have a resistance of less than 1,000 Ω, replace the ECM. Refer to section 61.3.5.
   [b] If all terminals have a resistance of greater than 1,000 Ω, refer to section 61.3.3.

61.3.3 Check for Short

Perform the following steps to check for a short.

1. Locate the injector harness connector terminals associated with the codes. See Figure 61-2.

2. Measure resistance between that cavity and the cylinder block.
   [a] If measured resistance is less than 10 Ω, the wire is shorted to the engine. Repair or replace the harness and refer to section 61.3.5.
   [b] If measured resistance is greater than 10 Ω, go to step 3.
3. Remove the valve cover to gain access to the cylinder associated with the code.
4. Remove the connector terminals at the injector solenoid(s).
5. Measure resistance between that cavity and the appropriate return cavity (G or E).
   [a] If measured resistance is less than 5 Ω, the wire is shorted to the return wire. Repair or replace the harness and refer to section 61.3.5.

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[b] If measured resistance is greater than 5 Ω, refer to section 61.3.4.

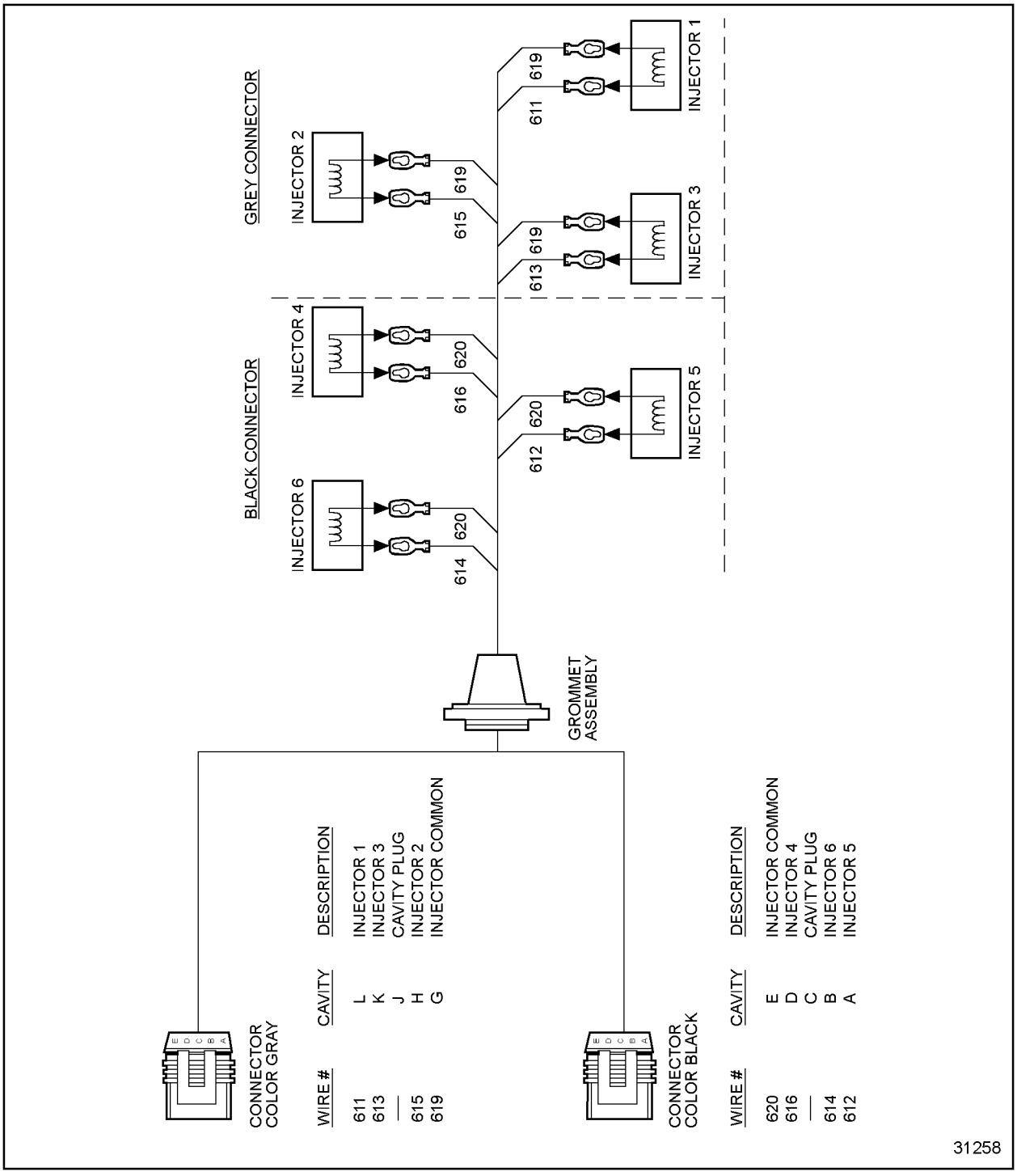

Figure 61-2 Injector Harness

61.3.4 Check for Open

Perform the following steps to check for an open.

1. Insert a jumper wire between the cavity associated with the code and the return for that connector (G or E).
2. Measure resistance across the injector connectors (disconnected from injector solenoid).
   [a] If the measured resistance is greater than 5 Ω, the injector wire is open. Repair or replace the harness and refer to section 61.3.5.
   [b] If the measured resistance is less than 5 Ω, and the ECM software is less than 3.00, reprogram the ECM. Refer to section 61.3.5.

61.3.5 Verify Repairs

Perform the following steps to verify repairs:

1. Start and run the engine. Warm to 87°F (30°C).
2. Check DDR for codes.
   [a] If injector codes are logged, please review this section from the first step to find the problem. Refer to section 61.3.2.
   [b] If no codes are logged, no further troubleshooting is required.

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62 FLASH CODE 62 - OUTPUT FAULT

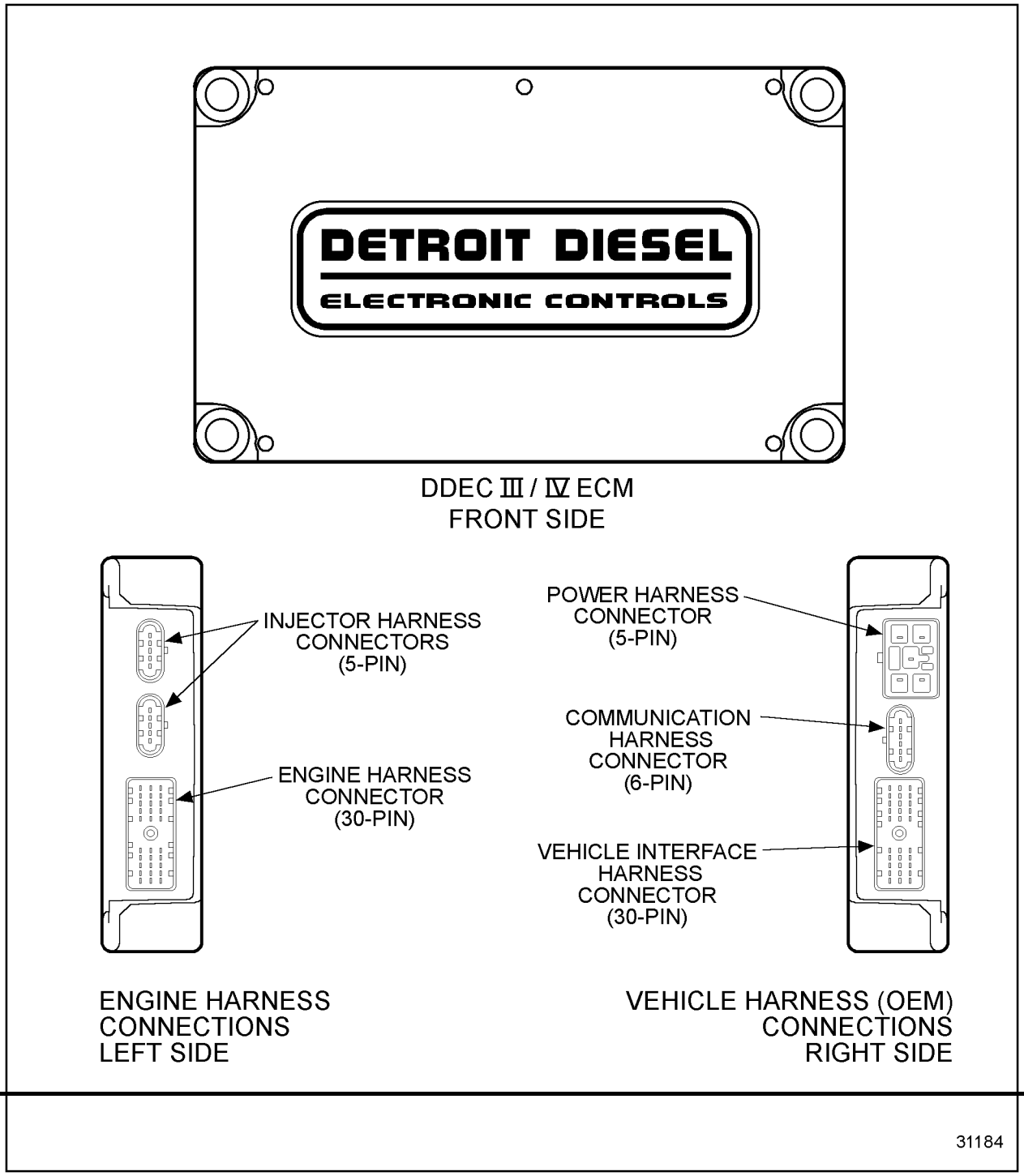

Figure 62-1 ECM

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62.1 DESCRIPTION OF FLASH CODE 62

Flash Code 62 indicates that the function assigned to the Auxiliary Output #1, #2, #5, #6, #7 or #8 circuit output has an open circuit or short to battery (+). A short to battery (+) is detected when the DDEC ECM, see Figure 62-1, is unsuccessful in turning "ON" the configured function.

The DDEC III ECM supplies a switched ground to the AUXILIARY OUTPUT circuit to turn ON the function assigned.

Flash Code 62 may also indicate that the function assigned to the Auxiliary Output #1, #2, #5, #6, #7 or #8 circuit output is open, shorted to ground. This diagnostic condition is detected when the Auxiliary Output # "X" function is OFF and the DDEC III ECM measures a low voltage on the circuit output.

62.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 62

The SAE J1587 equivalent codes for Flash Code 62 are listed in Table 62-1.

SAE J1587 Code	Output Number	Fault
s 026 3	Auxiliary output #1	Short to battery
s 026 4	Auxiliary output #1	Open circuit
s 040 3	Auxiliary output #2	Short to battery
s 040 4	Auxiliary output #2	Open circuit
s 053 3	Auxiliary output #5	Short to battery
s 053 4	Auxiliary output #5	Open circuit
s 054 3	Auxiliary output #6	Short to battery
s 054 4	Auxiliary output #6	Open circuit
s 055 3	Auxiliary output #7	Short to battery
s 055 4	Auxiliary output #7	Open circuit
s 056 3	Auxiliary output #8	Short to battery
s 056 4	Auxiliary output #8	Open circuit

Table 62-1 Auxiliary Output Open or Short to Battery

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62.3 TROUBLESHOOTING FLASH CODE 62

The following procedure will troubleshoot Flash Code 62.

62.3.1 Code Check

Perform the following steps to check for codes.

1. Turn vehicle ignition ON.
2. Plug in the diagnostic data reader (DDR).
3. Record codes logged.
4. Clear codes.
5. Start and run the engine for one minute.
   [a] If the code becomes active, refer to section 62.3.3.
   [b] If the code does not become active, refer to section 62.3.2.

62.3.2 Intermittent Code Check

Perform the following steps to check intermittent codes.

1. Perform road test.
   [a] If the code returns, refer to section 62.3.3.
   [b] If the code does not display again, return the vehicle to service, or refer to section 10.1.1.

62.3.3 Auxiliary Output Cavity Determination

Perform the following steps to determine which auxiliary output cavity is associated with the logged codes.

1. Determine which auxiliary output cavity is associated with the code or codes being logged. The SAE code descriptions of the flash codes and the DDC wire numbers are listed in Table 62-2. Continue troubleshooting. Refer to section 62.3.4.

SAE Code Description - Flash Code	DDC Wire Number	Cavity
Auxiliary Output #1 (026 3 or 026 4) 62	499	F3 (VIH)*
Auxiliary Output #2 (040 3 or 040 4) 62	555	A2 (VIH)
Auxiliary Output #5 (053 3 or 053 4) 62	563	W3 (ESH) †
Auxiliary Output #6 (054 3 or 053 4) 62	564	X3 (ESH)
Auxiliary Output #7 (055 3 or 055 4) 62	565	Y3 (ESH)
Auxiliary Output #8 (056 3 or 056 4) 62	988	A1 (VIH)

* Vehicle Interface Harness

† Engine Sensor Harness

Table 62-2 Auxiliary Output Cavities

62.3.4 Electrical Check

Perform the following steps to check connectors, dash light or vehicle power-down relay, or item being driven.

1. Check the connectors of the output wire associated with the code logged at the vehicle harness connector or engine sensor harness connector.
2. Check the connectors of the output wire associated with the code logged at the item being driven.
   [a] If the connectors are not good, repair or replace the terminals. Refer to section 62.3.6.
   [b] If the connectors are good and the items being driven (e.g. relay, light) are not in good condition, repair or replace the device. (Contact OEM for test procedure.) Refer to section 62.3.6.
   [c] If the connectors are good and the items being driven (e.g. relay, light, are in good condition, refer to section 62.3.5.

62.3.5 Measure Resistance

Perform the following steps to measure the resistance.

1. Turn ignition OFF.

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2. Connect the engine sensor harness or vehicle interface harness (connector with output fault).
3. Disconnect the output wire associated with the code logged at the component.
4. Measure the resistance between the removed connector and the ECM case.
   [a] If the reading is 47,000 Ω (± 3,000 Ω), contact Detroit Diesel Technical Service.
   [b] If the reading is less than 44,000 Ω or greater than 50,000 Ω, this wire is shorted to the battery or open. Repair or replace this wire. Refer to section 62.3.6.

62.3.6 Verify Repairs

Perform the following steps to verify repairs.

1. Reconnect all connectors.
2. Plug DDR into the connector.
3. Clear all codes.
4. Start and run the engine.
   [a] If the output code returns, refer to section 62.3.1.
   [b] If the output code does not return, troubleshooting is complete.

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63 FLASH CODE 63 - PWM FAULT

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63.1 DESCRIPTION OF FLASH CODE 63

Flash Code 63 indicates that the pulse width modulation (PWM) output(s) used is either shorted to battery positive or open-circuited.

63.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 63

The SAE J1587 equivalent code for Flash Code 63 is s 057 3, or s 057 4, or s 058 3, or s 058 4, or s 059 3, s 059 4, or s 060 3, or s 060 4.

(FMI 3 = Short to Battery; FMI 4 = Open Circuit)

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63.3 TROUBLESHOOTING FLASH CODE 63

The following procedure will troubleshoot Flash Code 63.

63.3.1 Determine Assignment

Perform the following steps to determine assignment.

1. Turn ignition ON.
2. Plug in the DDR.
3. Select INs/OUTs. To what is PWM assigned? Write down assignment vs cavity and code, listed in Table 63-1.

Code	PWM	Wire Location	Wire #
S057	PWM #1	J3	#908
S058	PWM #2	Y1	#909
S059	PWM #3	E2	#910
S060	PWM #4	X2	#911

Table 63-1 PWM Assignments

4. Select code display.
5. Determine Failure Mode Identifier (FMI).
   [a] If FMI 3 displays, there is a short to the battery. Refer to section 63.3.2
   [b] If FMI 4 displays, refer to step 6
6. Verify function.
   [a] If there is a component wired to this position, refer to section 63.3.3.
   [b] If there is no component wired to this position, reprogram to eliminate the assigned function. (A change may be required to the DDC mainframe.) Refer to section 63.3.9.

63.3.2 Verify Short to Battery

Perform the following steps to verify a short to battery:

1. Turn ignition OFF.
2. Disconnect 30-pin connector: engine connector if PWM 2, 3 or 4; vehicle connector if PWM 1.
3. Measure voltage between the cavity with the code and the good ground.
   [a] If the voltage measurement is greater than 3 volts, the connector is shorted to the battery. Repair. Refer to section 63.3.9.

[b] If the voltage measurement is less than 3 volts, contact Detroit Diesel Technical Service.

63.3.3 Check Component Connections

Perform the following steps to check component connections:

1. Turn the vehicle ignition switch to the OFF position.
2. Inspect the connections of the PWM wire associated with the flash code logged at both harness connector and the item being driven.
   [a] If the connectors are damaged or broken, repair or replace the damaged terminals. Verify repairs. Refer to section 63.3.9.
   [b] If the connectors are not damaged or broken, ensure the item is connected to the pulse width modulation wire. If the item is not connected, repair or replace the connector. Verify repairs. Refer to section 63.3.9.
   [c] If the item is connected, measure the resistance. Refer to section 63.3.8.
   [d] If this is an Optimized Idle vehicle, refer to section 63.3.4.

63.3.4 Check Installation of the Starter Harness Overlay Kit

Perform the following steps to check for proper installation of the starter harness overlay kit when a Code 63 is logged and the engine does not start; see Figure 63-1.

1. Turn off ignition (Optimized Idle Applications).
2. Remove relay from relay block.
3. Measure voltage between terminal 85 on the relay block and a good ground.
   [a] If voltage measurement is less than 4 VDC, the power lead to the relay is open. Verify connection of wire #439 from the starter relay harness overlay to DDEC wire #439 in the cab.
   [b] If voltage measurement is more than 4 VDC, measure voltage between terminal 86 on the relay block and a good ground. If voltage is less than 4 VDC, the resistor built into the harness is defective. Replace the harness and verify repairs. Refer to section 63.3.5.
   [c] If voltage measurement is more than 4 VDC, measure voltage between terminal 86 on the relay block and a good ground. If voltage is more than 4 VDC, the circuit

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between terminal 86 on the new relay and power side of Optimized Idle starter relay is open. Repair the open circuit and verify repairs. Refer to section 63.3.9.

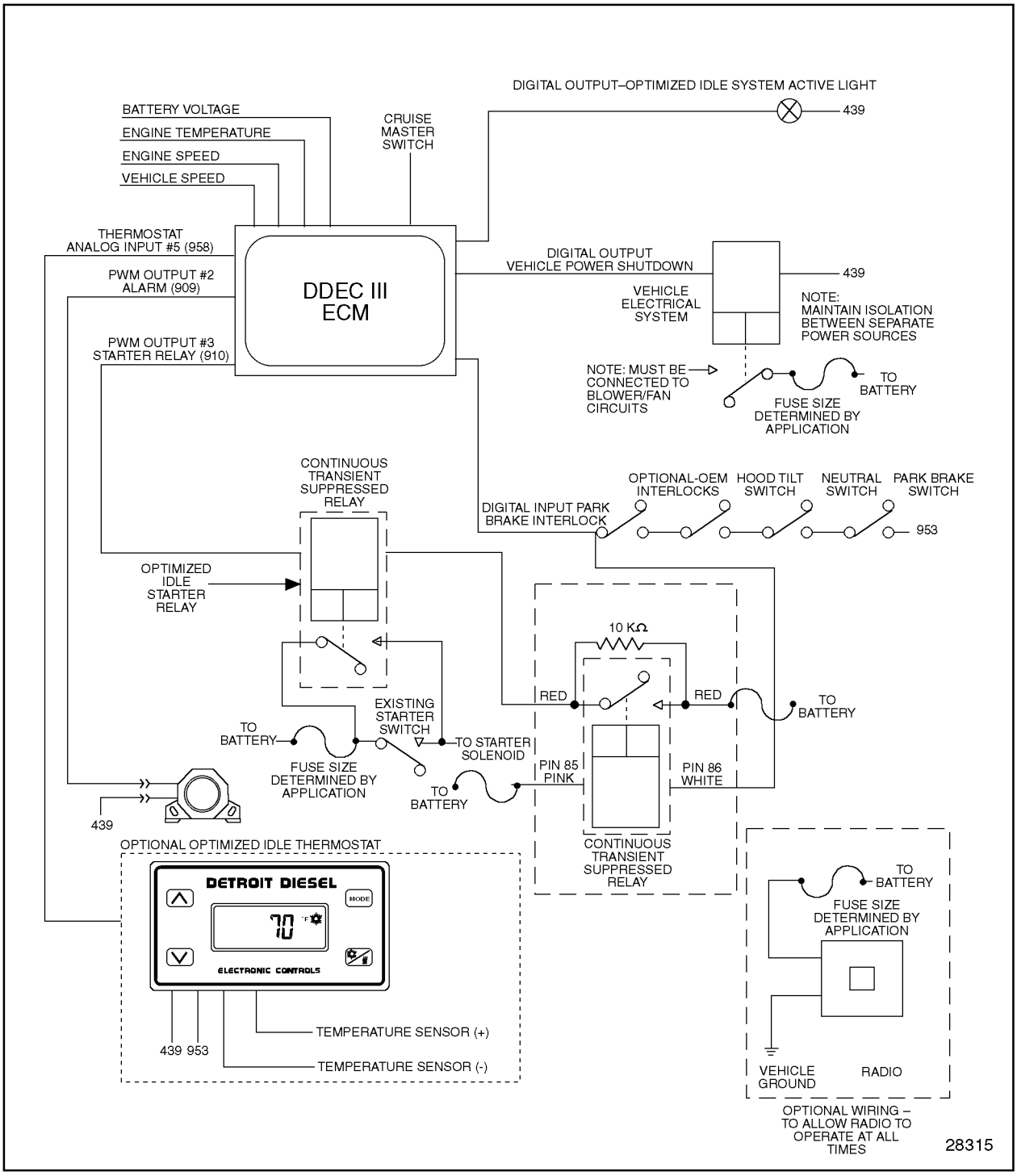

Figure 63-1 Optimized Idle Schematic

63.3.5 Verify Installation of Starter Relay Harness Overlay Service Kit

Use the following procedure to verify installation of the starter relay harness overlay service kit on Optimized Idle equipped vehicles only.

1. Turn ignition to ON position. Start engine.
2. Toggle cruise ON/OFF switch from OFF to ON. The Optimized Idle light should flash.
3. After the engine shuts down, turn the thermostat on by pressing any button.
4. Press UP or DOWN arrow until the heat or cool symbol begins to flash.
   [a] If the engine starts, the repairs are complete. Refer to section 63.3.9.
   [b] If the engine does not start, refer to section 63.3.6.

63.3.6 Engine Does Not Start in Optimized Idle Mode

Perform the following steps to start the engine.

1. Verify the hood is closed; the transmission is in neutral; the parking brake is set; and the vehicle wheels are blocked.

CAUTION:

To avoid personal injury, before starting and running the engine, be sure that the vehicle is parked on a level surface and that the wheels are properly blocked.

2. Remove the overlay relay from the relay block.
3. Measure voltage between terminal 85 and terminal 86 of the relay block.
   [a] If voltage measurement is less than 4 VDC, the white wire in the overlay harness is open. Repair the open circuit between the overlay harness and the hood/cab switch. Refer to section 63.3.5.
   [b] If voltage measurement is more than 4 VDC, the relay is inoperative. Replace the relay. Refer to section 8.6.5 of the proper engine Service Manual. Verify the repairs. Refer to section 63.3.9.
   [c] If this is a Series 55 engine, refer to section 63.3.7.

63.3.7 Verify Harness

Perform the following steps to verify harness.

1. If this is a Series 55 engine, verify the engine harness is correct, especially PWM 3 and 4.
   [a] If the harness is not correct, replace it. Refer to section 63.3.9.

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[b] If the harness is correct, refer to section 63.3.8.

63.3.8 Measure Resistance Between Connector and the Electronic Control Module Case

Perform the following steps to measure resistance between the connector and the ECM case:

1. Turn the vehicle ignition to the OFF position.
2. Ensure connector is installed on the engine harness side or vehicle harness side.
3. Disconnect the PWM wire associated with the code logged at the component.
4. Measure the resistance between the removed connector and the ECM case.
   [a] If the resistance measurement is between 46,000 and 48,000 Ω, verify the pin assignment with wiring - view with DDR. Refer to section 63.3.9.
   [b] If the resistance measurement is not between 46,000 and 48,000 Ω, the wire is open or shorted to battery. Repair or replace the wire. Verify repairs. Refer to section 63.3.9.

63.3.9 Verify Repairs

Perform the following steps to verify repairs for Flash Code 63. To check Optimized Idle, refer to *Optimized Idle Manual* 6SE518.

1. Reconnect all connectors.
2. Clear all codes from the DDR.
3. Plug in the DDR.
4. Turn vehicle ignition switch to the ON position.
   [a] If Flash Code 63 was not logged, no further troubleshooting is required.
   [b] If Flash Code 63 was logged, please review this section from the first step to find the error. Refer to section 63.3.1.

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64 (CHG) FLASH CODE 64

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64.1 DESCRIPTION OF FLASH CODE 64

Flash Code 64 is used to identify a turbo speed fault.

This code is not covered in this manual. If changes occur, notification will be sent from DDC.

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64.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 64

The SAE J1587 equivalent code for Flash Code 64 is p 103/0, turbo overspeed, and p 103/8, turbo speed sensor input failure.

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65 (CHG) FLASH CODE 65 - THROTTLE VALVE FAULT

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65.1 DESCRIPTION OF FLASH CODE 65

For diesel-fueled engines, Flash Code 65 indicates that the air filter sensor input voltage has exceeded or dropped below the expected range.

This code is not covered in this manual (for diesel engines). If changes occur, notification will be sent from DDC.

For gas-fueled engines, Flash Code 65 indicates a fault in the throttle plate.

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65.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 65

For diesel engines, the SAE J1587 equivalent codes for Flash Code 65 are 107/3, air filter sensor voltage high, and 107/4, air filter sensor voltage low.

For gas engines, the SAE J1587 equivalent codes for Flash Code 65 is one of the following:

- ☐ p 051/0 - Throttle plate above normal range
- ☐ p 051/1 - Throttle plate below normal range
- ☐ p 051/7 - Throttle plate not responding

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65.3 TROUBLESHOOTING FLASH CODE 65

The following procedure will troubleshoot Flash Code 65.

65.3.1 Determine System and Failure

Determine system and failure as follows:

1. Is code 051/0 and system model year 1997 or older with a 24–volt power supply.
   [a] Yes to both — install jumper and refer to section 65.3.8.
   [b] No to either — for jumper harness already installed, refer to section 65.3.2.

65.3.2 Check for Voltage

Perform the following steps to check for voltage.

1. Unplug throttle actuator sensor harness connector. See Figure 65-1.
2. Turn ignition ON.
3. Measure voltage between cavity A and B of the connector.
   [a] If the battery voltage reading (12v/24v) is ± 2 volts, refer to section 65.3.3.

[b] If the voltage is low, refer to section 65.3.4.

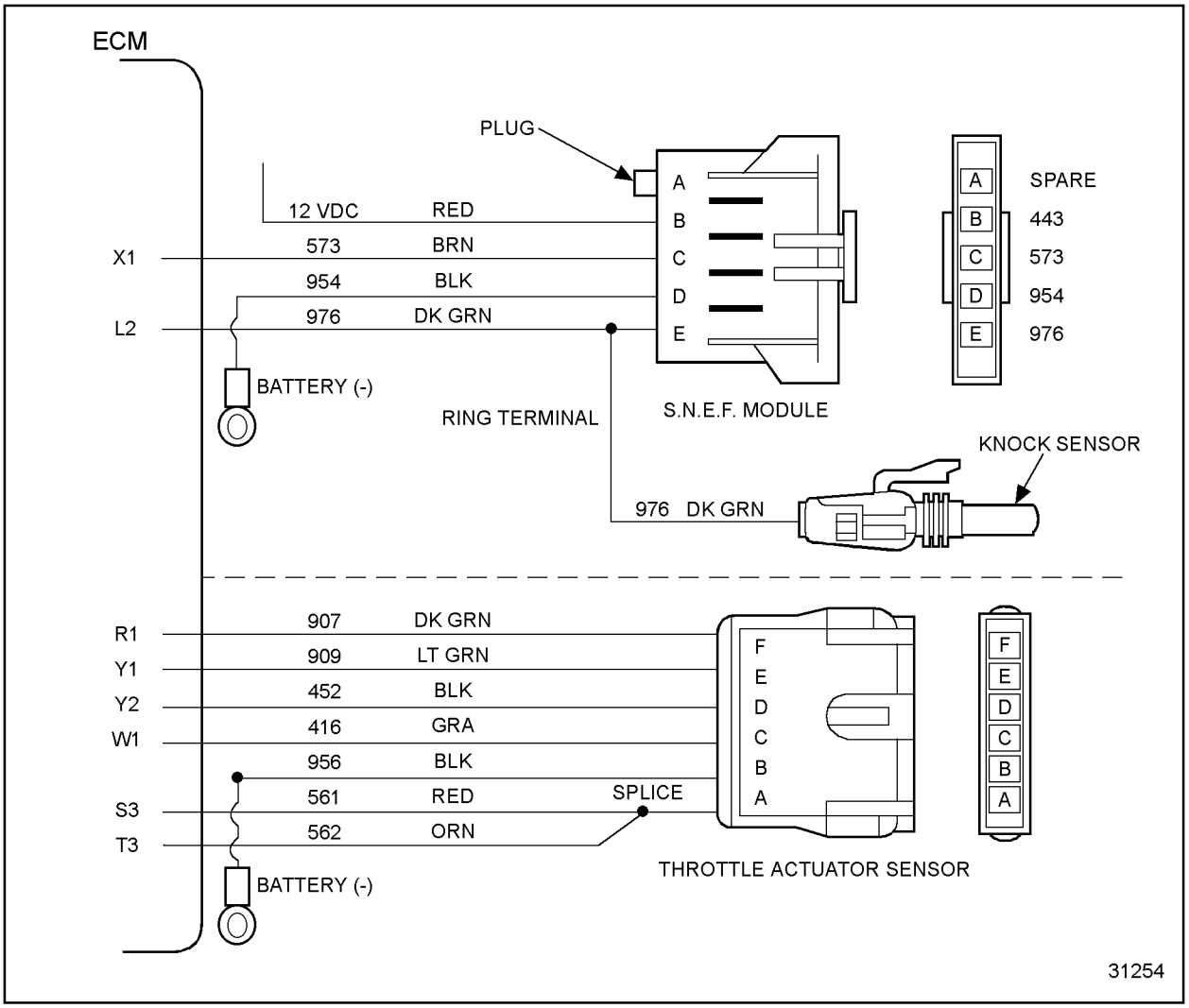

Figure 65-1 Series 50 Gas Engine Sensor Harness

65.3.3 Check for Ground

Perform the following steps to check for ground:

1. Turn ignition OFF.
2. Check ground wire from Cavity B to battery negative (-).
   [a] If the ground wire is okay, refer to section 65.3.5.
   [b] If the ground wire is bad, repair and refer to section 65.3.8.

65.3.4 Check for Supply

Perform the following steps to check for supply:

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1. Turn ignition OFF.
2. Unplug engine sensor harness.
3. Install a jumper between wire cavity A and F of the throttle actuator connector.
4. Measure resistance between cavity R1 and S3, then R1 and T3 at the engine sensor harness.
   [a] If both readings are less than 1,000 Ω refer to section 65.3.5.
   [b] If either reading is greater than 1,000 Ω, it indicates the #561 or #562 wire is open. Repair or replace the wire and refer to section 65.3.8.

65.3.5 Check PWM #2

Perform the following steps to check PWM #2:

1. Move jumper to cavities E and F at the throttle activator.
2. Measure resistance between cavities R1 and Y1 of the engine sensor harness.
   [a] If the measurement is less than 1,000 Ω, refer to section 65.3.6.
   [b] If the measurement is greater than 1,000 Ω, the wire #909 (PWM#2) is open. Repair or replace the wire and refer to section 65.3.8.

65.3.6 Check Connectors

Perform the following steps to check the connectors.

1. Check both connectors for damaged, bent or broken pins or terminals.
   [a] If the connectors are not damaged, refer to section 65.3.7.
   [b] If the connectors are damaged, repair or replace the connectors. Refer to section 65.3.8.

65.3.7 Check for Short

Perform the following steps to check for a short.

1. Remove jumper.
2. Measure resistance between cavity Y1 and R1 on the engine sensor harness.
3. Measure resistance between Y1 and T3 of the engine sensor harness.
   [a] If the measured resistance is less than 1,000 Ω, the wires are shorted to each other. Repair or replace the wires and refer to section 65.3.8.
   [b] If the measured resistance is greater than 1,000 Ω, troubleshooting is complete. Review this section or contact Detroit Diesel Technical Service to replace the actuator. Refer to section 65.3.8.

65.3.8 Verify Repairs

Perform the following steps to verify repairs.

1. Connect all connectors.
2. With the ignition ON, plug in the DDR and clear the codes.
3. Throttle the engine through various speeds (r/min).
4. Shut the engine off.
5. Turn ignition ON.
6. Read the logged codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 65 is logged with any other codes, troubleshooting is complete. Review this section or contact Detroit Diesel Technical Service.

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66 (CHG) FLASH CODE 66 - KNOCK SENSOR FAULT

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66.1 DESCRIPTION OF FLASH CODE 66

Flash Code 66 indicates the oil filter sensor input to the ECM has exceeded or dropped below the allowed range.

This code is not covered in this manual (for diesel engines). If changes occur, notification will be sent from DDC.

For gasoline engines, Flash Code 66 indicates one or more faults have occurred in the engine knock level circuitry.

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66.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 66

For diesel engines, the SAE J1587 equivalent code for Flash Code 66 is p 099/3, oil filter sensor input voltage high or p 099/4, oil filter sensor input voltage low.

For gasoline engines, the SAE J1587 equivalent code for Flash Code 66 is one of the following: s 076 0, s 076 7, s 076 3 or s 076 4.

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66.3 TROUBLESHOOTING FLASH CODE 66

The following procedure will troubleshoot Flash Code 66.

66.3.1 Determine Failure

The following procedure will enable you to determine the failure.

1. Code s 076 0, knock level above normal range - A Failure Mode Identifier (FMI) of 0 is used to advise the user that the knock level is too high to allow the electronics to compensate for it. Troubleshoot this as a mechanical problem.
2. Code s 076 - 7, knock level torque reduction - An FMI of 1 is used to advise the user the loss of engine power is due to the engine electronics trying to adjust the fueling to further reduce the knock level. Clear the code and retest. If the code continues to occur, contact Detroit Diesel Technical Service.
3. For code s 076-3, knock sensor input voltage high, refer to section 66.3.2.
4. For code s 076-4, knock sensor input voltage low; refer to section 66.3.3.

66.3.2 Check Signal to Noise Enhancement Filter Module / Knock Sensor

Perform the following steps to check the Signal to Noise Enhancement Filter (SNEF) and knock sensor.

1. Unplug the SNEF module.
2. Turn ignition ON.
3. Plug in DDR. Read codes.
   [a] If code s 076-4 is logged, refer to section 66.3.4.
   [b] If code s 076-3 is logged, refer to section 66.3.5.

66.3.3 Check for Open

Perform the following steps to check for an open:

1. Unplug SNEF.
2. Install a jumper wire between cavity B and E.
3. Turn ignition ON.
4. Plug in DDR. Read codes.
   [a] If code s 076-3 is logged, refer to section 66.3.4.
   [b] If code s 076-4 is logged, refer to section 66.3.7.

66.3.4 Check Connectors

Perform the following steps to check the connectors.

1. Check connectors at ECM and SNEF module.
   [a] If the connectors are in good condition, replace the SNEF module. Refer to section 66.3.9.
   [b] If the connectors are damaged, repair and refer to section 66.3.9.

66.3.5 Check for Short to (+)

Perform the following steps to check for a short to positive (+).

1. Turn ignition OFF.
2. Disconnect the engine sensor harness. See Figure 66-1.

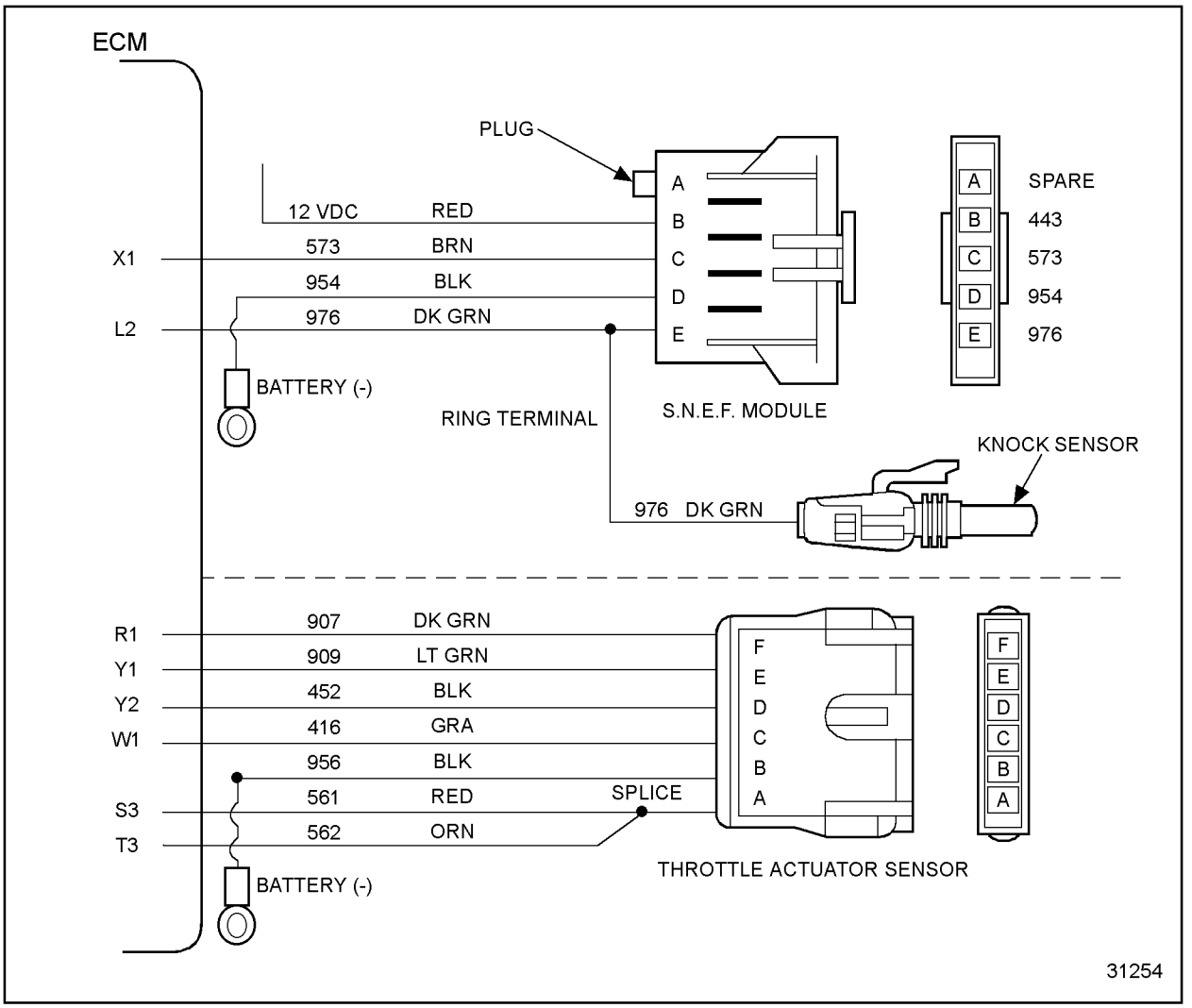

Figure 66-1 Series 50 Gas Engine Sensor Harness

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3. Measure resistance between cavity A and E of the SNEF module connector.
   [a] If the measured resistance is less than 1,000 Ω, the wires are shorted to each other. Repair the wires and refer to section 66.3.9.
   [b] If the measured resistance is greater than 1,000 Ω, refer to section 66.3.6.

66.3.6 Check for Ground

Perform the following steps to check for a ground:

1. Measure resistance between cavity D and battery ground.
   [a] If the measured resistance is greater than 1,000 Ω, the ground wire is open. Repair the open and refer to section 66.3.9.
   [b] If the measured resistance is less than 1,000 Ω, replace the SNEF module and refer to section 66.3.9.

66.3.7 Check for Short to Ground

Perform the following steps to check for a short to ground.

1. Turn ignition OFF.
2. Remove jumper wire.
3. Disconnect the engine harness connector.
4. Measure resistance between cavity A of the SNEF connector and a good ground.
   [a] If the measured resistance is less than 1,000 Ω, the signal wire (#976) is shorted to battery (-). Repair or replace the wire and refer to section 66.3.9.
   [b] If the measured resistance is greater than 1,000 Ω, replace the knock sensor and refer to section 66.3.8.

66.3.8 Check for Signal Open

Perform the following steps to check for a signal open.

1. Insert jumper wire between E and C of the SNEF module connector.
2. Unplug the engine sensor harness connector.
3. Measure resistance between L2 (#976) and X1 (#573).
   [a] If the measured resistance is greater than 1,000 Ω, wire #976 is open. Repair or replace the wire and refer to section 66.3.9.
   [b] If the measured resistance is less than 1,000 Ω, refer to section 66.3.4.

66.3.9 Verify Repairs

Perform the following steps to verify repairs.

1. Hook up all connectors.
2. Start and run the engine.
3. Operate under load. Road test.
4. Turn engine off.
5. Turn ignition ON.
6. Plug in DDR. Read logged codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code s 076-X is logged, all system diagnostics are complete. Please review this section from the first step to find the problem. Refer to section 66.3.1, or contact Detroit Diesel Technical Service.

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67 (CHG) FLASH CODE 67 - MAP SENSOR FAULT

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67.1 DESCRIPTION OF FLASH CODE 67

For diesel engines, Flash Code 67 indicates that the coolant pressure input voltage to the ECM has exceeded or dropped below the allowed range.

This code is not covered in this manual (for diesel engines). If changes occur, notification will be sent from DDC.

For gas engines, Flash Code 67 indicates that the input voltage to the ECM from the air inlet pressure sensor has dropped below 5%, or gone above 95% of the sensor supply voltage.

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67.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 67

For diesel engines, the SAE J1587 equivalent codes for Flash Code 67 are 109/3, coolant pressure sensor input voltage high, and 109/4, coolant pressure sensor input voltage low.

For gas engines, the SAE J1587 equivalent codes for Flash Code 67 are p 106/3, air inlet pressure sensor input voltage high, and p 106/4, air inlet pressure sensor input voltage low.

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67.3 TROUBLESHOOTING FLASH CODE 67

The following procedure will troubleshoot Flash Code 67.

67.3.1 Determine Failure

Perform the following steps to determine failure.

1. Turn ignition ON.
2. Plug in DDR.
3. Read codes.
   [a] If code 106/3 is logged, refer to section 33.3.2.
   [b] If code 106/4 is logged, refer to section 34.3.2.

NOTE:
Turbo Boost Sensor (TBS) references = air inlet pressure MAP (Manifold Air Pressure) sensor for troubleshooting codes 106/3 and 106/4. The wire numbers are the same.

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68 FLASH CODE 68 - IDLE VALIDATION FAULT

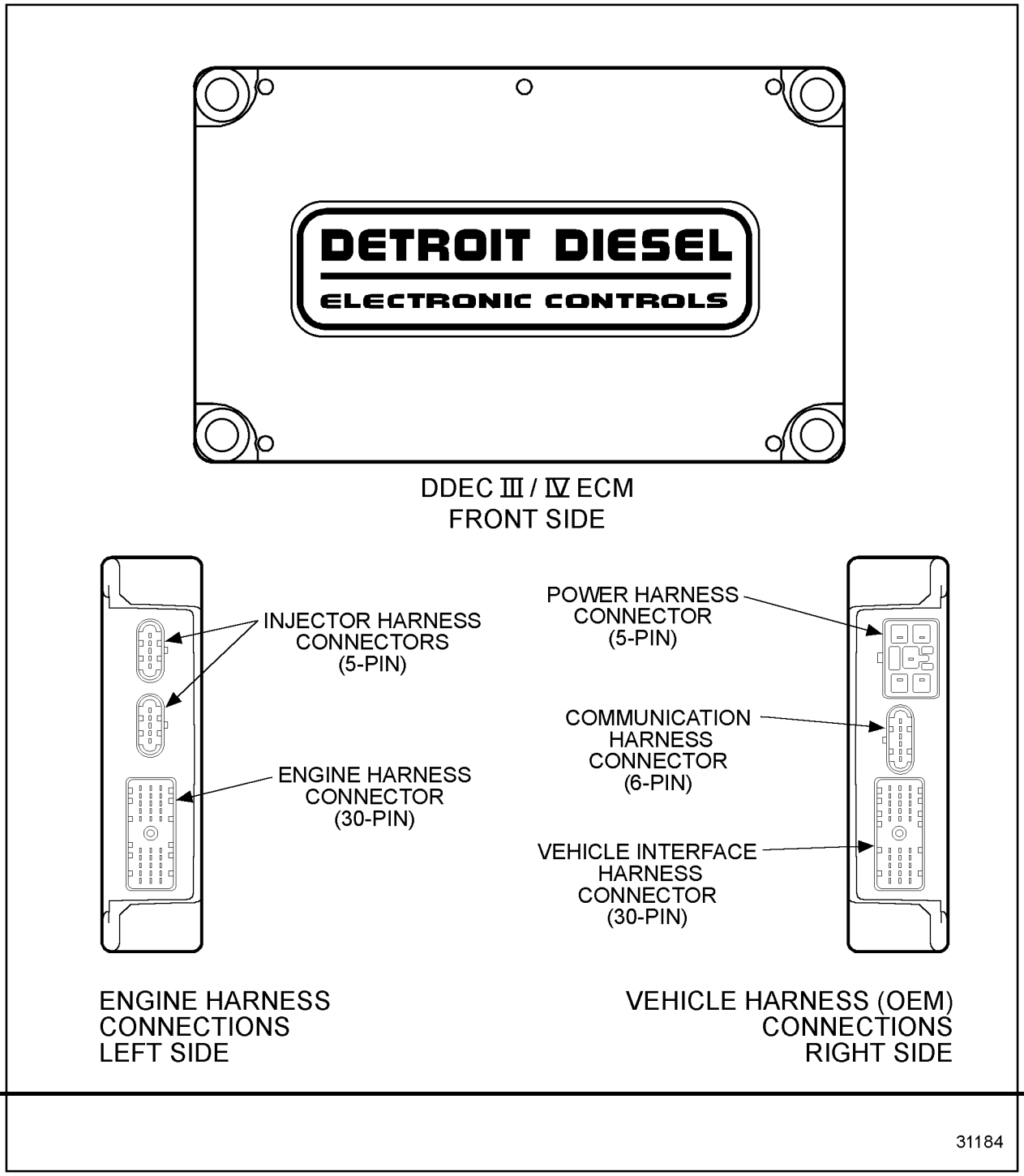

Figure 68-1 ECM

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68.1 DESCRIPTION OF FLASH CODE 68

Flash Code 68 indicates that the ECM, see Figure 68-1, has detected a fault in the idle validation switch (IVS) logic.

68.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 68

The SAE J1587 equivalent code for Flash Code 68 is s 230 5 (open circuit) or s 230 6 (short to ground).

NOTE:
Code 230/5 (open) is set when TPS counts are less than 120 and IVS input is opened.

NOTE:
Code 230/6 (short to ground) is set when TPS counts are greater than 282 and IVS input is grounded to battery (-).

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68.3 TROUBLESHOOTING FLASH CODE 68

The following procedure will troubleshoot Flash Code 68.

68.3.1 Check for Idle Validation Switch Code

Perform the following steps to check for IVS active code:

1. Turn ignition ON.
2. Plug in DDR.
3. Cycle foot pedal; then read codes.
   [a] If the IVS code is open (FMI=5), validate the throttle pedal application. Refer to section 68.3.4.
   [b] If the IVS code is grounded (FMI=6), check the IVS switch. Refer to section 68.3.2.

68.3.2 Check the Idle Validation Switch

Perform the following step to check the idle validation switch:

1. Turn the vehicle ignition switch to the ON position.

CAUTION:

To avoid personal injury, before starting and running the engine, be sure that the vehicle is parked on a level surface and that the wheels are properly blocked.

2. Start and run the engine.

NOTE:
Vehicle need not be moving to perform this check.

3. Plug in DDR.
4. Compare idle validation switch input status (switch light status) with the throttle position sensor counts.
   [a] If the IVS status is ON with the TPS count being greater than 282, measure for resistance. Refer to section 68.3.3.
   [b] If the IVS status is OFF with the TPS count being greater than 282, clear inactive codes. No further troubleshooting is required. Refer to section 68.3.7.

68.3.3 Check Resistance Between Idle Validation Switch Contacts

Perform the following steps to measure resistance:

1. Turn vehicle ignition to the ON position. Refer to OEM guidelines.
2. Move TPS so counts are greater than 285.
3. Measure resistance between the ECM input (IVS) at the TPS and battery ground using a volt-ohm meter.
   [a] If the resistance was less than 100 Ω, the idle validation input/switch is grounded or defective. Contact OEM for repair procedure. Refer to section 68.3.7.
   [b] If the resistance was greater than 100 Ω, the fault condition no longer exists. No further troubleshooting is required. Refer to section 68.3.7.

68.3.4 Check for Throttle Pedal Application

Perform the following steps to determine which type of TPS is being used:

1. Visually check to determine which throttle pedal has been installed that utilizes the IVS function.
   [a] If the throttle pedal has an idle validation switch installed, verify TPS count. Refer to section 68.3.5.
   [b] If the throttle pedal has no idle validation switch installed, update customer calibration using a programming station. Change the settings from idle validation to "No Function" and save changes. Verify repairs. Refer to section 68.3.7.

68.3.5 Determine Throttle Position Sensor Counts / Idle Validation Switch Status

Perform the following steps to determine TPS counts:

1. Turn vehicle ignition to the ON position. Refer to OEM guidelines.

CAUTION:

To avoid personal injury, before starting and running the engine, be sure that the vehicle is parked on a level surface and that the wheels are properly blocked.

2. Plug in DDR.

NOTE:
Vehicle need not be moving to determine TPS counts.

3. Compare idle validation switch status (switch light status) with the throttle position sensor counts.
   [a] If the IVS input is ON with the TPS count being less than 120, the problem no longer exists. Refer to section 68.3.7.

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[b] If the IVS input is OFF with the TPS count being less than 120, refer to section 68.3.6.

68.3.6 Check Resistance Between Idle Validation Switch Contacts

Perform the following steps to determine resistance:

1. Turn vehicle ignition switch to the ON position.
2. Measure resistance between the ECM input at the TPS/IVS end of the harness and battery ground.
   [a] If the resistance is less than 100 Ω, the IVS is defective. Replace the switch. (Contact the OEM for procedure.) Verify repairs. Refer to section 68.3.7.
   [b] If the resistance is greater than 100 Ω, either the IVS input or #953 wire is open or the IVS is defective. Replace the switch. (Contact the OEM for procedure.) Verify repairs. Refer to section 68.3.7.

68.3.7 Verify Repairs

Perform the following steps to verify repairs:

1. Clear inactive codes.

CAUTION:

To avoid personal injury, before starting and running the engine, be sure that the vehicle is parked on a level surface and that the wheels are properly blocked.

2. Start and run the engine.
3. Depress foot pedal to at least half throttle (>290 counts).
4. Release foot pedal and allow the engine to idle.
5. Visually observe the check engine light (CEL) and DDR.
   [a] If the CEL comes on, no further troubleshooting is required.
   [b] If code 68 is logged, refer to section 68.3.1 to troubleshoot Flash Code 68 again.

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69 FLASH CODE 69

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69.1 DESCRIPTION OF FLASH CODE 69

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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70 FLASH CODE 70

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70.1 DESCRIPTION OF FLASH CODE 70

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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71 (CHG) FLASH CODE 71 - INJECTOR RESPONSE SHORT

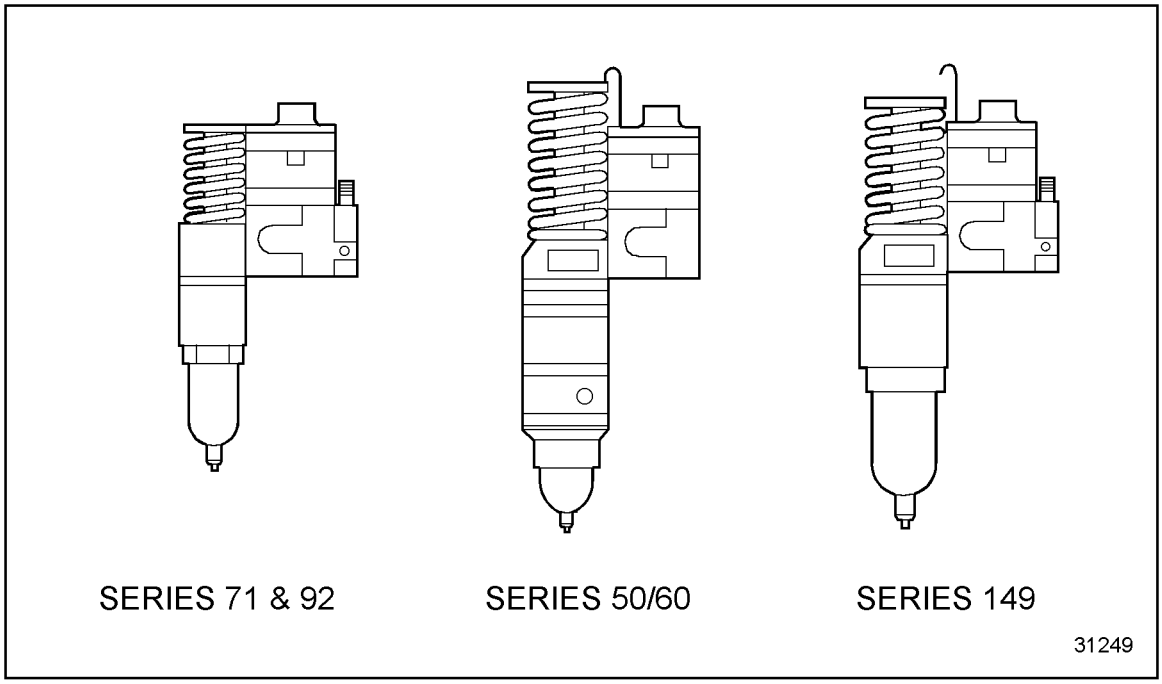

Figure 71-1 Injectors

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71.1 DESCRIPTION OF FLASH CODE 71

Flash Code 71 indicates that the time it takes from when the DDEC ECM, see Figure 71-1, requests an injector be turned on when the injector solenoid valve actually closes is shorter than the lower limit of the expected range.

This diagnostic condition is typically:

- Aerated fuel system
- High system battery (+) supply voltage
- Mechanical injector failure
- Failed solenoid

NOTE:
The injector diagnostic SID (Subsystem Identifier) indicates which cylinder number has an injector with a short response time. The injector number describes the cylinder and bank that has the injector with a short response time. The DDR will display the injector text description.

Injector response times generally increase with low battery supply voltage and decrease with high battery supply voltage. Although injector response times vary from injector to injector at a given r/min, each individual injector response time should remain relatively consistent from one firing to the next. Wide variations in response time (typically ± 0.2 ms) for one injector at a steady engine r/min may indicate an electrical problem (faulty alternator or regulator, poor or broken ground cables, etc.).

71.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 71

The SAE J1587 equivalent code for Flash Code 71 is s 001 1, or s 002 1, or s 003 1, or s 004 1, or s 005 1, or s 006 1.

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71.3 TROUBLESHOOTING FLASH CODE 71

The following procedure will troubleshoot Flash Code 71.

71.3.1 Determine Cylinders With Fault

The injector location that is logging the codes is listed in Table 71-1.

	#1	#2	#3	#4	#5	#6	
	(SID 1)	(SID 2)	(SID 3)	(SID 4)	(SID 5)	(SID 6)	
S55/60	1	5	3	6	2	4	cyl #
S50	1	3	4	2	-	-	cyl #

Table 71-1 Determine Cylinders With Fault

1. Disconnect the 5-pin injector harness connector at the ECM for those injectors logging the codes.
2. Establish a good ECM case ground by measuring the resistance across two points on the ECM. The resistance should measure less than or equal to 1 Ω.
3. Once a good case ground is established, keep one of the measurement probes in place and move the other probe to one of the five exposed male injector terminals on the ECM.
4. Measure the resistance. Repeat this procedure at each of the five terminals.
   [a] If any terminals have a resistance of less than 1000 Ω, replace the ECM. Refer to section 71.3.5.
   [b] If all terminals have a resistance of greater than 1000 Ω, refer to section 71.3.5.

71.3.2 Check for Short

Perform the following steps to check for a short. See Figure 71-2.

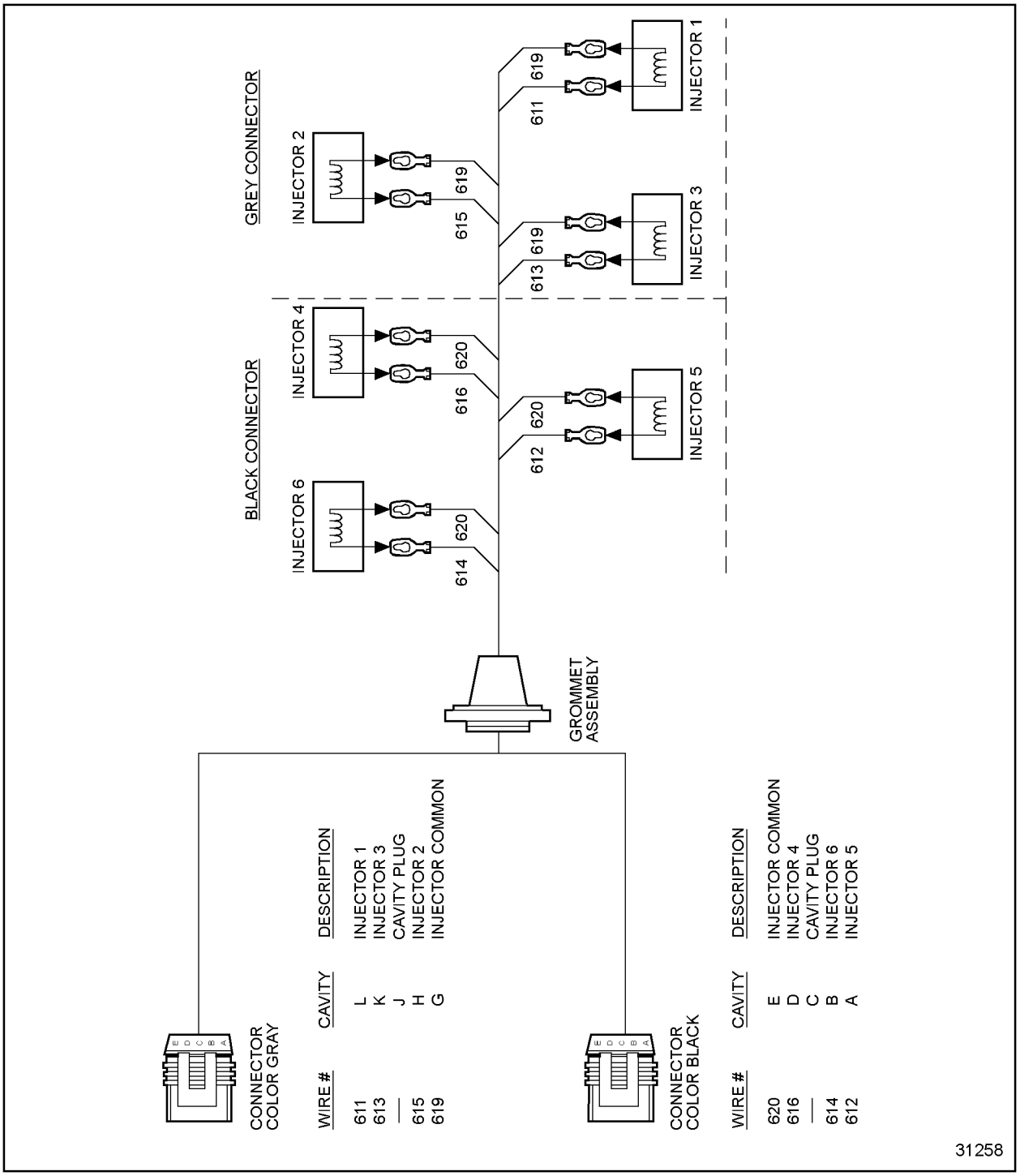

Figure 71-2 Injector Harness

1. Locate the injector harness connector terminals associated with the codes.

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2. Measure resistance between that cavity and the cylinder block.
3. Also, measure resistance between that cavity and the appropriate return cavity (G or E).
   [a] If measured resistance is less than 5 Ω, the wire is shorted. Repair or replace the harness and refer to section 71.3.5.
   [b] If measured resistance is greater than 5 Ω, refer to section 71.3.3.

71.3.3 Check for Open

Perform the following steps to check for an open.

1. Insert a jumper wire between the cavity associated with the code and the return for that connector (G or E).
2. Remove the valve cover to gain access to the cylinder associated with the code.
3. Remove the connector terminals at the injector solenoid.
4. Measure resistance between the terminal plugs.
   [a] If the measured resistance is greater than 5 Ω, the injector wire is open. Repair or replace the harness and refer to section 71.3.5.
   [b] If the measured resistance is less than 5 Ω, and the ECM software is less than 3.00, reprogram the ECM. Refer to section 71.3.5.
   [c] If the measured resistance is less than 5 Ω, and the ECM software is 3.00 or higher, remove the alternator belt to disable the actuator and refer to section 71.3.4.

71.3.4 Assemble

Perform the following steps to assemble the components.

1. Connect the connectors.
2. Install the valve cover.
3. Start and run the engine.
4. Stop engine.
5. Does the code return?
   [a] If the code does not return, repair or replace the alternator grounds and refer to section 71.3.5.
   [b] If the codes return, replace the injector and solenoid. Refer to section 71.3.5.

71.3.5 Verify Repairs

Perform the following steps to verify repairs:

1. Start and run the engine.
2. Stop engine.

3. Check DDR for codes.

   [a] If no codes are logged, no further troubleshooting is required.

   [b] If injector codes are logged, all system diagnostics are complete. Please review this section from the first step to find the error. Refer to section 71.3.1.

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72 FLASH CODE 72 - VEHICLE OVERSPEED

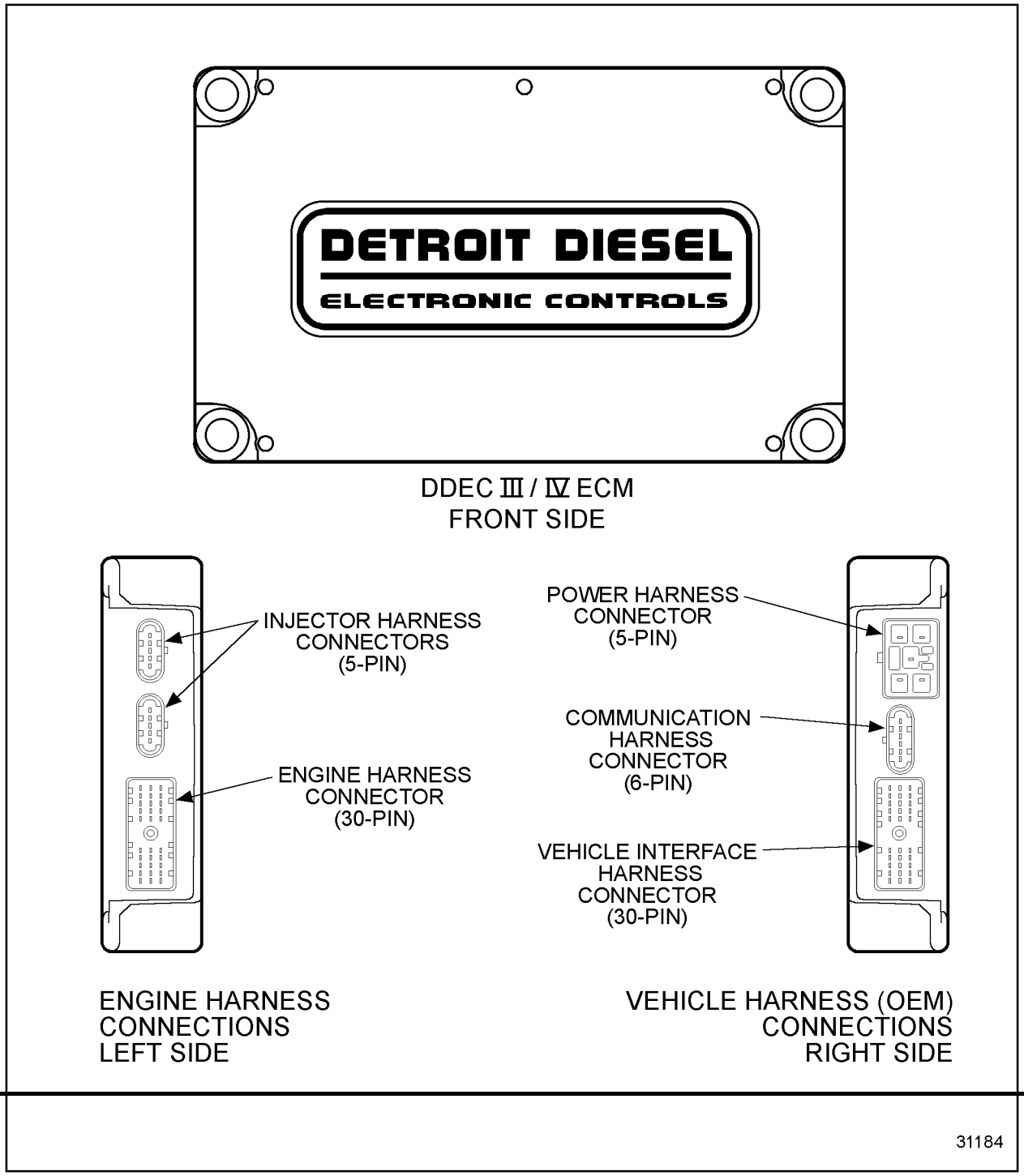

Figure 72-1 ECM

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72.1 DESCRIPTION OF FLASH CODE 72

Flash Code 72 indicates that the vehicle speed signal to the ECM (with fueling to the engine) has exceeded the vehicle speed limit that is defined in the ECM calibration. See Figure 72-1.

Flash Code 72 also may indicate that the vehicle speed signal to the ECM (without fueling to the engine) has exceeded a secondary vehicle speed limit that is defined in the ECM calibration.

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72.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 72

The SAE J1587 equivalent code for Flash Code 72 is p 084 0 or p 084 11.

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72.3 TROUBLESHOOTING FLASH CODE 72

The following procedure will troubleshoot Flash Code 72.

72.3.1 Overspeed

Perform the following steps to troubleshoot overspeed.

1. These codes indicate the vehicle speed has exceeded the limits programmed into the ECM. Verify cruise control and VSS information.
   [a] Code 84/0 - Overspeed with fuel limit has been exceeded.
   [b] Code 84/11 - Overspeed without fuel limit has been exceeded.
2. Limits are a reasonable distance above the road speed limit.
   [a] If the limits are a reasonable distance, go to step 3
   [b] If the limits are not a reasonable distance above the road speed limit, change the limits and perform the test. Refer to section 72.3.2.

NOTE:
For information regarding overspeed limits, refer to section 7.1.29.

3. Fuel Economy Incentive feature configured recently.
   [a] If configured recently, review the limits. W/FEI limits may need to be increased.
   [b] If not configured recently, the conditions are normal. The vehicle has exceeded speed limits set.

72.3.2 Test

Perform the following steps to troubleshoot overspeed.

1. Start and run the engine.
2. Perform a road test.
   [a] If the overspeed condition has disappeared, troubleshooting is complete.
   [b] If the overspeed condition still exists, review this section from the beginning to find the error. Refer to section 72.3.1.

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73 FLASH CODE 73

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73.1 DESCRIPTION OF FLASH CODE 73

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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74 FLASH CODE 74

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74.1 DESCRIPTION OF FLASH CODE 74

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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75 FLASH CODE 75 - BATTERY VOLT HIGH

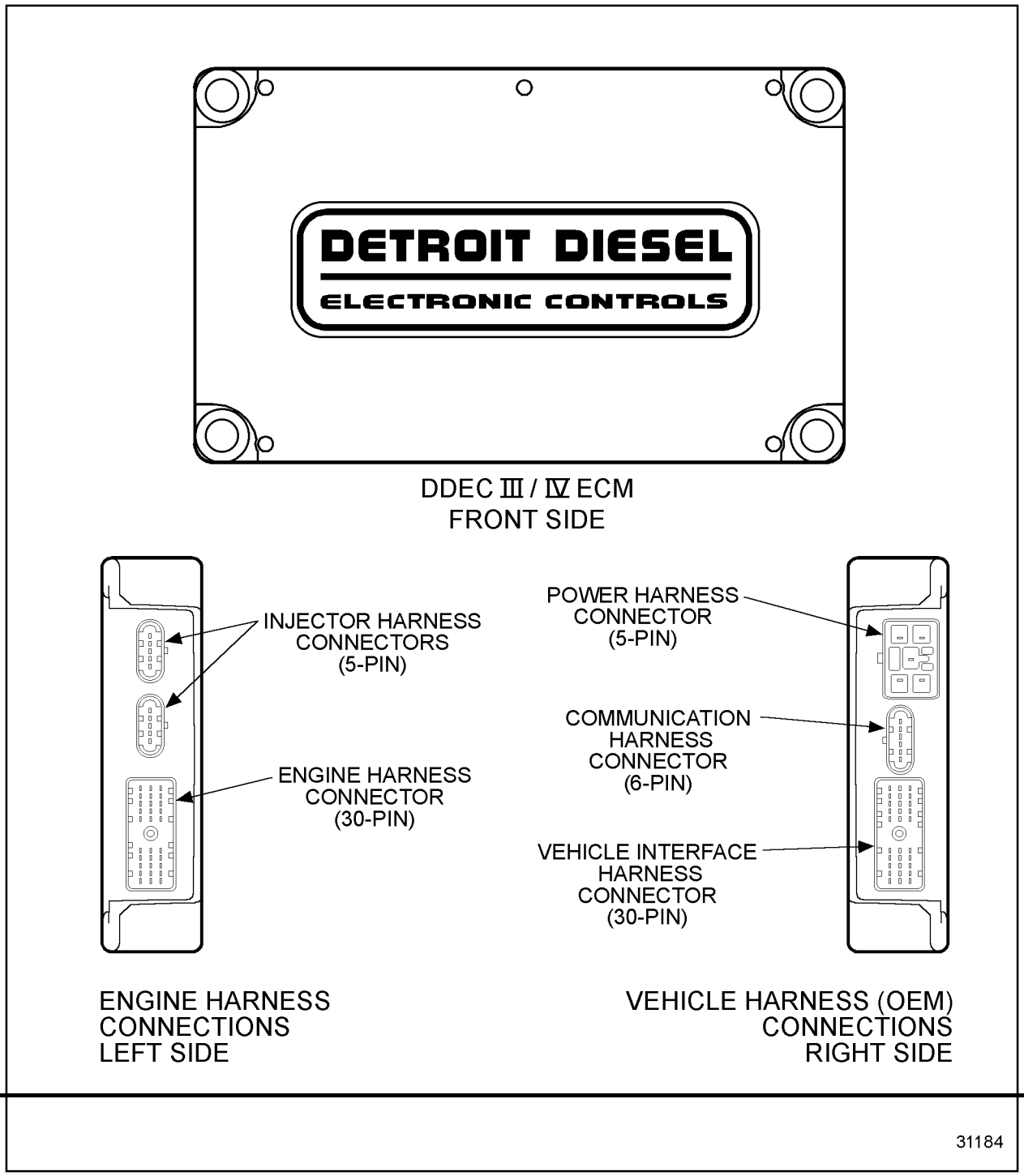

Figure 75-1 ECM

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75.1 DESCRIPTION OF FLASH CODE 75

Flash Code 75 indicates that the DDEC® ECM, see Figure 75-1, has detected that the main battery supply voltage to the ECM has exceeded the recommended operating range.

75.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 75

The SAE J1587 equivalent code for Flash Code 75 is p 168 0.

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75.3 TROUBLESHOOTING FLASH CODE 75

The following procedure will troubleshoot Flash Code 75.

75.3.1 High Voltage

Perform the following steps to troubleshoot high voltage.

1. Turn ignition ON.
2. Plug in the diagnostic data reader (DDR).
3. Read logged codes.
   [a] If any codes other than 168/0 are received, service the other codes first.
   [b] If code 168/0 and no other codes are logged, the voltage to the ECM is too high. Check batteries and/or vehicle charging system.

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76 FLASH CODE 76 - ENGINE OVERSPEED / BRAKE

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76.1 DESCRIPTION OF FLASH CODE 76

Flash Code 76 indicates the engine speed exceeded a calibration limit, and the engine brake output was active at the time the condition occurred.

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76.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 76

The SAE J1587 equivalent code for Flash Code 76 is p 121/0, Engine Overspeed with Engine Brake.

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76.3 TROUBLESHOOTING FLASH CODE 76

Perform the following steps to troubleshoot Flash Code 76.

76.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn vehicle ignition switch ON.
2. Plug in the diagnostic data reader (DDR).
3. Visually check the DDR for codes.
   [a] If codes other than 121/0 are logged, service them first.
   [b] If code 121/0 is logged, and no other codes are logged, there was an engine running condition at which the engine r/min exceeded a calibration limit during engine brake operation.

NOTE:
Determine the reason the engine r/min went too high.

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77 FLASH CODE 77 - FUEL TEMP HIGH

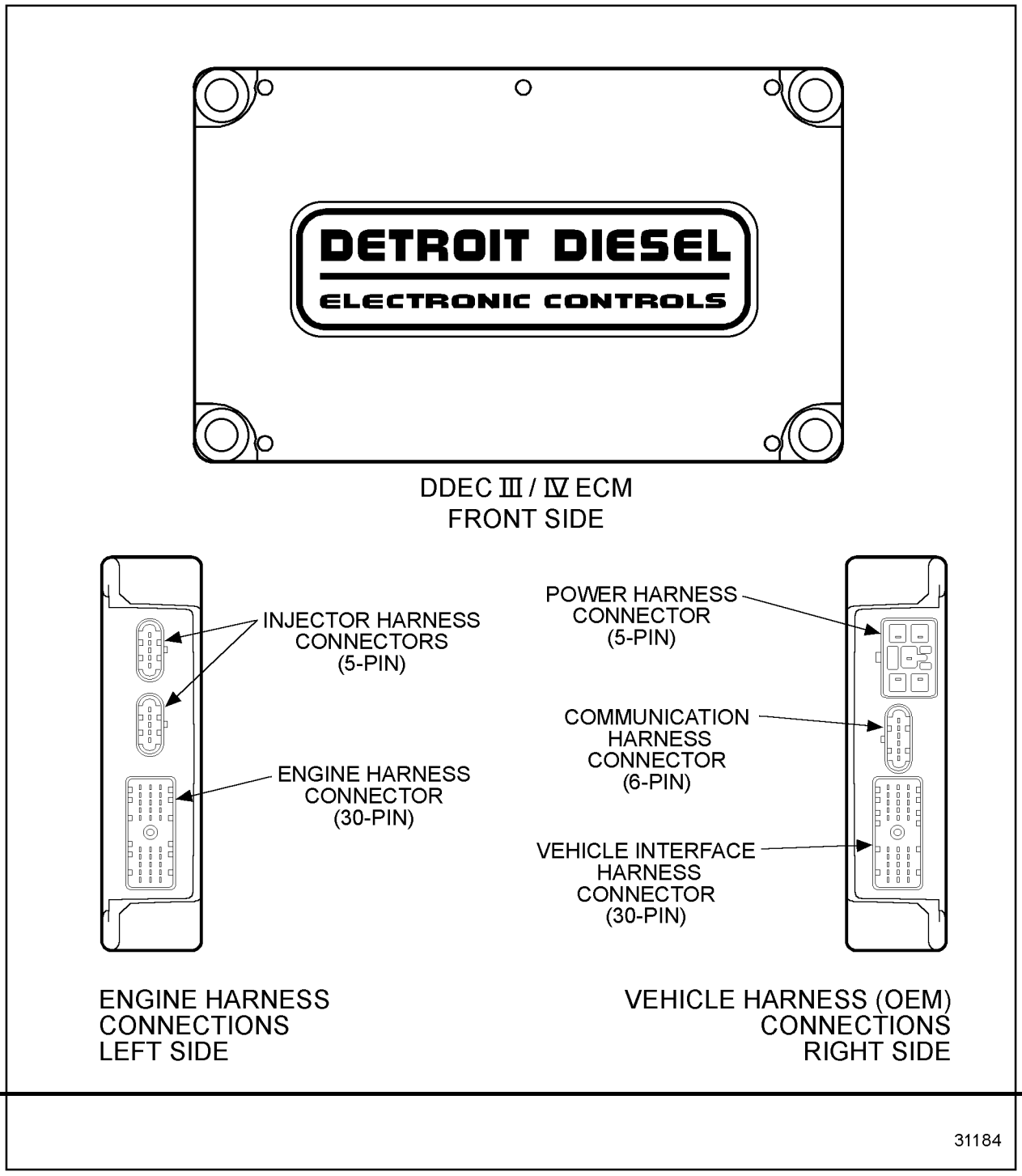

Figure 77-1 ECM

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77.1 DESCRIPTION OF FLASH CODE 77

Flash Code 77 indicates that the fuel temperature has exceeded a calibration limit set by DDC in the ECM, see Figure 77-1.

At this time, this code is logged without illuminating a CEL.

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77.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 77

The SAE J1587 equivalent code for Flash Code 77 is p 174 0.

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77.3 TROUBLESHOOTING FLASH CODE 77

There is no established procedure to troubleshoot Flash Code 77.

- The code is used to determine if high fuel temperature may be a cause of reduced power levels.
- High fuel temperature will reduce available horsepower.
- Refer to the recommendations of the vehicle manufacturer regarding the possible need for additional fuel cooling.

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78 (CHG) FLASH CODE 78

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78.1 DESCRIPTION OF FLASH CODE 78

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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79 FLASH CODE 79

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79.1 DESCRIPTION OF FLASH CODE 79

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

No DDEC code is currently assigned to this number. If changes occur, notification will be sent from DDC.

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80 FLASH CODE 80

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80.1 DESCRIPTION OF FLASH CODE 80

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

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81 (CHG) FLASH CODE 81

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81.1 DESCRIPTION OF FLASH CODE 81

Flash Code 81 is used to identify oil level, crankcase pressure, dual fuel BOI, or exhaust temperature voltage high.

This code is not covered in this manual. If changes occur, notification will be sent from DDC.

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81.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 81

The SAE J1587 equivalent code for Flash Code 81 is p 098 3, oil level sensor input voltage high; p 101 3, crankcase pressure sensor input voltage high, or s 020 3, dual fuel BOI input voltage high.

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82 (CHG) FLASH CODE 82

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82.1 DESCRIPTION OF FLASH CODE 82

Flash Code 82 is used to identify oil level, crankcase pressure, dual fuel BOI, or exhaust temperature voltage low.

This code is not covered in this manual. If changes occur, notification will be sent from DDC.

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82.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 82

The SAE J1587 equivalent code for Flash Code 82 is p 098 4, oil level sensor input voltage low; p 101 4, crankcase pressure sensor input voltage low, or s 020 4, dual fuel BOI input voltage low.

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83 (CHG) FLASH CODE 83

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83.1 DESCRIPTION OF FLASH CODE 83

Flash Code 83 is used to identify oil level, crankcase pressure, exhaust temperature, or external pump pressure high.

This code is not covered in this manual. If changes occur, notification will be sent from DDC.

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83.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 83

The SAE J1587 equivalent code for Flash Code 83 is p 098 0, oil level high; p 101 0, crankcase pressure high; p 173 0, exhaust temperature high; and p 173 3, 4, exhaust temperature sensor input.

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84 (CHG) FLASH CODE 84

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84.1 DESCRIPTION OF FLASH CODE 84

Flash Code 84 is used to identify oil level or crankcase pressure low.

This code is not covered in this manual. If changes occur, notification will be sent from DDC.

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84.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 84

The SAE J1587 equivalent code for Flash Code 84 is p 098/1, oil level low and p 101/1, crankcase pressure low.

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85 FLASH CODE 85 - ENGINE OVERSPEED

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85.1 DESCRIPTION OF FLASH CODE 85

Flash Code 85 indicates that an engine overspeed condition exists.

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85.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 85

The SAE J1587 equivalent code for Flash Code 85 is p 190 0, engine overspeed.

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85.3 TROUBLESHOOTING FLASH CODE 85

The following procedure will troubleshoot Flash Code 85.

85.3.1 Code Information

Perform the following steps to gather information. This code is logged whenever the engine has been operating over 2500 r/min for at least two seconds.

1. Turn ignition ON.
2. Plug diagnostic data reader (DDR) into the diagnostic data link (DDL). For vehicle harness connector.
3. Select inactive codes.
4. Part of the display will read as follows:
   [a] First Occurrence
   [b] Last Occurrence
   [c] Total Number
   [d] Total Time
5. If necessary, refer to section 6.2

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86 FLASH CODE 86 - PGS SENSOR HIGH

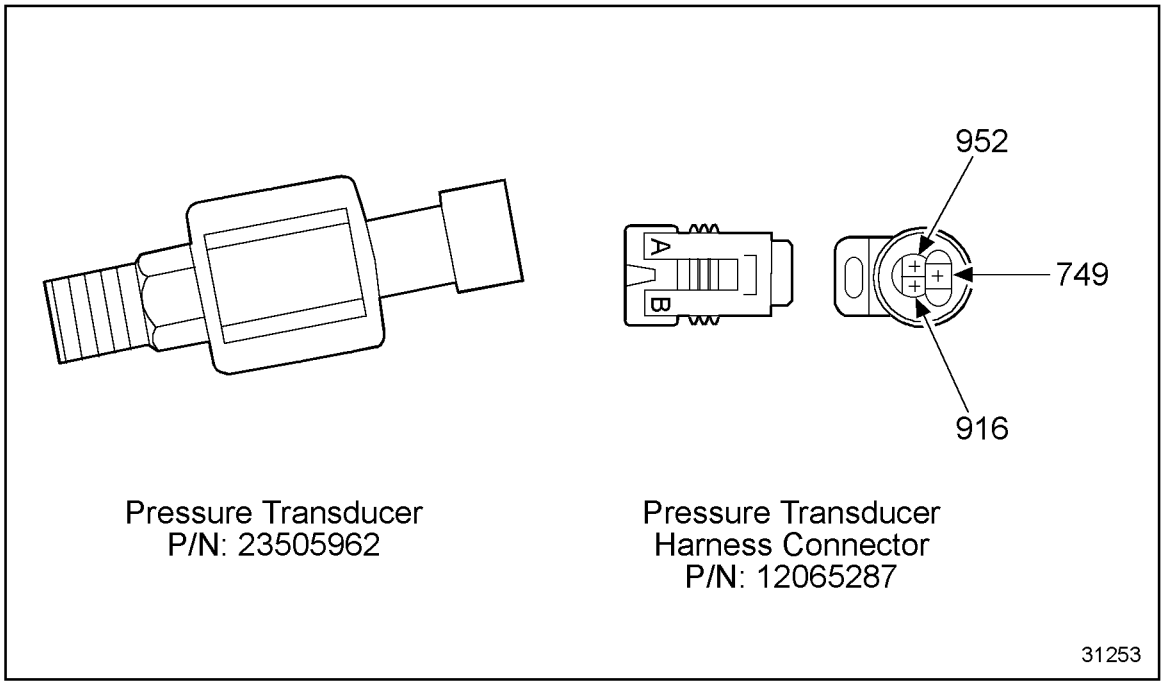

Figure 86-1 Pressure Transducer

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86.1 DESCRIPTION OF FLASH CODE 86

Flash Code 86 indicates that the pump pressure circuit failed high (below). For pressure transducer and connector, see Figure 86-1,

86.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 86

The SAE J1587 equivalent code for Flash Code 86 is p 073 3.

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86.3 TROUBLESHOOTING FLASH CODE 86

The following procedure will troubleshoot Flash Code 86.

86.3.1 Multiple Code Check

Perform the following steps to check for multiple codes.

1. Turn ignition ON.
2. Plug in DDR.
3. Read active codes.
   [a] If active code 73/3 was logged, and no other codes were logged, refer to section 86.3.2.
   [b] If active code 73/4 and any other codes were logged, refer to section 86.3.3.
   [c] If any codes other than 73/3 were logged, refer to section 91.1.

86.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition OFF.
2. Disconnect the Pressure Governor System (PGS) sensor connector.
3. Turn ignition ON.
4. Start engine and operate the PGS in the PRESSURE mode.
5. Read active codes.
   [a] If active code 73/3 and any other codes were logged, refer to section 86.3.5.
   [b] If active code 73/4 and any other codes except 73/3 were logged, refer to section 86.3.3.

86.3.3 Return Circuit Check

Perform the following steps to check the return circuit.

1. Turn vehicle ignition OFF.
2. Disconnect the vehicle harness connector at the ECM. See Figure 86-2.
3. Install a jumper wire between pins A and B of the PGS sensor harness connector.
4. Measure resistance between sockets D3 and C3 on the vehicle harness connectors.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 86.3.4.

[b] If the resistance measurement is greater than 5 Ω, or open, the return line (circuit #952) is open. Repair the open and refer to section 86.3.9.

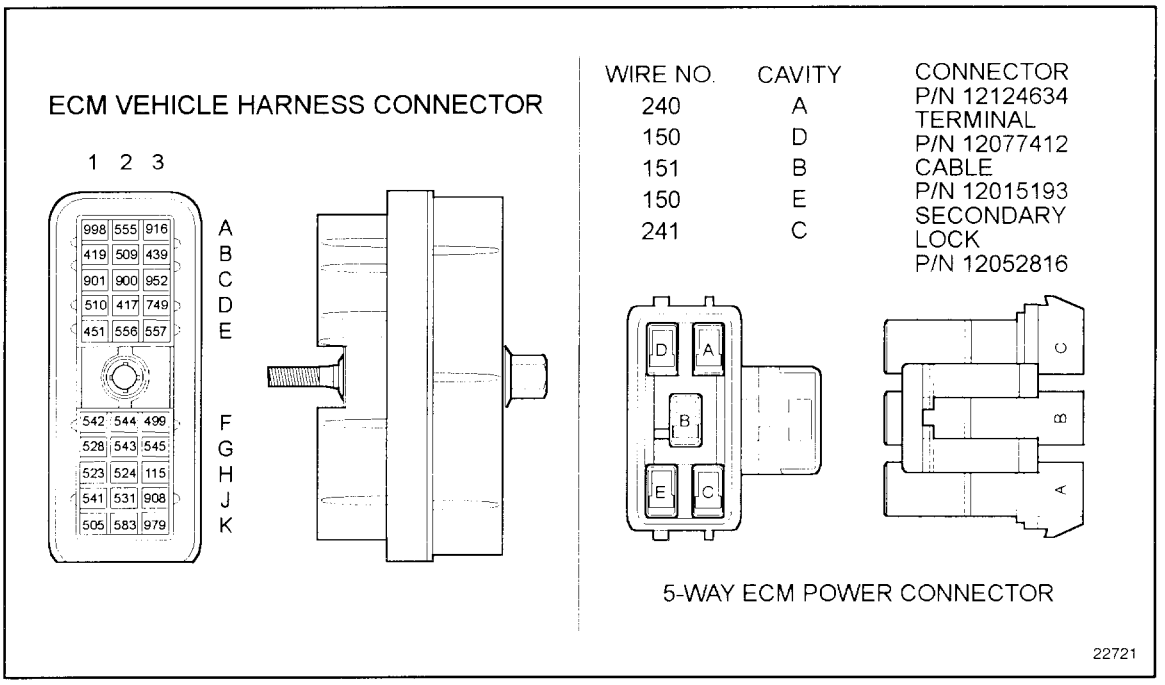

Figure 86-2 ECM Vehicle Harness Connector

86.3.4 Check Pressure Governor System Connectors

Perform the following steps to check the PGS connectors.

1. Inspect terminals at the PGS sensor connector (both the sensor and harness side) for damage: bent, corroded, and unseated pins or sockets.

   [a] If the terminals and connectors are damaged, repair them and refer to section 86.3.9.

   [b] If the terminals and connectors are not damaged, replace the PGS sensor and refer to section 86.3.9.

86.3.5 Check for Short to +5 Volts

Perform the following steps to check for a short to the +5 volts.

1. Turn ignition OFF.
2. Disconnect the vehicle harness connectors at the ECM.
3. Measure resistance between sockets A3 and D3 on the engine harness connector.

   [a] If the resistance measurement is greater than 100 Ω or open, refer to section 86.3.6.

   [b] If the resistance measurement is less than or equal to 100 Ω, the signal line (#749) is shorted to the engine +5 volt line (#916). Repair the short and refer to section 86.3.9.

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86.3.6 Check for Short to Battery +

Perform the following steps to check for a short to battery.

1. Remove both fuses to the ECM.
2. Disconnect the vehicle harness and 5-way power connectors at the ECM.
3. Measure resistance between socket D3 on the engine harness connector and battery (+).
4. Measure resistance between socket D3 of the engine harness connector, and the 5-way power harness sockets A and C.
   [a] If the resistance measurement for all readings is greater than 100 Ω or open, refer to section 86.3.7.
   [b] If the resistance measurement is less than or equal to 100 Ω, a short exists between the signal line (circuit #749) and battery (+). Repair short and reinsert fuses. Refer to section 86.3.9.

86.3.7 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Inspect terminals at the ECM connectors (both ECM and harness side) for damage: bent, corroded, and unseated pins or sockets.
   [a] If terminals and connectors are damaged, repair them. Refer to section 86.3.9.
   [b] If terminals and connectors are not damaged, install a test ECM. Refer to section 86.3.8.

86.3.8 Final Check

Perform the following steps to do a final check.

1. Reconnect all connectors.
2. Turn vehicle ignition ON.
3. Clear codes.
4. Start and run the engine for one minute.
5. Stop engine.
6. Check DDR for active codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If active code 73/3 is logged, install a test ECM. Refer to section 86.3.9.
   [c] If any codes except code 73/3 are logged, refer to section 9.1, to service other codes.

86.3.9 Verify Repairs

Perform the following steps to verify repairs.

1. Turn ignition switch OFF.
2. Reconnect all connectors.
3. Turn ignition ON.
4. Clear codes.
5. Start and run the engine for one minute.
6. Stop engine.
7. Check DDR for inactive codes.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If code 73/3 is not logged, and other codes are logged, refer to section 9.1, to service other codes.
   [c] If code 73/3 is logged, and other codes are logged, all system diagnostics are complete. Review this section from the first step to find the problem. Refer to section 86.3.1.

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87 FLASH CODE 87 - PGS SENSOR LOW

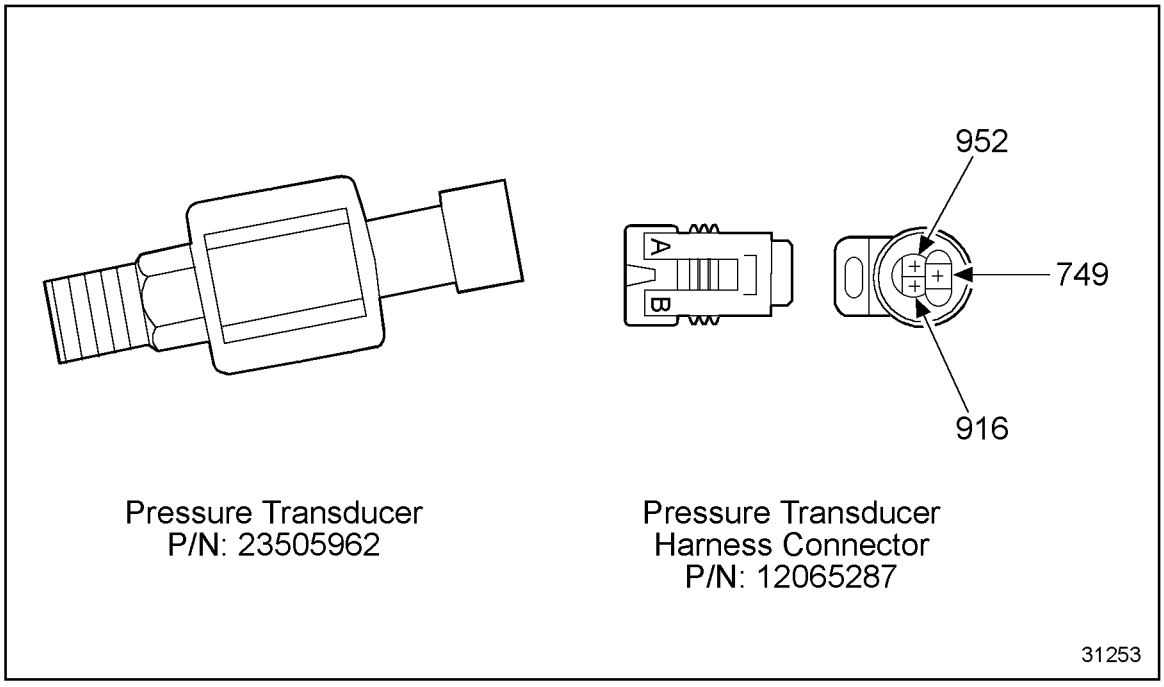

Figure 87-1 Pressure Transducer

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87.1 DESCRIPTION OF FLASH CODE 87

Flash Code 87 indicates pump pressure sensor input voltage low.

The signal volts dropped below 5% (normally = <0.25 volts) of the sensor supply. For pressure transducer and connector, see Figure 87-1.

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87.2 SAE J1587 EQUIVALENT CODE FOR FLASH CODE 87

The SAE J1587 equivalent code for Flash Code 87 is p 073/4.

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87.3 TROUBLESHOOTING FLASH CODE 87

The following procedure will troubleshoot Flash Code 87.

87.3.1 Multiple Code Check

Perform the following steps to check for codes.

1. Turn vehicle ignition ON.
2. Plug in DDR. Read the codes.
   [a] If codes p 73/4, 100/3 or 4, 102/3 or 4, 110/3 or 4, 174/3 or 4 or 175/3 or 4 are logged, refer to section 91.1.
   [b] If code 073/4 is logged and no other codes are logged, refer to section 87.3.2.
   [c] If code 073/4 is logged, and none of the following codes are logged: 100/3 or 4, 102/3 or 4, 110/3 or 4, 174/3 or 4 or 175/3 or 4, refer to section 87.3.2.

87.3.2 Sensor Check

Perform the following steps to check the sensor.

1. Turn ignition OFF.
2. Disconnect the pump pressure sensor connector and install a jumper between sockets B and C of the pump pressure sensor transducer connector.
3. Turn ignition ON.
4. Start engine and operate the Pressure Governor System (PGS) in the PRESSURE mode.
5. Read active codes.
   [a] If code p 73/3 and any other code except p 73/4 display, check to ensure the ECM and PGS sensor connectors are wired properly. If wired properly, refer to section 87.3.3.
   [b] If code p 73/4 and any other codes display, refer to section 87.3.4.

87.3.3 Check Pressure Governor System Sensor Connectors

Perform the following steps to check the pressure governor system (PGS) sensor connectors.

1. Turn ignition OFF.
2. Inspect terminals at the pump pressure sensor connectors (sensor and harness side) for damaged, bent, corroded, and unseated pins or sockets.
   [a] If the terminals and connectors are not damaged, replace the PGS sensor. Refer to section 87.3.7.
   [b] If the terminals and connectors are damaged, repair them. Refer to section 87.3.7.

87.3.4 Check for Short to Return

Perform the following steps to check for a short.

1. Turn ignition OFF.
2. Remove jumper wire.
3. Remove vehicle interface harness connector (30-pin).
4. Turn ignition ON.
5. Measure resistance between C3 (#952) and D3 (#749).
   [a] If the measured resistance is less than 1,000 Ω, the wires are shorted to each other. Replace the harness.
   [b] If the measured resistance is greater than 1,000 Ω, refer to section 87.3.5.

87.3.5 Check for Short to Battery (-)

Perform the following steps to check for a short to the battery (-).

1. Measure resistance between D3 (#749) and battery ground.
   [a] If the measured resistance is less than 1,000 Ω, the #749 wire is shorted to the battery. Replace the harness and refer to section 87.3.7.
   [b] If the measured resistance is greater than 1,000 Ω, refer to section 87.3.6.

87.3.6 Check for 5 Volt Open

Perform the following steps to check for a 5 volt open.

1. Plug in the 30-pin connector for the vehicle sensor harness.
2. Turn ignition ON.
3. Measure voltage between cavity B (#952) and A (#916) of the transducer connector.
   [a] If the measurement is less than 4.5 volts, wire #916 is open. Repair the open or replace the harness. Refer to section 87.3.7.
   [b] If the measurement is between 4.5 and 5.5 volts, the signal wire (#749) is open. Repair the wire and refer to section 87.3.7.

87.3.7 Verify Repairs

Perform the following steps to verify repairs.

1. Plug in all connectors.
2. Start and run the engine.
3. Plug in DDR and read the codes.
   [a] If no codes are logged, troubleshooting is complete.

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[b] If code p 073/4 is logged, review this section to find the error. Then, contact Detroit Diesel Technical Services.

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88 (CHG) FLASH CODE 88

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88.1 DESCRIPTION OF FLASH CODE 88

Flash Code 88 is used to identify coolant pressure low.

This code currently is not covered in this manual. If changes occur, notification will be sent from DDC.

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89 FLASH CODE 89

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89.1 DESCRIPTION OF FLASH CODE 89

This manual was designed to have the section number equal to the Flash Code for troubleshooting. This section is intentionally left blank.

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90 (CHG) ENGINE SENSOR HARNESS

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90.1 DESCRIPTION OF ENGINE SENSOR HARNESS

Referral to this section indicates a fault within the Engine Sensor Harness affecting signals of various sensors used by the DDEC system.

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90.2 TROUBLESHOOTING ENGINE SENSOR HARNESS

The following procedure will troubleshoot the engine sensor harness.

90.2.1 Check for Low Battery Voltage

Perform the following steps to check for low battery voltage.

1. Plug in the diagnostic data reader (DDR).
   [a] If Flash Code 168/1 is logged, refer to section 46.3.
   [b] If code 168/1 is not logged, refer to section 90.2.2.

90.2.2 Check for +5 Volts

Perform the following steps to check for +5 volts.

1. Turn vehicle ignition switch OFF.
2. Disconnect the Oil Pressure Sensor (OPS) and Turbo Boost Sensor (TBS) connectors.
3. If applicable, disconnect the Fuel Pressure Sensor (FPS).
4. Turn vehicle ignition switch ON.
5. At each sensor harness connector, measure voltage between socket C (red lead) and socket A (black lead).
   [a] If the voltage measurement is between 4.7 and 5.2 volts, the voltage reading is correct. Check voltage at the next connector. If all connector voltage readings are correct, refer to section 90.2.3.
   [b] If the voltage measurement is less than 4.7 volts at any or all connectors, refer to section 90.2.4.
   [c] If the voltage measurement is greater than 5.2 volts at all connectors, refer to section 90.2.6.

90.2.3 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Check terminals at the ECM engine harness connector (both the ECM and harness side) for damaged, bent, corroded and unseated pins or sockets.
   [a] If the terminals and connectors are not damaged, check all sensors, especially OPS, TBS, and TPS (on vehicle system), this indicates that there is no problem on the engine sensor harness. Refer to section 91.1.
   [b] If the terminals and connectors are damaged, repair them. Refer to section 90.2.7.

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90.2.4 Check for +5 volts or Return Open

Perform the following steps to check for +5 volts or return open.

1. Turn vehicle ignition switch OFF.
2. Disconnect the engine harness connector at the ECM.
3. Install a jumper wire between sockets A and C of any sensor connector that reads less than 4.7 volts. Refer to section 90.2.2.
4. Measure resistance between sockets W1 and Y2 of the engine harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 90.2.5.
   [b] If the resistance measurement is greater than 5 Ω or open, either the engine +5 volt line (#416), or the return line (#452) is open. Repair the open and refer to section 90.2.7.

90.2.5 Check for Short to Ground

Perform the following steps to check for short to ground.

1. Turn vehicle ignition switch OFF.
2. Remove jumper wire.
3. Measure resistance between sockets A and C of the sensor connector.
4. Measure resistance between socket C of the sensor connector and a good ground.
   [a] If the resistance measurement for both readings is greater than 1,000 Ω, or open, refer to section 90.2.3.
   [b] If either resistance measurement is less than or equal to 1,000 Ω, the engine +5 volt line (#416) is shorted to either the sensor return line (#452) or to chassis ground. Repair the short and refer to section 90.2.7.

90.2.6 Check for Short to Battery

Perform the following steps to check for a short to battery.

1. Turn vehicle ignition switch OFF.
2. Remove both fuses to the ECM.
3. Disconnect all five connectors at the ECM.
4. Measure resistance between socket W1 on the engine harness connector and B3 on the vehicle harness connector.
5. Measure resistance between socket W1 on the engine harness connector and the battery (+).
   [a] If the resistance measurement for both readings is greater than 1,000 Ω, or open, refer to section 90.2.3.

[b] If either resistance measurement is less than or equal to 1,000 Ω, a short exists between sockets where reading was taken. Repair the short and refer to section 90.2.7.

90.2.7 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition switch OFF.
2. Reconnect all connectors.
3. Reconnect fuses (or circuit breakers) if previously disconnected.
4. Turn ignition ON.
5. Clear codes.
6. If Check Engine Light (CEL) does not stay on, start engine and run for one minute
7. Stop engine.
8. Read inactive codes with the DDR.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If codes that brought you to this section are still logged, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 90.2.1.
   [c] If codes except those which brought you to this section are logged, refer to section 9.1.

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91 (CHG) VEHICLE HARNESS

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91.1 DESCRIPTION OF VEHICLE HARNESS +5 VOLT SUPPLY

Referral to this section indicates a fault within the vehicle interface harness.

NOTE:
It is suggested that the vehicle interface module be installed for test. If the fault(s) clear, you may wish to contact the vehicle manufacturer for instructions on troubleshooting. Otherwise, continue with this section.

91.2 TROUBLESHOOTING VEHICLE HARNESS +5 VOLT SUPPLY

The following procedure will troubleshoot vehicle harness.

91.2.1 Check for Low Battery Voltage

Perform the following steps to check for low battery voltage.

1. Plug in the diagnostic data reader (DDR).
   [a] If code 168/1 is logged, refer to section 46.3.1.
   [b] If code 168/1 is not logged, refer to section 91.2.2.

91.2.2 Check for +5 Volts

Perform the following steps to check for +5 volts at the Throttle Position Sensor (TPS).

1. Turn vehicle ignition switch OFF.
2. Disconnect the TPS (disconnect the VSG and PGS, if applicable).
3. Turn vehicle ignition switch ON.
4. Measure voltage on the TPS and VSG harness connector, pin C (#916) (red lead) to pin A (#952) (black lead), and pin A to pin B at the PGS connector, if applicable.
   [a] If the voltage measurement is between 4.7 and 5.2 volts, the voltage reading is correct. Check voltage at the next connector. If all connector voltage readings are correct, refer to section 91.2.5.
   [b] If the voltage measurement is less than 4.7 volts, refer to section 91.2.3.
   [c] If the voltage measurement is greater than 5.2 volts at all connectors, refer to section 91.2.8.

91.2.3 Check for +5 volts or Return Open

Perform the following steps to check for +5 volts or return open.

1. Turn vehicle ignition switch OFF.
2. Disconnect the vehicle harness connector at the ECM.
3. Install a jumper wire between pins A and C of the TPS harness connector.
4. Measure resistance between sockets A3 and C3 of the vehicle harness connector.
   [a] If the resistance measurement is less than or equal to 5 Ω, refer to section 91.2.4.
   [b] If the resistance measurement is greater than 5 Ω or open, either the vehicle +5 volt line (#916) or the sensor return line (#952) is open. Refer to section 91.2.9.

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91.2.4 Check for +5 Short to Ground

Perform the following steps to check for +5 short to ground.

1. Remove jumper wire.
2. Measure resistance between pins A and C of the TPS harness connector.
3. Measure resistance between pin C of the TPS harness connector and a good ground (battery-).
   [a] If the resistance measurement for both readings is greater than 1,000 Ω, or open, refer to section 91.2.7.
   [b] If either resistance measurement is less than or equal to 1,000 Ω, wire (#916) is shorted to wire (#952), or battery ground. Repair the short and refer to section 91.2.9.

91.2.5 Vehicle Harness 5V Check TPS

Perform the following steps to check TPS.

1. Turn vehicle ignition switch OFF.
2. Reconnect the TPS connector.
3. Turn vehicle ignition switch ON.
4. Select Throttle Sensor percentage on the DDR.
5. Observe throttle percentage at both no throttle and full throttle (engine not running).
   [a] If the percentage is between 0 and 100%, refer to section 91.2.7.
   [b] If not getting a reading between 0 and 100%, refer to section 91.2.6.

91.2.6 Vehicle Harness 5V Check Throttle Position Sensor Connectors

Perform the following steps to check TPS connectors.

1. Turn vehicle ignition switch OFF.
2. Disconnect the TPS.
3. Inspect terminals at the TPS connectors (sensor side and harness side) for damage; bent, corroded and unseated pins or sockets.
   [a] If the terminals and connectors are not damaged, replace TPS. Refer to section 91.2.9.
   [b] If the terminals and connectors are damaged, repair them. Refer to section 91.2.9.

91.2.7 Check ECM Connectors

Perform the following steps to check the ECM connectors.

1. Turn vehicle ignition switch OFF.
2. Disconnect the vehicle harness connector at the ECM (if not already disconnected).

3. Check terminals at the ECM vehicle harness connector (both the ECM and harness side) for damage; bent, corroded and unseated pins or sockets (especially terminals #952, #916, #417 and #510). Install new terminal if in doubt.
   [a] If the terminals and connectors are not damaged, refer to section 90.2.2.
   [b] If the terminals and connectors are damaged, repair them. Refer to section 91.2.9.

91.2.8 Check for Short to Battery (+)

Perform the following steps to check for a short to battery (+).

1. Turn vehicle ignition switch OFF.
2. Remove both fuses or circuit breakers to the ECM.
3. Disconnect the vehicle harness and the 5-pin power harness connectors at the ECM.
4. Measure resistance between sockets A3 and B3 on the vehicle harness connector.
5. Measure resistance between socket A3 on the vehicle harness connector and the battery (+).
   [a] If the resistance measurement for all readings is greater than 1,000 Ω, or open, refer to section 91.2.7.
   [b] If the resistance measurement is less than 1,000 Ω, a short exists between the vehicle +5 volt line (#916) and the lines where less than 1,000 was read (either circuit #240, #241 or #439). Repair the short and refer to section 91.2.9.

91.2.9 Verify Repairs

Perform the following steps to verify repairs.

1. Turn vehicle ignition switch OFF.
2. Reconnect all connectors.
3. Reconnect fuses (or circuit breakers) if previously disconnected.
4. Turn ignition ON.
5. Clear codes.
6. If Check Engine Light (CEL) does not stay on, start engine and run for one minute.
7. Stop engine.
8. Read inactive codes with the DDR.
   [a] If no codes are logged, troubleshooting is complete.
   [b] If codes that brought you to this section are still logged, all system diagnostics are complete. Review this section from the first step to find the error. Refer to section 91.2.1.
   [c] If codes except those which brought you to this section are logged, refer to section 9.1.

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92 (CHG) ENGINE WIRING SCHEMATICS

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92.1 INJECTOR HARNESS WIRING SCHEMATIC - SERIES 50 ENGINES WITH JAKE BRAKE

The following wire schematics support the injector harness; see Figure 92-1.

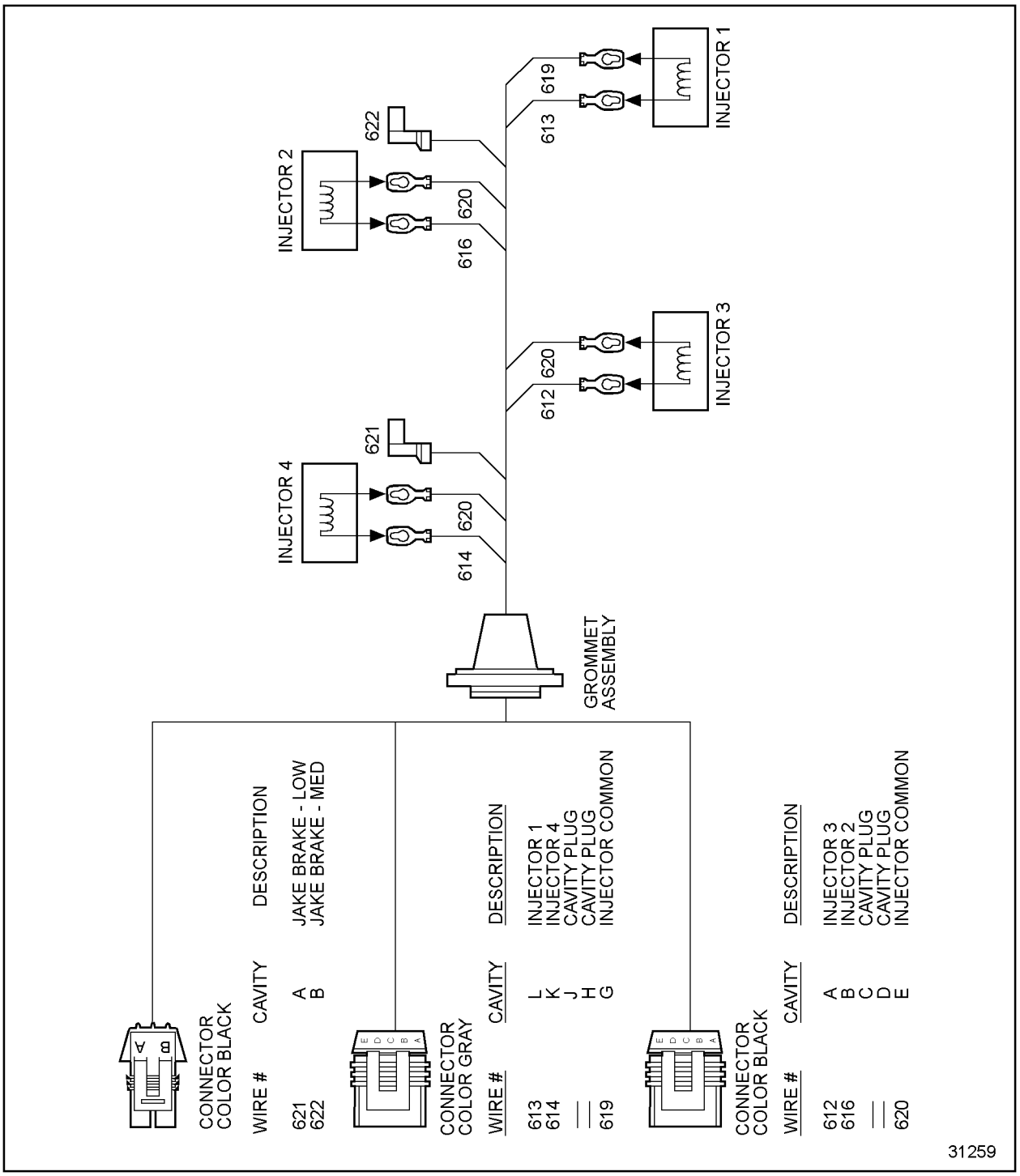
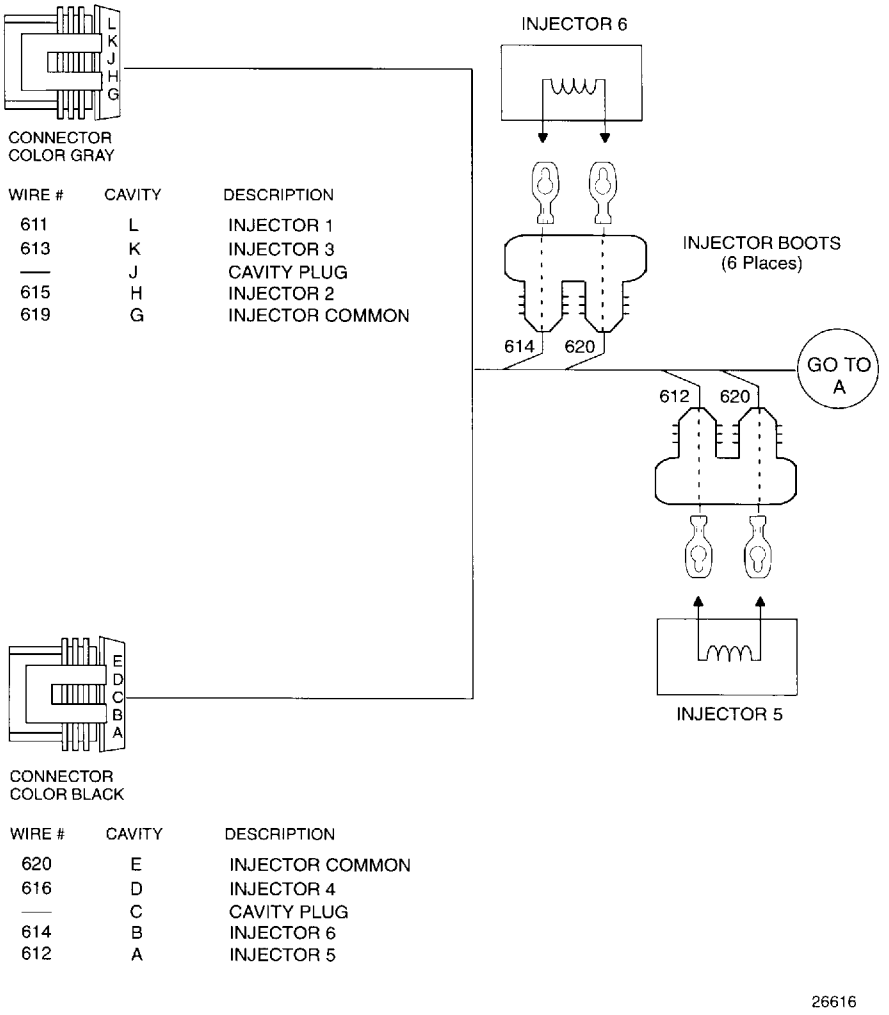


Figure 92-1 Injector Harness - Series 50 Engines With Jake Brake

92.2 INJECTOR HARNESS WIRING SCHEMATIC - SERIES 60 ENGINES

The following wire schematics support the injector harness; see Figure 92-2.



For "Go To A", see Figure 92-3.

Figure 92-2 Injector Harness (Sheet 1-2) (Series 60 Shown)

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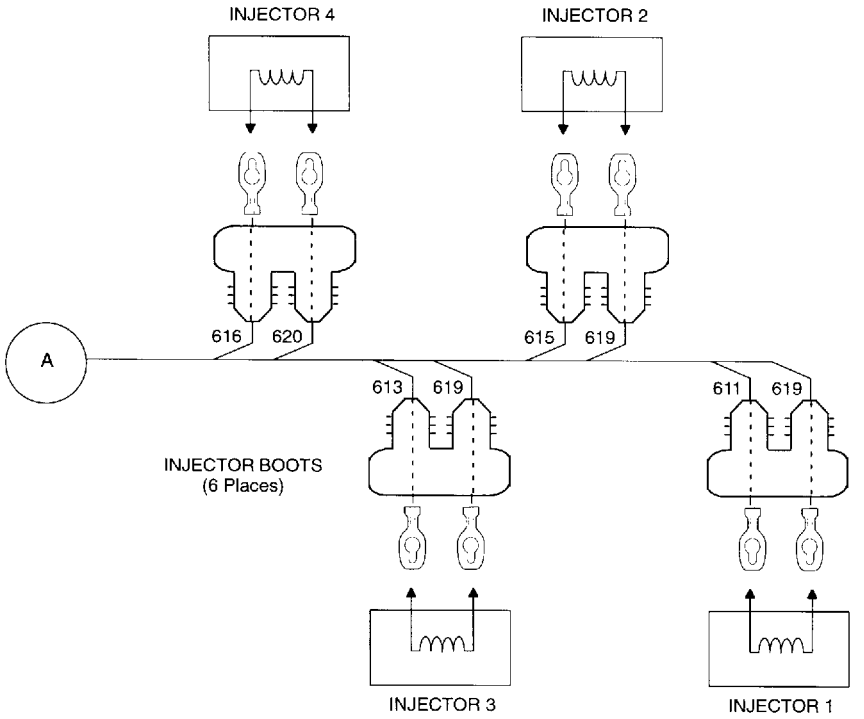

Figure 92-3 Injector Harness (Sheet 2-2)

92.3 INJECTOR HARNESS WIRING SCHEMATIC - SERIES 6V92 ENGINES

The following wire schematics support the injector harness; see Figure 92-4.

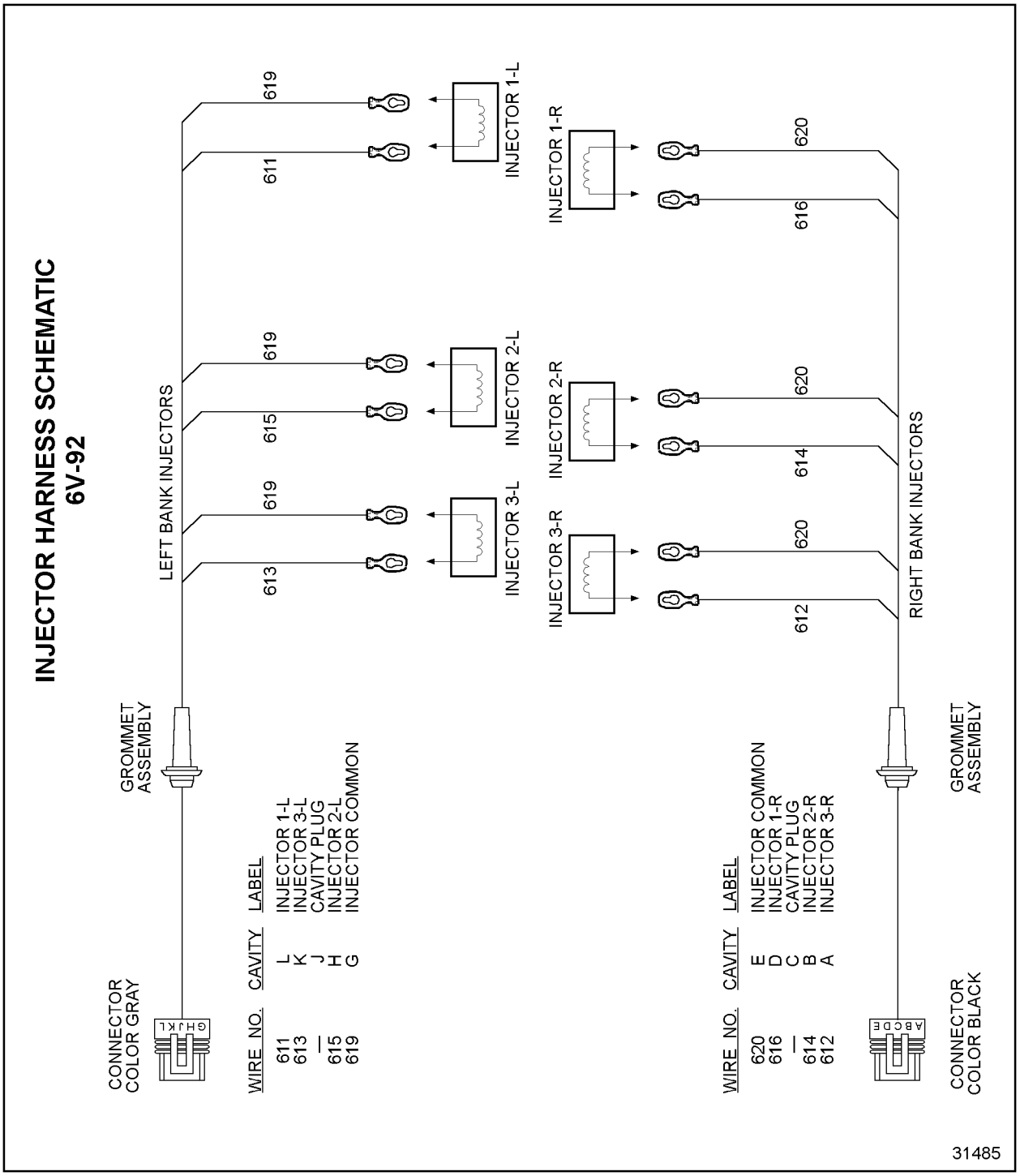

Figure 92-4 Injector Harness - Series 6V92 Engines

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92.4 INJECTOR HARNESS WIRING SCHEMATIC - SERIES 8V92 AND 8V149 ENGINES

The following wire schematics support the injector harness; see Figure 92-5.

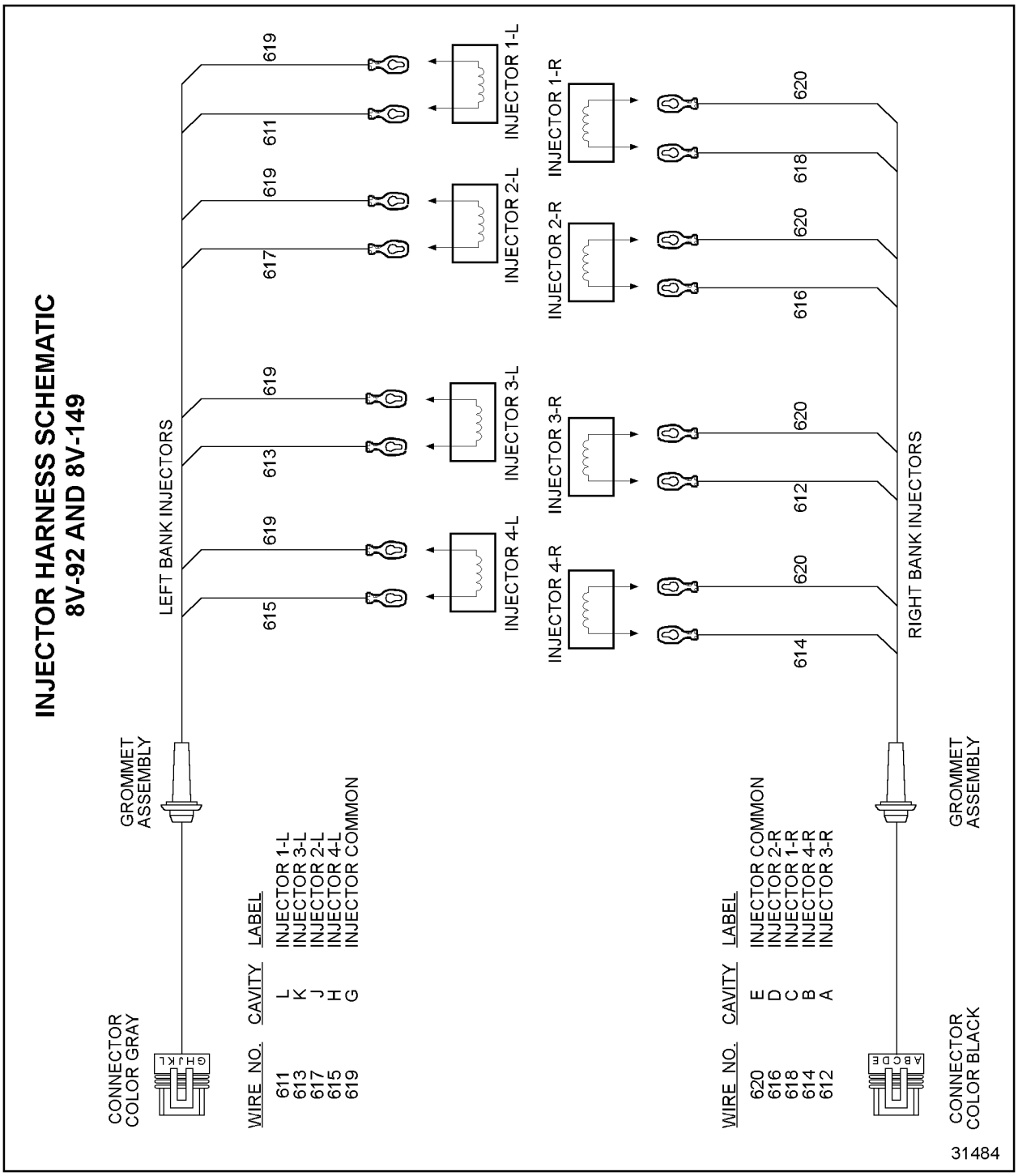

Figure 92-5 Injector Harness - Series 8V92 and 8V149 Engines

92.5 INTERNAL ENGINE BRAKE FOR ECM/WORLD TRANSMISSION INTERFACE

The following wire schematics support the internal engine brake for ECM/World transmission interface; see Figure 92-6.

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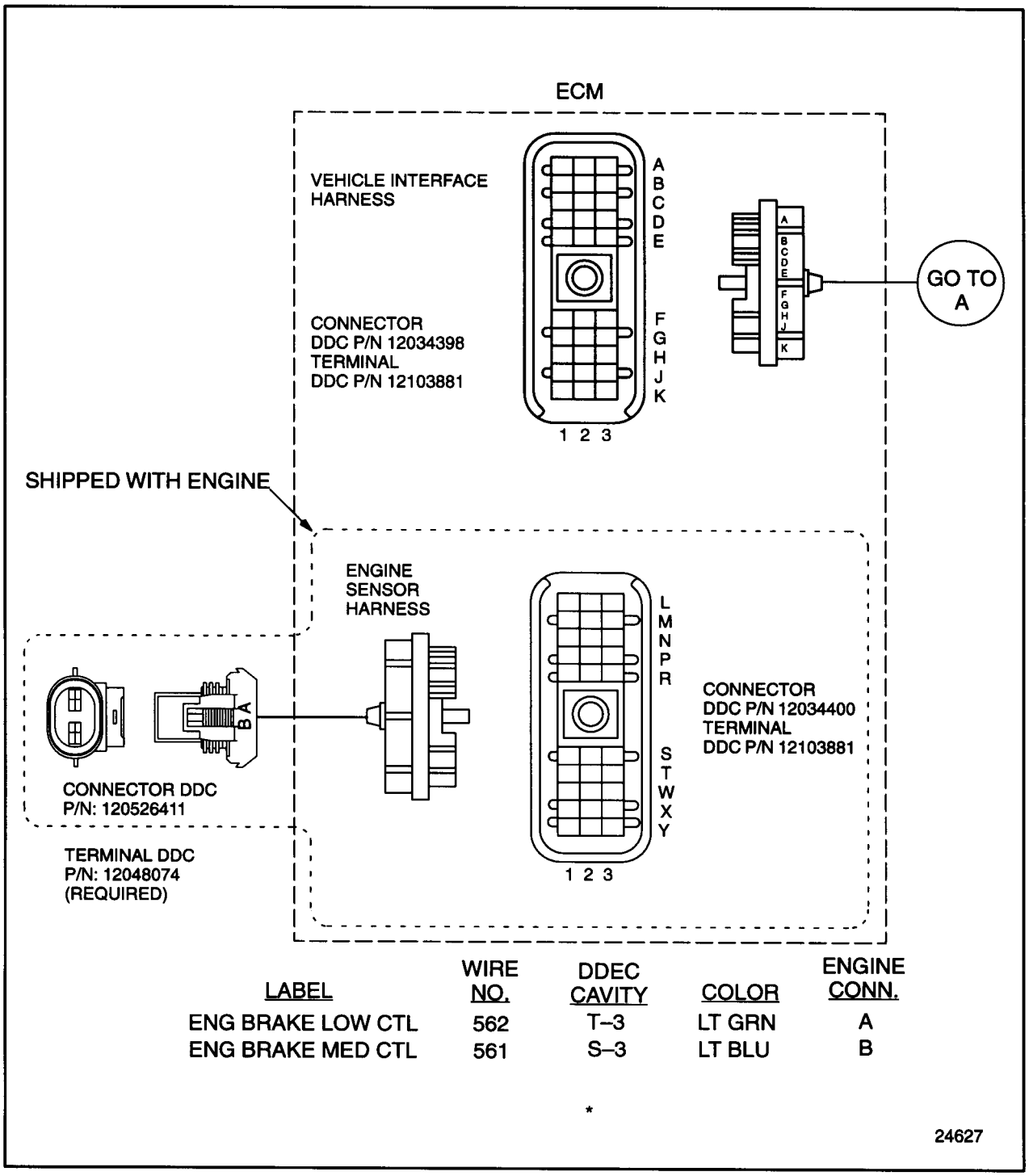

LABEL	WIRE NO.	DDEC CAVITY	COLOR	ENGINE CONN.
ENG BRAKE LOW CTL	562	T–3	LT GRN	A
ENG BRAKE MED CTL	561	S–3	LT BLU	B

*

For "Go To A", see Figure 92-7.

Figure 92-6 Internal Engine Brake ECM/World Transmission Interface (Sheet 1-2)

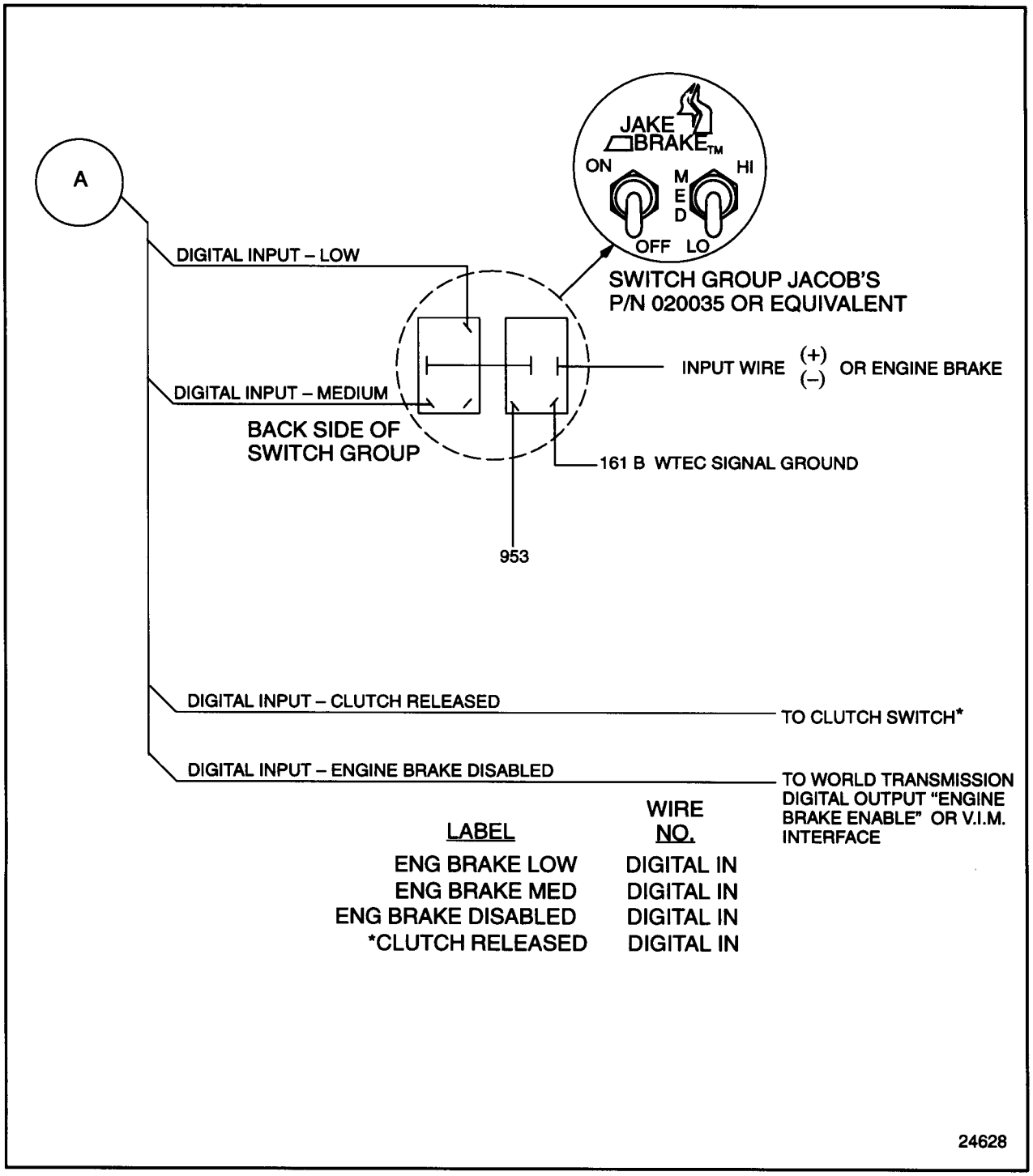

Figure 92-7 Internal Engine Brake ECM/World Transmission Interface (Sheet 2-2)

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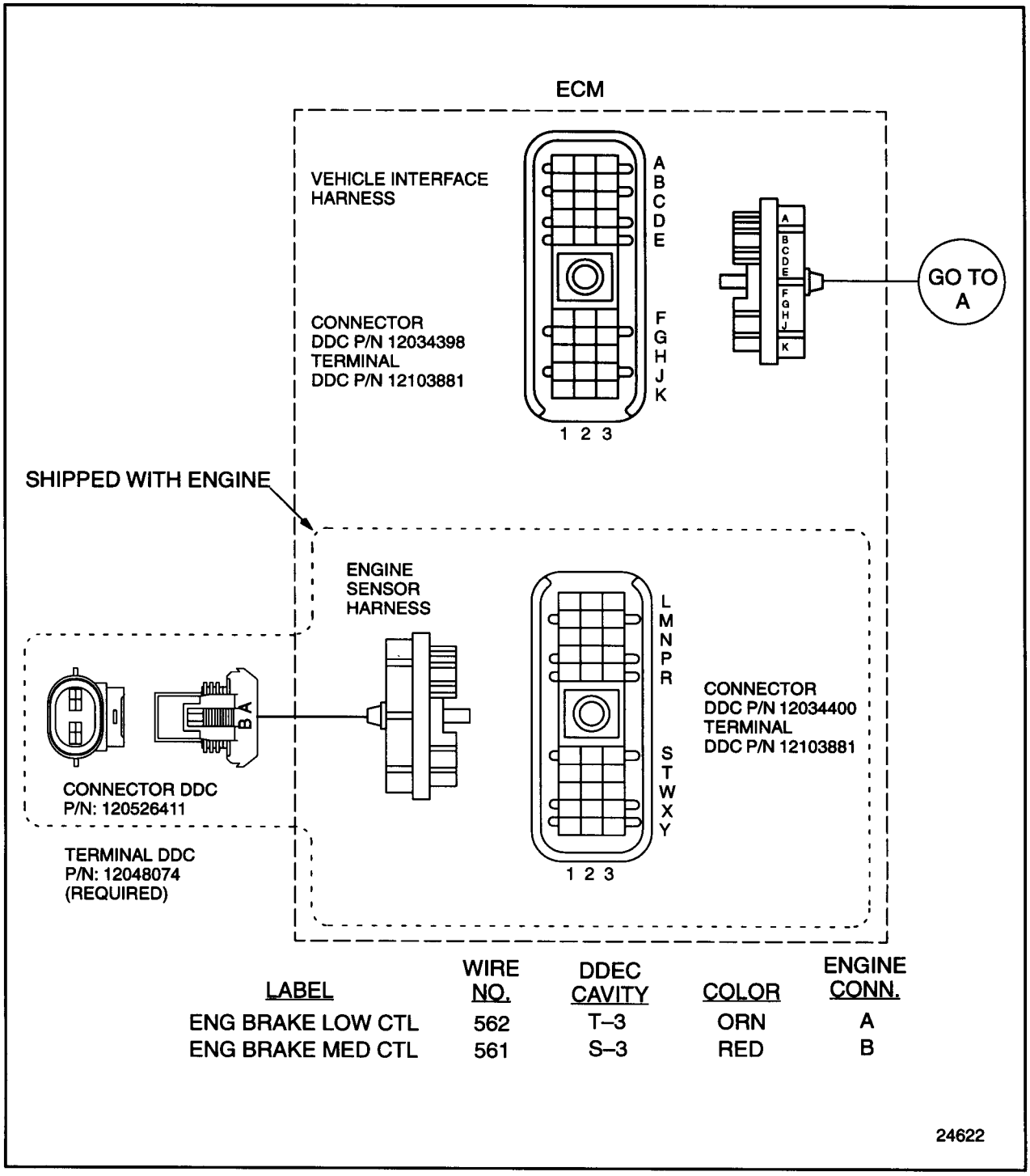
92.6 INTERNAL ENGINE BRAKE FOR DDEC SYSTEM ECM

The following wire schematics support the internal engine brake; see Figure 92-8.



LABEL	WIRE NO.	DDEC CAVITY	COLOR	ENGINE CONN.
ENG BRAKE LOW CTL	562	T–3	ORN	A
ENG BRAKE MED CTL	561	S–3	RED	B

For "Go To A", see Figure 92-9.

Figure 92-8 Internal Engine Brake (Sheet 1-2)

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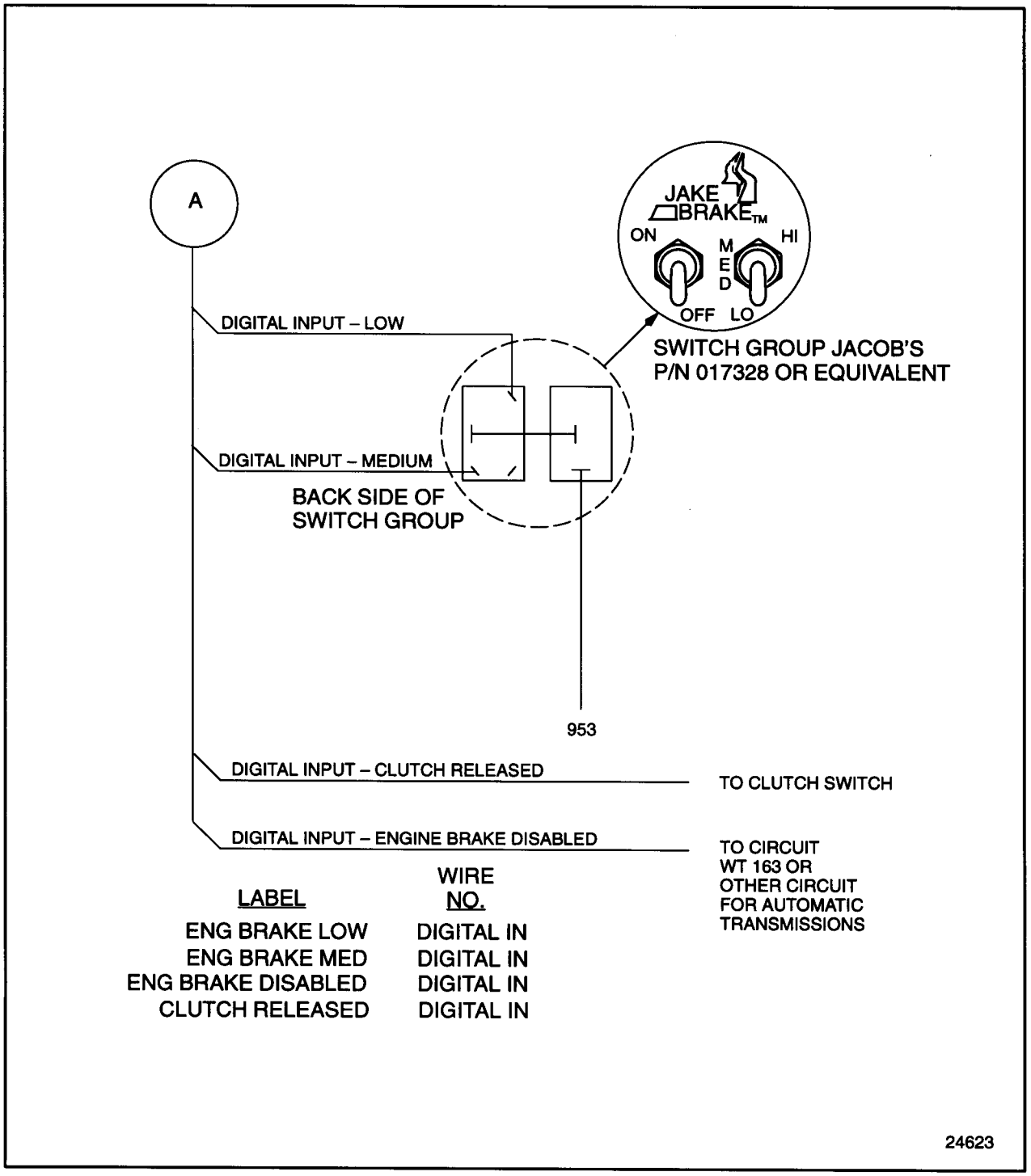

Figure 92-9 Internal Engine Brake (Sheet 2-2)

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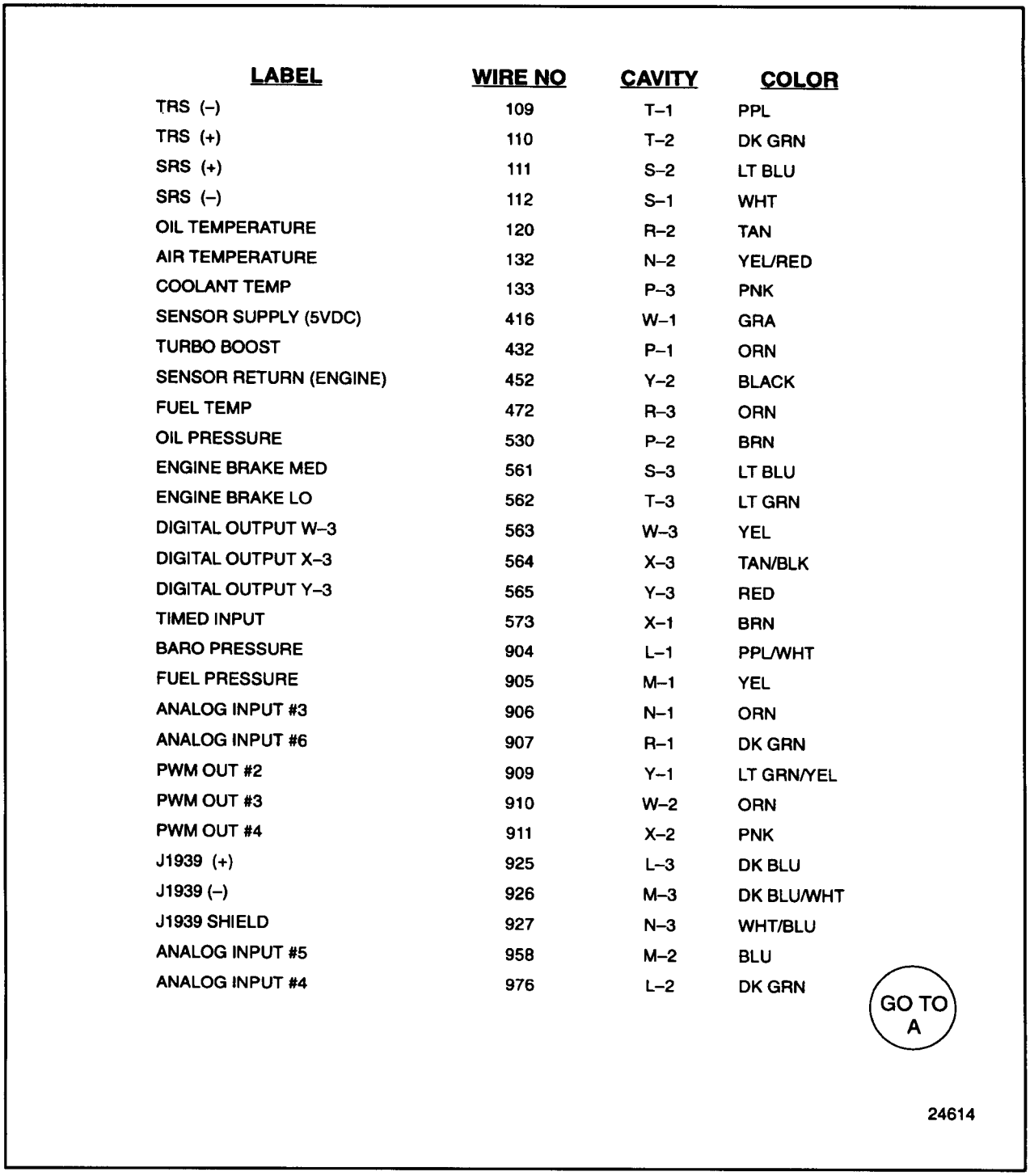
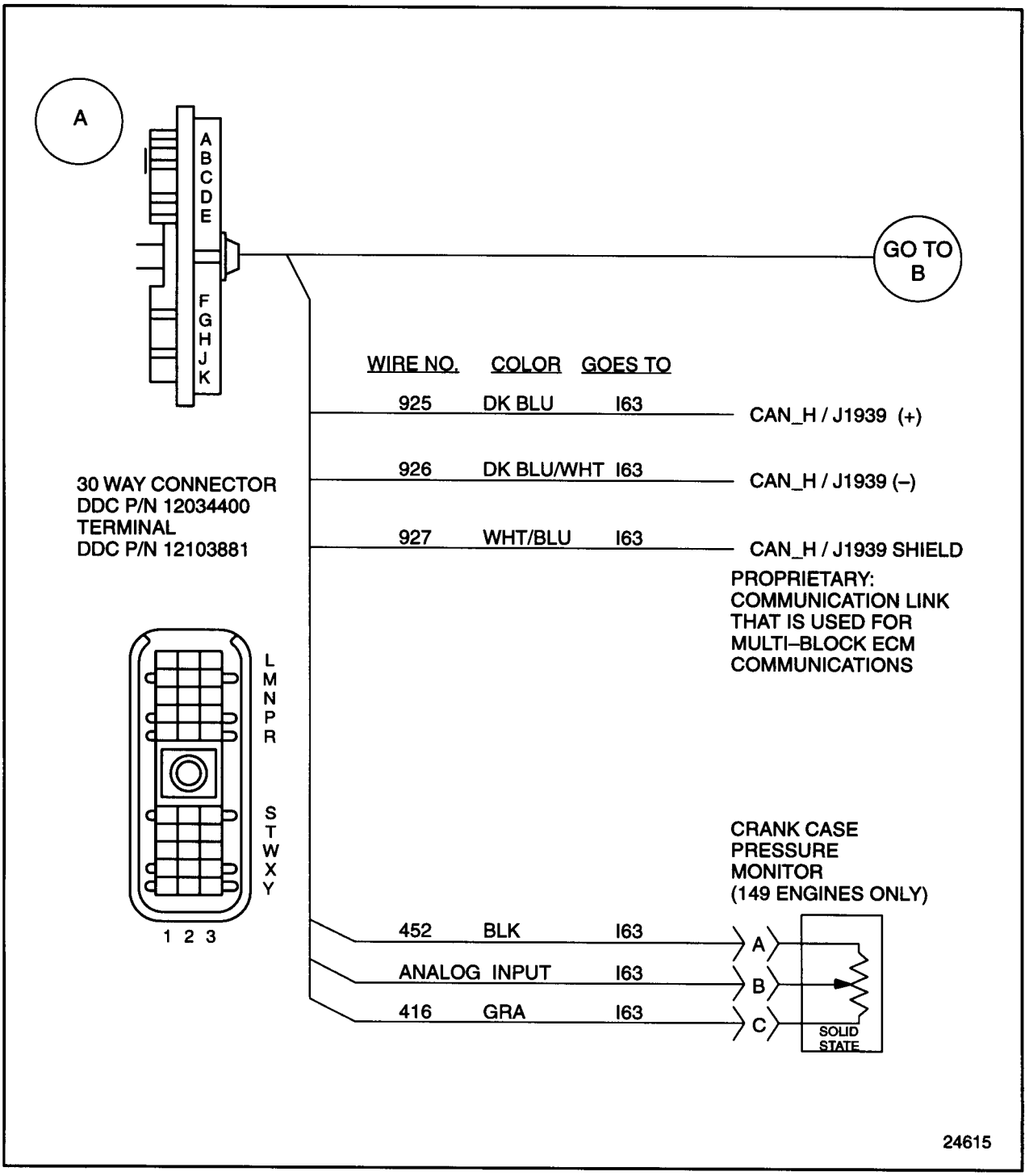
92.7 ENGINE HARNESS

The following wire schematics support the engine harness; see Figure 92-10.



For "Go To A", see Figure 92-11.

Figure 92-10 Engine Harness (Sheet 1-7)



For "Go To B", see Figure 92-12.

Figure 92-11 Engine Harness (Sheet 2-7)

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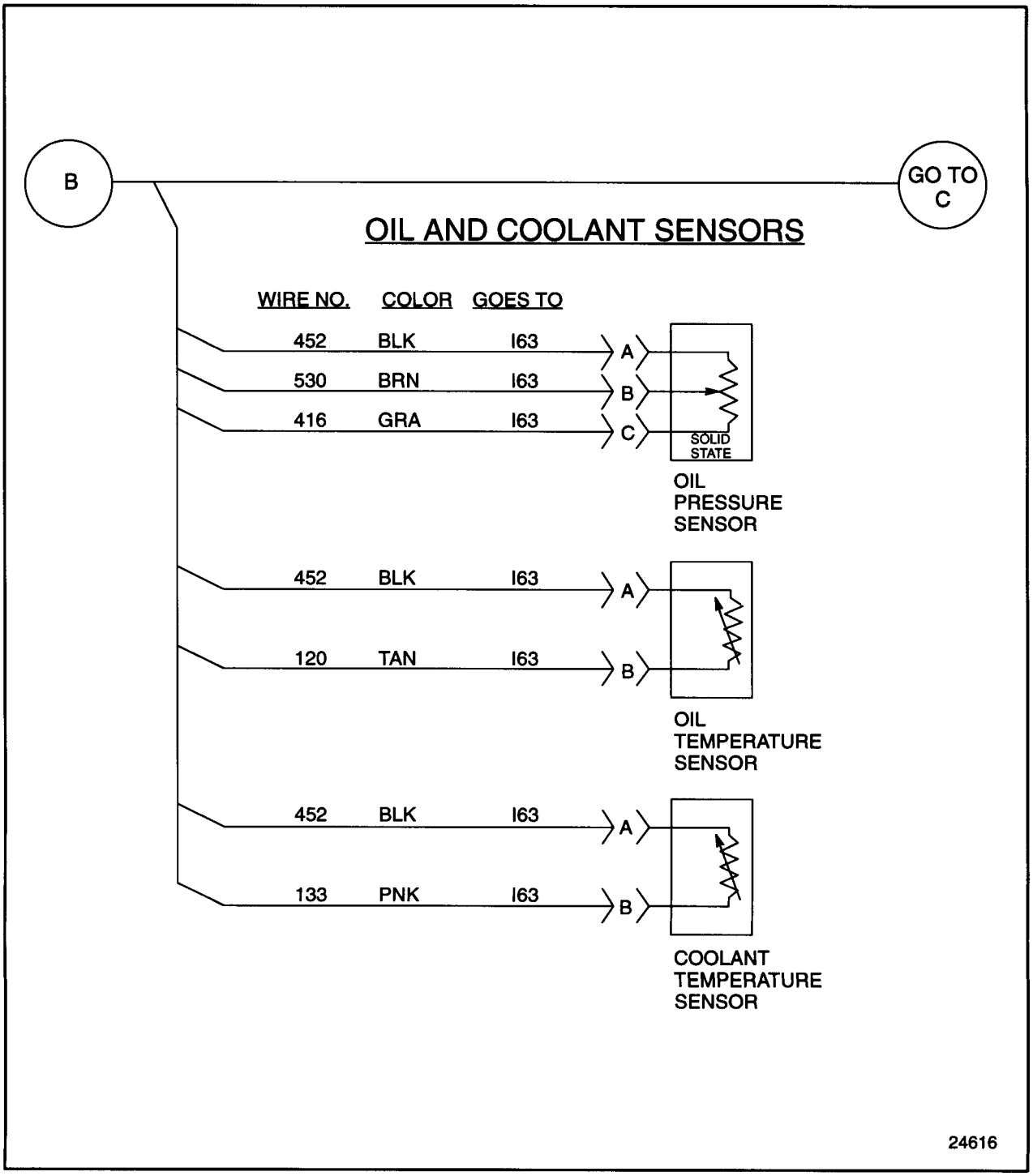
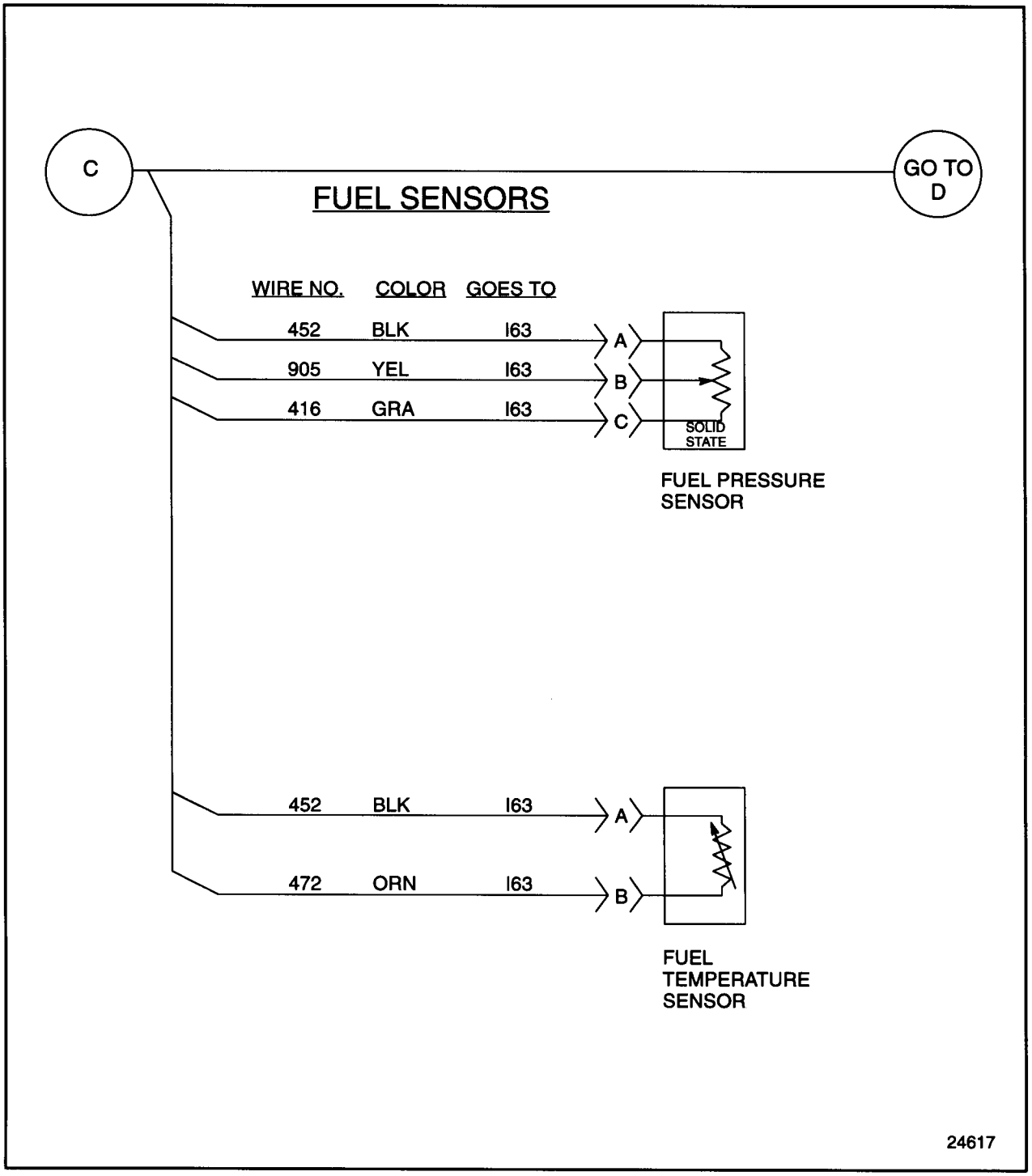


For "Go To C", see Figure 92-13.

Figure 92-12 Engine Harness (Sheet 3-7)



For "Go To D", see Figure 92-14.

Figure 92-13 Engine Harness (Sheet 4-7)

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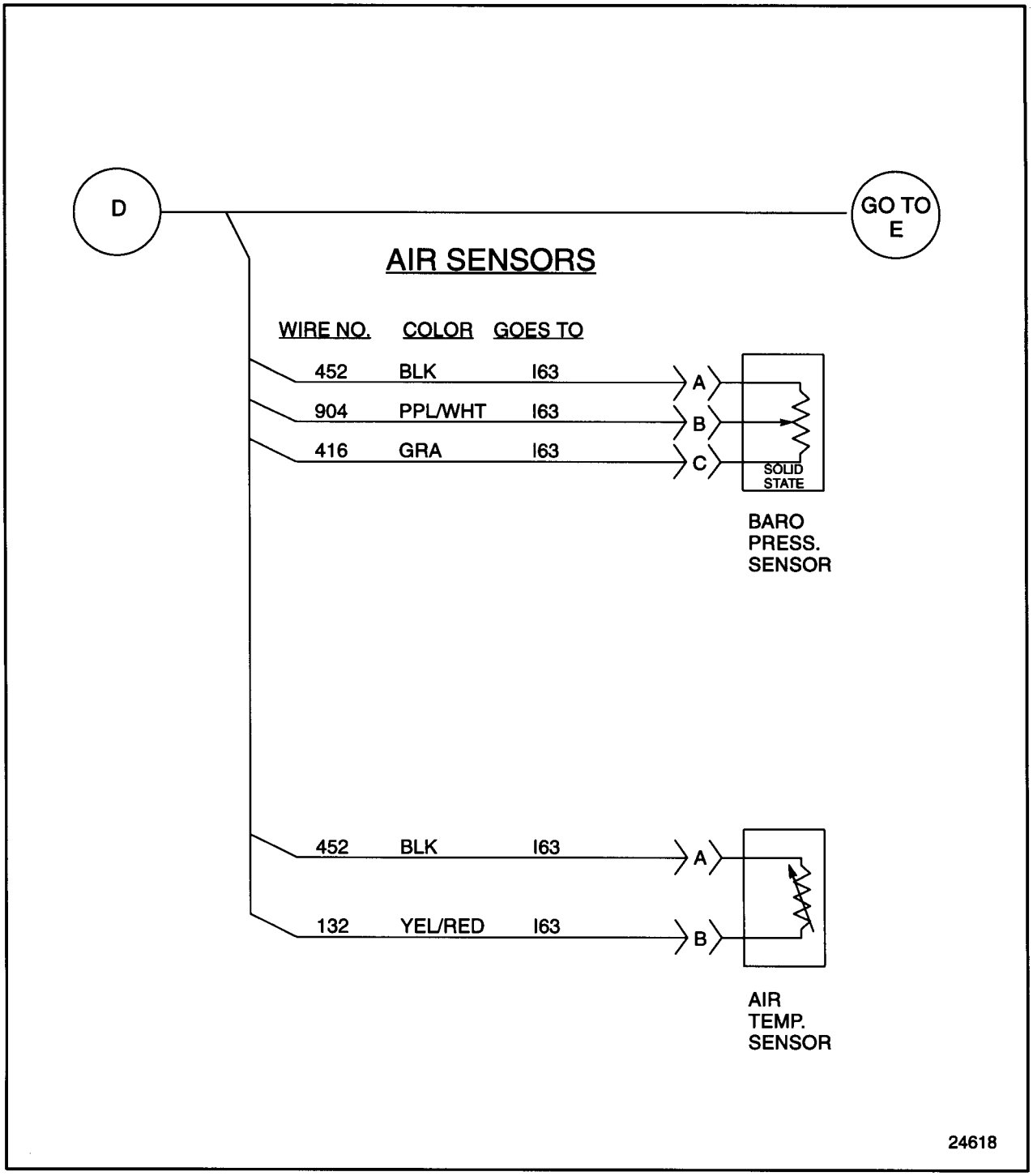
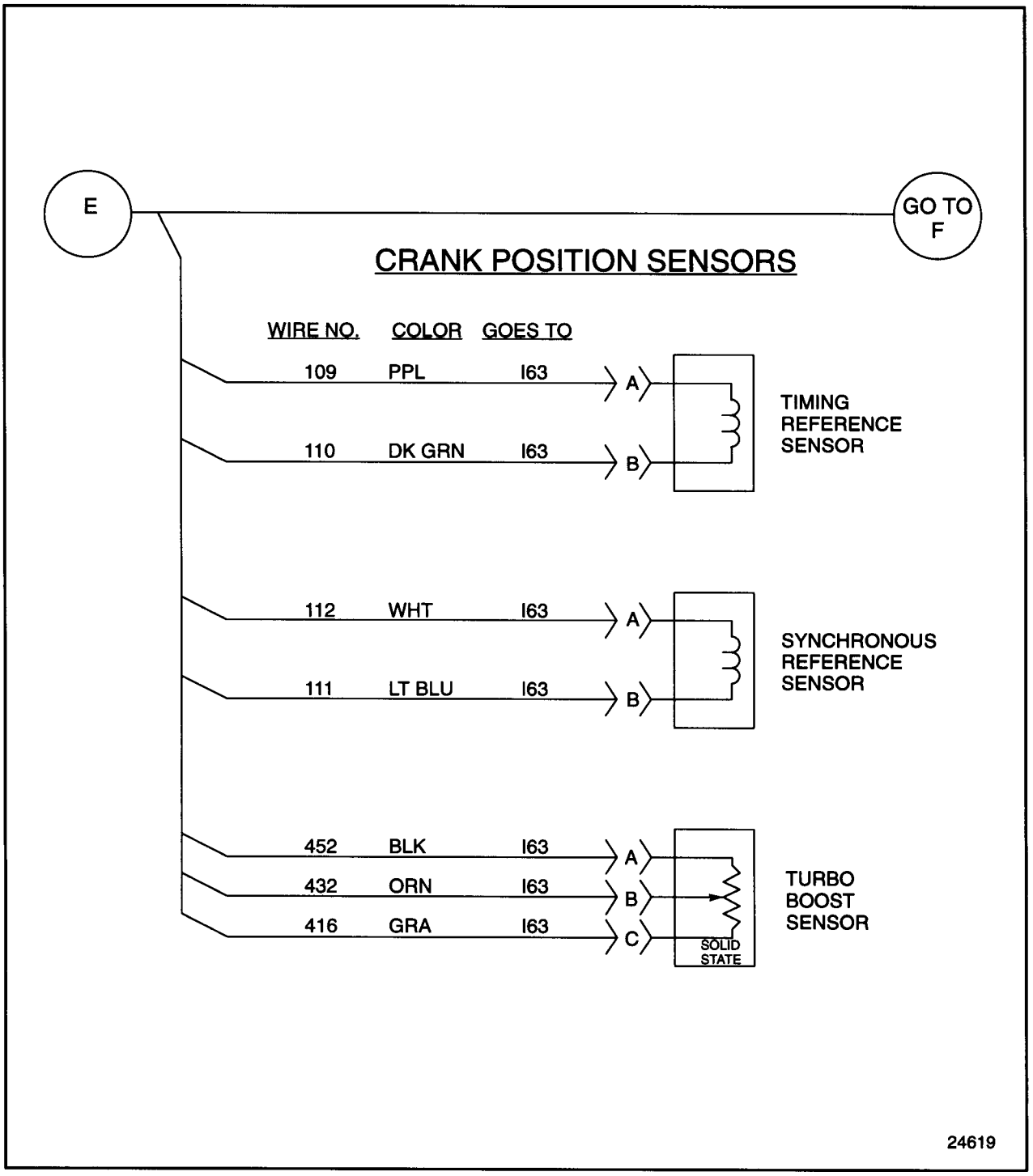


For "Go To E", see Figure 92-15.

Figure 92-14 Engine Harness (Sheet 5-7)



For "Go To F", see Figure 92-16.

Figure 92-15 Engine Harness (Sheet 6-7)

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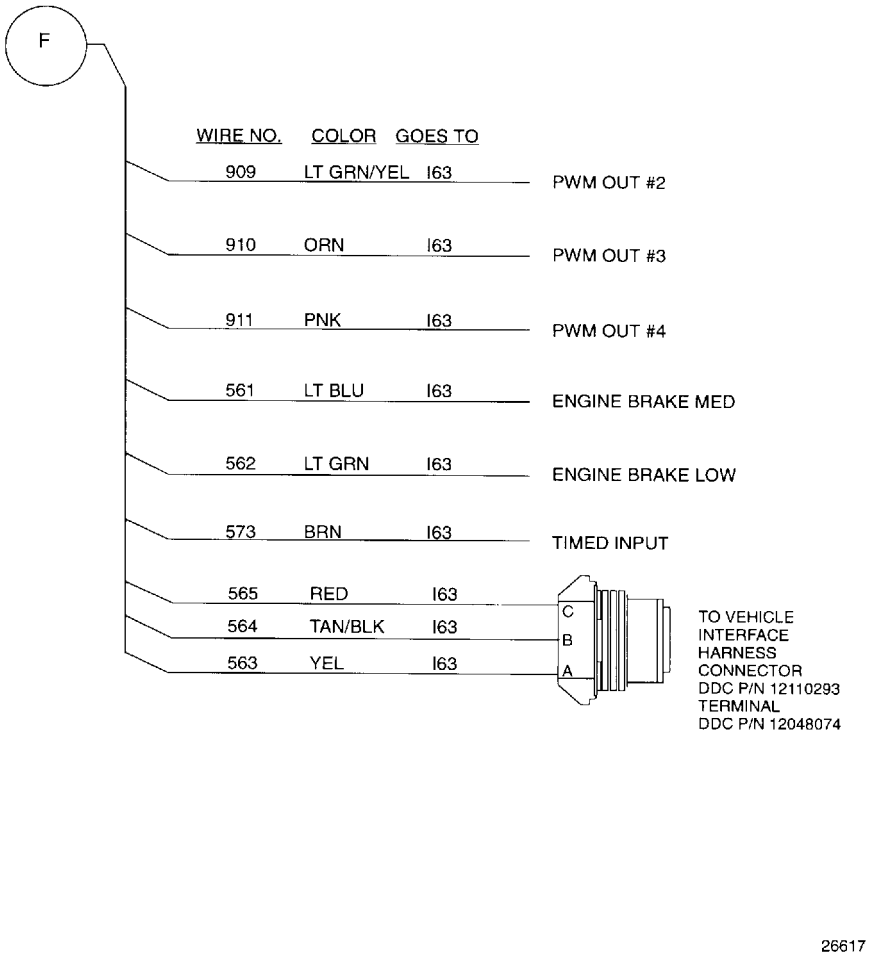

Figure 92-16 Engine Harness (Sheet 7-7)

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93 (CHG) VEHICLE WIRING SCHEMATICS

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93.1 VEHICLE INTERFACE HARNESS

The following wire schematics support the vehicle interface harness; see Figure 93-1.

LABEL	WIRE NO	CAVITY	COLOR
COOLANT LEVEL	115	H–3	ORN
LIMITING SPEED GOVERNOR	417	D–2	DK BLUE
CHECK ENGINE LIGHT	419	B–1	PPL/WHT
IGNITION	439	B–3	PNK
DIGITAL INPUT E–1	451	E–1	LT GRN
DIGITAL OUTPUT F–3	499	F–3	LT BLU
TACHOMETER DRIVE	505	K–1	GRA
STOP ENGINE LIGHT	509	B–2	PPL
VARIABLE SPEED GOVERNOR	510	D–1	BRN
DIGITAL INPUT H–1	523	H–1	GRA/RED
DIGITAL INPUT H–2	524	H–2	GRA
DIGITAL INPUT G–1	528	G–1	BRN/RED
DIGITAL INPUT J–2	531	J–2	ORN
DIGITAL INPUT J–1	541	J–1	YEL/RED
DIGITAL INPUT F–1	542	F–1	YEL
DIGITAL INPUT G–2	543	G–2	ORN/BLK
DIGITAL INPUT F–2	544	F–2	BRN/WHT
DIGITAL INPUT G–3	545	G–3	LT BLUE/YEL
DIGITAL OUTPUT A–2	555	A–2	TAN
VEHICLE SPEED (+)	556	E–2	LT BLUE/BLK
VEHICLE SPEED (–)	557	E–3	LT BLUE/ORN
DIGITAL INPUT K–2	583	K–2	LT BLUE/BLK
ANALOG INPUT #7	749	D–3	YEL
DATA LINK (+)	900	C–2	DK GREEN/YEL
DATA LINK (–)	901	C–1	DK GREEN
PWM #1 OUTPUT	908	J–3	WHT
SENSOR SUPPLY (5VDC)	916	A–3	RED/BLK
SENSOR RETURN	952	C–3	BLK
DIGITAL INPUT K–3	979	K–3	WHT
DIGITAL OUTPUT A–1	988	A–1	GRA

GO TO A

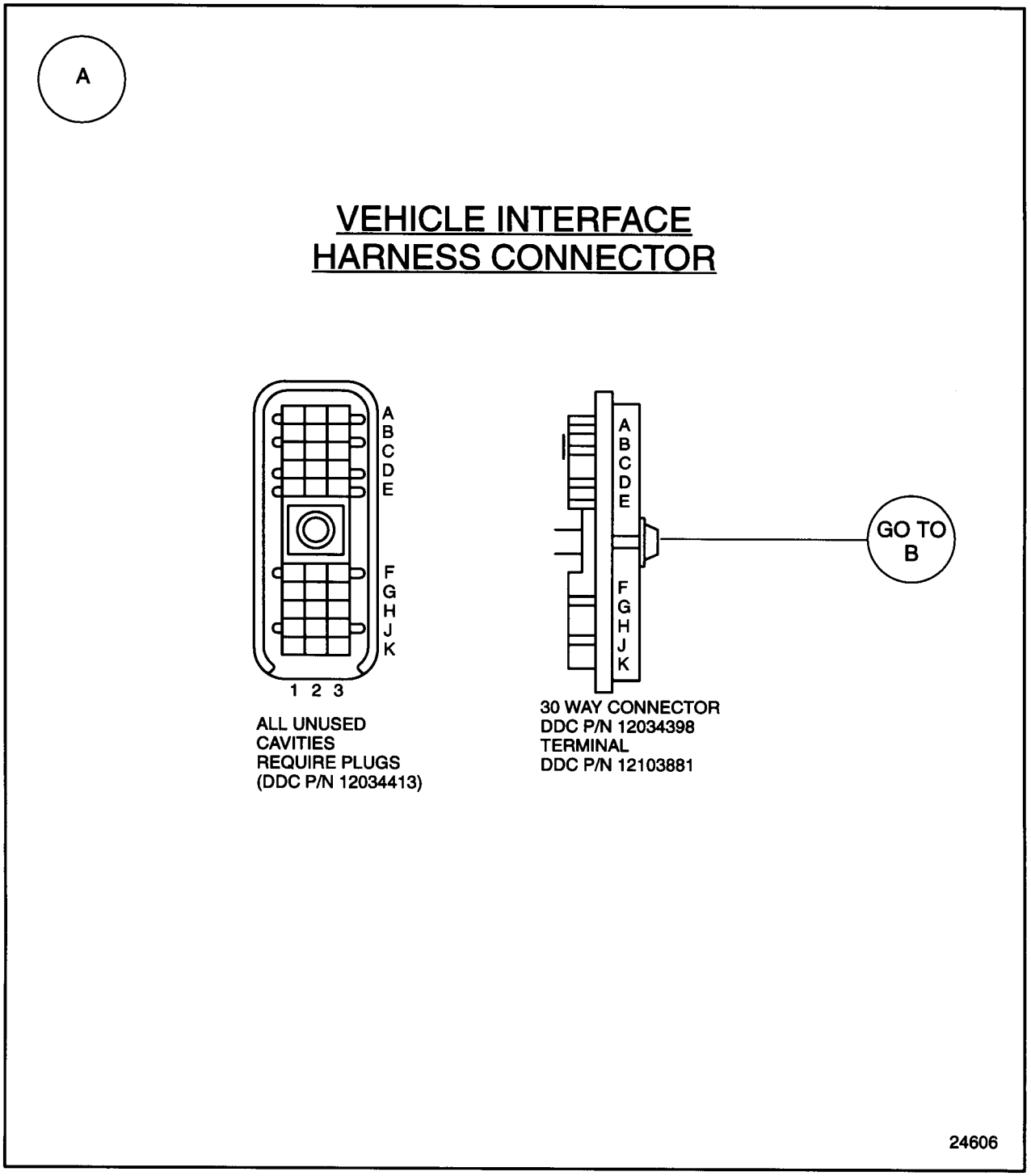
IGNITION CONNECTOR

+12 V FROM BATTERY	440	A	ORN
BATTERY GROUND	953	B	BLK/WHT

24605

For "Go To A", see Figure 93-2.

Figure 93-1 Vehicle Interface Harness (Sheet 1-9)



For "Go To B", see Figure 93-3.

Figure 93-2 Vehicle Interface Harness (Sheet 2-9)

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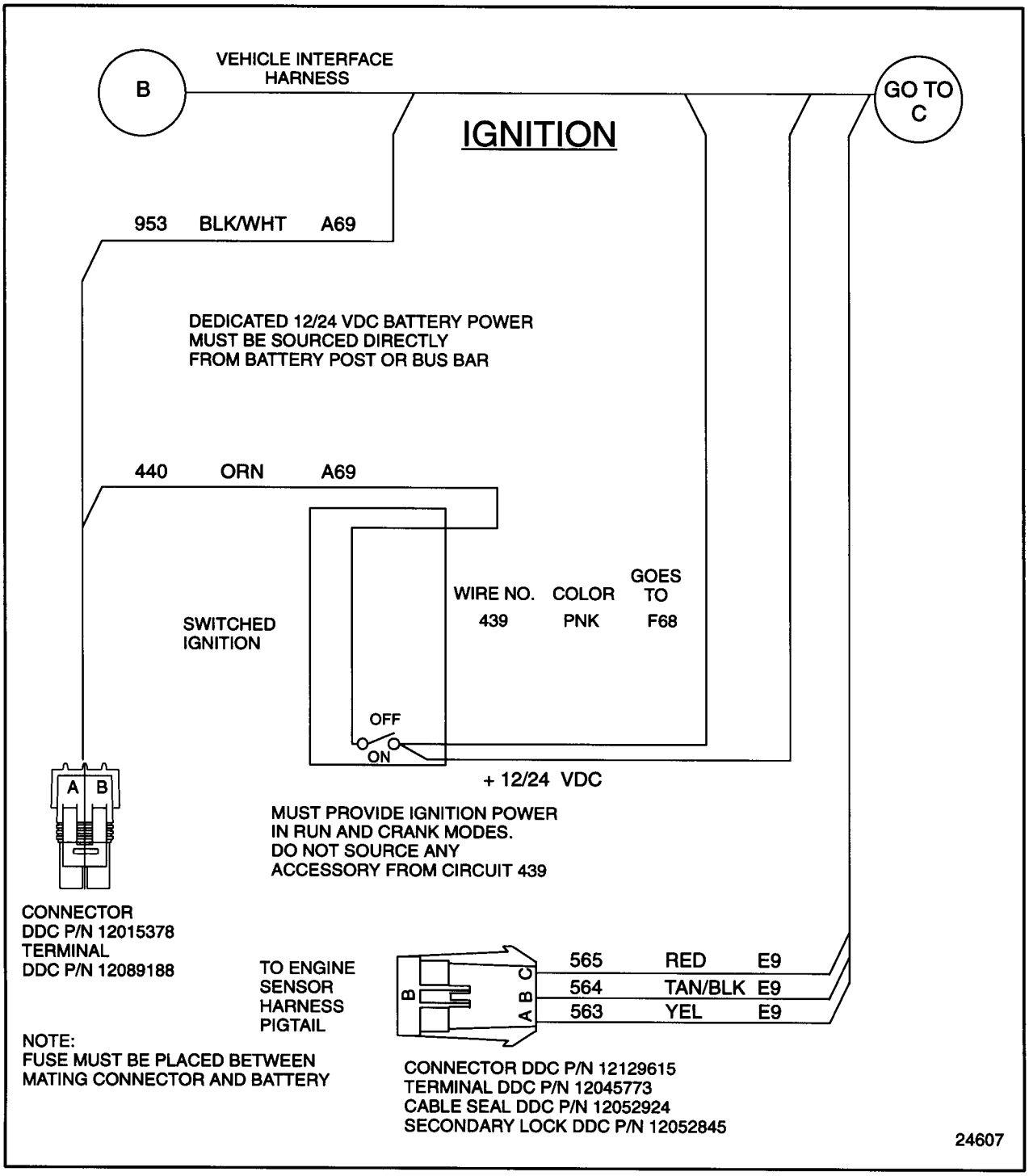
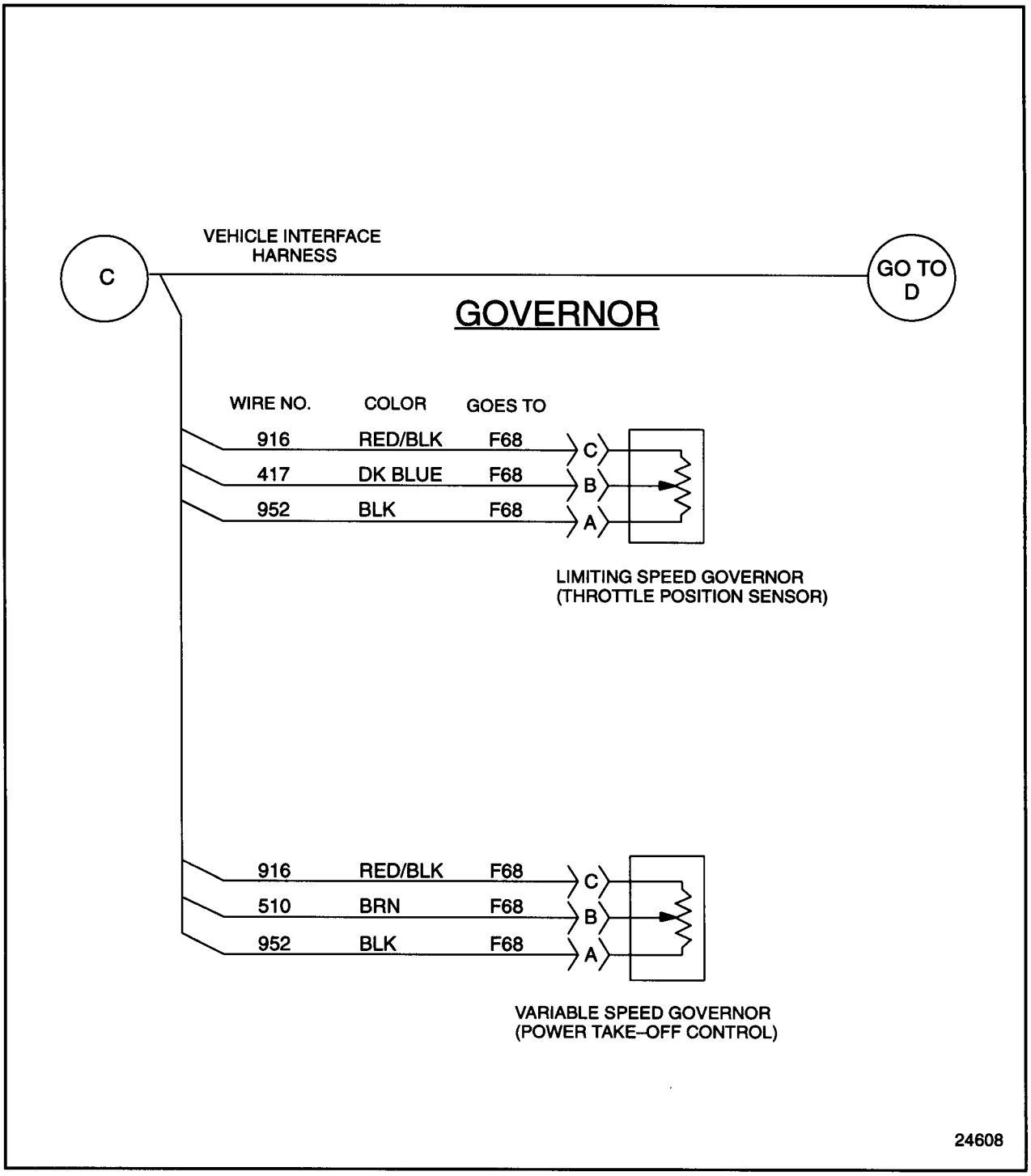


For "Go To C", see Figure 93-4.

Figure 93-3 Vehicle Interface Harness (Sheet 3-9)



For "Go To D", see Figure 93-5.

Figure 93-4 Vehicle Interface Harness (Sheet 4-9)

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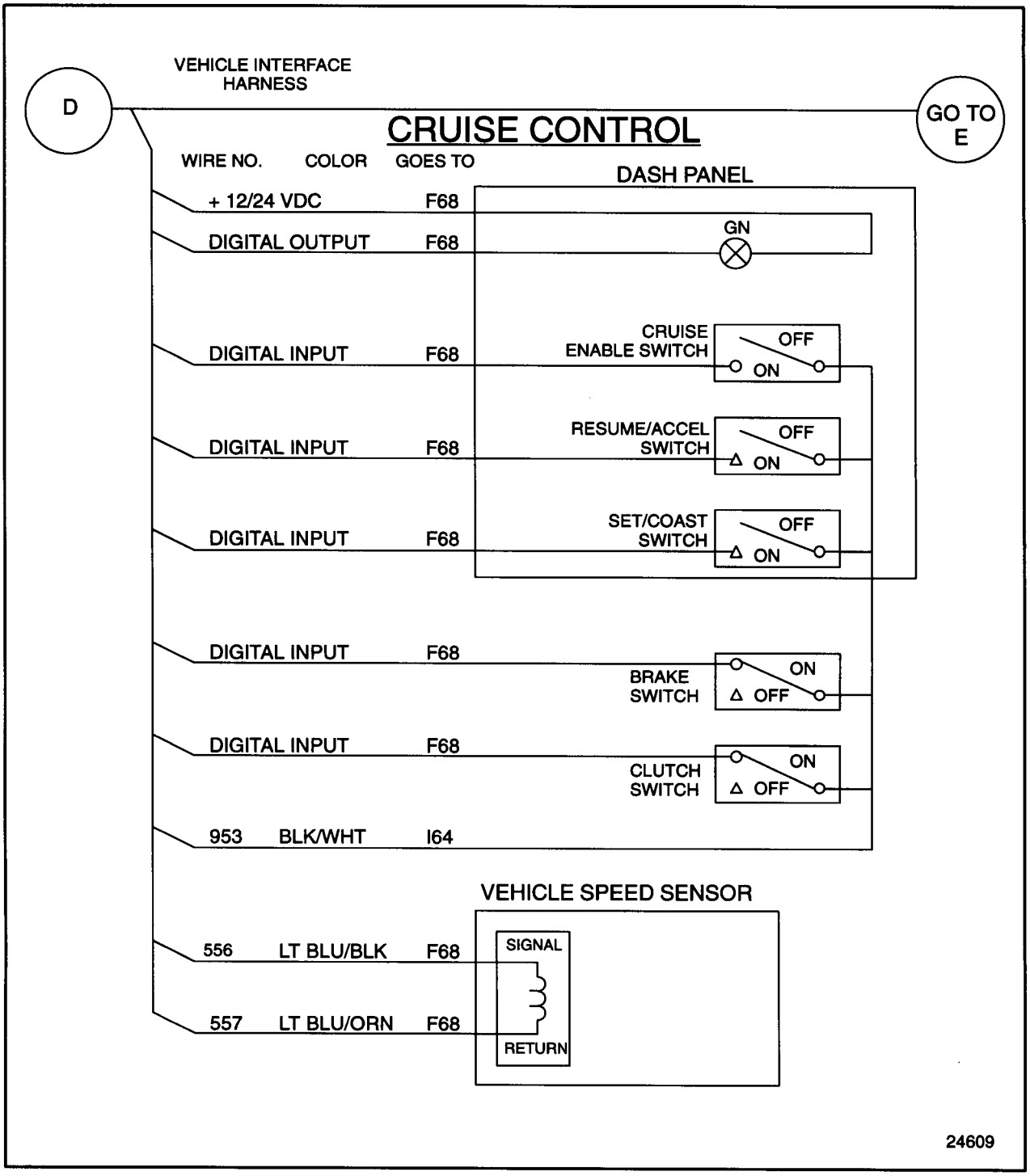
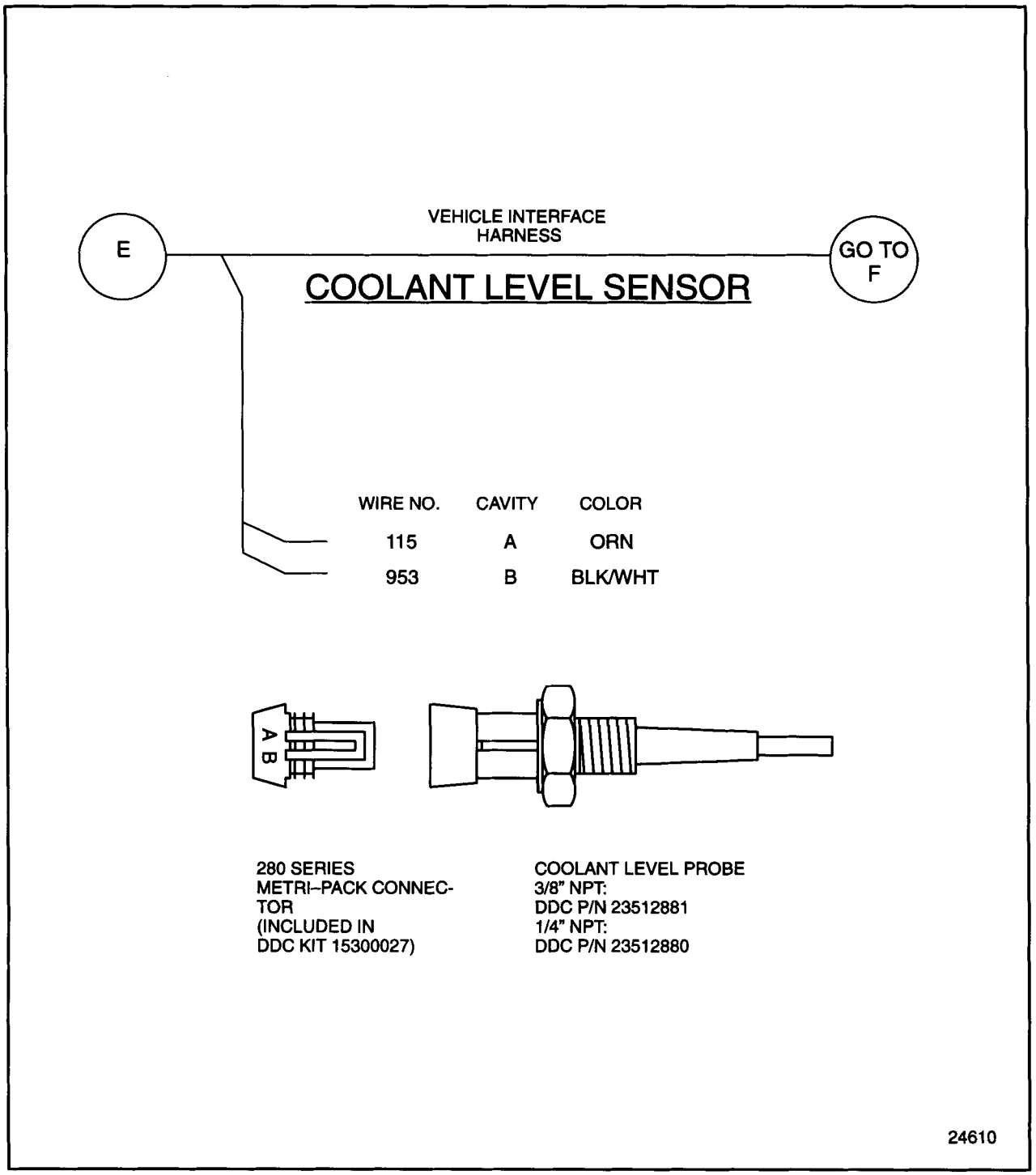


For "Go To E", see Figure 93-6.

Figure 93-5 Vehicle Interface Harness (Sheet 5-9)



For "Go To F", see Figure 93-7.

Figure 93-6 Vehicle Interface Harness (Sheet 6-9)

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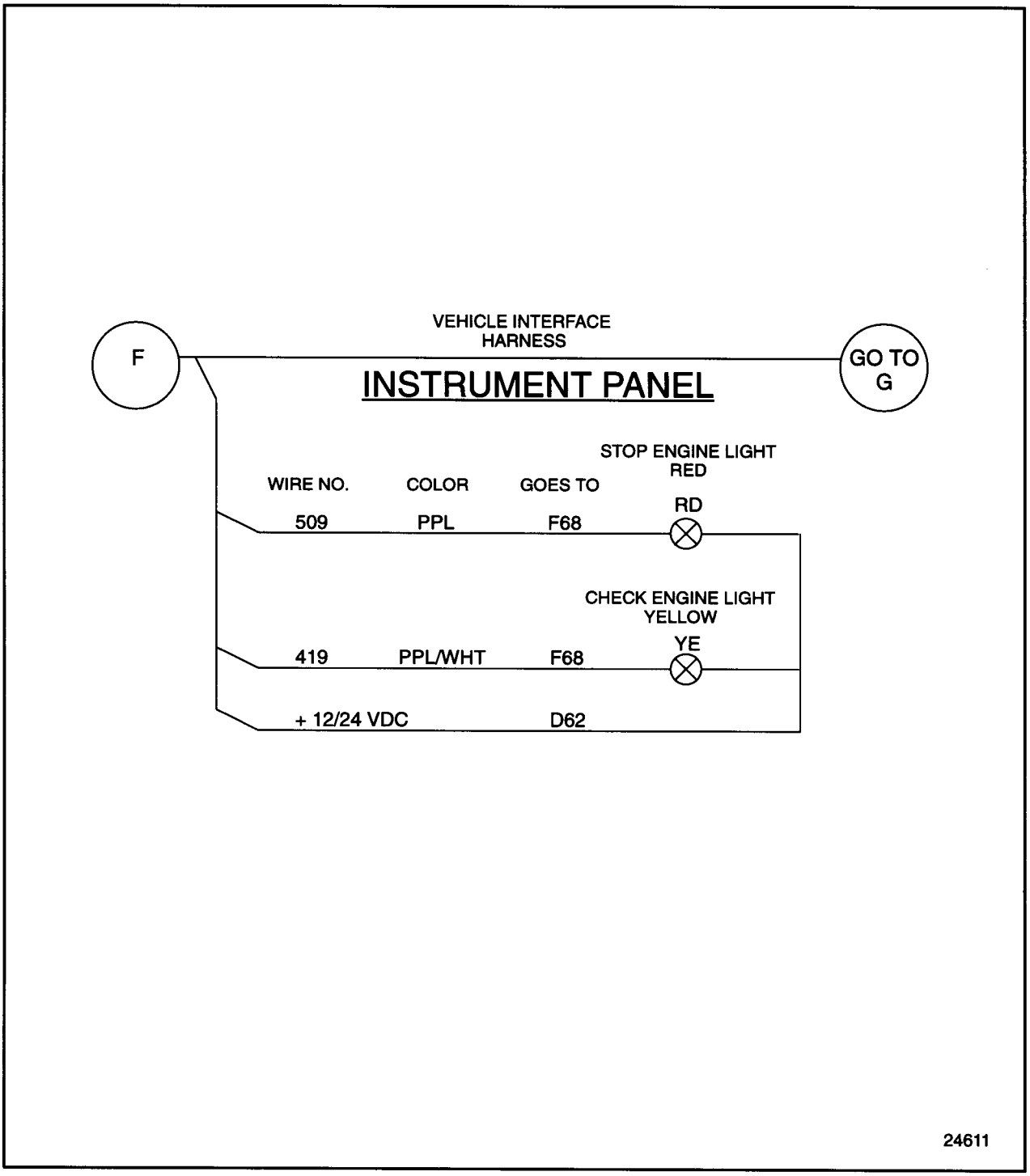
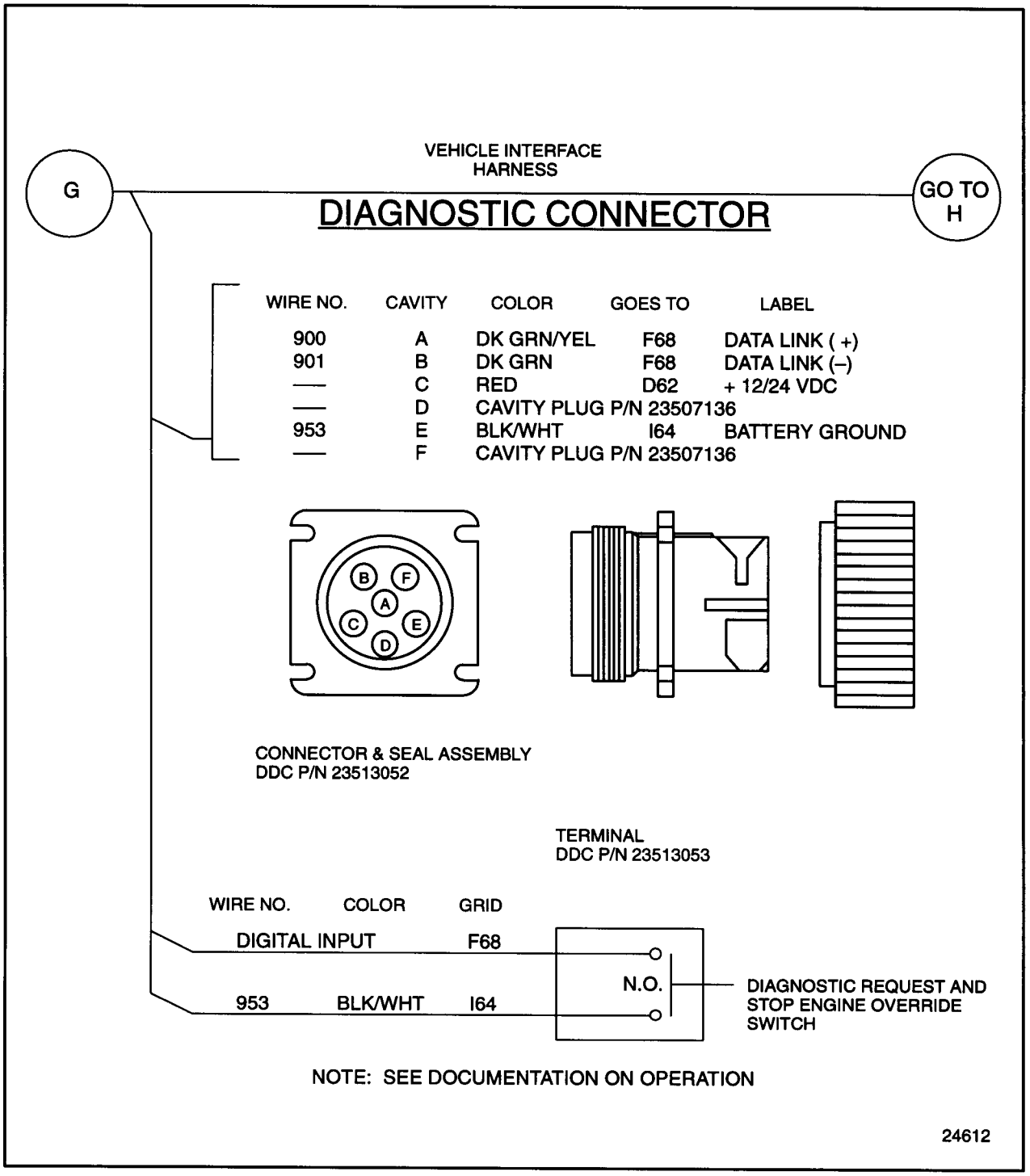


For "Go To G", see Figure 93-8.

Figure 93-7 Vehicle Interface Harness (Sheet 7-9)



For "Go To H", see Figure 93-9.

Figure 93-8 Vehicle Interface Harness (Sheet 8-9)

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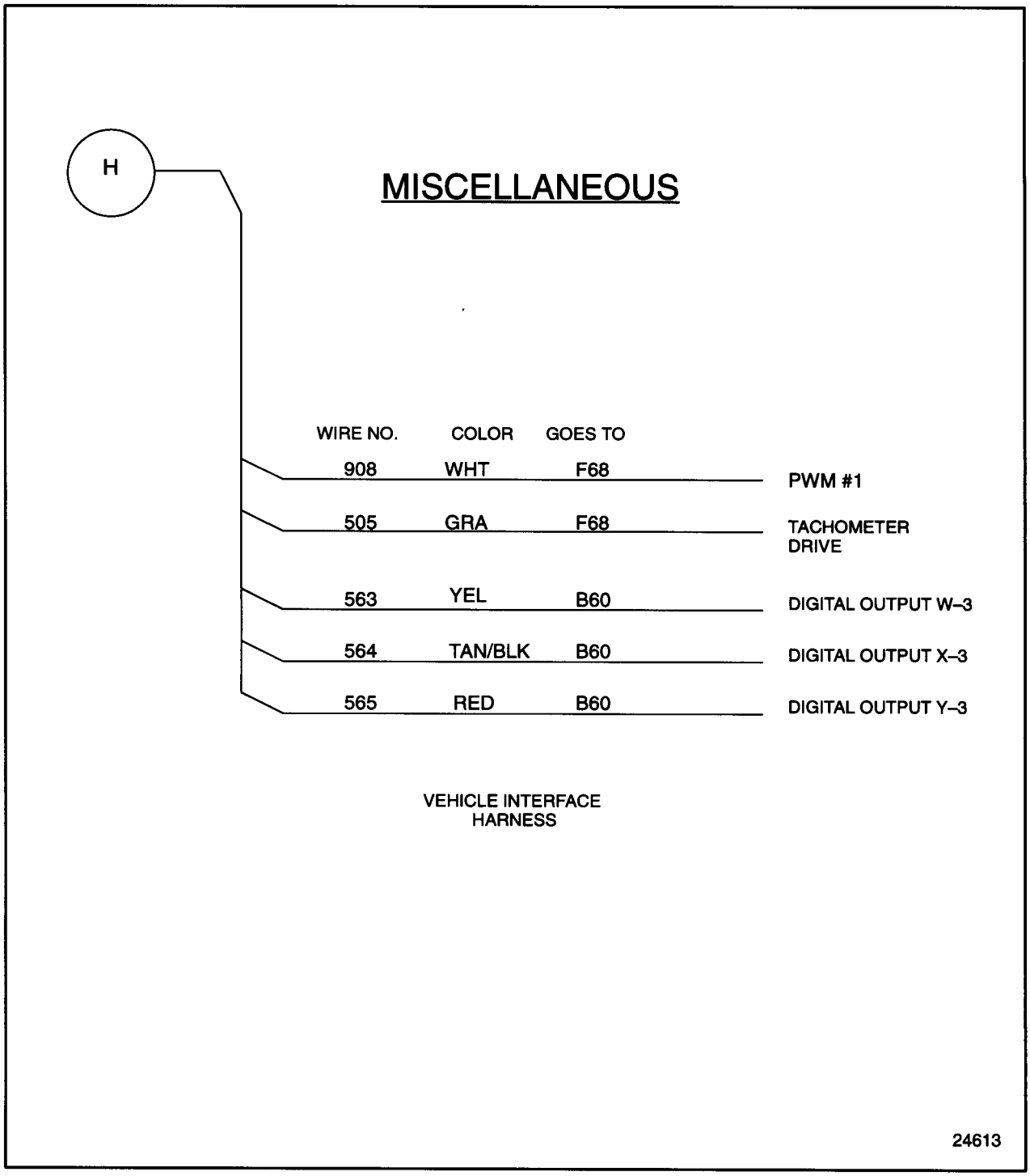

Figure 93-9 Vehicle Interface Harness (Sheet 9-9)

93.2 PRESSURE GOVERNOR SYSTEM - VEHICLE INTERFACE HARNESS CONNECTOR

The following wire schematics support the Pressure Governor System (PGS) vehicle interface harness connector; see Figure 93-10.

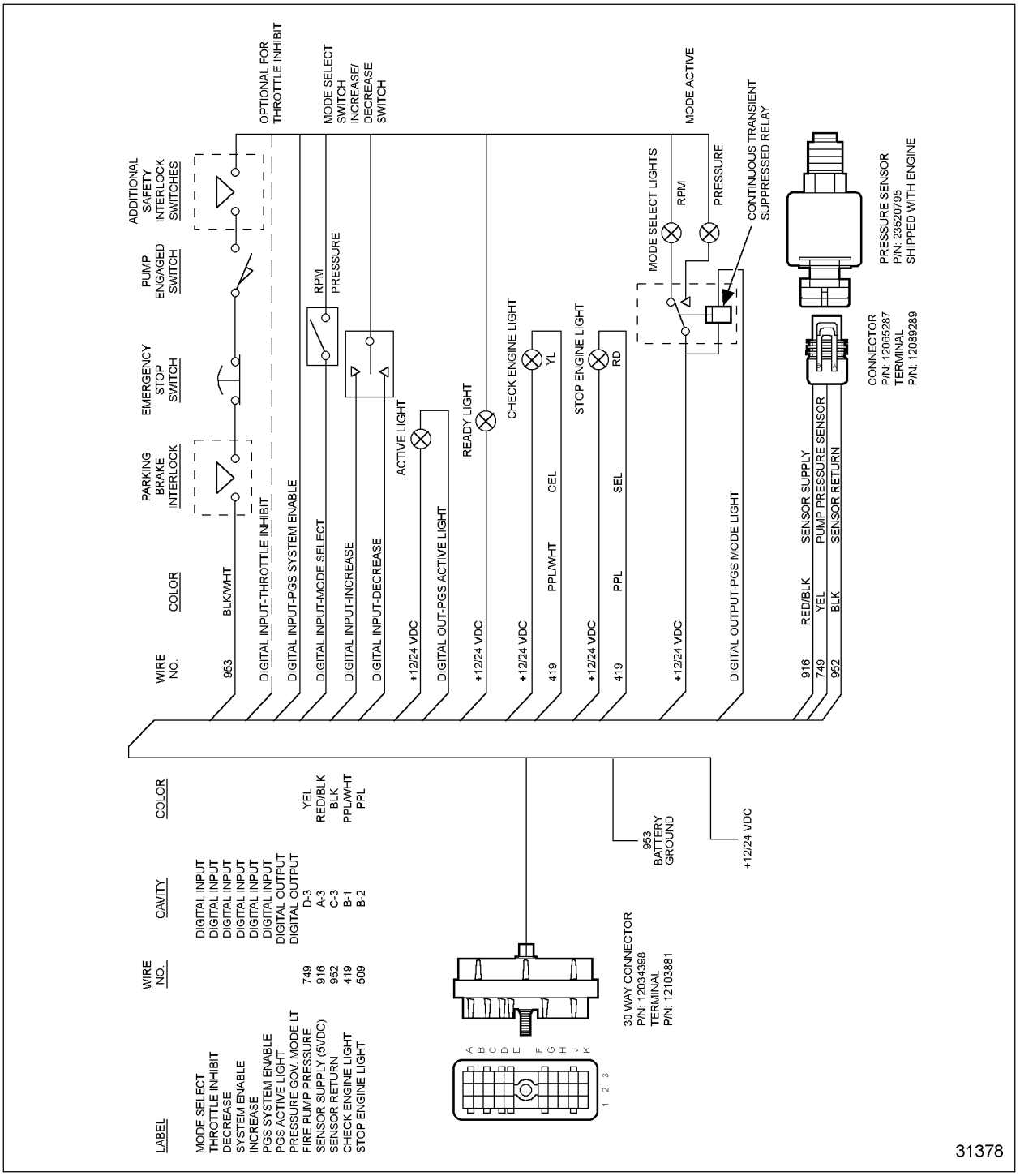

Figure 93-10 Pressure Governor System Vehicle Interface Harness Connector

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93.3 ELECTRONIC FIRE COMMANDER HARNESS

The following wire schematics support the electronic fire commander harness; see Figure 93-11.

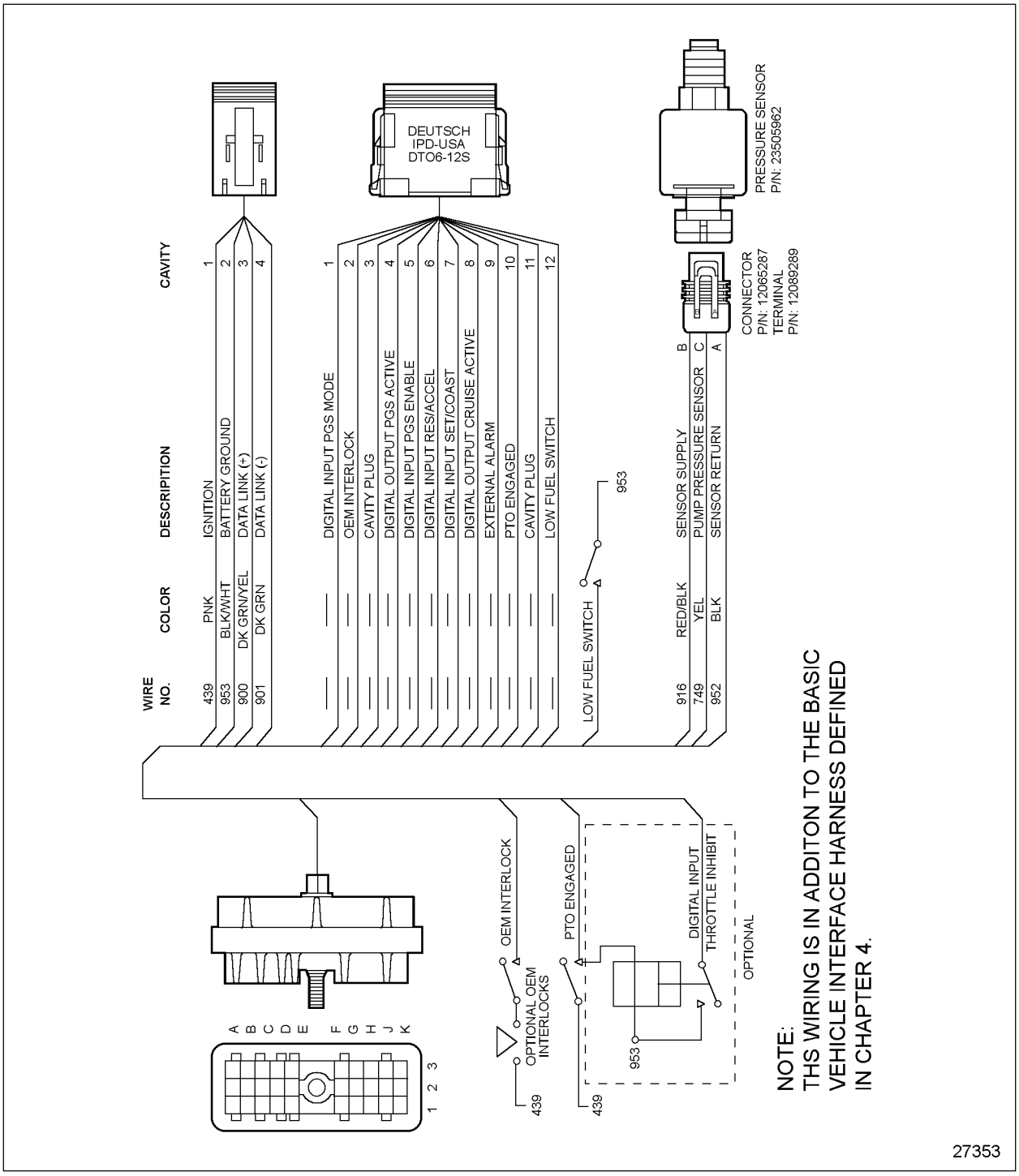

Figure 93-11 Electronic Fire Commander Harness

93.4 POWER HARNESS - SINGLE ECM, SINGLE FUSE

The following wire schematics support the vehicle interface harness; see Figure 93-12.

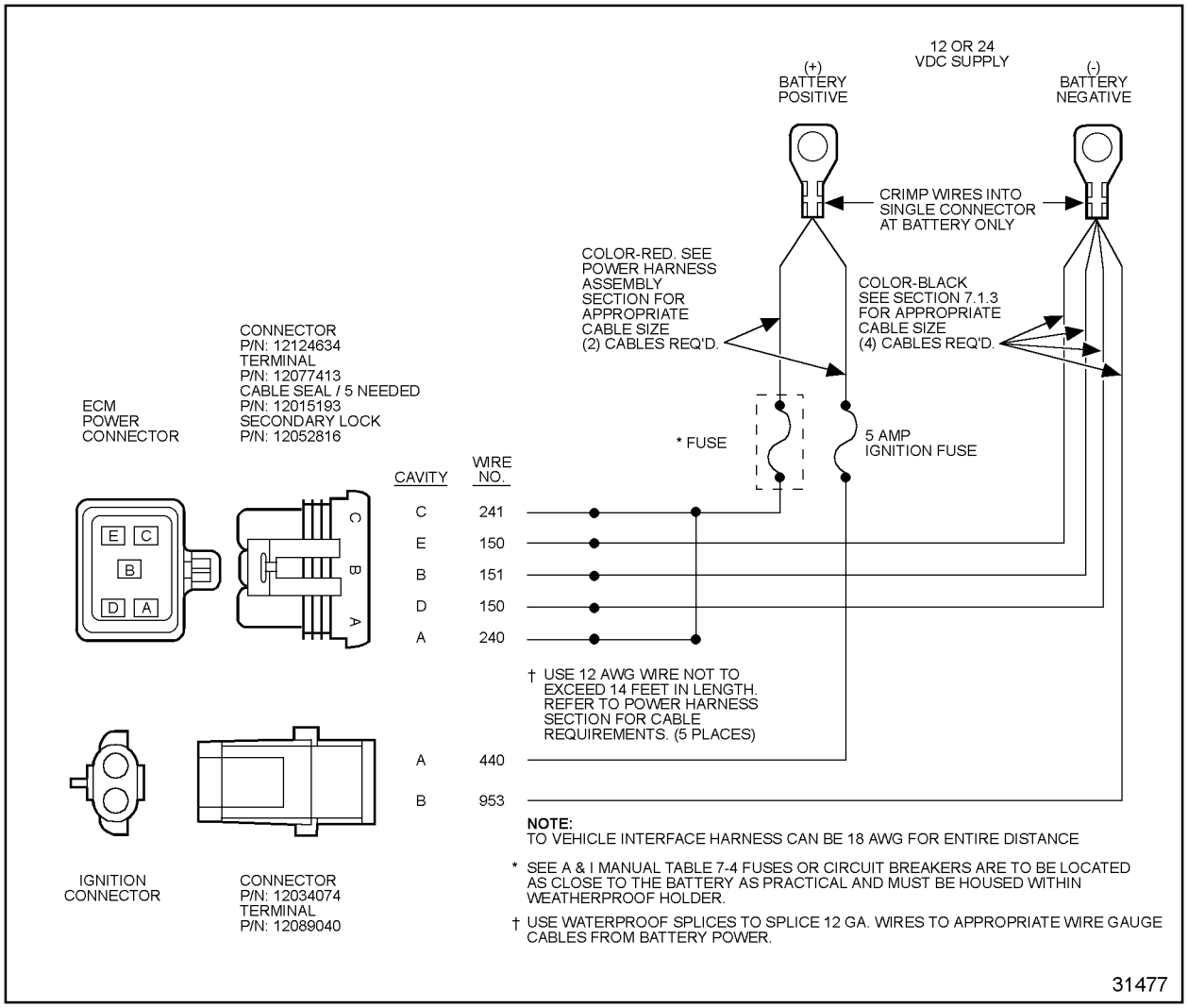

Figure 93-12 Power Harness - Single ECM, Single Fuse

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93.5 POWER HARNESS - SINGLE ECM, DUAL FUSES

The following wire schematics support the vehicle interface harness; see Figure 93-13.

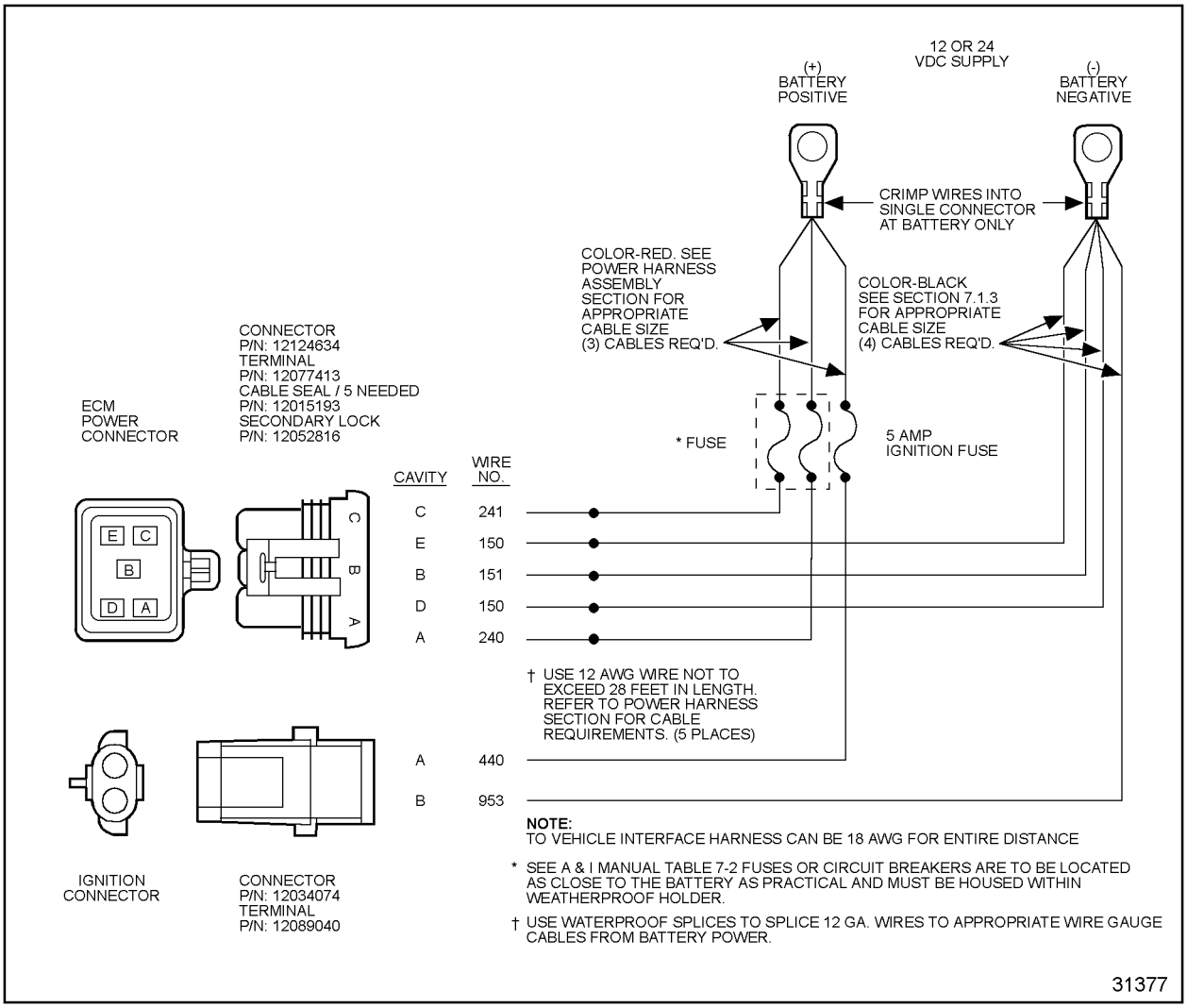

Figure 93-13 Power Harness - Single ECM, Dual Fuses

93.6 DDEC DIGITAL OUTPUT

The following wire schematics support the DDEC digital outputs; see Figure 93-14.

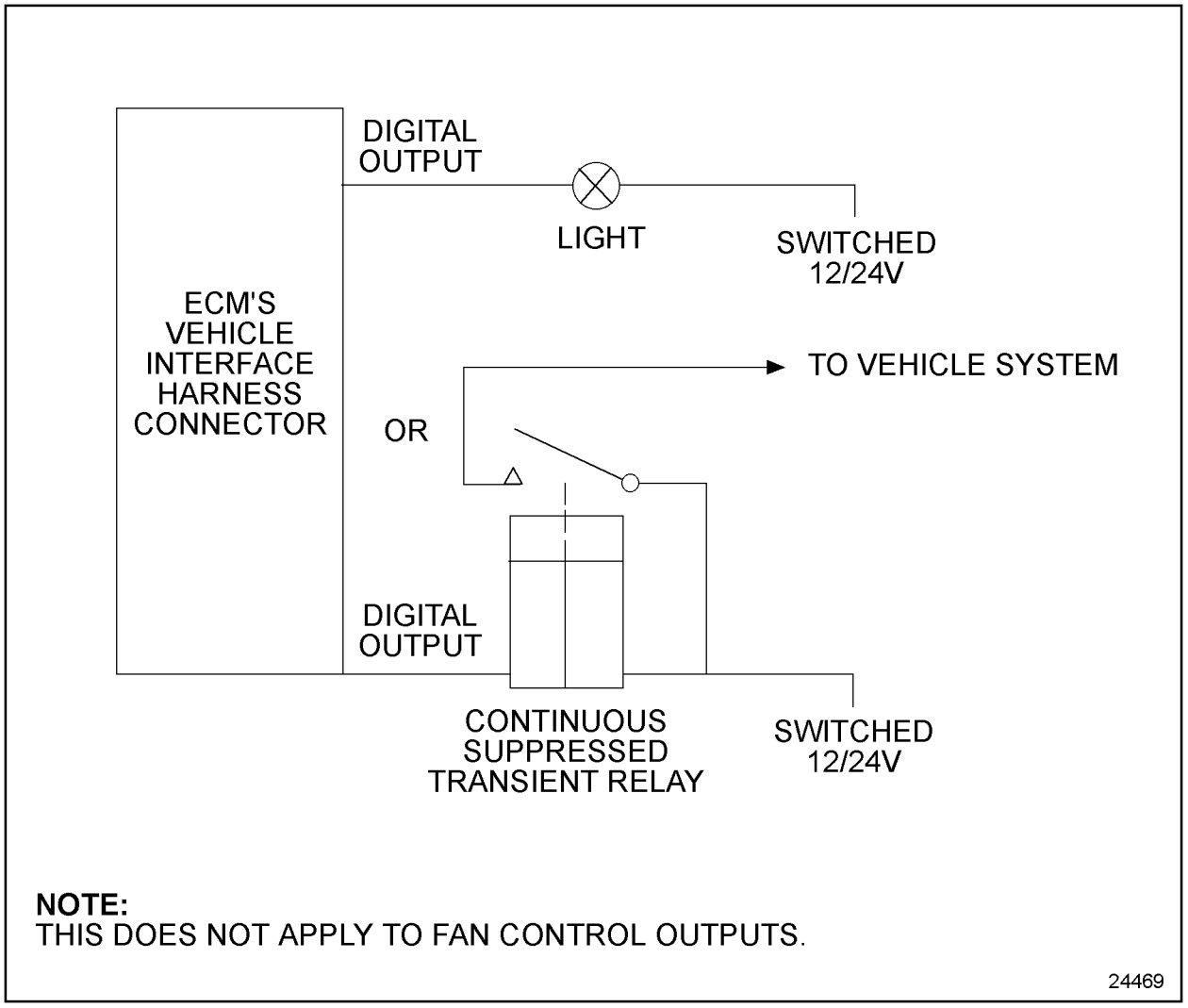

Figure 93-14 DDEC Digital Outputs

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93.7 COMMUNICATION HARNESS

The following wire schematics support the communication harness; see Figure 93-15.

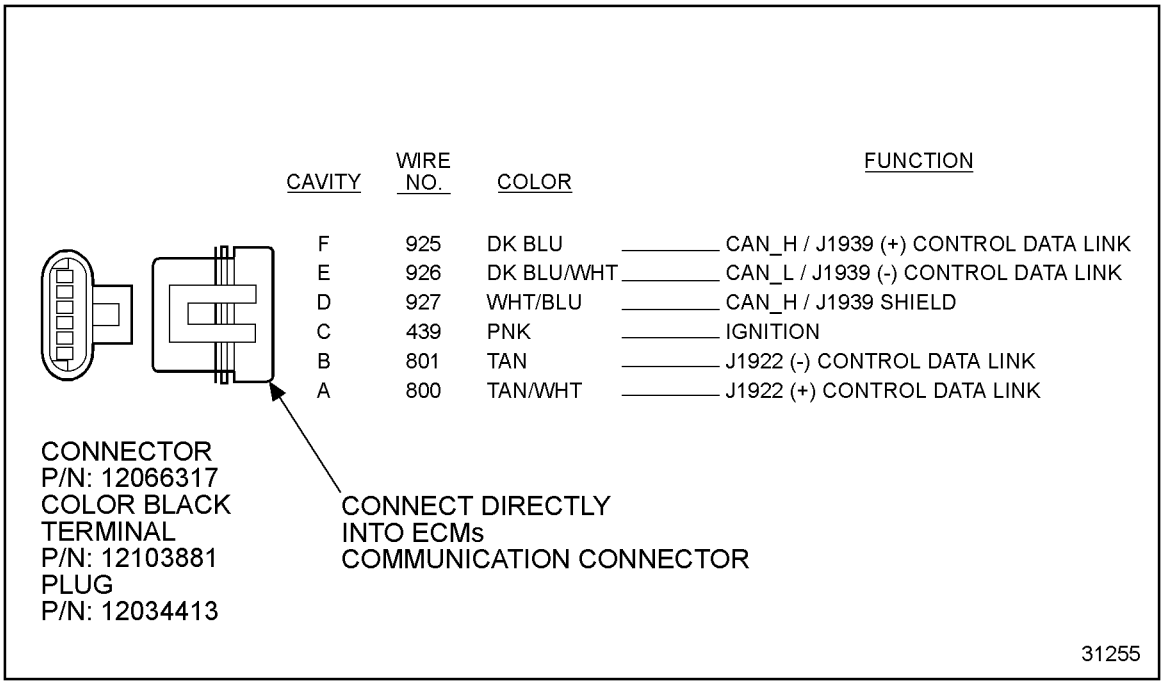

Figure 93-15 Communication Harness

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94 (CHG) DDEC PRO-LINK OPERATION

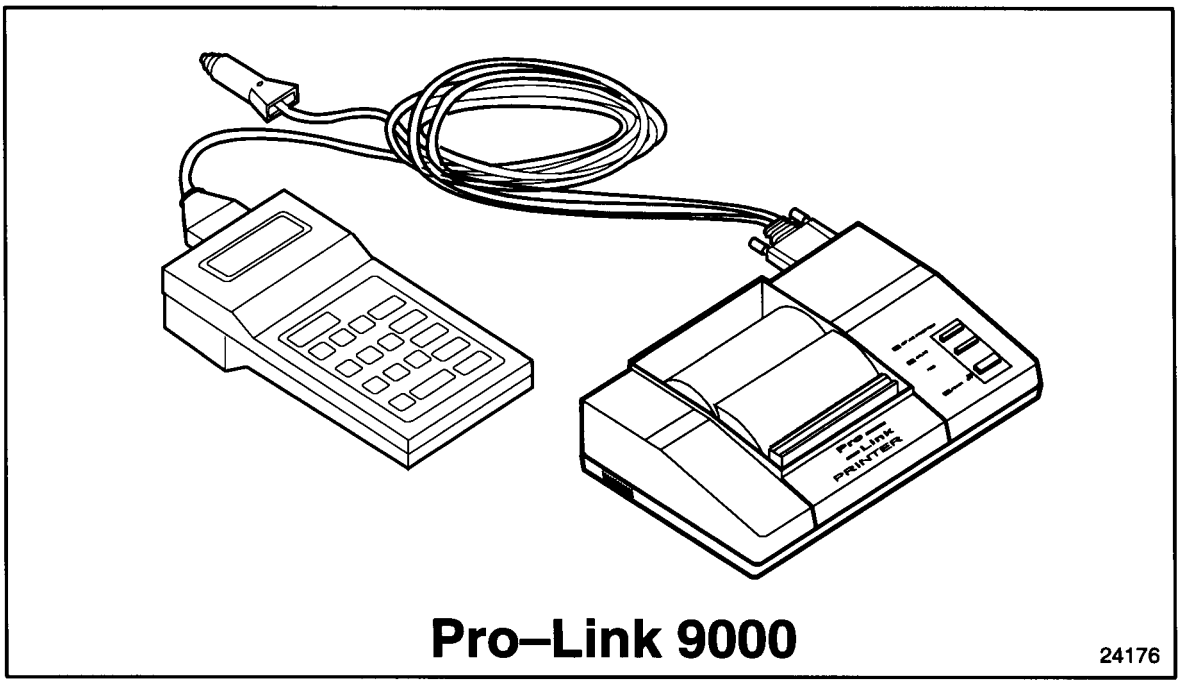

Figure 94-1 Pro-Link

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94.1 DDEC PRO-LINK OPERATION

The following procedure will suggest several ways to use the Pro-Link ® on the DDEC system, see Figure 94-1,

94.1.1 Diagnostic Codes

Start with the Menu Selection screen.

1. To call up active codes:
   [a] Select ENGINE and ENTER three times.
2. To call up inactive codes:
   [a] Select ENGINE and ENTER twice.
   [b] Select INACTIVE CODES and ENTER.
3. To clear codes:
   [a] Select ENGINE and push ENTER twice.
   [b] Go down and select CLEAR CODES and ENTER.
   [c] Left to YES, and ENTER.
   [d] Wait and then push FUNC three times.
   [e] Go to lines 1 and 2 of the Engine Data List, Active and Inactive Codes, and verify that both lines display NO.

94.1.2 Cylinder Cutout Sequence

Start with the Menu Selection screen.

1. Select ENGINE and ENTER.
2. Go down and select FUEL INJECTOR INFO and ENTER.
3. Go to CYLINDER CUTOUT and ENTER.
4. Select NEW TEST and ENTER, or REVIEW LAST TEST and ENTER.
5. Select IDLE and ENTER or 1000 RPM and ENTER.
6. Select AUTO and ENTER, or MANUAL and ENTER three times.
7. Test is now in progress.

NOTE:
Test results stay stored in the Pro-Link memory as long as the DDR remains powered up.

94.1.3 Injector Calibration Update

Start with the Menu Selection screen.

1. Select ENGINE and ENTER.
2. Go down to FUEL INJECTOR INFO and ENTER.
3. Go down to CAL UPDATE and ENTER.
4. Select VIEW and ENTER or select UPDATE and ENTER.
5. Enter password: 0000 or xxxx and ENTER twice.
6. Enter new CAL # and ENTER. Use UP/DN arrow keys to select line.
7. When finished, select FUNC, select YES, ENTER and wait.
8. ENTER to continue.

94.1.4 Reprogram Calibration

Start with the Menu Selection screen.

1. Select ENGINE and ENTER.
2. Down to CALIBRATION CHANGE and ENTER.
3. Select REPROGRAM CAL and ENTER.
4. Enter password: 0000 or xxxx and ENTER (xxxx=1 to 9 and A to Z).
5. Select menu to be changed with UP/DN arrow keys and ENTER twice.
6. Use RT/LT arrow keys to change a word or put in a new # and ENTER.
7. When finished, select FUNC.
8. SELECT ANOTHER MENU: left to YES and ENTER, or NO and ENTER.
9. Left to YES and ENTER.
10. Wait and then ENTER to continue.

94.1.5 Snapshot Sequence

Start with the Menu Selection screen.

1. Select PRO-LINK and ENTER.
2. Go up to SNAPSHOT and ENTER.
3. Go down to DATA UPDATE RATE and ENTER.
4. Type in NEW RATE and ENTER (.0 to 9.9 seconds); (90 frames will be recorded).
5. Up to TRIGGER SETUP and ENTER.
6. Select TRIGGER SOURCE and ENTER:
   [a] Any Numeric Key
   [b] Any code
   [c] Specific PID

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[d] Specific SID

7. Adjust TRIGGER POINT: NO, or select YES and ENTER; change trigger point with RT/LT arrow keys. ENTER.
8. WAITING FOR TRIGGER. When ready to take SNAPSHOT, apply the trigger. ANY NUMERIC KEY overrides all other triggers.
9. PROCESSING TRIGGER; Filling remaining frames (90 frames max). When all frames are filled, the first three lines of the TRIGGER FRAME, T, will display.

   [a] To do SNAPSHOT after setup is done, do items 1, 2, and 8 only, or go to QUICK TRIGGER and ENTER.

   [b] SNAPSHOT DATA stays stored in Pro-Link memory as long as the DDR remains powered up.

94.1.6 Print Function

Print custom data list of snapshot. The printer is attached to the DDR.

1. Select PROLINK. ENTER.
2. Select RS-232 SERIAL PORT. ENTER.
3. Select PRINTER OUTPUT. ENTER.
4. Arrow up or down to SNAPSHOT DATA. ENTER.
5. Right to CUSTOM. ENTER twice.
6. Select six items from data list using arrow up or down. ENTER after each selection. - FUNC.
7. Type 001; ENTER; 090; ENTER.

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EXHAUST SYSTEM TROUBLESHOOTING 0008 00

Refer to Engine Troubleshooting WP 0006 00.

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COOLING SYSTEM TROUBLESHOOTING 0009 00

Refer to Engine Troubleshooting WP 0006 00.

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Table 1. Electrical System Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Engine Brake System		
Engine Brake (Jake Brake) Inoperative or Operates Erratically.	1. Remove fuse panel cover and check engine brake 15A fuse.	Replace fuse as necessary (WP 0071 00).
	2. With ignition ON and engine OFF or at idle, press Check Engine Button, observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 3 and read Active Flash Codes. b. If CEL come on for up to five seconds and then turns off, perform step 3 and read Inactive Flash Codes. c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code, 10.4 (WP 0007 00).
	3. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).
Engine Fan Circuit		
Engine Fan Does Not Operate or Fails to Start at 190°F - 210°F (87°C - 98°C).	1. Remove fuse panel cover and check fan/modulator 15A fuse.	If defective, replace 15A fuse (WP 0071 00).
	2. Check fan clutch air lines and hoses for leaks.	If leaking or a damaged hose or line is found, replace (WP 0049 00).
	3. With ignition ON and engine OFF or at idle, press Check Engine Button and observe Check Engine Light (CEL).	a. If CEL comes on and stays on, perform step 4 and read Active Flash Codes. b. If CEL come on for up to five seconds and then turns off, perform step 4 and read Inactive Flash Codes. c. If CEL comes on, but is erratic or intermittent, refer to DDEC system fault code 10.4 (WP 0007 00).
	4. Connect Diagnostic Data Reader (DDR) to Diagnostic Data Link (DDL) connector.	Perform DDEC system troubleshooting. Refer to section number that matches flash code logged (WP 0007 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Charging Circuits		
1. Batteries Not Charging, Voltmeter Does Not Indicate Voltage.	1. Disconnect lead 83 from negative (-) terminal or alternator. Check for continuity between lead 83 and ground.	If continuity is indicated, go to step 2. If continuity is not indicated, repair lead 83 (WP 0119 00).
	2. Check for continuity between negative (-) terminal and negative field (F-) terminal or alternator.	If continuity is indicated, go to step 3. If continuity is not indicated, replace alternator (WP 0055 00).
	3. Disconnect lead 16D from positive (+) terminal or alternator. Check for +24 VDC at positive (+) terminal or alternator.	If +24 VDC is present, go to step 4. If voltage is not present, replace alternator (WP 0055 00).
	4. Disconnect lead 16D from dual voltage control unit. Check for +24 VDC at lead 16D.	If +24 VDC is present, go to step 5. If voltage is not present, repair lead 16D (WP 0119 00).
	5. Disconnect lead 123 from positive field (F+) connector on alternator. Check for +24 VDC at positive field (F+) connector.	If +24 VDC is present, go to step 6. If voltage is not present, replace alternator (WP 0055 00).
	6. Disconnect lead 123 from twinput voltage regulator. Check for +24 VDC at lead 123.	If +24 VDC is present, replace twinput voltage regulator (WP 0057 00). If voltage is not present, repair lead 123 (WP 0119 00).
2. +12 VDC Circuits Not Charging, +24 VDC Circuits Normal.	1. Disconnect lead 16E from connector no.1 on dual voltage control unit. Check for +12 VDC at dual voltage control unit.	If +12VDC is present, go to step 2. If voltage is not present, replace dual voltage control unit (WP 0058 00).
	2. Disconnect lead 16E from 12V junction terminal. Check for +12 VDC at lead 16E.	If +12 VDC is present, repair lead 5. If voltage is not present, repair lead 16E (WP 0119 00).
3. +24 VDC Circuits Not Charging, +12 VDC Circuits Normal.	1. Disconnect lead 16F from connector no. 2 on dual voltage control unit. Check for +24 VDC at dual voltage control unit.	If +24 VDC is present, go to step 2. If voltage is not present, replace dual voltage control unit (WP 0058 00).
	2. Disconnect lead 16F from connector at starter motor. Check for +24 VDC at lead 16F.	If +24 VDC is present, repair lead 1. If voltage is not present, repair lead 16F (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Headlight Circuits		
1. Neither Headlight Operates When Switch Is Turned On.	1. Check left and right headlight 15A fuses.	If defective, replace 15A fuses (WP 0071 00).
	2. Disconnect lead 420M from vehicular light switch. Check for +12 VDC at pin M.	If +12 VDC is present at vehicular light switch, go to step 3. If voltage is not present at vehicular light switch, replace vehicular light switch (WP 0063 00).
	3. Disconnect left headlight power relay from connector. Check for +12 VDC at connector 85.	If +12 VDC is present, replace left and right headlight power relay (WP 0071 00). If voltage is not present at connector 85, repair lead 420M (WP 0119 00).
2. Left/Right Headlight Fails to Operate When Switch Is Turned On.	1. Inspect headlight bulb.	Replace bulb if broken or defective (WP 0083 00).
	2. Check left headlight 15A fuse.	If defective, replace 15A fuse (WP 0071 00).
	3. Disconnect lead 14 from left headlight 15A fuse. Check for +12 VDC at lead 14.	If +12 VDC is present, go to step 4. If voltage is not present, repair lead (WP 0119 00).
	4. Disconnect ground lead from left/right headlight. Check for +12 VDC at ground lead to left/right headlight.	If +12 VDC is present, repair ground lead (WP 0119 00). If voltage is not present, go to step 5.
	5. Disconnect left/right headlight power relay from connector. Check for continuity between connector 86 and ground.	If continuity is indicated, go to step 6. If continuity is not indicated, repair ground lead (WP 0119 00).
	6. Disconnect left/right headlight power relay from connector. Check for +12 VDC at connector 30.	If +12 VDC is present, go to step 7. If voltage is not present, repair lead 20 (WP 0119 00).
	7. Disconnect left/right low/high beam relay from connector. Check for +12 VDC at connector 30.	If +12 VDC is present, replace left low/high beam relay (WP 0071 00). If voltage is not present, go to step 8.
	8. Check for continuity between connector 87 from left headlight power relay and connector 30 from left low/ high beam relay.	If continuity is present, replace left headlight power relay (WP 0071 00). If continuity is not indicated, repair lead 20L (WP 0119 00).
3. Neither Headlight Low/High Beam Operates When Turn Signal Switch Lever Is Set.	1. Disconnect ground lead from dimmer switch lever. Check for continuity between lead and ground.	If continuity is present, go to step 2. If continuity is not indicated, repair ground lead (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Headlight Circuits - Continued		
3. Neither Headlight Low/High Beam Operates When Turn Signal Switch Lever Is Set - Continued.	2. Disconnect lead 222 from dimmer switch lever. Check for continuity between terminals of switch in both positions.	If continuity is present, go to step 3. If continuity is not indicated, replace dimmer switch lever (WP 0073 00).
	3. Disconnect left low/high beam relay from connector. Check for continuity between connector 86 and lead 222.	If continuity is present, replace left low/high beam relay (WP 0071 00). If continuity is not indicated repair lead 222 (WP 0119 00).
4. Left/Right Highbeam Does Not Operate.	1. Inspect headlight bulb.	Replace bulb if broken or defective (WP 0083 00).
	2. Disconnect connector from left headlight. Check for continuity between ground and connector on left headlight at lead 21/21D.	If continuity is present, go to step 3. If no continuity is indicated, replace left headlight (WP 0083 00).
	3. Disconnect left low/high beam relay from connector. Check for continuity between lead 21/21D and connector 87.	If continuity is present, replace left low/high beam relay (WP 0071 00). If no continuity is indicated, repair lead 21/21D (WP 0119 00).
5. Left/Right Lowbeam Does Not Operate.	1. Inspect headlight bulb.	Replace bulb if broken or defective (WP 0083 00).
	2. Disconnect connector from left headlight. Check for continuity between ground and connector on left/right headlight at lead 22/22D.	If continuity is present, go to step 3. If continuity is not indicated, replace left headlight (WP 0083 00).
	3. Disconnect left low/high beam relay from connector. Check for continuity between lead 22/22D and connector 87A.	If continuity is present, replace left low/high beam relay (WP 0071 00). If continuity is not indicated, repair lead 22/22D (WP 0119 00).
Marker and Taillight Circuits		
1. None of Marker and Taillights Operate.	1. Check tractor tail marker 15A fuse.	Replace fuse if defective (WP 0071 00).
	2. Disconnect connector on vehicular light switch. Install jumper wire between connector 420F and pin F on switch. Check for +12 VDC at pin H.	If +12 VDC is present, repair lead 420H (WP 0119 00). If voltage is not present at vehicular light switch, replace vehicular light switch (WP 0063 00).
2. Left/Right Front Marker Light Does Not Operate.	1. Inspect light bulb.	Replace bulb if broken or defective (WP 0088 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Marker and Taillight Circuits - Continued		
2. Left/Right Front Marker Light Does Not Operate - Continued.	2. Remove lamp from socket. Check for continuity between contacts of lamp.	If continuity is indicated, go to step 3. If continuity is not indicated, replace lamp (WP 0088 00).
	3. Check for continuity between socket and ground.	If continuity is indicated, go to step 4. If continuity is not indicated, repair ground lead (WP 0119 00).
	4. Disconnect lead 46E/46F from lead 46. Check for +12 VDC at lead 46.	If +12 VDC is present, repair lead 46E/46F. If voltage is not present, repair lead 46 (WP 0119 00).
3. One or More Cab Marker Lights Does Not Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0089 00).
	2. Remove lamp(s) from defective circuit(s). Check for continuity between socket and ground.	If continuity is indicated, go to step 3. If continuity is not indicated, replace lamp(s) (WP 0089 00).
	3. Disconnect ground lead from marker light(s). Check for continuity between ground lead(s) and ground.	If continuity is indicated, repair lead(s) 46. If continuity is not indicated, repair ground lead(s) (WP 0119 00).
4. Both Taillights Do Not Operate, But All Marker Lights Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0087 00).
	2. Disconnect lead 23A from taillight terminal. Check for +12 VDC at lead 23A.	If +12 VDC is present, repair terminal connector (WP 0119 00). If voltage is not present, repair lead 23A (WP 0119 00).
Blackout Light Circuits		
1. None of Blackout (B/O) Lights Operate.	Check B/O 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
2. None of Blackout (B/O) Stoplights Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0086 00).
	2. Disconnect B/O stoplights relay from connector. Check for +24 VDC at connector 30.	If +24 VDC is present, go to step 3. If voltage is not present, repair lead connector 421V (WP 0119 00).
	3. Check for +24 VDC at connector 85.	If +24 VDC is present, go to step 4. If voltage is not present, repair lead 420N (WP 0119 00).
	4. Check for continuity between connector 86 and ground.	If continuity is indicated, go to step 5. If continuity is not indicated, repair ground lead (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Blackout Light Circuits - Continued		
2. None of Blackout (B/O) Stoplights Operate - Continued.	5. Install jumper wires between connector 30 and stoplights relay, connector 85 and stoplights relay, and connector 86 and stoplights relay. Check for +24 VDC at stoplights relay contact 87.	If +24 VDC is present, repair lead 421F (WP 0119 00). If voltage is not present, replace B/O stoplights relay (WP 0071 00).
3. One or None of Blackout (B/O) Marker Lights Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0085 00).
	2. Disconnect B/O marker lights relay from connector. Check for +24 VDC at connector 30.	If +24 VDC is present, go to step 3. If no voltage is present, repair lead 421V (WP 0119 00).
	3. Check for +24 VDC at connector 85.	If +24 VDC is present, go to step 4. If voltage is not present, repair lead 420E (WP 0119 00).
	4. Check for continuity between connector 86 and ground.	If continuity is indicated, go to step 5. If continuity is not indicated, repair ground lead (WP 0119 00).
	5. Install jumper wires between connector 30 and stoplights relay, connector 85 and stoplights relay, and connector 86 and stoplights relay. Check for +24 VDC at stoplights relay contact 87.	If +24 VDC is present, repair lead 421A (WP 0119 00). If voltage is not present, replace B/O marker lights relay (WP 0071 00).
4. One or None of Blackout (B/O) Drive Lights Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0084 00).
	2. Disconnect B/O drive lights relay from connector. Check for +24 VDC at connector 30.	If +24 VDC is present, go to step 3. If voltage is not present, repair lead 421V (WP 0119 00).
	3. Check for +24 VDC at connector 85.	If +24 VDC is present, go to step 4. If voltage is not present, repair lead 420D (WP 0119 00).
	4. Check for continuity between connector 86 and ground.	If continuity is indicated, go to step 5. If continuity is not indicated, repair ground lead (WP 0119 00).
	5. Install jumper wires between connector 30 and stoplights relay, connector 85 and stoplights relay, and connector 86 and stoplights relay. Check for +24 VDC at stoplights relay contact 87.	If +24 VDC is present, repair lead 421P or lead 421K (WP 0119 00). If voltage is not present, replace B/O drive lights relay (WP 0071 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Blackout Light Circuits - Continued		
4. One or None of Blackout (B/O) Drive Lights Operate - Continued.	6. Check for +24 VDC at connector 421K at trailer receptacle(s).	If +24 VDC is present, troubleshoot trailer circuit(s). If voltage is not present, repair lead(s) 421K (WP 0119 00).
Turn Signal and Stoplight Circuits		
1. Stoplights Do Not Operate.	1. Check stoplight 20A fuse.	Replace 20A fuse if defective (WP 0071 00).
	2. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0087 00).
	3. Disconnect leads 420A and 420K from stoplight switch. Check for continuity between switch contacts while pressing switch.	If continuity is indicated, go to step 4. If continuity is not indicated, replace stoplight switch (WP 0109 00).
	4. Disconnect leads 420A and 420K from vehicular light switch. Check for continuity between leads 420A and 420K with stoplight switch closed.	If continuity is indicated, go to step 5. If continuity is not indicated, repair lead 420A or 420K (WP 0119 00).
	5. Disconnect lead 420C from vehicular light switch. Disconnect lead 36C from turn signal switch. Check for continuity between lead 420C and 36C.	If continuity is indicated, go to step 6. If continuity is not indicated, repair lead 420C or lead 36C (WP 0119 00).
	6. Disconnect lead 36C from vehicular light switch. Check for +12 VDC in lead 36C with stoplight switch closed.	If +12 VDC is present, replace turn signal switch (WP 0073 00). If voltage is not present, replace vehicular light switch (WP 0063 00).
2. Left/Right Stoplight Does Not Operate.	1. Inspect light bulb.	Replace bulb if broken or defective (WP 0087 00).
	2. Remove lamp from left stoplight. Check for continuity between contact points.	If continuity is indicated, go to step 3. If continuity is not indicated, replace lamp (WP 0087 00).
	3. Remove left/right stoplight lamp. Check for continuity between socket and ground.	If continuity is indicated, go to step 4. If continuity is not indicated, repair ground lead (WP 0119 00).
	4. Check for +24 VDC at turn signal switch at lead 38B/39B contact point.	If +24 VDC is present, replace turn signal switch (WP 0073 00). If voltage is not present, repair lead 38B/39B (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Turn Signal and Stoplight Circuits - Continued		
3. Flasher Lights Do Not Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0088 00).
	2. Disconnect left flasher relay from connector. Check for +24 VDC at connector 30.	If +24 VDC is present, go to step 3. If voltage is not present, repair lead 421 (WP 0119 00).
	3. Check for continuity between connector 86 and ground.	If continuity is indicated, go to step 4. If continuity is not indicated, repair ground lead (WP 0119 00).
	4. Check for +12 VDC at connector 85.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 60 (WP 0119 00).
	5. Set turn signal switch in turn mode. Install jumper leads between connectors 30, 85, and 86 to their respective connectors at left flasher relay. Check for +24 VDC at flasher relay connection 87.	If +24 VDC is present, go to step 6. If voltage is not present, replace left flasher relay (WP 0071 00).
	6. Set turn signal switch in turn mode. Check for +24 VDC at trailer receptacle connectors.	If voltage is not present, repair leads (WP 0119 00).
4. Turn Signal Lights Do Not Operate.	1. Inspect light bulb.	Replace bulb if broken or defective (WP 0088 00).
	2. Remove lamp from defective left turn signal light. Check for continuity between contact points.	If continuity is indicated, go to step 3. If continuity is not indicated, replace lamp (WP 0088 00).
	3. Remove signal light lamp. Check for continuity between socket and ground.	If continuity is indicated, repair lead 60. If continuity is not indicated, repair ground lead (WP 0119 00).
5. Turn Signal Indicator Light Does Not Operate, But Turn Signals Operate Normally.	1. Inspect light bulb.	Replace bulb if broken or defective (WP 0061 00).
	2. Disconnect lead 60A from warning light bar. Check for +24 VDC at lead 60A.	If +24 VDC is present, troubleshoot warning light circuit. If voltage is not present, repair lead 60A (WP 0119 00).
Dome Light Circuits		
1. Dome Lights Do Not Operate.	1. Check dome/auxiliary/flasher lights 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Disconnect lead 420J from dome/auxiliary/flasher 15A fuse. Check for +12 VDC at lead 420J.	If +12 VDC is present, repair lead 41 (WP 0119 00). If voltage is not present, go to step 3.

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Dome Light Circuits - Continued		
1. Dome Lights Do Not Operate - Continued.	3. Disconnect connector from vehicular light switch. Check for +12 VDC at pin J.	If +12 VDC is present, repair lead 420J (WP 0119 00). If voltage is not present, replace vehicular light switch (WP 0063 00).
2. One Dome Light Operates, But Other Dome Light Does Not Operate in Either Mode.	1. Inspect light bulb.	Replace bulb if broken or defective (WP 0091 00).
	2. Disconnect lead 41 from defective dome light. Check for continuity from dome light ground lead to ground.	If continuity is indicated, go to step 3. If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect lead 41 from defective dome light. Check for +12 VDC at lead 41.	If +12 VDC is present, replace dome light assembly (WP 0091 00). If voltage is not present, repair lead 41 (WP 0119 00).
3. Dome Light Operates in On/Off Switch Mode Only.	1. Inspect dome light lamp.	Replace lamp if defective (WP 0091 00).
	2. Check for continuity between socket and ground.	If continuity is indicated, replace dome light assembly (WP 0091 00).
Auxiliary Light Circuits		
1. Auxiliary Lights or Accessory Circuits Do Not Operate.	1. Check for +12 VDC at auxiliary light power bus.	If +12 VDC is present, repair auxiliary light power bus. If voltage is not present, go to step 2.
	2. Disconnect auxiliary lights power relay. Check for +12 VDC at connector 30.	If +12 VDC is present, go to step 3. If voltage is not present, repair lead 420JC (WP 0119 00).
	3. Check for +12 VDC at auxiliary lights power relay connector 85.	If +12 VDC is present, go to step 4. If voltage is not present, check dome/auxiliary/flasher 15A fuse. If defective, replace 15A fuse (WP 0071 00). Check for continuity in lead 420JA and lead 420J. If continuity is not indicated, repair lead 420JA or 420J (WP 0119 00). If +12 VDC is still not present at connector 85, replace vehicular light switch (WP 0063 00).
	4. Disconnect auxiliary lights accessory lockout relay. Check for +12 VDC at connector 87.	If +12 VDC is present, go to step 5. If voltage is not present, check lead 420JB for continuity. If continuity is not indicated, repair lead 420JB (WP 0119 00). If voltage is still not present at connector 87, replace auxiliary lights power relay (WP 0071 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Auxiliary Light Circuits - Continued		
1. Auxiliary Lights or Accessory Circuits Do Not Operate - Continued.	5. Disconnect auxiliary lights accessory lockout relay. Check for +12 VDC at connector 85.	If +12 VDC is present, go to step 6. If voltage is not present, check start/auxiliary 15A fuse. If defective, replace 15A fuse (WP 0071 00). Check for continuity in lead 71AA and lead 71A. If continuity is not indicated, repair lead 71AA and lead 71A (WP 0119 00). If voltage is still not present at connector 85, replace vehicular light switch (WP 0063 00).
	6. Disconnect auxiliary lights accessory lockout relay. Check for continuity in connectors 30 and 86 to ground.	If continuity is indicated, go to step 7. If continuity is not indicated, repair connector lead 30 or connector lead 86 to ground (WP 0119 00).
	7. Check for +12 VDC at auxiliary light power bus.	If +12 VDC is not present, check for continuity in lead 420JD. If continuity is indicated, replace auxiliary lights power relay (WP 0071 00).
2. No Power to Auxiliary Heater Fan Power Relay.	Disconnect auxiliary lights accessory lockout relay and heater fan power relay. Check for continuity in lead 71AA.	If continuity is not indicated, repair lead 71AA (WP 0119 00).
Worklight Power Receptacle Circuits		
1. Worklight Power Receptacles Do Not Operate.	1. Check worklight receptacles 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Check for +12 VDC at lead 420JD from auxiliary light power bus.	If +12 VDC is present, go to step 3. If voltage is not present, repair lead 420JD (WP 0119 00).
	3. Check for +12 VDC at lead 73F for left and right worklight power receptacles.	If +12 VDC is present, repair ground lead from worklight power receptacles. If voltage is not present, repair lead 73F (WP 0119 00).
2. One Worklight Power Receptacle Does Not Operate, But Other Receptacle Operates Normally.	1. Check for +12 VDC at lead 73F to worklight power receptacle.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 73F (WP 0119 00).
	2. Check for continuity between receptacle and ground.	If continuity is indicated, replace defective receptacle. If continuity is not indicated, repair ground lead (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Backup Light Circuits		
1. Backup Lights Do Not Operate.	1. Check backup light 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0087 00).
	3. Disconnect lead 420JD from backup light 15A fuse. Check for +12 VDC at lead 420JD.	If +12 VDC is present, go to step 4. If voltage is not present, repair lead 420JD (WP 0119 00).
	4. Disconnect lead 120 from backup light switch. Check for +12 VDC at lead 120.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 120 (WP 0119 00).
	5. Disconnect lead 120B from backup light switch. Press backup light switch. Check for continuity between switch contacts.	If continuity is indicated, go to step 6. If continuity is not indicated, replace backup light switch (WP 0120 00).
	6. Disconnect lead 120B from chassis harness. Check for +12 VDC at lead 120B.	If +12 VDC is present, go to step 7. If voltage is not present, repair lead 120B between chassis and backup light switch (WP 0119 00).
	7. Check for +12 VDC at backup receptacle socket 120B connector.	If +12 VDC is present, repair receptacle socket ground leads to ground. If voltage is not present, repair lead 120B to chassis wiring harness (WP 0119 00).
2. Right/Left Backup Light Does Not Operate.	1. Check backup light lamp.	Replace lamp if defective (WP 0087 00).
	2. Check for continuity between socket and ground.	If continuity is indicated, replace backup light (WP 0087 00). If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect lead from backup light. Check for +12 VDC at lead.	If voltage is not present, repair red lead (WP 0119 00).
Utility Light Circuits		
1. Utility Lights Do Not Operate.	1. Inspect light bulbs.	Replace bulbs if broken or defective (WP 0090 00).
	2. Disconnect leads 420JD and 73 from 15A fuse. Check for continuity between contacts of 15A fuse.	If continuity is indicated, go to step 3. If continuity is not indicated, replace 15A fuse (WP 0071 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Utility Light Circuits - Continued		
1. Utility Lights Do Not Operate - Continued.	3. Check for +12 VDC at lead 420JD from auxiliary light power bus.	If +12 VDC is present, go to step 4. If voltage is not present, repair lead 420JD (WP 0119 00).
	4. Disconnect lead 73 from utility light switch. Check for +12 VDC at lead 73.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 73 (WP 0119 00).
	5. Disconnect lead 73B from utility light switch. Activate switch. Check for continuity between switch contacts.	If continuity is indicated, repair lead 73B (WP 0119 00). If continuity is not indicated, replace utility light switch (WP 0064 00).
2. Only One Utility Light Operates.	1. Disconnect lead 73B from defective utility light. Check for +12 VDC at lead 73B.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 73B (WP 0119 00).
	2. Check for continuity between socket and ground.	If continuity is indicated, replace utility light (WP 0090 00). If continuity is not indicated, repair ground lead (WP 0119 00).
3. Utility Light Indicator Light Does Not Operate, But Utility Lights Operate Normally.	Disconnect lead 73A from pin D16 of warning light bar. Check for +12 VDC at lead 73A.	If +12 VDC is present, troubleshoot warning light circuit. If voltage is not present, repair lead 73A (WP 0119 00).
Electric Horn Circuits		
Electric Horn Does Not Operate.	1. Check horn 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Check for +12 VDC at lead 420JD from auxiliary light power bus.	If +12 VDC is present, go to step 3. If voltage is not present, repair lead 420JD (WP 0119 00).
	3. Disconnect horn relay from connector. Check for +12 VDC at connector 30.	If +12 VDC is present, go to step 4. If voltage is not present, repair lead 24 (WP 0119 00).
	4. Disconnect horn relay. Check for +12 VDC at connector 85.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 24 (WP 0119 00).
	5. Disconnect lead 25 from horn button. Check for +12 VDC at lead 25.	If +12 VDC is present, go to step 6. If voltage is not present, replace horn relay (WP 0071 00).
	6. Disconnect ground lead from horn button. Check for continuity between ground lead and ground.	If continuity is indicated, go to step 7. If continuity is not indicated, repair ground lead (WP 0119 00).
	7. Disconnect lead 25 from horn button. Press horn switch. Check for continuity between switch contacts.	If continuity is indicated, go to step 8. If continuity is not indicated, replace horn button (WP 0112 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Electric Horn Circuits - Continued		
Electric Horn Does Not Operate - Continued.	8. Disconnect lead 26 from horn. Check for +12 VDC at lead 26 with horn button pressed.	If +12 VDC is present, go to step 9. If voltage is not present, disconnect horn relay and check for continuity between connector 87 and lead 26. If continuity is indicated, replace horn relay (WP 0071 00). If continuity is not indicated, repair lead 26 (WP 0119 00).
	9. Disconnect ground lead from horn. Check for continuity between ground lead and ground.	If continuity is indicated, replace horn (WP 0112 00). If continuity is not indicated, repair ground lead (WP 0119 00).
Tractor Beacon Light Circuits		
Tractor Beacon Light Does Not Operate.	1. Check tractor beacon light 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Remove lamp from tractor beacon light. Check for continuity between contacts on lamp.	If continuity is indicated, go to step 3. If continuity is not indicated, replace tractor beacon light (TM 9-2320-302-10).
	3. Disconnect lead 254A from tractor beacon light. Check for +12 VDC at lead 254A with beacon light switch in on position.	If voltage is not present, go to step 4. If +12 VDC is present, check for continuity between socket and ground. If continuity is indicated, replace tractor beacon light (TM 9-2320-302-10). If continuity is not indicated, repair ground lead (WP 0119 00).
	4. Remove tractor beacon light 15A fuse. Check for +12 VDC at lead 420JD fuse connector from auxiliary light power bus.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 420JD (WP 0119 00).
	5. Disconnect lead 254 from beacon light switch. Check for +12 VDC at lead 254.	If +12 VDC is present, go to step 6. If voltage is not present, repair lead 254 (WP 0119 00).
	6. Disconnect lead 254 and lead 254A from switch. Activate switch. Check for continuity between contacts of switch.	If continuity is indicated, go to step 7. If continuity is not indicated, replace beacon light switch (WP 0065 00).
	7. Disconnect lead 254A from tractor beacon light. Check for +12 VDC at lead 254A.	If voltage is not present, repair lead 254A between beacon lights and beacon light switch (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Panel Lights Circuits		
1. Panel Lights Do Not Operate.	1. Check panel lights 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Disconnect lead 420B from electronic dimmer switch. Check for +12 VDC at lead 420B from dimmer switch.	If +12 VDC is present, repair lead 420B (WP 0119 00). If voltage is not present, go to step 3.
	3. Disconnect ground lead from dimmer switch. Check for continuity between ground lead and ground.	If continuity is indicated, replace electronic dimmer switch (WP 0064 00). If continuity is not indicated, repair ground lead (WP 0119 00).
2. Heater Control Light Does Not Operate, But Other Heater Circuits Operate Normally.	1. Check heater control lamp.	If defective, replace lamp (WP 0067 00).
	2. Check for continuity between socket and ground.	If continuity is indicated, go to step 3. If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect lead 29A from heater control light. Check for +12 VDC at lead 29A from panel fuse.	If +12 VDC is present, repair lead 29A to heater control light. If voltage is not present, repair lead 29A from fuse (WP 0119 00).
3. One or More Gage Lights Do Not Operate.	Check panel gage lamp(s).	Replace lamp(s) if defective (WP 0061 00 and WP 0062 00).
4. Fiber Optics Do Not Operate.	1. Check fiber optic light source lamp.	Replace lamp if defective (WP 0069 00).
	2. Check for continuity between lamp socket and ground.	If continuity is indicated, go to step 3. If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect power lead to fiber optic light source. Check for +12 VDC at power lead.	If +12 VDC is present, replace fiber optic light source light (WP 0069 00). If voltage is not present, repair power lead (WP 0119 00).
5. Panel Lights Do Not Dim.	Disconnect lead 420B from electronic dimmer switch. Check for +12 VDC at lead 420B with main light switch in dim mode.	If +12 VDC is present, replace main light switch (WP 0063 00). If voltage is not present, replace electronic dimmer switch (WP 0064 00).
6. Panel Lights Do Not Brighten.	Disconnect lead 420B from electronic dimmer switch. Check for +12 VDC at lead 420B with main light switch in bright mode.	If +12 VDC is present, replace main light switch (WP 0063 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Radio Circuits		
Power Source for 24 VDC Radio Does Not Operate.	1. Check 24 VDC 25A radio fuse.	Replace 25A fuse if defective (WP 0071 00).
	2. Remove 24 VDC 25A radio fuse. Check for +24 VDC at lead 421W fuse connector.	If +24 VDC is present, go to step 3. If voltage is not present, repair lead 421W to 24 VDC constant power bus (WP 0119 00).
	3. Check for continuity between ground lead and ground.	If continuity is indicated, go to step 4. If continuity is not indicated, repair ground lead (WP 0119 00).
	4. Check for +24 VDC at lead 421R from radio power source connector.	If +24 VDC is not present, repair lead 421R (WP 0119 00).
Instrument Wiring Circuits		
1. Instruments on Dashboard Do Not Operate.	1. Check instruments 10A fuse.	Replace 10A fuse if defective (WP 0071 00).
	2. Check for +12 VDC at ignition run power bus connector.	If +12 VDC is present, repair lead 81C. If voltage is not present, repair connector on ignition run power bus (WP 00119 00).
2. Water Temperature Gage Does Not Operate.	1. Disconnect lead 81C from water temperature gage. Check for +12 VDC at lead 81C.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 81C (WP 0119 00).
	2. Disconnect ground lead from water temperature gage. Check for continuity between lead and ground.	If continuity is present, go to step 3. If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect lead 119 from water temperature gage. Check for +8 to +12 VDC at water temperature gage.	If +8 to +12 VDC is present, go to step 4. If voltage is not present, replace water temperature gage (WP 0060 00).
	4. Disconnect lead 119 from water temperature gage sensor. Check for +8 to +12 VDC at lead 119.	If +8 to +12 VDC is present, replace water temperature gage sensor (WP 0098 00). If voltage is not present, repair lead 119 (WP 0119 00).
3. Transmission Oil Temperature Gage Does Not Operate.	1. Disconnect lead 81C from transmission oil temperature gage. Check for +12 VDC at lead 81C.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 81C (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Instrument Wiring Circuits - Continued		
3. Transmission Oil Temperature Gage Does Not Operate - Continued.	2. Disconnect ground lead from transmission oil temperature gage. Check for continuity between lead and ground.	If continuity is present, go to step 3. If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect lead 30 from transmission oil temperature gage. Check for +8 to +12 VDC at transmission oil temperature gage.	If +8 to +12 VDC is present, go to step 4. If voltage is not present, replace transmission oil temperature gage (WP 0062 00).
	4. Disconnect lead 30 from transmission oil temperature gage sensor. Check for +8 to +12 VDC at lead 30.	If +8 to +12 VDC is present, replace transmission oil temperature gage sensor (WP 0096 00). If voltage is not present, repair lead 30 (WP 0119 00).
4. Fuel Level Gage Does Not Operate.	1. Disconnect lead 81C from fuel level gage. Check for +12 VDC at lead 81C.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 81C (WP 0119 00).
	2. Disconnect ground lead from fuel level gage. Check for continuity between ground lead and ground.	If continuity is present, go to step 3. If continuity is not indicated, repair ground lead (WP 0119 00).
	3. Disconnect lead 47 from fuel level gage. Check for +8 to +12 VDC at fuel level gage.	If +8 to +12 VDC is present, go to step 4. If voltage is not present, replace fuel level gage (WP 0062 00).
	4. Disconnect lead 47 from fuel level sensor. Check for +8 to +12 VDC at lead 47.	If +8 to +12 VDC is present, replace fuel level gage sensor (WP 0094 00). If voltage is not present, repair lead 47 (WP 0119 00).
5. Voltmeter Does Not Operate, But Warning Light Operates Normally.	1. Disconnect lead 19A from voltmeter. Check for +12 VDC at lead 19A.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 19A (WP 0119 00).
	2. Disconnect ground lead from voltmeter. Check for continuity between ground lead and ground.	If continuity is indicated, replace voltmeter (WP 0063 00). If continuity is not indicated, repair ground lead (WP 0119 00).
6. Axle Lock Indicator Light Does Not Operate.	1. Disconnect lead 81C from axle lock pressure switch. Check for +12 VDC at lead 81C.	If +12 VDC is present, go to step 2. If voltage is not present, repair lead 81C (WP 0119 00).
	2. Disconnect leads 87 and 81C from axle lock pressure switch. Check for continuity between contacts of switch.	If continuity is indicated, go to step 3. If continuity is not indicated, replace axle lock pressure switch (WP 0063 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Instrument Wiring Circuits - Continued		
6. Axle Lock Indicator Light Does Not Operate - Continued.	3. Disconnect lead 87 from axle lock pressure switch. Check for continuity between lead 87 and ground.	If no continuity is indicated, repair lead 87 (WP 0119 00).
Ether Cold-Start Circuit		
Ether Cold-start Does Not Operate When Container Has Ether.	1. Check ether 10A fuse.	Replace 10A fuse if defective (WP 0071 00).
	2. Remove ether 15A fuse. Check for +12 VDC at fuse connector from ignition run power bus.	If +12 VDC is present, go to step 3. If voltage is not present, repair circuit 18 (WP 0119 00).
	3. Disconnect lead 166 from ether switch. Check for +12 VDC at lead 166.	If +12 VDC is present, go to step 4. If voltage is not present, repair lead 166 (WP 0119 00).
	4. Disconnect lead 166A at cab/ chassis connection. Check for +12 VDC at lead 166A.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 166A (WP 0119 00).
	5. Disconnect lead 166A from ether solenoid. Check for +12 VDC at lead 166A.	If +12 VDC is present, go to step 6. If voltage is not present, repair lead 166A (WP 0119 00).
	6. Disconnect ground lead from ether solenoid. Check for continuity between ground lead and ground.	If continuity is indicated, replace ether solenoid (WP 0035 00). If continuity is not indicated, repair ground lead (WP 0119 00).
Air Dryer Heater Circuit		
Air Dryer Heater Does Not Operate.	1. Check reservoir heater/power take-off 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	2. Disconnect lead 94 from air dryer drain valve heater. Check for +12 VDC at lead 94.	If +12 VDC is present, go to step 3. If voltage is not present, repair lead 94 (WP 0119 00).
	3. Disconnect ground lead from air dryer drain valve heater. Check for continuity between lead and ground.	If continuity is indicated, replace air dryer drain valve heater. If continuity is not indicated, repair ground lead (WP 0119 00).
Standard Heater Circuits		
Heater Fan Does Not Operate at Any Speed.	1. Check heater fan 30A fuse.	Replace 30A fuse if defective (WP 0071 00).
	2. Check start/auxiliary 15A fuse.	Replace 15A fuse if defective (WP 0071 00).
	3. Remove heater fan 30A fuse. Check for +12 VDC at lead 14 fuse connector.	If +12 VDC is present, go to step 4. If voltage is not present, repair lead 14 to 12-volt constant power bus (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Standard Heater Circuits - Continued		
Heater Fan Does Not Operate at Any Speed - Continued.	4. Remove start/auxiliary 15A fuse. Check for +12 VDC at lead 71A fuse connector.	If +12 VDC is present, go to step 5. If voltage is not present, repair lead 71A (WP 0119 00).
	5. Disconnect heater fan power relay from connector. Check for +12 VDC at connector 30.	If +12 VDC is present, go to step 6. If voltage is not present, repair lead 98 (WP 0119 00).
	6. Disconnect heater fan high relay from connector. Check for +12 VDC at connector 87.	If +12 VDC is present, go to step 7. If voltage is not present, repair lead 98 (WP 0119 00).
	7. Check for continuity between connector 86 and ground for both relays.	If continuity is indicated, go to step 8. If continuity is not indicated, repair ground lead (WP 0119 00).
	8. Disconnect heater fan power relay from connector. Check for +12 VDC at connector 85.	If +12 VDC is present, go to step 9. If voltage is not present, repair lead 71A (WP 0119 00).
	9. Disconnect lead 98 from heater fan control. Check for +12 VDC at lead 98.	If +12 VDC is present, go to step 10. If voltage is not present, disconnect heater fan power relay. Check for continuity in lead 98. If continuity is indicated, replace heater fan power relay (WP 0071 00). If continuity is not indicated, repair lead 98 (WP 0119 00).
	10. Disconnect lead 98L from heater fan control. Check for +12 VDC at heater fan control connector (D) with heater fan control in high mode.	If +12 VDC is present, go to step 11. If voltage is not present, replace heater fan control (WP 0067 00).
	11. Disconnect heater fan high relay from connector. Check for +12 VDC at connector 85 with heater fan control in high mode.	If +12 VDC is present, go to step 12. If voltage is not present, repair lead 98L (WP 0119 00).
	12. Disconnect lead 98T from heater fan motor. Check for +12 VDC at lead 98T with heater fan control in high mode.	If +12 VDC is present, go to step 13. If voltage is not present, disconnect heater fan high relay from connector. Check for continuity in lead 98T between connector 30 and heater fan motor. If continuity is indicated, replace heater fan high relay (WP 0071 00). If continuity is not indicated, repair lead 98T (WP 0119 00).

Table 1. Electrical System Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Standard Heater Circuits - Continued		
Heater Fan Does Not Operate at Any Speed - Continued.	13. Disconnect ground lead from heater fan motor. Check for continuity between ground lead and ground.	If continuity is indicated, replace heater fan motor (WP 0220 00). If continuity is not indicated, repair ground lead (WP 0119 00).

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NOTE

In addition to the transmission troubleshooting located in Table 1 below, the *Allison Transmission Troubleshooting Manual* is duplicated in its entirety and is located beginning on page 0011 00-7. An index of troubleshooting diagnostic codes is on page 0011 00-36.

Table 1. Transmission and Driveline Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Transmission		
1. Shift Selector Display Is Blank.	1. Check if VIM fuse is blown.	Replace VIM fuse (WP 0071 00).
	2. Check for damaged or loose battery connections.	Tighten or repair battery connections (WP 0115 00).
	3. Check for blown fuse or fusible link at battery.	Replace battery fuse or fusible link (WP 0071 00).
2. Vehicle Does Not Start (Engine Does Not Crank).	1. Check that lever is in N (Neutral).	Place shift selector in N (Neutral) position and restart vehicle (TM 9-2320-302-10).
	2. Check for dead battery.	Recharge battery as necessary TM 9-6140-200-14).
	3. Check for damaged or loose battery connections.	Tighten or repair battery connections (WP 0115 00).
	4. Faulty starter circuit.	Repair vehicle starter circuit (WP 0010 00).
	5. Faulty neutral start relay.	Replace neutral start relay (WP 0071 00).
	6. Faulty wiring in neutral start circuit.	Repair wiring (WP 0119 00).
	7. Voltage to ECU too low.	Check battery and charging system voltage (WP 0010 00).
	8. Faulty shift selector.	Replace shift selector (WP 0120 00).
	9. Lack of battery voltage on circuit 123 from ECU when in neutral.	Repair circuit 123 (WP 0120 00) or replace ECU (WP 0124 00).
All Display Segments on Both Sides of Display Lighted.	No calibration installed in ECU. Voltage to ECU too low.	Check battery and charging system voltage (WP 0010 00). Notify Direct Support Maintenance.
Transmission Shifting		
1. DO NOT SHIFT Light Will Not Go Out at Start-up		
Vehicle Drives Normally	Faulty DO NOT SHIFT light, relay, or circuit.	Replace relay or repair circuit (WP 0120 00).

Table 1. Transmission and Driveline Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Transmission Shifting - Continued		
Vehicle Does Not Drive	1. Faulty ECU.	Replace ECU (WP 0124 00).
	2. Engine does not start.	Repair engine starting system (WP 0006 00).
	3. Faulty harness.	Repair harness (WP 0119 00) or replace harness (WP 0125 00).
	4. Faulty interface wiring to vehicle electrical system.	Repair wiring (WP 0119 00).
	5. Transmission fluid temperature too low.	Warm transmission fluid.
	6. Faulty ECU.	Replace ECU (WP 0124 00).
2. DO NOT SHIFT Light Flashes Intermittently.	1. Intermittent power to ECU.	Check connections to ECU and correct if necessary.
	2. Faulty or incorrect ground wire attachment.	Repair ground circuit (WP 0119 00).
3. No DO NOT SHIFT Light at Ignition.	1. Faulty light bulb or socket.	Replace light bulb or socket (WP 0120 00).
	2. Faulty wiring harness.	Check wiring between ECU and DO NOT SHIFT light. Repair where necessary (WP 0119 00).
	3. Faulty ECU.	Replace ECU (WP 0124 00).
4. ECU Will Not Turn Off When Ignition Switch Is Turned Off.	Faulty ignition switch.	Replace ignition switch (WP 0010 00). Notify Direct Support Maintenance.
5. Transmission Will Not Shift to Forward or Reverse (Stays In Neutral).	1. Engine RPM too high.	Reduce engine RPM.
	2. Low transmission fluid level.	Add fluid to proper level (TM 9-2320-302-10).
	3. Transmission fluid temperature too low.	Warm transmission fluid.
	4. Throttle position sensor set-up is incorrect.	Refer to throttle position sensor for correct set-up (WP 0006 00).
	5. Voltage to ECU too low.	Check vehicle battery and charging system (WP 0010 00).
	6. Shift selector is not functioning properly.	Replace shift selector (WP 0120 00).
	7. Disconnected or dirty connectors.	Perform connector checkout.
	8. Faulty wiring harnesses.	Repair harness (WP 0119 00).
	9. Faulty ECU.	Replace ECU (WP 0124 00).
6. Transmission Will Not Stay in Forward or Reverse.	Auto-neutral or quick-to-neutral circuit (input function) faulty.	Notify Direct Support Maintenance.

Table 1. Transmission and Driveline Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Transmission Shifting - Continued		
7. Transmission Will Not Make a Specific Shift.	1. Low engine power.	Correct engine problem (WP 0006 00).
	2. Incorrect transmission fluid level.	Correct fluid level (TM 9-2320-302-10).
	3. Extreme transmission fluid temperature.	Inspect cooling system and fluid level (WP 0006 00).
	4. Faulty shift selector.	Replace shift selector (WP 0120 00).
	5. Faulty ECU.	Replace ECU (WP 0124 00). Notify Direct Support Maintenance.
8. Transmission Does Not Shift Properly (Rough Shifts, Shifts Occurring at Too Low or Too High Speed).	1. Engine idle speed too fast (neutral to range shift).	Adjust engine idle speed (WP 0006 00).
	2. ECU input voltage low.	Check power, ground, charging system, and battery function (WP 0010 00).
	3. Incorrect transmission fluid level	Correct fluid level (TM 9-2320-302-10).
	4. Intermittent problems.	Check wiring harnesses and connectors (WP 0119 00). Notify Direct Support Maintenance.
Abnormal Activities or Responses from Transmission		
1. Excessive Creep in First and Reverse Gears.	Engine idle speed too high.	Adjust to correct idle speed between 500-800 RPM (WP 0006 00).
2. No Response to Shift Selector.	1. Shift selector not properly connected.	Check shift selector response with diagnostic tool. If no response, check remote connection and replace if necessary (WP 0120 00).
	2. Faulty shift selector.	Replace shift selector (WP 0120 00).
	3. Incorrect transmission fluid level.	Correct fluid level (TM 9-2320-302-10).
3. Vehicle Moves Forward in Neutral.	C1 clutch failed or not released.	Notify Direct Support Maintenance.
4. Vehicle Moves Backward in Neutral.	C3 clutch failed or not released.	Notify Direct Support Maintenance.
5. Engine Overspeed on Full-throttle Upshifts.	1. TPS adjustment: - Overstroke	Adjust TPS (WP 0006 00).

Table 1. Transmission and Driveline Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Abnormal Activities or Responses from Transmission - Continued		
5. Engine Overspeed on Full-throttle Upshifts - Continued.	2. ECU input voltage low.	Check electrical system and all connections from battery and ECU (WP 0010 00 or WP 0119 00).
	3. Incorrect transmission fluid level.	Correct fluid level (TM 9-2320-302-10).
	4. Piston seals leaking or clutch plates slipping in range involved.	Notify Direct Support Maintenance.
6. Excessive Slippage and Clutch Chatter.	1. Incorrect calibration.	Verify calibration. Notify Direct Support Maintenance.
	2. ECU input voltage low.	Check power, ground, charging system, and battery functions (WP 0010 00).
	3. Throttle position sensor out of adjustment or failed.	Adjust or replace throttle position sensor (WP 0006 00).
	4. Incorrect transmission fluid level.	Correct fluid level (TM 9-2320-302-10).
7. Abnormal Stall Speeds (Stall in First Range - 6-speed).		
High Stall Speeds.	1. Not in gear.	Select D (Drive).
	2. Low fluid level, aerated fluid.	Add fluid to proper level (TM 9-2320-302-10).
	3. C1 and C5 clutch slipping (6-speed, 1st range start).	Notify Direct Support Maintenance.
Low Stall Speeds.	Engine not performing efficiently (may be due to plugged or restricted injectors, high altitude conditions, dirty air filters, out of time, throttle linkage, electronic engine controls problem).	Refer to Engine Troubleshooting (WP 0006 00). Notify Direct Support Maintenance.
8. Overheating in All Ranges.	1. Aerated fluid - incorrect fluid level.	Adjust fluid to proper level (TM 9-2320-302-10).
	2. Engine overheat.	Correct overheat situation (WP 0006 00).
	3. Inaccurate temperature gage.	Replace gage (WP 0062 00).
	4. Fluid cooler lines restricted.	Remove restrictions, clean or replace lines (WP 0122 00). Notify Direct Support Maintenance.
9. Fluid Comes out Fluid Fill Tube and/or Breather.	1. Dipstick loose.	Tighten cap. Replace if necessary (WP 0121 00).

Table 1. Transmission and Driveline Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Abnormal Activities or Responses from Transmission - Continued		
9. Fluid Comes out Fluid Fill Tube and/or Breather - Continued.	2. Transmission fluid level too high.	Drain to proper level (TM 9-2320-302-10).
	3. Transmission fluid level too low.	Add fluid to proper level (TM 9-2320-302-10).
	4. Breather clogged.	Clean or replace breather (WP 0128 00).
	5. Transmission fluid contaminated with foreign liquid.	Drain and replace fluid (WP 0021 00). Locate and repair source of contaminating fluid.
	6. Dipstick or fill tube seal worn.	Replace seals or dipstick (WP 0121 00).
10. Noise Occurring Intermittently (Buzzing).	1. Low transmission fluid level.	Add fluid to proper level (TM 9-2320-302-10).
	2. Air leak in oil suction screen canister.	Replace oil suction screen canister (WP 0123 00).
	3. Clogged filters.	Replace filters (WP 0123 00).
	4. Aerated fluid causes noisy pump.	Correct fluid level (TM 9-2320-302-10). Notify Direct Support Maintenance.
11. Leaking Fluid (Output Shaft).	Faulty or missing seal at output flange.	Notify Direct Support Maintenance
12. Transmission Leaks (Input).	1. Front seal leaks	Notify Direct Support Maintenance.
	2. Converter leaks.	Notify Direct Support Maintenance.
13. Dirty Transmission Fluid.	1. Failure to change fluid and filters.	Change fluid and install new filters (WP 0123 00).
	2. Damaged fluid filter/seals.	Replace oil filter/seals (WP 0123 00).
Forward-rear Axle and Rear-rear Axle Driveline Assemblies		
1. No Drive at Forward-rear Axle and/or Rear-rear Axle.	1. Check propeller shaft and universal joints from transmission rear output to forward-rear axle for broken universal joint(s) and broken or damaged tube, splines or yoke(s).	Replace any defective universal joint(s) (WP 0130 00). Replace defective propeller shaft (WP 0129 00).

Table 1. Transmission and Driveline Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
Forward-rear Axle and Rear-rear Axle Driveline Assemblies - Continued		
1. No Drive at Forward-rear Axle and/or Rear-rear Axle - Continued.	2. Check propeller shaft and universal joints from forward-rear axle to rear-rear axle for broken universal joint(s) and broken or damaged tubes, splines or yoke(s).	Replace any defective universal joint(s) (WP 0130 00). Replace defective propeller shaft (WP 0129 00).
	3. Check forward-rear axle and rear-rear axle for broken axle shaft(s).	Notify Direct Support Maintenance.
2. Vibration or Noise During or While Driving.	1. Check propeller shafts and universal joints for obvious wear or damage.	Replace any defective universal joint(s) (WP 0130 00). Replace defective propeller shaft (WP 0129 00).
	2. Check wheels for looseness and obvious damage.	Tighten any loose wheel lug nuts (WP 0164 00). Replace any damaged wheel(s).
	3. If problem still exists, notify Direct Support Maintenance.	

FOREWORD — How to Use This Manual

This manual provides troubleshooting information for Allison Transmission Division, MD/HD/B Series On-Highway Transmissions. Service Manuals SM2148EN and SM2457EN, plus Parts Catalogs PC2150EN and PC2456EN may be used in conjunction with this manual.

This manual includes:

- Description of the WTEC III electronic control system.
- Description of the electronic control system components.
- Description of diagnostic codes, system responses to faults, and troubleshooting.
- Wire, terminal, and connector repair information.

Specific instructions for using many of the available or required service tools and equipment are not included in this manual. The service tool manufacturer will furnish instructions for using the tools or equipment.

Additional information may be published from time to time in Service Information Letters (SIL) and will be included in future revisions of this and other manuals. Please use these SILs to obtain up-to-date information concerning Allison Transmission products.

This publication is revised periodically to include improvements, new models, special tools, and procedures. A revision is indicated by a letter suffix added to the publication number. Check with your Allison Transmission service outlet for the currently applicable publication. Additional copies of this publication may be purchased from authorized Allison Transmission service outlets. Look in your telephone directory under the heading of Transmissions — Truck, Tractor, etc.

Take time to review the Table of Contents and the manual. Reviewing the Table of Contents will aid you in quickly locating information.

NOTE: Allison Transmission is providing for service of wiring harnesses and wiring harness components as follows:

- Repair parts for the internal wiring harness and for wiring harness components attached to the shift selector will be available through the Allison Transmission Parts Distribution Center (PDC). Use the P/N from your appropriate parts catalog or from Appendix E in this manual. Allison Transmission is responsible for warranty on these parts.
- Repair parts for the external harnesses and external harness components must be obtained from St. Clair Technologies Inc. (SCTI). SCTI provides parts to any Allison customer or OEM and is responsible for warranty on these parts. SCTI recognizes ATD, manufacturers, and SCTI part numbers. SCTI provides a technical HELPLINE at 519-627-1673 (Wallaceburg). SCTI will have parts catalogs available. The SCTI addresses and phone numbers for parts outlets are:

St. Clair Technologies, Inc.
1050 Old Glass Road
Wallaceburg, Ontario, Canada, N8A 3T2
Phone: (519) 627-1673
Fax: (519) 627-4227

St. Clair Technologies, Inc.
1111 Mikesell Street
Charlotte, Michigan 48813
Phone: (517) 541-8166
Fax: (517) 541-8167

St. Clair Technologies, Inc.
c/o Mequilas Tetakawi
Carr. Internationale KM 1969
Guadalajara – Nogales, KM2
Empalme, Sonora, Mexico
Phone: 011-52-622-34661
Fax: 011-52-622-34662

- St. Clair Technologies, Inc. stocks a WTEC III external harness repair kit, P/N 29532362, as a source for some external harness repair parts. SCTI is the source for external harness repair parts.

TRADEMARKS USED IN THIS MANUAL

IMPORTANT SAFETY NOTICE

IT IS YOUR RESPONSIBILITY to be completely familiar with the warnings and cautions used in this manual. These warnings and cautions advise against using specific service procedures that can result in personal injury, equipment damage, or cause the equipment to become unsafe. These warnings and cautions are not exhaustive. Allison Transmission could not possibly know, evaluate, or advise the service trade of all conceivable procedures by which service might be performed or of the possible hazardous consequences of each procedure. Consequently, Allison Transmission has not undertaken any such broad evaluation. Accordingly, ANYONE WHO USES A SERVICE PROCEDURE OR TOOL WHICH IS NOT RECOMMENDED BY ALLISON TRANSMISSION MUST first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the service procedures used.

Also, be sure to review and observe WARNINGS, CAUTIONS, and NOTES provided by the vehicle manufacturer and/or body builder before servicing the Allison transmission in that vehicle.

Proper service and repair is important to the safe and reliable operation of the equipment. The service procedures recommended by Allison Transmission and described in this manual are effective methods for performing troubleshooting operations. Some procedures require using specially designed tools. Use special tools when and in the manner recommended.

The WARNINGS, CAUTIONS, and NOTES in this manual apply only to the Allison transmission and not to other vehicle systems which may interact with the transmission. Be sure to review and observe any vehicle system information provided by the vehicle manufacturer and/or body builder at all times the Allison transmission is being serviced.

WARNINGS, CAUTIONS, AND NOTES

Three types of headings are used in this manual to attract your attention:

WARNING!	**Is used when an operating procedure, practice, etc., which, if not correctly followed, could result in injury or loss of life.**

CAUTION:	Is used when an operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

NOTE: Is used when an operating procedure, practice, etc., is essential to highlight.

Trademarks Used In This Manual

The following trademarks are the property of the companies indicated:

- DEXRON® is a registered trademark of General Motors Corporation.
- LPS® Cleaner is a registered trademark of LPS Laboratories.
- Loctite® is a registered trademark of the Loctite Corporation.
- Teflon® is a registered trademark of the DuPont Corporation.
- Pro-Link® is a registered trademark of MicroProcessor Systems, Inc.

SHIFT SELECTOR TERMS AND DISPLAY INDICATIONS

Shift selector terms and displays are represented in this manual as follows:

- Button Names —⇑, ⇓, “display mode”, **MODE**, etc.
- Transmission Ranges — **D** (Drive), **N** (Neutral), **R** (Reverse), **1** (First), **2** (Second), etc.
- Displays — “**o**, **L**”; “**o**, **K**”, etc. (Display occurs one character at a time.)

TABLE OF CONTENTS

Page

Foreword 0011 00-7

SAFETY INFORMATION

Important Safety Notice 0011 00-8
Warnings, Cautions, and Notes 0011 00-8
Trademarks Used in This Manual 0011 00-9
Shift Selector Terms and Display Indications 0011 00-9

SECTION 1. GENERAL DESCRIPTION

1–1. TRANSMISSION 0011 00-13
1–2. ELECTRONIC CONTROL UNIT (ECU) 0011 00-15
1–3. SHIFT SELECTOR 0011 00-15
Pushbutton Shift Selector 0011 00-15
1–4. SPEED SENSORS 0011 00-16
1–5. CONTROL MODULE 0011 00-17
1–6. WIRING HARNESSES 0011 00-18
A. External Wiring Harness 0011 00-18
B. Internal Wiring Harness 0011 00-20
1–7. VEHICLE INTERFACE MODULE 0011 00-20

SECTION 2. DEFINITIONS AND ABBREVIATIONS

2–1. CHECK TRANS LIGHT 0011 00-21
2–2. DIAGNOSTIC DATA READER 0011 00-21
2–3. ABBREVIATIONS 0011 00-22

SECTION 3. BASIC KNOWLEDGE

3–1. BASIC KNOWLEDGE REQUIRED 0011 00-25
3–2. USING THE TROUBLESHOOTING MANUAL 0011 00-25
3–3. SYSTEM OVERVIEW 0011 00-25
3–4. IMPORTANT INFORMATION IN THE TROUBLESHOOTING PROCESS 0011 00-26
3–5. BEGINNING THE TROUBLESHOOTING PROCESS 0011 00-27

SECTION 4. WIRE CHECK PROCEDURES

4–1. CHECKING OPENS, SHORTS BETWEEN WIRES, AND SHORTS-TO-GROUND . . . 0011 00-29
4–2. CHECKING AT TRANSMISSION CONNECTOR AND THE INTERNAL HARNESS FOR OPENS, SHORTS BETWEEN WIRES, AND SHORTS-TO-GROUND 0011 00-30

TABLE OF CONTENTS *(cont'd)*

Page

SECTION 5. DIAGNOSTIC CODES

5–1. DIAGNOSTIC CODE MEMORY 0011 00-33
5–2. CODE READING AND CODE CLEARING 0011 00-33
5–3. DIAGNOSTIC CODE RESPONSE 0011 00-35
5–4. SHIFT SELECTOR DISPLAYS RELATED TO ACTIVE CODES 0011 00-36
5–5. DIAGNOSTIC CODE LIST AND DESCRIPTION 0011 00-36
5–6. DIAGNOSTIC CODE TROUBLESHOOTING 0011 00-47
A. Beginning the Troubleshooting Process 0011 00-47
B. Solenoid Locations 0011 00-47
C. Diagnostic Code Schematics 0011 00-47
D. Wire/Terminal Numbering Scheme 0011 00-47

APPENDICES

A. IDENTIFICATION OF POTENTIAL CIRCUIT PROBLEMS 0011 00-122
B. CHECKING CLUTCH PRESSURES 0011 00-125
C. SOLENOID AND CLUTCH CHART 0011 00-135
D. WIRE/CONNECTOR CHART 0011 00-137
E. WELDING ON VEHICLE/VEHICLE INTERFACE MODULE 0011 00-167
F. DIAGNOSTIC TREE — WT SERIES HYDRAULIC SYSTEM 0011 00-169
G. PRO-LINK® 9000 DIAGNOSTIC DATA READER INFORMATION 0011 00-171
H. INPUT/OUTPUT FUNCTION WIRING SCHEMATICS 0011 00-173

SECTION 1 — GENERAL DESCRIPTION

1–1. TRANSMISSION

The World Transmission Electronic Controls (WTEC III) system features closed-loop clutch control to provide superior shift quality over a wide range of operating conditions. MD 3000, HD 4000, and B Series configurations can be programmed to have up to six forward ranges, neutral, and one reverse range. The MD 3070 and HD4070 have up to seven forward ranges and one reverse range.

Figure 1–1 is a block diagram of the basic system inputs and outputs.

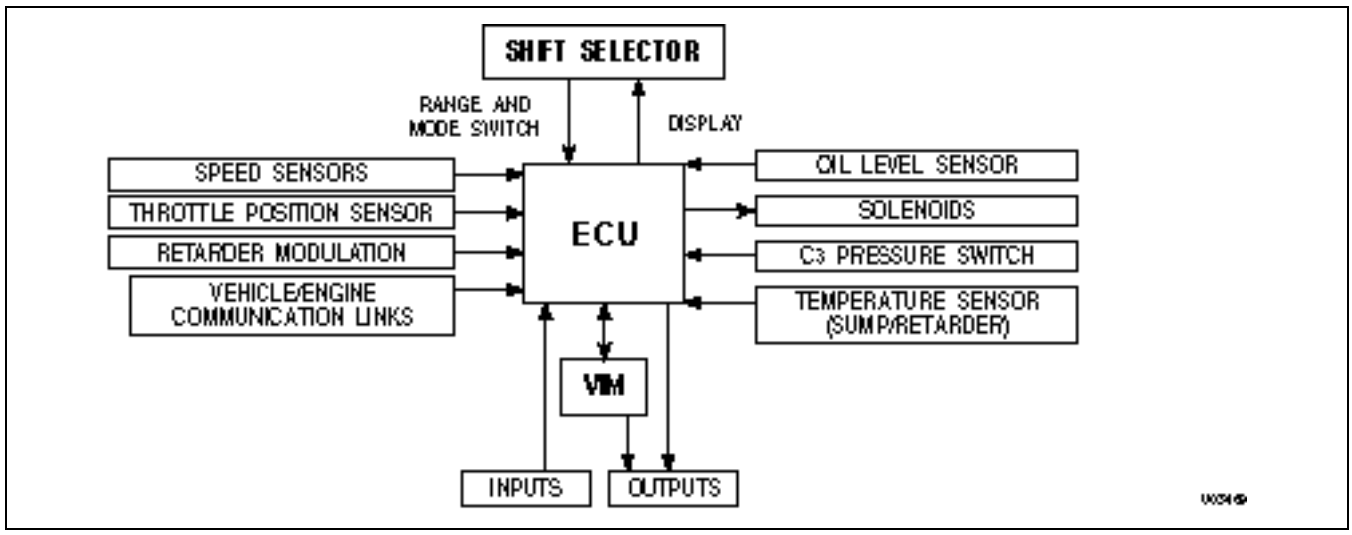


Figure 1–1. Electronic Control Unit Block Diagram

Figure 1–2 shows WTEC III electronic control components.

WTEC III Electronic Controls consist of the following elements:

- Remote 12/24V Max Feature Sealed Electronic Control Unit (ECU)
- Remote Pushbutton or Lever Shift Selector
- Optional Secondary Shift Selector
- Throttle Position Sensor (TPS) (or electronic engine throttle data or PWM signal)
- Engine, Turbine, and Output Speed Sensors
- Control Module (Electro-Hydraulic Valve Body)
- Wiring Harnesses
- Vehicle Interface Module (VIM)
- Autodetect Feature
- TransID Feature
- Optional Retarder Controls
- Optional Engine Coolant Temperature Input

NOTE:
- ***All external harnesses are OEM supplied***
- ***Some OEMs may supply their own shift selector***
- ***The VIM is an OEM option***

GENERAL DESCRIPTION

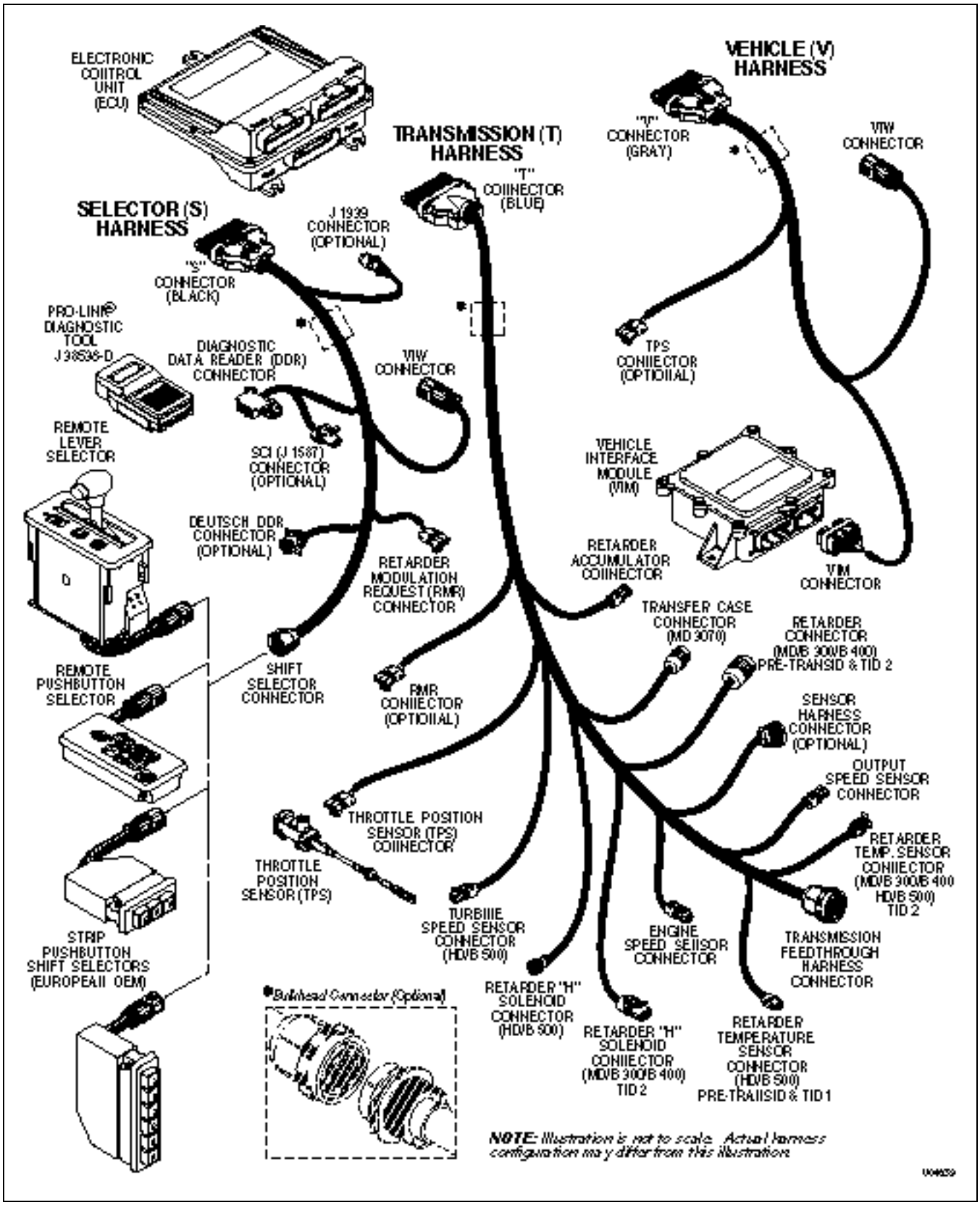


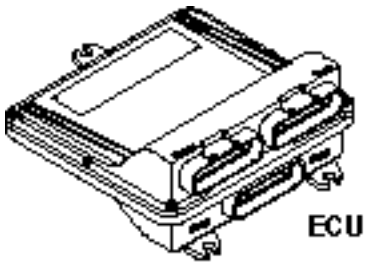
Figure 1–2. WTEC III Electronic Control Components

GENERAL DESCRIPTION

1–2. ELECTRONIC CONTROL UNIT (ECU)

The ECU (Figure 1–3) contains the microcomputer which is the brain of the control system. The ECU receives and processes information defining: shift selector position, throttle position, sump/retarder temperature, engine speed, turbine speed, and transmission output speed. The ECU uses the information to control transmission solenoids and valves, supply system status, and provide diagnostic information.

Each ECU has a date code stamped on the label which is attached to the outer case of the ECU. This is the date when the ECU passed final test. This date is commonly used to denote the change configuration level of the ECU. It is normal for the ECU date displayed electronically to be a few days prior to the date shown on the label.



NOTE: ECU wiring harness connector retainers are individually keyed and color-coded to ensure that the proper connector is attached to the correct ECU socket. The color of the connector retainer should match the color of the connector strain relief (see Appendix E, Paragraph 1–1).

Figure 1–3. Electronic Control Unit (ECU)

1–3. SHIFT SELECTOR

Pushbutton and lever shift selectors for the WTEC III Series are remote mounted from the ECU and connected to the ECU by a wiring harness. Both of these shift selectors have a single digit LED display and a mode indicator (LED). During normal transmission operation, illumination of the LED indicator shows that a secondary or special operating condition has been selected by pressing the **MODE** button. During diagnostic display mode, illumination of the LED indicator shows that the displayed diagnostic code is active. Display brightness is regulated by the same vehicle potentiometer that controls dash light display brightness. More information on both types of shift selectors is continued below.

A. Pushbutton Shift Selector *(Figure 1–4)*

There is a full-function pushbutton shift selector and a strip pushbutton shift selector. Strip pushbutton shift selectors are used by European OEMs. A full-function shift selector has a **MODE** button and diagnostic display capability through the single digit LED display. The strip pushbutton shift selector does not have a **MODE** button, diagnostic capability, or adjustable illumination. The full-function pushbutton shift selector has six (6) pushbuttons which are **R** (Reverse), **N** (Neutral), **D** (Drive), ⇓ (Down), ⇑ (Up), and **MODE**. Manual forward range downshifts and upshifts are made by pressing the ⇓ (Down) or ⇑ (Up) arrow buttons after selecting **D** (Drive). The **N** (Neutral) button has a raised lip to aid in finding it by touch. The **MODE** button is pressed to select a secondary or special operating condition, such as ECONOMY shift schedule. Diagnostic information is obtained by pressing the ⇑ (Up) and ⇓ (Down) arrow buttons at the same time. The strip pushbutton shift selector has either three or six range selection positions as shown in Figure 1–4. When a strip pushbutton shift selector is used, diagnostic information must be obtained by using the Pro-Link® 9000 or a customer-furnished remote display.

GENERAL DESCRIPTION

Figure 1–4. Pushbutton Shift Selectors

1–4. SPEED SENSORS *(Figure 1–5)*

Three speed sensors — engine speed, turbine speed, and output speed — provide information to the ECU. The engine speed signal is generated by ribs on the shell of the torque converter pump. The turbine speed signal is generated by the rotating-clutch housing spline contours. The output speed signal is generated by a toothed member attached to the output shaft (except for the MD 3070, where the toothed member is the transfer case idler gear). The speed ratios between the various speed sensors allow the ECU to determine if the transmission is in the selected range. Speed sensor information is also used to control the timing of clutch apply pressures, resulting in the smoothest shifts possible. Hydraulic problems are detected by comparing the speed sensor information for the current range to that range's speed sensor information stored in the ECU memory.

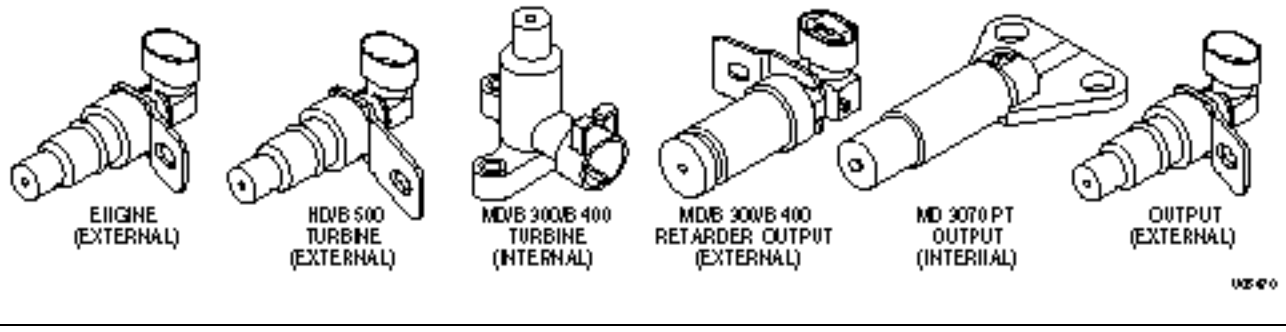


Figure 1–5. Speed Sensors

GENERAL DESCRIPTION

1–5. CONTROL MODULE *(Figure 1–6)*

The WT Series transmission control module contains a channel plate on which is mounted: the main valve body assembly, the stationary-clutch valve body assembly, and the rotating-clutch valve body assembly. For valve locations, refer to SIL 27-WT-93, Rev. A. Pulse width modulated solenoids are used in the valve bodies. The rotating-clutch valve body assembly contains A (C1), B (C2), and F (lockup) solenoids, solenoid regulator valves controlled by the solenoids, and the C3 pressure switch. The stationary-clutch valve body assembly contains C(C3), D (C4), and E (C5) solenoids and solenoid regulator valves controlled by the solenoids and the C3accumulator relay valve. The main valve body assembly contains G solenoid and the C1 and C2 latch valves controlled by the solenoid, the main and lube regulator valves, the control main and converter regulator valves, and the converter flow valve and exhaust backfill valves. The low valve body assembly (MD 3070PT and HD4070) contains N and J solenoids.

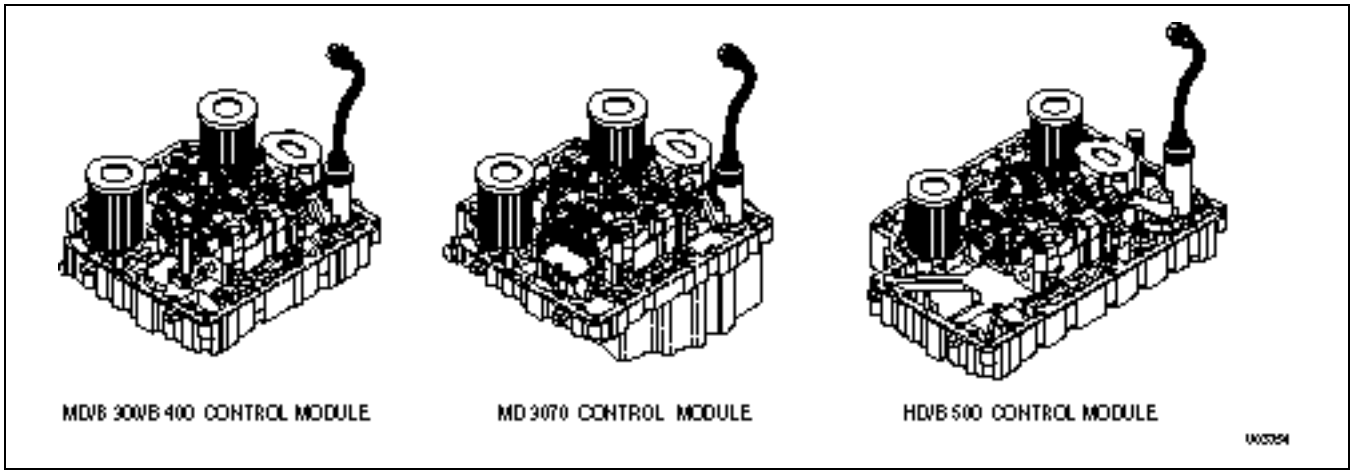


Figure 1–6. WTEC III Control Module

A temperature sensor (thermistor) is located in the internal wiring harness. Changes in sump fluid temperature are indicated by changes in sensor resistance which changes the signal sent to the ECU (see chart in Section 5, Code24).

The oil level sensor is a float type device, mounted on the control module channel plate, which senses transmission fluid level by electronically measuring the buoyancy forces on the float. The sensor operates on 5 VDC supplied by the ECU. The oil level sensor is required on all models with a shallow sump but is optional on other models. The oil level sensor is not available on the MD 3070.

The C3 pressure switch is mounted on the rotating-clutch valve body assembly and indicates when pressure exists in the C3 clutch-apply passage. An accumulator/relay valve is in-line ahead of the C3 pressure switch and prevents high frequency hydraulic pulses generated by the C3 solenoid from cycling the C3 pressure switch.

Also mounted in the control module is the turbine speed sensor for the MD/B 300/B 400 models. The turbine speed sensor is directed at the rotating-clutch housing. (The turbine speed sensor on the HD/B 500 models is located on the outside of the main housing.)

GENERAL DESCRIPTION

1–6. WIRING HARNESSES

A. External Wiring Harness *(Figure 1–7)*

WTEC III uses three external wiring harnesses to provide a connection between the ECU, the transmission (including engine, turbine, and output speed sensors), the throttle position sensor, the vehicle interface module (VIM), retarder control module, shift selectors, diagnostic tool connector, retarder, retarder temperature sensor, accumulator, and vehicle interface. Many harnesses will include a bulkhead fitting to separate cab and chassis components. Also, many different styles and materials for harnesses are likely to be encountered.

GENERAL DESCRIPTION

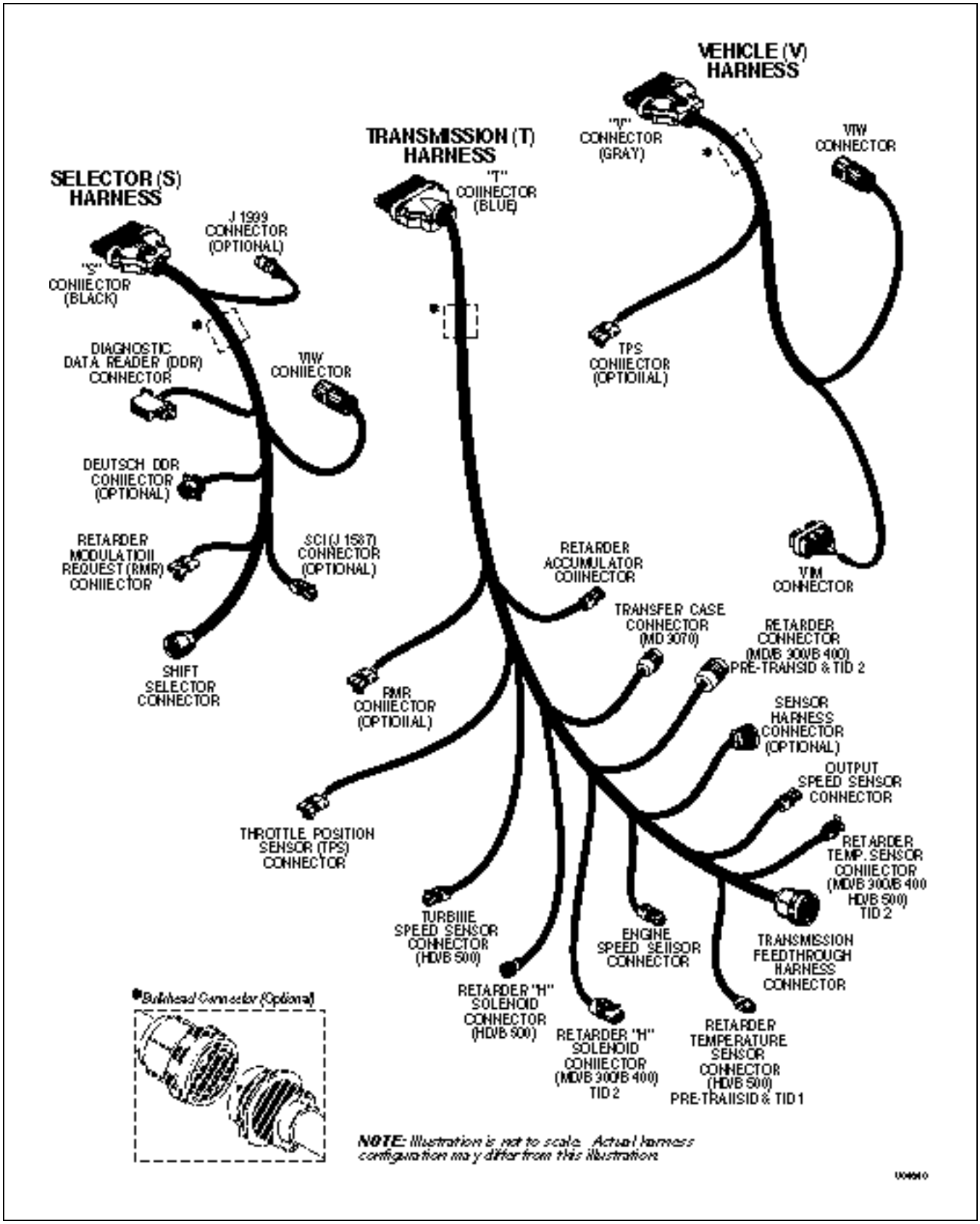


Figure 1–7. WTEC III External Wiring Harnesses

GENERAL DESCRIPTION

B. Internal Wiring Harness *(Figure 1–8)*

The internal wiring harness provides connection between the external harness, the pulse width modulated solenoids, oil level sensor, C3 pressure switch, and the temperature sensor.

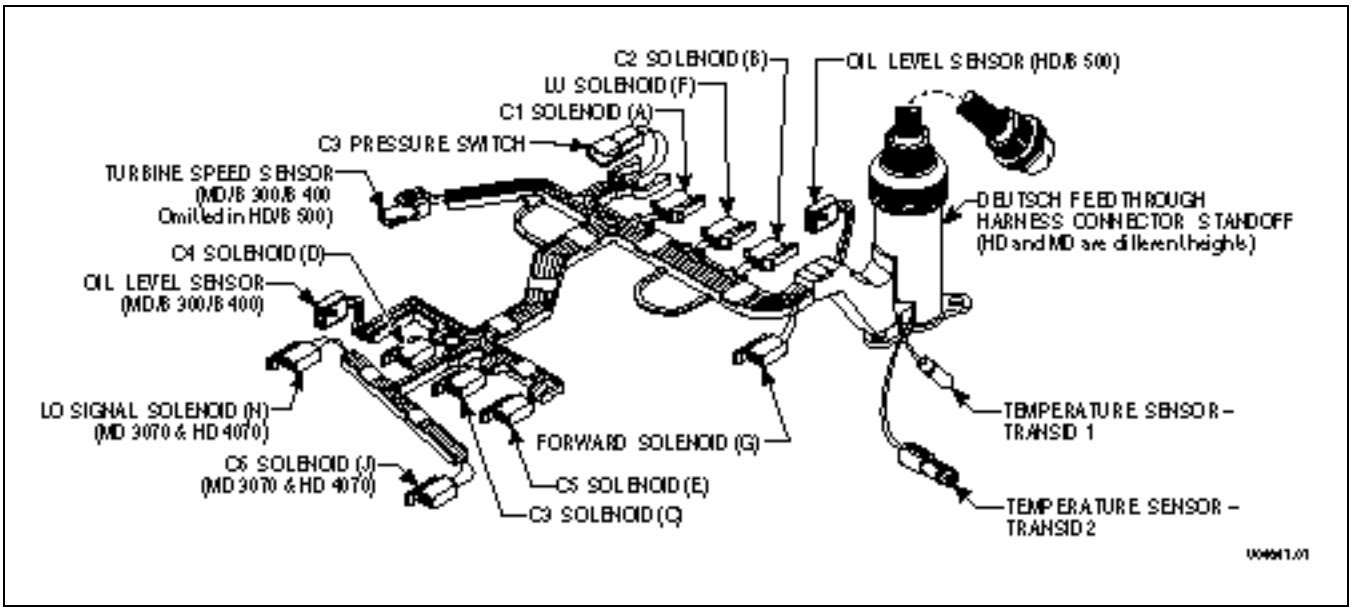


Figure 1–8. WTEC III Internal Wiring Harness

1–7. VEHICLE INTERFACE MODULE *(Figure 1–9)*

The vehicle interface module (VIM) provides relays, fuses, and connection points for interface with the output side of the vehicle electrical system. VIMs are available for both 12V and 24V electrical systems. The VIM for 12V systems uses all 12V relays. The VIM for 24V systems has all 24V relays. Refer to the Parts Catalog for the transmission assembly number that you are servicing for detailed parts information. Refer to Pages D–23 and D–24 for VIM wire number and terminal information.

Some OEMs may provide their own equivalent for the VIM which performs the same functions as the VIM shown in Figure 1–9.

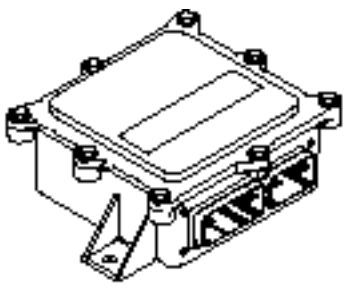


Figure 1–9. Vehicle Interface Module (VIM)

SECTION 2 — DEFINITIONS AND ABBREVIATIONS

2–1. CHECK TRANS LIGHT

When the ECU detects a serious fault, the **CHECK TRANS** light (usually located on the vehicle instrument panel) illuminates and action is automatically taken to protect operator, vehicle, and the transmission. A diagnostic code will nearly always be registered when the **CHECK TRANS** light is on; however, not all diagnostic codes will turn on the **CHECK TRANS** light. Codes related to the **CHECK TRANS** light are detailed in the code chart (refer to Section 6).

Illumination of the **CHECK TRANS** light indicates that a condition was detected that requires service attention. Operation may or may not be restricted but even when restricted will allow the vehicle to reach a service assistance location. Depending upon the cause for the **CHECK TRANS** light illumination, the ECU may or may not respond to shift selector requests. The transmission may be locked in a range. That range will be shown on the shift selector display. Both upshifts and downshifts may be restricted when the **CHECK TRANS** light is illuminated. Seek service assistance as soon as possible.

Each time the engine is started, the **CHECK TRANS** light illuminates briefly and then goes off. This momentary lighting shows the light circuit is working properly. If the light does not come on during engine start, request service immediately.

2–2. DIAGNOSTIC DATA READER *(Figure 2–1)*

The current Diagnostic Data Reader (DDR) is the Pro-Link® 9000 diagnostic tool which is available through Kent-Moore Heavy-Duty Division. A portable microcomputer-based receiver/transmitter/display unit, the Pro-Link® transmits and receives data to and from the ECU, processes the data, and displays appropriate information. Use the Pro-Link® during installation checkout and troubleshooting. There is a new Pro-Link® cartridge needed for use with WTEC III controls. The new Multi-Protocol Cartridge (MPC) contains a programmed PCMCIA card which allows for reprogramming of GPI/GPO packages. Reprogramming includes selection of a GPI/GPO package, enabling/disabling of wires and modification of certain data parameters. Operating instructions are supplied with each Pro-Link® and further information is also included in Appendix N of this manual. Connect the Pro-Link® 9000 to the diagnostic connector provided in the selector wiring harness.

Tool part numbers for the Pro-Link® are as follows:

- Diagnostic Kit J 38538D + J 38500–313 (PROM Update) = J 38538E
- Diagnostic Cartridge J 38500-302 + J 38500–313 = J 38500–303
- MPC J 38500–1500C
- PCMCIA (Diagnostic And Reprogramming) J 38500–1700B
- PCMCIA (Diagnostic Only) J 38500–1800A

NOTE: ***The new MPC is usable with WTEC II controls but the old WTEC II reprogramming cartridge will not display the WTEC III new information. The new MPC must be used to reprogram WTEC III systems.***

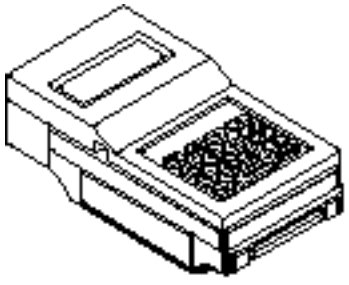


Figure 2–1. Pro-Link® 9000 Diagnostic Tool

DEFINITIONS AND ABBREVIATIONS

2–3. ABBREVIATIONS

A/N	**A**ssembly **N**umber
ABS	**A**nti-lock **B**rake **S**ystem — OEM-provided means to detect and prevent wheel stoppage to enhance vehicle handling. Retarder and engine brakes will not apply when ABS is active.
Amp	Unit of electrical current.
C3PS	**C3 P**ressure **S**witch — Pressure switch to signal the presence or absence of pressure in the C3 clutch-apply circuit.
CAN	**C**ontroller **A**rea **N**etwork — A network for all SAE J1939 communications in a vehicle (engine, trnasmission, ABS, etc.)
COP	**C**omputer **O**perating **P**roperly — Hardware protection which causes the ECU to reset if software gets lost.
CT	**C**losed **T**hrottle
DDR	**D**iagnostic **D**ata **R**eader — Diagnostic tool; most current version is the Pro-Link® 9000 made by MicroProcessor Systems, Inc. Used to interrogate the ECU for diagnostic information and for reprogramming I/O packages in a calibration.
DNA	**D**oes **N**ot **A**dapt — Adaptive shift control is disabled.
DNS	**D**O **N**OT **S**HIFT — Refers to the **DO NOT SHIFT** diagnostic response during which the **CHECK TRANS** light is illuminated and the transmission will not shift and will not respond to the Shift Selector.
DVOM	**D**igital **v**olt/**o**hm **m**eter
ECU	**E**lectronic **C**ontrol **U**nit (also commonly referred to as the “computer”)
GPI	**G**eneral **P**urpose **I**nput — Input signal to the ECU to request a special operating mode or condition.
GPO	**G**eneral **P**urpose **O**utput — Output signal from the ECU to control vehicle components (such as PTOs, backup lights, etc.) or allow a special operating mode or condition.
J1587	Engine/transmission serial data communications link.
J1939	High-speed vehicle serial data communications link.
LED	**L**ight-**E**mitting **D**iode — Electronic device used for illumination.
NNC	**N**eutral **N**o **C**lutches — Neutral commanded with no clutches applied.
NVL	**N**eutral **V**ery **L**ow — The ECU has sensed turbine speed below 150 rpm when output speed is below 100 rpm and engine speed is above 400 rpm when **N** (Neutral) was selected. This is usually caused by a dragging C1 or C3 clutch or a failed turbine speed sensor. NVL is attained by turning D solenoid “ON” (in addition to E solenoid) and the C4 and C5 clutches are applied to lock the transmission output.
OEM	**O**riginal **E**quipment **M**anufacturer — Maker of vehicle or equipment.
Ohm	Unit of electrical resistance.
OL	**O**ver **L**imit or **O**il **L**evel — For **O**ver **L**imit see “×”. Indicates **O**il **L**evel is being displayed on a shift selector.

DEFINITIONS AND ABBREVIATIONS

2–3. ABBREVIATIONS (CONTINUED)

OLS	**O**il **L**evel **S**ensor — Electronic device (optional) on control module for indicating transmission fluid level.
PCCS	**P**ROM **C**alibration **C**onfigurator **S**ystem
PCMCIA	**P**ersonal **C**omputer **M**emory **C**ard **I**nternational **A**ssociation — Memory device for use with Pro-Link® containing Allison Transmission programming and diagnostics.
PROM	**P**rogrammable **R**ead **O**nly **M**emory
PSS	**P**rimary **S**hift **S**elector — Main shift selector in a two-selector control system.
PTO	**P**ower **T**ake**o**ff
PWM Solenoid	**P**ulse **W**idth **M**odulated **Solenoid** — Solenoids are controlled by pulse width modulation. Solenoid control of clutch pressures is based on the solenoid's duty cycle. Duty cycle is determined by the ratio of solenoid's on-time to off-time.
RMR	**R**etarder **M**odulation **R**equest — Signal from a retarder control device.
RPR	**R**eturn to **P**revious **R**ange — Diagnostic response in which the transmission is commanded to return to previously commanded range.
SCI	**S**erial **C**ommunication **I**nterface — Used to transmit data and messages between the diagnostic tool and the ECU and other systems such as electronically-controlled engines.
SOL OFF	All **SOL**enoids **OFF**
SPI	**S**erial **P**eripheral **I**nterface — The means of communication between the microprocessor and the interface circuits.
SSS	**S**econdary **S**hift **S**elector — Alternate shift selector in a two-selector control system.
TID	**T**rans**ID** — A feature which allows the ECU to know the transmission configuration and provide the corresponding calibration required.
TPS	**T**hrottle **P**osition **S**ensor — Potentiometer for signaling the position of the engine fuel control lever.
V	**V**ersion — Abbreviation used in describing ECU software levels.
VDC	**V**olts **D**irect **C**urrent (DC)
VIM	**V**ehicle **I**nterface **M**odule — A watertight box containing relays and fuses — interfaces the transmission electronic control system with components on the vehicle.
VIW	**V**ehicle **I**nterface **W**iring — Interfaces ECU programmed input and output functions with the vehicle wiring.
Volt	Unit of electrical force.
VOM	**V**olt/**o**hm **m**eter
WOT	**W**ide **O**pen **T**hrottle
WT	**W**orld **T**ransmission
×	Infinity — Condition of a circuit with higher resistance than can be measured, effectively an open circuit.

DEFINITIONS AND ABBREVIATIONS

SECTION 3 — BASIC KNOWLEDGE

3–1. BASIC KNOWLEDGE REQUIRED

To service WTEC III Electronic Controls, the technician must understand basic electrical concepts. Technicians need to know how to use a volt/ohmmeter (VOM) to make resistance and continuity checks. Most troubleshooting checks consist of checking resistance, continuity, and checking for shorts between wires and to ground. The technician should be able to use jumper wires and breakout harnesses and connectors. Technicians unsure of making the required checks should ask questions of experienced personnel or find instruction.

The technician should also have the mechanical aptitude required to connect pressure gauges or transducers to identified pressure ports used in the troubleshooting process. Pressure tap locations and pressure values are shown in Appendix B — Checking Clutch Pressures.

Input power, ground, neutral start circuitry, etc., can cause problems with electronic controls or vehicle functioning and may not generate a diagnostic code. A working knowledge of WT Series Electronic Controls vehicle installation is necessary in troubleshooting installation-related problems.

Refer to Section 8 for information concerning performance complaints (non-code) troubleshooting. A complete wiring schematic is shown in Appendix J. Refer to the WTEC III Controls and General Information Sales Tech Data Book for information concerning electronic controls installation and the Installation Checklist. Reliable transmission operation and performance depend upon a correctly installed transmission. Review the Installation Checklist in the MD, HD, B 300/B 400, and B 500 Sales Tech Data Books to ensure proper installation.

3–2. USING THE TROUBLESHOOTING MANUAL

Use this manual as an aid to troubleshooting the WTEC III Electronic Controls. Every possible problem and its solution cannot be encompassed by any manual. However, this manual does provide a starting point from which most problems can be resolved.

Once a problem solution is discovered in the manual do not look further for other solutions. It is necessary to determine *why* a problem occurred. For example, taping a wire that has been rubbing on a frame rail will not correct the problem unless the rubbing contact is eliminated.

3–3. SYSTEM OVERVIEW

WTEC III Electronic Control functions are controlled by the ECU. The ECU reads shift selector range selection, output speed, and throttle position to determine when to command a shift. When a shift occurs, the ECU monitors turbine speed, output speed, and throttle position to control the oncoming and off-going clutches during the shift.

When the ECU detects an electrical fault, it logs a diagnostic code indicating the faulty circuit and may alter the transmission operation to prevent or reduce damage.

When the ECU detects a non-electrical problem while trying to make a shift, the ECU may try that shift a second or third time before setting a diagnostic code. Once that shift has been retried, and a fault is still detected, the ECU sets a diagnostic code and holds the transmission in a fail-to-range mode of operation.

BASIC KNOWLEDGE

3–4. IMPORTANT INFORMATION IN THE TROUBLESHOOTING PROCESS

Before beginning the troubleshooting process, read and understand the following:

- WTEC III wire identification presents the wire number followed by the ECU terminal source (i.e., 157-S30). If there is a letter suffix following the wire number, there is a splice between the ECU source and wire destination (i.e., 136A-S16).
- Shut off the engine and ignition before any harness connectors are disconnected or connected.
- Remember to do the following when checking for shorts and opens:
  - Minimize movement of wiring harnesses when looking for shorts. Shorts involve wire-to-wire or wire-to-ground contacts and moving the harnesses may eliminate the problem.
  - Wiggle connectors, harnesses, and splices when looking for opens. This simulates vehicle movements which occur during actual operation.
- When disconnecting a harness connector, be sure that pulling force is applied to the connector itself and **not the wires** extending from the connector.
- Resistance checks involving the wiring between the ECU connectors and other components adds about one ohm of resistance to the component resistance shown.

- Inspect all connector terminals for damage. Terminals may have bent or lost the necessary tension to maintain firm contact.
- Clean dirty terminals or connectors with isopropyl alcohol and a cotton swab, or a good quality, non-residue, non-lubricating, cleaning solvent such as LPS Electro Contact Cleaner® or LPS NoFlash Electro Contact Cleaner®.

CAUTION:	The cleaning solvent must not be chlorine based, contain petroleum distillates, or conduct electricity. The cleaning solvent should evaporate quickly to prevent the possibility of condensation within the connectors. Always blow or shake any excess cleaner from the connector before assembling it to its mating connector or hardware. Cleaner trapped in the connector can affect the connector seal. (Refer to SIL 17-TR-94 for detailed information on the recommended cleaners.)

CAUTION:	Care should be taken when welding on a vehicle equipped with electronic controls. Refer to Appendix E, Paragraph 1–1.

- Diagnostic codes displayed after system power is turned on with a harness connector disconnected, can be ignored and cleared from memory. Refer to Section 5, Diagnostic Codes, for the code clearing procedure.

3–5. BEGINNING THE TROUBLESHOOTING PROCESS

NOTE: Whenever a transmission is overhauled, exchanged, or has undergone internal repairs, the Electronic Control Unit (ECU) must be "RESET TO UNADAPTED SHIFTS." See Service Information Letter 16-WT-96, Revision A availability from Freightliner dealer for further details.

1. Begin troubleshooting by checking the transmission fluid level and ECU input voltage. Remember that some problems may be temperature related. Do troubleshooting at the temperature level where the problem occurs. Check diagnostic codes by:
   - Using the shift selector display. (See Paragraph 5–2 for code reading.)
   - Using the Pro-Link® 9000 diagnostic tool.
2. When a problem exists but a diagnostic code is not indicated, refer to Transmission and Driveline Troubleshooting WP 0011 00 for a listing of various problems, their causes, and remedies.
3. If a diagnostic code is found in the ECU memory, record all available code information and clear the active indicator (refer to Section 5).
4. Test drive the vehicle to confirm a diagnostic code or performance complaint.
   - If the code reappears, refer to the Diagnostic Code section (Section 5) and the appropriate code chart. The Diagnostic Code section lists diagnostic codes and their description. Locate the appropriate troubleshooting chart and follow the instructions.

BASIC KNOWLEDGE

- If the code does not reappear, it may be an intermittent problem. Use the Pro-Link® and the code display procedure described in Section 5. The code display procedure will indicate the number of times the diagnostic code has occurred. Refer to the troubleshooting chart for possible cause(s) of the problem.
- Appendix A deals with the identification of potential circuit problems. Refer to Appendix A if a circuit problem is suspected.

SECTION 4 — WIRE CHECK PROCEDURES

4–1. CHECKING OPENS, SHORTS BETWEEN WIRES, AND SHORTS-TO-GROUND

(Use Digital Volt/Ohmmeter J 34520-A and Jumper Wire Set J 39197)

NOTE: Please refer to Paragraph 3–5 to begin the troubleshooting process.

1. Make sure all connectors are tightly connected and re-check the circuit.

2. Disconnect and inspect all connectors.

3. Thoroughly clean corroded or dirty terminals. If dirty or corroded terminals are the probable cause of the problems, reconnect the clean connectors and operate the vehicle normally. If the problem recurs, proceed with Step (4).

CAUTION:	The cleaning solvent must not be chlorine based, contain petroleum distillates, or conduct electricity. The cleaning solvent should evaporate quickly to prevent the possibility of condensation within the connectors. Always blow or shake any excess cleaner from the connector before assembling it to its mating connector or hardware.

4. Review the WTEC III wire numbering system described in Paragraph 3–4.

5. If all connectors are clean and connected correctly, determine which wires in the chassis harness are indicated by the diagnostic code. For example, Code 4112, indicates an open or short-to-ground in the solenoid A circuit — wires 102-T1 and 120-T4.

   a. Check continuity of wires 102-T1 and 120-T4 by performing the following (refer to Figure 4–1):

      (1) Disconnect the blue "T" connector from the ECU and disconnect the harness from the transmission main connector. At one end of the harness, using jumper wire kit J39197 and connector probes in J39775-CP, connect wire 102-T1 and 120-T4 to each other, being careful not to distort the terminals. Jumping the wires together creates a circuit between wires 102-T1 and 120-T4.

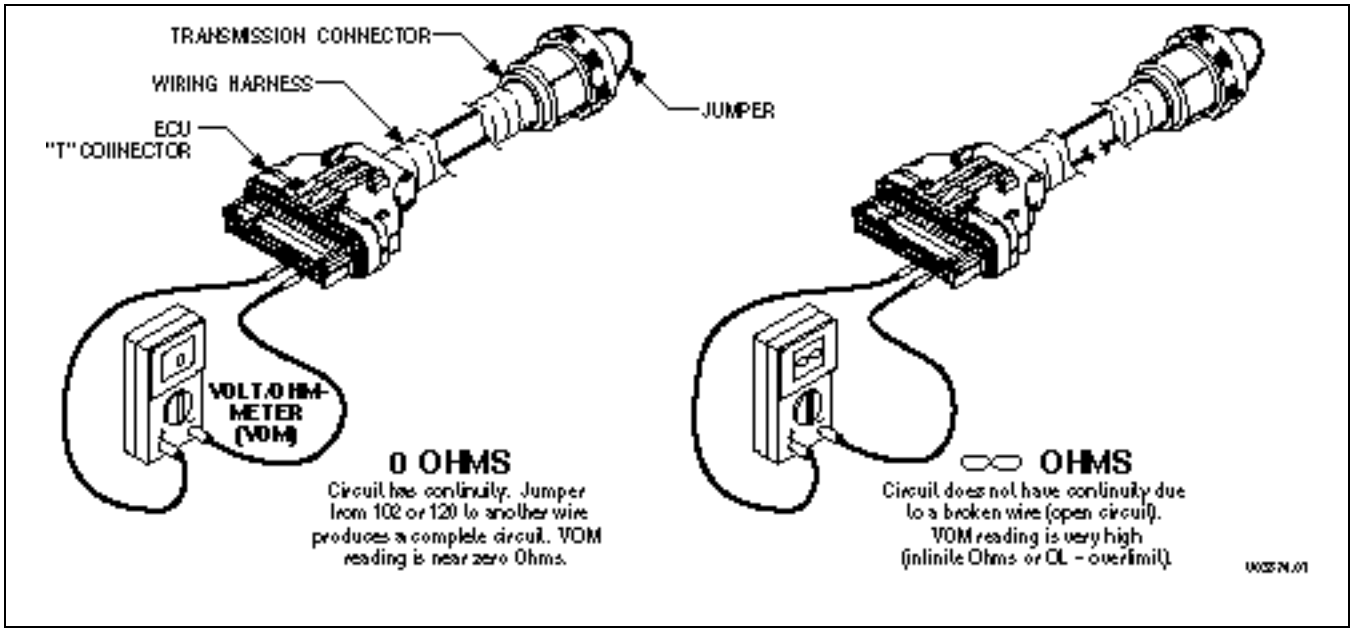


Figure 4–1. Open Circuit

WIRE CHECK PROCEDURES

(2) On the opposite end of the harness, check the continuity of the jumpered pair. No continuity in a jumpered pair circuit (infinite resistance reading) indicates an open in the wire being tested. Locate and repair the damaged portion of the wire.

b. If the continuity check is good (0–2 Ohms resistance), remove the jumpers. Check the harness for shorts between wires and shorts-to-ground by performing the following (refer to Figure 4–2):

(1) At the ECU end of the harness, touch one VOM probe to one wire of the circuit being tested and touch the other probe to each terminal in the same connector, then touch the probe to chassis ground and to the transmission main housing. Do this for both wires in the circuit being tested.

(2) If at any time the VOM shows zero to low resistance, or the meter's continuity beeper sounds, there is a short between the two points being probed — wire-to-wire or wire-to-ground. Isolate and repair the short.

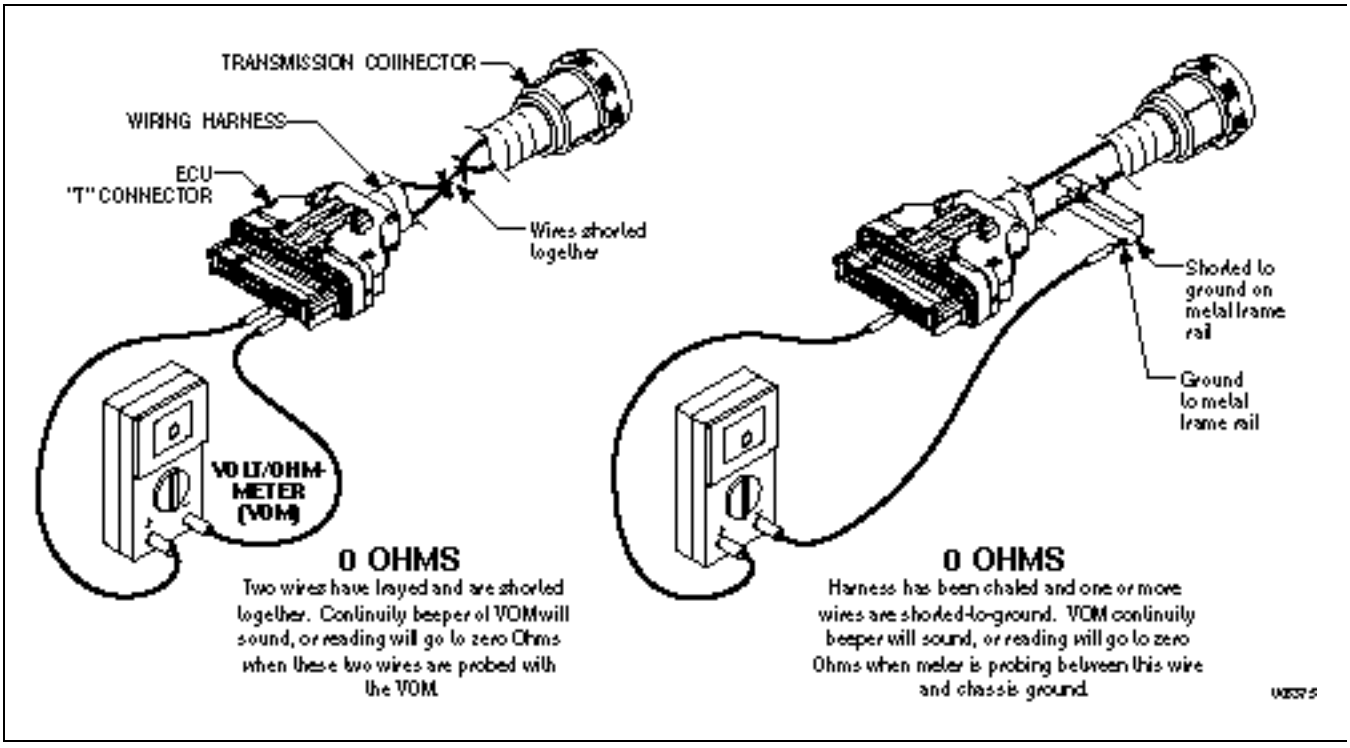


Figure 4–2. Short Between Wires and to Ground

4–2. CHECKING AT TRANSMISSION CONNECTOR AND THE INTERNAL HARNESS FOR OPENS, SHORTS BETWEEN WIRES, AND SHORTS-TO-GROUND

1. Disconnect the external wiring harness from the transmission.

2. Inspect the connectors. Any terminals which are corroded or dirty must be thoroughly cleaned.

3. If the connectors are clean and connected correctly, determine which wires in the harness to test. Use the diagnostic code system schematic to locate the wire terminals. For this example, Code 41 12 indicates an open or short-to-ground in solenoid "A" circuit — wires 102-T1 and 120-T4 (refer to Figure 4–3 and 4–4).

WIRE CHECK PROCEDURES

CAUTION: The cleaning solvent must not be chlorine based, contain petroleum distillates, or conduct electricity. The cleaning solvent should evaporate quickly to prevent the possibility of condensation within the connectors. Always blow or shake any excess cleaner from the connector before assembling it to its mating connector or hardware. Cleaner trapped in the connector can affect the connector seal.

a. At the transmission connector, check the resistance of the A solenoid circuit. Resistance of a solenoid circuit should be 2.4–5 Ohms — covering a temperature range of –18°C to 149°C (0°Fto300°F). No continuity in the circuit (infinite resistance) indicates an open in the internal harness, the feedthrough connector, or the solenoid coil. Locate and repair the open in the internal harness or replace the internal harness, replace the feedthrough connector, or replace the solenoid.

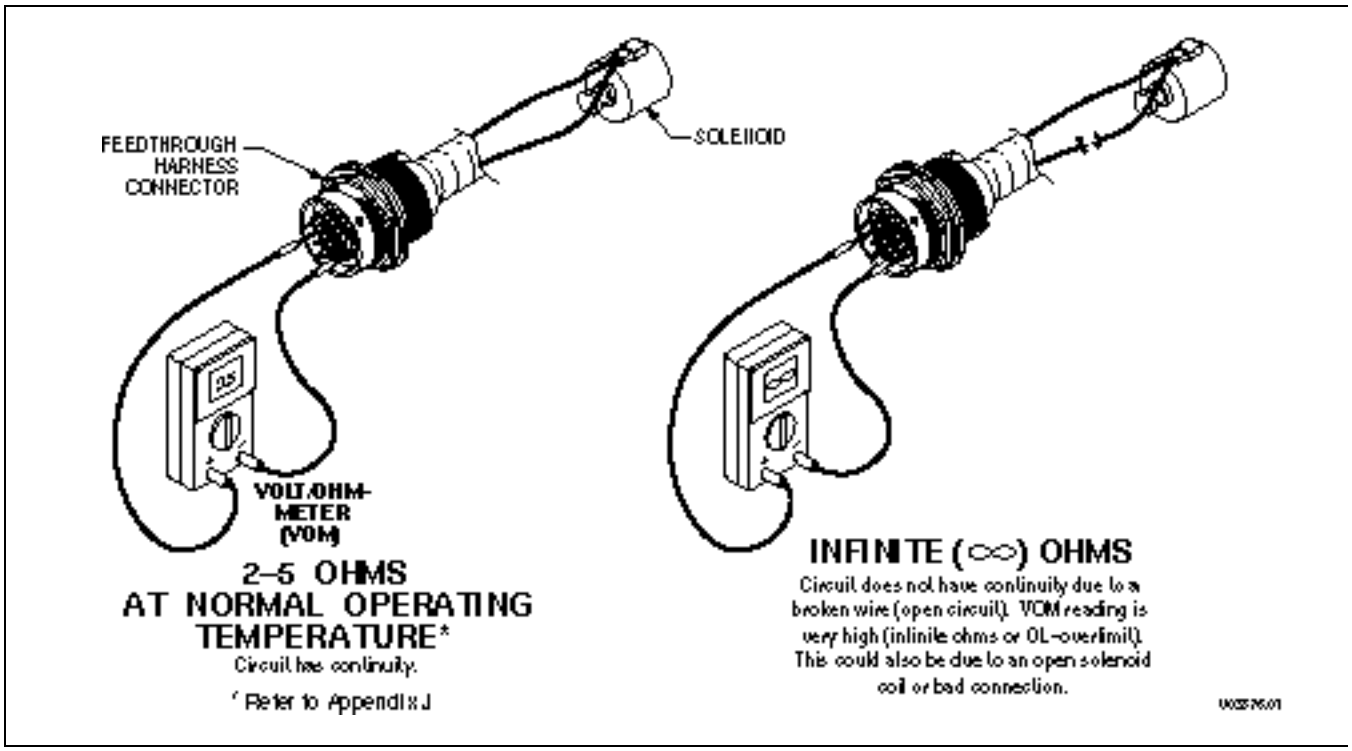


Figure 4–3. Checking Continuity

b. If the resistance check is good, check the harness for shorts between wires and to ground by performing the following (refer to Figure 4–4):

(1) At the transmission connector, touch one probe of the VOM to one wire of the circuit being tested and touch the other probe to each terminal in the connector and to chassis ground and the transmission main housing. Do this for both wires in the circuit being tested.

(2) If the VOM shows zero to low resistance, or the continuity beeper sounds, there is a short between the two points being probed, wire-to-wire or wire-to-ground. An indication of a short may be caused by a splice to the wire being checked. Check the wiring diagram in Appendix J for splice locations. If the short is not a splice, then isolate and repair the short.

WIRE CHECK PROCEDURES

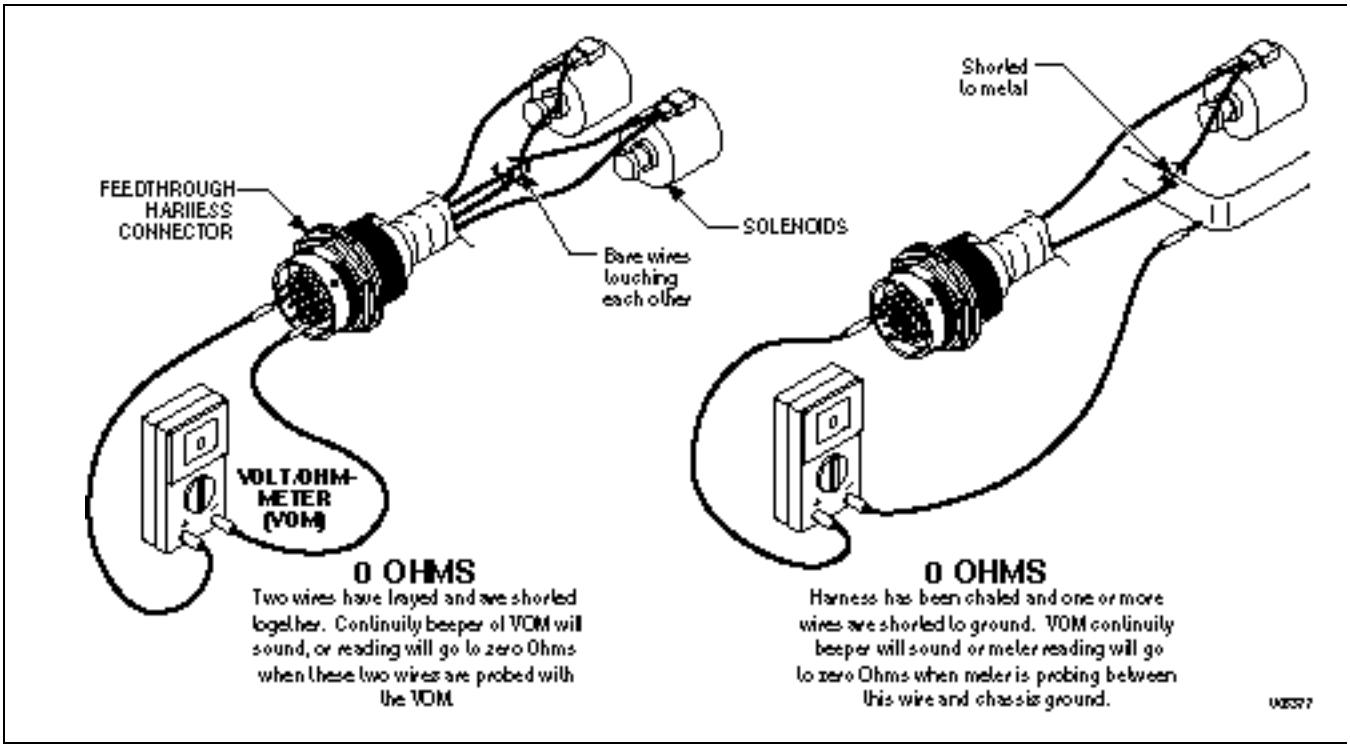


Figure 4–4. Short Between Wires and to Ground

NOTE: ***When conducting circuit checks that include the external harness, add one (1) Ohm to the values shown. Speed sensor resistance is 270–330 Ohms. C3 pressure switch resistance is two (2) Ohms maximum when switch is closed and 20,000 Ohms minimum when switch is open.***

SECTION 5 — DIAGNOSTIC CODES

5–1 DIAGNOSTIC CODE MEMORY

Diagnostic codes are logged in a list in memory (sometimes referred to as the queue), listing the most recently occurring code first and logging up to five codes. The codes contained in the list have information recorded as shown in the table below (codes are examples). Access to the code list position, main code, subcode and active indicator is through either the shift selector display or the Pro-Link® diagnostic tool. Access to ignition cycle counter and event counter information is through the diagnostic tool only. Further detail on the use of Pro-Link® 9000 DDR is presented in Appendix G of this manual.

Table 5–1. Code List

Code List Position	Main Code	Subcode	Active Indicator	Ignition Cycle Counter	Event Counter
d1	21	12	YES	00	10
d2	41	12	YES	00	04
d3	23	12	NO	08	02
d4	34	12	NO	13	01
d5	56	11	NO	22	02
Displayed on shift selector and diagnostic tool d = “diagnostic”			YES = LED indicator illuminated	Not available on shift selector display	

The following paragraphs define the different parts of the code list.

A. Code List Position. The position which a code occupies in the code list. Positions are displayed as “d1” through “d5” (Code List Position #1 through Code List Position #5).

B. Main Code. The general condition or area of fault detected by the ECU.

C. Subcode. The specific area or condition related to the main code in which a fault is detected.

D. Active Indicator. Indicates when a diagnostic code is active. The MODE indicator LED on the shift selector is illuminated or the diagnostic tool displays **YES**.

E. Ignition Cycle Counter. Determines when inactive diagnostic codes are automatically cleared from the code list. The counter is increased by one each time a normal ECU power down occurs (ignition turned off). Inactive codes are cleared from the code list after the counter exceeds 25.

F. Event Counter. Counts the number of occurrences of a diagnostic code. If a code is already in the code list and the code is again detected, that code is moved to position d1, the active indicator is turned on, the Ignition Cycle Counter is cleared, and 1 is added to the Event Counter.

5–2. CODE READING AND CODE CLEARING

Diagnostic codes can be read and cleared by two methods: by using the Pro-Link® 9000 diagnostic tool or by entering the diagnostic display mode and using the shift selector display. The use of the Pro-Link® 9000 diagnostic tool is described in the instruction manual furnished with each tool and briefly in Appendix G of this manual. The method of reading and clearing codes described in this section refers to entering the diagnostic display mode by the proper button movements on the shift selector.

DIAGNOSTIC CODES

The diagnostic display mode may be entered for viewing of codes at any speed. Active codes can only be cleared when the output speed = 0 and no output speed sensor failure is active.

A. Reading Codes. Enter the diagnostic display mode by pressing the ⇑ (Up) and ⇓ (Down) arrow buttons at the same time on a pushbutton selector, or by momentarily pressing the "display mode" button on a lever shift selector.

NOTE: If a DO NOT SHIFT condition is present (CHECK TRANS light illuminated) at this time, the shift selector may or may not respond to requested range changes.

NOTE: If an oil level sensor is present, then fluid level will be displayed first. Diagnostic code display is achieved by simultaneously depressing the ⇑ (Up) and ⇓ (Down) arrow buttons a second time or the "display mode" button a second time.

The code list or queue position is the first item displayed, followed by the main code and the subcode. Each item is displayed for about one second. The display cycles continuously until the next code list position is accessed by pressing the **MODE** button. The following list represents the display cycle using code 25 11 as an example:

1. Code list position — **d**, **1**
2. Main code — **2**, **5**
3. Subcode —**1**, **1**
4. Cycle repeats — **d**, **1**, **2**, **5**, **1**, **1**

To view the second, third, fourth, and fifth positions (d2, d3, d4, and d5), momentarily press the **MODE** button as explained above.

Momentarily press the **MODE** button after the fifth position is displayed to restart the sequence of code list positions.

An active code is indicated by the illumination of the LED indicator when a code position is displayed while in the diagnostic display mode. In the normal operating mode, the LED indicator illuminates to show a secondary mode operation.

Any code position which does not have a diagnostic code logged will display "–" for both the main and subcodes. No diagnostic codes are logged after an empty code position.

B. Clearing Active Indicators. A diagnostic code's active indicator can be cleared, which allows the code inhibit to be cleared but remains in the queue as inactive.

The active indicator clearing methods are:

1. Power down — All active indicators, except code 69 34 (refer to the code chart), are cleared at ECU power down.
2. Self-clearing — Some codes will clear their active indicator when the condition causing the code is no longer detected by the ECU.

DIAGNOSTIC CODES

3. Manual — Some active indicators can be cleared manually, while in the diagnostic display mode, after the condition causing the code is corrected.

CAUTION:	If an active indicator is cleared while the transmission is locked in a forward range or reverse (fail-to-range), the transmission will remain in the forward range or reverse after the clearing procedure is completed. Neutral must be manually selected.

C. Manually Clearing Codes and Active Indicators from the Code List. To clear active indicators or all codes:

1. Enter the diagnostic display mode.
2. Press and hold the **MODE** button for approximately three seconds until the LED indicator flashes. All active indicators are cleared. To remove all inactive codes, press and hold the **MODE** button for about ten seconds until the LED indicator flashes again. All active indicators will be cleared at ECU power down.
3. Codes that cannot be manually cleared will remain.

D. Exiting the diagnostic display mode. Exit the diagnostic display mode using one of the following procedures:

1. On a pushbutton shift selector, press the ⇑ (Up) and ⇓ (Down) arrow buttons at the same time or press any range button, **D**, **N**, or **R**. The shift (**D**, **N**, or **R**) is commanded if not inhibited by an active code.
2. On a lever shift selector, momentarily press the “display mode” button or move the shift lever to any shift position other than the one it was in when the diagnostic display mode was activated. If the shift is inhibited, the ECU will continue to command the current transmission range attained and the lever should be returned to its original position.
3. Wait until timeout (approximately 10 minutes) and the system will automatically return to the normal operating mode.
4. Turn off power to the ECU (turn off the vehicle engine at the ignition switch).

5–3. DIAGNOSTIC CODE RESPONSE

The following ECU responses to a fault provide for safe transmission operation:

- **D**o **N**ot **S**hift (DNS) Response
  - — Release lockup clutch and inhibit lockup operation.
  - — Inhibit all shifts.
  - — Turn on the **CHECK TRANS** light.
  - — Display the range attained.
  - — Ignore any range selection inputs from the pushbutton or lever shift selector.
- **D**o **N**ot **A**dapt (DNA) Response
  - — The ECU stops adaptive shift control while the code is active. Do not adapt shifts when a code with the DNA response is active.

DIAGNOSTIC CODES

- **SOL**enoid **OFF** (SOL OFF) Response
  - — All solenoids are commanded off (turning solenoids “A” and “B” off electrically causes them to be on hydraulically).
- **R**eturn to **P**revious **R**ange (RPR) Response
  - — When the speed sensor ratio or C3 pressure switch tests associated with a shift are not successful, the ECU commands the same range as commanded before the shift.
- **N**eutral **N**o **C**lutches (NNC) Response
  - — When certain speed sensor ratio or C3 pressure switch tests are not successful, the ECU commands a neutral condition with no clutches applied.

5–4. SHIFT SELECTOR DISPLAYS RELATED TO ACTIVE CODES

- “Cateye” — The forward slash segments and the middle horizontal segments (-\-) may be on under the following conditions:
  - — RSI link fault is active (code 23 12 or 23 14)
  - — When two COP timeouts occur within two seconds of each other (reference code 69 33)
  - — Shift selector display line fault is active (23 16)
- All Segments Displayed — All display segments will be illuminated if a severity 1 diagnostic code is present during initialization, or if an electrical code for solenoids A, B, C, D, E, or G is logged before initialization completes.

5–5. DIAGNOSTIC CODE LIST AND DESCRIPTION

Table 5–2. WT Series Diagnostic Codes

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
13 (0011 00-50)	12	ECU input voltage, low	Yes	DNS, DNA, SOL OFF (hydraulic default)
	13	ECU input voltage, medium low	No	DNA
	23	ECU input voltage, high	Yes	DNS, SOL OFF (hydraulic default)
14	12	Oil level sensor, failed low	No	None
(0011 00-53)	23	Oil level sensor, failed high	No	None
21	12	Throttle position sensor, failed low	No	Use throttle default values, DNA
(0011 00-56)	23	Throttle position sensor, failed high	No	Use throttle default values, DNA
22 (0011 00-59)	14	Engine speed sensor reasonableness test	No	Use default engine speed, DNA
	15	Turbine speed sensor reasonableness test	Yes	DNS, lock in current range, DNA
	16	Output speed sensor reasonableness test	Yes (1)	DNS, lock in current range, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
23 (0011 00-62)	12	Primary shift selector or RSI link fault	No	Hold in last valid direction. May cause “cateye” display.
	13	Primary shift selector mode function fault	No	Mode change not permitted
	14	Secondary shift selector or RSI link fault	No	Hold in last valid direction. May cause “cateye” display.
	15	Secondary shift selector mode function fault	No	Mode change not permitted
	16	Shift Selector display line fault	No	None. May cause “cateye” display.
24	12	Sump fluid temperature, cold	Yes	DNS, lock in neutral
(0011 00-64)	23	Sump fluid temperature, hot	No	No upshifts above a calibration range
25 (011 00-69)	00	Output speed sensor, detected at 0 output rpm, Low	Yes (1)	DNS, lock in current range (Low), DNA
	11	Output speed sensor, detected at 0 output rpm, 1st	Yes (1)	DNS, lock in current range (1st), DNA
	22	Output speed sensor, detected at 0 output rpm, 2nd	Yes (1)	DNS, lock in current range (2nd), DNA
	33	Output speed sensor, detected at 0 output rpm, 3rd	Yes (1)	DNS, lock in current range (3rd), DNA
	44	Output speed sensor, detected at 0 output rpm, 4th	Yes (1)	DNS, lock in current range (4th), DNA
	55	Output speed sensor, detected at 0 output rpm, 5th	Yes (1)	DNS, lock in current range (5th), DNA
	66	Output speed sensor, detected at 0 output rpm, 6th	Yes (1)	DNS, lock in current range (6th), DNA
	77	Output speed sensor, detected at 0 output rpm, Reverse range	Yes (1)	DNS, lock in current range (R), DNA
26	00	Throttle source not detected	No	Use throttle default values, DNA
(0011 00-71)	11	Engine coolant source not detected	No	Use default value of –18°C (0°F)
32	00	C3 pressure switch open, Low range	Yes	DNS, lock in current range (Low), DNA
(0011 00-73)	33	C3 pressure switch open, 3rd range	Yes	DNS, lock in current range (3rd), DNA
	55	C3 pressure switch open, 5th range	Yes	DNS, lock in current range (5th), DNA
	77	C3 pressure switch open, Reverse range	Yes	DNS, lock in current range (R), DNA
33 (0011 0-75)	12	Sump oil temperature sensor failed low	No	Use default value of 93°C (200°F)
	23	Sump oil temperature sensor failed high	No	Use default value of 93°C (200°F)

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
34 (0011 00-77)	12	Factory calibration compatibility number wrong	Yes(5)	DNS, SOL OFF (hydraulic default), DNA
	13	Factory calibration block checksum	Yes(5)	DNS, SOL OFF (hydraulic default), DNA
	14	Power off block checksum	No	Use previous location, or factory calibration and reset adaptive, DNA
	15	Diagnostic queue block checksum	No	Use previous location, or clear diagnostic queue, DNA
	16	Real time block checksum	Yes	DNS, SOL OFF (hydraulic default), DNA
	17	Customer modifiable constants checksum	Yes(5)	DNS, SOL OFF (hydraulic default), DNA
35 (0011 00-79)	00	Power interruption (code set after power restored)	No	None (hydraulic default during interruption)
	16	Real time write interruption	Yes	DNS, SOL OFF (hydraulic default), DNA
36 (0011 00-80)	00	Hardware/software not compatible	Yes (2)	DNS, SOL OFF (hydraulic default), DNA
	01	TID not compatible with hardware/ software	No(2)	Use TIDCAP cal
	02	TID did not complete	No	Use TIDCAP cal, code 42 XX or 69 XX may be logged
42	12	Short-to-battery, A solenoid circuit	Yes	DNS, SOL OFF, DNA
(0011 00-82)	13	Short-to-battery, B solenoid circuit	Yes	DNS, SOL OFF, DNA
	14	Short-to-battery, C solenoid circuit	Yes	DNS, SOL OFF, DNA
	15	Short-to-battery, D solenoid circuit	Yes	DNS, SOL OFF, DNA
	16	Short-to-battery, E solenoid circuit	Yes	DNS, SOL OFF, DNA
	21	Short-to-battery, F solenoid circuit	No	Lockup inhibited, DNA
	22	Short-to-battery, G solenoid circuit	Yes	DNS, SOL OFF, DNA
	23	Short-to-battery, H solenoid circuit	No	Differential lock inhibited (3070 only), retarder inhibited
	24	Short-to-battery, J solenoid circuit	No	Low and 1st inhibited
	26	Short-to-battery, N solenoid circuit	No	Low and 1st inhibited, allow retarder
44 (0011 00-86)	12	Short-to-ground, A solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	13	Short-to-ground, B solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	14	Short-to-ground, C solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	15	Short-to-ground, D solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	16	Short-to-ground, E solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	21	Short-to-ground, F solenoid circuit	No	Lockup inhibited, DNA
	22	Short-to-ground, G solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
44 *(cont'd)*	23	Short-to-ground, H solenoid circuit	No	Differential lock inhibited (3070 only), retarder operation inhibited
	24	Short-to-ground, J solenoid circuit	No	Low and 1st inhibited
	26	Short-to-ground, N solenoid circuit	No	Low and 1st inhibited, retarder allowed
45	12	Open circuit, A solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
(0011 00-90)	13	Open circuit, B solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	14	Open circuit, C solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	15	Open circuit, D solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	16	Open circuit, E solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	21	Open circuit, F solenoid circuit	No	Lockup inhibited, DNA
	22	Open circuit, G solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
	23	Open circuit, H solenoid circuit	No	Differential lock inhibited (3070 only), retarder inhibited
	24	Open circuit, J solenoid circuit	No	Low and 1st inhibited
	26	Open circuit, N solenoid circuit	No	Low and 1st inhibited, retarder allowed
46	21	Overcurrent, F solenoid circuit	No	Lockup inhibited, DNA
(0011 00-94)	26	Overcurrent, N and H solenoid circuit	No	Low and first inhibited or retarder inhibited, DNA
	27	Overcurrent, A-Hi solenoid circuit	Yes	DNS, SOL OFF (hydraulic default), DNA
51 (0011 00-95)	01	Offgoing ratio test (during shift), Low to 1	Yes	DNS, RPR, DNA
	10	Offgoing ratio test (during shift), 1 to Low	Yes	DNS, RPR, DNA
	12	Offgoing ratio test (during shift), 1 to 2	Yes	DNS, RPR, DNA
	21	Offgoing ratio test (during shift), 2 to 1	Yes	DNS, RPR, DNA
	23	Offgoing ratio test (during shift), 2 to 3	Yes	DNS, RPR, DNA
	24	Offgoing ratio test (during shift), 2 to 4	Yes	DNS, RPR, DNA
	35	Offgoing ratio test (during shift), 3 to 5	Yes	DNS, RPR, DNA
	42	Offgoing ratio test (during shift), 4 to 2	Yes	DNS, RPR, DNA
	43	Offgoing ratio test (during shift), 4 to 3	Yes (1)	DNS, RPR, DNA
	45	Offgoing ratio test (during shift), 4 to 5	Yes (1)	DNS, RPR, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
51 *(cont'd)*	46	Offgoing ratio test (during shift), 4 to 6	Yes	DNS, RPR, DNA
	53	Offgoing ratio test (during shift), 5 to 3	Yes	DNS, RPR, DNA
	64	Offgoing ratio test (during shift), 6 to 4	Yes	DNS, RPR, DNA
	65	Offgoing ratio test (during shift), 6 to 5	Yes	DNS, RPR, DNA
	XY	Offgoing ratio test, X to Y (3)		
52 (0011 00-97)	01	Offgoing C3PS test (during shift), Low to 1	Yes	DNS, RPR, DNA
	08	Offgoing C3PS test (during shift), Low to N1	Yes	DNS, NNC, DNA
	32	Offgoing C3PS test (during shift), 3 to 2	Yes	DNS, RPR, DNA
	34	Offgoing C3PS test (during shift), 3 to 4	Yes	DNS, RPR, DNA
	54	Offgoing C3PS test (during shift), 5 to 4	Yes	DNS, RPR, DNA
	56	Offgoing C3PS test (during shift), 5 to 6	Yes	DNS, RPR, DNA
	71	Offgoing C3PS test (during shift), R to 1	Yes	DNS, NNC, DNA
	72	Offgoing C3PS test (during shift), R to 2	Yes	DNS, NNC, DNA
	78	Offgoing C3PS test (during shift), R to N1	Yes	DNS, NNC, DNA
	99	Offgoing C3PS test (during shift), N3 to N2	Yes	DNS, RPR, DNA
	XY	Offgoing C3PS test, X to Y (3)		
53 (0011 00-99)	08	Offgoing speed test (during shift), L to N1	Yes (1)	DNS, NNC, DNA
	18	Offgoing speed test (during shift), 1 to N1	Yes (1)	DNS, NNC, DNA
	28	Offgoing speed test (during shift), 2 to N1	Yes (1)	DNS, NNC, DNA
	29	Offgoing speed test (during shift), 2 to N2	Yes (1)	DNS, RPR, DNA
	38	Offgoing speed test (during shift), 3 to N1	Yes (1)	DNS, NNC, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
53 *(cont'd)*	39	Offgoing speed test (during shift), 3 to N3	Yes (1)	DNS, RPR, DNA
	48	Offgoing speed test (during shift), 4 to N1	Yes (1)	DNS, NNC, DNA
	49	Offgoing speed test (during shift), 4 to N3	Yes (1)	DNS, RPR, DNA
	58	Offgoing speed test (during shift), 5 to N1	Yes (1)	DNS, NNC, DNA
	59	Offgoing speed test (during shift), 5 to N3	Yes (1)	DNS, RPR, DNA
	68	Offgoing speed test (during shift), 6 to N1	Yes (1)	DNS, NNC, DNA
	69	Offgoing speed test (during shift), 6 to N4	Yes (1)	DNS, RPR, DNA
	78	Offgoing speed test (during shift), R to N1	Yes	DNS, NNC, DNA
	99	Offgoing speed test (during shift), N2 to N3 or N3 to N2	Yes	DNS, RPR, DNA
	XY	Offgoing speed test (during shift), X to Y (3)		
54 (0011 00-101)	01	Oncoming ratio test (after shift), L to 1	Yes	DNS, RPR, DNA
	07	Oncoming ratio test (after shift), L to R	Yes	DNS, NNC, DNA
	10	Oncoming ratio test (after shift), 1 to L	Yes	DNS, RPR, DNA
	12	Oncoming ratio test (after shift), 1 to 2	Yes	DNS, RPR, DNA
	17	Oncoming ratio test (after shift), 1 to R	Yes	DNS, NNC, DNA
	21	Oncoming ratio test (after shift), 2 to 1	Yes	DNS, RPR, DNA
	23	Oncoming ratio test (after shift), 2 to 3	Yes	DNS, RPR, DNA
	24	Oncoming ratio test (during shift), 2 to 4	Yes	DNS, RPR, DNA
	27	Oncoming ratio test (after shift), 2 to R	Yes	DNS, RPR, DNA
	32	Oncoming ratio test (after shift), 3 to 2	Yes	DNS, RPR, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
54 *(cont'd)*	34	Oncoming ratio test (after shift), 3 to 4	Yes	DNS, RPR, DNA
	35	Oncoming ratio test (during shift), 3 to 5	Yes	DNS, RPR, DNA
	42	Oncoming ratio test (during shift), 4 to 2	Yes	DNS, RPR, DNA
	43	Oncoming ratio test (after shift), 4 to 3	Yes	DNS, RPR, DNA
	45	Oncoming ratio test (after shift), 4 to 5	Yes	DNS, RPR or SOL OFF (hydraulic default), DNA
	46	Oncoming ratio test (during shift), 4 to 6	Yes	DNS, RPR, DNA
	53	Oncoming ratio test (during shift), 5 to 3	Yes	DNS, RPR, DNA
	54	Oncoming ratio test (after shift), 5 to 4	Yes	DNS, RPR, DNA
	56	Oncoming ratio test (after shift), 5 to 6	Yes	DNS, RPR, DNA
	64	Oncoming ratio test (after shift), 6 to 4	Yes	DNS, RPR, DNA
	65	Oncoming ratio test (after shift), 6 to 5	Yes	DNS, RPR, DNA
	70	Oncoming ratio test (after shift), R to L	Yes	DNS, NNC, DNA
	71	Oncoming ratio test (after shift), R to 1	Yes	DNS, NNC, DNA
	72	Oncoming ratio test (after shift), R to 2	Yes	DNS, NNC, DNA
	80	Oncoming ratio test (after shift), N1 to L	Yes	DNS, RPR, DNA
	81	Oncoming ratio test (after shift), N1 to 1	Yes	DNS, RPR, DNA
	82	Oncoming ratio test (after shift), N1 to 2	Yes	DNS, RPR, DNA
	83	Oncoming ratio test (after shift), N1 to 3	Yes	DNS, RPR, DNA
	85	Oncoming ratio test (after shift), N1 to 5	Yes	DNS, RPR, DNA
	86	Oncoming ratio test (after shift), N1 to 6	Yes	DNS, RPR, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
54 *(cont'd)*	92	Oncoming ratio test (after shift), N2 to 2	Yes	DNS, RPR, DNA
	93	Oncoming ratio test (after shift), N3 to 3	Yes	DNS, RPR, DNA
	95	Oncoming ratio test (after shift), N3 to 5	Yes	DNS, RPR, DNA
	96	Oncoming ratio test (after shift), N4 to 6	Yes	DNS, RPR, DNA
	XY	Oncoming ratio test (after shift), X to Y (3)		
55 (0011 00-103)	07	Oncoming C3PS test (after shift), Low to R	Yes (1)	DNS, NNC, DNA
	17	Oncoming C3PS test (after shift), 1 to R	Yes (1)	DNS, NNC, DNA
	27	Oncoming C3PS test (after shift), 2 to R	Yes (1)	DNS, NNC, DNA
	87	Oncoming C3PS test (after shift), N1 to R	Yes	DNS, RPR, DNA
	97	Oncoming C3PS test (after shift), NVL to R	Yes (1)	DNS, NNC, DNA
	XY	Oncoming C3PS test (after shift), X to Y (3)		
56	00	Range verification test, L	Yes (1)	DNS, 1st, Low, or SOL OFF (Low), DNA
(0011 00-105)	11	Range verification ratio test, 1st	Yes	DNS, 6th, DNA
	22	Range verification ratio test, 2nd	Yes (1)	DNS, 6th or 5th, DNA
	33	Range verification ratio test, 3rd	Yes (1)	DNS, 5th or SOL OFF (4th), DNA
	44	Range verification ratio test, 4th	Yes	DNS, 3rd or 5th, DNA
	55	Range verification ratio test, 5th	Yes (1)	DNS, SOL OFF (5th) or 3rd, DNA
	66	Range verification ratio test, 6th	Yes	DNS, 5th, 3rd, or SOL OFF (3rd), DNA
	77	Range verification ratio test, R	Yes	DNS, N2 or N3, DNA
57	11	Range verification C3PS test, 1st	Yes	DNS, SOL OFF (3rd), DNA
(0011 00-107)	22	Range verification C3PS test, 2nd	Yes	DNS, 3rd, DNA
	44	Range verification C3PS test, 4th	Yes	DNS, 5th or SOL OFF (3rd), DNA
	66	Range verification C3PS test, 6th	Yes	DNS, SOL OFF (5th), DNA
	88	Range verification C3PS test, N1	Yes	DNS, N3, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
	99	Range verification C3PS test, N2 or N4	Yes	DNS, N3, DNA
61 (0011 00-108)	00	Retarder oil temperature, hot	No	None
62 (0011 00-110)	12	Retarder temperature sensor failed low	No	None
	23	Retarder temperature sensor failed high	No	None
	32	Engine coolant sensor failed low	No	Use default value of 0°F
	33	Engine coolant sensor failed high	No	Use default value of 0°F
63 (0011 00-113)	00	Input function fault	No	Does not prevent neutral to range shifts for Aux Function Range Inhibit-Special when two signals required are not “on” within 120 seconds of each other.
	26	Kickdown input failed on	No	Kickdown operation inhibited
	40	Service brake status input failed on	No	No auto Neutral to Drive shifts for refuse packer. (I/O package #41). No retarder if a TPS code is also active
	41	Pump/pack and a neutral general purpose input	No	No auto N–D shifts for refuse packer (I/O package #41)
64 (0011 00-114)	12	Retarder modulation request sensor failed low	No	Retarder operation inhibited
	23	Retarder modulation request sensor failed high	No	Retarder operation inhibited
		Engine rating too high	Yes	DNS, Lock-in-neutral, DNA
65 (0011 00-117)	00	Engine rating too high	Yes	DNS, Lock-in-neutral
66	00	Serial communications interface fault	No	Use default throttle values, DNA
(0011 00-118)	11	SCI engine coolant source fault	No	Use default value of 0°F
69	27	ECU, inoperative A-Hi switch	Yes	DNS, NNC, DNA
(0011 00-120)	28	ECU, inoperative F-Hi switch	Yes	Lockup inhibited, DNA
	29	ECU, inoperative N and H-Hi switch	No	Low and first inhibited, retarder inhibited, DNA

DIAGNOSTIC CODES

Table 5–2. WT Series Diagnostic Codes (Continued)

Main Code	Sub-code	Description	CHECK TRANS Light	Inhibited Operation Description
69 *(cont'd)*	33	ECU, Computer Operating Properly (COP) timeout	No	Reset ECU, shutdown ECU on 2nd occurrence (power loss; hydraulic defaults). May cause "cateye" display or all segments blank display, DNA[4]
	34	ECU, write timeout	Yes	DNS, SOL OFF (hydraulic default), DNA
	35	ECU, checksum test	No	Induce COP timeout (reset ECU), DNA[4]
	36	ECU, RAM self test	No	Induce COP timeout (reset ECU), DNA[4]
	39	Communication chip addressing error	No	Use defaults for J1939 data, DNA
	41	ECU, I/O ASIC addressing test	No	Induce COP timeout (reset ECU), DNA[4]
	42	SPI output failure	Yes	GPO 1–8 and reverse warning inoperable
	43	SPI input failure	Yes	DNS, lock-in-range, DNA
70	12	Software, minor loop overrun	No	Induce COP timeout (reset ECU)
	13	Illegal write to address $0000	No	Induce COP timeout (reset ECU)
	14	Software, major loop overrun	No	Induce COP timeout (reset ECU)

NOTES

(1) This code is logged to real time to protect the transmission in case a loss of power to the ECU (Power Interruption, code 35 00) occurs.

(2) The ECU hardware or software must be changed so that they are compatible.

(3) Additional codes could be logged for other shifts where X indicates range shifted from and Y indicates range shifted to.

(4) The COP reset will clear the active inhibit.

(5) The factory calibration must be rewritten to the ECU, or a different factory calibration is required to match the software in the ECU.

TRANSMISSION COMPONENT WIRING DIAGRAMS AND DIAGNOSTICS

DIAGNOSTIC CODES

5–6. DIAGNOSTIC CODE TROUBLESHOOTING

A. Beginning The Troubleshooting Process

1. Begin troubleshooting by checking the transmission fluid level and ECU input voltage. Check diagnostic codes by:

   - Using the shift selector display.
   - Using the Pro-Link® 9000 diagnostic tool.

2. When a problem exists but a diagnostic code is not indicated, refer to the Performance Complaint Section for a listing of various electrical and hydraulic problems, their causes, and remedies.

3. If a diagnostic code is found in the ECU memory, record all available code information and clear the active indicator (refer to Paragraph 5–2).

4. Test drive the vehicle to confirm a diagnostic code or performance complaint.

   - If the code reappears, refer to the Diagnostic Code section (Section 6) and the appropriate code chart. The Diagnostic Code section lists diagnostic codes and their description. Locate the appropriate troubleshooting chart and follow the instructions.
   - If the code does not reappear, it may be an intermittent problem. Use the Pro-Link® and the code display procedure described in Section 5. The code display procedure will indicate the number of times the diagnostic code has occurred. Refer to the troubleshooting chart for possible cause(s) of the problem.
   - Appendix A deals with the identification of potential circuit problems. Refer to Appendix A if a circuit problem is suspected.

NOTE: Information concerning specific items is contained in the appendices located in the back of this manual. The appendices are referred to throughout the manual.

B. Solenoid Locations

Solenoid locations in the control module are as illustrated in Figure 5–1. Refer to Figure 5–1 as necessary when using the diagnostic code schematics.

C. Diagnostic Code Schematics

The diagnostic code schematics in this section show wiring for both the optional oil level sensor and retarder, where applicable. If your transmission is not equipped with an oil level sensor or retarder, disregard the portions of the schematic pertaining to those optional pieces of equipment. Refer to the appropriate transmission Service Manual for solenoid replacement procedures.

D. Wire/Terminal Numbering Scheme

WTEC III wire identification presents the wire number followed by the ECU terminal source (i.e., 157-S30). This is done to retain the wire number/function assignments from WTEC II and indicate the ECU connector and terminal origination for WTEC III. If there is a letter suffix following the wire number, there is a splice between the ECU source and wire destination (i.e., 136A-S16).

DIAGNOSTIC CODES

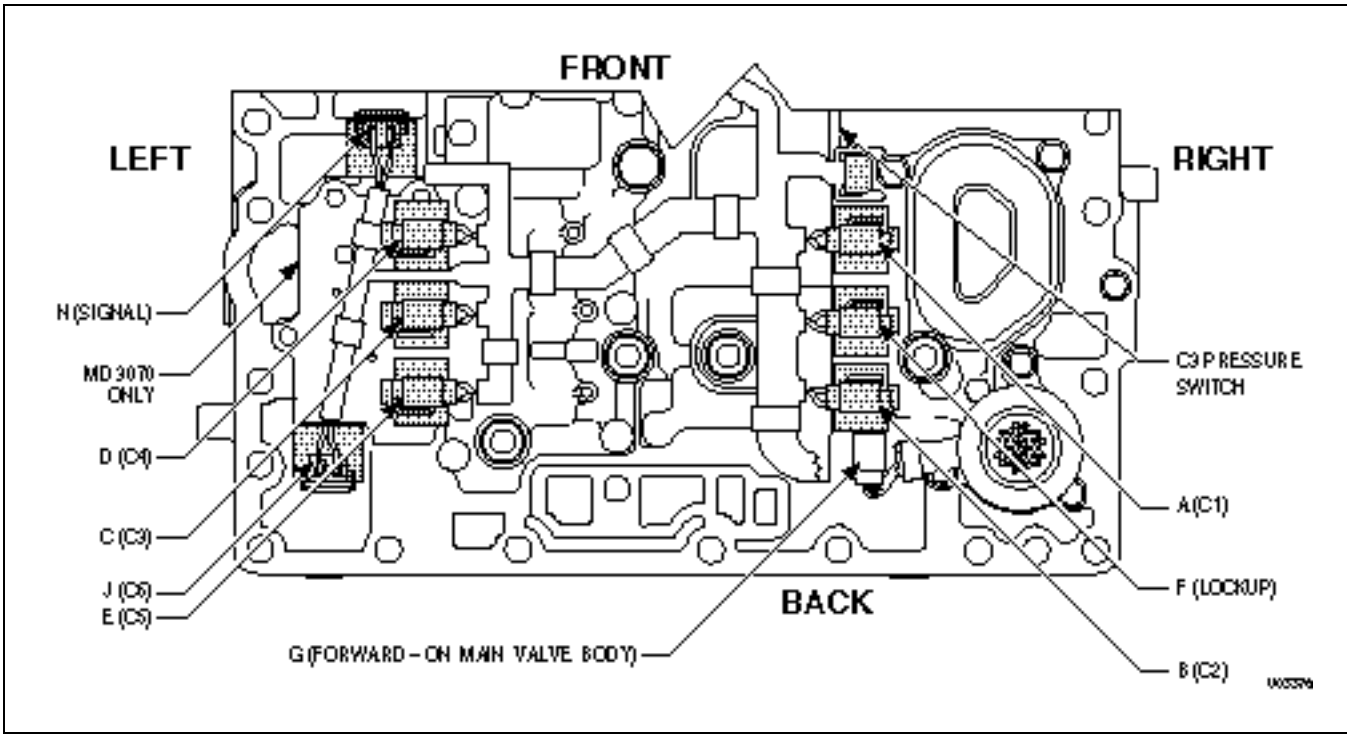


Figure 5–1. Control Module Solenoid Location

CODE 13 XX — ECU INPUT VOLTAGE

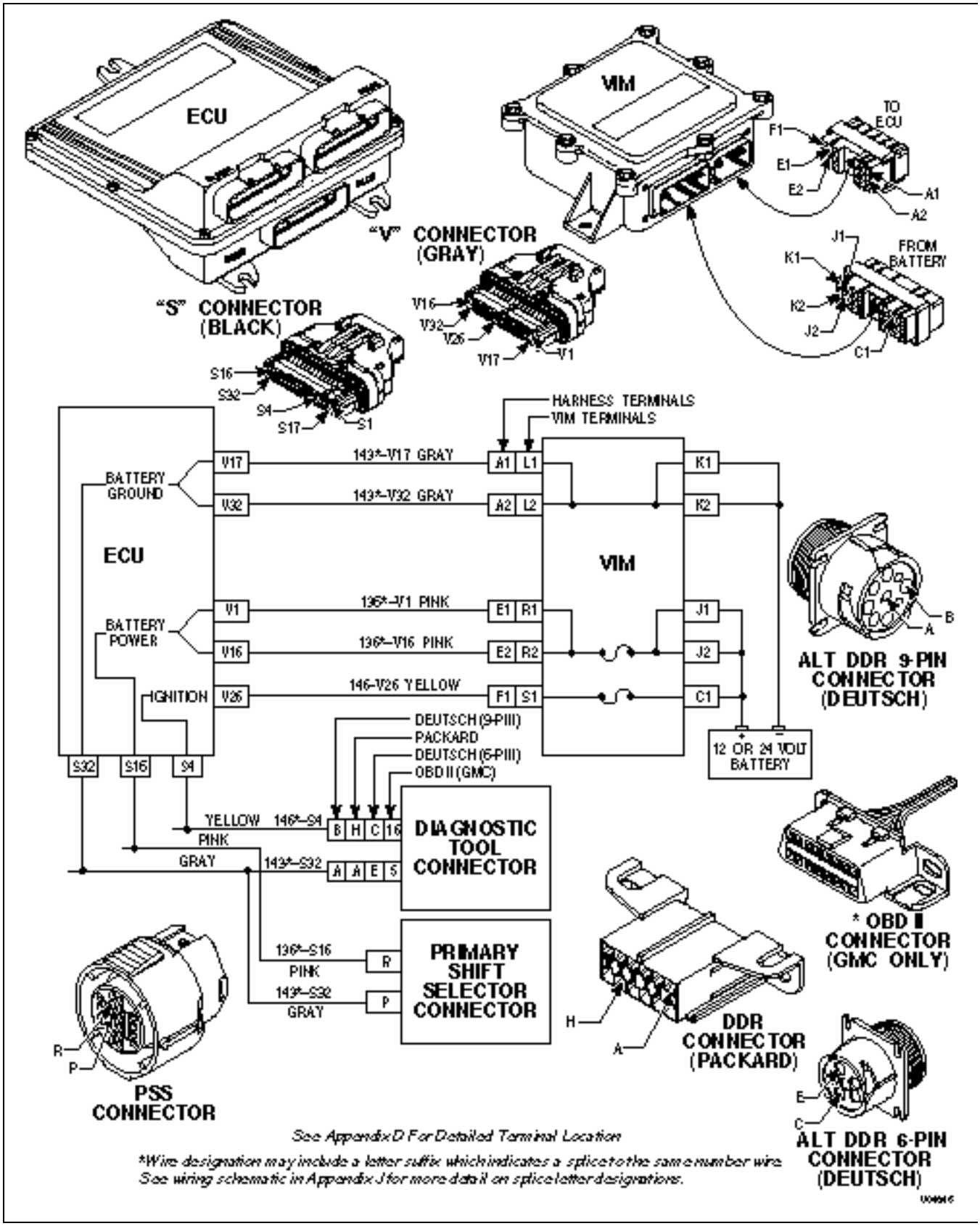


Figure 5–2. Code 13 Schematic Drawing

CODE 13 XX — ECU INPUT VOLTAGE *(Figure 5–2)*

Main code 13 indicates either a high or low input voltage. Low voltage is less than 8 volts. High voltage is over 33 volts.

Common causes for a low voltage code are:

- Bad batteries
- Faulty vehicle charging system
- No dedicated power and ground connection directly to the battery or through an electronic bus bar to the battery

Common causes for the high voltage code are:

- Faulty vehicle alternator
- Faulty vehicle voltage regulator

In the event of a power loss, the transmission fails to the ranges indicated in the following, depending upon which latch valve releases first:

Attained Range	Fail to Range
Reverse and neutral	Neutral
Low, 1	3C
2, 3, 4	4C usually, 3C sometimes
5	4C usually, 5C sometimes
6	5C

Main Code	Subcode	Meaning
13	12	Battery voltage to the ECU too low
13	13	Battery voltage to the ECU too low (medium)
13	23	Battery voltage to the ECU too high

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

B. Troubleshooting:

1. Connect the diagnostic tool and turn on vehicle ignition. Select Diagnostic Data to find input voltage. Record reading.

2. Turn off vehicle ignition and remove the connectors from the ECU.

3. Check system voltage at wire 136A and 136C, pin V1 and V16. If power is low or high at this point, and the diagnostic tool reading is also low or high, the vehicle wiring is suspect. Check for fuse problems, lack of battery-direct power and ground, faulty charging system/batteries, and loose or dirty connections (see Appendix A). Power may also be low or high at pins V1 and V16 (system power) if the batteries/charging system is faulty. Bad grounds may also cause incorrect input power readings.

CODE 13 XX — ECU INPUT VOLTAGE *(Figure 5–2)*

4. If power is correct but the diagnostic tool reading indicates incorrect voltage, closely inspect terminals V1 and V16 or S16; make sure they are not corroded or deformed. Clean or replace as necessary.
5. If the voltage condition is intermittent, closely inspect the vehicle wiring for transmission system power and grounds. Check for loose, dirty, or painted connections. Check the VIM for loose, incorrect, or overheating relays or fuses (refer to Appendix E). Check for wires that are chafed and touching other components.
6. If no other cause is found, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

Table 5–3. Voltage Chart

Voltage	Condition
33.0 (High Set Point)	High Fail Limit
32.0	Maximum Continuous ECU Voltage
10.0 (Medium Low Set Point)	Cannot Compensate With Sub-Modulation (Bad Shifts). Adaptive logic stops functioning
8.0	Low Voltage Fail Limit, Set Code, DNS
7.0 (Low Set Point)	Software Off (ECU loses power)
4.5	Neutral Start Off

CODE 14 XX — OIL LEVEL SENSOR (OLS)

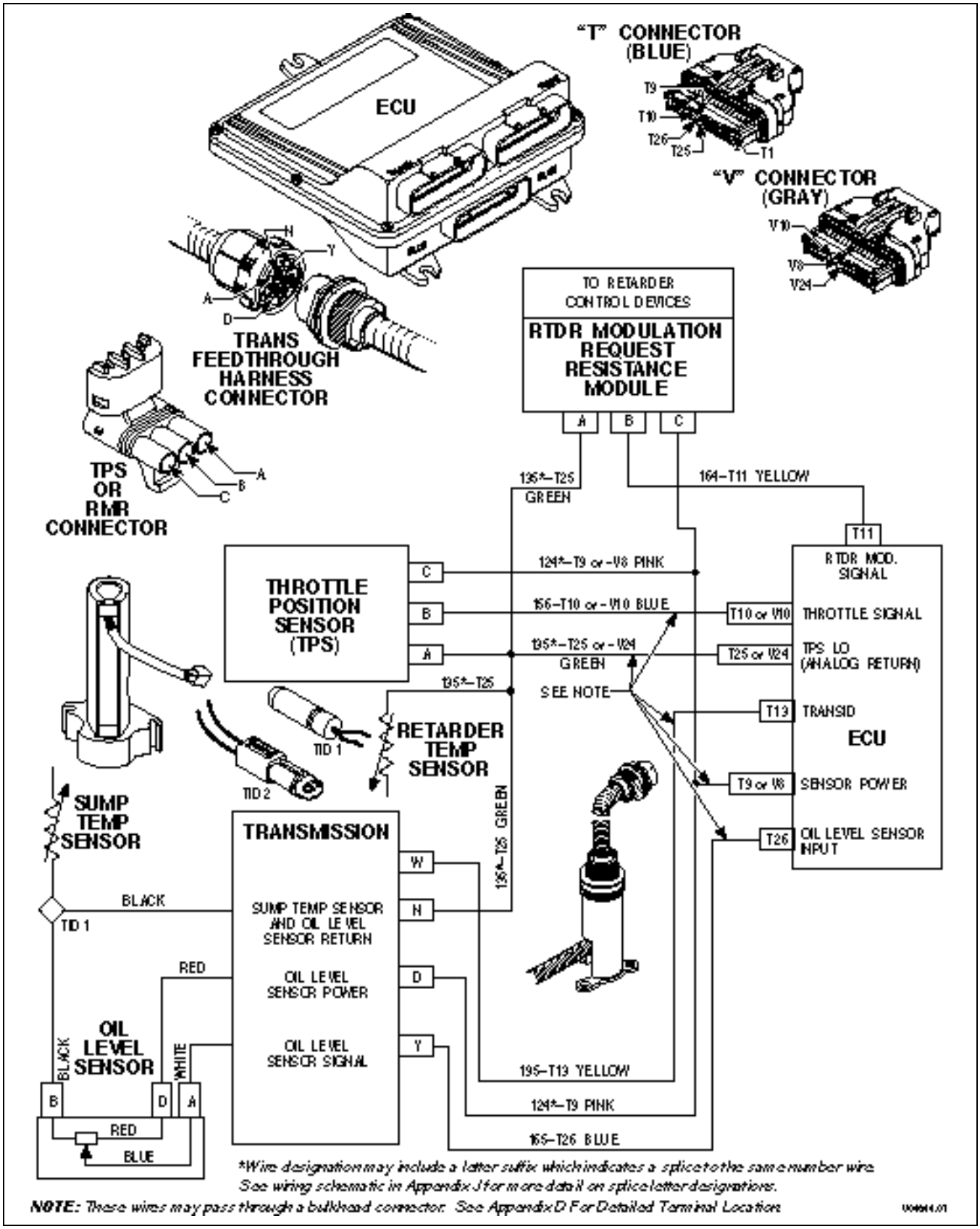


Figure 5–3. Code 14 Schematic Drawing

CODE 14 XX — OIL LEVEL SENSOR (OLS) *(Figure 5–3)*

The oil level sensor (OLS) must have been recognized by autodetect or manually selected using the Pro-Link® (see WTEC III Pro-Link® Manual) before these codes can be logged.

Code 14 12 indicates the ECU has detected a voltage signal in the low error zone.

Code 14 12 can be caused by:

- Faulty wiring to the OLS
- A faulty OLS
- A faulty ECU

CAUTION:	Never use a volt/ohmmeter to measure any parameters on the OLS. Damage to the OLS will result.

OLS ground wire 135B is common to the TPS and the RMR devices. A power wire short-to-ground for any of these devices will cause “sensor failed low” codes (21 12 and 64 12) and shutdown of the electronic pushbutton or lever selector. An OLS signal open or short-to-ground results in a code 14 12 only. Code 14 23 is programmed out of all calibrations.

A permanent maximum voltage signal generates a steady OLS sensor maximum count and a maximum fluid level overfill indication. A maximum overfill indication occurs if signal wire 165 or power wire 124 is shorted to battery or the ground wire (wire 135) is open between the OLS and the sump temperature sensor branch. An open in the ground circuit wire 135 in the portion common to the OLS, TPS and RMR devices results in code 14 12, 21 23, and 64 23.

If the ECU software supports it, Oil Level Sensor counts can be read by a DDR with Pro-Link® version 3.0 (or later). For a complete description of fluid level checking procedures using the oil level sensor, see Section 5. Normal operation of the OLS can be checked as follows: Attach the DDR and display OIL LEVEL COUNTS. Read the number of counts when the engine is not running, but the ignition is ON. The count reading should be near 255. Start the engine and observe the counts. In normal operation, the count should be 100–200 because the oil level drops when the engine starts and oil from the sump is delivered to other parts of the transmission.

NOTE: Intermittent connections or lack of battery-direct power and ground connections can cause this and other electronic control codes.

Main Code	Subcode	Meaning
14	12	Oil level sensor failed low
14	23	Oil level sensor failed high (not used)

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

CODE 14 XX — OIL LEVEL SENSOR (OLS) *(Figure 5–3)*

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check the following:

- ***Fluid level, using dipstick***
- ***Battery voltage***
- ***ECU input voltage***
- ***Other diagnostic codes***

B. Troubleshooting:

The following procedure is to find the cause for an OLS problem. The procedure is sequential. Follow the procedure until the cause for the OLS problem is found and repaired. Once the problem is found and repaired, STOP. For example, if the problem is fixed in step 3, there is no need to continue to the other steps.

1. Disconnect the external wiring harness at the transmission feedthrough connector. With the ignition ON, verify there is 5.0 VDC between the OLS power and ground pins (see page D–10) on the external harness connector. This is to verify that power and ground are getting to the OLS. If the 5.0 VDC is not present, check the wiring for the OLS power and ground circuits (wires 124–T9 and 135–T25, respectively). If there are no wiring problems (opens, shorts-to-ground, shorts-to-battery), and if the 5.0 VDC is present, go to Step 2.

2. Observe the OIL LEVEL COUNTS on the DDR while jumpering the OLS power pin to the OLS signal pin. If the count jumps from 0 to 250+, the OLS signal line is good and the ECU function is good. Continue to Step 3. If the count remains at zero, locate and repair problems in the wiring of OLS signal (wire 165–T26). If there are no wiring problems, and the count still remains at zero, the ECU may be bad. Go to Step 5.

3. If all checks prior to this have been normal, the problem is either in the OLS itself, the internal harness wires or the transmission side of the feedthrough harness connection. Inspect the transmission feedthrough harness connector to be sure that the OLS power, ground and signal pins are not loose or out of position. Correct any connector problems found. Reconnect the external harness to the transmission feedthrough harness connector. See if Code 14 12 recurs before continuing to Step 4.

4. Consult the appropriate transmission Service Manual for proper procedure and remove the control module from the transmission. Remove the OLS from the channel plate. Reconnect the external harness to the transmission feedthrough connector, if not done in Step 3. With the ignition ON, observe OIL LEVEL COUNTS on the DDR. With the OLS in normal position, the count should be 8–35. Invert the OLS and the count should be 192–255. If the counts are abnormal, replace the sensor. Check the new sensor in both normal and inverted positions. If the counts respond correctly, the problem should be resolved. Attach the new OLS to the channel plate and reinstall the control module using the appropriate transmission Service Manual for proper procedure.

5. Replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 21 XX — THROTTLE OR PWM FAULT

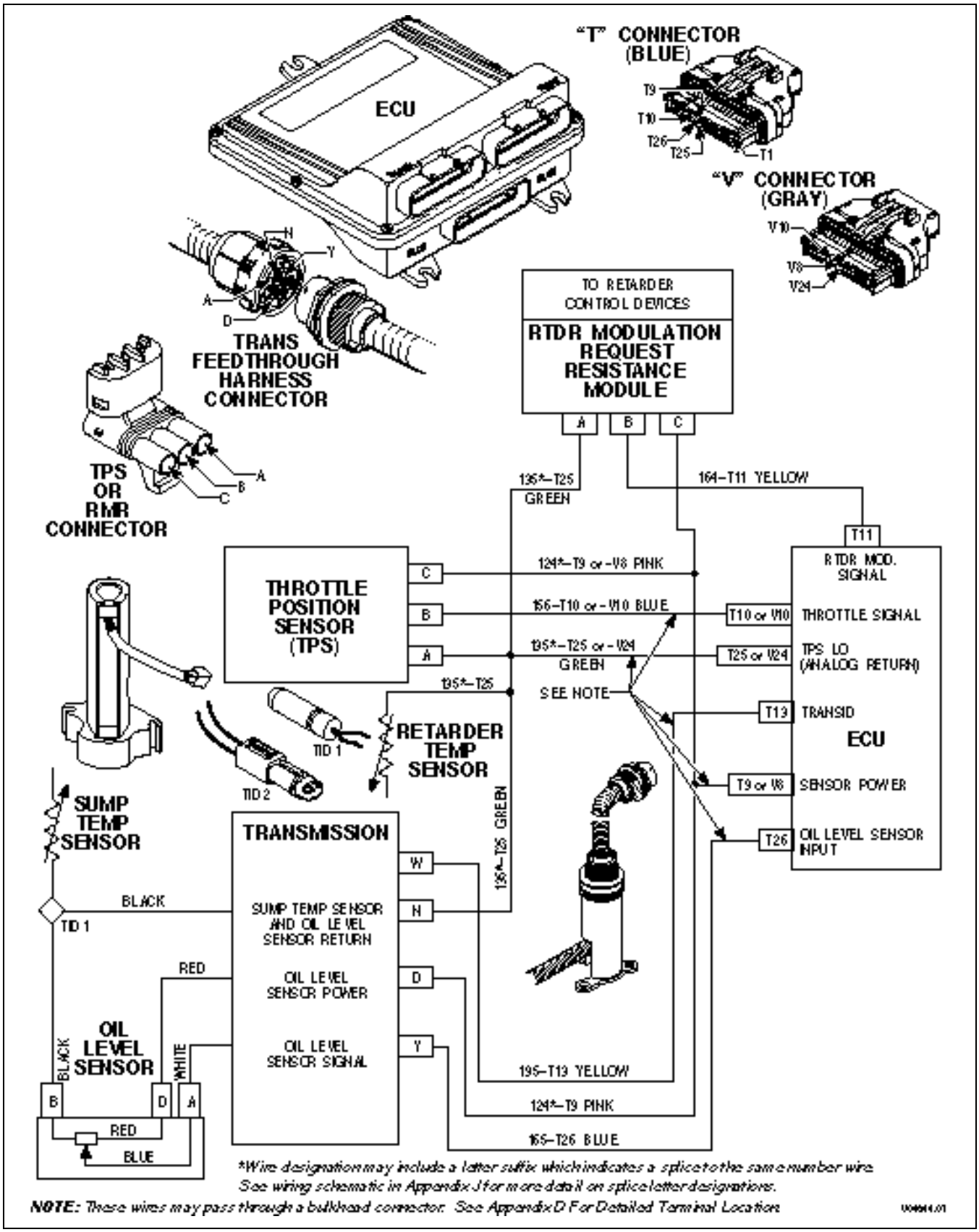


Figure 5–4. Code 21 Schematic Drawing

CODE 21 XX — THROTTLE OR PWM FAULT *(Figure 5–4)*

The throttle sensor must have been recognized by autodetect or manually selected using the Pro-Link® (see WTEC III Pro-Link® Manual) before these codes can be logged. See Paragraph 1–9 for further information.

Main code 21 indicates the throttle position sensor has been retracted or extended by its linkage into an error zone. This may be due to a fault with the sensor, or a fault in the wiring to the sensor or to the ECU. This code may also indicate a PWM signal problem. A PWM signal is proportional to throttle position and comes from some source other than an analog throttle position sensor. Code 21 12 is set when the ECU receives TPS counts of 14 or less. Code 21 23 is set when the ECU senses TPS counts of 233–255. Whenever a code 21 XX condition is detected, the system uses default throttle values and shifts will not adapt.

NOTE: Code 21 XX in conjunction with code 33 XX or code 14 XX indicates the potential loss of common ground wire 135 between the throttle, temperature sensor, and oil level sensor.

Main Code	Subcode	Meaning
21	12	Throttle position sensor failed low and ECU signals throttle default value
21	23	Throttle position sensor failed high and ECU signals a throttle default value

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check the ECU input voltage.

B. Troubleshooting:

1. Plug in the DDR, select Diagnostic Data, and read throttle counts and percent. If the TPS failed high (code 21 23), the problem may be toward the full throttle end of the TPS travel. If the TPS failed low (code 21 12), the problem may be at the closed throttle end of the TPS travel.

NOTE: Code 21 12 may occur when the throttle source is J1587 or J1939 and an analog throttle source is falsely detected. This condition may be due to a problem in an unused TPS branch of a universal external harness. To prevent this occurrence, remove wire 156 from the ECU connector and insert a cavity plug in the space vacated by the wire. Be sure that the unused TPS branch is routed away from potential induced voltage sources and the connector is protected from external contamination.

NOTE: Code 21 12 can result when the +5V line (wire 124) which powers the analog sensor is shorted to ground. Wire 124 also powers the OLS, RMR, retarder temperature sensor, sump temperature sensor, and shift selector and is present in all three ECU connectors.

2. If counts are high but the percentage never reaches 100 percent, TPS linkage may have bound up and overstroked the TPS to set a false 100 percent reading. After TPS overstroking ceases, the TPS will not automatically return to 100 percent. After the TPS is correctly installed and adjusted, use the Pro-Link® to reset throttle calibration or cycle the ignition 5 times to reset the 0 percent and 100 percent settings.

CODE 21 XX — THROTTLE OR PWM FAULT *(Figure 5–4)*

3. If the throttle counts do not change or are erratic, check the throttle sensor wiring for opens, shorts between wires, or shorts-to-ground. Also check for correct TPS voltages using test wiring harness J41339. If wiring problems are found, isolate and repair the fault.

4. If the wiring is satisfactory, replace the throttle position sensor and adjust its linkage so the counts are not in the error zones.

5. If the throttle sensor and its linkage adjustment are correct and the wiring to the sensor is satisfactory, the condition is intermittent. Replace the sensor and properly adjust the new sensor.

6. If the condition recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the throttle sensor circuit.

7. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

NOTE: A good throttle position sensor should have resistance of:

(1) 9000–15,000 Ohms across terminals A and C.

(2) 500 Ohms, moving to 9000–15,000 Ohms as TPS is stroked (measured across terminals A and B).

CODE 22 XX — SPEED SENSOR/CIRCUITRY FAULT

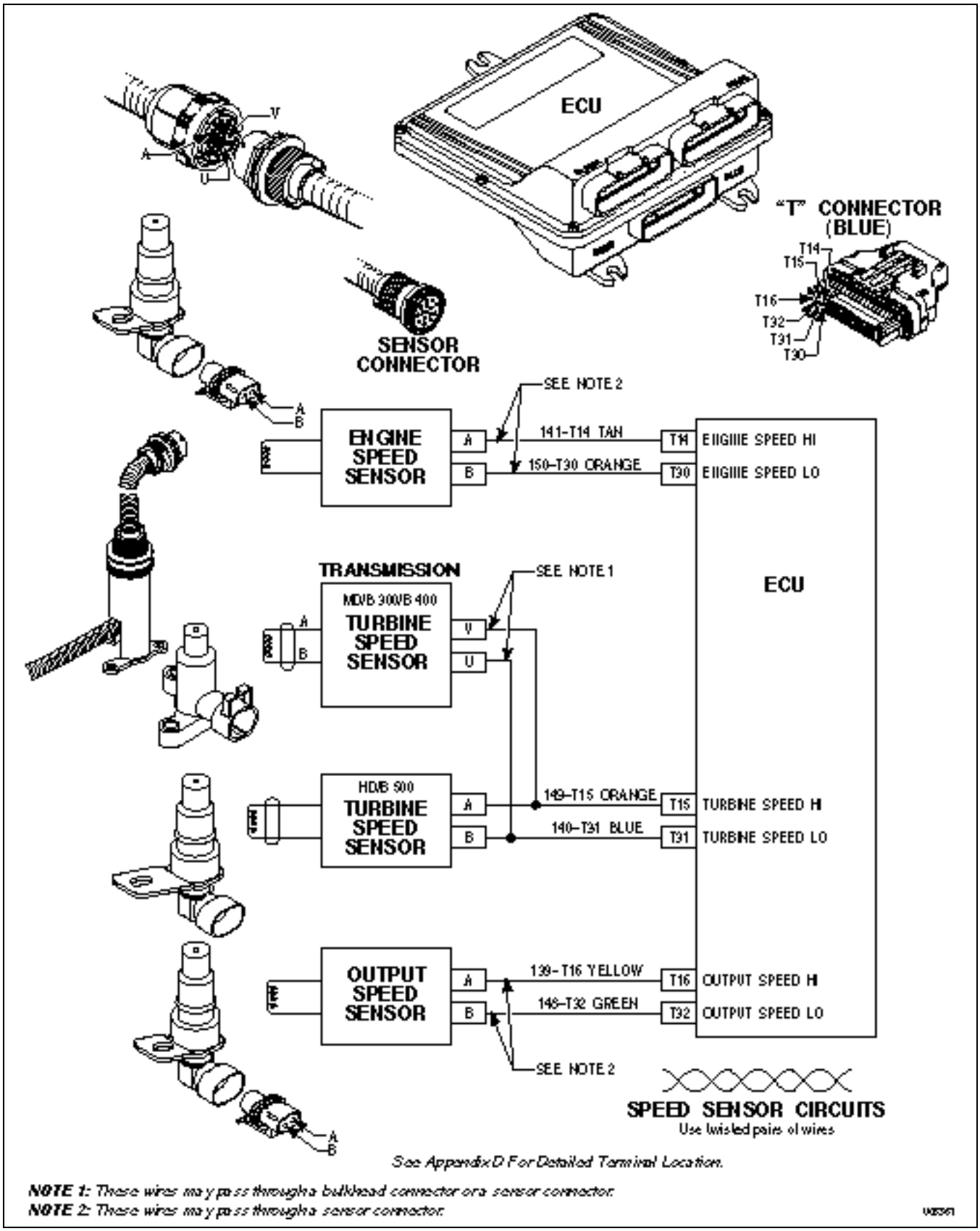


Figure 5–5. Code 22 Schematic Drawing

CODE 22 XX — SPEED SENSOR/CIRCUITRY FAULT *(Figure 5–5)*

Main code 22 indicates a fault within a speed sensor, the wiring to a speed sensor, incorrect speed sensor gap, or damaged bumps or teeth which create the speed signal. This fault is determined by the reasonableness of a speed sensor signal when compared with the other two speed sensors and the commanded range. A speed sensor will not pass the reasonableness test if there is no signal at all from that sensor when a signal should be present.

NOTE: If turbine speed is below 150 rpm when output speed is below 100 rpm and engine speed is above 400rpm, Neutral Very Low (NVL) is commanded when N (Neutral) is the range selected. NVL is attained by turning D solenoid "ON" in addition to E solenoid. This causes the output to be locked (C4and C5 clutch applied).

NOTE: If the engine speed sensor code (2214) is active and a range verification test is failed, the range verification code will not be set but a DO NOT SHIFT response is commanded.

Main Code	Subcode	Failed Sensor
22	14	Engine Speed
22	15	Turbine Speed
22	16	Output Speed

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check the ECU input voltage.

B. Troubleshooting:

1. Check to see if the sensor is loose, missing, or disconnected. If not, disconnect the wiring harness from the sensor and measure the resistance of the sensor (see chart below). Also check the terminals for dirt, corrosion, or damage. If resistance is not correct, replace the sensor.

Resistance	Temp °C	Temp °F
200 ¾	–40	–40
300 ¾	20	68
400 ¾	110	230

2. Remove the transmission harness connector from the ECU. Check the sensor circuit (in the external harness) for open wires, shorts between wires, or shorts-to-ground. Isolate and repair any faults.

3. If no opens or shorts are found, the condition must be intermittent. Replace the sensor indicated by the trouble code. Before replacing a speed sensor, check the sensor for physical damage or contamination. Refer to the appropriate transmission Service Manual for proper replacement procedure.

4. If the condition recurs, install new wiring (twisted-pair) for the sensor circuit between the ECU and the transmission. Use St. Clair P/N 200153 Service Harness Twisted Pair for this purpose.

CODE 22 XX — SPEED SENSOR/CIRCUITRY FAULT *(Figure 5–5)*

5. If the condition again recurs, connect the diagnostic tool and select the speed signal indicated by the trouble code. Drive the vehicle and watch the speed reading on the diagnostic tool. If the signal is erratic, sensor gap, vehicle vibration, an external AC signal source, or intermittent connector contact may be inducing the erratic signal. Inspect the sensor and its surroundings for irregularities that would affect sensor gap. Isolate and correct any abnormal vehicle vibrations (particularly driveline and abnormal engine torsionals. Recheck the sensor wiring for intermittent conditions (see Appendix A).
6. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 23 XX — SHIFT SELECTOR

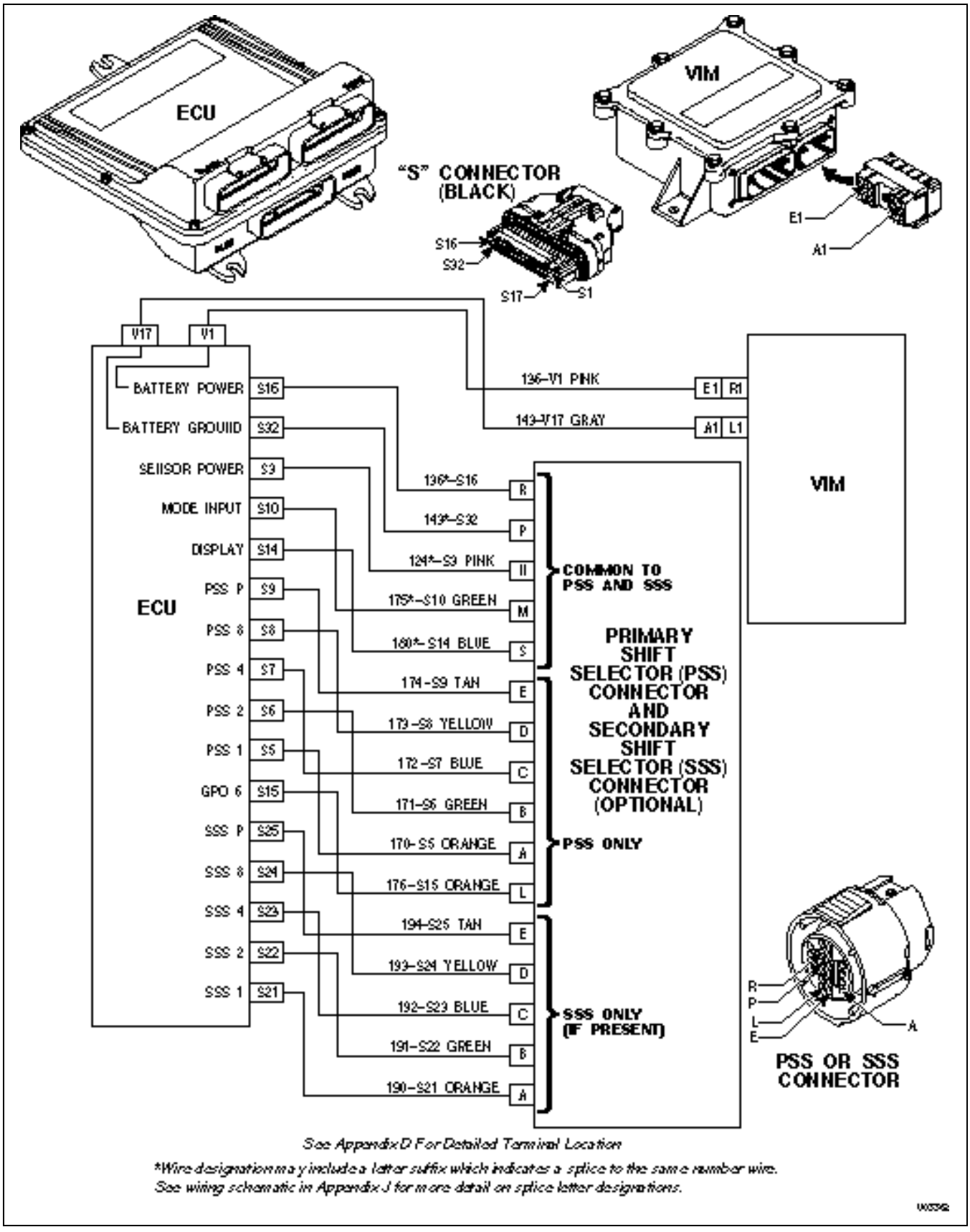


Figure 5–6. Code 23 Schematic Drawing

CODE 23 XX — SHIFT SELECTOR *(Figure 5–6)*

Main code 23 indicates a fault with a shift selector or the wiring between a shift selector and the ECU.

Main Code	Subcode	Meaning
23	12	Primary shift selector fault — a “cateye” type display may occur
23	13	Primary shift selector mode function fault. Mode change not permitted
23	14	Secondary shift selector fault — a “cateye” type display may occur
23	15	Secondary shift selector mode function fault. Mode change not permitted
23	16	Shift selector display line fault

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6.

B. Troubleshooting:

1. Clear the active indicator for code 23XX. If code recurs, continue to Step (2).
2. Check for a poor connection at the shift selector.

NOTE: Code 23 12 can result when the +5V line (wire 124) which powers the shift selector is shorted to ground. Wire 124 also powers the TPS, OLS, RMR, retarder temperature sensor, and sump oil temperature sensor and is present in all three ECU connectors.

3. Disconnect the selector “S” harness connector from the ECU and from the shift selector and check for opens, shorts, and shorts-to-ground between the shift selector and ECU (refer to Section 4).
4. If no problem is found with the shift selector connection or wiring, replace the shift selector.
5. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 24 XX — SUMP FLUID TEMPERATURE

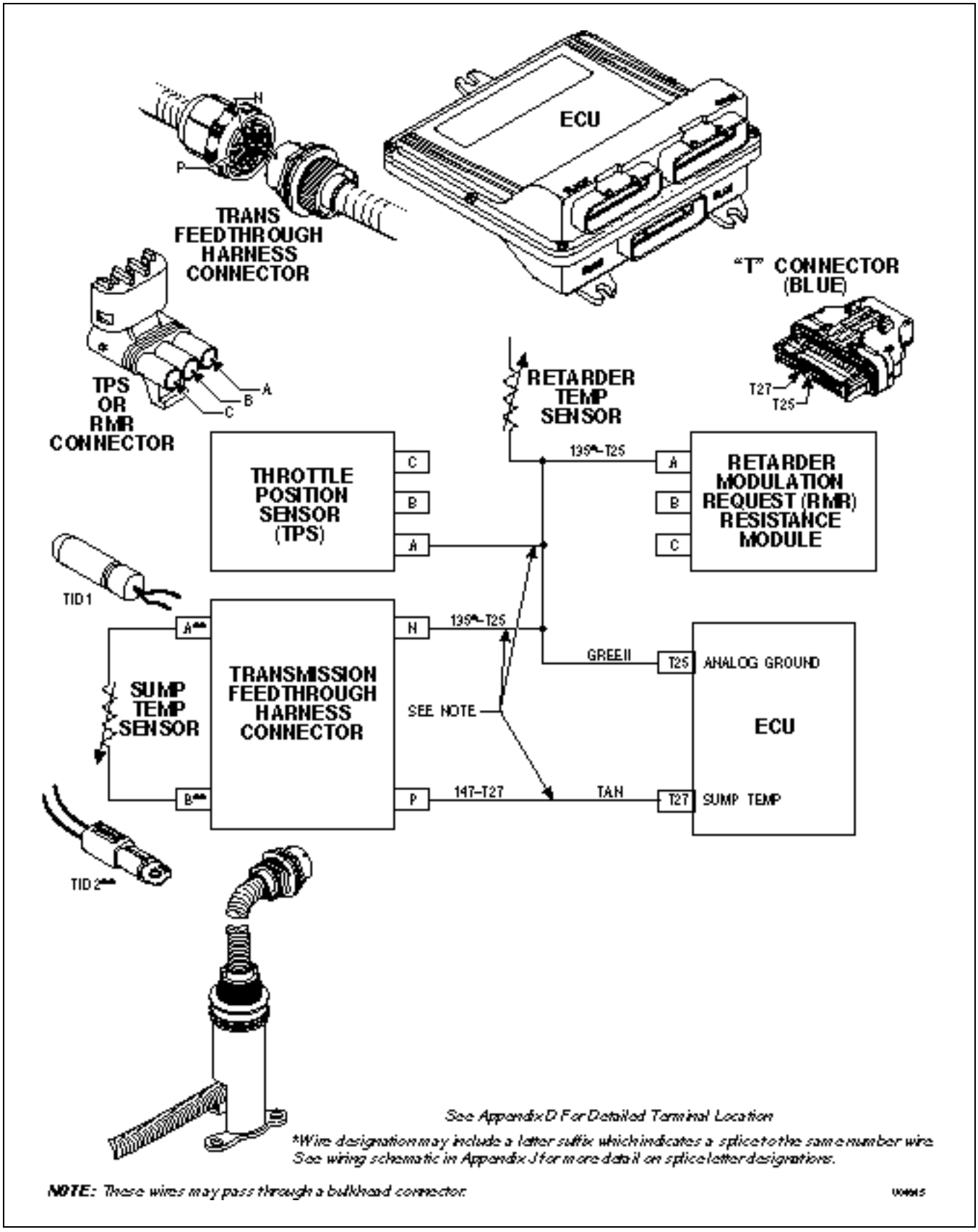


Figure 5–7. Code 24 Schematic Drawing

CODE 24 XX — SUMP FLUID TEMPERATURE *(Figure 5–7)*

Main code 24 indicates the ECU has detected either a high or low fluid temperature in the transmission sump (via the sump temperature sensor in the internal harness). All shifts are inhibited when code 2412 is set (only Neutral range operation is allowed). No upshifts are allowed above a calibration range when code 2423 is set. All inhibits are cleared when the temperature conditions are normal. A related code is 3312 which indicates a temperature reading outside the usable range of the sensor and indicates a probable sensor failure.

NOTE: When an ECU with a version 8 calibration (CIN=0A...) is used with a TransID 2 transmission, 24 XX codes are set because the ECU does not have the proper calibrations for the TID 2 thermistors. The ECU calibration must be updated to version 8A or later (CIN=0B).

Main Code	Subcode	Meaning
24	12	Sump fluid temperature cold
24	23	Sump fluid temperature hot

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check the ECU input voltage.

B. Troubleshooting:

Code 24 12:

1. If the outside temperature is between –32°C (–26°F) and –7°C (+19°F), the ECU will allow reverse, neutral, and second-range start operation. Only hold override upshifts are allowed. (See Table 6–4 on next page.) The sump must be warmed to an acceptable temperature to avoid logging codes and transmission diagnostic response.

NOTE: Code 24 12 can result when the +5V line (wire 124) which powers the sump temperature sensor is shorted to ground. Wire 124 also powers the TPS, OLS, RMR, retarder temperature sensor, and shift selectors and is present in all three ECU connectors.

2. After allowing the temperatures to normalize, if ambient temperature does not match the sump temperature reading (check using diagnostic tool), compare resistance versus sump fluid temperature. Refer to Figure 5–8 for TID 1 thermistors and Appendix Q for TID 2 thermistors. If resistance check is acceptable, then check the sensor wiring for opens, shorts, or shorts-to-ground.

3. If the sensor wiring is satisfactory, drain the fluid, remove the control module, and replace the temperature sensor.

4. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage that may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 24 XX — SUMP FLUID TEMPERATURE *(Figure 5–7)*

Table 5–4. Transmission Operation as a Function of Temperature

Condition	Version 8 Software	
	°C	°F
Temperature sensor failed high (refer to code 33 23)	177	350
Hot fluid (code 2423) adaptive turned off; maximum range limited (not limited in "emergency" calibration)	128	262
Output function "on" for sump over temp above this temperature	121	250
Output function "off" for sump over temp below this temperature	116	240
Cool/cold fluid; adaptive turned off	34	93
Turbine reasonableness and speed tie-up tests turned off	0	32
Medium cold fluid R, N, D allowed, 2nd range start (hold override upshifts only)	–7	19
All C3 Pressure Switch tests turned off	–32	–25
Temperature sensor failed low (refer to code 33 12)	–45	–49

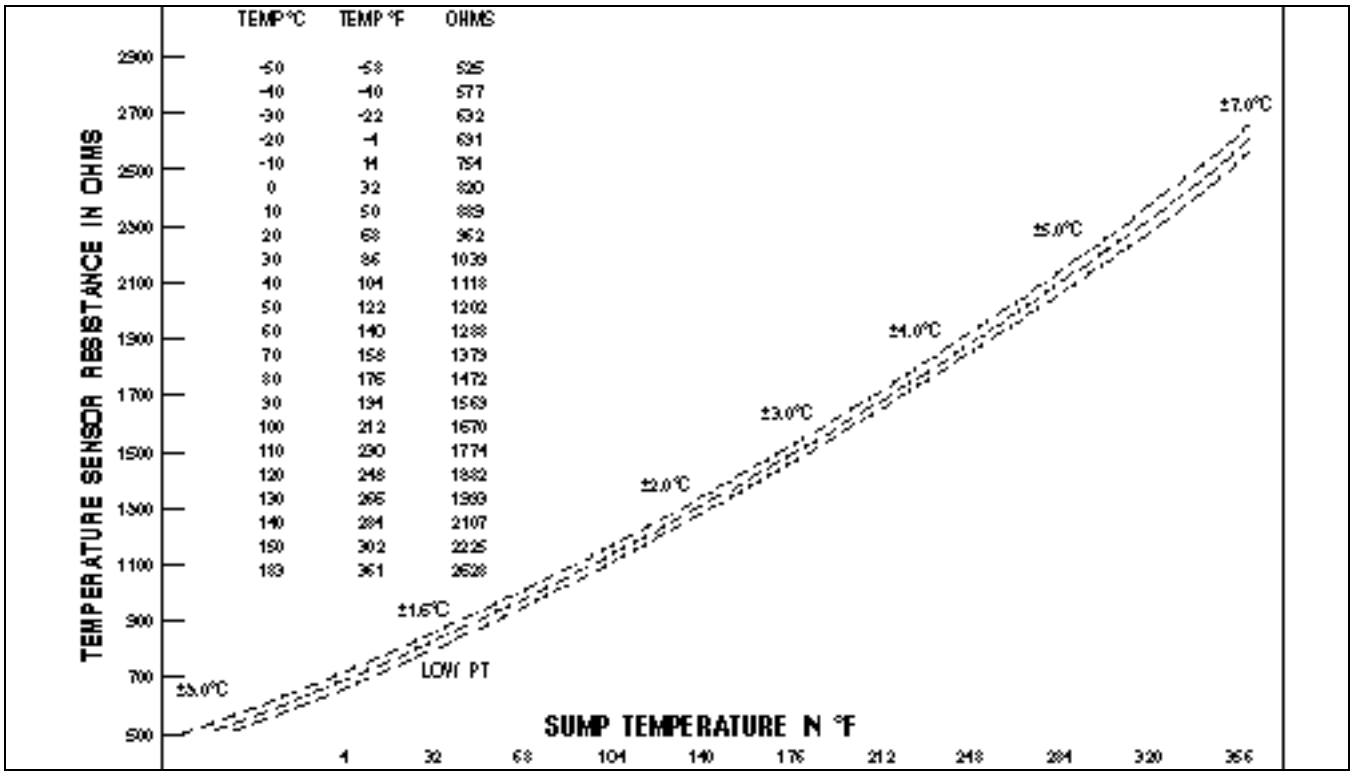


Figure 5–8. TransID 1 Temperature Sensor Chart

Code 24 23:

1. Install temperature gauges for transmission temperature and engine water temperature. Drive the vehicle. Verify that the code can be reproduced and verify the reading shown on the diagnostic tool. Observe the gauges and check for hot fluid when the code is produced.

2. If the fluid is not hot when the code is produced, remove the transmission "T" harness connector at the ECU and the transmission. Check the fluid temperature sensor wiring for opens, shorts, and shorts-to-ground. Compare the resistance readings of the sensor and the actual temperature

CODE 24 XX — SUMP FLUID TEMPERATURE *(Figure 5–7)*

as shown on the gauge with Figure 5–8 for TID 1 thermistors and Appendix Q for TID 2 thermistors. If wiring problems or a great difference between temperature and resistance compared with the chart are found, drain the fluid, remove the control module, and replace the temperature sensor. If wiring problems are found, repair or replace as necessary.

3. If the fluid is hot when the code is produced, observe the gauges to see if the engine became hot before the transmission. If the engine cooling system is overheating and heating the transmission, the problem is with the engine or its cooling system.

4. If the transmission became hot before the engine, allow the vehicle to idle for 3–5 minutes and check the transmission fluid level. Correct the fluid level if necessary.

5. Attach pressure gauges to the cooling system (from a "to cooler" connection to a point after the cooling circuit filter) and check for pressure drop problems. If pressure drop is excessive (refer to Table 5–5), check for a plugged cooler filter, collapsed lines, obstructions, etc.

6. If the fluid level is correct and the cooling circuits satisfactory, drain the fluid, remove the control module, and inspect for damaged valve body gaskets. Replace any damaged gaskets.

7. If no problems are found in the control module area, remove the transmission and disassemble, inspecting for causes of overheating (stuck stator, plugged orifices, dragging clutches, etc.).

Table 5–5. External Hydraulic Circuit Characteristics
Basic, PTO, 93°C (200°F) Sump Temperature

HD/B 500

CONVERTER OPERATION MAXIMUM COOLER FLOW AT MINIMUM PRESSURE DROP				
Input	Flow		Pressure Drop	
rpm	L/s	gpm	kPa	psi
600	0.22	3.4	0	0
900	0.38	6.1	0	0
1200	0.55	8.7	0	0
1500	0.80	12.7	0	0
1800	1.03	16.4	0	0
2100	1.13	18.0	0	0
2300	1.20	19.0	0	0

CONVERTER OPERATION COOLER FLOW AT MAXIMUM ALLOWABLE PRESSURE DROP				
Input	Flow		Pressure Drop	
rpm	L/s	gpm	kPa	psi
600	0.20	3.2	31	4.5
900	0.37	5.8	63	9.1
1200	0.55	8.7	108	15.7
1500	0.77	12.2	167	24.2
1800	0.92	14.5	213	30.9
2100	0.97	15.3	238	34.5
2300	1.00	15.9	250	36.3

CODE 24 XX — SUMP FLUID TEMPERATURE *(Figure 5–7)*

Table 5–6. External Hydraulic Circuit Characteristics
Basic, PTO, 93°C (200°F) Sump Temperature

MD/B 300/B 400

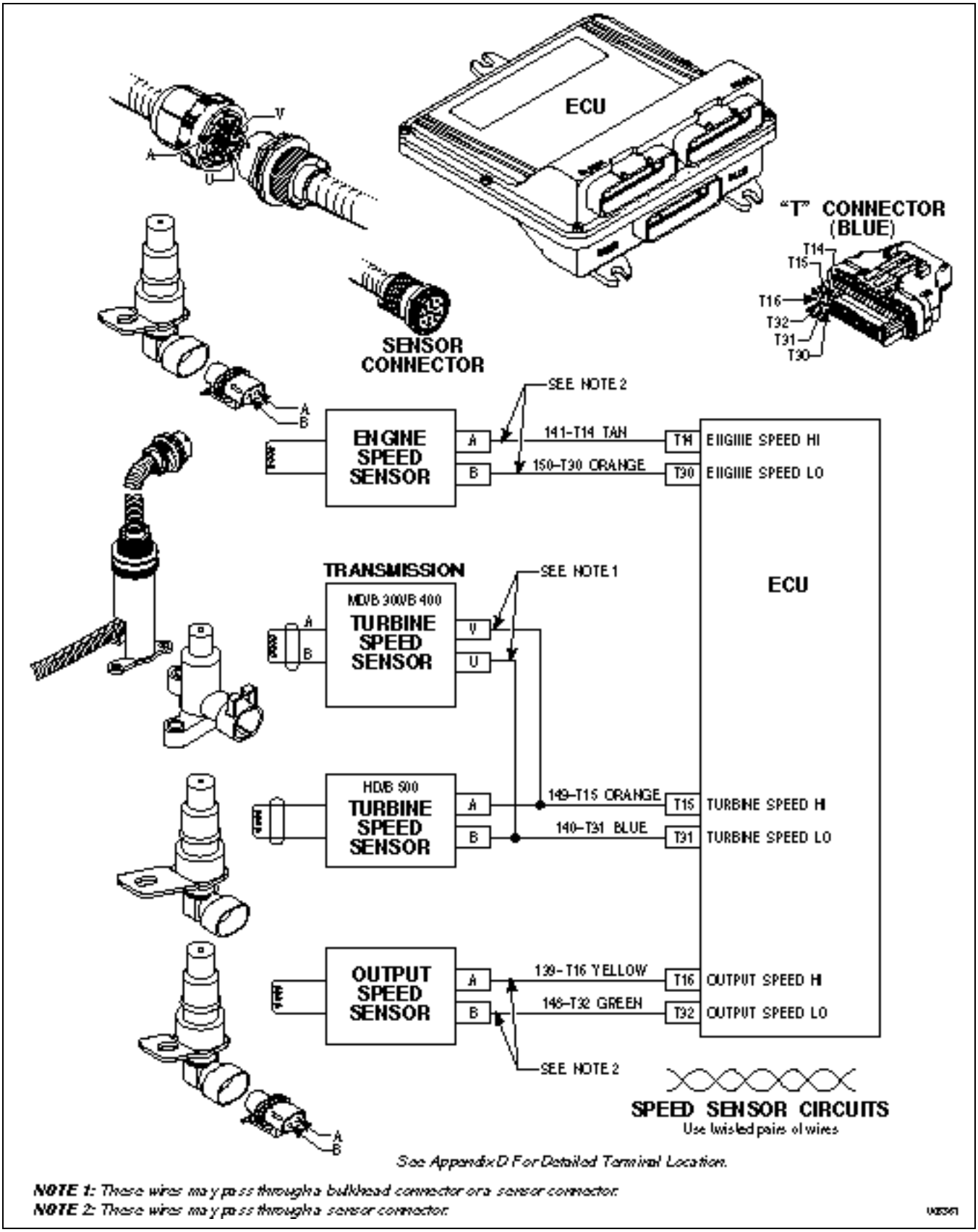
CONVERTER OPERATION MAXIMUM COOLER FLOW AT MINIMUM PRESSURE DROP				
Input	Flow		Pressure Drop	
rpm	L/s	gpm	kPa	psi
600	0.10	1.6	0	0
800	0.23	3.7	0	0
1200	0.47	7.4	0	0
1400	0.61	9.7	0	0
1600	0.74	11.7	0	0
2000	0.94	14.9	0	0
2400	1.19	18.9	0	0
3200	1.28	20.3	0	0

LOCKUP OPERATION MAXIMUM COOLER FLOW AT MINIMUM PRESSURE DROP				
Input	Flow		Pressure Drop	
rpm	L/s	gpm	kPa	psi
600	0.10	1.6	0	0
800	0.23	3.7	0	0
1200	0.50	7.9	0	0
1400	0.63	10.0	0	0
1600	0.77	12.2	0	0
2000	0.95	15.1	0	0
2400	1.12	17.8	0	0
2800	1.22	19.3	0	0
3200	1.28	20.3	0	0

CONVERTER OPERATION MAXIMUM ALLOWABLE PRESSURE DROP				
Input	Flow		Pressure Drop	
rpm	L/s	gpm	kPa	psi
600	0.10	1.6	10	1.5
800	0.22	3.5	40	5.8
1200	0.45	7.1	159	23.1
1400	0.57	9.0	252	36.5
1600	0.67	10.6	338	49.0
2000	0.80	12.7	481	69.8
2400	0.85	13.5	549	79.6
3200	0.85	13.5	549	79.6

LOCKUP OPERATION MAXIMUM ALLOWABLE PRESSURE DROP				
Input	Flow		Pressure Drop	
rpm	L/s	gpm	kPa	psi
600	0.10	1.6	5	0.7
800	0.23	3.7	46	6.7
1200	0.48	7.6	148	21.5
1400	0.62	9.8	247	35.8
1600	0.73	11.6	346	50.2
2000	0.90	14.3	561	81.4
2400	1.07	17.0	737	106.9
2800	1.10	17.4	770	111.7
3200	1.10	17.4	791	114.7

CODE 25 XX — OUTPUT SPEED SENSOR, DETECTED AT ZERO SPEED, X RANGE



See Appendix D For Detailed Terminal Location.

NOTE 1: *These wires may pass through a bulkhead connector or a sensor connector.*
NOTE 2: *These wires may pass through a sensor connector.*

CODE 25 XX — OUTPUT SPEED SENSOR, DETECTED AT ZERO SPEED, X RANGE *(Figure 5–9)*

Figure 5–9. Code 25 Schematic Drawing

Main code 25 occurs if the output speed sensor reports a zero speed reading while both engine and turbine speeds are approximately equal, turbine speed is above a calibration value, and neutral is not selected or commanded. Main code 25 indicates either the output speed sensor has failed or the required oncoming clutch or clutches did not come on. Code 2511 can be generated by a false turbine speed reading. This may be due to crosstalk between solenoid and turbine speed sensor circuits caused by direct wire-to-wire short or by water in the electrical connectors. See Section 4 for corrective action.

NOTE: If code 25XX is in memory at ECU initialization (ignition on), all display segments are illuminated.

Main Code	Subcode	Meaning	Applied Clutches
25	00	Output speed sensor, detected at zero speed, Low range	C3, C6
25	11	Output speed sensor, detected at zero speed, 1st range	C1, C5
25	22	Output speed sensor, detected at zero speed, 2nd range	C1, C4
25	33	Output speed sensor, detected at zero speed, 3rd range	C1, C3
25	44	Output speed sensor, detected at zero speed, 4th range	C1, C2
25	55	Output speed sensor, detected at zero speed, 5th range	C2, C3
25	66	Output speed sensor, detected at zero speed, 6th range	C2, C4
25	77	Output speed sensor, detected at zero speed, Reverse	C3, C5

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections can cause this and other codes.

B. Troubleshooting:

1. Check the transmission fluid level and ensure correct fluid level.
2. Check for the presence of code 2216. If code 2216 is in the code list, go to code 22XX section and follow troubleshooting steps for code 2216.
3. Connect the Pro-Link® 9000 with ignition on, engine off; check for indication of turbine speed. If turbine speed is indicated, refer to Paragraph 4–2 for corrective action.
4. If the output speed sensor and wiring are satisfactory, install pressure gauges into the appropriate clutch pressure taps (see Appendix B in this manual) and make the shift again. See if either of the clutches has low or no pressure. Lack of pressure in C1 in first range may be due to a G solenoid stuck closed. Lack of pressure in C5 in first range may be due to an E solenoid stuck closed.
5. If a clutch is leaking pressure, drain the fluid, remove the control module and check for damaged valve body gaskets and stuck or sticky valves. If no problems are found, replace the solenoids for the clutches used in the range indicated by the code (refer to Figure 5–1). Refer to the appropriate transmission Service Manual for replacement procedure.

CODE 25 XX — OUTPUT SPEED SENSOR, DETECTED AT ZERO SPEED, X RANGE *(Figure 5–9)*

6. If, after detecting leaking pressure and replacing solenoids, the problem persists, check for worn clutch or piston seals. Remove the transmission and repair or replace as necessary.

7. This code requires accurate output and turbine speed readings. If there were no transmission problems detected, use the diagnostic tool and watch the speed readings for noise (erratic signals) from low speed to high speed in the range indicated by the code.

8. If a noisy sensor is found, check the sensor resistance (refer to the sensor resistance chart below) and check its wiring for opens, shorts, and shorts-to-ground (see code 22XX). Also closely check the terminals in the connectors for corrosion, contamination, or damage. Ensure the wiring to the sensors is a properly twisted wire pair. Remove sensor and check for damage at the tone wheel end. Check for looseness of the tone wheel. Replace the sensor if it is damaged or if its resistance (refer to Service Manual for proper procedure) is incorrect and isolate and repair any noted wiring problems. (Use St. Clair P/N 200153 Service Harness Twisted Pair for this procedure.)

Resistance	Temp. °C	Temp. °F
200 ¾	–40	–40
300 ¾	20	68
400 ¾	110	230

9. If no apparent cause for the code can be located, replace the turbine and output speed sensors. Refer to the appropriate transmission Service Manual for proper procedure.

10. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 26 XX — THROTTLE SOURCE/ENGINE COOLANT SOURCE NOT DETECTED

Main code 26 occurs when the ECU has not detected either a throttle source or an engine coolant source.

.

Main Code	Subcode	Meaning
26	00	Throttle source not detected
26	11	Engine coolant source not detected

Code 26 00 means that the ECU has not detected the presence of engine throttle data or analog circuitry. For details about or using Pro-Link® to select a throttle source, see WTEC III Pro-Link® Manual.

Code 26 11 means that the ECU has not detected the presence of engine coolant temperature data or analog circuitry. For details about or using Pro-Link® to select an engine coolant temperature source, see WTEC III Pro-Link® Manual.

A. Active Indicator Clearing Procedure

- Power down
- Manual

B. Troubleshooting

1. When code 26 00 is logged and an analog TPS is known to be installed, refer to code 21 XX for troubleshooting steps. If a J1587 or J1939 throttle signal is used, refer to code 66 00 for troubleshooting steps.

2. When code 26 11 is logged and if an analog engine coolant temperature sensor is being used, refer to code 62 XX for troubleshooting steps. If a J1587 or J1939 engine coolant temperature signal is being used, refer to code 66 00 for troubleshooting steps.

CODE 32 XX — C3 PRESSURE SWITCH

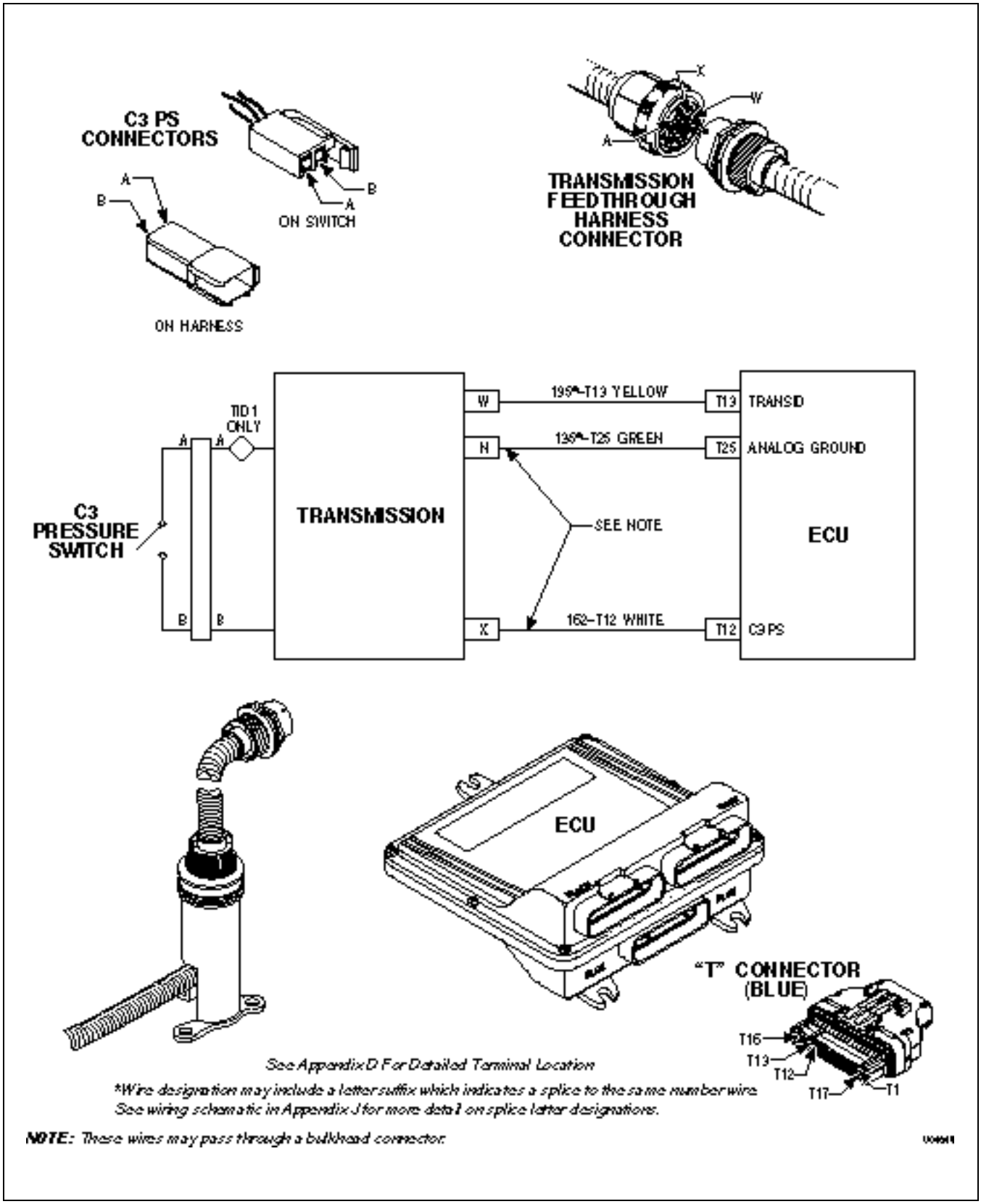


Figure 5–10. Code 32 Schematic Drawing

CODE 32 XX — C3 PRESSURE SWITCH *(Figure 5–10)*

Main code 32 indicates the transmission gear ratio is correct, but the C3 pressure switch is open when it should be closed.

NOTE: When an ECU with a version 8 or 8A calibration is used with a pre-TransID transmission, 32 XX codes are set because the ECU sees wire 195 is open. To correct this condition, convert to a TID 1 internal harness or install Adapter P/N 200100 available from St. Clair Technologies.

Main Code	Subcode	Meaning
32	00	C3 switch open in low range (MD 3070 or HD 4070 only)
32	33	C3 switch open in third range
32	55	C3 switch open in fifth range
32	77	C3 switch open in reverse range

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

B. Troubleshooting:

1. Disconnect the transmission "T" harness connector at the ECU and the transmission. Check the C3 switch circuit for opens, shorts to other wires, shorts-to-ground, or short-to-battery. If wiring problems are found, isolate and repair. The C3 pressure switch closes at 206.8 ± 48 kPa (30±7psi); resistance should be 2 Ohms maximum when the switch is closed and 20,000 to infinity when the switch is open. Infinity is often indicated as OL (over limit) on a DVOM.

2. If problems are not found in the external harness, drain the fluid, remove the control module, and check the internal harness for opens, shorts between wires, or shorts-to-ground (refer to the proper transmission Service Manual). If wiring problems are found, isolate and repair.

3. If no wiring problems are found, replace the C3 pressure switch.

4. If the problem recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the C3 pressure switch circuit.

5. If the problem recurs again, replace the internal harness.

6. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 33 XX — SUMP OIL TEMPERATURE SENSOR

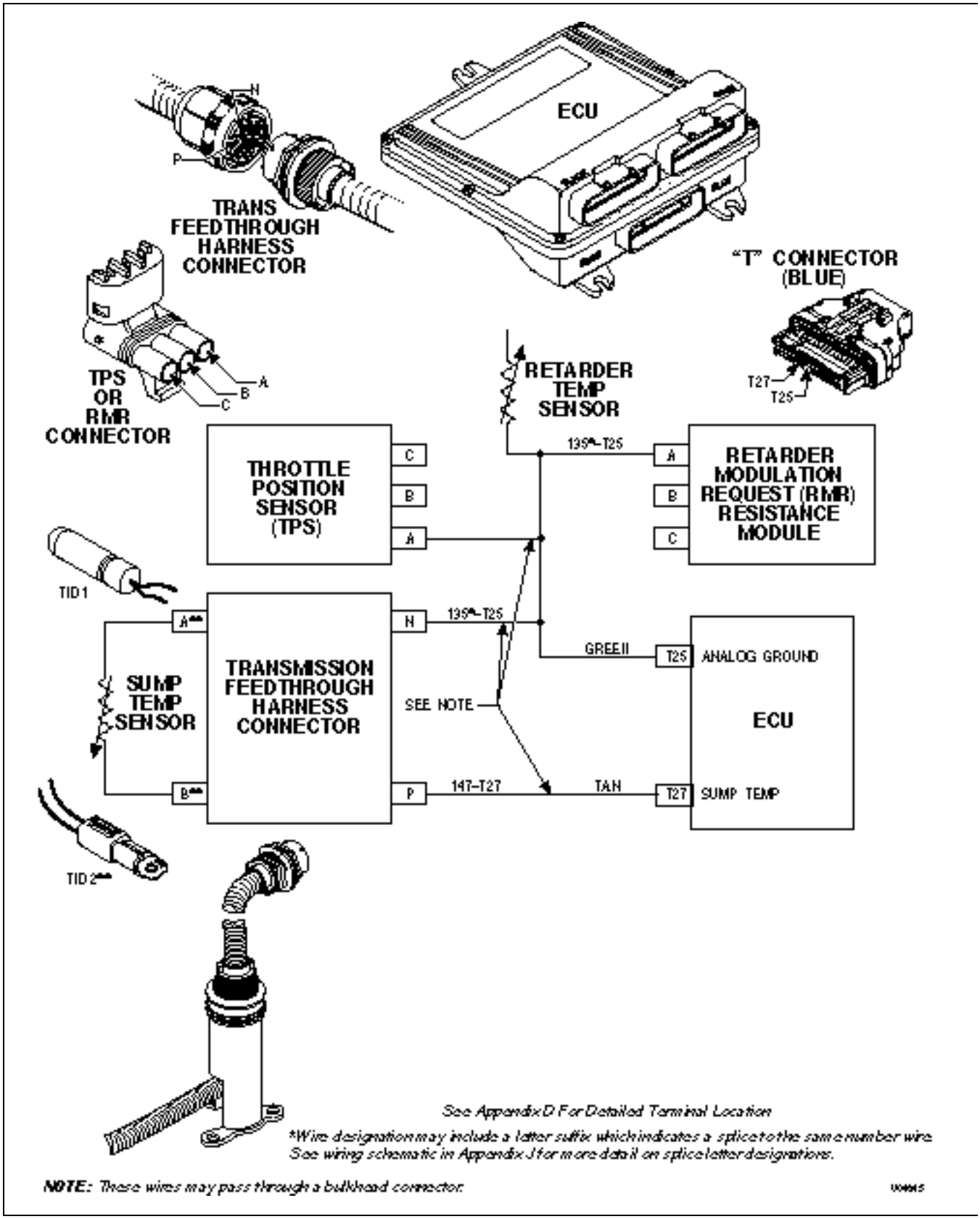


Figure 5–11. Code 33 Schematic Drawing

CODE 33 XX — SUMP OIL TEMPERATURE SENSOR *(Figure 5–11)*

NOTE: When an ECU with a version 8 calibration(CIN=0A...) is used with a Trans ID 2 transmission, 33 XX codes are set because the ECU does not have the proper calibrations for the TID 2 thermistors. The ECU calibration must be updated to version 8A or later (CIN=0B...).

Main code 33 indicates the sump temperature sensor is providing a signal outside the usable range of the ECU. This code indicates the sensor failed showing abnormally high or low temperature readings. Main code 33 can be caused by a component or circuit failure or by extremely high or low temperatures. There are no operational inhibits related to main code 33. The ECU assumes a hardware failure and that transmission temperatures are normal (93ºC; 200ºF). Temperatures above or below normal cause poor shift quality.

NOTE: Codeþ33 23 in conjunction with code 21þ23 indicates the loss of common ground (wire 135) between the throttle and temperature sensors.

Main Code	Subcode	Meaning
33	12	Sump oil temperature sensor failed low
33	23	Sump oil temperature sensor failed high

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check the transmission fluid level.

B. Troubleshooting:

NOTE: Code 33 12 can be caused when the +5V power line (wire 124) is shorted to ground or open. Wire 124 also provides power for the OLS, TPS, RMR, retarder temperature sensor, and shift selectors and is present in all three ECU connectors.

1. If possible, check the sump temperature with a DDR. Use the fastest sample rate available on the DDR. This is necessary to catch momentary changes due to an intermittent open or short to ground. If a DDR is not available, use the shift selector display to determine if the code is active (refer to Paragraph 5–2). Disconnect the transmission “T” harness at the ECU and check resistance of the sensor and compare with Figure 6–12 for TID 1 for TID 2.

2. If Step (1) reveals that the extreme temperature indication is no longer present, the temperature limit could have been reached due to operational or ambient temperature extremes. Also, you may be experiencing an intermittent problem and the code will not be active. Proceed cautiously, it is unlikely there is a sensor hardware fault.

CODE 33 XX — SUMP OIL TEMPERATURE SENSOR *(Figure 5–11)*

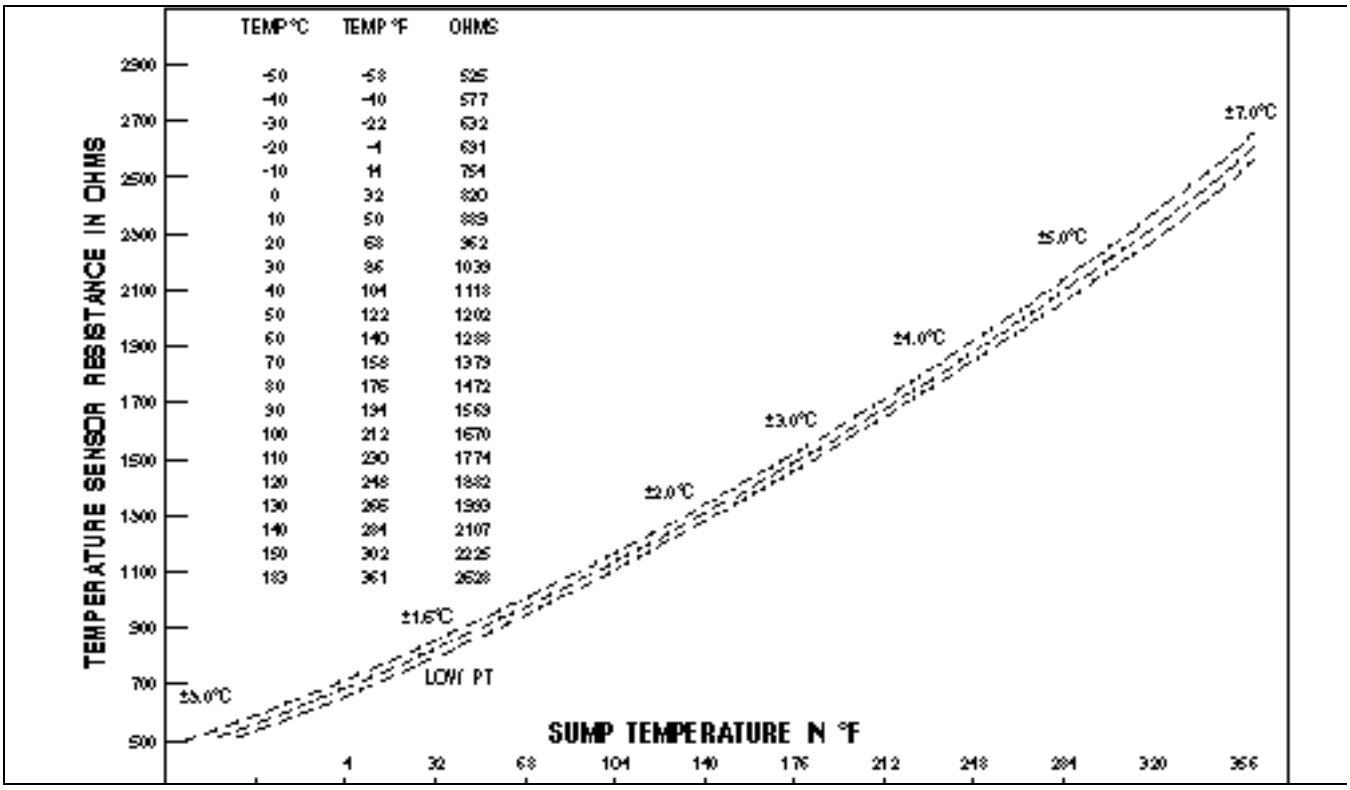


Figure 5–12. Temperature Sensor Chart

3. Disconnect the external harness at the transmission. Check the connectors and terminals for dirt, corrosion, or damage. Clean or replace as necessary.

4. Check the sensor wires in the external harness for opens (code 33 23), shorts between wires, or shorts-to-ground (code 33 12 — refer to Section 4). If wiring problems are found, isolate and repair.

5. If no harness problems are found, check the feedthrough harness for damage. If the feedthrough harness connector is satisfactory, drain the fluid and remove the control module. Check for chafing of the sensor wires, especially near the separator plate. Eliminate the chafe point. If no chafe point is found, replace the sensor.

6. If the problem recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the temperature sensor circuit.

7. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 34 XX — CALIBRATION COMPATIBILITY OR CHECKSUM FAULT

Main code 34 indicates there is a problem with the calibration.

Main Code	Subcode	Meaning
34	12	Factory calibration compatibility number wrong
34	13	Factory calibration checksum
34	14	Power off block checksum
34	15	Diagnostic queue block checksum
34	16	Real-time block checksum
34	17	Customer modifiable constants checksum

A. Active Indicator Clearing Procedure:

- Power down

NOTE: ***Copying the current calibration from the ECU and reloading it will not correct the fault. The calibration must be downloaded directly from PCCS.***

B. Troubleshooting:

1. If the code set is 34 14 and it occurs in conjunction with code 35 00, proceed to find the cause for code 35 00 and correct it.
2. After the cause for code 35 00 has been corrected, drive the vehicle to see if code 34 14 recurs. If code 34 14 recurs, proceed to Step (3).
3. Reprogram the correct calibration. Contact your nearest Allison distributor/dealer location qualified to do recalibration. Be certain the calibration and the software level are compatible.
4. If the code recurs after reprogramming, replace the ECU.
5. If the code set is 34 17, reprogram the GPI/GPO package after re-calibration of the ECU.

CODE 35 XX — POWER INTERRUPTION

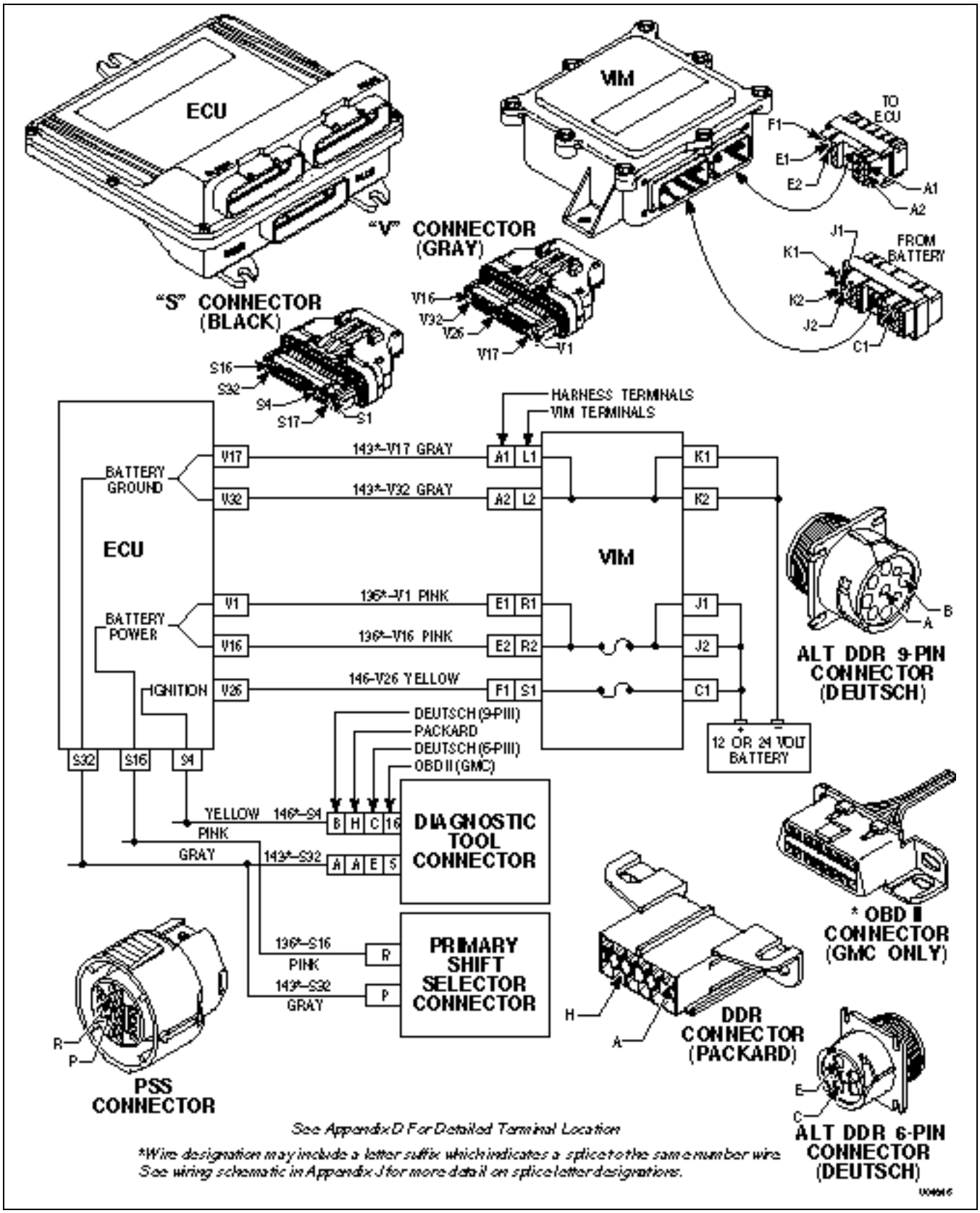


Figure 5–13. Code 35 Schematic Drawing

CODE 35 XX — POWER INTERRUPTION *(Figure 5–13)*

Main code 35 indicates the ECU has detected a complete power loss before the ignition was turned off or before ECU shutdown is completed. When this happens, the ECU is not able to save the current operating parameters in memory before turning itself off.

Main Code	Subcode	Meaning
35	00	Power interruption. (Not an active code; only appears after power is restored.) During power interruption, DNS light is not illuminated and the transmission will not shift.
35	16	Real-time write interruption. (Power interruption at the same time the ECU is recording a critical code to the real-time section.)

A. Active Indicator Clearing Procedure:

- Power down
- Manual — except code 35 16

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

B. Troubleshooting:

1. If the vehicle has a master switch controlling battery power to the ECU and an ignition switch, turning the master switch off before turning the ignition switch off can cause this code. Turning the master switch off before ECU shutdown is completed will also cause this code. No troubleshooting is necessary.

2. If improper switch sequencing is not the cause, check ECU power and ground for opens, shorts, and shorts-to-ground. Not using battery-direct power and battery ground connections can cause this code. A defective charging system, or open battery fuse or fusible link can also cause this code. The battery fuse or fusible link may be at the battery or in the VIM. Dirty, corroded, or painted power and ground connections can also cause this code.

3. If all system power and ground connections are satisfactory and the problem persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem reoccurs, reinstall the replacement ECU.

Main code 36 indicates the system has detected a mismatch between the ECU hardware and the ECU software or that there is a TransID (TID) problem.

Main Code	Subcode	Meaning
36	00	Mismatch between ECU hardware and software
36	01	TransID not compatible with hardware/software
36	02	TransID did not complete

A. Active Indicator Clearing Procedure:

- Power down

CODE 36 XX — HARDWARE AND SOFTWARE NOT COMPATIBLE

B. Troubleshooting:

1. Correction for code 36 00 requires the installation of software that is compatible with the ECU hardware involved. (If a different calibration is required, update the ECU hardware to be compatible.)

2. Correction for code 36 01 is to update the ECU calibration. Installation of the latest calibration makes the ECU compatible with the latest TransID configuration.

3. Correction for code 36 02 is to troubleshoot TransID wire 195 for short-to-battery. Codes 42 XX or 69 XX may be associated with this code.

CODE 42 XX — SHORT-TO-BATTERY IN SOLENOID CIRCUIT

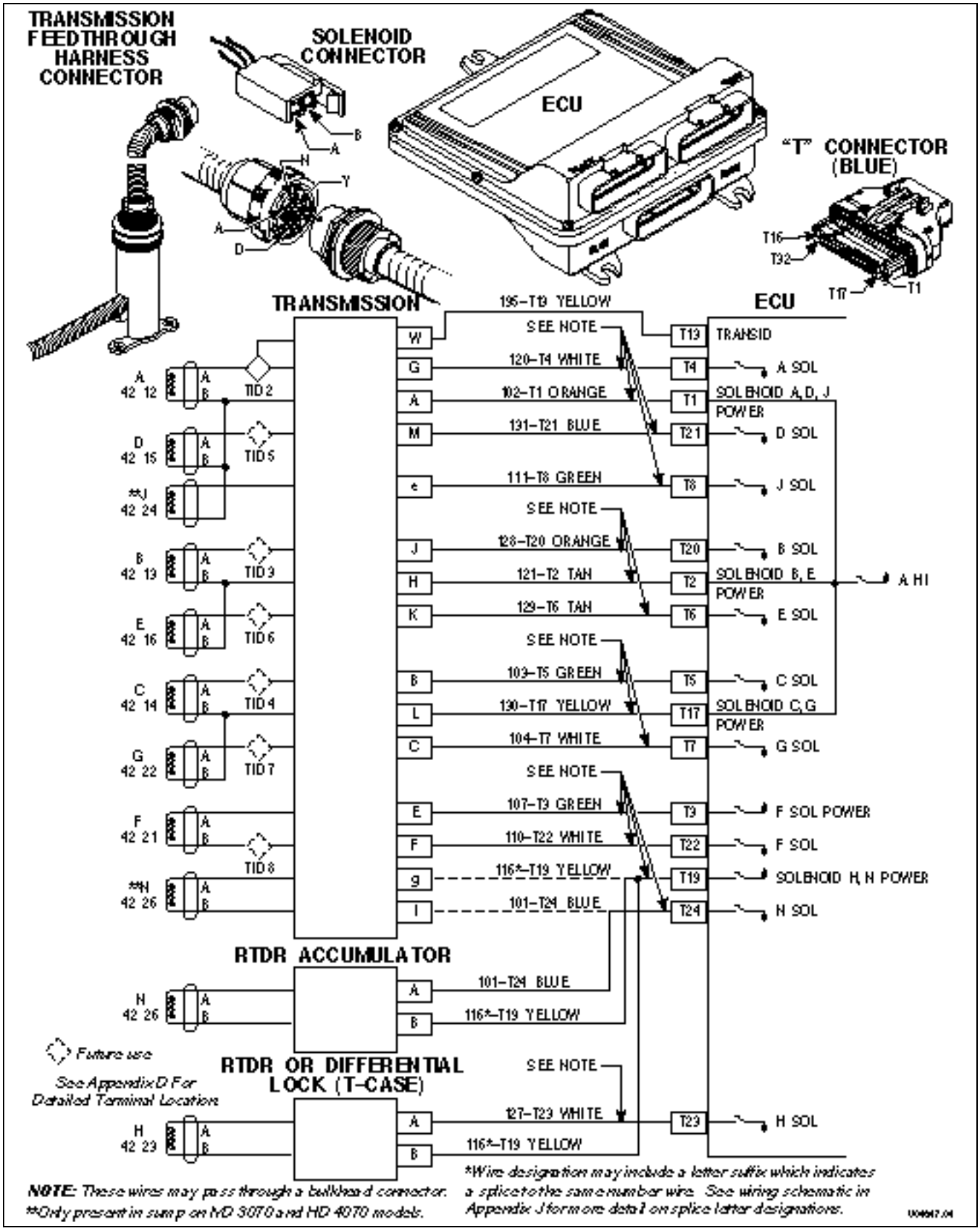


Figure 5–14. Code 42 Schematic Drawing

CODE 42 XX — SHORT-TO-BATTERY IN SOLENOID CIRCUIT *(Figure 5–14)*

Main code 42 indicates the ECU has detected a short-to-battery condition in a solenoid wiring circuit. The **DO NOT SHIFT** response is activated when some subcodes are detected, all solenoids are turned off and the **CHECK TRANS** light is illuminated. All solenoids have a driver on the low (ground) side which can turn off the solenoid. All solenoids also have a driver on the high (power) side of the solenoid. Even though the high side driver can be turned off, a short-to-battery means the solenoid is continuously powered at an unregulated 12V or 24V instead of a regulated (pulse width modulated) voltage. The low side driver will not tolerate direct battery current and will open, causing the solenoid to be deenergized.

NOTE: For subcodes 12, 13, 14, 15, 16, 22 — neutral start is inoperable; all display segments are on if the code is logged during ECU initialization (ignition on). Subcodes 21, 23, 24, and 26 will not trigger the CHECK TRANS light.

Main Code	Subcode	Meaning
42	12	Short-to-battery A Solenoid Circuit
42	13	Short-to-battery B Solenoid Circuit
42	14	Short-to-battery C Solenoid Circuit
42	15	Short-to-battery D Solenoid Circuit
42	16	Short-to-battery E Solenoid Circuit
42	21	Short-to-battery F Solenoid Circuit
42	22	Short-to-battery G Solenoid Circuit
42	23	Short-to-battery H Solenoid Circuit
42	24	Short-to-battery J Solenoid Circuit
42	26	Short-to-battery N Solenoid Circuit

A. Active Indicator Clearing Procedure:

- Power down
- Manual

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Energizing the solenoids and listening for ball/plunger movement is sometimes useful in troubleshooting.

NOTE: "N" solenoid on the retarder accumulator has either a 12.5 ± 1.5 Ohm coil or a 23.5 ± 2.4 Ohm coil and is not correlated to sump temperature.

PROBING THE CONNECTOR

When testing the control system from the feedthrough connector with the internal harness connected, the resistance of each solenoid can be measured by using a VOM. Refer to Figure 5–15 for solenoid resistance versus temperature.

CODE 42 XX — SHORT-TO-BATTERY IN SOLENOID CIRCUIT *(Figure 5–15)*

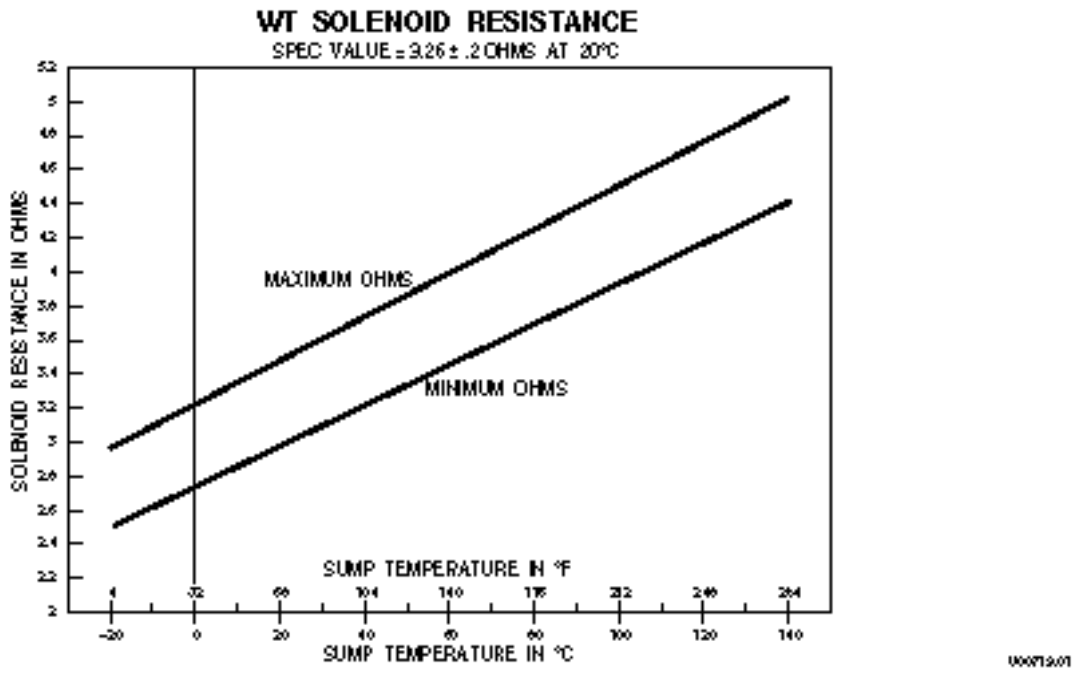


Figure 5–15. Solenoid Resistance vs. Temperature

B. Troubleshooting:

1. Make sure the transmission connector is tightly connected. If the connector is properly connected, disconnect the wiring harness at the transmission. Check the connector for corroded or damaged terminals. Clean or replace as necessary.

2. Test each solenoid circuit at the transmission connector for shorts between the solenoid circuit being diagnosed and all other terminals in the connector. This test may be simplified by using the J41612 test tool. Refer to the system schematic and/or chart to identify wires in the internal harness which are connected. If a short is found, isolate and repair the short. The short will probably be in the internal wiring harness.

3. If multiple code 42s occur (4212, 4213, 4214, 42 12, 4216, 4222, and 4224), and wiring and solenoids check okay, the A-Hi driver is probably failed open.

4. Replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the problem recurs, reinstall the new ECU to complete the repair.

5. If code 4221 occurs repeatedly and the F solenoid and wiring checks okay, the F-Hi or F-Lo driver may be failed open. Follow Step (4) above.

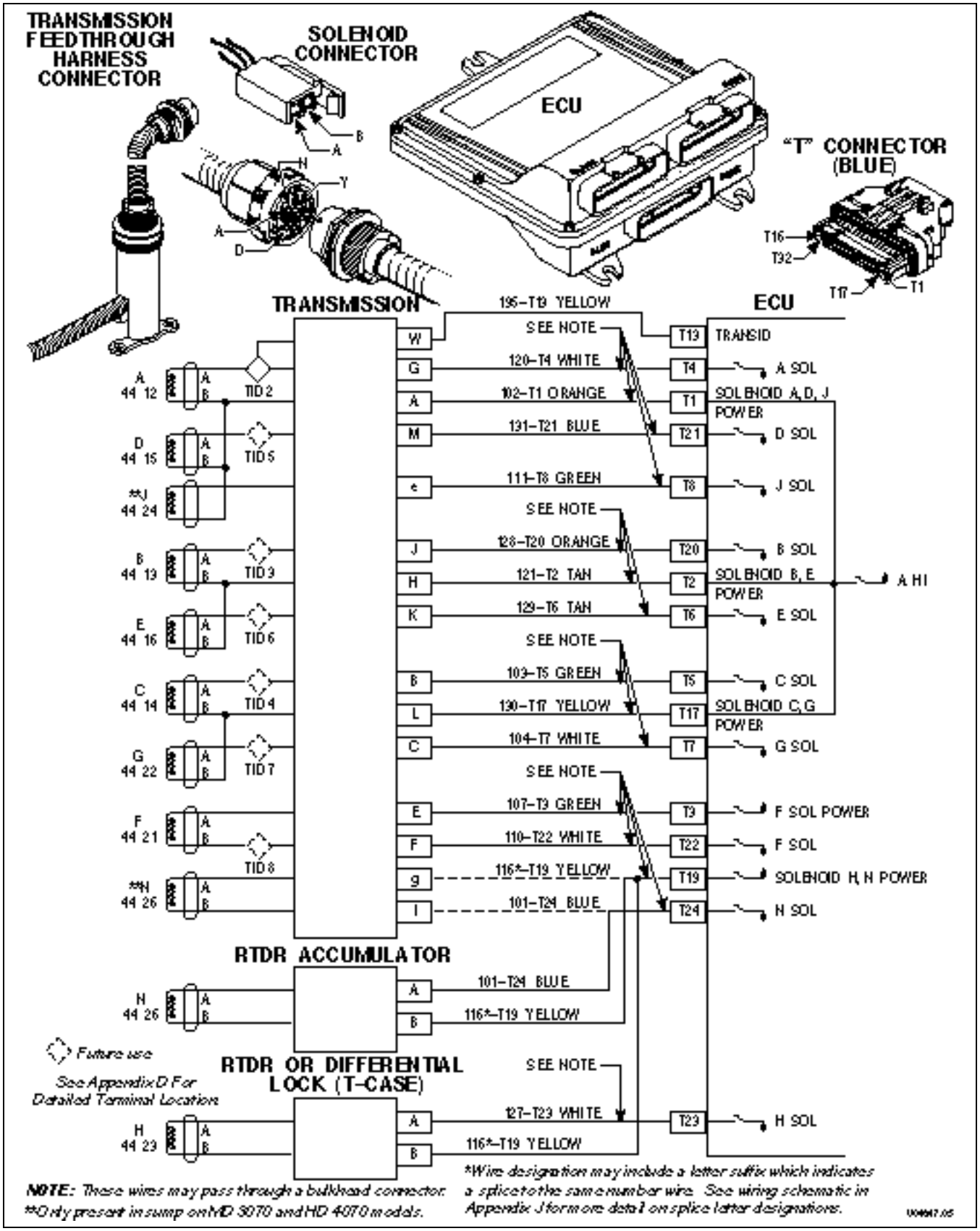
6. If codes 4223 and 4226 occur repeatedly and solenoids and wiring check okay, the H and N-Hi driver may be failed open. Follow Step (4) above.

7. If the short is not found at the transmission connector, disconnect the transmission "T" harness connector at the ECU and check the wires of the solenoid circuit for shorts between the solenoid wires. If the short is found in one of the wires, isolate and repair it. Use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose).

CODE 42 XX — SHORT-TO-BATTERY IN SOLENOID CIRCUIT *(Figure 5–15)*

8. If the short is not found in either the transmission or the harness, the condition must be intermittent.
9. Drain the fluid, remove the control module and closely inspect the internal harness for damage. Repair or replace as necessary.
10. If the condition recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the solenoid circuit indicated by the trouble code.
11. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 44 XX — SHORT-TO-GROUND IN SOLENOID CIRCUIT



CODE 44 XX — SHORT-TO-GROUND IN SOLENOID CIRCUIT *(Figure 5–16)*

Figure 5–16. Code 44 Schematic Drawing

Main code 44 indicates the ECU has detected a short-to-ground in a solenoid or its wiring. The **DO NOT SHIFT** response is activated when some subcodes are detected, all solenoids are turned off, and the **CHECK TRANS** light is illuminated.

NOTE: For subcodes 12, 13, 14, 15, 16, 22 — neutral start is inoperable. Subcodes 21, 23, 24, and 26 do not trigger the CHECK TRANS light.

Main Code	Subcode	Meaning
44	12	Short-to-ground A Solenoid Circuit
44	13	Short-to-ground B Solenoid Circuit
44	14	Short-to-ground C Solenoid Circuit
44	15	Short-to-ground D Solenoid Circuit
44	16	Short-to-ground E Solenoid Circuit
44	21	Short-to-ground F Solenoid Circuit
44	22	Short-to-ground G Solenoid Circuit
44	23	Short-to-ground H Solenoid Circuit
44	24	Short-to-ground J Solenoid Circuit
44	26	Short-to-ground N Solenoid Circuit

A. Active Indicator Clearing Procedure:

- Power down
- Manual

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

PROBING THE CONNECTOR

When testing the control system from the feedthrough connector with the internal harness connected, the resistance of each solenoid can be checked using a VOM. Refer to Figure 5–17 for resistance values versus temperature.

CODE 44 XX — SHORT-TO-GROUND IN SOLENOID CIRCUIT *(Figure 5–17)*

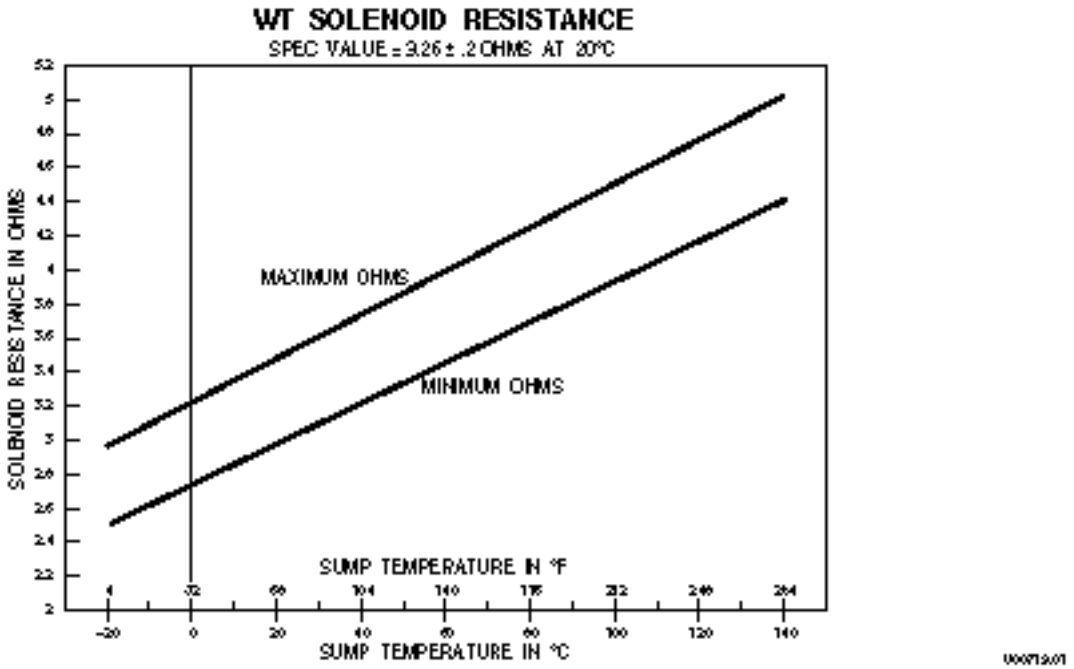


Figure 5–17. Solenoid Resistance vs. Temperature

B. Troubleshooting:

1. Check the transmission connector and make sure it is tightly connected. If the connector is properly connected, disconnect the harness at the transmission and inspect the terminals in the transmission harness and feedthrough harness connectors. Clean or replace as necessary (Appendix D).

2. If the connector is connected, clean, and not damaged, check the solenoid circuit in the transmission for shorts to other wires. (Tool J41612 may be useful in making this test.) Refer to the system schematic and/or chart to identify wires in the internal harness which are connected. If the short circuit is found, drain the fluid, remove the control module (refer to the transmission Service Manual), and isolate the short. The short is probably in the feedthrough harness, or the solenoid itself (refer to Figure 5–1 for solenoid locations).

3. If the short is not found in the transmission, disconnect the transmission harness connector at the ECU and inspect the terminals for damage or contamination. Clean or replace as necessary. If the terminals are satisfactory, check the wires of the solenoid circuit in the transmission harness for shorts-to-ground or shorts between wires. If a short is found in one of the wires, isolate and repair it or use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) in the external harness. Refer to Appendix E for connector/terminal repair information.

4. If the short is not found in either the transmission or the harness, the condition must be intermittent.

5. Drain the fluid, remove the control module, and closely inspect the solenoid and internal harness for damage. Repair or replace as necessary.

CODE 44 XX — SHORT-TO-GROUND IN SOLENOID CIRCUIT *(Figure 5–17)*

6. If the condition recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the solenoid circuit indicated by the diagnostic code.
7. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 45 XX — OPEN CONDITION IN SOLENOID CIRCUIT

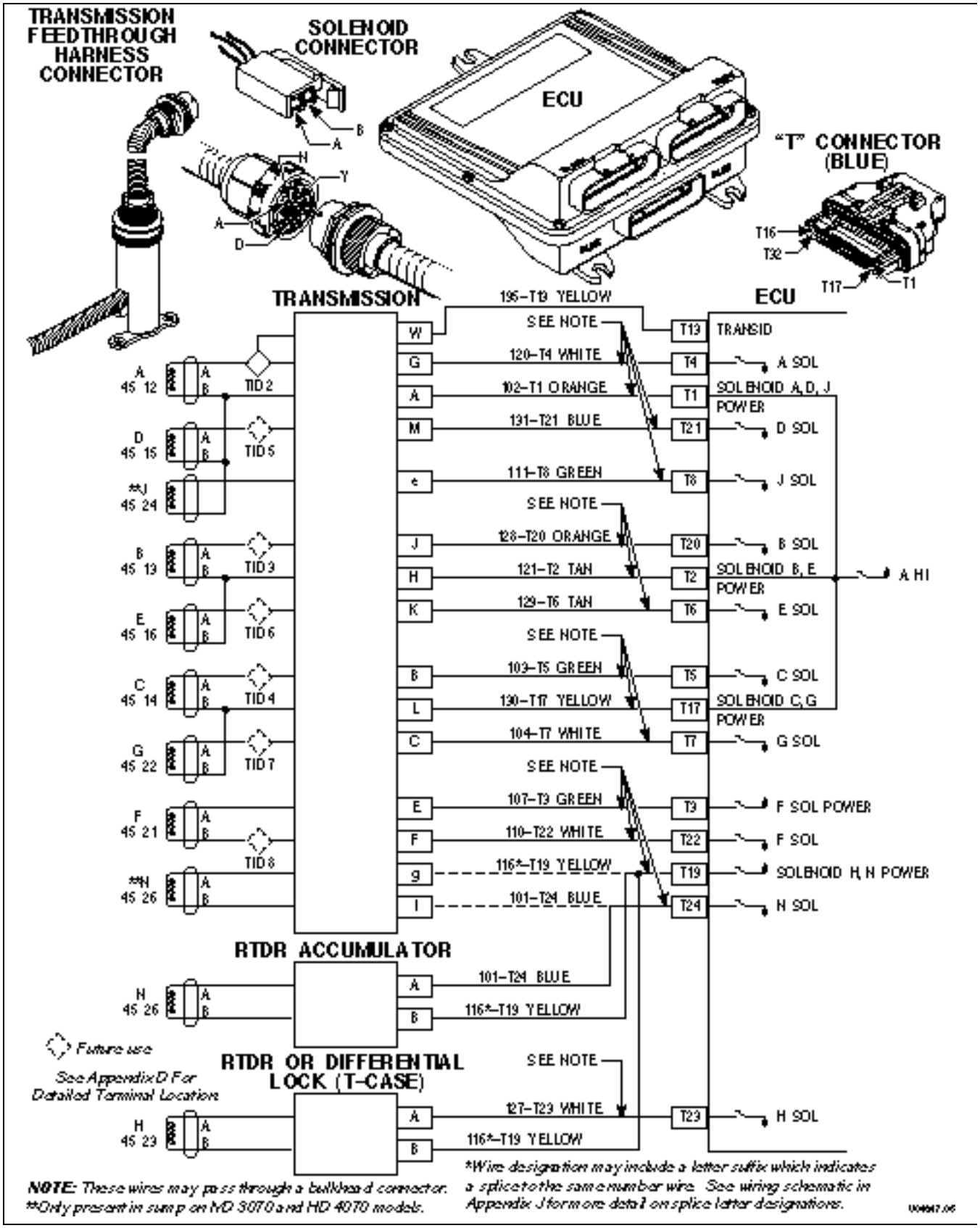


Figure 5–18. Code 45 Schematic Drawing

CODE 45 XX — OPEN CONDITION IN SOLENOID CIRCUIT *(Figure 5–18)*

Main code 45 indicates the ECU has detected either an open circuit condition in a solenoid coil or the wiring to that solenoid. The **DO NOT SHIFT** response is activated when some subcodes are detected, all solenoids are turned off, and the **CHECK TRANS** light is illuminated.

Main Code	Subcode	Meaning
45	12	Open Circuit A Solenoid Circuit
45	13	Open Circuit B Solenoid Circuit
45	14	Open Circuit C Solenoid Circuit
45	15	Open Circuit D Solenoid Circuit
45	16	Open Circuit E Solenoid Circuit
45	21	Open Circuit F Solenoid Circuit
45	22	Open Circuit G Solenoid Circuit
45	23	Open Circuit H Solenoid Circuit
45	24	Open Circuit J Solenoid Circuit
45	26	Open Circuit N Solenoid Circuit

A. Active Indicator Clearing Procedure:

- Power down
- Manual

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

PROBING THE CONNECTOR

When testing the control system from the feedthrough connector with the internal harness connected, the resistance of each solenoid can be checked using a VOM. Refer to Figure 5–19 for solenoid resistance values versus temperature.

CODE 45 XX — OPEN CONDITION IN SOLENOID CIRCUIT *(Figure 5–19)*

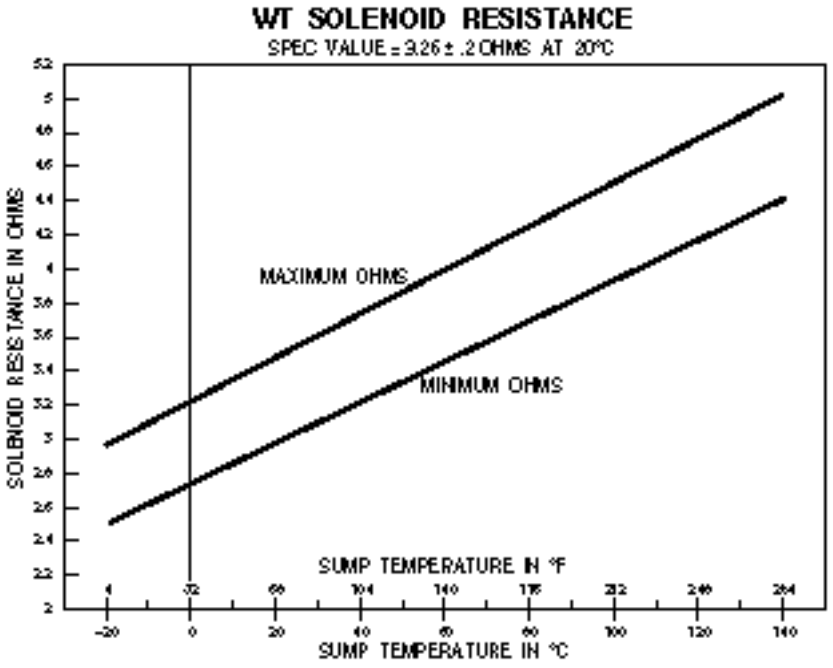


Figure 5–19. Solenoid Resistance vs. Temperature

B. Troubleshooting:

1. Check the transmission connector and make sure it is tightly connected. If the connector is properly connected, disconnect the harness at the feedthrough harness connector and check the terminals in the transmission harness and feedthrough harness connectors.

2. If the connector is connected, clean, and not damaged, check the solenoid circuit in the transmission for opens. Refer to the system schematic and/or chart to identify wires in the internal harness which are connected. If the open circuit is found, drain the fluid, remove the control module (see the transmission Service Manual), and isolate the open. The fault will be in the feedthrough harness or the solenoid itself (see Figure 5–1 for solenoid locations).

3. If the open is not found at the transmission connector, disconnect the transmission harness connector at the ECU and inspect the terminals in the connector and the ECU for damage or contamination. Clean or replace as necessary. If the terminals are satisfactory, check the wires of the solenoid circuit in the transmission harness for continuity. If the open is found in one of the wires, isolate and repair it. If this is not feasible, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose).

4. If multiple code 45s occur (4512, 4513, 4514, 4515, 4516, 4522, and 4524), and wiring and solenoids check okay, the A-Hi driver is probably failed open.

5. Replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the problem recurs, reinstall the new ECU to complete the repair.

6. If code 4521 occurs repeatedly and the F solenoid and wiring checks okay, the F-Hi or F-Lo driver may be failed open. Follow Step (5) above.

CODE 45 XX — OPEN CONDITION IN SOLENOID CIRCUIT *(Figure 5–19)*

7. If codes 4523 and 4526 occur repeatedly and solenoids and wiring check okay, the H and N-Hi driver may be failed open. Follow Step (5) above.

8. If the open is not found in either the transmission or the harness or the ECU drivers, the condition must be intermittent.

9. Drain the fluid, remove the control module, and closely inspect the solenoid and internal harness for damage. Repair or replace as necessary.

10. If the condition recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the solenoid circuit indicated by the diagnostic code.

11. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 46 XX — OVERCURRENT TO SOLENOIDS

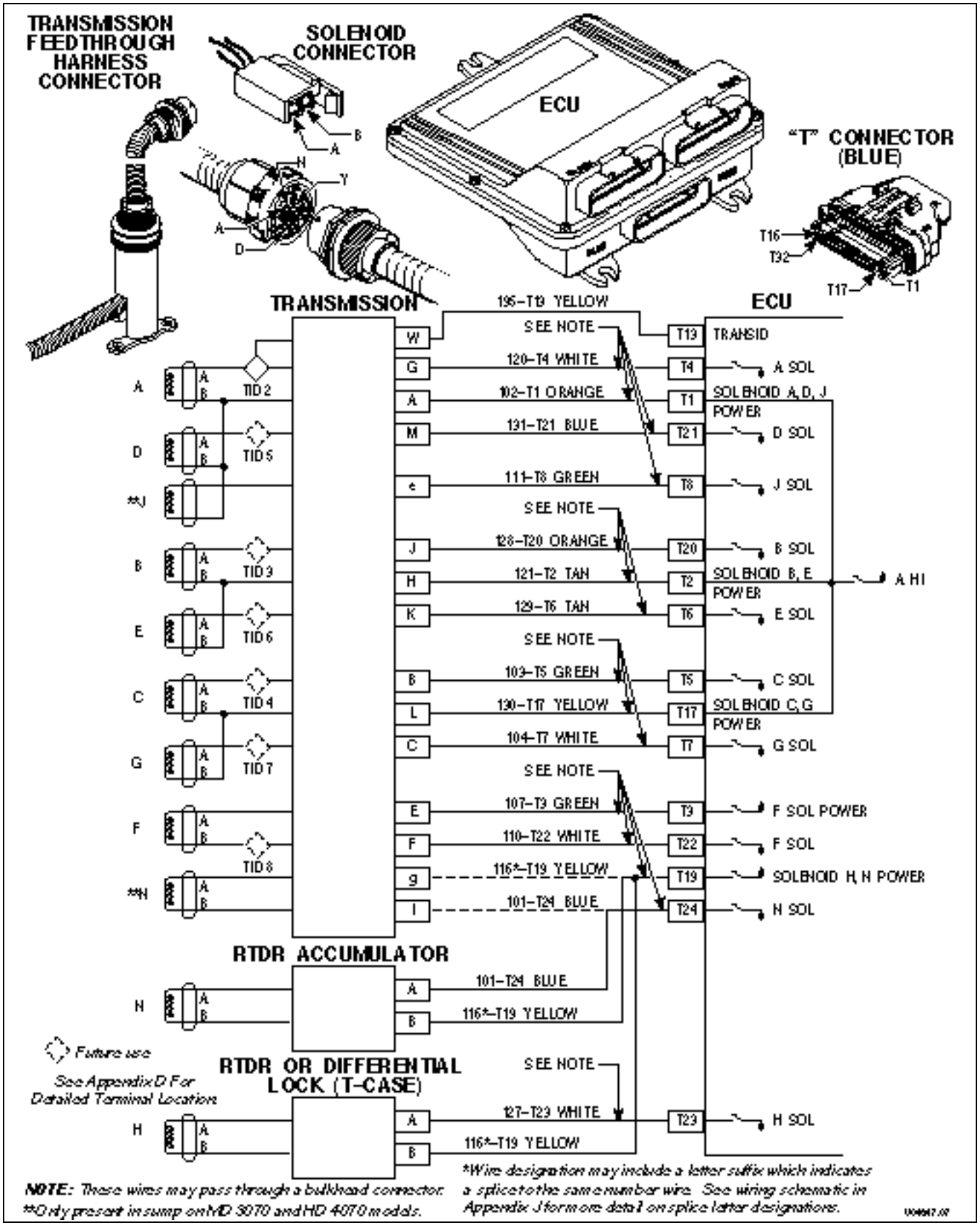


Figure 5–20. Code 46 Schematic Drawing

CODE 46 XX — OVERCURRENT TO SOLENOIDS *(Figure 5–20)*

Main code 46 indicates that an overcurrent condition exists in one of the switches sending power to the transmission control solenoids.

Main Code	Subcode	Meaning
46	21	Overcurrent, F-High solenoid circuit
46	26	Overcurrent, N and H-High solenoid circuit
46	27	Overcurrent, A-High solenoid circuit

A. Active Indicator Clearing Procedure:

- Power down
- Manual

B. Troubleshooting:

1. Probable cause is a wiring problem. A solenoid wire is probably shorted to ground or the solenoid has a shorted coil which would cause an overcurrent condition. May also be an ECU problem.
2. Follow the troubleshooting steps for code 44 XX.

CODE 51 XX — OFFGOING RATIO TEST DURING SHIFT (TIE-UP TEST)

Main code 51 indicates a failed offgoing ratio test. An offgoing ratio test occurs during a shift and uses turbine and output speed sensor readings to calculate the ratio between them. The calculated speed sensor ratio is then compared to the programmed speed sensor ratio of the commanded range. After a shift is commanded, the ECU, after a period of time, expects the old ratio to be gone. If the ratio does not change properly, the ECU assumes the offgoing clutch did not release. The shift is retried if conditions still exist to schedule the shift. If the second shift is not successfully completed, code 51 XX is set and the ECU returns the transmission to the previous range. Additional codes could be logged for other shifts where "X" indicates the range from and "Y" indicates the range to.

NOTE: This test is not performed below a calibrated transmission output speed of 200 rpm.

Main Code	Subcode	Meaning
51	01	Low–1 upshift
51	10	1–Low downshift
51	12	1–2 upshift
51	21	2–1 downshift
51	23	2–3 upshift
51	24	2–4 upshift
51	35	3–5 upshift
51	42	4–2 downshift
51	43	4–3 downshift
51	45	4–5 upshift
51	46	4–6 upshift
51	53	5–3 downshift
51	64	6–4 downshift
51	65	6–5 downshift
51	XY	X–Y upshift or downshift

A. Active Indicator Clearing Procedure:

- Power down
- Manual — except subcodes 35, 42, 43, 45, 53

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

B. Troubleshooting:

1. Incorrect fluid level can cause 51 series codes. Allow the vehicle to idle for 3–4 minutes and check the transmission fluid level. If level is not correct, add or drain fluid to correct level.

2. If the fluid level is correct, connect a pressure gauge into the pressure tap for the offgoing clutch indicated by the code (refer to solenoid and clutch chart, Appendix C). Make the shift indicated by the subcode or use the Pro-Link® diagnostic tool clutch test mode to put the transmission in the off-going and oncoming ranges (refer to Appendix B for clutch pressure check information).

CODE 51 XX — OFFGOING RATIO TEST DURING SHIFT (TIE-UP TEST)

3. If the offgoing clutch stays pressurized, drain the fluid, remove the control module, disassemble the control module and clean it, inspecting for damaged valve body gaskets and stuck or sticky valves. Inspect the transmission for signs of clutch damage indicating the need to remove and overhaul the transmission.
4. If the problem has not been isolated, replace the solenoid for the offgoing clutch.
5. If after replacing the solenoid the problem persists, install another ECU. If this corrects the problem, temporarily reinstall the old ECU to verify the repair.
6. If this does not correct the problem, reinstall the original ECU and check for mechanical problems. The clutch may be mechanically held (coned, burned and welded, etc.). It may be necessary to remove the transmission and repair or rebuild as required.

CODE 52 XX — OFFGOING C3 PRESSURE SWITCH TEST DURING SHIFT

Main code 52 indicates a failed C3 pressure switch test. When a shift is commanded and C3 is the offgoing clutch, the ECU expects the C3 pressure switch to open within a period of time after the shift is commanded. If the ECU does not see the switch open, it assumes C3 has not released. If conditions for a shift exist, the shift is retried. If the C3 pressure switch still remains closed, the code is logged and the **DO NOT SHIFT** response is commanded. If the code is set during a direction change, neutral with no clutches is commanded, otherwise the transmission is commanded to the previous range. Additional codes could be logged for other shifts where "X" indicates the range from and "Y" indicates the range to.

NOTE: C3 tests are turned off below a calibrated temperature of –32ºC (–25°F).

Main Code	Subcode	Meaning
52	01	L–1 upshift
52	08	L–N1 shift
52	32	3–2 downshift
52	34	3–4 upshift
52	54	5–4 downshift
52	56	5–6 upshift
52	71	R–1 shift
52	72	R–2 shift
52	78	R–N1 shift
52	79	R–2 shift (R to NNC to 2)
52	99	N3–N2 shift
52	XY	X–Y shift

A. Active Indicator Clearing Procedure:

- Power down
- Manual

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

B. Troubleshooting:

1. Use the Pro-Link® diagnostic tool to check the state of the C3 pressure switch.
2. Check the C3 pressure switch wiring for a short-to-ground or a switch stuck closed (refer to code 32XX). If a short is found, isolate and repair; or replace the switch if it is stuck closed.
3. If a fault is not found with the C3 pressure switch or circuitry, connect a pressure gauge to the C3 pressure tap.
4. Drive the vehicle to make the shift indicated by the subcode or use the DDR clutch test mode. Compare actual C3 pressure value with the table of specifications in Appendix B.

CODE 52 XX — OFFGOING C3 PRESSURE SWITCH TEST DURING SHIFT

5. If C3 is being held on hydraulically (C3 remains pressurized), drain the fluid, remove the control module, disassemble and clean the control module, checking for damaged valve body gaskets or stuck and sticky valves.
6. If the problem recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the C3 pressure switch in the external harness.
7. If the problem again recurs, replace the C solenoid.
8. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 53 XX — OFFGOING SPEED TEST (DURING SHIFT)

Main code 53 indicates a failed offgoing speed test. The speed test during a shift is designed to ensure neutral is attained during shifts to neutral. This test compares engine speed to turbine speed. If neutral is selected and turbine speed is found to be much lower than engine speed, the ECU sees this as neutral not being attained. The transmission is commanded to Neutral with No Clutches and code 53XX is set. Additional codes could be logged for other shifts where "X" indicates the range from and "Y" indicates the range to.

NOTE: This test is not performed if neutral output is below 200 rpm or when temperatures are below a calibrated 0°C (32°F).

Main Code	Subcode	Meaning
53	08	L–N1 shift
53	18	1–N1 shift
53	28	2–N1 shift
53	29	2–N2 shift
53	38	3–N1 shift
53	39	3–N3 shift
53	48	4–N1 shift
53	49	4–N3 shift
53	58	5–N1 shift
53	59	5–N3 shift
53	68	6–N1 shift
53	69	6–N4 shift
53	78	R–N1 shift
53	99	N3–N2 or N2–N3 shift
53	XY	X–Y shift

A. Active Indicator Clearing Procedure:

- Power down
- Manual — subcodes 78 and 99 only

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

B. Troubleshooting:

1. Be sure the transmission is warm and the fluid level is correct. Correct transmission fluid level as necessary.

2. Using the DDR, check the engine and turbine speed sensor signals under steady conditions. If a tachometer is available, compare the tachometer reading with the engine rpm reading on the diagnostic tool. Check signals in neutral, at idle, high idle, and maximum no load rpm. If a signal is erratic, check sensor wiring for opens, shorts, and shorts-to-ground (refer to code 22þXX). Check all connections for dirt and corrosion. If wiring problems are found, repair or replace as necessary.

CODE 53 XX — OFFGOING SPEED TEST (DURING SHIFT)

3. If fluid and wiring are satisfactory, install a pressure gauge in the pressure tap for the offgoing clutch. Make the shift indicated by the subcode using the clutch test mode of the Pro-Link® diagnostic tool. If the pressure gauge shows clutch pressure (above 55 kPa or 8 psi) remains in the offgoing clutch, drain the fluid and remove the control module (see the transmission Service Manual). Disassemble and clean the control module and check for damaged valve body gaskets and stuck or sticky valves, particularly latch valves and solenoid second-stage valves.
4. If excessive clutch pressure is not remaining in the offgoing clutch, replace the engine speed sensor and the turbine speed sensor.
5. If the control module is removed to replace the turbine speed sensor (MD, B 300, B 400), clean the control module and inspect for stuck or sticky valves (particularly the latch valves and solenoid G second stage valve). Check the rotating clutch drum to which the turbine speed sensor is directed for damage, contamination, or signs of contact between the drum and the sensor.
6. If the problem recurs, replace the solenoid(s) for the offgoing clutch(es).
7. If the problem again recurs, the offgoing clutch must be held on mechanically (coned, burned, etc.). Remove the transmission and repair or rebuild as necessary.
8. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 54 XX — ONCOMING SPEED TEST (AFTER SHIFT)

Main code 54 indicates a failed oncoming ratio test. The ratio test after a shift is failed when the ECU has commanded the end of a shift and has not seen the transmission shift into the target range (comparing turbine and output speeds). Erratic readings from speed sensors are a likely cause of an oncoming ratio test failure. If conditions for a shift still exist, the shift will be retried one more time. If the ratio test is still not met, a code is logged and the **DO NOT SHIFT** response is commanded. If the code is set during a direction change, Neutral with No Clutches is commanded, otherwise the transmission is commanded to the previous range. **Code 54 12 can also be caused by the ECU being calibrated for a close ratio transmission and installed with a wide ratio transmission, or vice versa.** Additional codes could be logged for other shifts where "X" indicates the range from and "Y" indicates the range to.

NOTE: This test is not performed below a calibrated transmission output speed of 200 rpm.

Main Code	Subcode	Meaning
54	01	L–1 upshift
54	07	L–R shift
54	10	1–L downshift
54	12	1–2 upshift — incorrect calibration, wide ratio vs. close ratio
54	17	1–R shift
54	21	2–1 downshift
54	23	2–3 upshift
54	24	2–4 upshift
54	27	2–R shift
54	32	3–2 downshift
54	34	3–4 upshift
54	35	3–5 upshift
54	42	4–2 downshift
54	43	4–3 downshift
54	45	4–5 upshift
54	46	4–6 downshift
54	53	5–3 downshift
54	54	5–4 downshift
54	56	5–6 upshift
54	64	6–4 downshift
54	65	6–5 downshift
54	70	R–L shift
54	71	R–1 shift
54	72	R–2 shift
54	80	N1–L shift
54	81	N1–1 shift
54	82	N1–2 shift
54	83	N1–3 shift
54	85	N1–5 shift
54	86	N1–6 shift
54	92	N2–2 shift
54	93	N3–3 shift
54	95	N3–5 shift
54	96	N4–6 shift
54	XY	X to Y shift

CODE 54 XX — ONCOMING SPEED TEST (AFTER SHIFT)

A. Active Indicator Clearing Procedure:

- Power down
- Manual

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

B. Troubleshooting:

1. After the transmission is at operating temperature, allow the vehicle to idle on level ground for 3–4 minutes. Check transmission fluid level. If improper fluid level is found, correct as necessary. Improper fluid level could be the cause of the code (not enough or too much fluid may produce inadequate clutch pressure).

2. Connect a pressure gauge and check main pressure. If pressure is not adequate, the pump is possibly worn. See Appendix B for main pressure specifications.

3. If the fluid level is correct, check the turbine and output speed sensors for accurate, steady signals using the diagnostic tool (check with vehicle stopped and in range to confirm a zero speed reading from the turbine and output speed sensors). Check the wiring for opens and shorts (refer to code 22XX) and the sensor coils for proper resistance. If problems are found, repair or replace as necessary. Remove speed sensor and check for loose tone wheel.

4. If sensor and wiring resistance are acceptable, connect a pressure gauge(s) to the pressure tap for the oncoming clutches indicated by the subcode (refer to solenoid and clutch chart in Appendix C). Make the shift indicated by the code by operating the vehicle or by using the diagnostic tool's clutch test mode.

5. If the clutch pressure does not show on the gauge(s), the control module is probably not commanding the clutch on. Drain the fluid and remove the control module. Disassemble and clean the control module, inspect for stuck or sticking valves.

6. Internal leakage is indicated by the clutch pressure gauge showing that pressure is being sent to the clutch but the clutch fails to hold. The fault may be: missing or damaged face seals, burnt clutch, leaking piston sealrings, or damaged control module gaskets. Drain the fluid, remove the control module, and inspect the face seals and control module gaskets. If the seals and gaskets are satisfactory, replace the solenoid(s) indicated by the code. If replacing the solenoid does not eliminate the code, remove the transmission and repair as necessary.

7. If clutch pressures are correct and the clutch appears to be holding, replace the output and turbine speed sensors.

8. If the problem recurs, use the diagnostic tool to check the speed sensor signals for erratic readings. Possible causes of erratic speed readings are: loose sensors, intermittent contact in the wiring, vehicle-induced vibrations, or speed sensor wiring that is not a properly twisted-pair. If necessary, use a twisted-pair for a new speed sensor circuit — Service Harness Twisted Pair P/N200153 is available from St. Clair Technologies for this purpose.

9. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 55 XX — ONCOMING C3 PRESSURE SWITCH (AFTER SHIFT)

Main code 55 indicates the C3 clutch is the oncoming clutch in a shift and the C3 pressure switch did not close at the end of the shift. When this code is set, the **DO NOT SHIFT** response and **Neutral with No Clutches** is commanded. On the N1 to R shift the transmission is commanded to the previous range. Additional codes could be logged for other shifts where "X" indicates the range from and "Y" indicates the range to.

NOTE: ***When an ECU with a version 8 or 8A calibration is used with a pre-TransID transmission, 55 XX codes are set because the ECU sees wire 195 is open. To correct this condition, convert to a TID 1 internal harness or install Adapter P/N 200100 available from St. Clair Technologies.***

Main Code	Subcode	Meaning
55	07*	Oncoming C3PS (after shift), L–R shift
55	17*	Oncoming C3PS (after shift), 1–R shift
55	27*	Oncoming C3PS (after shift), 2–R shift
55	87	Oncoming C3PS (after shift), N1–R shift
55	97	Oncoming C3PS (after shift), N1–L to R shift
55	XY	Oncoming C3PS (after shift), X to Y shift

****NOTE:*** ***When sump temperature is below 10°C (50°F), and transmission fluid is C4 (not DEXRON®), follow this procedure when making directional change shifts:***

- ***To shift from forward to reverse; select N (Neutral) and then R (Reverse).***
- ***Failure to follow this procedure may cause illumination of the CHECK TRANS light and then transmission operation will be restricted to N (Neutral).***

A. Active Indicator Clearing Procedure:

- Power down
- Manual — subcode 87 only

NOTE: ***Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.***

NOTE: ***Check battery and ECU input voltages before troubleshooting.***

B. Troubleshooting:

NOTE: ***Do not bring the transmission to operating temperature if the problem occurs at sump temperatures below that level. Do troubleshooting at the temperature level where the problem occurs.***

1. After the transmission is at operating temperature, allow vehicle engine to idle on level ground for 3–4 minutes. Check transmission fluid level. If improper fluid level is found, correct as necessary. Improper fluid level could be the cause of the code (not enough or too much fluid may produce inadequate clutch pressure).
2. Connect a pressure gauge and check main pressure. If pressure is not adequate, the pump is possibly worn. See Appendix B for main pressure specifications.

CODE 55 XX — ONCOMING C3 PRESSURE SWITCH (AFTER SHIFT)

3. If fluid level and main pressure are adequate, connect a pressure gauge to the C3 pressure tap on the transmission and make the shift indicated by operating the vehicle using the Pro-Link® diagnostic tool's CLUTCH TEST MODE.

NOTE: When using the CLUTCH TEST MODE on the Pro-Link®, be sure to use the correct pressure specification. If testing is done with the vehicle stopped, the lockup clutch is not applied, so use the clutch pressure specification for converter operation (see Appendix B; pressure in 3C would be the same as in 2C). If testing is done with the vehicle moving, the lockup clutch may be applied depending upon the vehicle speed and throttle position. Be sure to use the clutch pressure specification for lockup operation (see Appendix B).

4. If, when making the shift and producing the code, the C3 clutch does not show any pressure, drain the fluid and remove the control module. Disassemble, clean, and inspect the control module for stuck or sticky valves (particularly the "C" solenoid second stage valve and C-1 latch valve). If no obvious problems are found, replace the "C" solenoid and reassemble (see Figure 5–1 for location of the "C" solenoid).

5. If the gauge shows inadequate pressure being sent to the clutch, the clutch is probably worn, has leaking piston or face seals, or the control module gaskets are damaged. See Appendix B for clutch pressure specification. Drain the fluid, remove the control module and inspect the face seals and valve body gaskets. If the face seals or control module gaskets are not damaged, remove and repair the transmission (refer to the transmission Service Manual for repair procedure).

6. If the gauge shows adequate clutch apply pressure, the problem is with the C3 pressure switch or its wires. Check the C3 pressure switch wires in the transmission harness for opens, shorts, or shorts-to-ground (see code 32þXX). If found, isolate and repair the C3 pressure switch circuit.

NOTE: A leakage problem may be temperature related. Be sure to check pressures at the sump temperature where the problem occurred.

7. If the problem is not in the transmission harness, drain the fluid and remove the control module. Check the feedthrough harness assembly for opens. If wiring problems are found, repair as necessary. If no wiring problems are found, replace the C3 pressure switch (see Figure 5–1 for the location).

8. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 56 XX — RANGE VERIFICATION RATIO TEST (BETWEEN SHIFTS)

Main code 56 indicates a failed range verification speed sensor ratio test. The ratio test occurs after a shift and determines if a clutch has lost torque carrying capability. If output speed is above programmed output speed for a range but the correct speed sensor ratio is not present, the **DO NOT SHIFT** response is commanded and a range which can carry the torque without damage is commanded or attempted. Turbine and output speed sensor readings are used to calculate the actual ratio that is compared to the commanded ratio. **Main code 56 can also be caused by the ECU being calibrated for a close ratio transmission and installed with a wide ratio transmission, or vice versa.**

Main Code	Subcode	Meaning
56	00	Range verification ratio test (between shifts) L
56	11	Range verification ratio test (between shifts) 1
56	22	Range verification ratio test (between shifts) 2
56	33	Range verification ratio test (between shifts) 3
56	44	Range verification ratio test (between shifts) 4
56	55	Range verification ratio test (between shifts) 5
56	66	Range verification ratio test (between shifts) 6
56	77	Range verification ratio test (between shifts) R

A. Active Indicator Clearing Procedure:

- Power down
- Manual — subcodes 11, 44, 66, 77 only

NOTE: When a code 22 16 (output speed fault) is also present, follow the troubleshooting sequence for code 22 16 first. After completing the 22 16 sequence, drive the vehicle to see if a code 56 XX recurs.

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

B. Troubleshooting:

1. After the transmission is at operating temperature, allow vehicle engine to idle on level ground for 3–4 minutes. Check the transmission fluid level. If improper fluid level is found, correct as necessary. Improper fluid level could be the cause of the code. Not enough or too much fluid may produce inadequate clutch pressure.

2. Connect a pressure gauge and check main pressure. If the pressure is not adequate, the pump is probably worn. See Appendix B for main pressure specifications.

3. If main pressure is adequate, check clutch pressure for the range indicated by following the procedure in Appendix B. The transmission range indicated by the trouble code can be found by referring to the solenoid and clutch chart in Appendix C. Drive the vehicle or use the diagnostic tool's clutch test mode and check clutch pressure.

4. If a clutch is leaking pressure, drain the fluid, remove the control module and check for damaged control module gaskets and stuck or sticking valves. Also look for damaged or missing face seals. If no problems are found, replace the solenoids for the clutches used in the range indicated by the code.

CODE 56 XX — RANGE VERIFICATION RATIO TEST (BETWEEN SHIFTS)

5. If replacing solenoids does not correct the pressure problem, a worn clutch or worn piston seals are probably the source of the pressure leak. Remove the transmission and repair or replace as necessary.

6. This code requires accurate output and turbine speed readings. If there were no transmission problems detected, use the diagnostic tool and check the speed sensor signals for noise (erratic signals) from low speed to high speed in the range indicated by the code.

7. If a noisy sensor is found, check the resistance of the sensor (300 ± 30 Ohms, refer to the code 22XX temperature variation chart) and its wiring for opens, shorts, and shorts-to-ground (refer to code 22XX). Carefully check the terminals in the connectors for corrosion, contamination, or damage. Ensure the wiring to the sensors is a properly twisted wire pair. Replace a speed sensor if its resistance is incorrect. Isolate and repair any wiring problems. (Use a twisted-pair if a new speed sensor circuit is needed — Service Harness Twisted Pair P/N 200153 is available from St.Clair Technologies for this purpose.)

8. If no apparent cause for the code can be found, replace the turbine and output speed sensors.

9. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 57 XX — RANGE VERIFICATION C3 PRESSURE TEST (BETWEEN SHIFTS)

Main code 57 indicates failure of the range verification C3 pressure switch test. This test determines if the C3 pressure switch is closed when it should be open. The test occurs when a range is commanded that does not use the C3 clutch (neutral, 1, 2, 4, and 6). The code is set if the C3 pressure switch is closed when it should be open. If C3 clutch comes on when not needed, three clutches are applied and a transmission tie-up occurs. The ECU will command a range which does use the C3 clutch and activate the **DO NOT SHIFT** response.

Main Code	Subcode	Meaning	Replace Solenoid
57	11	Range verification C3 pressure switch while in 1st	B
57	22	Range verification C3 pressure switch while in 2nd	C
57	44	Range verification C3 pressure switch while in 4th	C
57	66	Range verification C3 pressure switch while in 6th	A
57	88	Range verification C3 pressure switch while in N1	C
57	99	Range verification C3 pressure switch while in N2 or N4	C

A. Active Indicator Clearing Procedure:

- Power down
- Manual

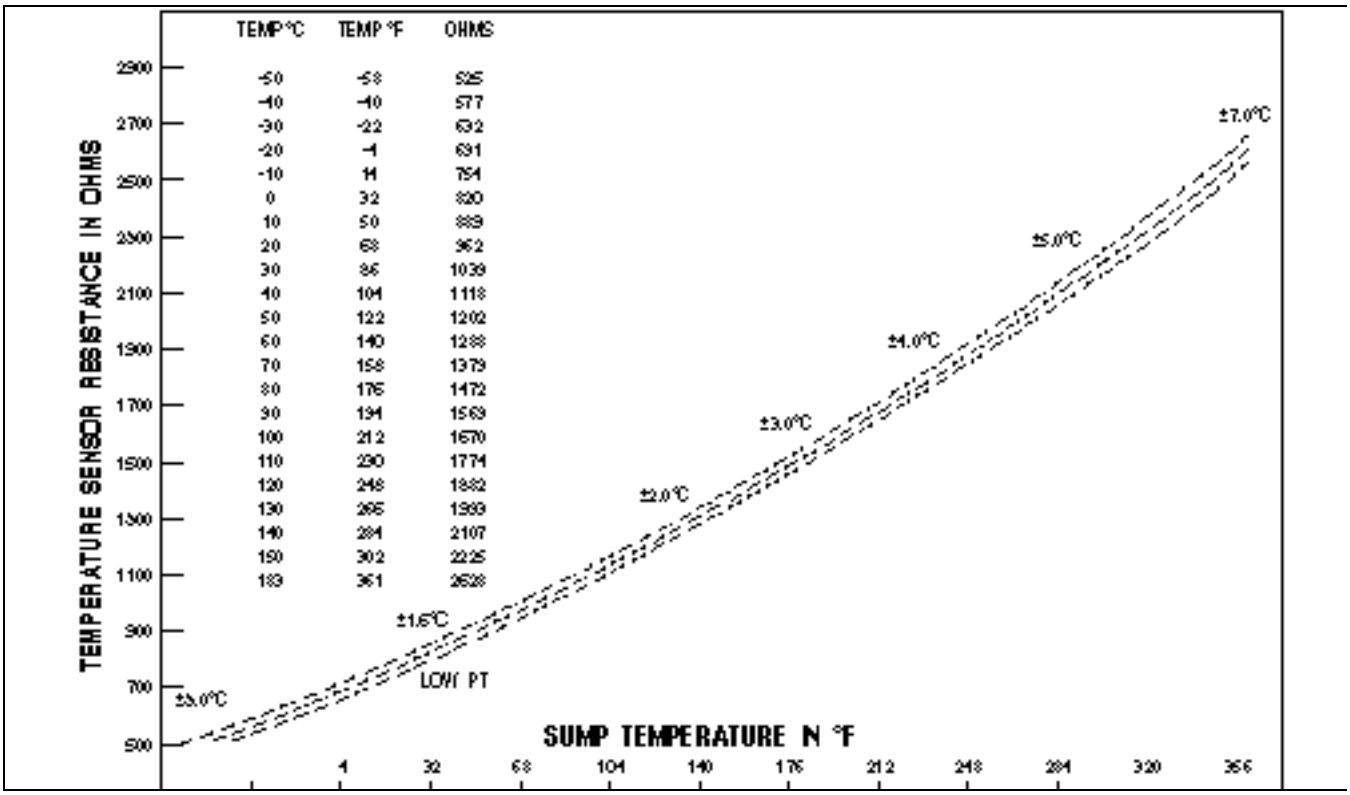
NOTE: Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.

NOTE: Intermittent connections or lack of battery-direct power and ground connections may cause this and other codes.

B. Troubleshooting:

1. Disconnect the harness from the transmission. Check the C3 pressure switch circuit at the feedthrough harness connector for continuity (refer to code 32XX).
2. Continuity at the feedthrough harness connector indicates the C3 pressure switch is closed or the C3 circuit is shorted together. Drain the fluid, remove the control module, and isolate the short. The fault is either a shorted feedthrough harness or stuck C3 pressure switch. Repair or replace as necessary.
3. If there is no continuity at the transmission, disconnect the transmission harness connector from the ECU and check the C3 pressure switch wires in the transmission harness for shorts. Use the system wiring diagram to identify wires which are connected. If a shorted C3 pressure switch circuit in the external harness is found, isolate and repair.
4. If the C3 pressure switch or circuit is not shorted either in the transmission or the external harness, connect a pressure gauge in the C3 pressure tap (refer to Appendix B for pressure tap location). Drive the vehicle in the range indicated by the code or use the diagnostic tool's clutch test mode to attain that range.
5. If the gauge shows C3 pressure is present in the range indicated by the subcode, drain the fluid and remove the control module. Check for damaged valve body gaskets or stuck or sticking valves. Repair or replace as necessary. If no obvious defects are found, replace the listed solenoid.
6. If the gauge shows C3 pressure is not present in the range indicated by the subcode, drain the fluid and remove the control module. Replace the C3 pressure switch.
7. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem reoccurs, reinstall the replacement ECU.

CODE 61 XX — RETARDER OIL TEMPERATURE HOT



Main code 61 indicates the ECU has detected a hot fluid condition in the output retarder. Table 5–7 shows what actions are taken by the ECU at elevated retarder temperatures.

Possible causes (but not all causes) for hot fluid are:

1. Prolonged retarder use.
2. TID 2 transmission with ECU prior to Version 8A.
3. Low fluid level.
4. High fluid level.
5. A retarder apply system that allows the throttle and retarder to be applied simultaneously.
6. Cooler inadequately sized for retarder.

If the validity of the hot fluid diagnosis is in question, temperature can be checked by using a temperature gauge at the retarder-out port or by reading retarder temperature with the Pro-Link® diagnostic tool. Another method of checking retarder temperature is to remove the “T” connector at the ECU and measure resistance (Ohms) between terminals T28 and T25. Compare the resistance value to the value in Figure 6–21 to see if the result is within the expected operating range.

NOTE: Use the Pro-Link® diagnostic tool to determine the software version being used.

The retarder temperature sensor is located externally on the HD retarder housing and under the plate on the MD retarder housing. When retarder temperature reaches a preset level, a retarder hot temperature light is illuminated.

NOTE: When an ECU with a version 8 calibration is used with a TransID 2 transmission, 62 XX codes are set because the ECU does not have the proper calibrations for the TID 2 thermistors. The ECU calibration must be updated to version 8A.

CODE 61 XX — RETARDER OIL TEMPERATURE HOT

Main code 62 indicates the retarder temperature sensor or engine coolant sensor or circuitry is providing a signal outside the usable range of the ECU. Main code 62 can be the result of a hardware failure or an actual extremely high or low temperature condition.

Main Code	Subcode	Meaning
62	12	Retarder temperature sensor failed low (–45°C; –49°F)
62	23	Retarder temperature sensor failed high (178°C; 352°F)
62	32	Engine coolant sensor failed low
62	33	Engine coolant sensor failed high

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

NOTE: Before troubleshooting, read Paragraph 5–6. Also, check the transmission fluid level.

B. Troubleshooting:

NOTE: A combination of codes 6223, 3323, and 2123 indicates a problem with one of the branches of the common ground wire (wire 135) between the throttle and temperature sensors.

NOTE: Code 62 12 can be caused when the +5V power line (wire 124) is shorted to ground or open. Wire 124 also provides power for the OLS, TPS, RMR, sump temperature sensor, and shift selectors and is present in all three ECU connectors.

1. Check the retarder temperature or engine coolant temperature with a DDR. If a DDR is not available, use the shift selector display to determine if the code is active (cycle the ignition on and off at least once since the code was logged to clear the code's active indicator). If a condition that is unreasonable for the current conditions exists, go to Step (3).

2. If Step (1) reveals that the extreme temperature indication is no longer present, the temperature limit could have been reached due to operational or ambient temperature extremes. Proceed cautiously as it is unlikely there is a sensor hardware fault.

3. Remove the connector at the ECU. Measure resistance between harness terminals T25 and T28 or between harness terminals V9 and V24. Compare resistance value to chart (see Figure 5–21) to see if reading is within expected operating range.

4. Disconnect the sensor connector and remove the connector at the ECU. Check the sensor and the ECU terminals for dirt, corrosion, and damage. Clean or replace as necessary.

5. Check the temperature sensor circuit for opens (code 62 23 or 62 33), shorts between wires, and short-to-ground (code 6212 or 62 32). If a wiring problem is found, isolate and repair.

6. If no wiring problem is found, replace the retarder or engine coolant temperature sensor.

7. If the problem recurs, use a spare wire, if available, or provide a new wire (St. Clair P/N 200153 may be used for this purpose) for the retarder or engine coolant temperature circuit.

CODE 62 XX — RETARDER TEMPERATURE SENSOR

8. If the condition continues to recur, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

Code 6300 is set when one of the two inputs for an input function Auxiliary Function Range Inhibit (Special) is in a different state (on or off) from the other input for longer than two minutes. When this condition is detected, code 6300 is set. The transmission will not be inhibited in shifting from neutral to range.

Main Code	Subcode	Meaning
63	00	Auxiliary Function Range Inhibit (Special) inputs states are different
63	26	Kickdown input failed on (software version 8 only)
63	40	Service brake status failed on
63	41	Pump/pack and a neutral general purpose input

Subcode 26 is set when this function (Kickdown) is selected by calibration, the calibration designated input is active for a calibration time, and throttle position is less than the calibration value defined. The kickdown shift schedule is inhibited when subcode 26 is active. The service indicator will be turned on if it is selected by the calibration. The kickdown shift schedule is not inhibited, the code is cleared and the service indicator will be turned off if the kickdown input remains inactive for the calibration time period while throttle position is less than the calibration value. This diagnostic and code has been removed from software version 8A.

Subcode 40 is set when this function (Service Brake Status) is selected by calibration, and the specified input remains active for a calibration number of consecutive acceleration events. The service indicator will be turned on if it is selected by the calibration. A vehicle acceleration event is defined as an increase in transmission output speed from 1 rpm to a calibration value. The operation of the Automatic Neutral For Refuse Packer will be limited when this code is active. The active inhibit for this code is self-cleared and the service indicator will be turned off if the designated input for the Service Brake Status function becomes inactive.

Subcode 41 is set when the states of the calibration inputs are different for a calibration number of consecutive updates. The inputs in this case are Pump/Pack Enable and Automatic Neutral For Refuse Packer. The service display will also be turned ON if selected by calibration.

A. Active Indicator Clearing Procedure:

- Power down
- Manual — subcodes 26, 40, and 41
- Self-clearing — subcodes 26 and 40

B. Troubleshooting:

1. Code 63 00

   a. Use the DDR to identify the two input wires programmed with Auxiliary Function Range Inhibit (Special). Inspect the input wiring, connectors, and switches to determine why the input states are different. Correct any problems which are found.

   b. If the condition persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

2. Code 63 26

   Inspect kickdown switch circuit.

CODE 62 XX — RETARDER TEMPERATURE SENSOR *(Figure 5–21)*

3. Code 63 40

   Inspect service brake status switch circuit.

4. Use the DDR to identify the two wires associated with the input functions for Pump/Pack Enable and Automatic Neutral For Refuse Packer. Inspect the input wiring, connectors, and switches to determine why the input states are different. Correct problems which are found. There is further information on these input functions on pages H–25, H–26, H–29, and H–30.

CODE 62 XX — RETARDER TEMPERATURE SENSOR *(Figure 5–21)*

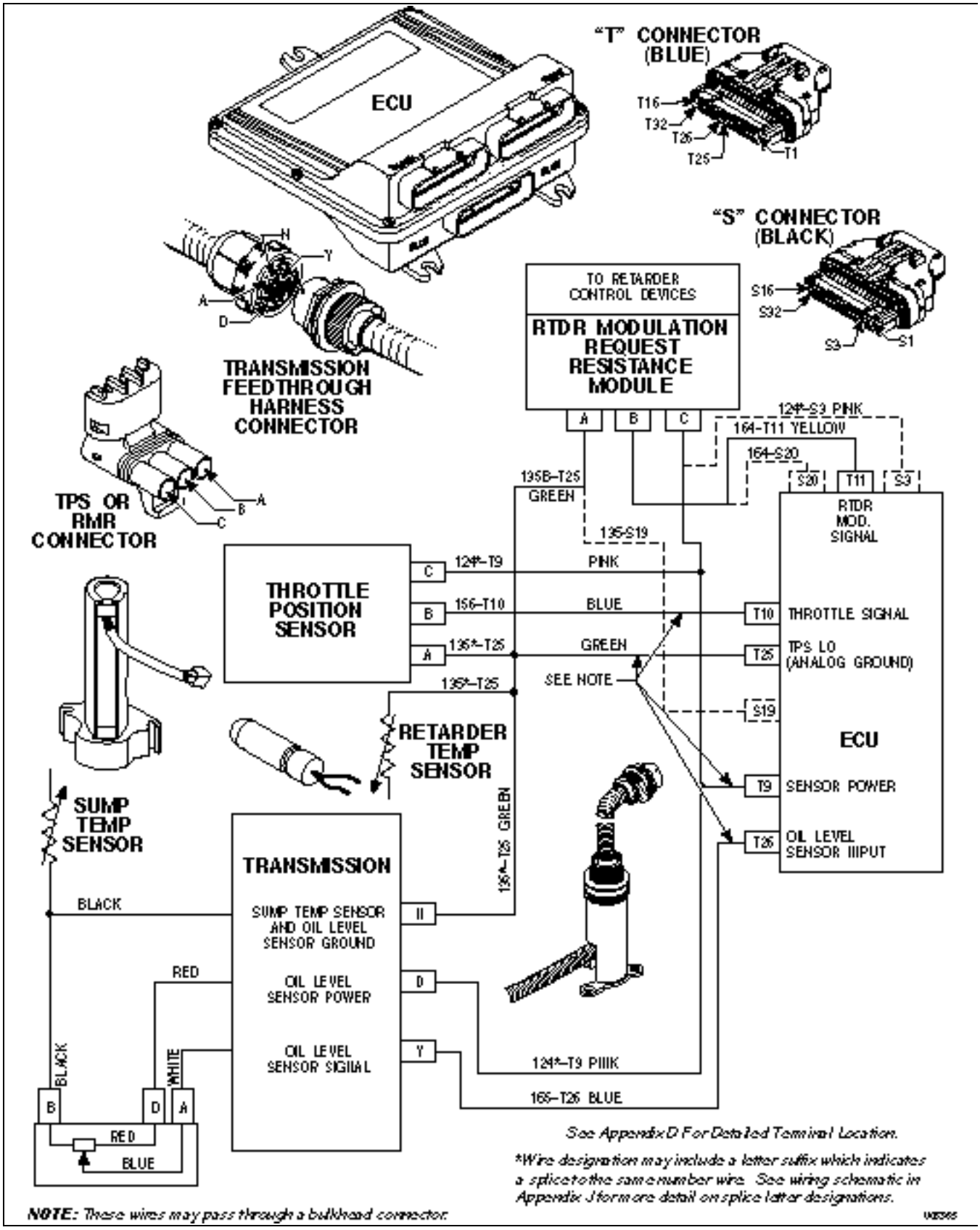


Figure 5–21. Code 64 Schematic Drawing

CODE 63 XX — INPUT FUNCTION FAULT

Main code 64 indicates the ECU has detected a voltage signal from the retarder modulation request sensor (consisting of a module and a retarder control device) in either the high or low error zone. These codes can be caused by faulty wiring, faulty connections to the resistance module or retarder control device, a faulty resistance module, a faulty retarder control device, or a faulty ECU. Power wire 124 and ground wire 135 for the retarder modulation request sensor are a common power and ground with the TPS and OLS devices. A short-to-ground on the common power wire causes a "sensor failed low" code for the other devices (codes 2112, and 1412). An open or a short-to-ground on retarder modulation request sensor signal wire 164 results in a code 6412 only.

A TPS failure changes the status of the output retarder. The retarder is enabled by the Service Brake Status (wire 137) when a TPS code is active (21XX). If a code 6340 is also active, the Service Brake Status (wire 137) is ignored and the retarder will not work. Retarder response problems may not cause retarder modulation request sensor diagnostic codes. If response questions occur, test the retarder control devices for proper voltage signals at each of the percentage of retarder application settings. Table 5–8 contains the voltage measurements for each device's application percentage and resistances measured across terminals A and C of the retarder request sensor. **Use test wiring harness J41339 when conducting voltage tests.**

Main Code	Subcode	Meaning
64	12	Retarder Modulation Request sensor failed Low (14 counts and below)
64	23	Retarder Modulation Request sensor failed High (232 counts and above)

A. Active Indicator Clearing Procedure:

- Power down

NOTE: ***Before troubleshooting, read Paragraph 5–6. Also, check battery and ECU input voltages.***

NOTE: ***Intermittent connections or lack of battery-direct power and ground connections can cause this and other electronic control codes.***

B. Troubleshooting:

NOTE: ***Code 64 12 can be caused when the +5V power line (wire 124) is shorted to ground or open. Wire 124 also provides power for the OLS, TPS, sump temperature sensor, retarder temperature sensor, and shift selectors and is present in all three ECU connectors..***

1. Plug in the DDR and set to read retarder counts and percent (0 percent will be between 15 and 60 counts and 100 percent will be between 150 and 233 counts). A retarder request sensor failed high code can be caused by a short-to-battery of either signal wire 164 or power wire 124 or an open on ground wire 135. An open in the portion of the ground circuit common to the TPS and OLS devices will also result in a code 2123 and a high fluid level reading. A retarder request sensor failed low code can be caused by an open or short-to-ground on either signal wire 164 or power wire 124.
2. Isolate and repair any wiring problems found.
3. If no wiring or connector problems are found, check the retarder request sensor voltages for each position on each of the retarder request sensors used on the vehicle. If two resistance modules are used, disconnect one of them when measuring voltage signals from the other. If problems are found, replace the resistance modules or retarder control devices.
4. If the problem persists, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the original ECU now works, inspect the ECU connectors for any corrosion or damage which may cause an intermittent condition. If the original problem recurs, reinstall the replacement ECU.

CODE 64 XX — RETARDER MODULATION REQUEST DEVICE FAULT

Table 5–1. RMR Device Resistance Checks

	Resistance Check in Resistance Module*		Voltage Signal **		Wiring to Control Device
Description	**Terminals**	**Resistance ± 5%**	**% Retarder Application**	**Voltage ± 0.2 v**	**Device Terminal**
Auto Full On	A to C	12K	100	3.6	No connections
Pressure Switch					
Full On	A to C	32K	0	1.1	A
High			100	3.6	B
3-Step E-10R Bendix	A to C	32K	0	1.1	A
Pedal			32	1.9	B
			58	2.8	C
			100	3.6	D
6-Step Hand Lever —	A to C	32K			
Off			0	1.1	+
Position 1			14	1.5	1
Position 2 Position			28	1.9	2
3 Position 4			45	2.3	3
Position 5 Position			65	2.8	4
6			82	3.2	5
			100	3.6	6
Auto ½ On	A to C	12K	50	2.4	No connections
3 Pressure Switches —	A to C	32K	0	1.1	
Low			32	1.9	A
					B
Medium			68	2.8	A
					B
High			100	3.6	A
					B
Auto ⅓ On	A to C	21.4K			
2 Pressure Switches					
Auto			32	1.9	A
Medium			68	2.8	B
High			100	3.6	A
					B
Dedicated Pedal	No Checks	Interface not	0	0.7 – 1.2	A
		a resistance	100	3.4 – 3.5	B
		module			C

* Resistance module must be disconnected from the wiring harness and retarder control devices

** These voltages must be measured between terminals A and B.

CODE 64 XX — RETARDER MODULATION REQUEST DEVICE FAULT *(Figure 5–22)*

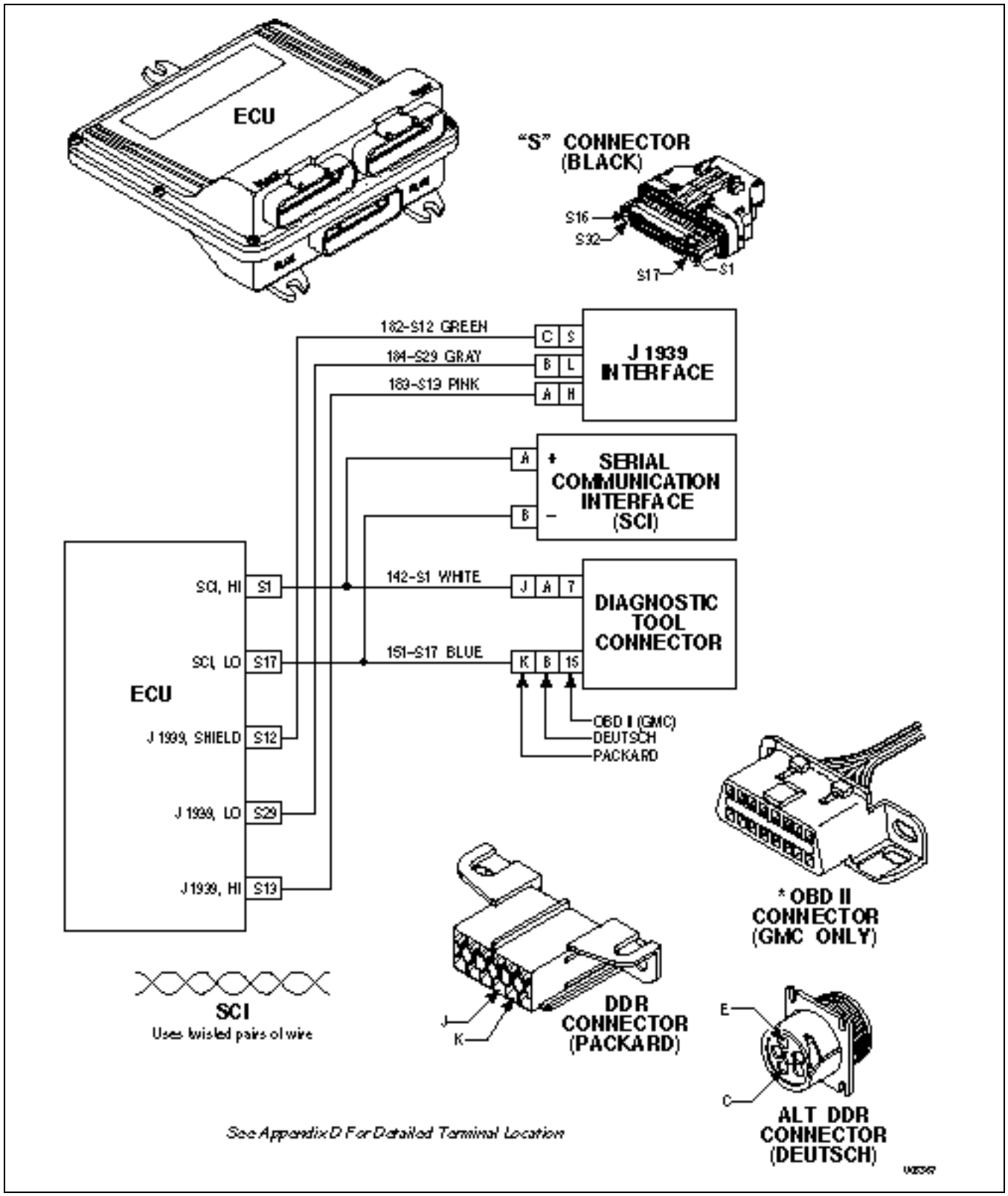


Figure 5–22. Code 66 Schematic Drawing

CODE 64 XX — RETARDER MODULATION REQUEST DEVICE FAULT

The datalink for throttle sensor or engine coolant temperature must have been recognized by autodetect or manually selected using the Pro-Link® (see WTEC III Pro-Link® Manual) before these codes can be logged.

Main code 66 indicates the ECU is expecting to get its throttle position signal or engine coolant signal across a serial communication interface from a computer-controlled engine. Either the engine computer is not sending the throttle or engine coolant information or the wiring between the engine and transmission computers has failed.

Code 66 00 can occur when the transmission ECU remains powered when the engine ECM is powered down. The transmission sees this as a communication link failure.

Main Code	Subcode	Meaning
66	00	SCI (Serial Communication Interface) fault
66	11	SCI Engine coolant source fault

A. Active Indicator Clearing Procedure:

- Power down
- Manual
- Self-clearing

B. Troubleshooting:

1. Check for a throttle signal or engine coolant signal from the engine to the transmission, an engine computer malfunction, an engine throttle fault, or an engine coolant fault.

NOTE: Throttle position data sent from a computer-controlled engine may register a low number of counts on the DDR, but the counts will not change as throttle percentage is changed.

2. Check wires 142 and 151 between the engine and transmission ECU for an open or short. Check that all connectors are clean and tightly connected.

NOTE: These codes can also be set if J1939 communications fail. Check wires 183-S13, 184-S29, and 182-S12 for opens or shorts.

3. Use the Pro-Link® to see if the ECU is receiving power when it should not.

CODE 65 XX — ENGINE RATING HIGH

Main code 65 indicates the vehicle's engine horsepower/governor speed rating is too high. This code is set only when computer-controlled engines are used. Code 65 means the engine computer is able to tell the transmission, the engine horsepower and/or governor speed is beyond the transmission rating or does not match the transmission shift calibration.

When a code 65 is set, no shifts out of neutral are allowed. It is possible the transmission calibration selected for this engine is improper. Contact local Allison Transmission Division distributor for assistance in selecting a proper calibration.

If the engine is beyond transmission ratings, contact the vehicle OEM for correction. The local ATD regional representative may also be contacted for assistance.

This code cannot be cleared until the proper level engine is installed or the transmission is properly calibrated.

CODE 66 XX — SCI (SERIAL COMMUNICATION INTERFACE) FAULT

Main code 69 indicates a problem which has been identified as being from within the ECU.

A “cateye” display or a blank display may occur with subcode 33.

Main Code	Subcode	Meaning
69	27	ECU, Inoperative A-Hi switch
69	28	ECU, Inoperative F-Hi switch
69	29	ECU, Inoperative N-Hi and H-Hi switch
69	33	ECU, computer operating properly timeout
69	34	ECU, write timeout
69	35	ECU, checksum
69	36	ECU, RAM self-check failure
69	39	Communication chip addressing error
69	41	ECU, I/O ASIC addressing test
69	42	SPI output failure
69	43	SPI input failure

A. Active Indicator Clearing Procedure:

- Power down
- Manual — except subcodes 33, 35, 36, 41, 42, and 43
- Self-clearing — subcode 42 and subcodes 33, 35, 36, and 41; after an ECU reset

NOTE: Subcode 34 cannot be cleared.

B. Troubleshooting:

1. For subcodes 27, 28, and 29, check for shorts to battery before replacing the ECU. Follow the troubleshooting steps for code 42 XX for checking shorts to battery. If no shorts are found, replace the ECU. If replacing the ECU corrects the problem, reinstall the original (bad) ECU to confirm that the problem is in the ECU. If the problem recurs, reinstall the new ECU to complete the repair.
2. For all other subcodes, replace the ECU.

APPENDICES

Appendix A	Identification of Potential Circuit Problems
Appendix B	Checking Clutch and Retarder Pressures
Appendix C	Solenoid and Clutch Chart
Appendix D	Wire/Connector Chart
Appendix E	Welding on Vehicle/Vehicle Interface Module
Appendix F	Diagnostic Tree — WT Series Hydraulic System
Appendix G	Pro-Link® 9000 Diagnostic Data Reader Information
Appendix H	Input/Output Function Wiring Schematics

APPENDIX A — IDENTIFICATION OF POTENTIAL CIRCUIT PROBLEMS

Intermittent codes are a result of faults that are detected, logged, and then disappear, only to recur later. If, when troubleshooting, a code is cleared in anticipation of it recurring and it does not, check the items in the following list for the fault's source.

A. Circuit Inspection

1. Intermittent power/ground problems — can cause voltage problems during ECU diagnostic checks which can set various codes depending upon where the ECU was in the diagnostic process.
2. Damaged terminals.
3. Dirty or corroded terminals.
4. Terminals not fully seated in the connector. Check indicated wires by uncoupling connector and gently pulling on the wire at the rear of the connector and checking for excessive terminal movement.
5. Connectors not fully mated. Check for missing or damaged locktabs.
6. Screws or other sharp pointed objects pushed into or through one of the harnesses.
7. Harnesses which have rubbed through and may be allowing intermittent electrical contact between two wires or between wires and vehicle frame members.
8. Broken wires within the braiding and insulation.

B. Finding an Intermittent Fault Condition

To find a fault, like one of those listed, examine all connectors and the external wiring harnesses. Harness routing may make it difficult to see or feel the complete harness. However, it is important to thoroughly check each harness for chafed or damaged areas. Road vibrations and bumps can damage a poorly installed harness by moving it against sharp edges and cause some of the faults. If a visual inspection does not identify a cause, move and wiggle the harness by hand until the fault is duplicated.

The next most probable cause of an intermittent code is an electronic part exposed to excessive vibration, heat, or moisture. Examples of this are:

1. Exposed harness wires subjected to moisture.
2. A defective connector seal allows moisture to enter the connector or part.
3. An electronic part (ECU, shift selector, solenoid, or throttle sensor) affected by vibration, heat, or moisture may cause abnormal electrical conditions within the part.

When troubleshooting Item 3, eliminate all other possible causes before replacing any parts.

Another cause of intermittent codes is good parts in an abnormal environment. The abnormal environment will usually include excessive heat, moisture, or voltage. For example, an ECU that receives excessive voltage will generate a diagnostic code as it senses high voltage in a circuit. The code may not be repeated consistently because different circuits may have this condition on each check. The last step in finding an intermittent code is to observe if the code is set during sudden changes in the operating environment.

Troubleshooting an intermittent code requires looking for common conditions that are present whenever the code is diagnosed.

APPENDIX A — IDENTIFICATION OF POTENTIAL CIRCUIT PROBLEMS

C. Recurring Conditions

A recurring condition might be:

- Rain
- Outside temperature above or below a certain temperature
- Only on right-hand or left-hand turns
- When the vehicle hits a bump, etc.

If such a condition can be related to the code, it is easier to find the cause. If the time between code occurrences is very short, troubleshooting is easier than if it is several weeks or more between code occurrences.

DIAGNOSTIC CODES

APPENDIX B — CHECKING CLUTCH AND RETARDER PRESSURES

Checking individual clutch pressures helps to determine if a transmission malfunction is due to a mechanical or an electrical problem. Properly making these pressure checks requires transmission and vehicle (or test stand) preparation, recording of data, and comparing recorded data against specifications provided. These instructions are for all WT Series transmissions.

NOTE: ***Check to see if there are diagnostic codes set which are related to the transmission difficulty you are evaluating. Proceed to make mechanical preparations for checking clutch pressures after codes have first been evaluated.***

A. Transmission and Vehicle Preparation

1. Remove the plugs from the pressure tap locations where measurement is desired (refer to Figure B–1).

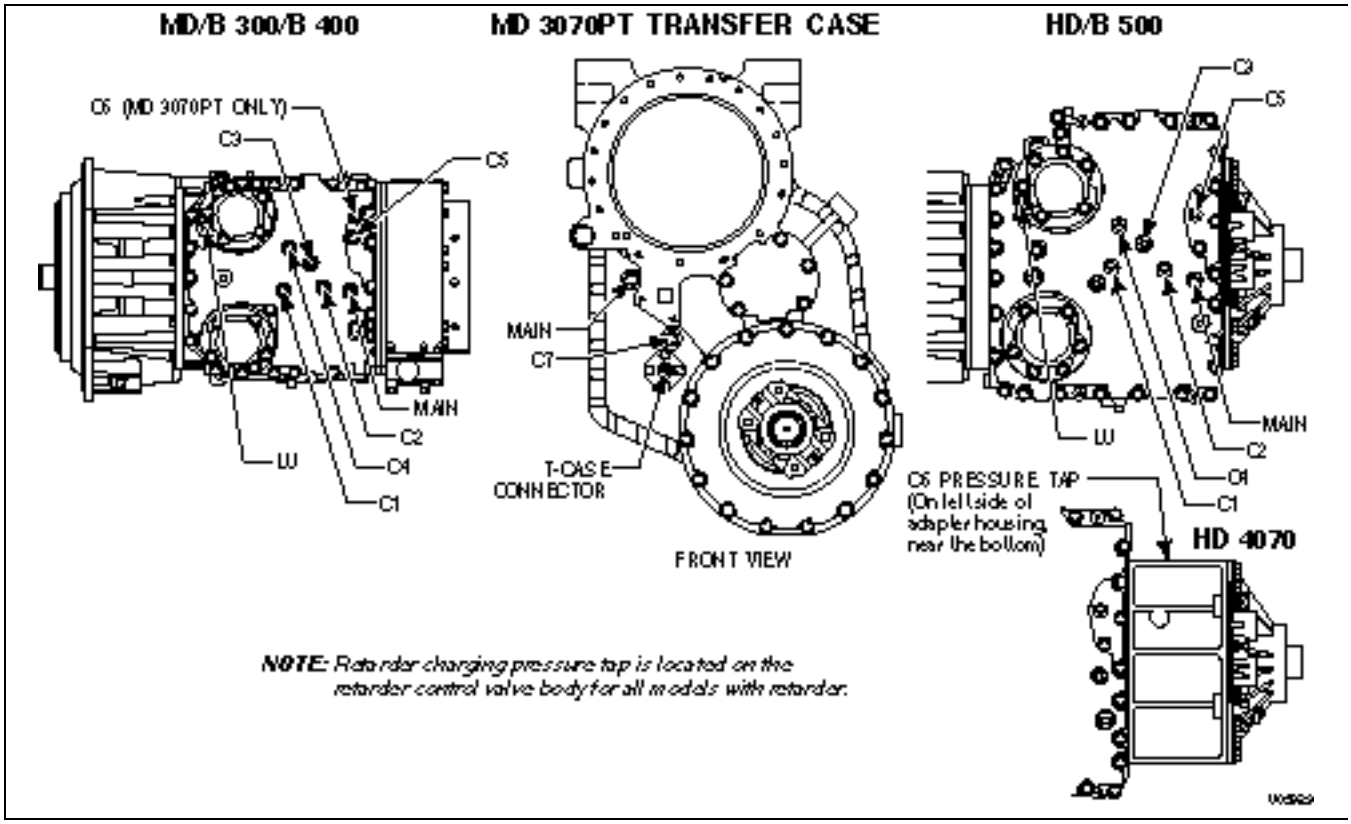


Figure B–1. Clutch Pressure Check Points

CAUTION:	Be sure that the hydraulic fittings have the same thread as the plugs removed (7/16-20 UNF-2A). Also please note that these fittings must be straight thread, O-ring style. Failure to do this will result in damage to the control module.

2. Install hydraulic fittings suitable for attaching pressure gauges or transducers.
3. Connect pressure gauges or transducers. Pressure gauge set J26417-A is available for this purpose. See Table B–2 for pressure levels expected.
4. Check that engine speed can be monitored (Pro-Link® 9000 diagnostic tool may be used for this purpose).

APPENDIX B — CHECKING CLUTCH AND RETARDER PRESSURES

5. Be sure that transmission sump fluid temperature can be measured (Pro-Link® 9000 diagnostic tool may be used for this purpose).
6. Be sure that the transmission has enough fluid for cold operation until an operating temperature fluid level can be set.
7. Bring the transmission to normal operating temperature of 71–93ºC (160–200ºF). Check for fluid leaks in the added pressure gauge/transducer lines. Repair leaks as needed. Be sure that fluid level is correct.

B. Recording Data

1. Use the Pro-Link® 9000 diagnostic tool, which allows checking of individual range clutch pressures, with the vehicle stationary. Consult Appendix G or the Pro-Link® 9000 operating instructions for Action Request and select Clutch Test Mode. Follow instructions to check clutch pressures in individual ranges.

NOTE: ***Check lockup clutch pressure by driving the vehicle in a range where lockup can be obtained. Record the pressure values at the engine speed and sump fluid temperature values shown in Table B–1. The lockup clutch is functioning correctly when engine speed and turbine speed values are equal as recorded from the Pro-Link® 9000.***

2. Consult Table B–1 and locate the transmission model that you are testing.
3. Operate the transmission at the conditions shown in Table B–1 and record engine speed, transmission sump fluid temperature, main hydraulic pressure, and clutch pressures in the ranges where a problem is suspected.

Table B–1. Clutch Pressure Test Conditions

Transmission Model/ Test Type	Engine rpm	Sump Fluid Temperature	Range	Clutches Pressurized
All (except MD 3070) — Idle Check	580–620	71–93ºC (160–200ºF)	Neutral Reverse 1C 2C (2nd range start)	C5 C3 C5 C1 C5 C1 C4
MD 3070 — Idle Check	580–620	71–93ºC (160–200ºF)	Neutral Reverse LowC 1C	C5 C3 C5 C3 C6 C1 C5
MD (except 3070) B 300/B 400 — High Speed	2080–2120	71–93ºC (160–200ºF)	Reverse Neutral 1C 2C 2L 3L 4L 5L 6L	C3 C5 C5 C1 C5 C1 C4 C1 C4 LU C1 C3 LU C1 C2 LU C2 C3 LU C2 C4 LU

APPENDIX B — CHECKING CLUTCH AND RETARDER PRESSURES

Table B–1. Clutch Pressure Test Conditions (Continued)

Transmission Model/ Test Type	Engine rpm	Sump Fluid Temperature	Range	Clutches Pressurized
MD 3070 — High Speed	2080–2120	71–93ºC (160–200ºF)	Reverse	C3 C5
			Neutral	C5
			LowC	C3 C6
			1C	C1 C5
			2C	C1 C4
			2L	C1 C4 LU
			3L	C1 C3 LU
			4L	C1 C2 LU
			5L	C2 C3 LU
			6L	C2 C4 LU
HD/B500 — High Speed	1780–1820	71–93ºC (160–200ºF)	Reverse	C3 C5
			Neutral	C5
			LowC**	C1 C6
			1C	C1 C5
			2C	C1 C4
			2L	C1 C4 LU
			3L	C1 C3 LU
			4L	C1 C2 LU
			5L	C2 C3 LU
			6L	C2 C4 LU
			** Only applies to HD 4070.	

C. Comparing Recorded Data to Specifications

1. Be sure that engine speed and transmission sump fluid temperatures were within the values specified in Table B–1.
2. Compare the main pressure and clutch pressure data, recorded in Step B, with the specifications in Table B–2.
3. If clutch pressures are within specifications, return the transmission and vehicle to their original configuration and proceed with electrical troubleshooting.
4. If clutch pressures are not within specification, take corrective action to replace the internal parts of the transmission necessary to correct the problem. (Refer to the Transmission Service Manual for the model being checked.)
5. Recheck pressure values after the transmission has been repaired.
6. Return the transmission to its original configuration. (Remove instrumentation and reinstall any components removed for the pressure testing.)

Table B–2. Main Pressure and Clutch Pressure Specifications
(Sump Fluid Temperature Same as in Table B–1)

Transmission Model/Test Type	Engine rpm	Range	Clutches Applied	Main Press. Spec kPa [psi]	Range Clutch Press. Spec* kPa [psi]	Conv. Out Press. Spec kPa [psi]	Lube Press. Spec kPa [psi]	LU Clutch Press. Spec* kPa [psi]	D'BOX MAIN Press. Spec* kPa [psi]
MD — Idle (except 3070)	580–620	Neutral	C5	1400–2000 [203–290]	0–40 (C5) [0–5.8]		—		
		Reverse	C3 C5	1400–2000 [203–290]	0–40 (C3 And C5) [0–5.8]		3.5 min. [0.5 min.]		
		1C	C1 C5	1300–1970 [189–286]	0–70 (C1) [0–10] 0–40 (C5) [0–5.8]		3.5 min. [0.5 min.]		
		2C	C1 C4	1300–1970 [189–286]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]		3.5 min. [0.5 min.]		
MD 3070 — Idle		Neutral	C5	1400–2000 [203–290]	0–40 (C5) [0–5.8]		—		1400–2000 [203–290]
		Reverse	C3 C5	1400–2000 [203–290]	0–40 (C3 And C5) [0–5.8]		3.5 min. [0.5 min.]		1400–2000 [203–290]
		LowC	C3 C6	1300–1970 [189–286]	0–40 (C3 And C6) [0–5.8]		3.5 min. [0.5 min.]		1300–1970 [189–286]
		1C	C1 C5	1300–1970 [189–286]	0–70 (C1) [0–10] 0–40 (C5) [0–5.8]		3.5 min. [0.5 min.]		1300–1970 [189–286]
MD — High Speed (except 3070)	2080–2120	Neutral	C5	1825–1965 [265–285]	0–40 (C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		Reverse	C3 C5	1825–1965 [265–285]	0–40 (C3 And C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		1C	C1 C5	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		

* Subtract clutch pressure from main pressure; the difference must fall within the specifications given (unless a pressure range is supplied).

Table B–2. Main Pressure and Clutch Pressure Specifications (Sump Fluid Temperature Same as in Table B–1) (Continued)

Transmission Model/Test Type	Engine rpm	Range	Clutches Applied	Main Press. Spec kPa [psi]	Range Clutch Press. Spec* kPa [psi]	Conv. Out Press. Spec kPa [psi]	Lube Press. Spec kPa [psi]	LU Clutch Press. Spec* kPa [psi]	D'BOX MAIN Press. Spec* kPa [psi]
MD — High Speed (except 3070) *(cont'd)*	2080–2120	2C	C1 C4	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		2L	C1 C4 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		3C	C1 C3	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		3L	C1 C3 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		4C	C1 C2	1550–1690 [225–245]	0–70 (C1) [0–10] 0–70 (C2) [0–10]	310–410 [45–60]	150–190 [22–28]		
		4L	C1 C2 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–70 (C2) [0–10]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		5C	C2 C3	1550–1690 [225–245]	0–70 (C2) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		5L	C2 C3 LU	1100–1240 [160–180]	0–70 (C2) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		6C	C2 C4	1550–1690 [225–245]	0–70 (C2) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		6L	C2 C4 LU	1100–1240 [160–180]	0–70 (C2) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	

* Subtract clutch pressure from main pressure; the difference must fall within the specifications given (unless a pressure range is supplied).

Table B–2. Main Pressure and Clutch Pressure Specifications (Sump Fluid Temperature Same as in Table B–1) (Continued)

Transmission Model/Test Type	Engine rpm	Range	Clutches Applied	Main Press. Spec kPa [psi]	Range Clutch Press. Spec* kPa [psi]	Conv. Out Press. Spec kPa [psi]	Lube Press. Spec kPa [psi]	LU Clutch Press. Spec* kPa [psi]	D'BOX MAIN Press. Spec* kPa [psi]
MD 3070 — High Speed	2080–2120	Neutral	C5	1825–1965 [265–285]	0–40 (C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		Reverse	C3 C5	1825–1965 [265–285]	0–40 (C3 And C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		LowC	C3 C6	1550–1690 [225–245]	0–40 (C3 And C6) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		1C	C1 C5	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		2C	C1 C4	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		2L	C1 C4 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	1440–1700 [209–247]
		3C	C1 C3	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		3L	C1 C3 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	1440–1700 [209–247]
		4C	C1 C2	1550–1690 [225–245]	0–70 (C1 And C2) [0–10]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		4L	C1 C2 LU	1100–1240 [160–180]	0–70 (C1 And C2) [0–10]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	1440–1700 [209–247]
		5C	C2 C3	1550–1690 [225–245]	0–70 (C2) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]

* Subtract clutch pressure from main pressure; the difference must fall within the specifications given (unless a pressure range is supplied).

Table B–2. Main Pressure and Clutch Pressure Specifications (Sump Fluid Temperature Same as in Table B–1) (Continued)

Transmission Model/Test Type	Engine rpm	Range	Clutches Applied	Main Press. Spec kPa [psi]	Range Clutch Press. Spec* kPa [psi]	Conv. Out Press. Spec kPa [psi]	Lube Press. Spec kPa [psi]	LU Clutch Press. Spec* kPa [psi]	D'BOX MAIN Press. Spec* kPa [psi]
MD 3070 — High Speed *(cont'd)*	2080–2120	5L	C2 C3 LU	1100–1240 [160–180]	0–70 (C2) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	1440–1700 [209–247]
		6C	C2 C4	1550–1690 [225–245]	0–70 (C2) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]		1440–1700 [209–247]
		6L	C2 C4 LU	1100–1240 [160–180]	0–70 (C2) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	1440–1700 [209–247]
HD — Idle	580–620	Neutral	C5	1400–2000 [203–290]	0–40 (C5) [0–5.8]		—		
		Reverse	C3 C5	1400–2000 [203–290]	0–40 (C3 And C5) [0–5.8]		3.5 min. [0.5 min.]		
		1C	C1 C5	1300–1970 [189–286]	0–70 (C1) [0–10] 0–40 (C5) [0–5.8]		3.5 min. [0.5 min.]		
		2C	C1 C4	1300–1970 [189–286]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]		3.5 min. [0.5 min.]		
HD — High Speed	1780–1820	Neutral	C5	1825–1965 [265–285]	0–40 (C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		Reverse	C3 C5	1825–1965 [265–285]	0–40 (C3 And C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		LowC**	C3 C6	1550–1690 [225–245]	0–40 (C3 And C6) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		1C	C1 C5	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C5) [0–5.8]	310–410 [45–60]	150–190 [22–28]		

* Subtract clutch pressure from main pressure; the difference must fall within the specifications given (unless a pressure range is supplied).

** HD 4070 Only.

Table B–2. Main Pressure and Clutch Pressure Specifications (Sump Fluid Temperature Same as in Table B–1) (Continued)

Transmission Model/Test Type	Engine rpm	Range	Clutches Applied	Main Press. Spec kPa [psi]	Range Clutch Press. Spec* kPa [psi]	Conv. Out Press. Spec kPa [psi]	Lube Press. Spec kPa [psi]	LU Clutch Press. Spec* kPa [psi]	D'BOX MAIN Press. Spec* kPa [psi]
HD — High Speed *(cont'd)*	1780–1820	2C	C1 C4	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		2L	C1 C4 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		3C	C1 C3	1550–1690 [225–245]	0–70 (C1) [0–10] 0–40(C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		3L	C1 C3 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		4C	C1 C2	1550–1690 [225–245]	0–70 (C1) [0–10] 0–70 (C2) [0–10]	310–410 [45–60]	150–190 [22–28]		
		4L	C1 C2 LU	1100–1240 [160–180]	0–70 (C1) [0–10] 0–70 (C2) [0–10]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		5C	C2 C3	1550–1690 [225–245]	0–70 (C2) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		5L	C2 C3 LU	1100–1240 [160–180]	0–70 (C2) [0–10] 0–40 (C3) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	
		6C	C2 C4	1550–1690 [225–245]	0–70 (C2) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]		
		6L	C2 C4 LU	1100–1240 [160–180]	0–70 (C2) [0–10] 0–40 (C4) [0–5.8]	310–410 [45–60]	150–190 [22–28]	0–60 [0–8.7]	

* Subtract clutch pressure from main pressure; the difference must fall within the specifications given (unless a pressure range is supplied).

APPENDIX B — CHECKING CLUTCH AND RETARDER PRESSURES

D. Retarder Pressure Checks — MD/B 300/B 400 And HD/B 500

1. MD 3060/3066, B 300, B 400 Test Conditions:

   Second Range Lockup, 100 Percent Retarder Apply, Input Speed = 1075–1125 rpm

2. MD 3560 Test Conditions:

   Second Range Lockup, 100 Percent Retarder Apply, Input Speed = 1350–1400 rpm

Table B–3. Retarder Specifications At Above Test Conditions

Parameter To Check	High Capacity	Medium Capacity	Low Capacity
Main Pressure–kPa [psi]	1200–1260 [174–183]	1200–1260 [174–183]	1200–1260 [174–183]
Retarder Charge Pressure–kPa [psi]	250–370 [36–54]	215–280 [31–41]	140–240 [20–35]
Cooler In Pressure–kPa [psi]	250–340 [36–49]	210–300 [30–44]	140–255 [20–37]
Cooler In Temperature–°C [°F]	150 [300] Max (Ref)	150 [300] Max (Ref)	150 [300] Max (Ref)

3. HD 4060/4070/B 500 Test Conditions:

   Second Range Lockup, 100 Percent Retarder Apply, Input Speed = 800–850 rpm

4. HD 4560 Test Conditions:

   Second Range Lockup, 100 Percent Retarder Apply, Input Speed = 965–1015 rpm

Table B–4. Retarder Specifications At Above Test Conditions

Parameter To Check	High Capacity	Medium Capacity	Low Capacity
Main Pressure–kPa [psi]	1120–1270 [162–184]	1120–1270 [162–184]	1120–1270 [162–184]
Retarder Charge Pressure–kPa [psi]	375–480 [54–70]	345–450 [50–65]	325–420 [47–61]
Cooler In Pressure–kPa [psi]	360–530 [52–77]	310–510 [45–74]	290–480 [42–70]
Cooler In Temperature–°C [°F]	150 [300] Max (Ref)	150 [300] Max (Ref)	150 [300] Max (Ref)

APPENDIX B — CHECKING CLUTCH AND RETARDER PRESSURES

APPENDIX C — SOLENOID AND CLUTCH CHART

BASIC CONFIGURATION

Range	Solenoid Non-Latching Modulating							Clutches					
	A N/O	B N/O	C N/C	D N/C	E N/C	F N/C	G N/C	C1	C2	C3	C4	C5	LU
6	X			X		0			Y		Y		0
5	X		X			0	X		Y	Y			0
4						0	X	Y	Y				0
3		X	X			0	X	Y		Y			0
2		X		X		0	X	Y			Y		0
1		X			X	0		Y				Y	0
N1	X	X		*	X	0					*	Y	0
NVL	X	X		X	X						Y	Y	
N2	X	X		X							Y		
N3	X	X	X							Y			
N4	X	X		X							Y		
R	X	X	X		X					Y		Y	

NOTE: ***See Page C–2 for legend.***

7-SPEED CONFIGURATION (MD 3070 AND HD 4070)

Range	Solenoid Non-Latching Modulating										Clutches							
	N/O	N/O	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C								
	C1	C2	C3	C4	C5	LU	FWD	LOW	C6	DIF								
	A	B	C	D	E	F	G	N	J	H	C1	C2	C3	C4	C5	LU	C6	DIF
6	X			X		0				0		Y		Y		0		0
5	X		X			0	X			0		Y	Y			0		0
4						0	X			0	Y	Y				0		0
3		X	X			0	X			0	Y		Y			0		0
2		X		X		0	X			0	Y			Y		0		0
1		X			X	0				0	Y				Y	0		0
LO	X					0	X	X	X	0			Y			0	Y	0
N1	X	X		*	X					0					Y			0
N2	X	X		X			X			0				Y				0
N3	X	X	X				X			0			Y					0
N4	X	X		X			X			0				Y				0
R	X	X	X		X					0			Y		Y			0

NOTE: ***See Page C–2 for legend.***

APPENDIX C — SOLENOID AND CLUTCH CHART

LEGEND

X	Indicates solenoid is electrically ON.
Y	Indicates clutch is hydraulically applied.
Blank	Indicates solenoid is electrically OFF or clutch is not hydraulically applied.
0	Optional ON or OFF.
*	See NVL explanation below.
NVL	**As a diagnostic response:** If Turbine Speed is below 150 rpm when Output Speed is below 100 rpm and Engine Speed is above 400 rpm, Neutral Very Low (**NVL**) is commanded when **N1** (Neutral) is the selected range. **NVL** is achieved by turning D solenoid “on” in addition to E solenoid being “on,” which locks the output. Otherwise, D solenoid is turned off in **N1** (Neutral).

APPENDIX D — WIRE/CONNECTOR CHART

The connector information in this appendix is provided for the convenience of the servicing technician. The connector illustration and pin identifications for connection to Allison Transmission components will be accurate. Allison Transmission components are the ECU, speed sensors, retarder connectors, transmission connectors, and shift selectors. Other kinds of connectors for optional or customer-furnished components are provided based on typical past practice for an Allison-designed system.

Contact St. Clair Technologies, Inc. or your vehicle manufacturer for information on connectors not found in this appendix.

NOTE: The following abbreviation guide should be used to locate connector termination points for wires in the WTEC III wiring harness(es).

Table D–1. Appendix D Abbreviation Guide

Termination Point Abbreviation	Connector Name
AGND	Analog Ground
ASOL	Solenoid A — Transmission Control Module
BSOL	Solenoid B — Transmission Control Module
C3PS	C3 Pressure Switch — Control Module
CSOL	Solenoid C — Transmission Control Module
DDRD	Diagnostic Connector — Deutsch
DDRP	Diagnostic Connector — Packard
DSOL	Solenoid D — Transmission Control Module
ECU–S	Electronic Control Unit — Selector (S) Connector
ECU–S	Electronic Control Unit — Vehicle (V) Connector
ECU–T	Electronic Control Unit — Transmission (T) Connector
ESOL	Solenoid E — Transmission Control Module
GSOL	Solenoid F — Transmission Control Module
GSOL	Solenoid G — Transmission Control Module
HSOL	Retarder H Solenoid — Retarder Housing Or Retarder Valve Body
J1939	J1939 Datalink From ECU Selector (S) Harness
JSOL	Solenoid J — Transmission Control Module (7-Speed Only)
NE	Engine Speed Sensor
NO	Output Speed Sensor
NSOL	Retarder Accumulator Solenoid
NSOL	Solenoid N — Transmission Control Module (7-Speed Only)
NT	Turbine Speed Sensor
OBDII	Diagnostic Connector — GMC On Board Diagnostics
OLS	Oil Level Sensor
PSS	Primary Shift Selector
RMOD	Retarder Module (Units Built Prior To 1/98)
RMR	Retarder Modulation Request Device
RNGTRM	Chassis Ground Ring Terminal
RTEMP	Retarder Temperature — Retarder Housing

APPENDIX D — WIRE/CONNECTOR CHART

Table D–1. Appendix D Abbreviation Guide (Continued)

Termination Point Abbreviation	Connector Name
SCI	Serial Communication Interface
SSS	Secondary Shift Selector
TCASE	MD 3070 Transfer Case
TPS	Throttle Position Sensor
TRANS	Transmission Feedthrough Harness
VIM	Vehicle Interface Module
VIWS	Vehicle Interface Wiring — ECU Selector (S) Harness
VIWV	Vehicle Interface Wiring — ECU Vehicle (V) Harness

APPENDIX D — WIRE/CONNECTOR CHART

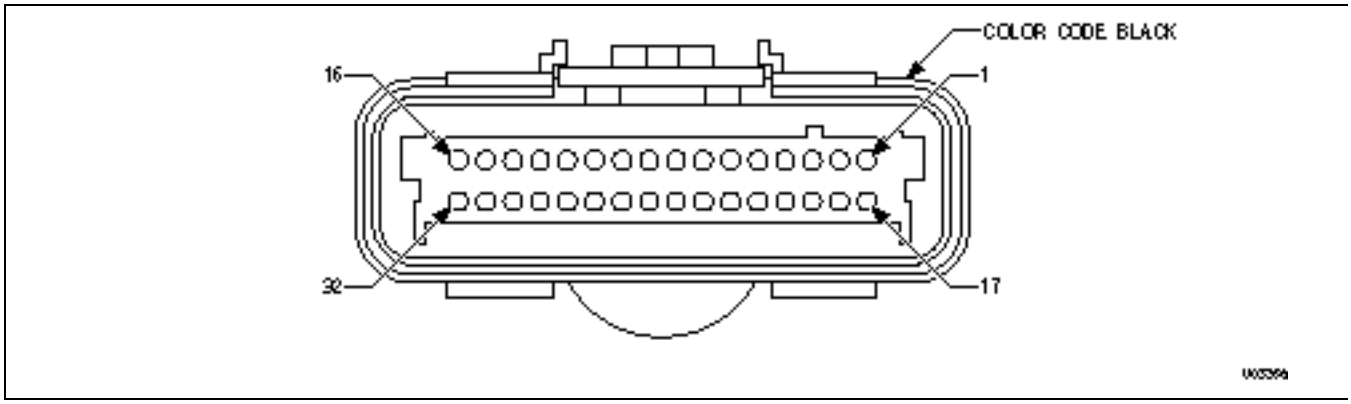


Figure D–1. ECU Connector "S"

ECU CONNECTOR "S" (BLACK)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
1	White	142-S1	Serial Communication Interface, High	DDRP-J, DDRD-A, OBDII-7
2	Tan	159-S2	Diagnostic Communication Link (ISO9141)	VIWS-A
3	Pink	124-S3	Sensor Power	RMR-C, PSS-N, SSS-N
4	Yellow	146-S4	Ignition Sense	VIWS-E, DDRP-H, DDRD-C, OBDII-16
5	Orange	170-S5	Primary Shift Selector, Data Bit 1	PSS-A
6	Green	171-S6	Primary Shift Selector, Data Bit 2	PSS-B
7	Blue	172-S7	Primary Shift Selector, Data Bit 4	PSS-C
8	Yellow	173-S8	Primary Shift Selector, Data Bit 8	PSS-D
9	Tan	174-S9	Primary Shift Selector, Parity	PSS-E
10	Green	175-S10	Shift Selector Mode Input	PSS-M, SSS-M
11	Yellow	119-S11	General Purpose Input 4	VIWS-M
12	Green	182-S12	CAN Controller Shield (J1939)	J1939C
13	Pink	183-S13	CAN Controller, High (J1939)	J1939A
14	Blue	180-S14	Shift Selector Display	PSS-S, SSS-S
15	Orange	176-S15	General Purpose Output 6	PSS-L, SSS-L, VIWS-L
16	Pink	136-S16	Battery Power	PSS-R, SSS-R
17	Blue	151-S17	Serial Communication Interface, Low	DDRP-K, DDRD-B, OBDII-15
18	Tan	166-S18	General Purpose Output 7	VIWS-N
19	Green	135-S19	Analog Ground	RMR-A
20	Yellow	164-S20	Retarder Modulation Request	RMR-B
21	Orange	190-S21	Secondary Shift Selector, Data Bit 1	SSS-A
22	Green	191-S22	Secondary Shift Selector, Data Bit 2	SSS-B
23	Blue	192-S23	Secondary Shift Selector, Data Bit 4	SSS-C
24	Yellow	193-S24	Secondary Shift Selector, Data Bit 8	SSS-D
25	Tan	194-S25	Secondary Shift Selector, Parity	SSS-E
26	Blue	169-S26	General Purpose Input 12	VIWS-S
27	Blue	163-S27	General Purpose Input 6	VIWS-R
28	Yellow	126-S28	General Purpose Input 9	VIWS-C
29	Gray	184-S29	CAN Controller, Low (J1939)	J1939-B
30	Tan	157-S30	Vehicle Speed	VIWS-D
31	Green	115-S31	Check Transmission	VIWS-B
32	Gray	143-S32	Battery Ground	PSS-P, SSS-P, VIWS-P, DDRP-A, DDRD-E, OBDII-5

APPENDIX D — WIRE/CONNECTOR CHART

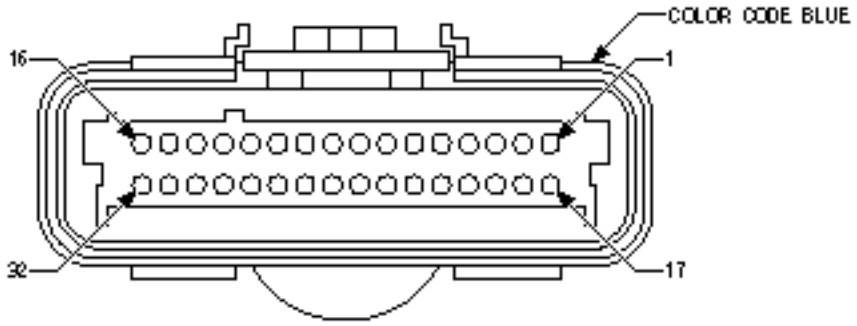


Figure D–2. ECU Connector "T"

ECU CONNECTOR "T" (BLUE)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
1	Orange	102-T1	Solenoid Power, Solenoids A, D, and J (MD 3070 only)	TRANS-A
2	Tan	121-T2	Solenoid Power, Solenoids B and E	TRANS-H
3	Green	107-T3	Solenoid Power, Solenoid F	TRANS-E
4	White	120-T4	A Solenoid, Low	TRANS-G
5	Green	103-T5	C Solenoid, Low	TRANS-B
6	Tan	129-T6	E Solenoid, Low	TRANS-K
7	White	104-T7	G Solenoid, Low	TRANS-C
8	Blue	111-T8	J Solenoid, Low	TRANS-e
9	Pink	124-T9	Sensor Power	TRANS-D, TPS-C, RMR-C
10	Blue	156-T10	Throttle Position Sensor	TPS-B
11	Yellow	164-T11	Retarder Modulation Request	RMR-B
12	White	162-T12	C3 Pressure Switch Input	TRANS-X
13	Yellow	195-T13	Transmission Identification	TRANS-W
14	Tan	141-T14	Engine Speed Sensor, High	NE-A
15	Orange	149-T15	Turbine Speed Sensor, High	NT-A (HD), TRANS-V (MD)
16	Yellow	139-T16	Output Speed Sensor, High	NO-A, TCASE-C (MD 3070), RMOD-C (MDR)
17	Yellow	130-T17	Solenoid Power, Solenoids C and G	TRANS-L
18				
19	Yellow	116-T19	Solenoid Power, Solenoids H and N	HSOL-B, NSOL-B, TRANS-g, TCASE-B (MD 3070), RMOD-B (MDR)
20	Orange	128-T20	B Solenoid, Low	TRANS-J
21	Blue	131-T21	D Solenoid, Low	TRANS-M
22	White	110-T22	F Solenoid, Low	TRANS-F
23	White	127-T23	H Solenoid, Low	HSOL-A (HD), RMOD-A (MDR), TCASE-A (MD 3070)
24	Blue	101-T24	N Solenoid, Low	NSOL-A (HD and MD), TRANS-f (MD 3070)
25	Green	135-T25	Analog Ground	RMR-A, RTEMP-B (HD), RMOD-F (MD)
26	Blue	165-T26	Oil Level Sensor Input	TRANS-Y
27	Tan	147-T27	Sump Temperature Sensor Input	TRANS-P
28	Orange	138-T28	Retarder Temperature Sensor Input	RTEMP-A (HD), RMOD-E (MD)
29				
30	Orange	150-T30	Engine Speed Sensor, Low	NE-B
31	Blue	140-T31	Turbine Speed Sensor, Low	NT-B, TRANS-U (MD)
32	Green	148-T32	Output Speed Sensor, Low	NO-B, TCASE-D (MD 3070), RMOD-D (MDR)

APPENDIX D — WIRE/CONNECTOR CHART

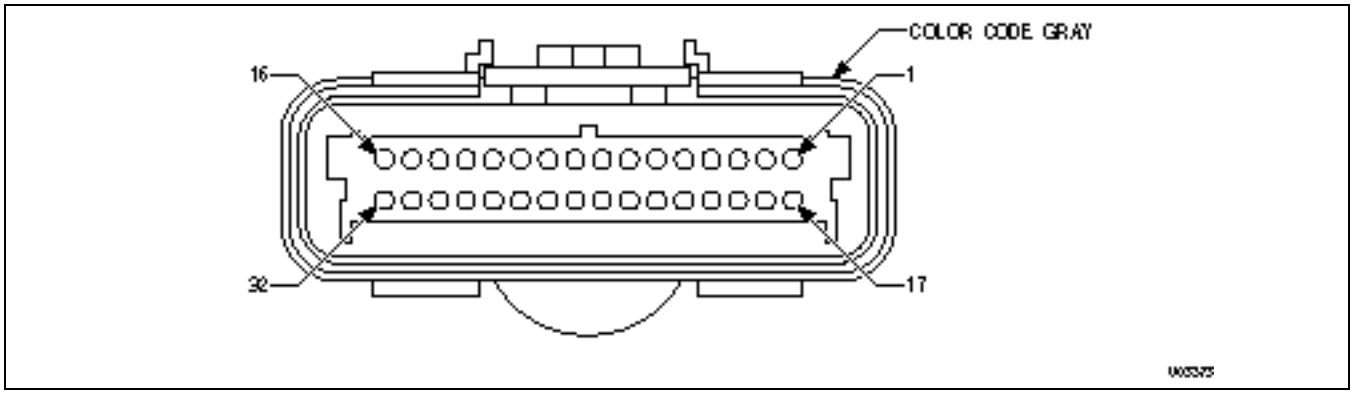


Figure D–3. ECU Connector "V"

ECU CONNECTOR "V" (GRAY)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
1	Pink	136-V1	Battery Power	VIM-E1
2	White	114-V2	General Purpose Output 1	VIM-F3
3	Orange	132-V3	General Purpose Output 2	VIM-B1
4	White	113-V4	Reverse Warning	VIM-F2
5	White	167-V5	General Purpose Output 8	VIWV-V
6	Tan	123-V6	Neutral Start	VIM-D1
7				
8	Pink	124-V8	Sensor Power	TPS-C
9	Blue	179-V9	Engine Water Temperature	VIWV-M
10	Blue	156-V10	Throttle Position Sensor	TPS-B
11	Green	155-V11	General Purpose Input 1	VIWV-A
12	Yellow	153-V12	General Purpose Input 2	VIWV-B
13	Blue	118-V13	General Purpose Input 3	VIWV-C
14	Tan	177-V14	General Purpose Input 10	VIWV-S
15				
16	Pink	136-V16	Battery Power	VIM-E2
17	Gray	143-V17	Battery Ground	VIM-A1
18	White	125-V18	General Purpose Output 4	VIM-C2
19	Green	105-V19	General Purpose Output 5	VIWV-E
20	Tan	157-V20	Vehicle Speed	VIM-B2
21				
22	Tan	112-V22	General Purpose Output 3	VIM-D2
23				
24	Green	135-V24	Analog Ground	TPS-A, VIWV-N
25	Gray	144-V25	Chassis Ground	RNGTRM
26	Yellow	146-V26	Ignition Sense	VIM-F1
27	White	154-V27	General Purpose Input 5	VIWV-D
28	Orange	178-V28	General Purpose Input 11	VIWV-R
29	Orange	137-V29	General Purpose Input 7	VIWV-U
30	Green	117-V30	General Purpose Input 8	VIWV-P
31	Yellow	161-V31	Digital Ground (GPI)	VIWV-L
32	Gray	143-V32	Battery Ground	VIM-A2

APPENDIX D — WIRE/CONNECTOR CHART

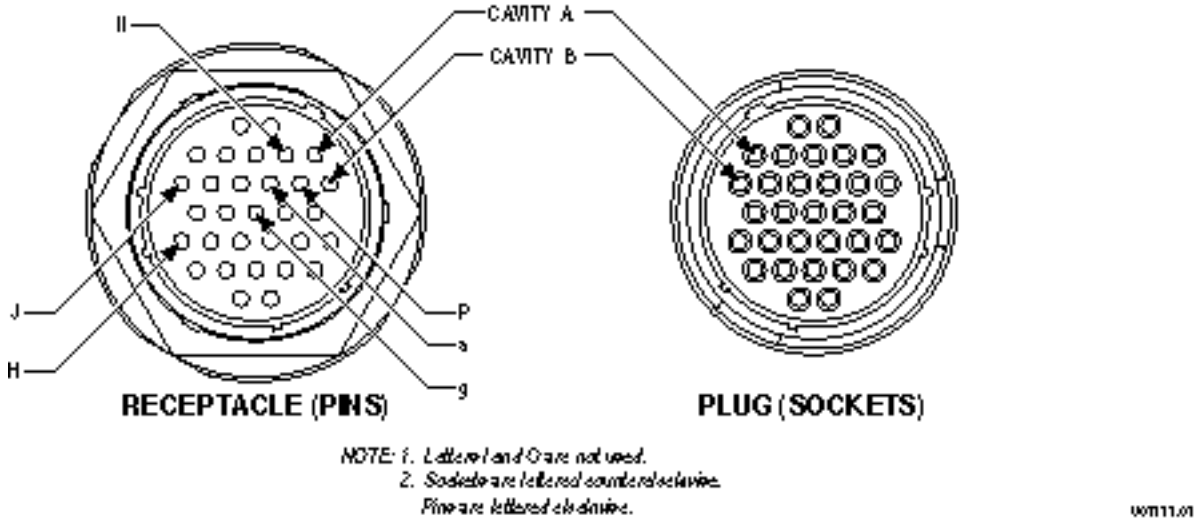


Figure D–4. Deutsch Bulkhead Connector, ECD

BULKHEAD CONNECTOR FOR "S" HARNESS (Plug With Sockets, Receptacle With Pins)

Terminal No.*	Color	Wire No.	Description	Termination Points*
A	Tan	159-S2	Diagnostic Communication Link (ISO 9141)	ECU-S2, VIWS-A
B	Green	115-S31	Check Transmission	ECU-S31, VIWS-B
C	Yellow	126-S28	General Purpose Input 9	ECU-S28, VIWS-C
D	Pink	124-S3	Sensor Power	ECU-S3, RMR-C, PSS-N, SSS-N
E	Yellow	146-S4	Ignition Sense	ECU-S4, VIWS-E, DDRP-H, DDRD-C, OBDII-16
F	Orange	170-S5	Primary Shift Selector, Data Bit 1	ECU-S5, PSS-A
G	Pink	136-S16	Battery Power	ECU-S16, PSS-R, SSS-R
H	White	142-S1	Serial Communication Interface, High	ECU-S1, DDRP-J, DDRD-A, OBDII-7, SCI-A
J	Blue	172-S7	Primary Shift Selector, Data Bit 4	ECU-S7, PSS-C
K	Blue	151-S17	Serial Communication Interface, Low	ECU-S17, DDRP-K, DDRD-B, OBDII-15, SCI-B
L	Orange	176-S15	General Purpose Output 6	ECU-S15, PSS-L, SSS-L, VIWS-L
M	Yellow	119-S11	General Purpose Input 4	ECU-S11, VIWS-M
N	Green	135-S19	Analog Ground	ECU-S19, RMR-A
P	Gray	143-S32	Battery Ground	ECU-S32, PSS-P, SSS-P, VIWS-P, DDRP-A, DDRD-E, OBDII-5
Q	Green	171-S6	Primary Shift Selector, Data Bit 2	ECU-S6, PSS-B
R	Blue	163-S27	General Purpose Input 6	ECU-S27, VIWS-R
S	Yellow	173-S8	Primary Shift Selector, Data Bit 8	ECU-S8, PSS-D
T	Tan	174-S9	Primary Shift Selector, Parity	ECU-S9, PSS-E
U	Green	175-S10	Shift Selector Mode Input	ECU-S10, PSS-M, SSS-M
V	Blue	180-S14	Shift Selector Display	ECU-S14, PSS-S, SSS-S
W	Tan	166-S18	General Purpose Output 7	ECU-S18, VIWS-N
X	Blue	169-S26	General Purpose Input 12	ECU-S26, VIWS-S
Y	Orange	190-S21	Secondary Shift Selector, Data Bit 1	ECU-S21, SSS-A

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

BULKHEAD CONNECTOR FOR "S" HARNESS (Plug With Sockets, Receptacle With Pins) (Contin-

Terminal No.*	Color	Wire No.	Description	Termination Points*
Z				
a	Yellow	164-S20	Retarder Modulation Request	ECU-S20, RMR-B
b	Green	191-S22	Secondary Shift Selector, Data Bit 2	ECU-S22, SSS-B
c	Blue	192-S23	Secondary Shift Selector, Data Bit 4	ECU-S23, SSS-C
d	Tan	157-S30	Vehicle Speed	ECU-S30, VIWS-D
e	Yellow	193-S24	Secondary Shift Selector, Data Bit 8	ECU-S24, SSS-D
f	Tan	194-S25	Secondary Shift Selector, Parity	ECU-S25, SSS-E
g				

BULKHEAD CONNECTOR FOR "T" HARNESS (Receptacle With Sockets, Plug With Pins)

Terminal No.*	Color	Wire No.	Description	Termination Points*
A	Orange	102-T1	Solenoid Power, Solenoids A, D, and J (MD 3070 only)	ECU-T1, TRANS-A
B	Green	103-T5	C Solenoid, Low	ECU-T5, TRANS-B
C	White	104-T7	G Solenoid, Low	ECU-T7, TRANS-C
D	Pink	124-T9	Sensor Power	ECU-T9, TRANS-D, TPS-C, RMR-C
E	Green	107-T3	Solenoid Power, Solenoid F	ECU-T3, TRANS-E
F	White	110-T22	F Solenoid, Low	ECU-T22, TRANS-F
G	White	120-T4	A Solenoid, Low	ECU-T4, TRANS-G
H	Tan	121-T2	Solenoid Power, Solenoids B and E	ECU-T2, TRANS-H
J	Orange	128-T20	B Solenoid, Low	ECU-T20, TRANS-J
K	Tan	129-T6	E Solenoid, Low	ECU-T6, TRANS-K
L	Yellow	130-T17	Solenoid Power, Solenoids C and G	ECU-T17, TRANS-L
M	Blue	131-T21	D Solenoid, Low	ECU-T21, TRANS-M
N	Green	135-T25	Analog Ground	ECU-T25, TRANS-N, TPS-A, RMR-A, RTEMP-B (HD), RMOD-F (MD)
P	Tan	147-T27	Sump Temperature Sensor Input	ECU-T27, TRANS-P
Q	Green	148-T32	Output Speed Sensor, Low	ECU-T32, NO-B, TCASE-D (MD 3070), RMOD-D (MDR)
R	Yellow	139-T16	Output Speed Sensor, High	ECU-T16, NO-A, TCASE-C (MD3070), RMOD-C (MDR)
S	Orange	150-T30	Engine Speed Sensor, Low	ECU-T30, NE-B
T	Tan	141-T14	Engine Speed Sensor, High	ECU-T14, NE-A
U	Blue	140-T31	Turbine Speed Sensor, Low	ECU-T31, NT-B (HD), TRANS-U (MD)
V	Orange	149-T15	Turbine Speed Sensor, High	ECU-T15, NT-A (HD), TRANS-V (MD)
W	Yellow	195-T13	Transmission Identification	ECU-T13, TRANS-W
X	White	162-T12	C3 Pressure Switch Input	ECU-T12, TRANS-X
Y	Blue	165-T26	Oil Level Sensor Input	ECU-T26, TRANS-Y
Z				
a	Yellow	164-T11	Retarder Modulation Request	ECU-T11, RMR-B
b	Blue	156-T10	Throttle Position Sensor	ECU-T10, TPS-B
c	White	127-T23	H Solenoid, Low	ECU-T23, HSOL-A (HD), RMOD-A (MDR), TCASE-A (MD 3070)

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

BULKHEAD CONNECTOR FOR "T" HARNESS (Receptacle With Sockets, Plug With Pins) (Contin-

Terminal No.*	Color	Wire No.	Description	Termination Points*
d	Orange	138-T28	Retarder Temperature Sensor Input	ECU-T28, RTEMP-A (HD), RMOD-E (MD)
e	Blue	111-T8	J Solenoid, Low	ECU-T8, TRANS-e
f	Blue	101-T24	N Solenoid, Low	ECU-T24, NSOL-A (HD and MD), TRANS-f (MD 3070)
g	Yellow	116-T19	Solenoid Power, Solenoids H and N	ECU-T19, HSOL-B, NSOL-B, TRANS-g, TCASE-B (MD 3070), RMOD-B (MDR)

BULKHEAD CONNECTOR FOR "V" HARNESS (Receptacle With Sockets, Plug With Pins)

Terminal No.*	Color	Wire No.	Description	Termination Points*
A	Green	155-V11	General Purpose Input 1	ECU-V11, VIWV-A
B	Yellow	153-V12	General Purpose Input 2	ECU-V12, VIWV-B
C	Blue	118-V13	General Purpose Input 3	ECU-V13, VIWV-C
D	Pink	124-V8	Sensor Power	ECU-V8, TPS-C
E	Green	105-V19	General Purpose Output 5	ECU-V19, VIWV-E
F	Gray	143-V32	Battery Ground	ECU-V32, VIM-A2
G	Gray	143-V17	Battery Ground	ECU-V17, VIM-A1
H	Tan	112-V22	General Purpose Output 3	ECU-V22, VIM-D2
J	White	114-V2	General Purpose Output 1	ECU-V2, VIM-F3
K	Tan	123-V6	Neutral Start	ECU-V6, VIM-D1
L	Yellow	161-V31	Digital Ground (GPI)	ECU-V31, VIWV-L
M	Blue	179-V9	Engine Water Temperature	ECU-V9, VIWV-M
N	Green	135-V24	Analog Ground	ECU-V24, TPS-A, VIWV-N
P	Green	117-V30	General Purpose Input 8	ECU-V30, VIWV-P
Q	White	113-V4	Reverse Warning	ECU-V4, VIM-F2
R	Orange	178-V28	General Purpose Input 11	ECU-V28, VIWV-R
S	Tan	177-V14	General Purpose Input 10	ECU-V14, VIWV-S
T				
U	Orange	137-V29	General Purpose Input 7	ECU-V29, VIWV-U
V	White	167-V5	General Purpose Output 8	ECU-V5, VIWV-V
W	Pink	136-V16	Battery Power	ECU-V16, VIM-E2
X	Tan	157-V20	Vehicle Speed	ECU-V20, VIM-B2
Y	White	125-V18	General Purpose Output 4	ECU-V18, VIM-C2
Z				
a				
b	Blue	156-V10	Throttle Position Sensor	ECU-V10, TPS-B
c				
d	White	154-V27	General Purpose Input 5	ECU-V27, VIWV-D
e	Yellow	146-V26	Ignition Sense	ECU-V26, VIM-F1
f	Orange	132-V3	General Purpose Output 2	ECU-V3, VIM-B1
g	Pink	136-V1	Battery Power	ECU-V1, VIM-E1

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

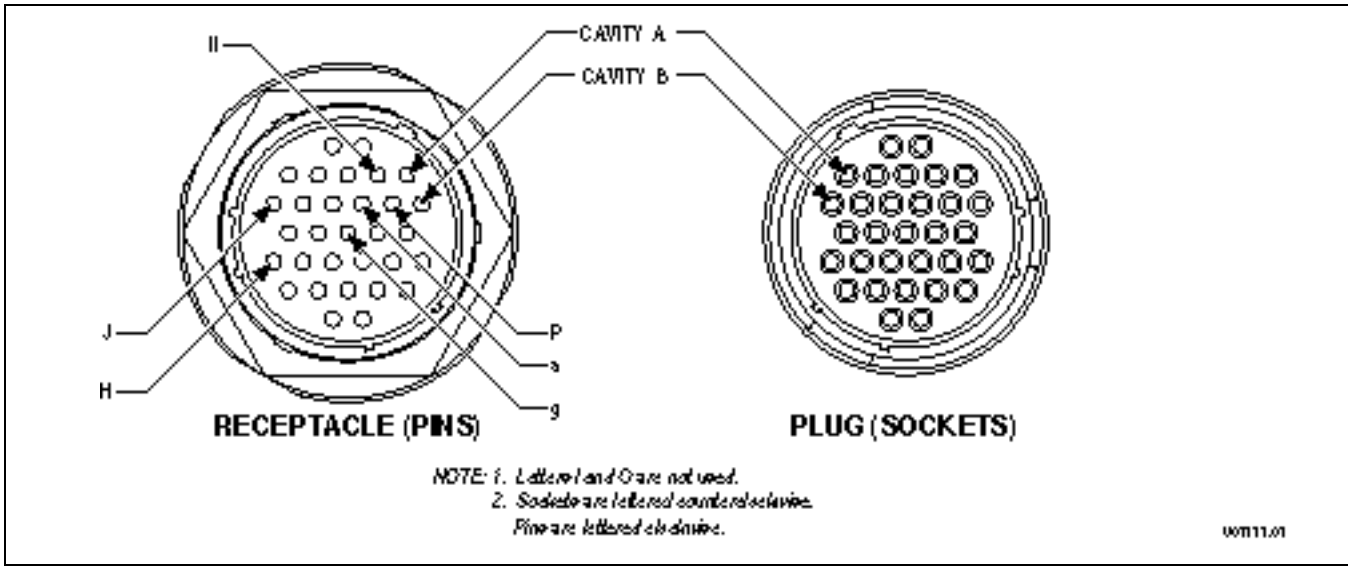


Figure D–5. Deutsch Transmission Connector, ECD

DEUTSCH TRANSMISSION CONNECTOR (Plugs With Sockets, Receptacles With Pins)

Terminal No.*	Color	Wire No.	Description	Termination Points*
A	Orange	102-T1	Solenoid Power, Solenoids A, D, and J	ECU-T1, ASOL-B, DSOL-B, JSOL-B
B	Green	103-T5	C Solenoid, Low	ECU-T5, CSOL-A
C	White	104-T7	G Solenoid, Low	ECU-T7, GSOL-A
D	Pink	124-T9	Sensor Power	ECU-T9, TPS-C, RMR-C, OLS-D
E	Green	107-T3	Solenoid Power, Solenoid F	ECU-T3, FSOL-A
F	White	110-T22	F Solenoid, Low	ECU-T22, FSOL-B
G	White	120-T4	A Solenoid, Low	ECU-T4, ASOL-A
H	Tan	121-T2	Solenoid Power, Solenoids B and E	ECU-T2, BSOL-B, ESOL-B
J	Orange	128-T20	B Solenoid, Low	ECU-T20, BSOL-A
K	Tan	129-T6	E Solenoid, Low	ECU-T6, ESOL-A
L	Yellow	130-T17	Solenoid Power, Solenoids C and G	ECU-T17, GSOL-B, CSOL-B
M	Blue	131-T21	D Solenoid, Low	ECU-T21, DSOL-A
N	Green	135-T25	Analog Ground	ECU-T25, TPS-A, RMR-A, RTEMP-B (HD), RMOD-F (MD), C3PS-B, OILT-LO, OLS-B
P	Tan	147-T27	Sump Temperature Sensor Input	ECU-T27, OILT-HI
Q				
R				
S				
T				
U	Blue	140-T31	Turbine Speed Sensor, Low (MD, MD7 only)	ECU-T31, NT-B
V	Orange	149-T15	Turbine Speed Sensor, High (MD, MD7 only)	ECU-T15, NT-A
W	Yellow	195-T13	Transmission Identification (TransID)	ECU-T13, AGND
X	White	162-T12	C3 Pressure Switch Input	ECU-T12, C3PS-A

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

DEUTSCH TRANSMISSION CONNECTOR (Plugs With Sockets, Receptacles With Pins) (Continued)

Terminal No.*	Color	Wire No.	Description	Termination Points*
Y	Blue	165-T26	Oil Level Sensor Input	ECU-T26, OLS-A
Z				
a				
b				
c				
d				
e	Blue	111-T8	J Solenoid, Low (MD7 or HD7 only)	ECU-T8, JSOL-A
f	Blue	101-T24	N Solenoid, Low (MD7 or HD7 only)	ECU-T24, NSOL-A
g	Yellow	116-T19	Solenoid Power, Solenoids H and N (MD7 only)	ECU-T19, HSOL-B, NSOL-B

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulk-head connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

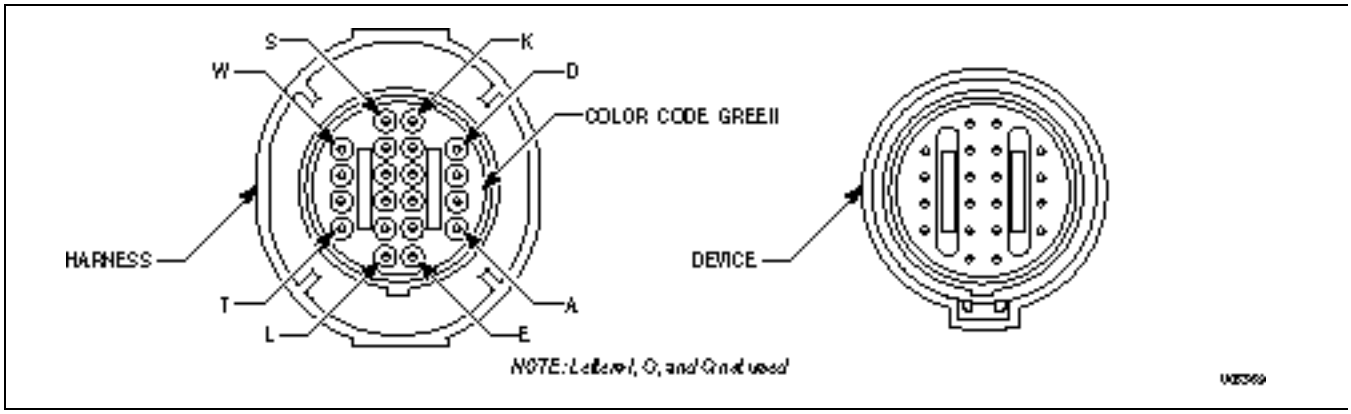


Figure D–6. Remote Selector Connector

REMOTE SHIFT SELECTOR CONNECTOR — PRIMARY SELECTOR

Terminal No.*	Color	Wire No.	Description	Termination Point(s)*
A	Orange	170-S5	Primary Shift Selector, Data Bit 1	ECU, S5
B	Green	171-S6	Primary Shift Selector, Data Bit 2	ECU, S6
C	Blue	172-S7	Primary Shift Selector, Data Bit 4	ECU, S7
D	Yellow	173-S8	Primary Shift Selector, Data Bit 8	ECU, S8
E	Tan	174-S9	Primary Shift Selector, Parity	ECU, S9
F				
G				
H				
J				
K				
L	Orange	176-S15	General Purpose Output 6	VIWS-L, SSS-L
M	Green	175-S10	Shift Selector Mode Output	SSS-M
N	Pink	124-S3	Sensor Power	RMR-C, SSS-N
P	Gray	143-S32	Battery Ground	VIWS-P, SSS-P, DDRP-A, DDRD-E, or OBDII-5
R	Pink	136-S16	Battery Power	SSS-R
S	Blue	180-S14	Shift Selector Display	SSS-S
T	White	186	Dimmer Input A	SSS-T
U	Yellow	187	Dimmer Input B	SSS-U
V	Gray	188	Dimmer Ground	SSS-V
W				

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

REMOTE SHIFT SELECTOR CONNECTOR — SECONDARY SELECTOR

Terminal No.*	Color	Wire No.	Description	Termination Point(s)*
A	Orange	190-S5	Secondary Shift Selector, Data Bit 1	ECU, S21
B	Green	191-S6	Secondary Shift Selector, Data Bit 2	ECU, S22
C	Blue	192-S7	Secondary Shift Selector, Data Bit 4	ECU, S23
D	Yellow	193-S8	Secondary Shift Selector, Data Bit 8	ECU, S24
E	Tan	194-S9	Secondary Shift Selector, Parity	ECU, S25
F				
G				
H				
J				
K				
L	Orange	176-S15	General Purpose Output 6	VIWS-L, SSS-L
M	Green	175-S10	Shift Selector Mode Output	SSS-M
N	Pink	124-S3	Sensor Power	RMR-C, SSS-N
P	Gray	143-S32	Battery Ground	VIWS-P, SSS-P, DDRP-A, DDRD-E, or OBDII-5
R	Pink	136-S16	Battery Power	SSS-R
S	Blue	180-S14	Shift Selector Display	SSS-S
T	White	186	Dimmer Input A	SSS-T
U	Yellow	187	Dimmer Input B	SSS-U
V	Gray	188	Dimmer Ground	SSS-V
W				

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulk-head connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

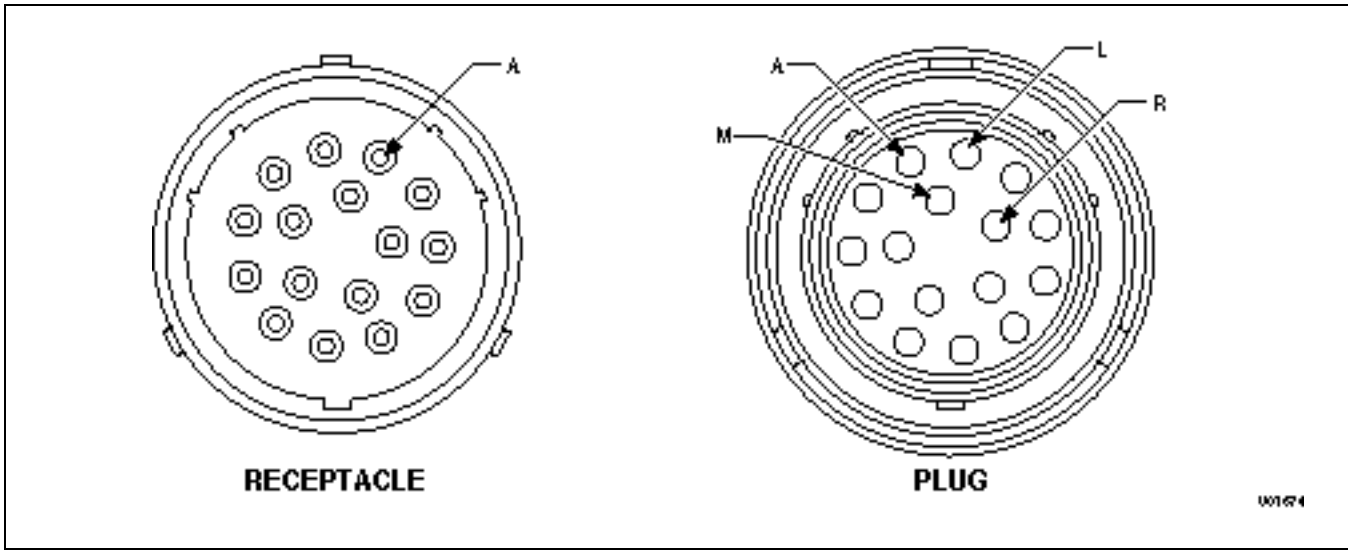


Figure D–7. Optional Deutsch Sensor Harness Connector

OPTIONAL DEUTSCH SENSOR HARNESS CONNECTOR

Terminal No.*	Color	Wire No.	Description	Termination Point(s)*
A				
B				
C	Green	135-T25	Analog Ground	ECU-T25, TRANS-N, RTEMP-B (HD), RMOD-F (MD), TPS-A, RMR-A
D	Orange	138-T28	Retarder Temperature Sensor Input	ECU-T28, RTEMP-A (HD), RMOD-E (MD)
E	Yellow	116-T19	Solenoid Power, Solenoids H and N	ECU-T19, HSOL-B, NSOL-B
F	White	127-T23	H Solenoid, Low	ECU-T23, HSOL-A
G	Yellow	116-T19	Solenoid Power, Solenoids H and N	ECU-T19, HSOL-B, NSOL-B
H	Blue	101-T24	N Solenoid, Low	ECU-T24, NSOL-B
J				
K				
L	Blue	140-T31	Turbine Speed Sensor, Low	ECU-T31, NT-B (HD)
M	Orange	149-T15	Turbine Speed Sensor, High	ECU-T15, NT-A (HD)
N	Orange	150-T30	Engine Speed Sensor, Low	ECU-T30, NE-B
P	Tan	141-T14	Engine Speed Sensor, High	ECU-T14, NE-A
R	Green	148-T32	Output Speed Sensor, Low	ECU-T32, NO-B
S	Yellow	139-T16	Output Speed Sensor, High	ECU-T16, NO-A

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

Figure D–8. Speed Sensor Connector

ENGINE SPEED SENSOR CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Tan	141-T14	Engine Speed Sensor Hi	ECU-T14
B	Orange	150-T30	Engine Speed Sensor Lo	ECU-T30

TURBINE SPEED SENSOR CONNECTOR (HD/B 500 ONLY)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Orange	149-T15	Turbine Speed Sensor Hi	ECU-T15
B	Blue	140-T31	Turbine Speed Sensor Lo	ECU-T31

OUTPUT SPEED SENSOR CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Yellow	139-T16	Output Speed Sensor Hi	ECU-T16
B	Green	148-T32	Output Speed Sensor Lo	ECU-T32

ACCUMULATOR (N) SOLENOID

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Blue	101-T24	N Solenoid Lo	ECU-T24
B	Yellow	116-T19	N Solenoid Hi	ECU-T19

MD RETARDER (H SOLENOID, TID 2)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	White	127-T23	H Solenoid Lo	ECU-T23
B	Yellow	116C-T19	H Solenoid Hi	ECU-T19

APPENDIX D — WIRE/CONNECTOR CHART

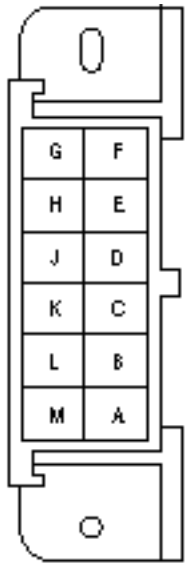


Figure D–9. Diagnostic Connector (Packard)

DIAGNOSTIC CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Gray	143-S32	Battery (–)	ECU-S32, VIWS-P, PSS-P, SSS-P
H	Yellow	146-S4	Ignition Signal (+)	ECU-S4, VIWS-E
J	White	142-S1	Serial Communication (+)	ECU-S1, SCI-A
K	Blue	151-S17	Serial Communication (–)	ECU-S17, SCI-B

APPENDIX D — WIRE/CONNECTOR CHART

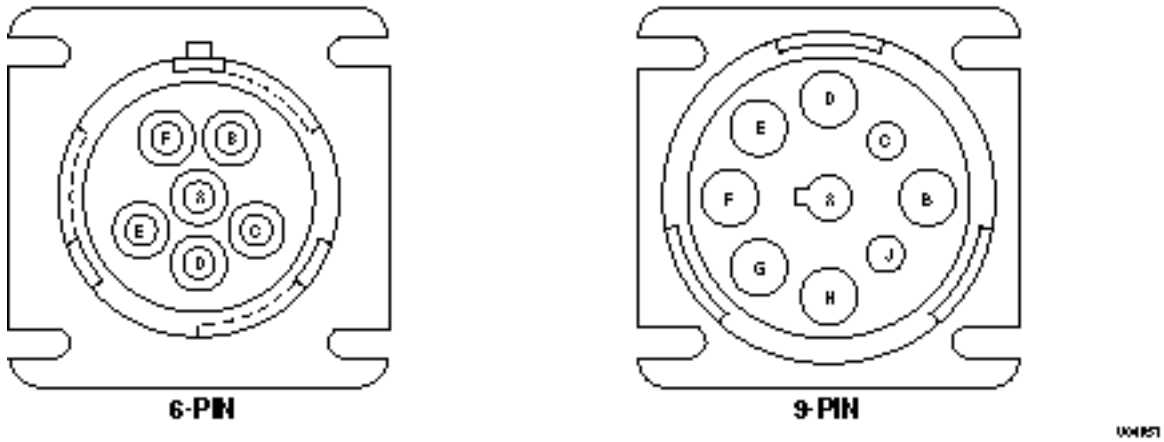


Figure D–10. Optional Deutsch DDR Connectors

OPTIONAL 6-PIN DIAGNOSTIC CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	White	142-S1	Serial Communication (+)	ECU-S1, SCI-A
B	Blue	151-S17	Serial Communication (–)	ECU-S17, SCI-B
C	Yellow	146-S4	Ignition Signal (+)	ECU-S4, VIWS-E
D			Open	
E	Gray	143-S32	Battery (–)	ECU-S32, VIWS-P, PSS-P, SSS-P
F			Open	

OPTIONAL 9-PIN DIAGNOSTIC CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Gray	143-S32	Battery Ground (–)	ECU-S32, VIWS-P, PSS-P, SSS-P
B	Yellow	146-S4	Ignition Power (+)	ECU-S4, VIWS-E
B (Optional)	Pink	136-S16	Battery Power (+)	ECU-S16, PSS-R, SSS-R
C	Pink	183-S13	J1939 High	ECU-S13, J1939-A/H
D	Gray	184-S29	J1939 Low	ECU-S29, J1939-B/L
E	Green	182-S12	J1939 Shield/Ground	ECU-S12, J1939-C/S
F	White	142-S1	Serial Communication (+)	ECU-S1, SCI-A
G	Blue	151-S17	Serial Communication (–)	ECU-S17, SCI-B

APPENDIX D — WIRE/CONNECTOR CHART

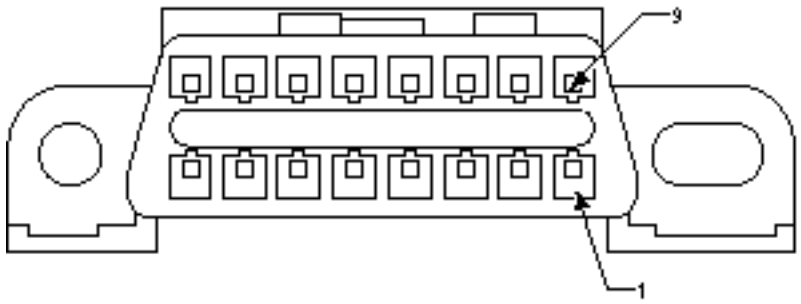


Figure D–11. GMC Connector for OBD-II DDR Adapter

OPTIONAL OBD–II DDR CONNECTOR

Terminal No.*	Color	Wire No.	Description	Termination Point(s)*
1				
2				
3				
4				
5	Gray	143-S32	Battery Ground (–)	ECU-S32, VIWS-P, PSS-P, SSS-P
6				
7	White	142-S1	Serial Communication Interface, Hi	ECU-S1, SCI-A
8				
9				
10				
11				
12				
13				
14				
15	Blue	151-S17	Serial Communication Interface, Lo	ECU-S17, SCI-B
16	Yellow	146-S4	Ignition Sense (+)	ECU-S4, VIWS-E

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulkhead connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

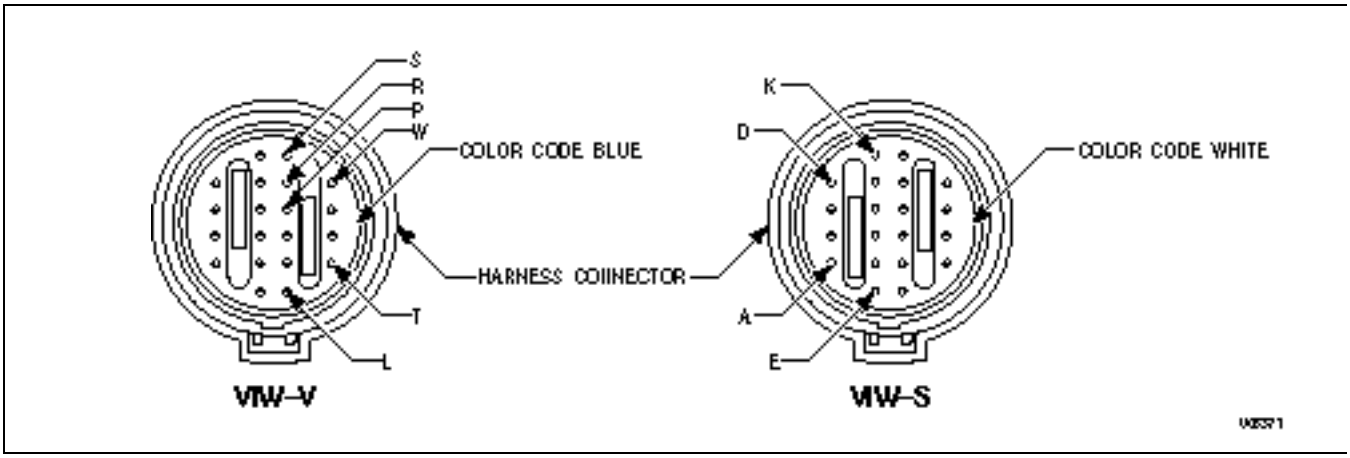


Figure D–12. VIW Connector (Packard Micro Pack)

VIW–V CONNECTOR

Terminal No.*	Color	Wire No.	Description	Termination Point(s)*
A	Green	155-V11	General Purpose Input 1	ECU-V11, VIWV-A
B	Yellow	153-V12	General Purpose Input 2	ECU-V12, VIWV-B
C	Blue	118-V13	General Purpose Input 3	ECU-V13, VIWV-C
D	White	154-V27	General Purpose Input 5	ECU-V27, VIWV-D
E	Green	105-V19	General Purpose Output 5	ECU-V19, VIWV-E
F				
G				
H				
J				
K				
L	Yellow	161-V31	Digital Ground (GPI)	ECU-V31, VIWV-L
M	Blue	179-V9	Engine Water Temperature	ECU-V9, VIWV-M
N	Green	135-V24	Analog Ground	ECU-V24, TPS-A, VIWV-N
P	Green	117-V30	General Purpose Input 8	ECU-V30, VIWV-P
R	Orange	178-V28	General Purpose Input 11	ECU-V28, VIWV-R
S	Tan	177-V14	General Purpose Input 10	ECU-V14, VIWV-S
T				
U	Orange	137-V29	General Purpose Input 7	ECU-V29, VIWV-U
V	White	167-V5	General Purpose Output 8	ECU-V5, VIWV-V
W				

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulk-head connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

VIW–S CONNECTOR

Terminal No.*	Color	Wire No.	Description	Termination Point(s) *
A	Tan	159-S2	Diagnostic Communication Link (ISO9141)	ECU-S2, VIWS-A
B	Green	115-S31	Check Transmission	ECU-S31, VIWS-B
C	Yellow	126-S28	General Purpose Input 9	ECU-S28, VIWS-C
D	Tan	157-S30	Vehicle Speed	ECU-S30, VIWS-D
E	Yellow	146-S4	Ignition Sense	ECU-S4, VIWS-E, DDRP-H, DDRD-C
F				
G				
H				
J				
K				
L	Orange	176-S15	General Purpose Output 6	ECU-S15, VIWS-L, PSS-L, SSS-L
M	Yellow	119-S11	General Purpose Input 4	ECU-S11, VIWS-M
N	Tan	166-S18	General Purpose Output 7	ECU-S18, VIWS-N
P	Gray	143-S32	Battery Ground	ECU-S32, VIWS-P, PSS-P, SSS-P, DDRP-A, DDRD-E
R	Blue	163-S27	General Purpose Input 6	ECU-S27, VIWS-R
S	Blue	169-S26	General Purpose Input 12	ECU-S26, VIWS-S
T	White	186	Dimmer Input A	VIWS-T, PSS-T, SSS-T
U	Yellow	187	Dimmer Input B	VIWS-U, PSS-U, SSS-U
V	Gray	188	Dimmer Ground	VIWS-V, PSS-V, SSS-V
W				

* Terminal number and termination points shown only apply when an Allison Transmission recommended harness configuration and bulk-head connector are used.

APPENDIX D — WIRE/CONNECTOR CHART

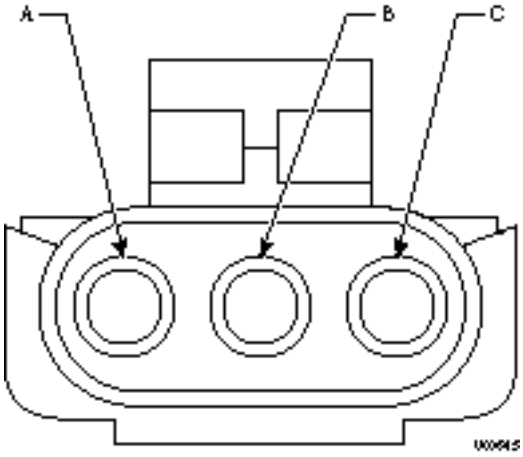


Figure D–13. TPS Connector

THROTTLE POSITION SENSOR CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	Green	135-T25 or 135-V24	Analog Ground	ECU-T25 or V24; TRANS-N; RMR-A, RMOD-F or B; VIWV-N
B	Blue	156-T10 or V10	TPS Signal	ECU-T10 or V10
C	Pink	124-T9 or V8	TPS Hi	ECU-T9 or V8; RMR-C

APPENDIX D — WIRE/CONNECTOR CHART

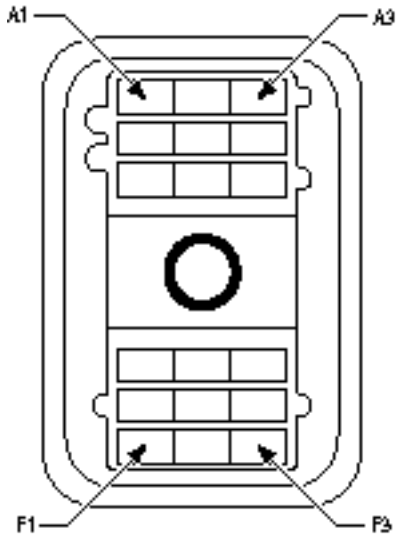


Figure D–14. VIM Connector (Harness)

VIM CONNECTOR (HARNESS)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A1	Gray	143-V17	Battery (–)	ECU-V17
A2	Gray	143-V32	Battery (–)	ECU-V32
A3			Reserved	
B1	Orange	132-V3	GPO 2	ECU-V3
B2	Tan	157-V20	Speedometer Signal	ECU-V20
B3			Reserved	
C1			Reserved	
C2	White	125-V18	GPO 4	ECU-V18
C3			Reserved	
D1	Tan	123-V6	Neutral Start	ECU-V6
D2	Tan	112-V22	GPO 3	ECU-V22
D3			Reserved	
E1	Pink	136-V1	Battery (+)	ECU-V1
E2	Pink	136-V16	Battery (+)	ECU-V16
E3			Reserved	
F1	Yellow	146-V26	Ignition Sense (+)	ECU-V26
F2	White	113-V4	Reverse Warning	ECU-V4
F3	White	114-V2	GPO 1	ECU-V2

APPENDIX D — WIRE/CONNECTOR CHART

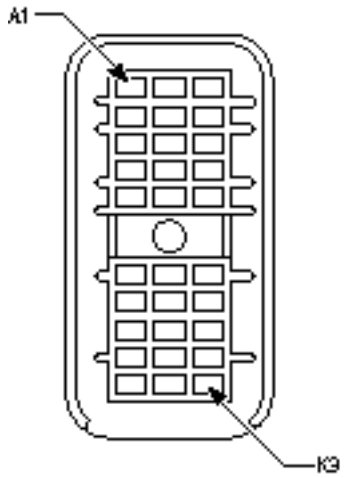


Figure D–15. VIM Connector (Harness)

VIM CONNECTOR (HARNESS 30-WAY)

Terminal No.	Color	Wire No.	Description	Termination Point(s)*
A1	Blue	313NO	Reverse Warning Relay — Normally Open	
A2	Yellow	314CM	Output Wire 114 Relay — Common	
A3	Blue	314NO	Output Wire 114 Relay — Normally Open	
B1	Yellow	313CM	Reverse Warning Relay — Common	
B2	Green	314NC	Output Wire 114 Relay — Normally Closed	
B3			Reserved	
C1	Orange	346	Ignition Power	
C2	Green	312NC	Output Wire 112 Relay — Normally Closed	
C3			Reserved	
D1	Green	325NC	Output Wire 125 Relay — Normally Closed	
D2	Green	332NC	Output Wire 132 Relay — Normally Closed	
D3			Reserved	
E1	Yellow	325CM	Output Wire 125 Relay — Common	
E2	Yellow	332CM	Output Wire 132 Relay — Common	
E3	Blue	332NO	Output Wire 132 Relay — Normally Open	
F1	Blue	323NO	Neutral Start Relay — Normally Open	
F2	Yellow	312CM	Output Wire 112 Relay — Common	
F3	Blue	312NO	Output Wire 112 Relay — Normally Open	
G1	Yellow	323CM	Neutral Start Relay — Common	
G2			Reserved	
G3			Reserved	
H1			Reserved	
H2	White	357UF	Speedometer — Unfiltered	
H3			Reserved	
J1	Pink	336A	Battery Power	
J2	Pink	336C	Battery Power	
J3			Reserved	
K1	Gray	343A	Battery Ground	
K2	Gray	343C	Battery Ground	
K3			Reserved	

* Termination Points are determined by OEM electrical system design.

APPENDIX D — WIRE/CONNECTOR CHART

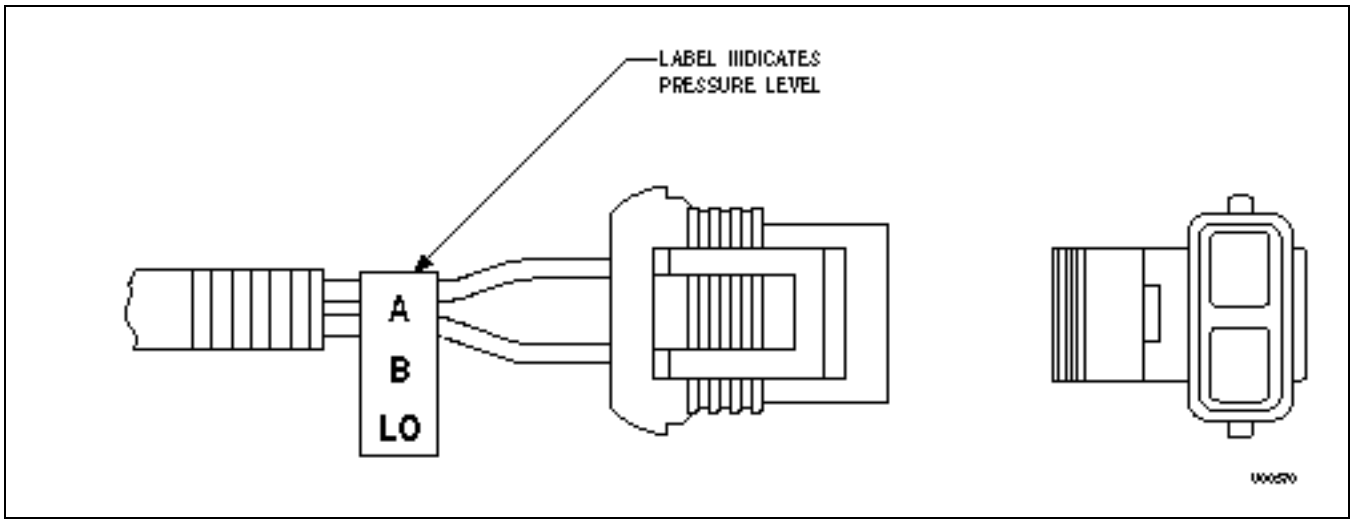


Figure D–16. Resistance Module Type 2 — Single Pressure Switch and SCI Interface

RESISTANCE MODULE TYPE 2

Terminal No.
A
B

SCI INTERFACE CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A	White	142-S1	Serial Communication Interface, Hi	ECU-S1, DDRP-J, DDRD-A
B	Blue	151-S17	Serial Communication Interface, Lo	ECU-S17, DDRP-K, DDRD-B

APPENDIX D — WIRE/CONNECTOR CHART

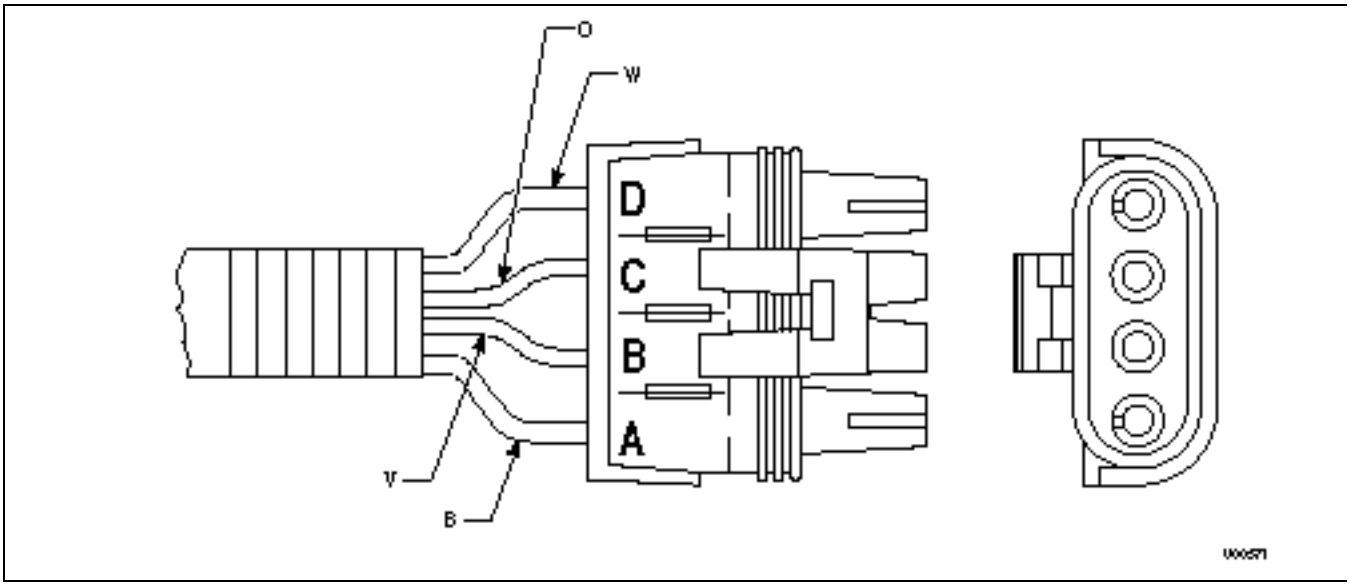


Figure D–17. Resistance Module Type 3 — Bendix E-10R Pedal

RESISTANCE MODULE TYPE 3

Terminal No.	Wire Color
A	Blue
B	Violet
C	Orange
D	White

APPENDIX D — WIRE/CONNECTOR CHART

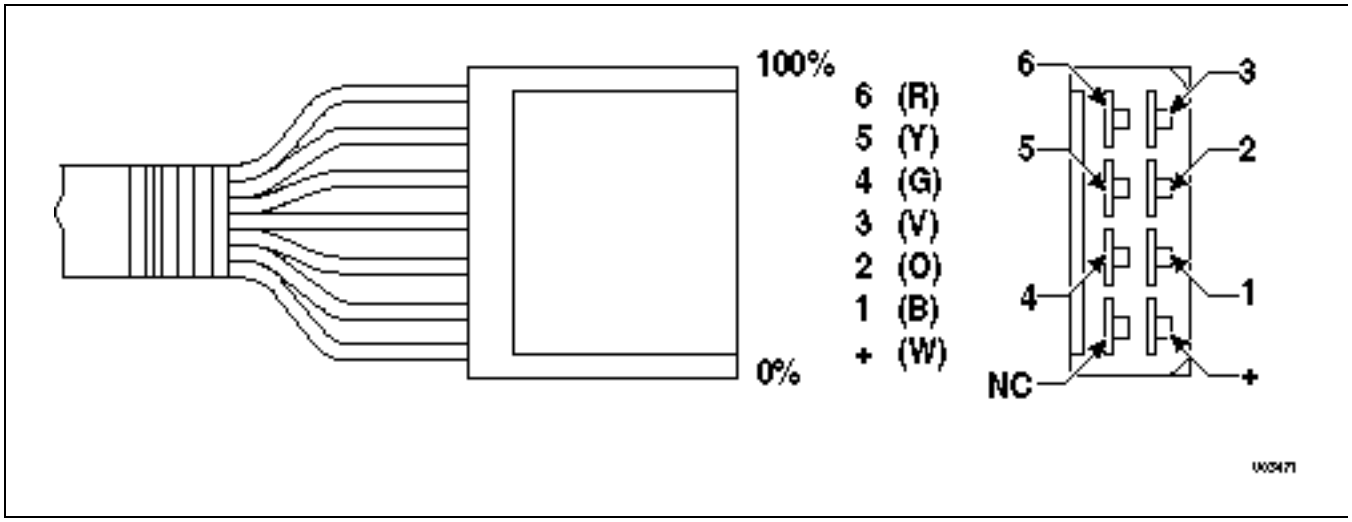


Figure D–18. Resistance Module Type 5 — Hand Lever

RESISTANCE MODULE TYPE 5

Terminal No.	Wire Color
+	White
1	Blue
2	Orange
3	Violet
4	Green
5	Yellow
6	Red

APPENDIX D — WIRE/CONNECTOR CHART

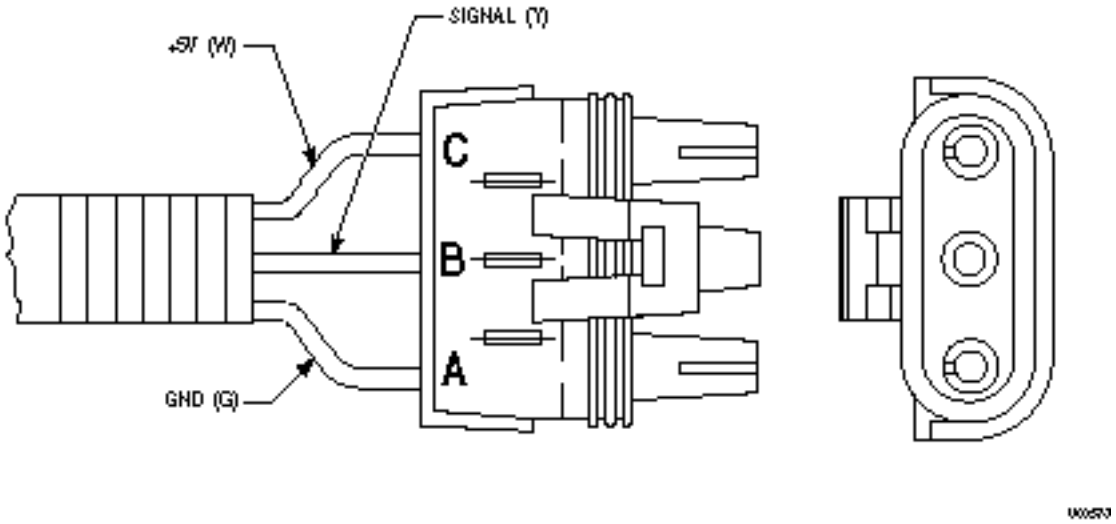


Figure D–19. Resistance Module Type 7 — Dedicated Pedal

RESISTANCE MODULE TYPE 7

Terminal No.	Wire Color
A	Green
B	Yellow
C	White

APPENDIX D — WIRE/CONNECTOR CHART

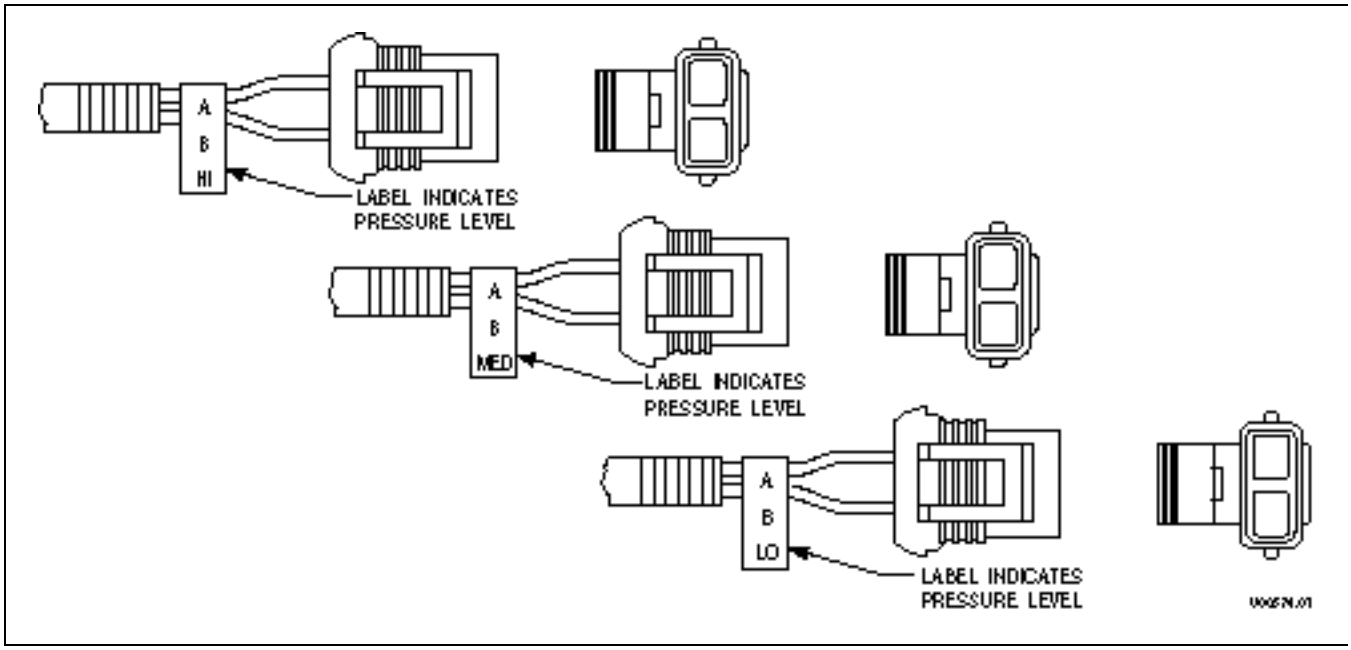


Figure D–20. Resistance Module Type 8 — Three Pressure Switch

RESISTANCE MODULE TYPE 8

LOW PRESSURE

Terminal No.	Wire Color
A	White
B	Blue

MEDIUM PRESSURE

Terminal No.	Wire Color
A	White
B	Orange

HIGH PRESSURE

Terminal No.	Wire Color
A	White
B	Violet

APPENDIX D — WIRE/CONNECTOR CHART

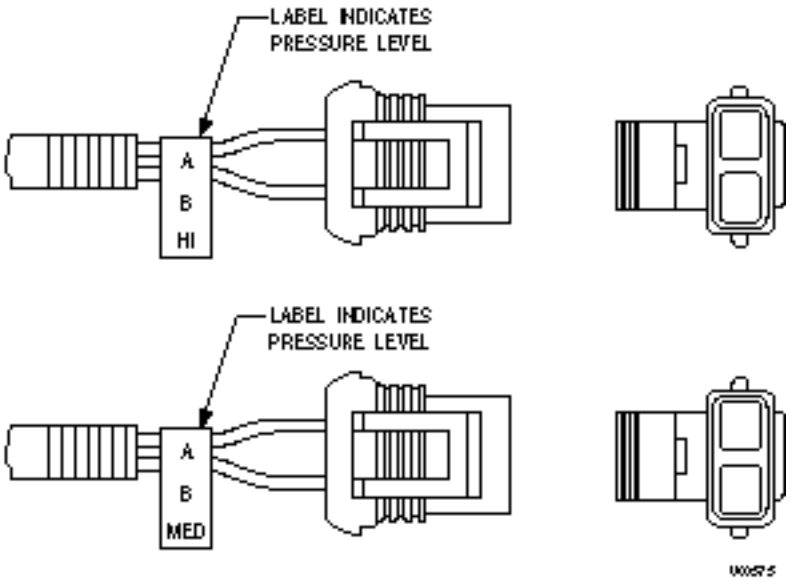


Figure D–21. Resistance Module Type 9 — Two Pressure Switch

RESISTANCE MODULE TYPE 9

MEDIUM PRESSURE

Terminal No.	Wire Color
A	White
B	Orange

HIGH PRESSURE

Terminal No.	Wire Color
A	White
B	Violet

APPENDIX D — WIRE/CONNECTOR CHART

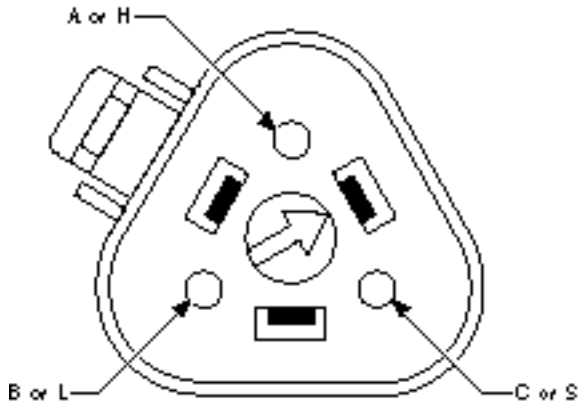


Figure D–22. J1939 Interface Connector

J1939 INTERFACE CONNECTOR

Terminal No.	Color	Wire No.	Description	Termination Point(s)
A or H	Pink	183-S13	J1939 Controller, Hi	ECU-S13
B or L	Gray	184-S29	J1939 Controller, Lo	ECU-S29
C or S	Green	182-S12	J1939 Shield	ECU-S12

APPENDIX D — WIRE/CONNECTOR CHART

APPENDIX E — WELDING ON VEHICLE/VEHICLE INTERFACE MODULE

1–3. WELDING ON VEHICLE

When frame or other welding is required on the vehicle, take the following precautions to protect the electronic control components:

1. Disconnect the wiring harness connectors at the transmission electronic control unit.
2. Disconnect the positive and negative battery connections, and any electronic control ground wires connected to the frame or chassis.
3. Cover electronic control components and wiring to protect them from hot sparks, etc.
4. Do not connect welding cables to electronic control components.

WARNING!	**Do not jump start a vehicle with arc welding equipment. Arc welding equipment's dangerously high currents and voltages cannot be reduced to safe levels.**

1–4. VEHICLE INTERFACE MODULE

The Allison Vehicle Interface Module (VIM) containing all Allison system relays and fuses must be used as the interface to all vehicle wiring. Refer to Figure E–2 for VIM component location and pin-out.To close an open VIM, tighten the bolts in the numerical order shown in Figure E–1 to provide a sealed, water-tight box. Torque the bolts to 5–8 N·m (4–6 lb ft).

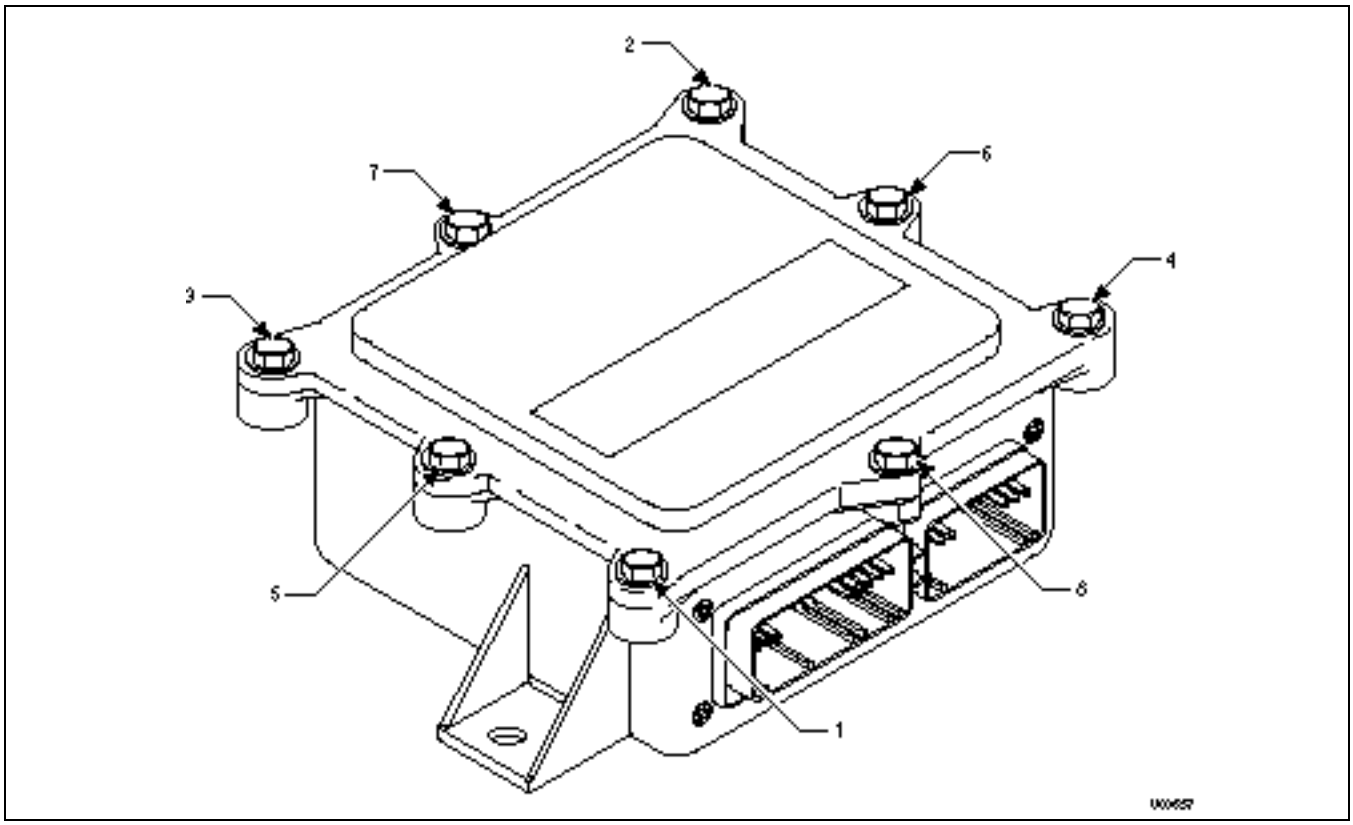


Figure E–1. Vehicle Interface Module

APPENDIX E — WELDING ON VEHICLE/VEHICLE INTERFACE MODULE

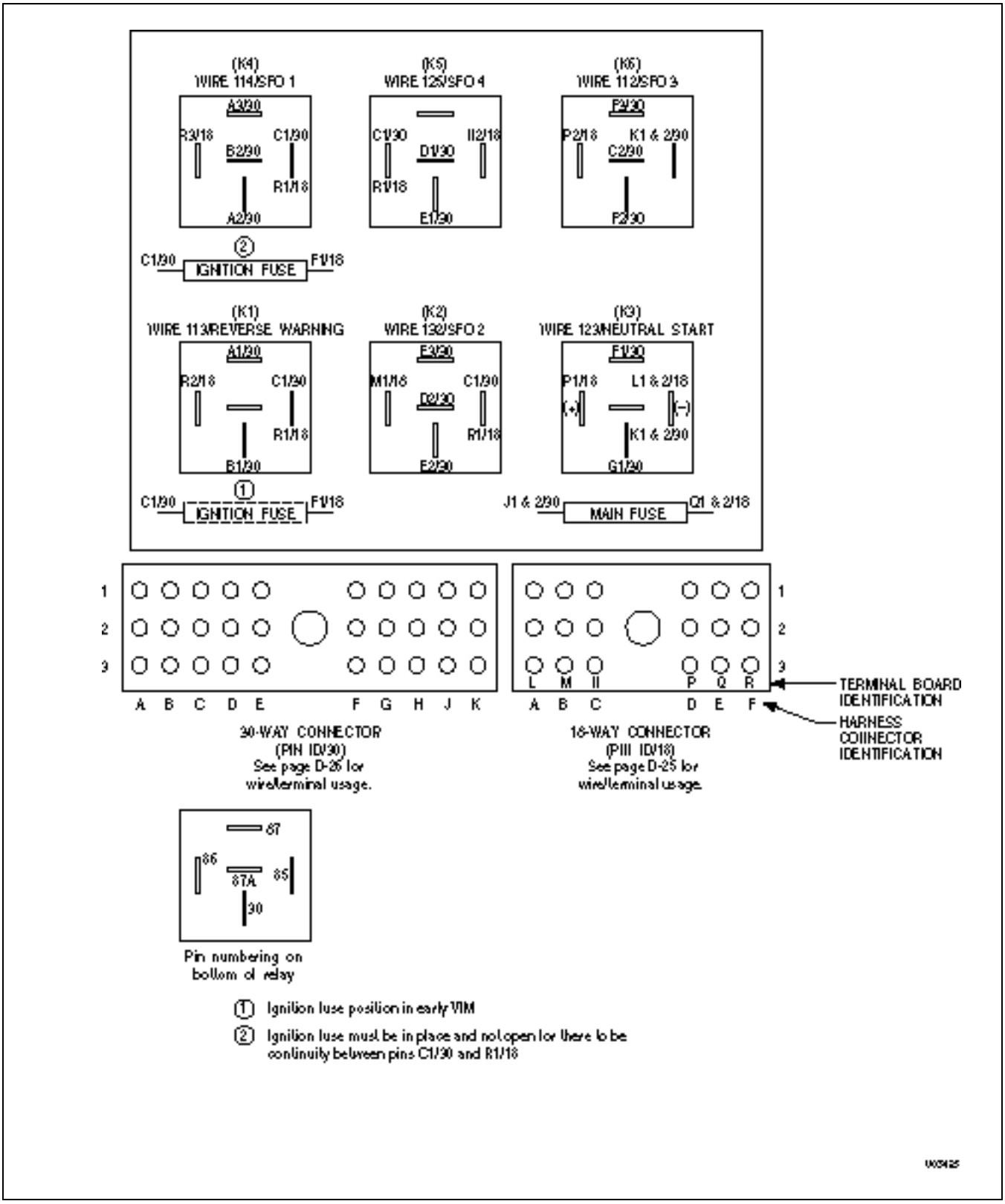


Figure E–2. VIM Components Location and Pin-Out Diagram

APPENDIX F — DIAGNOSTIC TREE — WT HYDRAULIC SYSTEM

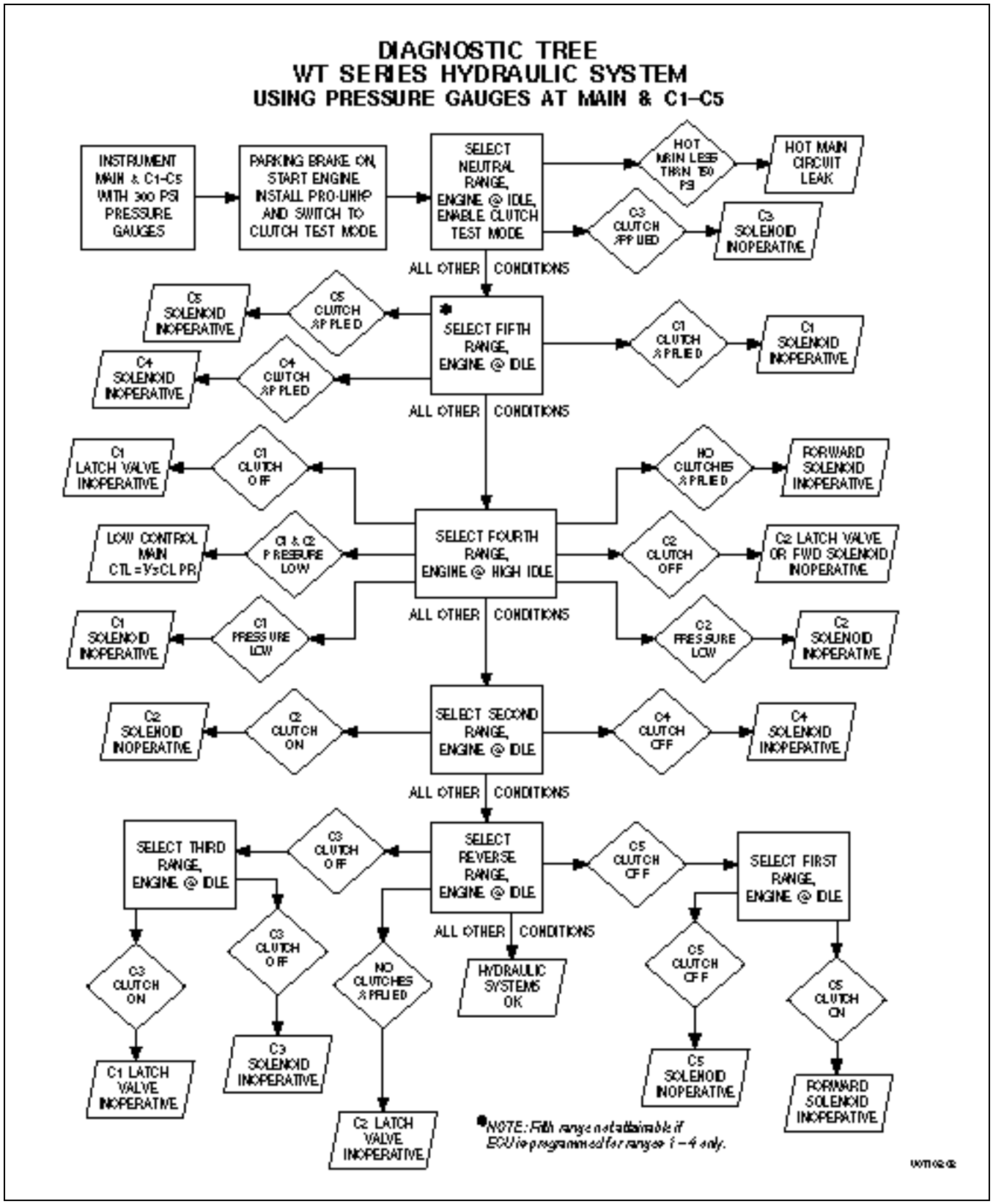


Figure F–1. Diagnostic Tree — WT Series Hydraulic System With Gauges

APPENDIX F — DIAGNOSTIC TREE — WT HYDRAULIC SYSTEM

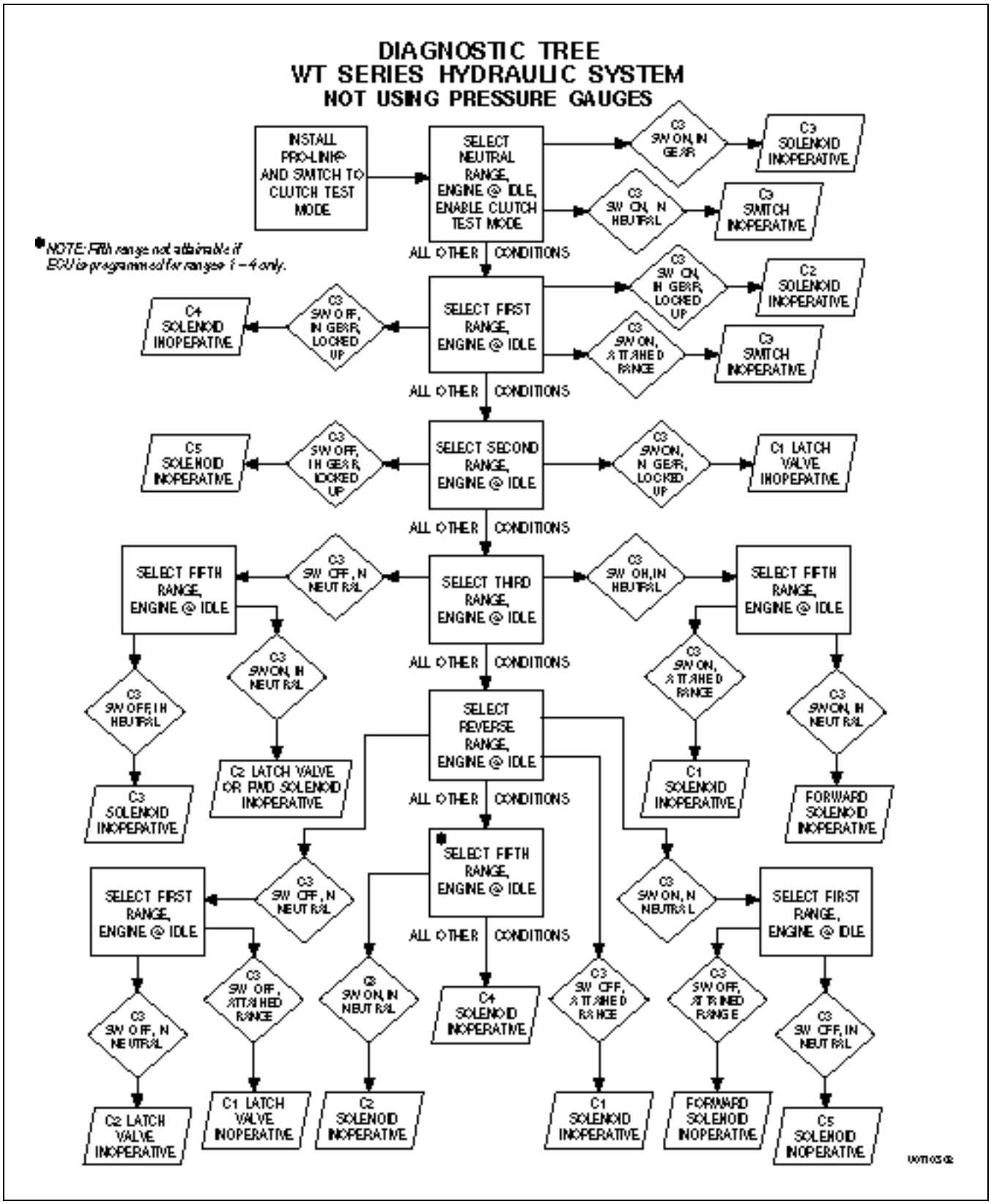


Figure F–2. Diagnostic Tree — WT Series Hydraulic System Without Gages

APPENDIX G — PRO-LINK® 9000 DIAGNOSTIC DATA READER INFORMATION

Pro-link® 9000 Diagnostic Tools

The WTEC III system will require new Pro-Link® 9000 hardware for reprogramming and diagnostics. The following is a list of required updates to the current Pro-Link® 9000 hardware:

Hardware	Tool P/N
Diagnostic Cartridge	J38500-303
PROM Update Kit	J38500-313
MultiProtocol Cartridge (MPC)	J38500-1500A
Reprogramming PCMCIA Card*	J38500-1700
Diagnostic Card*	J38500-1800

* Requires J38500-1500A to function

Limited diagnostic information for the WTEC III system can be accessed through the current WTEC II Pro-Link® 9000 hardware. This diagnostic information will however be limited to that information that is common to the WTEC II and WTEC III systems. Access to information described in this SIL can only be accessed through **either** the WTEC III Diagnostic Cartridge or by updating the current WTEC II Diagnostic Cartridge with the PROM update kit or the WTEC III Reprogramming Cartridge.

The MultiProtocol Cartridge (MPC) and the Reprogramming Card are required to modify customer constants and alter Calibration packages within the WTEC III ECU. After completing an ATD-approved training class, those ordering a reprogramming cartridge are required to submit a copy of their completion certificate with their order. This serves as proof of eligibility to purchase these items. Training is available from ATD and ATD distributors.

APPENDIX G — PRO-LINK® 9000 DIAGNOSTIC DATA READER INFORMATION

APPENDIX H — INPUT/OUTPUT FUNCTIONS

The schematics which follow were taken from the Sales Tech Data Book entitled “WTEC III Controls.” These schematics provide detail information needed to correctly perform input and output function connections.

WARNING!	**These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.**

A. SECONDARY SHIFT SCHEDULE

USES: Provides operator selection of dual shift schedules. Can be used for performance/economy, loaded/empty, or other shift schedule combinations.

VARIABLES TO SPECIFY: None

VOCATIONS: Various

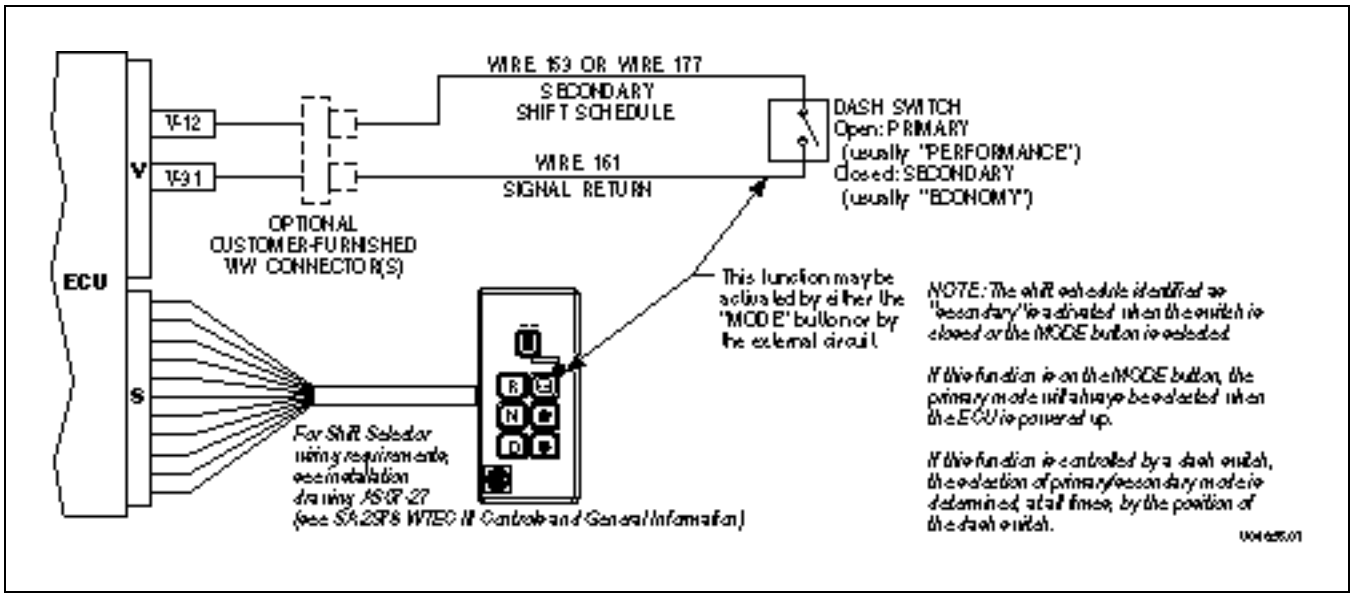


Figure H–1. Secondary Shift Schedule

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!	**These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.**

B. D1 SELECTION

USES: Provides a convenient means of attaining 1st range hold for pushbutton shift selectors. Range to select is programmable for Primary and Secondary modes.

VARIABLES TO SPECIFY: Primary Mode selected range, Secondary Mode selected range (usually 1st range). Can be used only on the MODE button.

VOCATIONS: Various

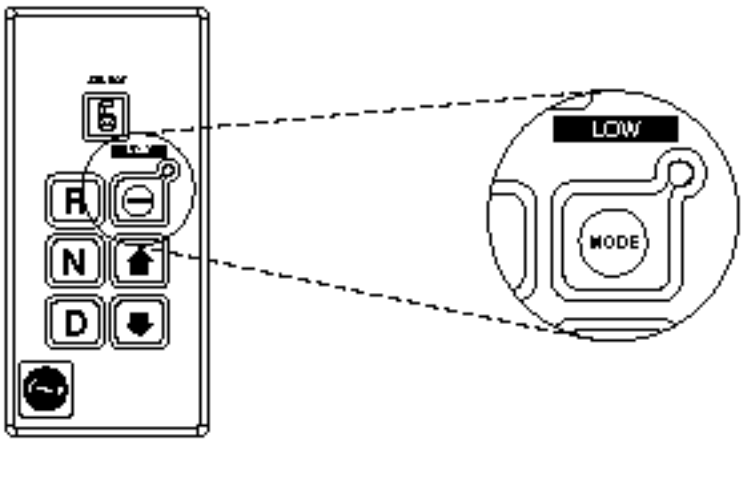


Figure H–2. D1 Selection

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!	**These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.**

D. SHIFT SELECTOR TRANSITION

USES: When two shift selectors are used, to select which one is active.

VARIABLES TO SPECIFY: None

VOCATIONS: Various

WARNING!	**If this function is enabled in the shift calibration, the function MUST be integrated into the vehicle wiring. If the function is available in the shift calibration but will not be used in the vehicle, it MUST be disabled in the calibration.**

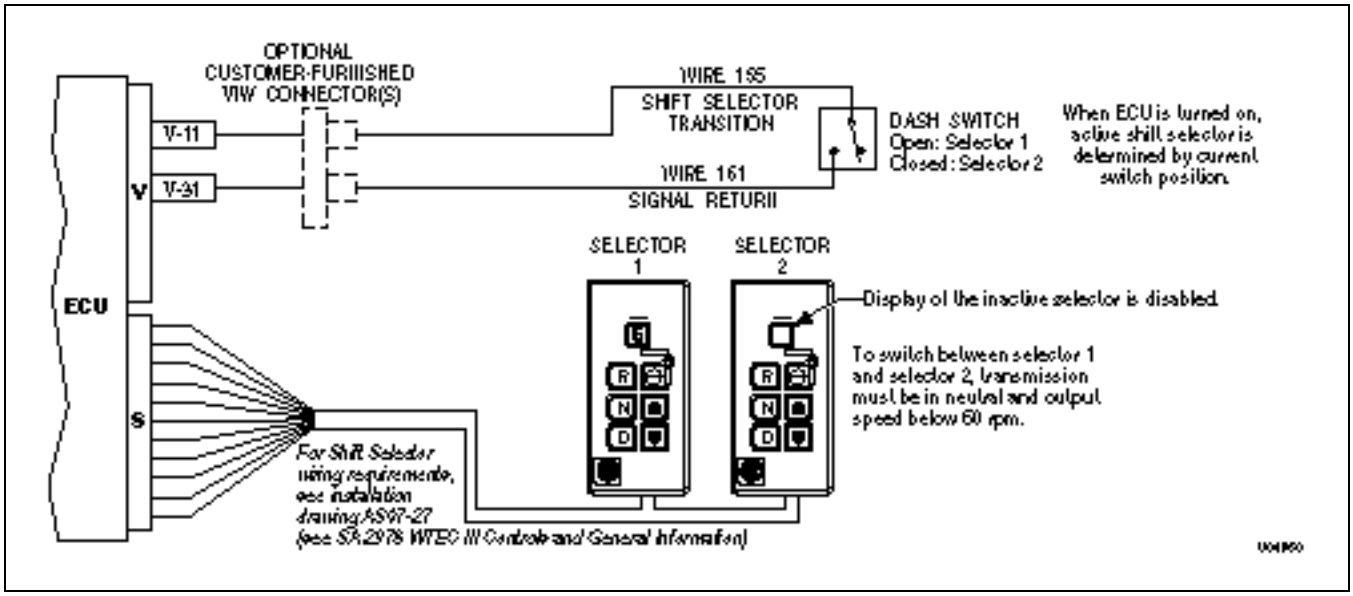


Figure H–3. Shift Selector Transition

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!	**These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.**

H. ENGINE BRAKE/PRESELECT REQUEST AND ENGINE BRAKE ENABLE (EXHAUST BRAKE – OPTIONAL)

USES: Used with engine brakes controlled by electronic engines to signal the ECU that the brake is active and to provide increased braking by preselecting a lower range. Also prevents engagement of engine brake with throttle > 0 or lockup OFF.

VARIABLES TO SPECIFY: Preselect range. Standard value is second range.

VOCATIONS: Various

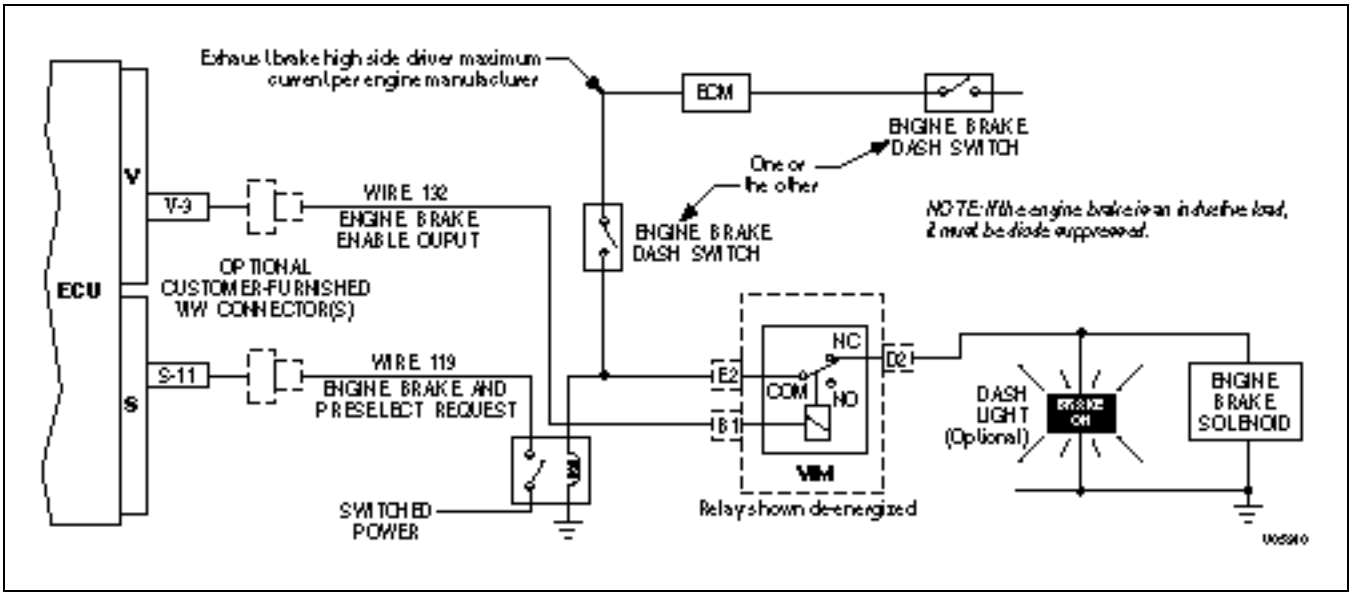


Figure H–4. Engine Brake/Preselect Request and Engine Brake Enable (Exhaust Brake — Optional)

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!

These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.

H. ENGINE BRAKE/PRESELECT REQUEST AND ENGINE BRAKE ENABLE (COMPRESSION BRAKE)

USES: Used with single-level compression brakes to signal the ECU that the brake is active and to provide increased braking by preselecting a lower range. Also prevents engagement of engine brake with throttle > 0 or lockup OFF.

VARIABLES TO SPECIFY: Preselect range. Standard value is fourth range.

VOCATIONS: Various

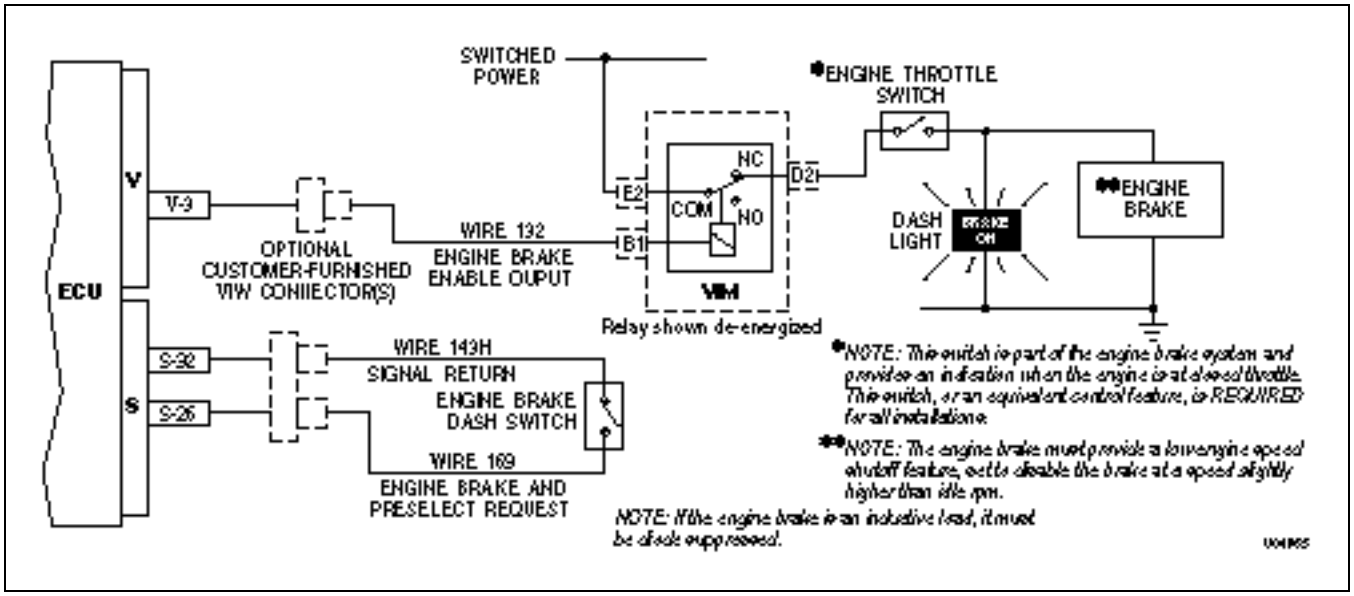


Figure H–5. Engine Brake/Preselect Request and Engine Brake Enable (Compression Brake)

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!

These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.

I. ENGINE BRAKE/PRESELECT REQUEST AND ENGINE BRAKE ENABLE (EXHAUST BRAKE — SPECIAL)

USES: Used with engine brakes to provide a signal to the ECU that the brake is active and to provide increased braking by preselecting a lower range. Also prevents engagement of engine brake with throttle > 0 or lockup OFF.

VARIABLES TO SPECIFY: Preselect range. Standard value is second range.

VOCATIONS: Various

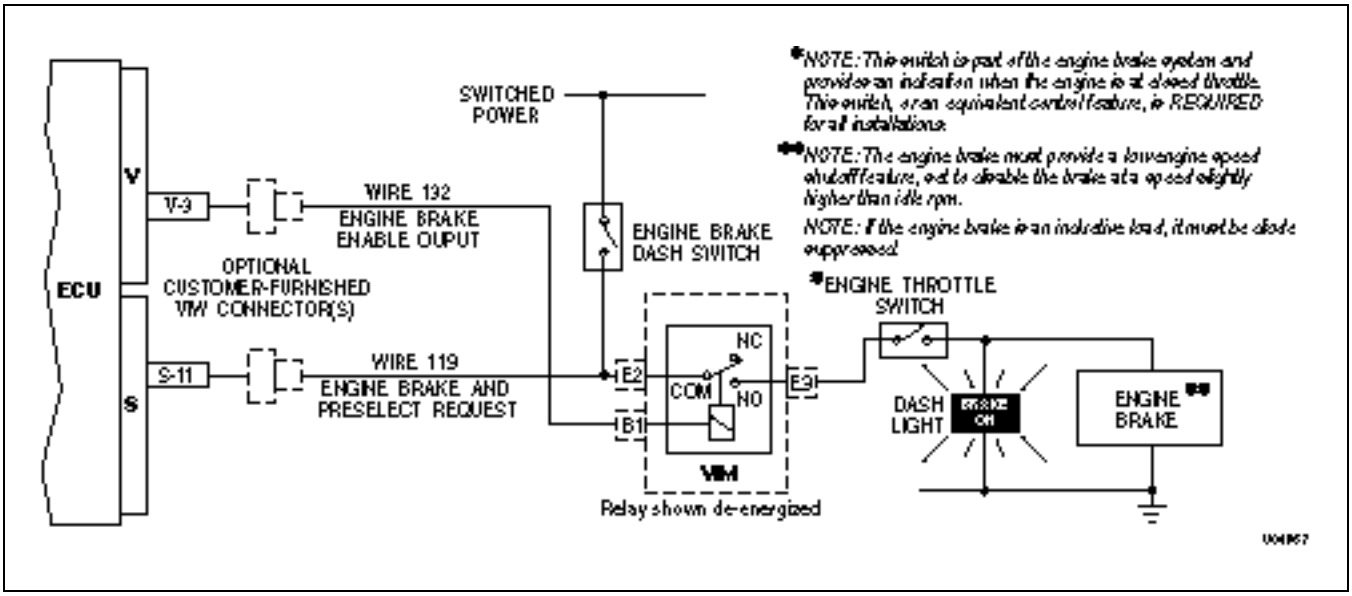


Figure H–6. Engine Brake/Preselect Request and Engine Brake Enable (Exhaust Brake — Special)

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!

These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.

Y. ANTI-LOCK BRAKE RESPONSE

USES: Signals the ECU when ABS function is active, so that lockup clutch and retarder will be disabled.

VARIABLES TO SPECIFY: None

VOCATIONS: Various

For schematics of this function, see the **ANTI-LOCK BRAKES** section located in Section C: Vehicle Electrical System Interface of SA2978, WTEC III Controls And General Information.

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!

These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.

Y. ANTI-LOCK BRAKE RESPONSE (OPTIONAL)

USES: Provides for enhanced control of lockup and retarder during hard braking conditions. Can be used separately or in conjunction with ABS.

VARIABLES TO SPECIFY: None

VOCATIONS: Various

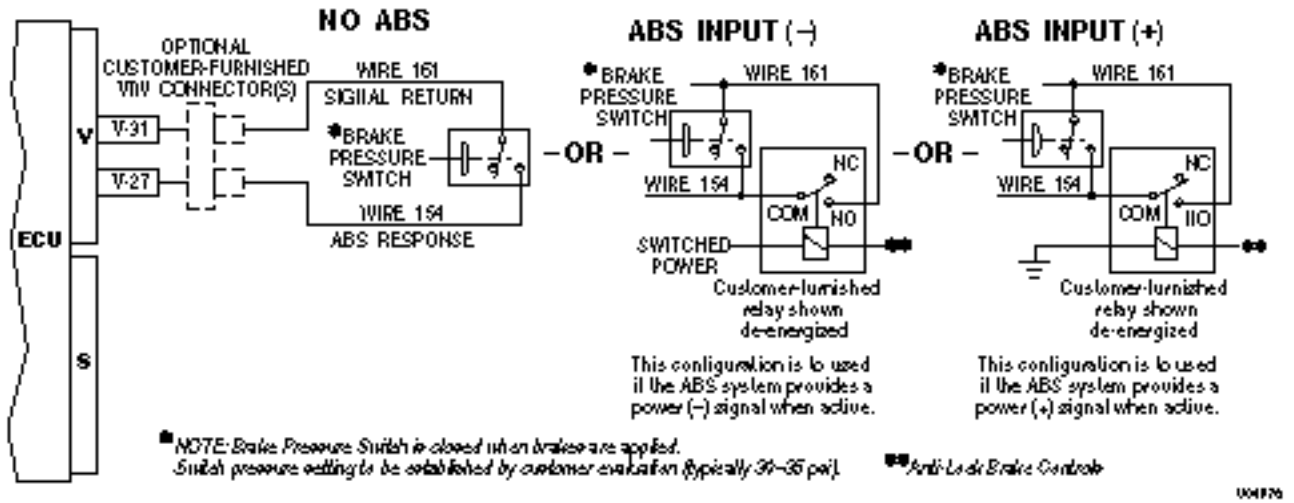


Figure H–7. Anti-Lock Brake Response (Optional)

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!	**These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.**

AI. MILITARY AUXILIARY FUNCTION RANGE INHIBIT (STANDARD)

USES: Prevents inadvertent range selection when auxiliary equipment is operating.

VARIABLES TO SPECIFY: None

VOCATIONS: Military wheeled vehicles

WARNING!	**If this function is turned "ON" in the shift calibration, the function MUST be integrated into the vehicle wiring. If the function is available in the shift calibration but will not be used in the vehicle, it MUST be turned "OFF" in the calibration.**

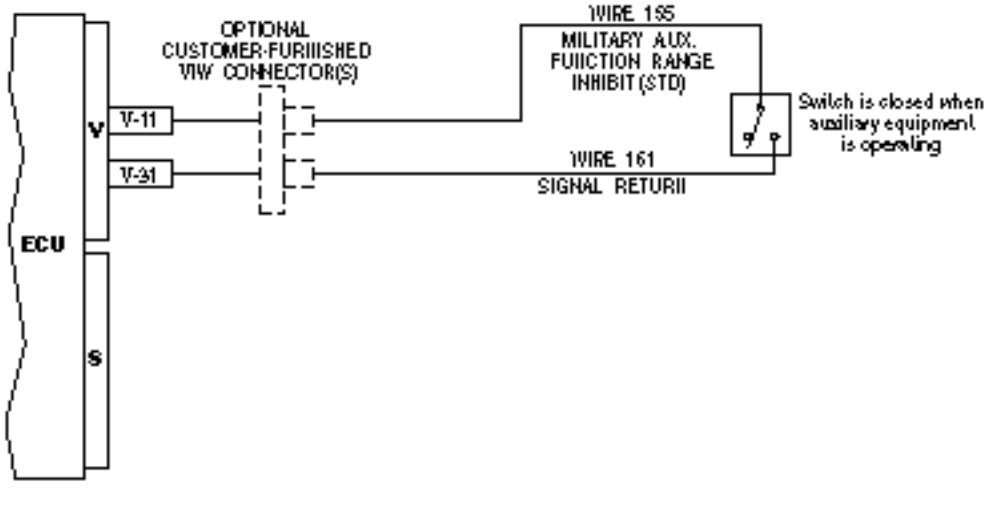


Figure H–8. Military Auxiliary Function Range Inhibit (Standard)

APPENDIX H — INPUT/OUTPUT FUNCTIONS

WARNING!	**These schematics show the intended use of the specified controls features which have been validated in the configuration shown. Any miswiring or use of these features which differs from that shown could result in damage to equipment or property, personal injury, or loss of life. ALLISON TRANSMISSION IS NOT LIABLE FOR THE CONSEQUENCES ASSOCIATED WITH MISWIRING OR UNINTENDED USE OF THESE FEATURES.**

AQ. SELECTOR DISPLAY BLANKING

USES: Blanks the digital display and mode on indicator on the lever or pushbutton shift selectors.

VARIABLES TO SPECIFY: None

VOCATIONS: Military wheeled vehicles

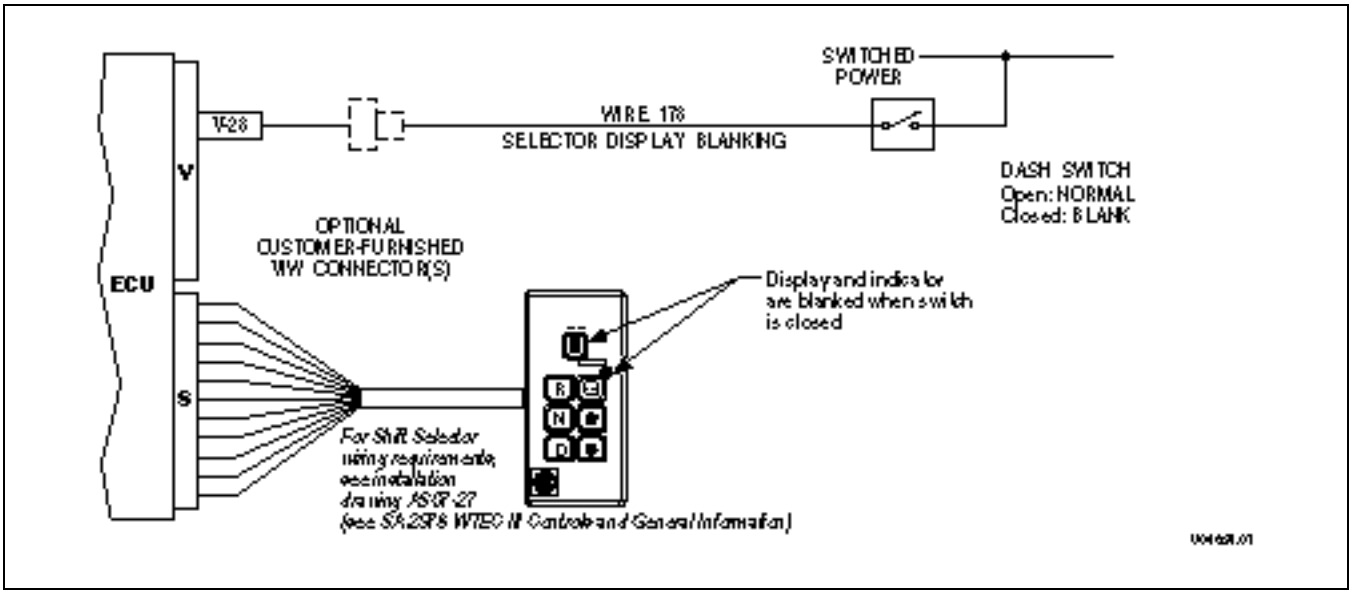


Figure H–9. Selector Display Blanking

Table 1. Brake System Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. Vehicle Does Not Slow Down Quickly Enough When Brakes Are Applied.	1. Check for proper lubrication and adjustment of brakes.	Lubricate brake system (TM 9-2320-302-10) or adjust brakes (WP 0139 00) as necessary.
	2. Check for heat-damaged and glazed brakeshoe linings.	Replace any damaged or glazed brakeshoes (all brakeshoes must be replaced on an axle) (WP 0135 00 or WP 0137 00).
	3. Check brake drums for excessive heat damage, cracks, scoring, and out-of-roundness.	Replace damaged brake drums (WP 0165 00 or WP 0166 00).
	4. Check for faulty air chambers.	Replace faulty air chamber(s) (WP 0141 00 or WP 0142 00).
	5. Check for air pressure leakage to air chambers.	Replace air compressor (Notify Direct Support Maintenance).
2. Brakes Do Not Release or Release Too Slowly.	1. Check for proper lubrication of brake system.	Lubricate brake system (TM 9-2320-302-10).
	2. Check that foot valve returns to fully released position.	Remove any debris interfering with pedal travel.
	3. Check exhaust ports on brake foot valve, quick release valve, and gladhand vent holes for blockage.	Clear obstructions from exhaust port(s) and vents (WP 0161 00).
	4. Check for weak and broken brakeshoe return springs.	Replace weak or broken springs (WP 0135 00 or WP 0137 00).
	5. Check for frozen brakeshoe anchor pins.	Clean and lubricate sticking pins or replace pins if damaged (WP 0135 00 or WP 0137 00).
	6. Check for broken spring in air chamber.	Replace air chamber (WP 0141 00 or WP 0142 00).
3. Brakes Are Uneven, Drag or Pull When Applied.	1. Check for uneven adjustment between axles.	Adjust brakes (WP 0139 00).
	2. Check for proper wheel bearing adjustment.	Adjust wheel bearings (WP 0165 00 or WP 0166 00).
	3. Check for grease-saturated or worn brake linings.	Replace brake linings (WP 0135 00 or WP 0137 00).
	4. Check for out-of-round brakedrum(s).	Replace brakedrum(s) (WP 0165 00 or WP 0166 00).
	5. Check for worn s-cam or roller.	Replace s-cam or roller (WP 0140 00).

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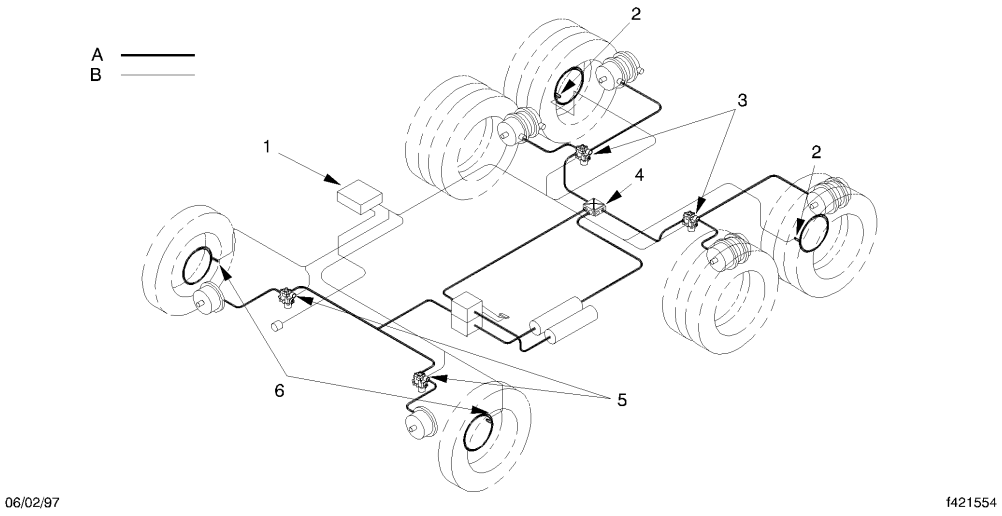
ANTI-LOCK BRAKE SYSTEM (ABS) TROUBLESHOOTING AND TESTING 0013 00

INTRODUCTION

This work package contains information on troubleshooting and testing the Anti-lock Brake System (ABS) using blink code diagnostics and Prolink. The ABS is an electronic system that monitors and controls braking only during emergency situations. The ABS controls the braking of each wheel separately, which prevents wheel locking, maintains steerability, and reduces stopping distance. The ABS has two diagonal circuits. Each circuit connects the front wheel of one side of the vehicle to the rear wheels of the opposite side. In case of a system fault, only half of the ABS stops working. Control of that half is returned to the standard braking system. The ABS uses a tone ring and sensor on the hub of each monitored wheel. The sensor sends wheel speed information to the Electronic Control Unit (ECU). The ECU signals the modulator valve for that wheel to increase, reduce or maintain pressure in the brake chamber (Figure 1).

PRETEST INSPECTION

Prior to performing vehicle test, ensure that daily Preventive Maintenance Checks and Inspections (PMCS) has been performed.



A. Air Lines
B. Electrical Lines

1.	Cab-mounted ECU	3.	ABS Modulator Valves	5.	ABS Modulator Valves
2.	Wheel Speed Sensors	4.	Relay Valve	6.	Wheel Speed Sensor

Figure 1. Location of ABS Components.

GENERAL INFORMATION

1. Rockwell WABCO ABS D Version is an electronic system that monitors and controls wheel speed during braking. The system works with standard air brake systems. ABS monitors wheel speeds at all times and controls braking during wheel lock situations. The system improves vehicle stability and control by reducing wheel lock during braking.

GENERAL INFORMATION - CONTINUED

2. The ECU receives and processes signals from the wheel speed sensors. When the ECU detects a wheel lockup, the unit activates the appropriate modulator valve, and air pressure is controlled. In the event of a malfunction in the system, the ABS in the affected wheel(s) is disabled; that wheel still has normal brakes. The other wheels keep the ABS function.
3. An ABS warning lamp lets the driver know the status of the system. If the ECU senses a fault during normal vehicle operation, the ABS warning lamp will come on. This lamp is also used to display blink code diagnostics.

ABS WARNING LAMP

The ABS warning lamp works as shown in Table 1. If the ECU senses a fault during normal vehicle operation, the ABS warning lamp will come on and stay on.

Table 1. Warning Lamp Operation.

WHAT YOU DO	WHAT HAPPENS	WHAT IT MEANS
Turn the ignition on.	The ABS lamp comes on momentarily for a bulb check, then goes out.	The system is okay.
	The ABS lamp does not go out at ignition.	If the lamp goes out when the vehicle is driven above 4 mph (6 km/h), the system is okay. If the lamp does not go out at speeds above 4 mph (6 km/h), the ECU senses a fault in the ABS system.

ABS MODULATOR VALVES

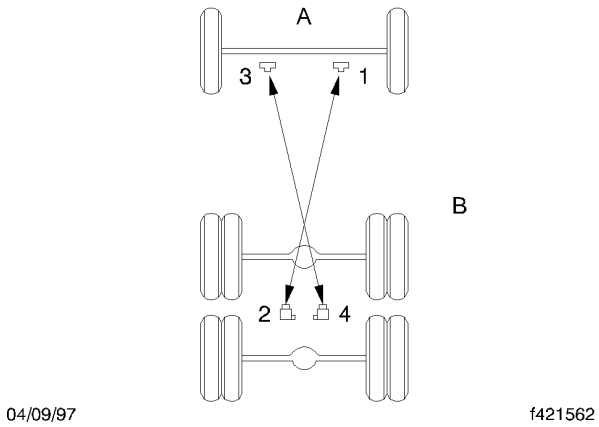
1. Modulator valves control the air pressure to each affected brake during an ABS function.
2. To make sure the ABS valves are working, listen to them as follows:
   a. Turn on the ignition.
   b. Wait for the ABS light.

NOTE

The valves will cycle in 1-2-3-4 order, then diagonally in 1-2 and 3-4 order.

   c. Listen for the valves to cycle, one by one, then together diagonally (Figure 2).

ABS MODULATOR VALVES - CONTINUED



NOTE: The valves will cycle in 1-2-3-4 order, then diagonally in 1-2 and 3-4 order

A. Cab
B. Curbside

Figure 2. Modulator Valve Checking.

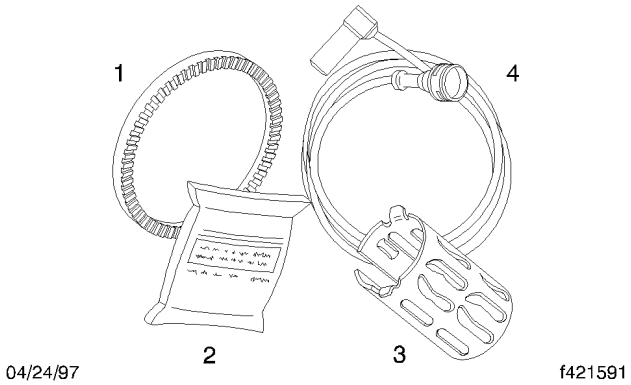
ABS SENSORS

1. ABS sensor systems consist of a tooth wheel mounted on the hub of each monitored wheel and a sensor installed so that its end is against the tooth wheel. The sensor continuously sends wheel speed information to the ECU. A sensor clip holds the sensor in place at the tooth wheel.
2. The type of axle determines the sensor mounting location:
   a. Steering axle sensors are installed in the steering knuckle or in a bolted-on bracket.
   b. Drive axle sensors are mounted in a block attached to the axle housing or in a bolted-on bracket.

SYSTEM COMPONENTS

1. The ECU is the brain of the ABS system. It receives information from the sensors and sends signals to the ABS valves (Figure 1).
2. A tooth wheel (Figure 3) is mounted at the hub of each sensed wheel, with a sensor installed so that its end is against the tooth wheel. A sensor clip holds the sensor in place at the tooth wheel. The sensor and clip must be greased with Rockwell WABCO-recommended lubricant.

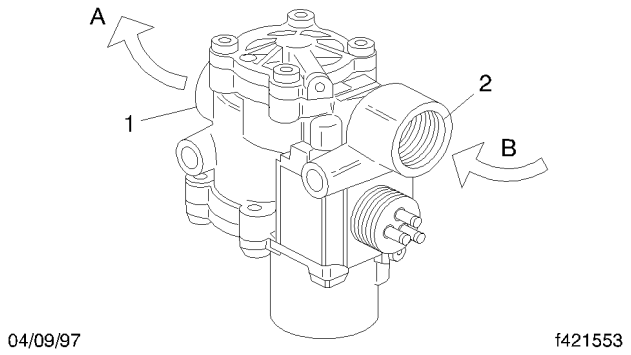
SYSTEM COMPONENTS - CONTINUED



1. Tooth Wheel
2. Lubricant
3. Sensor Clip
4. Sensor

Figure 3. Sensor Components.

3. An ABS modulator valve controls air pressure to each affected brake during emergency braking situations (Figure 4).



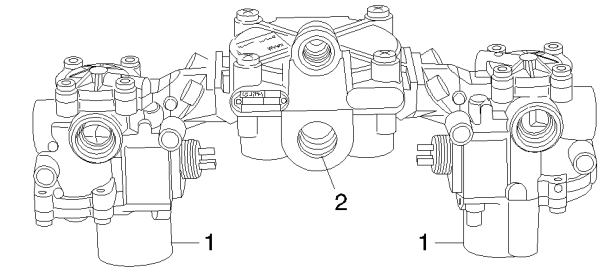
A. Out
B. In

1. Port 2
2. Port 1

Figure 4. ABS Modulator Components.

SYSTEM COMPONENTS - CONTINUED

4. The ABS valve package is an alternative to individual valves on the rear axles. It combines two ABS modulator valves and one service relay valve (Figure 5).



1. Modulator
2. Relay Valve

Figure 5. ABS Valve Package.

5. Sensor cables connect the sensor to the ECU (Figure 6).

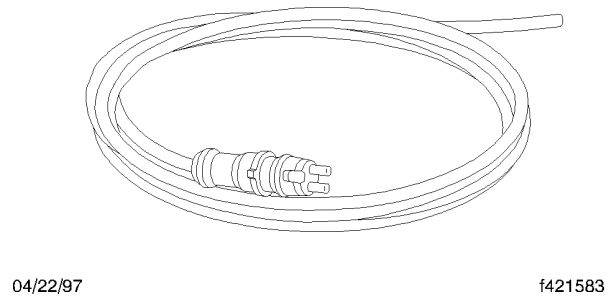


Figure 6. ABS Sensor Cable.

6. ABS modulator valve cables connect the modulator valve to the ECU (Figure 7).

SYSTEM COMPONENTS - CONTINUED

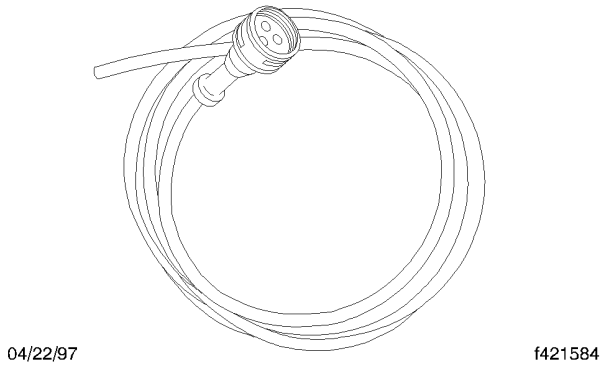


Figure 7. ABS Modulator Valve Cable.

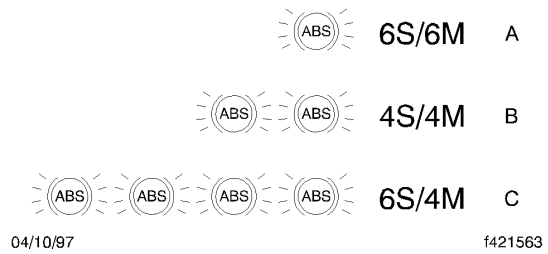
LAMP BULB CHECK

To make sure the ABS lamp is operating, drivers should check the lamp every time the vehicle is started. When the vehicle is started, the ABS lamp should come on momentarily. If it does not come on, it could mean a burned-out bulb.

DIAGNOSTICS

1. **Diagnostic Methods.** You can troubleshoot the system in the following ways:
   a. Blink Code Diagnostics
   b. Pro-link 9000
2. **Blink Code Diagnostics.** Before using blink code diagnostics, you should be familiar with a few basic terms. If you used previous versions of Rockwell WABCO blink code diagnostics, review these definitions to identify major changes.
   a. **ABS Warning Lamp.** This lamp serves two purposes: it alerts drivers to an ABS fault and it is used during diagnostics to display the blink code.
   b. **Blink Code.** A series of blinks or flashes that describe a particular ABS system fault or condition.
   c. **Blink Code Cycle.** A set of two flashes with each flash separated by a one-and-one-half second pause. Blink codes are defined in Table 2.
   d. **Blink Code Switch.** A switch that activates blink code diagnostic capabilities. Switch types and locations vary, depending on the vehicle.
   e. **Clear**. The process of erasing faults from the ECU.
   f. **Diagnostics.** The process of using blink codes to determine ABS system faults.
   g. **Fault.** An ABS malfunction detected and stored in memory by the Rockwell WABCO ECU. System faults may be Active or Stored.
   h. **Active Fault.** A condition that currently exists in the ABS system; for example, a sensor circuit malfunction on the left front steering axle. An active fault must be repaired before it can be cleared from memory and before you can display additional codes.
   i. **Stored Fault.** There are two types of stored faults: One type is a repaired fault that has not been cleared from the ECU. The other type is a fault that occurred, but no longer exists, for example a loose wire that makes intermittent contact. Because stored faults are not currently active, they do not have to be repaired before they can be cleared from memory.
   j. **System Configuration Code.** A one digit code (Blink Code: 2) is displayed during the clear mode. Blink codes for common ABS system configurations are shown in Figure 8.

DIAGNOSTICS - CONTINUED



A. Blink Code: 1
B. Blink Code: 2
C. Blink Code: 4

Figure 8. System Configuration Codes.

Table 2. Blink Code Identification.

FIRST DIGIT (TYPE OF FAULT)	SECOND DIGIT (SPECIFIC LOCATION OF FAULT)
1. No Faults	1. No Faults
2. ABS modulator valve 3. Too much sensor gap 4. Sensor short or open 5. Sensor signal erratic 6. Tooth wheel	1. Right front steer axle (curb side) 2. Left front steer axle (driver side) 3. Right forward/rear tandem drive axle (curb side) 4. Left forward/rear tandem drive axle (driver side) 5. Right rearmost tandem drive axle (curb side) 6. Left rearmost tandem drive axle (driver side)
7. System function	1. J1922 or J1939 datalink 2. ATC valve (not used on M915A3) 3. Retarder relay (third brake) 4. ABS warning lamp 5. ATC configuration (not used on M915A3) 6. Reserved for future use
8. ECU	1. Low power supply 2. High power supply 3. Internal fault 4. System configuration error 5. Ground

NOTE

Blink code switch is located on ABS Electronic Control Unit (ECU) behind passenger's seat.

3. **Diagnostic Mode.** To enter the diagnostic mode, press and hold the blink code switch for one second, then release.

DIAGNOSTICS - CONTINUED

4. **Clear Mode.**

   a. To erase faults from the ECU, you must be in the clear mode. To enter the clear mode, press and hold the blink code switch for at least three seconds, then release.

   b. If the system displays eight quick flashes followed by a system configuration code, the clear was successful. The ABS fault has been cleared from memory.

   c. If you do not receive eight flashes, there are still active faults that must be repaired before they can be cleared.

5. **Blink Code Diagnostic Procedures.**

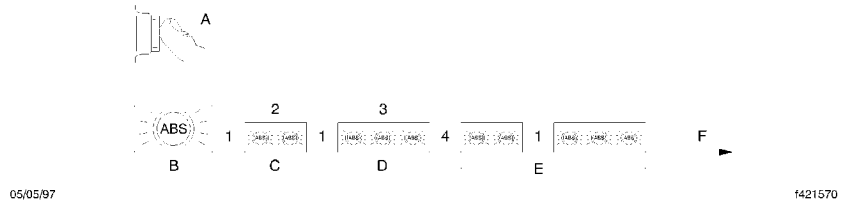
   For the step-by-step blink code diagnostic procedure, see Table 3.

Table 3. Blink Code Diagnostic Procedure.

MODE	PROCEDURE	SYSTEM RESPONSE	ACTION
Diagnostic	**Step 1.** Turn the ignition on.	The ABS warning lamp comes on momentarily then goes out, indicating System Okay.	No recognizable faults in the ABS. No action required.
		The ABS warning lamp does not light, indicating possible wiring fault or burned-out bulb.	Inspect the wiring. Inspect the bulb. Make necessary repairs.
		The ABS warning lamp stays on, indicating there is a fault, or faults, in the system.	Continue with the blink code diagnostics. Go to the next step.
	Step 2. Press and hold the Blink Code Switch for one second, then release.	The ABS warning lamp begins flashing two-digit blink codes(s).	Determine if the fault is active or stored: **Active Fault:** The lamp will repeatedly display one code. **Stored Fault:** The lamp will display the code for each stored fault then stop blinking. Faults will be displayed *one at a time*.
	Step 3. Count the flashes to determine the blink code.	First Digit: 1 to 8 flashes; Pause (1-1/2 seconds). Second Digit: 1 to 6 flashes; pause (4 seconds).	Turn the ignition off. Find the definition for the blink code in Table 2.
	Step 4. Repair and record the faults.	Active Fault.	Make the necessary repairs. Repeat the first three steps of this procedure until System Okay Code (1-1) is received.
		Stored Faults.	Record for future reference. **NOTE:** The last fault code stored is the first fault code displayed.
Clear	**Step 5.** Clear faults from the memory: Press and hold the blink code switch for at least three seconds, then release.	The ABS warning lamp flashes eight times.	All faults are successfully cleared. Turn the ignition off.
		Eight flashes are not received.	Active faults still exist. Repeat the first four steps of this procedure.

DIAGNOSTICS - CONTINUED

6. **Blink Codes Illustrated.** Refer to the following figures for examples of typical blink codes.
   a. For a typical Active Fault code, refer to Figure 9.
   b. For typical Stored Fault codes, refer to Figure 10.
   c. For the System Okay code, refer to Figure 11.
   d. For the Stored Fault Cleared code, refer to Figure 12.
   e. For the Faults Not Cleared (active faults exist) code, refer to Figure 13.

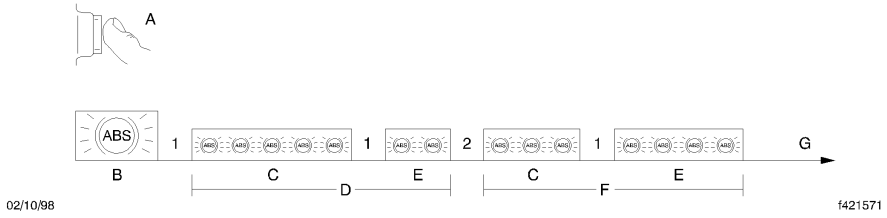


NOTE: Blink Code 2-3 is shown here: Fault in the ABS modulator valve, right side of forward-rear axle.

A.	Hold 1 second	C.	First digit (2)	E.	Repeat of blink code
B.	Light on	D.	Second digit (3)	F.	Continues until the ignition is turned off

1. Pause of 1.5 seconds
2. 1 to 8 flashes
3. 1 to 6 flashes
4. Pause of 4 seconds

Figure 9. Typical Active Fault Code.



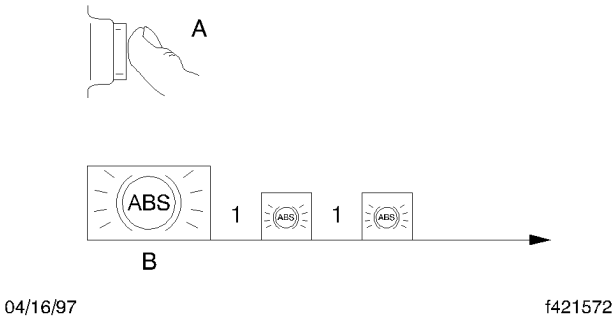
NOTE: Blink Codes 5-2 and 3-4 are shown here. Code 5-2: Sensor signal erratic, left-front steer axle. Code 3-4: Too much sensor gap, left side of forward-rear axle.

A.	Hold 1 second	C.	First digit (5)	E.	Second digit (2)	G.	Displays all stored faults at once-last fault stored is the first displayed
B.	Light on	D.	First stored fault	F.	Second stored fault		

1. Pause of 1.5 seconds
2. Pause of 4 seconds

Figure 10. Stored Fault Codes.

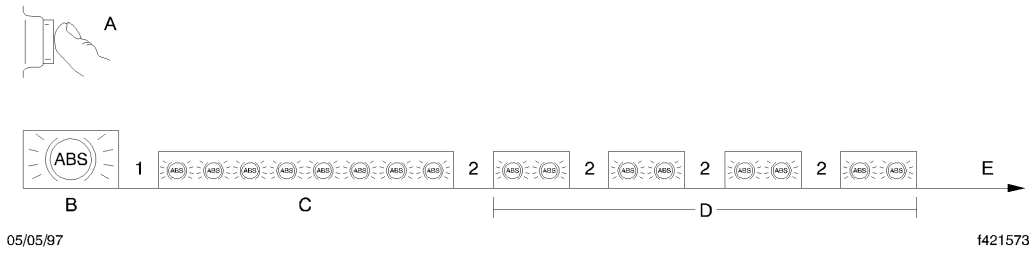
DIAGNOSTICS - CONTINUED



NOTE: Blink Code 1-1 is shown here: System okay.

A. Hold 1 second
B. Light on
1. Pause of 1.5 seconds

Figure 11. System Okay Code.



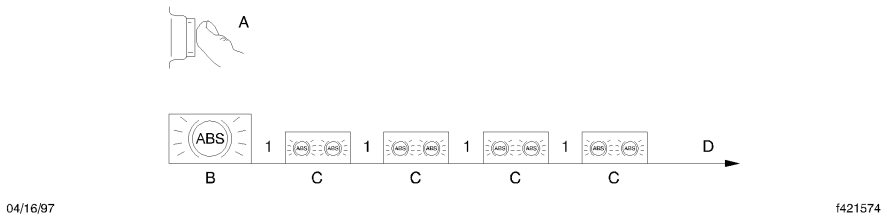
NOTE: System configuration code 2 shown: 4S/4M. After the faults are cleared and the vehicle is started, the ABS lamp will stay on until the vehicle is driven over 4 mph (6 km/h).

A. Hold 3 seconds
B. Light on
C. 8 quick blinks - fault cleared
D. System identification
E. Continues until the ignition is turned off

1. Pause of 1.5 seconds
2. Pause of 4 seconds

Figure 12. Stored Fault Cleared Codes.

DIAGNOSTICS - CONTINUED



A. Hold 3 seconds
B. Light on
C. System identification
D. Continues until the ignition is turned off

1. Pause of 4 seconds

Figure 13. Faults Not Cleared Code.

7. **Working with Blink Codes.** If problems occur while working with blink codes, see Table 4.

Table 4. Blink Code Conditions.

CONDITION	REASON	ACTION
ABS lamp does not come on at ignition.	Loose or burned-out bulb.	Check the bulb. Check the connections. Make necessary repairs.
	Voltage not within acceptable range (11 to 15 volts)	Make necessary repairs.
Can't use blink code diagnostics; ABS lamp will not go off when blink code is activated.	Switch not held for the proper length of time. 1 second - Diagnostics Mode 3 seconds - Clear All Mode	Repeat procedure, hold the switch for the proper length of time.
	Improper or faulty wiring.	Inspect and repair the wiring.
Eight flashes not received after blink code switch is pressed for at least three seconds, then released.	Active faults still exist.	Identify the active faults, then make necessary repairs. Turn the ignition off, then repeat the blink code diagnostics (Table 3).

8. **Repairs Required by Blink Codes.** For the specific tests or repairs required by each blink code, see Table 5.

DIAGNOSTICS - CONTINUED

Table 5. Troubleshooting and Repair.

BLINK CODE	ACTION REQUIRED	REFERENCE
2-1 2-2 2-3 2-4 2-5 2-6	Check the ABS modulator valve, valve cable, and connections.	Perform resistance check.
3-1 3-2 3-3 3-4 3-5 3-6	Adjust the wheel sensor to touch the tooth wheel. Check the sensor gap. Check for loose wheel bearings or excessive hub runout.	Perform sensor adjustment, sensor voltage test, or Pro-link component test.
4-1 4-2 4-3 4-4 4-5 4-6	Check sensor, sensor cable, and connectors.	Perform resistance check.
5-1 5-2 5-3 5-4 5-5 5-6	Check for tire size mismatch or tooth wheel difference.	Review tire size range.
6-1 6-2 6-3 6-4 6-5 6-6	Check for damaged tooth wheel.	
7-1	Check for proper data link connection (J1922 and J1939)	Refer to wiring diagrams.
7-2	Check the ATC valve, valve cables, and connectors. (Not used on M915A3)	Perform resistance check.
7-3	Check the brake relay connections.	Refer to wiring diagrams.
7-4	Check the ABS warning light connections.	
7-5	Verify proper ATC set-up. (Not used on M915A3)	
7-6	Verify the accuracy of the blink code and clear it from the ECU memory.	Review blink code diagnostics.
8-1	Check vehicle voltage and supply to the ECU (11 to 14 volts).	Refer to wiring diagrams. Perform voltage check.

DIAGNOSTICS - CONTINUED

Table 5. Troubleshooting and Repair - Continued.

BLINK CODE	ACTION REQUIRED	REFERENCE
8-2	Check the vehicle voltage (11 to 14 volts). Verify accuracy of blink code and clear from ECU memory.	Perform voltage check. Review blink code diagnostics.
8-3 8-4	Verify accuracy of blink code and clear from ECU memory.	Review Blink Code Diagnostics.
8-4	Verify accuracy of blink code and clear from ECU memory. *If code does not clear, it may be necessary to replace ECU.*	Contact Rockwell Customer Service at 1-800-535-5560.
8-5	Check ABS ground connections.	Refer to wiring diagrams.

MPSI PRO-LINK 9000

NOTE

You must use the D Version cartridge with D Version ECUs.

1. The Pro-link 9000 may be used in place of blink code diagnostic procedures.
2. Use the Pro-link 900 to:
   a. Diagnose system faults on ABS or ABS/ATC systems.
   b. Perform component measurement and function tests.

COMPONENT TESTS

Components that may be tested with the Pro-link 9000 are:

a. Vehicle voltages
b. ABS modulator valves
c. ABS lamps
d. Sensors
e. ABS switches

DIAGNOSTIC AND TESTING PROCEDURE

1. Slide Rockwell WABCO D Version cartridge into the Pro-link keypad until connection is tight (Figure 14).

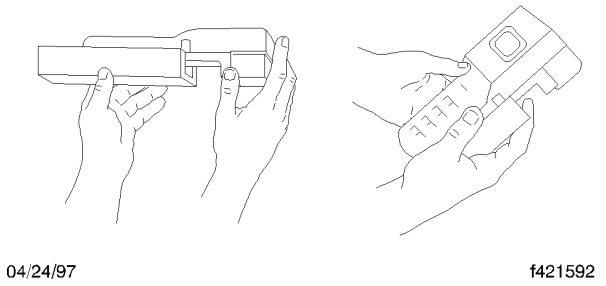


Figure 14. Pro-link Cartridge Replacement.

2. Chock the wheels, apply the parking brake, and make sure the ignition power is off.
3. Locate the 6-pin diagnostic receptacle in the vehicle cab. Insert the 6-pin connector from the Pro-link into the receptacle (Figure 15).

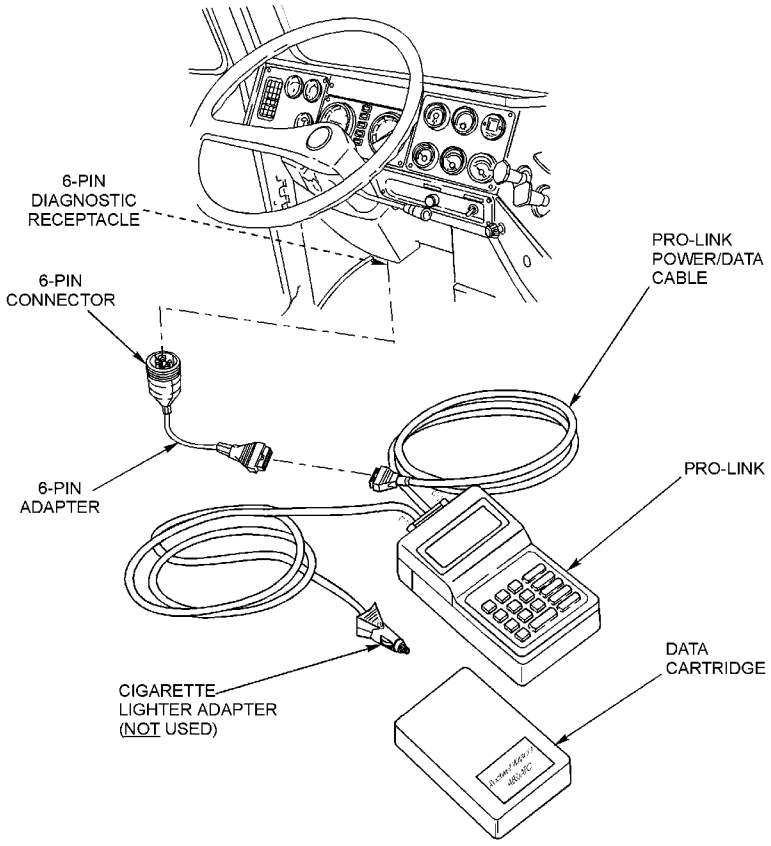


Figure 15. Pro-link Hook-up to Vehicle.

DIAGNOSTIC AND TESTING PROCEDURES - CONTINUED

4. Turn ignition to ON/RUN position. Pro-link screen should power up. If Pro-link does not power up or if the screen indicates NO DATA RECEIVED:

   a. Check connections.

   b. Make sure the cartridge is properly connected to the Pro-link keypad.

   c. Verify 12 volts DC power and ground at the connector and ABS ECU.

   d. Check the fuse panel for a blown fuse.

   e. Check for proper wiring in the diagnostic connector.

PRO-LINK SCREENS

1. **General.** This paragraph provides basic screen explanations for the Pro-link 9000 with a Rockwell WABCO D Version cartridge. For complete operating instructions and test information, refer to the Pro-link manual. The most commonly used types of screens are the Fault Information screens and the Component Test screens.

2. **Fault Information Screens.**

   a. **Existing Faults.** Use these screens to identify existing faults. The Pro-link screen displays a written description of the fault, including location on the vehicle where each exists. As long as there is an active (existing) fault in the system, Pro-link will not let you clear faults.

   b. **Stored Faults.** Use these screens to identify faults stored in the ECU memory. Stored faults may be existing faults that have been repaired, or faults that existed for a short time, then corrected themselves. After displaying stored faults, Pro-link lets you erase them from memory. All stored faults are cleared at one time.

3. **Using Pro-Link.** The following illustrates a typical fault screen sequence for a 4S/4M ABS system with an existing fault.

   a. Figure 16 indicates existing and stored faults in the system. Press FUNC to display the menu shown in Figure 17.

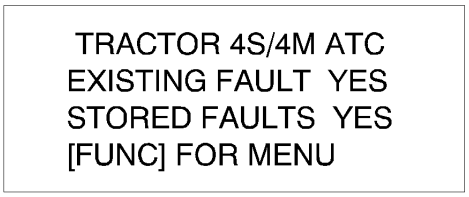


Figure 16. Pro-link Screen One.

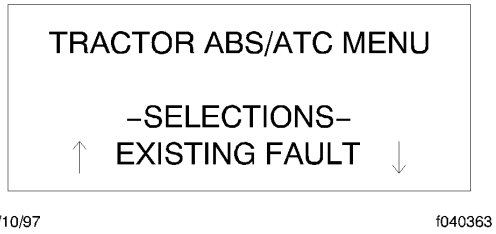


Figure 17. Pro-link Screen Two.

   b. Select Existing Fault to display active fault. Press ENTER to select. Screen shown in Figure 18 should appear. The first line displays the number of existing faults (1 of 1), blink code (2-3), and number of times fault occurred (1 time). Lines two and three provide a written description of the fault.

PRO-LINK SCREENS - CONTINUED

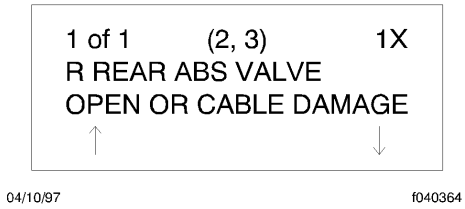


Figure 18. Pro-link Screen Three.

c. Press FUNC to exit. The screen shown in Figure 19 should appear. Remove power from the ECU, make necessary repairs, and recycle ECU.

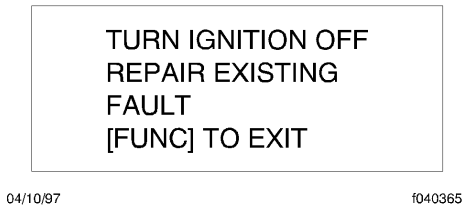


Figure 19. Pro-link Screen Four.

d. Press FUNC to return to vehicle ABS/ATC menu shown in Figure 20.

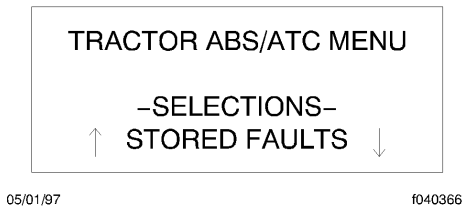


Figure 20. Pro-link Screen Five.

PRO-LINK SCREENS - CONTINUED

e. Press ENTER to display stored faults as shown in Figure 21. A description of the stored fault appears. In this example, only one fault is stored in memory, as indicated on line one. The blink code and number of times the fault occurred also appear on line one. Lines two and three provide a written description of the fault. Press FUNC to exit. The screen shown in Figure 22 appears if you try to clear a stored code with an existing fault present.

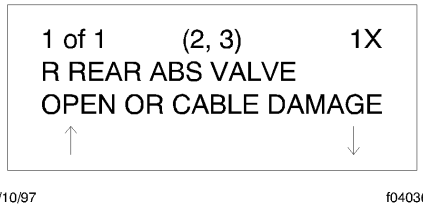


Figure 21. Pro-link Screen Six.

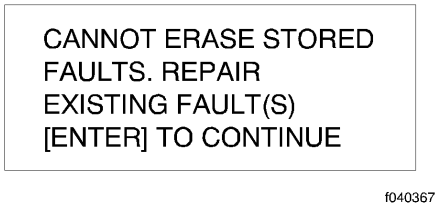


Figure 22. Pro-link Screen Seven.

f. Remove the power from the ECU, make necessary repairs, and recycle the ECU.

4. **Clearing Stored Faults.** The screens you will see when clearing stored faults are illustrated in Figures 23 and 24.

a. Figure 23 shows there are no existing faults. Select stored faults to view and clear memory. Press FUNC to display the menu shown in Figure 24.

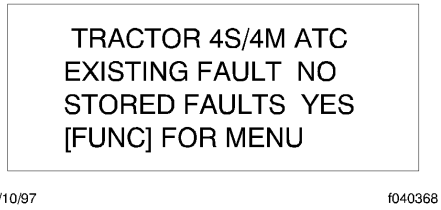


Figure 23. Pro-link Screen Eight.

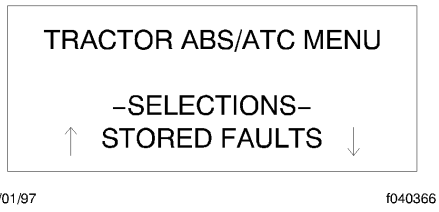


Figure 24. Pro-link Screen Nine.

PRO-LINK SCREENS - CONTINUED

b. Select Stored Faults, then press ENTER to display the stored faults shown in Figure 25. Pro-link displays number, blink code, number of occurrences, and written description of the stored faults.

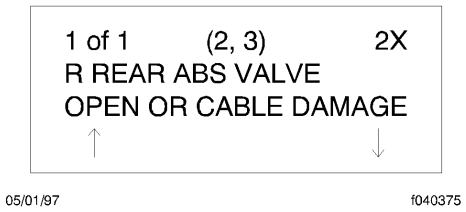


Figure 25. Pro-link Screen Ten.

c. Press FUNC, and the screen shown in Figure 26 will appear.

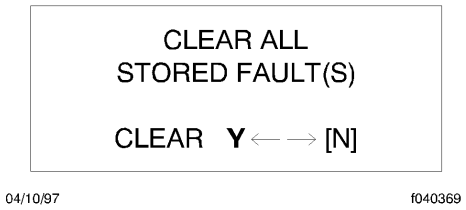


Figure 26. Pro-link Screen Eleven.

d. When the faults are cleared, Pro-link will prompt you to continue. See Figures 27 and 28.

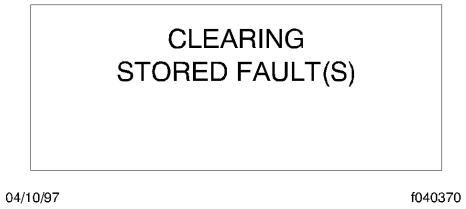


Figure 27. Pro-link Screen Twelve.

PRO-LINK SCREENS - CONTINUED

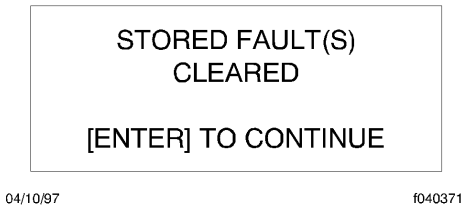


Figure 28. Pro-link Screen Thirteen.

e. Press ENTER to return to the ABS menu.

5. **Component Test Screens.**

a. These screens help you test ABS components. Select this function from the vehicle ABS/ATC menu (Figure 29). Select appropriate function. Each screen has instructions to guide you through test. Refer to Pro-link service information for complete instructions.

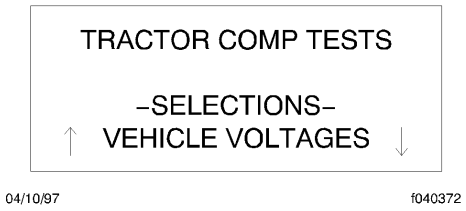


Figure 29. Typical Component Test Screen.

b. You can test the following components:

(1) ABS valves

(2) ABS lamp

(3) ABS switches

(4) Sensors

c. See Table 6 for definitions that explain the function of each test.

PRO-LINK SCREENS - CONTINUED

Table 6. Component Test Functions.

COMPONENT TEST	FUNCTION
Vehicle voltages	Monitors two voltage signals powering the ECU.
ABS valves	Cycles valves, one at a time. You hear each valve cycle. A menu selection lets you choose from four or six valves. This test may also be used to verify valve locations. NOTE: The treadle may be applied to put air in chambers.
ABS lamp	Monitors commanded (on/off) states of the ATC lamp. Follow screen prompts (1 On, 2 Off) to change the status of lamp on instrument panel.
Sensors	Monitors input to ECU from wheel. Wheels must be rotated during this test.

COMPONENT TESTING

WARNING

When troubleshooting and testing the ABS system, do not damage the connector terminals. Damaged terminals can result in the system not functioning correctly and subsequent vehicle accidents resulting in personal injury to personnel and damage to equipment.

1. **Voltage Check.** Voltage must be between 11 and 14 volts. Ignition must be turned on for this test. Measure voltage between pins 7 and 10, pins 8 and 11, and pins 9 and 12 on cab-mounted systems.

2. **Sensor Adjustment.**

   a. Push sensor in until it contacts tooth wheel.

   b. DO NOT pry or push sensors with sharp objects. Sensor will self-adjust after wheel rotation.

   c. On steering axles, sensor is accessible on in-board side of steering knuckle.

   d. On drive axles, drum assembly may have to be pulled to gain access to sensor.

3. **Sensor Output Voltage Test.** Voltage must be at least 0.200 volts AC at 30 rpm. Check sensor voltage as follows:

   a. Turn off ignition.

   b. Rotate wheel by hand at 30 rpm (2 revolutions per second).

   c. Measure voltage at the points shown in Table 7.

Table 7. Voltage Test Points.

ECU	SENSOR	CONNECTOR	PINS
Cab-mounted	LF RF LR RR	6-pin 9-pin 15-pin 15-pin	4 and 5 4 and 5 5 and 6 8 and 9

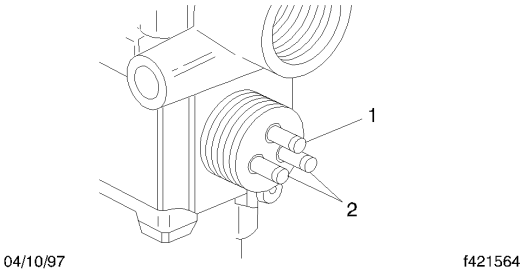
TIRE SIZE RANGE

1. For proper ABS operation with the standard ECU, front and rear tire sizes must be within ±14% of each other. When tire size range is exceeded without electronically modifying ECU, system performance can be affected and warning lamp can illuminate.
2. Call Rockwell WABCO at 1-800-535-5560 if you plan a tire size difference greater than 14%. Calculate tire size with the following equation:

   % Difference = {RPM Steer divided by RPM Drive minus 1} x 100 (in this equation RPM means tire revolutions per mile)

ABS MODULATOR VALVE TEST

1. Measure the resistance across each valve solenoid coil terminal and ground on the ABS valve to ensure 4.0 to 8.0 ohms (Figure 30).



1. Ground Terminal
2. Solenoid

Figure 30. ABS Modulator Valve.

2. If resistance is greater than 8.0 ohms, clean electrical contacts in solenoid. Check resistance again.
3. To check cable and ABS valve as one unit, measure resistance across the pins on ECU connector of harness. Check wiring diagrams of system being tested (Figures 31 through 34).

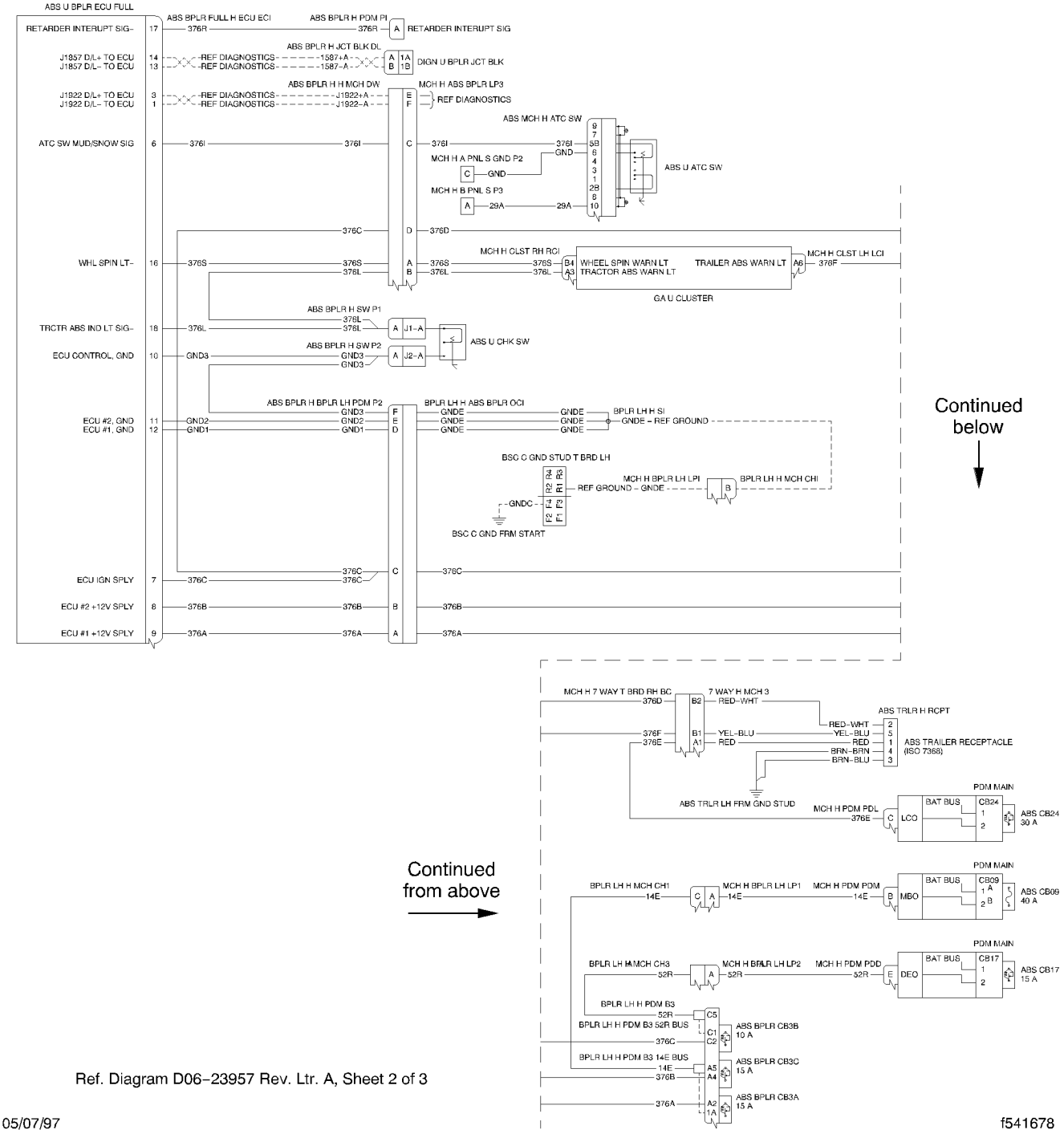


Figure 31. Wiring Diagram, Power and Control Wiring.

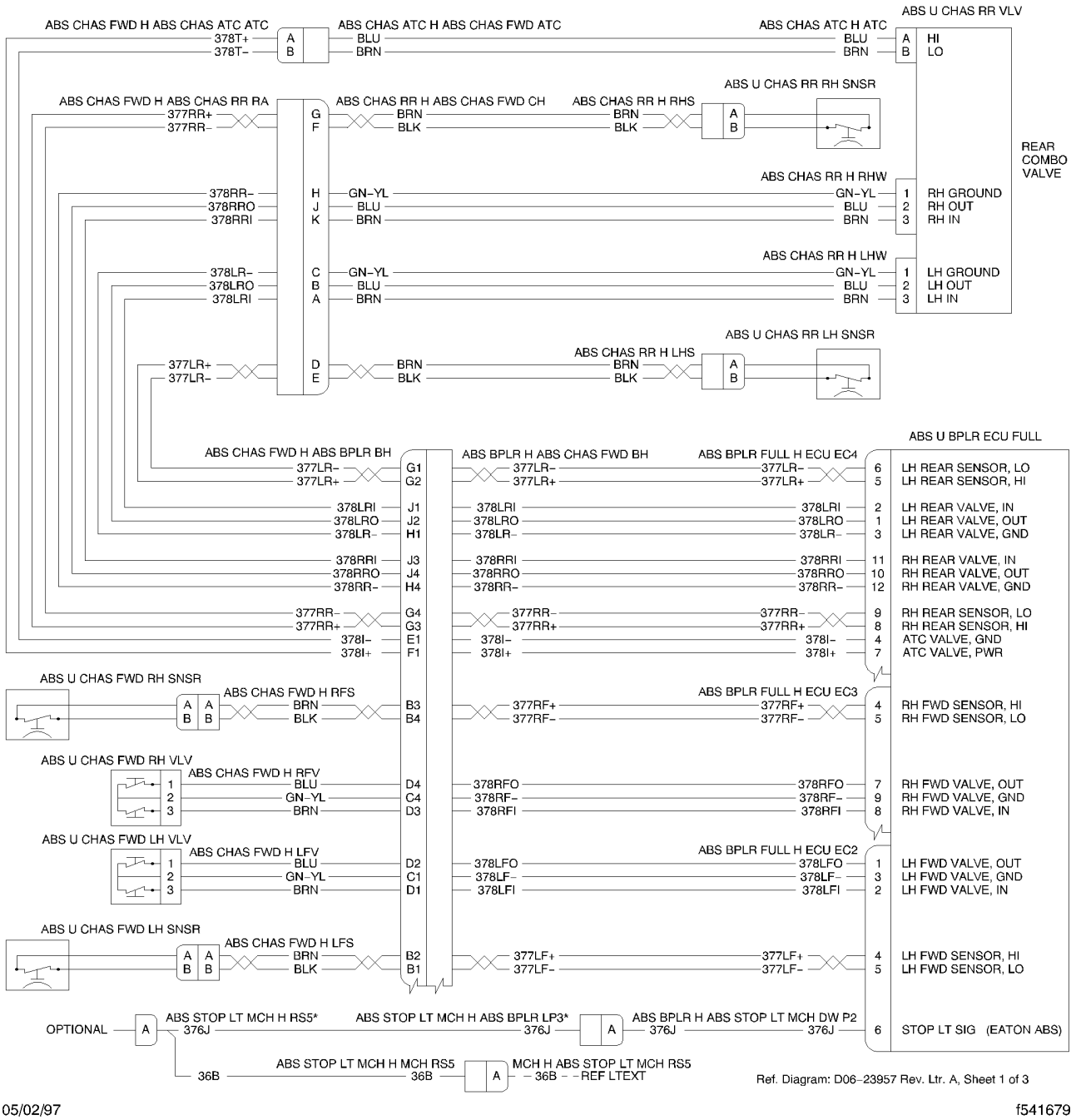


Figure 32. Wiring Diagram, Sensor and Valve Wiring.

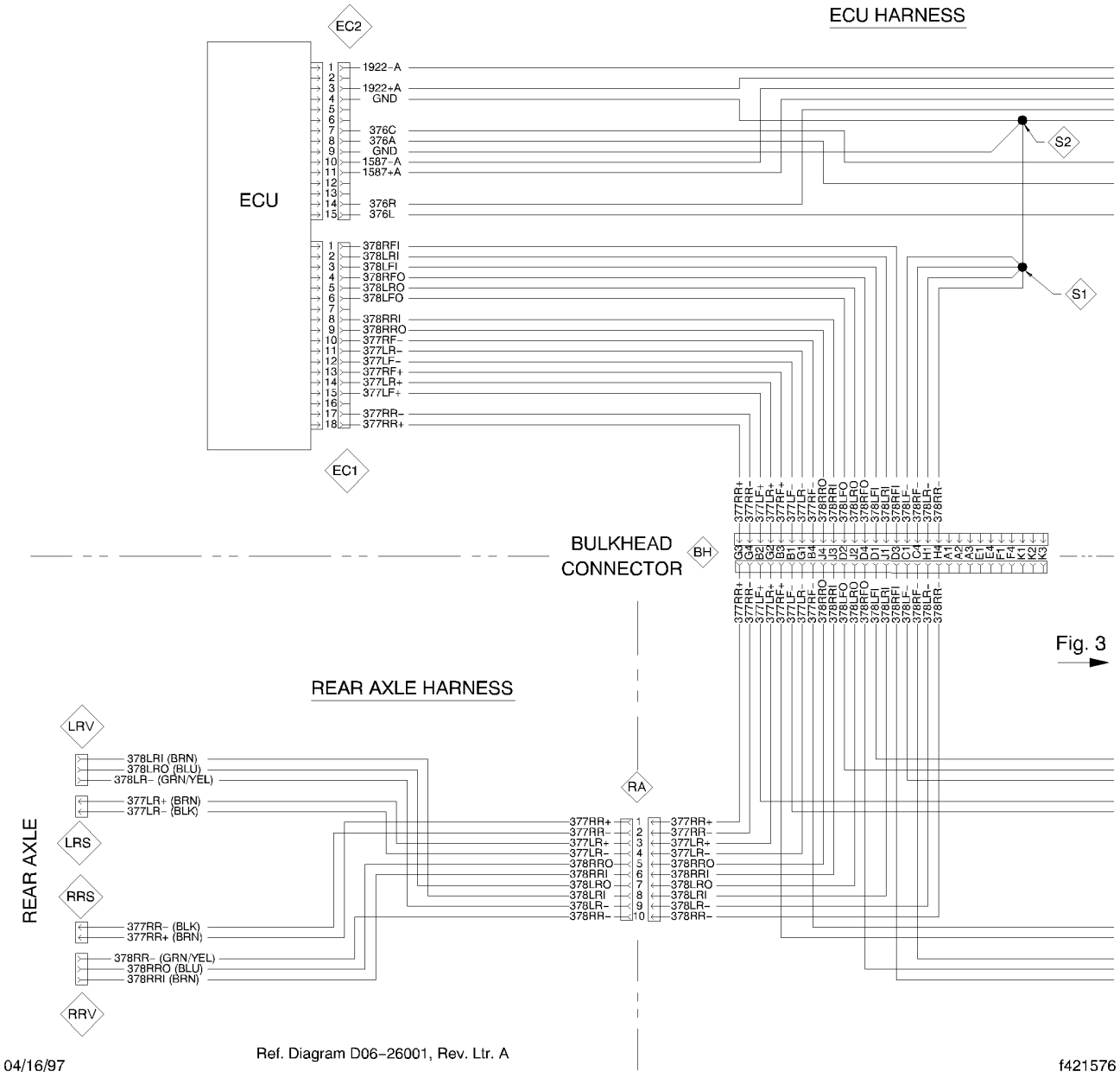


Figure 33. Wiring Diagram, Basic WABCO Wiring (Partial View).

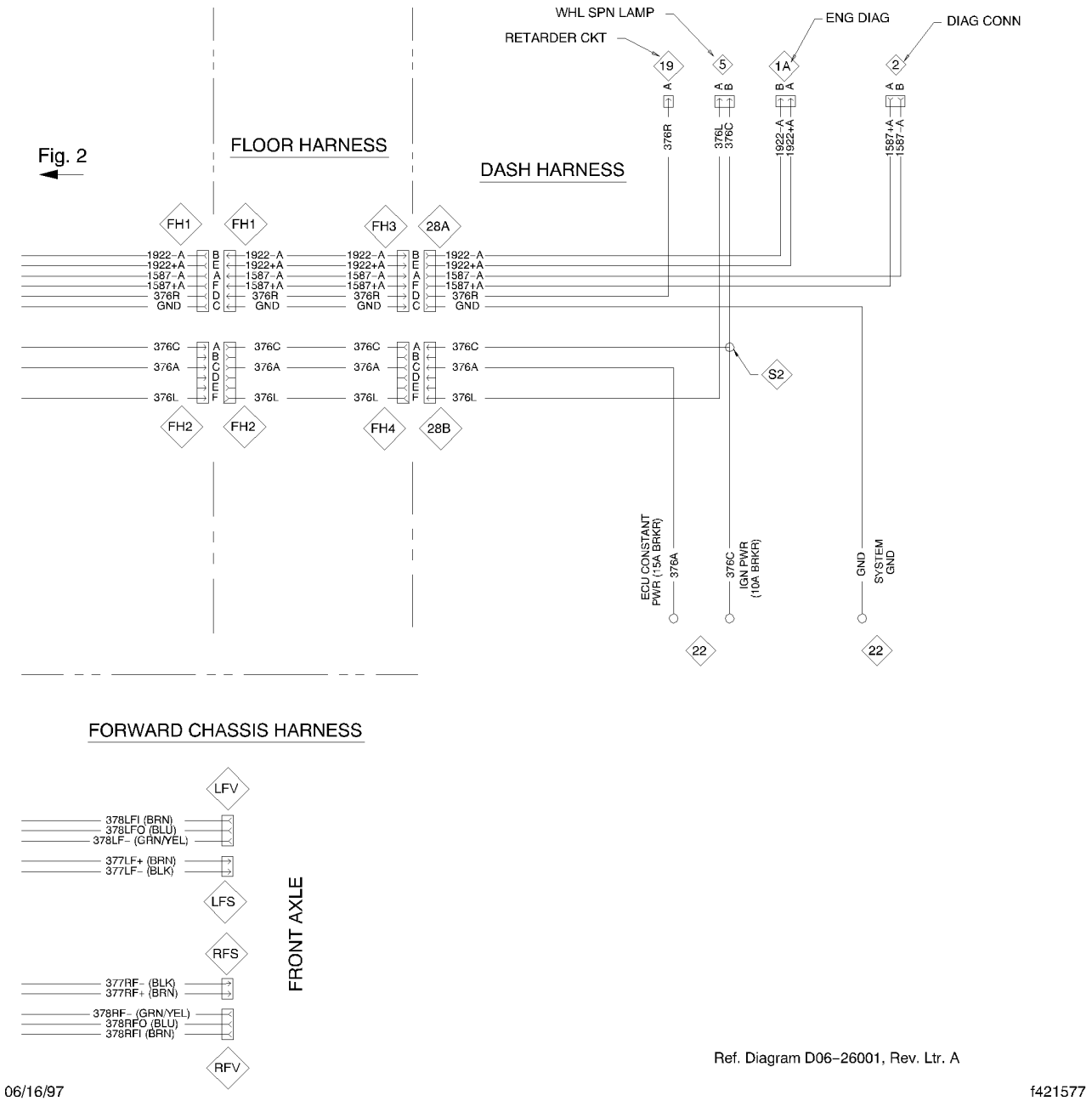


Figure 34. Wiring Diagram, Basic WABCO Wiring (Partial View).

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Table 1. Air System Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. Loss of Air Pressure.	1. Check for leaks in air lines and fittings.	Replace air lines and fittings as necessary (WP 0147 00).
	2. Check damaged supply tanks and components for damage.	Replace damaged components (WP 0143 00 through WP 0146 00).
2. Loss of Air Supply Function.	1. Check for blocked or kinked air lines.	Replace damaged or blocked air lines (WP 0147 00).
	2. Check all valves for damage.	Replace faulty valves (WP 0150 00 through WP 0156 00).
3. Air Dryer Leaks.	Check for faulty filter seal.	Replace filter seal (WP 0158 00).
4. Air Dryer Fails to Absorb Moisture.	1. Check for dirty air dryer filter(s).	Service or replace air dryer (WP 0158 00).
	2. Check for contaminated desiccant beads (drying beads).	Service or replace air dryer (WP 0158 00).
	3. Check purge valve for damage.	Service or replace air dryer (WP 0158 00).

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STEERING SYSTEM TROUBLESHOOTING 0015 00

Table 1. Steering System Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. Loss of Steering Control.	1. Check for failed mounting of steering wheel to steering column shaft.	Replace steering wheel or column shaft if defective (WP 0167 00 or WP 0168 00).
	2. Check for defective steering wheel.	Replace steering wheel if defective (WP 0167 00).
	3. Check for defective universal joint.	Replace universal joint if defective (WP 0168 00).
	4. Check tie rod, pitman arm, and drag link for damage.	Replace tie rod, pitman arm or drag link if damaged (WP 0169 00).
2. Difficult Steering.	1. Check universal shaft for damage.	Replace universal shaft if damaged (WP 0168 00).
	2. Check for defective yoke assembly.	Replace universal shaft if defective (WP 0168 00).
	3. Check for defective attaching hardware.	Tighten or replace attaching hardware if defective (WP 0168 00).
3. Tie Rod, Drag Link or Pitman Arm Fails.	1. Check for proper lubrication.	Replace tie rod assembly (Notify Direct Support Maintenance).
	2. Check tie rod assembly for corrosion.	Replace tie rod assembly if corroded (Notify Direct Support Maintenance).
4. Hose Assembly Fails (Leaks).	1. Check hose assembly for loose and damaged fittings.	Tighten or replace fittings as necessary (WP 0170 00).
	2. Check hose for cracks and brittleness.	Replace hose assembly if cracked or brittle (WP 0170 00).
5. Power Steering Reservoir Leaks.	1. Check for dirty filter and contamination.	Replace filter (WP 0170 00).
	2. Check for loose or damaged fitting connection(s).	Replace or repair power steering fitting (WP 0170 00).
	3. Check for damaged cover assembly and loose or damaged wing screw.	Tighten or replace cover assembly and wing screw as necessary (WP 0170 00).
	4. Check power steering reservoir for damage and cracks.	Replace power steering reservoir if damaged or cracked (WP 0170 00).

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CHASSIS AND FIFTH WHEEL TROUBLESHOOTING 0016 00

Table 1. Chassis and Fifth Wheel Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. Pintle Hook Will Not Lock or Swivel.	1. Check pintle for proper lubrication.	Lubricate pintle (TM 9-2320-302-10).
	2. Check pintle hook for damage.	Replace or repair pintle hook (WP 0179 00).
2. Trailer Will Not Couple or Becomes Uncoupled.	1. Check for proper coupling by visually inspecting fifth wheel and trailer king pin.	
	2. Check fifth wheel for worn or damaged parts.	Replace worn or damaged parts (Notify Direct Support Maintenance).
	3. Check operation of fifth wheel locking device.	Adjust locking mechanism (WP 0178 00).
3. Restricted Motion Between Tractor and Trailer.	Check adjustment of side bracket.	Adjust side bracket (WP 0178 00).

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AIR CONDITIONING SYSTEM TROUBLESHOOTING AND TESTING 0017 00

PRELIMINARY CHECKS

Before testing operation of air conditioning system, make the following checks:

1. Ensure the refrigerant compressor drive belt is not damaged and is under proper tension (WP 0054 00). Check compressor mountings for tightness.
2. Check for broken, burst, and cut hoses. Check for loose fittings on all parts.
3. Check for road debris buildup on condenser coil fins. Using air pressure and a whiskbroom or a soapy spray of water, carefully clean condenser, using care not to bend fins.
4. Check color in moisture indicator sight glass. If color is a deep cobalt blue, refrigerant charge is dry. If moisture indicator is *not* blue, system is contaminated with moisture. Notify your supervisor.
5. If there is not enough airflow, ensure that leaves and other debris has not entered fresh air ports under windshield. If debris is present, it could clog fins of evaporator core and block airflow. Ensure that all ducts are connected to dash louvers and air-control flaps in heater housing are moving properly (this requires removal of right and center dash panel).

SAFETY PRECAUTIONS

1. Whenever repairs are made to any air conditioner parts that hold refrigerant, it is necessary to discharge, purge or flush (if contaminated), evacuate, charge, and leak test system. In a good system, refrigerant lines are always under pressure and should be disconnected only after air conditioning system has been discharged to a refrigerant recovery unit through service valves on compressor.
2. Refrigerants are safe when used under proper conditions. Always wear safety goggles and non-leather gloves while discharging, purging, flushing, evacuating, charging, and leak testing system. DO NOT wear leather gloves. When refrigerant gas or liquid contacts leather, leather will stick to skin.

WARNING

Liquid refrigerant, when exposed to the air, quickly evaporates and will freeze skin or eye tissue. Use care to prevent refrigerant from touching your skin or eyes. Serious injury or blindness result if you come in contact with liquid refrigerant.

3. Refrigerant splashed in eyes should first be treated with a few drops of sterile mineral oil in eyes, and rinsed with a weak boric acid solution. DO NOT rub eyes. Seek medical attention immediately.
4. Refrigerant splashed on skin should be treated the same as frostbite. Gently pour cool water on area, but do not rub skin. Keep skin warm with layers of soft, sterile cloth. Seek medical attention immediately.
5. Even though refrigerant does not burn, when it contacts extreme heat or flame, poisonous phosgene gas is created. This gas is also produced when an open flame leak detector is used. Phosgene fumes have an acrid (bitter) smell.

WARNING

DO NOT work in an area where refrigerant may contact an open flame or any burning material such as a cigarette. When refrigerant contacts extreme heat, refrigerant breaks down into poisonous phosgene gas which, if breathed, causes severe respiratory irritation. DO NOT breathe fumes from an open flame leak detector.

6. You must work in an area where there is a constant flow of fresh air when system is discharged, flushed, charged, and leak tested using an open flame leak detector.

SAFETY PRECAUTIONS - CONTINUED

7. Changes in both federal and state laws will affect the way dealerships service air conditioning systems. Under current federal laws, refrigerant must be recovered and recycled by all users to protect environment, and not released into atmosphere. Many service operations not directly involving the air conditioning system require release of refrigerant charge. Under new regulations, dealerships not having required recovery and recycling equipment (and properly trained and certified personnel) will not be allowed to do any of this service work.

8. Because of its very low boiling point, refrigerant must be stored under pressure. To prevent refrigerant cans from exploding, never expose to temperatures higher than 125°F (52°C). Never leave refrigerant cans in the sun, and DO NOT store them in sun-exposed areas where heat can build up (such as gloveboxes, automobile trunks, etc).

PERFORMANCE TESTS

Following is a brief description of symptoms or conditions that could exist if something goes wrong with a refrigerant part.

1. **Receiver-drier.**

   a. The receiver-drier is normally at outside temperature. To the touch, entire length of unit should be same temperature. If noticeable cool spots exist, notify your supervisor.

   b. A blockage at receiver-drier inlet will cause high head pressures. Blockages at receiver-drier outlet will cause low head pressures and little or no cooling.

   c. If moisture indicator color is pink or white (showing system is wet), receiver-drier is saturated with moisture and must be replaced. Notify your supervisor.

2. **Cooling System.**

   a. Although not physically connected, a close tie exists between vehicle air conditioner and cooling system. Poor air conditioner cooling can be the result of a problem in the cooling system.

   b. If cooling system does not work correctly, heat of engine will rise to abnormal levels. The added heat will transfer to the air conditioner, other underhood parts, and may make its way into the cab. The added heat makes it necessary for air conditioner to work harder and, at the same time, reduces air conditioner ability to cool down air in cab. Also, if water regulating valve is not closing fully, heat will enter cab, giving the impression that the air conditioning system is not working.

3. **Expansion Valve.**

   a. Problems that start in expansion valve show up as follows:

      (1) When expansion valve is stuck closed, evaporator coil and expansion valve will be at outside temperature.

      (2) When expansion valve is stuck open, both coil and valve will be extremely cold with frost or ice buildup.

   b. Because expansion valve channels are very small, blockages in system tend to be found here (valve is very sensitive to contamination). Usually, contaminant is water. Less than a drop of water is all it takes to make valve inoperative. When water reaches valve, extreme cold that results from pressure drop freezes water, forming a block of ice in valve. After system shuts down and valve warms up, the ice melts and valve operates again, only to freeze up when moisture returns.

   c. On-and-off operation of expansion valve means that receiver-drier is not removing moisture from system. These contaminants should cause moisture indicator element to turn white and then pink.

4. **Refrigerant Compressor.**

   a. Compressor problems usually show in one of four ways: abnormal noise; seizure; leakage; or low suction and discharge pressures.

   b. Resonant compressor noises are not causes for alarm. Irregular noise or rattles are likely to be caused by broken parts.

PERFORMANCE TESTS - CONTINUED

5. **Evaporator.**

   a. Evaporator coils are basically trouble-free when air flow over fins is not blocked. External or, less often, internal blockages will cause low suction pressure as well as little or no cooling.

   b. If a leak exists in system and cannot be traced to other parts or fittings, suspect damage to one of evaporator coils. Notify your supervisor.

6. **Condenser.**

   a. The condenser is usually trouble-free. Normally, temperature of condenser outlet line is noticeably cooler than inlet line. However, when road debris (such as leaves or dirt buildup) builds up, air flow over condenser fins is blocked and air is not able to absorb enough heat to turn hot refrigerant gas into a liquid. High head pressures will result. In this case, carefully clean outer surfaces of the condenser with compressed air or soap and water solution using care not to bend fins.

   b. High head pressures also occur if the condenser tubing is abnormally bent, blocking flow of refrigerant. Frost will appear at point where flow is restricted.

   c. Less common internal blockages (bits of foreign material or metallic grit buildup) will stop the flow of refrigerant.

   d. A quick test to check if poor system performance is caused by condenser is to direct a spray of water onto condenser while system is running. If the air conditioner cools better because of the assist provided by water, the condenser is not working.

   e. When troubleshooting a suspected condenser problem, remember that the problem may be caused by radiator transferring high levels of heat to condenser.

7. **Thermostatic Switch.**

NOTE

- Before troubleshooting thermostatic switch, notify your supervisor to check for a full charge of refrigerant in system. Compressor will not operate or will cycle too often if there is not enough refrigerant in the system.
- Quick or delayed cycling of compressor may be caused by a thermostatic switch that is working, but is out of adjustment. If, after performing tests below, switch seems to be out of adjustment, replace switch (the thermostatic switch cannot be recalibrated).

   a. Ensure that compressor clutch is operating properly.

   b. Expose evaporator coil.

   c. Start engine. Place air conditioner control at coldest setting and turn on air conditioner and fan.

   d. Place an accurate thermometer in contact with a tube on evaporator coil. Ensure that thermometer is in good contact with tube or incorrect reading will result. When temperature drops below 31°F - 36°F (-1°C - 2°C), compressor clutch should disengage and remain this way until temperature rises to 39°F - 44°F (4°C - 7°C).

   e. If the compressor did not engage when temperature was above accepted high range, perform the following test:

      (1) Connect voltmeter or test light from one terminal on thermostatic switch to ground. Repeat this test with other terminal on switch.

      (2) With engine running and air conditioner and blower on, both terminals will show voltage when compressor should be engaged. One terminal will show voltage when compressor should be disengaged. If voltage is not present, there is a problem in electrical system from batteries to thermostatic switch. Check all circuits for cause, and repair or replace necessary wiring or parts. In all other cases where compressor is not engaging and disengaging properly, thermostatic switch is cause. Replace thermostatic switch.

PERFORMANCE TESTS - CONTINUED

(3) Shut down engine and, to prevent accidental electric shock or shorting during dash assembling, disconnect batteries.

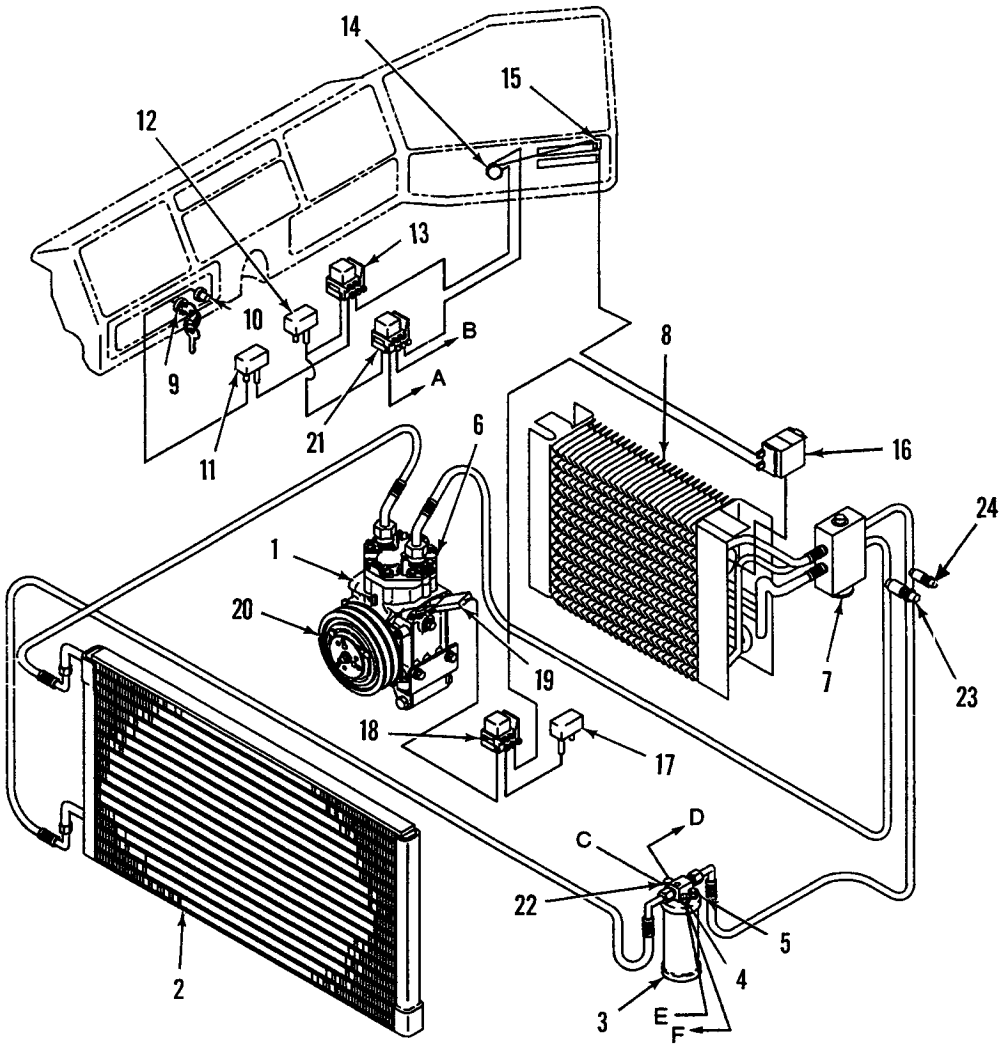
(4) Assemble dash.

8. **Line Restrictions**.

a. A restricted suction line causes low suction pressure at compressor and little or no cooling. A restriction in a line between compressor and expansion valve can cause high discharge and low suction pressure and insufficient cooling.

b. Usually, areas of ice or frost buildup mean a blockage. Parts that often freeze up are probably corroded or inoperative and should be replaced. Parts (such as expansion valve) that freeze up once in a while may do so because of moisture in system, which will cause the moisture indicator element to turn white or pink. If this happens, notify your supervisor.

PERFORMANCE TESTS - CONTINUED



A To resistor block
B To blower motor
C From engine fan thermal switch
D To engine fan thermal switch
E From a/c clutch relay
F To compressor clutch

1	Compressor	9	Ignition Switch	17	Circuit Breaker (15A)
2	Condenser	10	Start Button	18	A/C clutch Relay
3	Receiver-drier	11	Circuit Breaker (10A)	19	Diode
4	Binary Switch	12	Circuit Breaker (30A)	20	Compressor Clutch
5	Moisture Indicator	13	Power Relay	21	High-speed Relay
6	High Pressure Relief Valve	14	Blower Switch	22	Fan Cycling Switch
7	Expansion Valve	15	“On-Off” Microsoft	23	Discharger Service Valve
8	Evaporator	16	Thermostatic Switch	24	Suction Service Valve

Figure 1. Air Conditioning System Components.

PERFORMANCE TESTS - CONTINUED

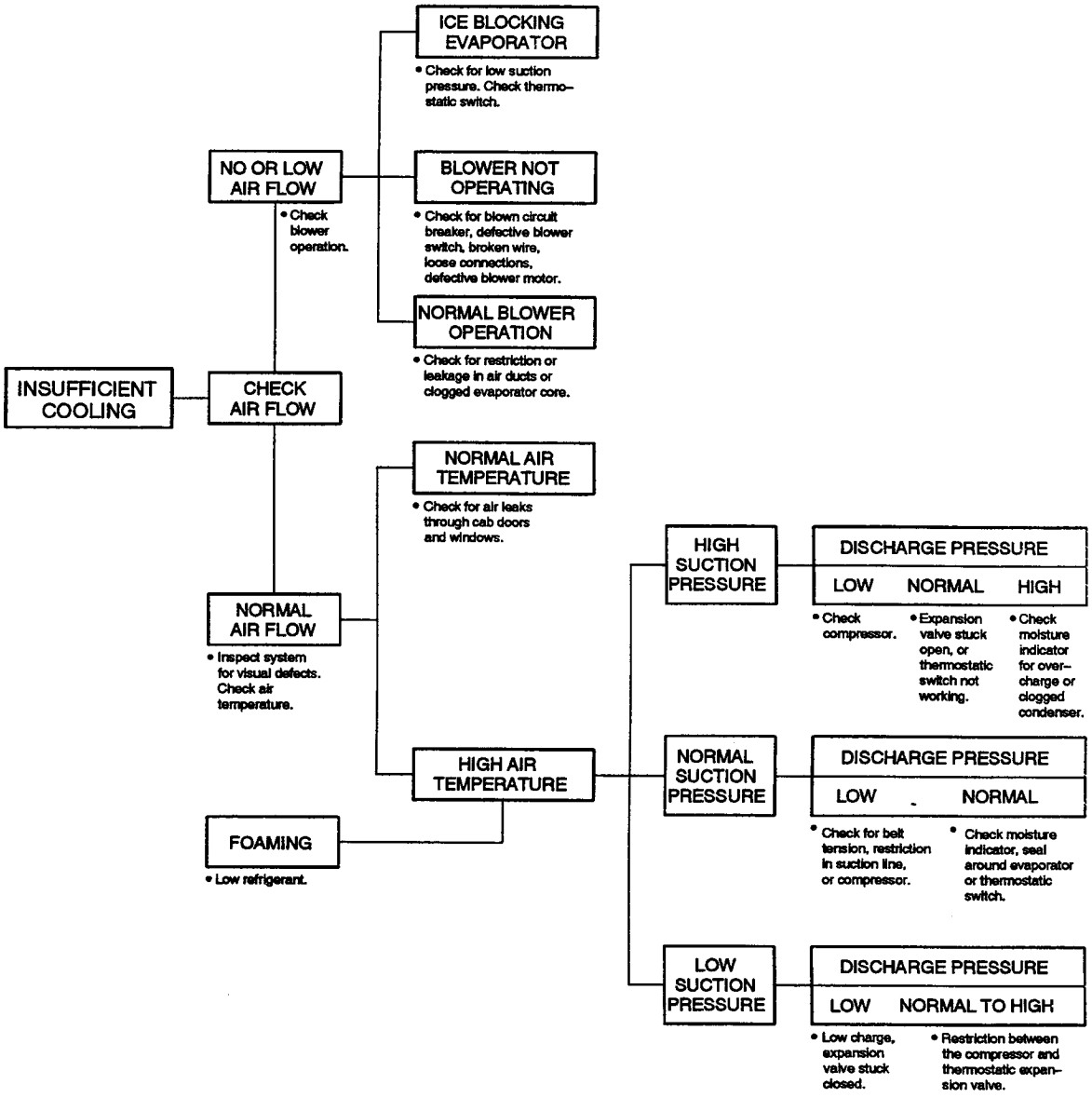


Figure 2. Air Conditioning System Troubleshooting.

AIR CONDITIONING SYSTEM TROUBLESHOOTING

Table 1. Problem - Little or No Air Flow.

POSSIBLE CAUSE	REMEDY
Blower is not operating.	Check for open circuit breaker. Open circuit indicates a short in electrical system, which must be located and repaired. Check air conditioner relays for operation. Replace as necessary (WP 0071 00). Blower motor switch is working. Replace if necessary. Check wiring to blower motor. Tighten any loose connections. Check blower motor for operation. Replace blower motor if sticking or otherwise inoperative (WP 0220 00). Check resistor block. Replace if necessary (WP 0222 00). **CAUTION** Never attempt to bypass fuse in resistor block. To do so could cause blower motor to overheat, resulting in serious damage to heater/air conditioning system.
Restrictions or leaks in the ducts.	Examine air ducts and remove blockages. Stop any leaks or replace portion if leaks cannot be stopped.
Ice has formed on evaporator coil.	Defrost evaporator coil before resuming operation of air conditioner.

Table 2. Problem - Warm Air Flow When Air Conditioner Is On.

POSSIBLE CAUSE	REMEDY
No refrigerant charge in system.	Perform air conditioner leak test (WP 0225 00).
Refrigerant compressor is not operating.	Perform air conditioner leak test (WP 0225 00). Repair or replace drive belt (WP 0054 00).
Air conditioner microswitch is not working.	Replace microswitch.
Ice has formed on evaporator coil.	Defrost evaporator coil before resuming operation of air conditioner.

Table 3. Problem - Compressor Operates Too Often or Continuously.

POSSIBLE CAUSE	REMEDY
Too little refrigerant in system.	Perform air conditioner leak test (WP 0225 00).
Ice has formed on evaporator coil.	Defrost evaporator coil before resuming operation of air conditioner. Check operation of thermostatic switch and replace as necessary.
Dirt and debris are clogging condenser fins.	Remove dirt and debris from condenser fins.
The thermostatic switch is not working.	Replace thermostatic switch.

AIR CONDITIONING SYSTEM TROUBLESHOOTING - CONTINUED

Table 4. Problem - Quick or Delayed Cycling of Compressor.

POSSIBLE CAUSE	REMEDY
Thermostatic switch operates, but is out of adjustment.	Replace thermostatic switch. Do not attempt to adjust it.
Loss of refrigerant is causing a delayed cycling of compressor.	Perform air conditioner leak test (WP 0225 00).

Table 5. Problem - Temperature in Cab Too Low or No Heat.

POSSIBLE CAUSE	REMEDY
Water regulating valve is not open.	Slide temperature lever slide control toward “warm”.
Water regulating valve is not opening fully.	Adjust water regulating valve cable.
Water regulating valve is not working.	Replace water regulating valve.
Heater hose is pinched or twisted.	Repair or replace heater hose.
Coolant is leaking from system.	Check for leakage at heater core and at all hose connections from heater core to engine. Check radiator coolant level and add coolant if necessary (TM 9-2320-302-10). Check and repair any leaks at the radiator.
Dust or dirt is clogging heater core fins.	Remove and clean heater core.

Table 6. Problem - Condensed Water Is Leaking from Air Conditioner.

POSSIBLE CAUSE	REMEDY
Drain tubes are plugged.	Clean drain holes and drain tubes.

COLLISION WARNING SYSTEM (CWS) TROUBLESHOOTING 0018 00

THIS WORK PACKAGE COVERS

Initial System Troubleshooting, Driver's Display Unit Diagnostics Features, Activating/Clearing Failure Display Mode, Prolink Diagnostic Features, CWS Troubleshooting Procedures

INITIAL SETUP

Tools and Special Tools

Cartridge, CWS (Item 7, WP 0236 00)

Multimeter, digital (Item 24, WP 0236 00)

Pro-link MPSI Reader (Item 33, WP 0236 00)

INITIAL SYSTEM TROUBLESHOOTING

1. Check CWS components and wiring harness for obvious damage.
2. Check all connectors for corrosion, damage, and missing pins. Repair connectors as necessary (WP 0119 00).
3. Check that all electrical connections and ground wires are secure.
4. Check that other vehicle components are not causing interference.

DRIVER'S DISPLAY UNIT (DDU) DIAGNOSTIC FEATURES

1. Red failure light on DDU illuminates until cause of failure is corrected.
2. Fault codes are indicated by a pattern of flashes blinked out on Driver Display Unit (DDU) red "FAIL" light indicator. Each fault code consists of a two digit number.
3. A pause of 3/4 of one second separates blinking of first and second digit of fault code. Example: Fault code 32 is indicated by 3 blinks, a 3/4 second pause, and 2 more blinks.
4. A pause of 3 seconds exists between each flash code fault.
5. Code 41 is flashed if there are no faults OR after all faults have been displayed.

ACTIVATING/CLEARING FAILURE DISPLAY MODE

1. Press in and hold DDU "VOLUME" knob for a minimum of five seconds. If knob is released before five seconds has elapsed, system will turn off.
2. After five seconds, DDU red "FAIL" indicator will begin to blink out fault codes.
3. Code 41 is flashed if there are no faults OR after all faults have been displayed.
4. To read active fault codes, position DDU "RANGE" knob to left of center; only active fault codes will flash.
5. To read inactive fault codes, position "RANGE" knob to right of center; only inactive fault codes will flash.
6. To clear fault codes, push and hold DDU "RANGE" knob while system is in self-test (when ignition key is turned on).

ACTIVATING/CLEARING FAILURE DISPLAY MODE - CONTINUED

Table 1. Fault Codes.

FAULT CODE	SUSPECT FAILURE
11	Central Processing Unit (CPU)
13	Driver Display Unit (DDU)
14	Antenna assembly
15	Right side sensor
21	Right turn signal
23	Brake
24	Speed
31	J1587
32	J1939
33	VBUS
34	DDU communications
35	Antenna assembly communications

PROLINK DIAGNOSTIC FEATURES

1. Connect Pro-link MPSI Reader with CWS troubleshooting cartridge to vehicle.
2. Follow instructions on Pro-link MPSI Reader display.

CWS TROUBLESHOOTING PROCEDURES

NOTE

- Perform Initial System Troubleshooting prior to replacing any component.
- Asterisk (*) indicates step requiring Pro-link w/cartridge.

Table 2. CWS Troubleshooting Procedures.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. Red Fail Light on Driver's Display Unit or Side Sensor Display Illuminates Continuously.	1. While performing side sensor test, wave hand in front of side sensor and verify that correct signal is received.*	If OK, proceed to next step. If NOT OK, replace side sensor (WP 0111 00).
	2. Verify a 5-volt output at side sensor signal wire at side sensor connector, with a target present.	If OK, notify supervisor. If NOT OK, replace side sensor (WP 0111 00).
2. Warnings Tones Not Audible.	1. Verify volume control knob is turned fully clockwise.	Turn volume control knob fully clockwise.
	2. Turn system off and back on. Turn volume control knob and listen for tone.	If tone is not heard, proceed to next step.
	3. Perform speaker test and verify audible tone is heard from DDU speaker.*	If tone is not heard, proceed to next step.
	4. Verify speed input.	If OK, proceed to next step. If NOT OK, replace DDU (WP 0111 00).
	5. Perform brake test and verify correct signal is received when brake pedal is depressed.*	If OK, notify supervisor. If NOT OK, replace DDU (WP 0111 00).
3. Warning Tones Audible When Brakes Are Applied.	1. Perform brake test and confirm receipt of correct signal when brake pedal is depressed.*	If OK, proceed to next step. If NOT OK, replace DDU (WP 0111 00).
	2. Verify brake mode setting is correctly configured in CPU.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	3. Verify brake logic is correctly configured.*	If OK, replace DDU (WP 0111 00). If NOT OK, notify supervisor.
4. Side Sensor Warning Tone Audible When Brakes Are Applied.	1. Verify tone is not audible when hand is waved in front of side sensor with only brake pedal depressed (turn signal not activated).	If tone is heard, replace side sensor (WP 0111 00). If tone is not heard, proceed to next step.

Table 2. CWS Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
4. Side Sensor Warning Tone Audible When Brakes Are Applied - Continued.	2. Verify turn signal setting is correctly configured in CPU.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	3. Perform turn signal test and confirm receipt of correct signal when turn signal is applied.*	If OK, notify supervisor. If NOT OK, replace DDU (WP 0111 00).
5. Volume Knob Does Not Reduce Volume.	1. Verify MIN VOL setting is zero.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Perform DDU test and confirm proper operation of volume knob.*	If OK, notify supervisor. If NOT OK, replace DDU (WP 0111 00).
6. Range Knob Does Not Change Alert Levels.	1. Verify RANGE ENABLE configuration is ON.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Perform DDU test and confirm proper operation of range knob.*	If OK, notify supervisor. If NOT OK, replace DDU (WP 0111 00).
7. Front Antenna Detects Vehicles in an Adjacent Lane With No Vehicle in Front of Host Vehicle.	Confirm antenna alignment (WP 0110 00).	If proper alignment is confirmed and fault still exists, notify supervisor.
8. Front Antenna Detects Vehicle in Both Left and Right Adjacent Lanes, With No Vehicle in Front of Host Vehicle.	1. Confirm antenna minimum height requirement or above.	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Confirm antenna is secured to mounting.	Tighten antenna if necessary (WP 0111 00).
	3. Confirm radar beam path is unobstructed.	Clear radar beam path if obstructed. If radar beam path is not obstructed, notify supervisor.
9. Front Antenna Loses or Ignores Detected Vehicles Within 100 Feet in Front of Host Vehicle.	1. Confirm antenna minimum height requirement or above.	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Confirm antenna is secured to mounting.	Tighten antenna as necessary (WP 0111 00).
	3. Confirm radar beam path is unobstructed.	Clear radar beam path if obstructed. If radar beam path is not obstructed, notify supervisor.
10. Side Sensor Display Does Not Indicate Power, or a Detected Object.	1. Verify side sensor display operation.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Check for correct continuity and supplied voltage readings at connector.	1. If OK, notify supervisor. If NOT OK, replace side sensor (WP 0111 00).
		2. If fault still exists, replace CPU (WP 0111 00).
11. DDU Blinks Out Fault Code 11 (Central Processing Unit).		Replace CPU (WP 0111 00).

Table 2. CWS Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
12. DDU Blinks Out Fault Code 13 (Driver's Display Unit).		Replace DDU (WP 0111 00).
13. DDU Blinks Out Fault Code 14 (Antenna Assembly).		1. Replace antenna (WP 0111 00). 2. If fault still exists, replace CPU (WP 0111 00).
14. DDU Blinks Out Fault Code 15 (Right Side Sensor).	1. While performing side sensor test, wave hand in front of side sensor and verify that correct signal is received.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Verify a 5-volt output at side sensor signal wire at side sensor connector, with a target present.	If OK, proceed to next step. If NOT OK, replace side sensor (WP 0111 00).
15. DDU Blinks Out Fault Code 21 (Right Turn Signal).	1. Confirm operation of exterior turn signals.	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Confirm operation of turn signal switch.	If OK, proceed to next step. If NOT OK, notify supervisor.
	3. Check that right turn signal input is connected to right turn signal lead.	If OK, proceed to next step. If NOT OK, notify supervisor.
	4. Perform turn signal test to confirm correct input is received when right turn signal is activated.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	5. Verify pin number 15, on top row of main harness connector, receives 12 volts when right signal is activated.	If OK, notify supervisor. If NOT OK, replace connector (WP 0119 00).
16. DDU Blinks Out Fault Code 23 (Brake).	1. Confirm brake source is correctly configured in CPU.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Confirm operation of exterior brake lights.	If OK, proceed to next step. If NOT OK, notify supervisor.
	3. Confirm operation of brake switch.	If OK, proceed to next step. If NOT OK, notify supervisor.
	4. Perform brake test and confirm correct signal is received when brake pedal is depressed.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	5. Confirm brake logic is correctly configured.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	6. Confirm brake input wire is connected to proper source.	If OK, proceed to next step. If NOT OK, notify supervisor.

Table 2. CWS Troubleshooting Procedures - Continued.

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
16. DDU Blinks Out Fault Code 23 (Brake) - Continued.	7. Verify pin number 9, on top row of main harness connector, receives 12 volts when brake is applied.	Notify supervisor.
17. DDU Blinks Out Fault Code 24 (Speed).	1. Confirm that SPEEDO BIT setting is correcting configured in CPU.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	2. Confirm speed mode is correctly configured.*	If OK, proceed to next step. If NOT OK, notify supervisor.
	3. Perform speedometer test to confirm speedometer accuracy against vehicle speed.*	Notify supervisor.
18. DDU Blinks Out Fault Code 31 (J1587).	Confirm proper connection of J1587 wires at pin #7 positive and pin #8 negative on top row of CPU connector.	If OK, notify supervisor. If NOT OK, replace connector (WP 0119 00).
19. DDU Blinks Out Fault Code 32 (J1939).	Confirm proper connection of J1939 wires at pin #7 positive and pin #8 negative on bottom row of CPU connector.	If OK, notify supervisor. If NOT OK, replace connector (WP 0119 00).
20. DDU Blinks Out Fault Code 33 (VBUS).	Check connection of J1587 wires to vehicle harness.	If OK, notify supervisor. If NOT OK, replace connector (WP 0119 00).
21. DDU Blinks Out Fault Code 34 (DDU Communications).	Check connection of J1587 wires to vehicle harness.	If OK, notify supervisor. If NOT OK, replace connector (WP 0119 00).
22. DDU Blinks Out Fault Code 35 (Antenna Assembly Communications).	Check connection of J1587 wires to vehicle harness.	If OK, notify supervisor. If NOT OK, replace connector (WP 0119 00).

END OF WORK PACKAGE

CHAPTER 3
UNIT MAINTENANCE INSTRUCTIONS

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SERVICE UPON RECEIPT 0019 00

GENERAL

1. When a new, used or reconditioned M915A3 Tractor Truck is first received, determine whether it has been properly prepared for service and is in condition to perform its mission.
2. Follow the inspection and servicing instructions that follow.

INSPECTION INSTRUCTIONS

1. Read and follow all precautions and instructions on DD Form 1397.
2. Remove all packing and shipping material, such as tape, tie downs, protective covers, and shipping seals.
3. Inspect equipment for any damage incurred during shipment. Check if equipment has been modified.
4. Check equipment against packing slip to ensure that shipment is complete. Report any discrepancies on SF Form 364.
5. Remove all Basic Issue Item (BII), Additional Authorization List (AAL), and Components of End Item (COEI) equipment and store in accordance with TM 9-2320-302-10.

SERVICING INSTRUCTIONS

1. Service the vehicle in accordance with TM 9-2320-302-10 and Unit PMCS (WP 0021 00). Schedule the next PMCS on DD Form 314.
2. Refer to TM 9-2320-302-10 and perform functional checks of all major vehicle systems.

END OF WORK PACKAGE

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UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS) INTRODUCTION 0020 00

GENERAL

1. To ensure that the M915A3 Tractor Truck is ready for operation at all times, it must be lubricated and inspected on a regular basis so that defects may be found before they result in serious damage, equipment failure or injury to personnel.
2. Table 1 lists the types, amounts, and temperature ranges of the lubricants required for specified intervals.
3. Table 1 in WP 0021 00 contains systematic instructions on lubrications, inspections, adjustments, and corrections to be performed by Unit Maintenance to keep the vehicles in good operating condition and ready for their primary mission.
4. Table 2 in WP 0021 00 lists PMCS mandatory replacement parts, by interval.

EXPLANATION OF TABLE ENTRIES

1. **Item Number (Item No.) Column.** Numbers in this column are for reference. When completing DA Form 2404 (*Equipment Inspection and Maintenance Worksheet*), include the item number for the check/service indicating a fault. Item numbers also appear in the order you must perform checks and services for the interval listed.
2. **Interval Column.** This column tells you when you must perform the procedure in the procedure column. Intervals are based on calender dates.
   a. *Semiannual* procedures must be done once every six months.
   b. *Annual* procedures must be done once each year.
3. **Location, Item to Check/Service Column.** This column identifies the location and the item to be checked or serviced.

NOTE

The WARNINGs and CAUTIONs appearing in your PMCS table should always be observed. WARNINGs and CAUTIONs appear before applicable procedures. These WARNINGs and CAUTIONs must be observed to prevent serious injury to yourself and others or to prevent your equipment from being damaged.

4. **Procedure Column.** This column gives the procedure you must perform to check or service the item listed in the Item to Check/Service column to know if the equipment is ready or available for its intended mission or for operation. You must perform the procedure at the time stated in the interval column.
5. **Not Fully Mission Capable if: Column.** Information in this column tells you what fault will keep your equipment from being capable of performing its primary mission. If you perform check and service procedures that show faults listed in this column, the equipment is not mission-capable. Follow standard operating procedures for maintaining the equipment or reporting equipment failure.

GENERAL LUBRICATION PROCEDURES

NOTE

These lubrication instructions are mandatory.

1. Recommended intervals are based on normal conditions of operation, temperature, and humidity. When operating under extreme conditions, such as high or low temperatures, fording in water over 20 inches deep, or exposure to sand or dust, lubricants should always be changed more frequently. Lubricants that have become contaminated will be changed regardless of interval. When in doubt, notify your supervisor.
2. Keep all lubricants in a closed container and store in a clean, dry place away from extreme heat. Keep container covers clean and do not allow dust, dirt or other foreign material to mix with lubricants. Keep all lubrication equipment clean and ready for use.
3. Maintain a good record of all lubrication performed and report any problem noted during lubrication. Refer to DA Pam 738-750 for maintenance forms and procedures to record and report any findings.

GENERAL LUBRICATION PROCEDURES - CONTINUED

4. Keep all external parts of equipment not requiring lubrication free of lubricants. Before lubrication, wipe lubrication fittings with a clean rag (Item 28, WP 0235 00). After lubrication, wipe off excess oil or grease to prevent accumulation of foreign matter.

5. Refer to FM 9-207 for lubrication instructions in cold weather.

6. Refer to AR 70-12 for use of standardized fuels and lubricants.

7. Oil filters will be changed when:

   a. they are known to be contaminated or clogged;

   b. service is directed by Army Oil Analysis Program (AOAP) laboratory analysis; or

   c. at prescribed hardtime intervals.

8. Engine oil and transmission fluid must be sampled initially at 90 days of operation as prescribed by DA Pam 738-750. Thereafter, engine oil and transmission fluid are sampled semiannually, unless AOAP results dictate otherwise.

9. For equipment under manufacturer's warranty, hardtime oil service intervals shall be followed. Intervals shall be shortened if lubricants are known to be contaminated or if operation is under adverse conditions (i.e., longer than usual operating hours, extended idling periods or extreme dust).

GENERAL PMCS PROCEDURES

1. Always perform PMCS in the same order so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry. If any deficiency is discovered, perform the appropriate troubleshooting task in Chapter 2 of this manual. If any component or system is not serviceable, or if the given service does not correct the deficiency, notify your supervisor.

2. Before performing preventive maintenance, read all the checks required for the applicable interval and prepare all tools needed to make all checks. Have several clean rags (Item 28, WP 0235 00) handy. Perform ALL inspections at the applicable interval.

   a. **Keep It Clean.** Dirt, grease, oil, and debris get in the way and may cover up a serious problem. Clean as you work and as needed. Use detergent (Item 11, WP 0235 00) and water when you clean.

   b. **Rust and Corrosion.** Check metal parts for rust and corrosion. If any bare metal or corrosion exists, clean and apply a light coat of lubricating oil (Item 19, WP 0235 00). Report it to your supervisor.

   c. **Bolts, Nuts, and Screws.** Check bolts, nuts, and screws for obvious looseness, missing, bent or broken condition. You can't try them all with a tool, but look for chipped paint, bare metal or rust around bolt heads. If you find one you think is loose, tighten it.

   d. **Welds.** Look for loose or chipped paint, rust or gaps where parts are welded together. If you find a bad weld, report it to your supervisor.

   e. **Electric Wires and Connectors.** Look for cracked or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors and ensure that the wires are in good condition.

GENERAL PMCS PROCEDURES - CONTINUED

f. **Hydraulic Hoses and Lines.** Look for wear, damage, and signs of leaks. Ensure that clamps and fittings are tight. Wet spots indicate leaks, but a stain around a fitting or connector can also mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, correct it if authorized by the Maintenance Allocation Chart (WP 0234 00). If not authorized, notify your supervisor.

g. **Fluid Leakage.** It is necessary for you to know how fluid leakage affects the status of your truck. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your truck. Learn and be familiar with them, and remember - when in doubt, notify your supervisor.

Leakage Definitions For PMCS

Class I	Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
Class II	Leakage of fluid great enough to form drops, but not enough to cause drops to drip from item being checked/inspected.
Class III	Leakage of fluid great enough to form drops that fall from item being checked/inspected.

CAUTION

Operation is allowable with Class I and Class II leakage. WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR. When operating with Class I or Class II leaks, check fluid levels more frequently. Class III leaks must be reported immediately to your supervisor. Failure to do this will result in damage to vehicle and/or components.

PMCS INITIAL SETUP

1. **General.**
   a. This paragraph lists tools, materials, and personnel required for PMCS and lubrication.
   b. Mandatory replacement parts for PMCS and lubrication are listed after Unit PMCS, Table 2, WP 0021 00.
2. **Tools.**
   a. Common no. 1 shop set
   b. General mechanic’s tool kit
   c. Tensiometer, dial indicating
3. **Materials.**
   a. Antifreeze
   b. AOAP sampling kit
   c. Detergent
   d. GAA grease
   e. Lubricating oil, OE/HDO 10
   f. Lubricating oil, OE/HDO 40
   g. Lubricating oil, OE/HDO 15/40
   h. Lubricating oil, OE/HDO 30
   i. Lubricating oil, OEA
   j. Lubricating oil, GO 85/140
   k. Lubricating oil, GO 80/90
   l. Lubricating oil, GO 75
   m. Rags
4. **Personnel.**
   a. Driver/Operator
   b. Unit Maintenance Mechanic

Table 1. Lubrication Data.

LUBRICANT/ COMPONENT	REFILL CAPACITY	EXPECTED TEMPERATURES*		
		+6°F TO +122°F (-14°C TO +50°C)	-4°F TO +50°F (-20°C TO +10°C)	-67°F TO +32°F (-55°C TO 0°C)
OE/HDO (MIL-L-2104) Lubricating Oil, ICE, Tactical				
OEA (MIL-L-46167) Lubricating Oil, ICE, Arctic				
Engine Crankcase w/ Filters	41 Qt (38.8 l)	See Chart A		
Power Steering Reservoir	2 Qt (1.9 l)	See Chart A		
Transmission	51 Qt (48 l)	See Chart B		
GO (MIL-PRF-2105) Lubricating Oil, Gear, Multipurpose				
Front Axle Wheel Bearings	As Reqd	See Chart C		
Rear Axle Differential, Forward-rear	13 Qt (12.3 l)	See Chart C		
Rear Axle Differential, Rear-rear	14.5 Qt (13.7 l)	See Chart C		
GAA (M-10924) Grease, Automotive and Artillery	As Reqd	All Temperatures		
ANTIFREEZE (MILA46153) Ethylene Glycol, Inhibited, Heavy Duty				
ANTIFREEZE (MIL-A-11755) Ethylene Glycol, Arctic Grade				
Engine Radiator	65 Qt (61.5 l)	See Chart D		
* For arctic operation, refer to FM 9-207				

Table 2. Chart A - Engine and Power Steering Reservoir.

Lubricant	EXPECTED TEMPERATURES																			
	°F	-70	-60	-50	-40	-30	-20	-10	0	+10	+20	+30	+40	+50	+60	+70	+80	+90	+100	+120
	°C	-57	-51	-46	-40	-34	-29	-23	-18	-12	-7	-1	+4	+10	+16	+21	+27	+32	+38	+49
OE/HDO (MIL-L-2104)	Lubricating Oil, ICE, Tactical																			
OEA (MIL-L-46167)	Lubricating Oil, ICE, Arctic																			
OE/HDO-15/40 (0 - 1236)																				
OE/HDO-10 * (0237)																				
OE/HDO-30 (0 - 238)																				
OE/HDO-40 (N/A)																				
OEA * (0 - 183)																				

*If OEA lubricant is required to meet the low expected-temperature range, OEA lubricant is to be used in lieu of OE/HDO-10 lubricant for all expected temperatures where OE/HDO-10 is specified.

Table 3. Chart B - Transmission.

Lubricant	EXPECTED TEMPERATURES																			
	°F	-70	-60	-50	-40	-30	-20	-10	0	+10	+20	+30	+40	+50	+60	+70	+80	+90	+100	+120
	°C	-57	-51	-46	-40	-34	-29	-23	-18	-12	-7	-1	+4	+10	+16	+21	+27	+32	+38	+49
OE/HDO (MIL-L-2104)	Lubricating Oil, ICE, Tactical																			
OEA (MIL-L-46167)	Lubricating Oil, ICE, Arctic																			
OE/HDO-15/40 (0 - 1236)																				
OE/HDO-10 * (0 - 237)																				
OEA * (0 - 183)																				

*If OEA lubricant is required to meet the low expected-temperature range, OEA lubricant is to be used in lieu of OE/HDO-15/40 lubricant for all expected temperatures where OE/HDO-10 and OE/HDO-15/40 are specified.

Table 4. Chart C- Front Axle Wheel Bearings and Rear Axle Differentials.

Lubricant	EXPECTED TEMPERATURES																			
	°F	-70	-60	-50	-40	-30	-20	-10	0	+10	+20	+30	+40	+50	+60	+70	+80	+90	+100	+120
	°C	-57	-51	-46	-40	-34	-29	-23	-18	-12	-7	-1	+4	+10	+16	+21	+27	+32	+38	+49
GO (MIL-PRF-2105)	Lubricating Oil, Gear, Multipurpose																			
GO-75 (0 - 186)																				
GO-80/90 (0 - 226)																				
GO-85/140 (0 - 228)																				

Table 5. Chart D - Antifreeze.

Lubricant	EXPECTED TEMPERATURES																			
	°F	-90	-80	-70	-60	-50	-40	-30	-20	-10	0	+10	+20	+30	+40	+50	+60	+70	+80	+90
	°C	-68	-62	-57	-51	-46	-40	-34	-29	-23	-18	-12	-7	-1	+4	+10	+16	+21	+27	+32
MILA46153	Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty																			
MIL-A-11755	Antifreeze, Arctic Grade																			
MILA46153																				
MIL-A-11755																				

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
			WARNING Unless otherwise specified, perform all lubrication and preventive maintenance checks and services with truck on level ground, transmission in N (Neutral), parking brake applied, and engine off. Failure to follow this warning may result in personnel injury.	
			NOTE Perform all operator PMCS, as appropriate, while performing road test (TM 9-2320-302-10). Drive at least 5 mi (8 km) to give enough time to detect malfunctions.	
1	**Semi-annual**	**Road Test, Starter**	While starting vehicle, listen for unusual noises and difficult cranking of starter.	
2	**Semi-annual**	**Road Test, Engine and Engine Compartment**	a. Listen for unusual noises, hesitation, and varying idle speed. Observe accelerator response. b. Ensure that engine does not exceed maximum governed speed (2100 rpm). c. Check instrument panel for proper operation of switches, gages, and indicator and warning lights (TM 9-2320-302-10).	
			NOTE Refer to TM 9-2320-302-10 for operation of brake components.	
3	**Semi-annual**	**Road Test, Brakes**	a. Test braking response to brake pedal. Response should be immediate. b. At approximately 30 mph (48 kph), apply brake pedal. Vehicle should stop smoothly without noticeable side pull or chatter. c. After stopping vehicle, with transmission in gear, release brake pedal. Wheel brake release should be immediate. d. With vehicle on downgrade and transmission in N (Neutral), set parking brake. Vehicle should not move.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
3 (Con't)	**Semi-annual**	**Road Test, Brakes**	e. Start vehicle moving downhill. Engage engine Jake brake and check operation in all switch positions (2, 4, and 6 cylinders braking power). Ensure that vehicle speed drops in each position, with maximum braking power with all 6 cylinders engaged in braking.	
			WARNING Cautiously feel each wheel hub and brakedrum. Wheel hubs and brakedrums may be hot. Failure to follow this warning may result in serious burns.	
			f. Immediately after road test, carefully check and compare each wheel hub and brakedrum for overheating, which could indicate a dragging brake. A cool wheel hub and brakedrum could mean improperly adjusted, defective or inoperative brakes.	
4	**Semi-annual**	**Road Test, Interaxle Lockout**	Check operation of interaxle lockout.	
5	**Semi-annual**	**Road Test, Steering**	Check vehicle response to steering wheel action. Vehicle should respond quickly. With vehicle on straight level ground, lightly hold steering wheel to check for pull or wander. With vehicle in motion, free play should be no more than 2 ½ in (6.4 cm) in either direction.	
6	**Semi-annual**	**Road Test, Suspension**	Observe how vehicle responds to road shocks. Shifts, knocks or constant bouncing indicate possible malfunctions.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

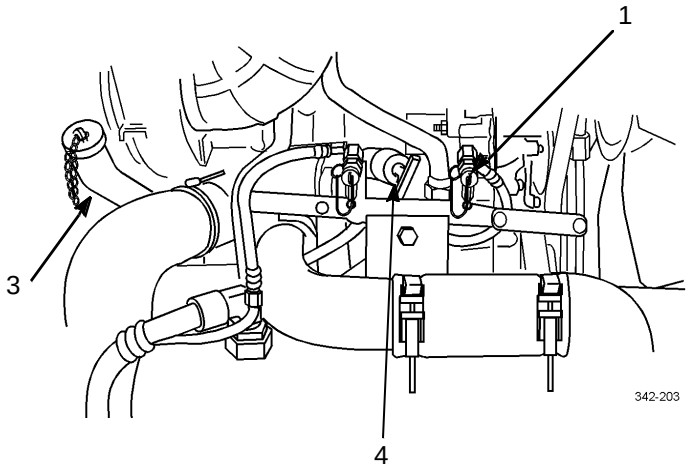
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
			NOTE Engine oil must be sampled initially at 90 days of operation, as prescribed by DA Pam 738-750. Thereafter, it is sampled semiannually unless AOAP results indicate otherwise.	
7	**Semi-annual**	**Engine Compartment, AOAP Sampling Valve**	Raise hood and take sample of engine oil: a. Start engine and bring to operating temperature (TM 9-2320-302-10). b. Remove cap from discharge port. Clean sampling valve (1) with a rag. c. Press knob of sampling valve (1) and collect approximately 2 oz. (60 ml) into a suitable container. Discard oil in accordance with local policies and regulations.	
				
			d. Collect oil sample into clean sample bottle to approximately 1/2 in (1.3 cm) below neck of sample bottle. e. Install cap on discharge port and check for leaks.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

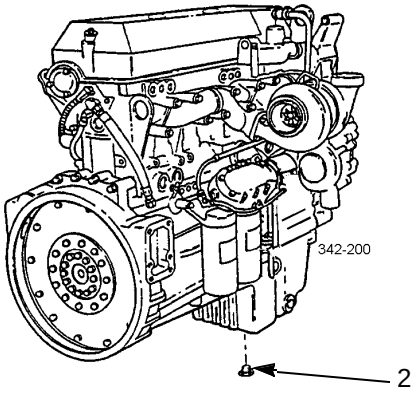
ITEM NO.	INTERVAL	LOCATION ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
8	Semi-annual	**Engine Compartment, Engine Crankcase**	a. With engine warm, remove drain plug (2) from oil pan and completely drain oil from crankcase. b. Replace all oil filters. c. Install drain plug (2).  d. Fill crankcase with OE/HDO or OEA (Items 16 through 21, WP 0235 00) through filler tube (3) opening. Capacity with filters is approximately 41 qt (38.8 l). e. Run engine. Remove dipstick (4) and check level of oil on dipstick. Level should be between ADD and FULL marks on dipstick.	
9	Semi-annual	**Engine Compartment, Engine**	a. Check all oil lines, fittings, and hoses for leaks. b. Check oil filter housing, oil pan, and oil pan drain plug for leaks. Tighten or replace any damaged component, if authorized. c. Check rocker arm cover for leaks. Tighten or replace any damaged component, if authorized.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

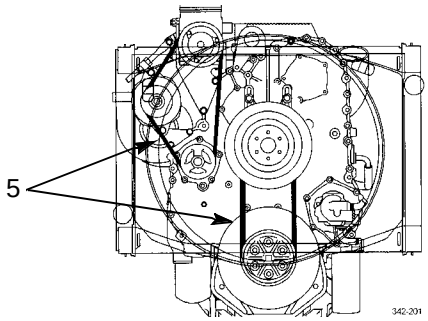
ITEM NO.	INTERVAL	LOCATION ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
9 (Con't)	**Semi-annual**	**Engine Compartment, Engine**	d. Check mounting hardware and attaching hardware for looseness. Tighten or replace any damaged component, if authorized.	
			WARNING DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flame or sparks. Fuel may ignite, causing injury or death to personnel and damage to vehicle.	
10	**Semi-annual**	**Engine Compartment, Fuel System**	a. Replace all fuel filter elements. b. Inspect fuel lines, fuel tank, and fuel system components for leaks and damage. If authorized, replace damaged components.	
11	**Semi-annual**	**Engine Compartment, Drive Belts and Pulleys**	a. Check for loose, missing, worn, broken, frayed or cracked drive belts (5).	
				
			b. Check alternator and air conditioning compressor mounting for looseness. Inspect brackets and attaching hardware for cracks, bends, and loose mounting. Replace damaged components as needed.	
			c. Use a dial indicating tensionmeter (Item 32, WP 0236 00) placed at the center of the longest belt free-span to check belt tension. Gage should register 80-100 lb-ft (108-135 Nm) for alternator and AC compressor belt. Gage should register 60-80 lb-ft (81-108 Nm) for fan belt. Adjust tension as required.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
11 (Con't)	**Semi-annual**	**Engine Compartment, Drive Belts and Pulleys**	d. Check for cracked pulleys or pulleys out of alignment.	
			WARNING If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your NBC Officer or NBC NCO for appropriate handling or disposal procedures.	
12	**Semi-annual**	**Engine Compartment, Air Intake System**	a. Check air cleaner, hoses, and air cleaner seal for proper installation, cracks, breaks or loose connections that could let unfiltered air into air intake system. b. Check air cooler intake screen for debris and damage. c. Check air intake filter element for clogging and wear.	
			NOTE Refer to TM 750-651 for cooling system service information.	
13	**Semi-annual**	**Engine Compartment, Cooling System**	a. Remove debris from cooling fins and check for bent fins. b. Inspect radiator and charge air cooler for leaks. c. Check radiator hoses for cracks, bulges or soft spots. Ensure that hose clamps are tight. d. Check radiator cap, gaskets, and rubber isolator mounts and fan shroud for cracks and leaks. e. Inspect water pump for leaks.	
14	**Semi-annual**	**Engine Compartment, Power Steering Components**	a. Inspect power steering pump and reservoir (6) for leaks, cracks, loose hoses, or other damage. b. Remove plug (7) from reservoir (6) and drain fluid into a suitable container.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

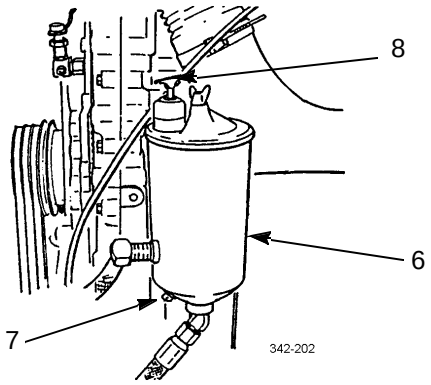
ITEM NO.	INTERVAL	LOCATION ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
14 (Con't)	**Semi-annual**	**Engine Compartment, Power Steering Components**	c. Replace filter element. d. Install plug (7). Fill reservoir (6) through dipstick (8) opening with OE/HDO or OEA (Items 18 through 22, WP 0235 00). Capacity is approximately 2 qt (1.9 l). e. Start engine (TM 9-2320-302-10). Bring to operating temperature. Turn steering wheel in both directions to circulate power steering fluid. f. Check level of fluid on dipstick (8). Add fluid as required until level shows within correct range on dipstick.	
				
15	**Semi-annual**	**Engine Compartment, Electrical Components**	a. Inspect wiring for frays, splits, missing insulation or poor connections. Make repairs as needed, if authorized. b. Check alternator and DUVAC wiring for frays, splits, missing insulation, and loose terminal connections. Make repairs as needed, if authorized.	
16	**Semi-annual**	**Cab Floor and Engine Compartment Firewall, Foot Brake Valve**	Remove foot brake valve from firewall. Lubricate sliding surfaces of plunger and adapter bore with silicone grease (Item 16, WP 0235 00). Install foot brake valve.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
			WARNING To avoid eye injury, eye protection is required when working around batteries. DO NOT smoke, use open flame, make sparks or create other ignition sources around batteries. If a battery is giving off gases, it can explode and cause injury to personnel. Remove all jewelry such as rings, ID tags, watches, and bracelets. If jewelry or a tool contacts a battery terminal, a direct short will result in instant heating, injury to personnel, and damage to equipment.	
			CAUTION To reduce battery damage, do not remove batteries from battery box unless battery compartment is corroded (greenish/white powder) or during battery replacement. Do not jerk or pull on battery cables during visual inspection. Battery replacement will be performed only by Unit Maintenance personnel.	
17	**Semi-annual**	**Battery Box, Batteries**	a. Remove batteries from battery box.	
			b. Check for damaged or missing filler caps.	b. Filler caps are damaged or missing.
			c. Check for damaged terminal posts.	c. Terminal posts are damaged.
			d. Check electrolyte level (TM 9-6140-200-14).	d. Electrolyte is not at proper level.
			e. Check and record specific gravity of each cell in all batteries (TM 9-6140-200-14).	e. Specific gravity is not within standards.
			f. Check battery cables for frays, splits, and breaks.	f. Cables are missing, frayed, split or broken.
			g. Clean battery box.	
			h. Install batteries.	
			i. Coat terminals lightly with grease (Item 15, WP 0235 00).	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
18	Semi-annual	Exhaust System	Inspect exhaust manifold, exhaust pipes, muffler, and tailpipe for leaks. Check for damaged pipes, loose clamps, and damaged gaskets and seals. Replace damaged components as needed.	
19	Semi-annual	Air System, Brakes	a. Fully charge air system (TM 9-2320-302-10). b. Listen for sounds of leaks in all air lines and at valves and fittings. c. With air system fully pressurized, apply a solution of detergent (Item 11, WP 0235 00) and water to air lines, valves, and fittings. Tighten loose connections. Make repairs as needed. d. Ensure that all air lines are not kinked and that they are properly supported.	
20	Semi-annual	Air Conditioning System	Leak test air conditioning system (WP 0225 00).	
21	Semi-annual	Under Vehicle, Frame and Crossmembers	a. Inspect frame and side rails for cracks, breaks, bends, wear, deterioration, and loose bolts. b. Inspect crossmembers for weld breaks, wear, and missing or loose capscrews, huckbolts, and rivets.	
22	Semi-annual	Vehicle Exterior	a. Inspect for corrosion in accordance with TB 43-0213. b. Inspect cab glass and doors, fenders, stowage boxes, and brackets for damage. **NOTE** Transmission fluid must be sampled initially at 90 days of operation, as prescribed by DA Pam 738-750. Thereafter, it is sampled semiannually unless AOAP results indicate otherwise.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

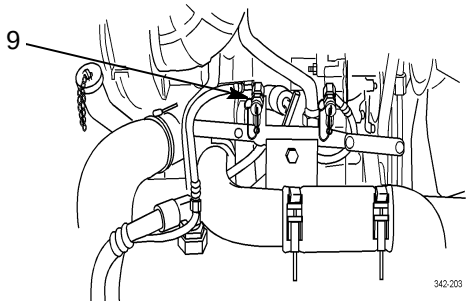
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
23	Semi-annual	**Transmission, AOAP Sampling Valve**	Take sample of transmission fluid: a. Ensure that transmission is at operating temperature. b. Remove cap from discharge port. Clean sampling valve (9) with a rag. c. Press knob of sampling valve (9) and collect approximately 2 oz. (60 ml) into a suitable container. Discard fluid.	
				
			d. Collect fluid sample into clean sample bottle to approximately 1/2 in (1.3 cm) below neck of sample bottle. e. Install cap on discharge port and check for leaks.	
24	Semi-annual	**Transmission**	a. Check transmission for leaks, loose bolts, and obvious damage. b. Check transmission output shaft seal for damage or leaking.	
			NOTE When lubricating front axle steering components, vehicle must be raised to take weight off the suspension to permit lubrication to reach all axle bearing surfaces.	
25	Semi-annual	**Front Axle Steering Components, Lubrication**	a. Apply grease (Item 15, WP 0235 00) to grease fittings (10) at top and bottom of steering knuckle (11) until old lubricant is purged and fresh grease comes out areas indicated by arrows. Perform service at both axle ends.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

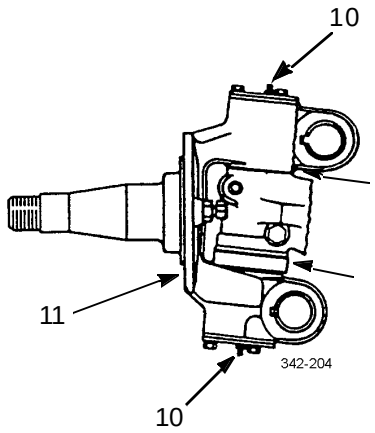
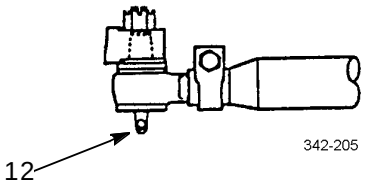
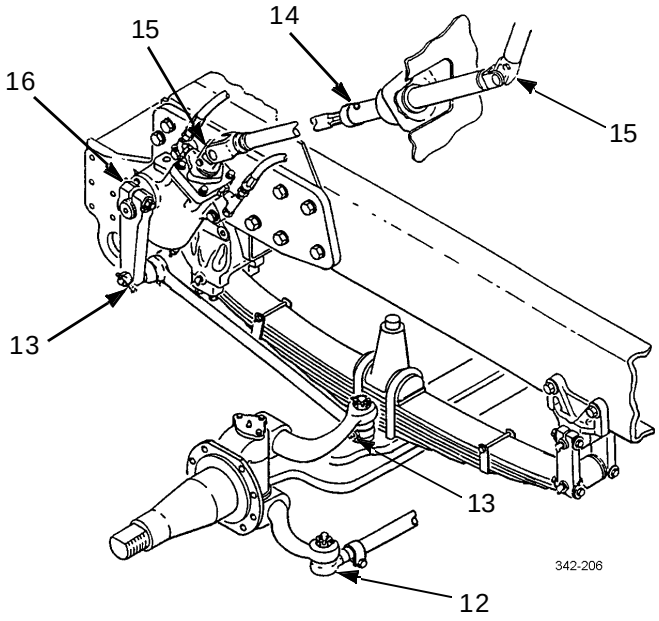
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
25 (Con't)	Semi-annual	**Front Axle Steering Components, Lubrication**		
			CAUTION If excess grease accumulates at front axle ball exterior between services, notify Direct Support Maintenance. Ball seal may be worn or leaking.	
			b. Lubricate two tie-rod end grease fittings (12) with grease (Item 15, WP 0235 00).	
				

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
25 (Con't)	**Semi-annual**	**Front Axle Steering Components, Lubrication**	c. Lubricate two drag link grease fittings (13) with grease (Item 15, WP 0235 00). d. Lubricate steering column fitting (14) and two U-joint grease fittings (15) with grease (Item 15, WP 0235 00). Observe purging from all seals until new grease comes out. If grease does not purge, manipulate U-joints until purging occurs.	



CAUTION

DO NOT use an automatic or power grease gun on fitting on trunnion side of steering gear because the rate of flow is too high. High flow rate could force grease inside high-pressure seal, contaminating hydraulic system and promoting seal leakage.

e. Lubricate grease fitting (16) on trunnion side of steering gear, near output shaft, with grease (Item 15, WP 0235 00).

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

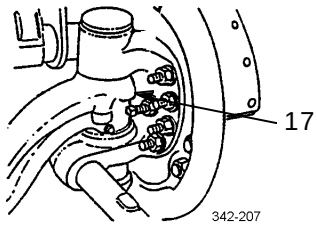
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
26	Semi-annual	**Front Axle Steering Components, Inspection**	a. Check for looseness in steering column U-joints. b. Check steering gear for leaks and loose mounting bolts and components. Tighten or replace any damaged component, if authorized. c. Check tie-rod and drag link for movement by attempting to move by hand. Visually check ball joint ends for worn or damaged dust seals. If movement or damage is present, make repairs if authorized. d. Inspect all steering lines and fittings for looseness, damage or leaks. Tighten if loose or replace if damaged. e. Check adjustment of front axle steering stops (17). With brakes fully applied, turn steering wheel to one side to end of travel. Check both sides of vehicle for interference at tires and wheels. Minimum clearance is 1/2 in (1.3 cm) from any fixed object and 3/4 in (1.9 cm) from any moving object. Repeat for opposite end of steering wheel travel. Make adjustments as required. 	
27	Semi-annual	**Front Axle, Suspension**	a. Inspect spring leaves for cracks and breaks. b. Inspect spring clips, saddles, saddle caps, spring hangers, and attaching hardware for looseness, cracks or other damage. Tighten or replace any damaged component, if authorized.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

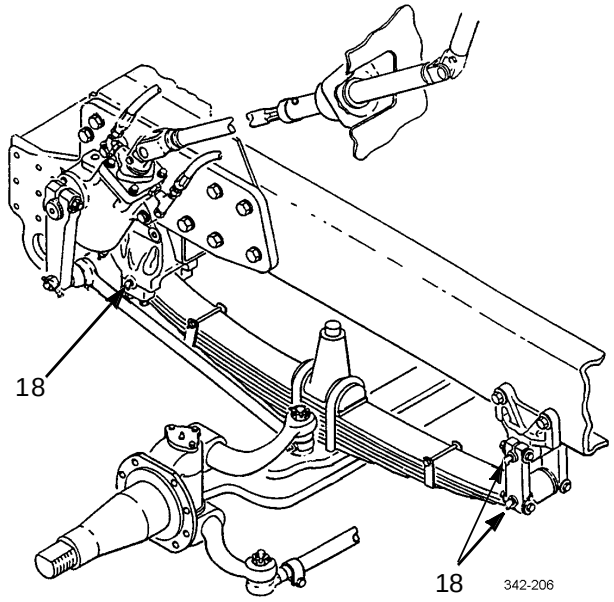
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
27 (Con't)	**Semi-annual**	**Front Axle, Suspension**	c. Check for loose screws and missing and damaged front axle mounting hardware.	
			NOTE When lubricating front axle suspension components, vehicle must be raised to take weight off suspension to permit lubrication to reach bearing surfaces.	
			d. Lubricate three spring grease fittings (18) with grease (Item 15, WP 0235 00).	
				
			e. Check shock absorbers and mounting hardware for looseness or damage. Replace damaged components, if authorized.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

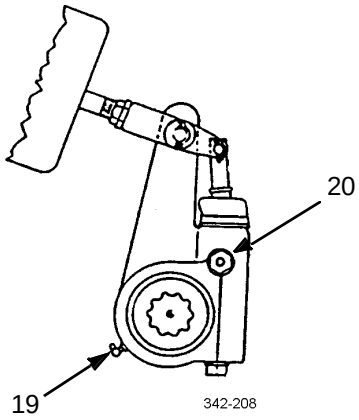
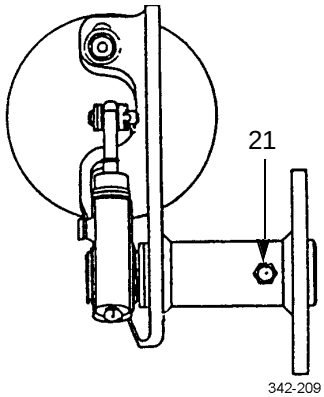
ITEM NO.	INTERVAL	LOCATION ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
28	Semi-annual	**Front Axle Brake Components, Slack Adjusters**	Lubricate grease fitting (19) at each slack adjuster with grease (Item 15, WP 0235 00) until new grease flows from pressure relief valve in pawl capscrew (20).	
				
29	Semi-annual	**Front Axle Brake Components, Camshaft Bushings**	Lubricate grease fitting (21) at each camshaft bracket with grease (Item 15, WP 0235 00).	
				

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

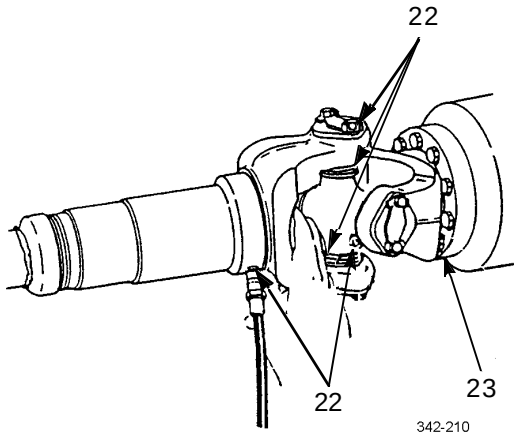
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
30	**Semi-annual**	**Drivelines**	a. Check for looseness or side play in front and rear drivelines. There should be no play at U-joints. Check for bends, cracks, and missing weights. Make repairs as needed. b. Check that U-joint mounting screw torque is 33-38 lb-ft (44-52 Nm). c. Inspect for loose or worn bearings, damaged seals, and damaged or missing grease fittings. Make repairs as needed. d. Using a hand-type grease gun, lubricate five grease fittings (22) at each driveline with grease (Item 15, WP 0235 00) until purging takes place at air hole in end of slip yoke. Cover pressure relief hole while lubricating. e. Inspect for damaged or leaking input or output shaft seals (23). If damaged or leaking, notify Direct Support Maintenance.	
				
31	**Semi-annual**	**Rear Axles, Suspension**	a. Inspect spring pack for cracks or breaks. b. Inspect spring pack and attaching hardware for looseness, cracks, or other damage. Tighten or replace damaged components, if authorized.	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
31 (Con't)	Semi-annual	**Rear Axles, Suspension**	c. Check torque rod rubber bushings for splitting or deterioration. Notify Direct Support Maintenance of any damage found.	
			d. Check shock absorbers and mounting hardware for looseness or damage. Replace damaged component, if authorized.	
32	Semi-annual	**Rear Axle Brake Components, Slack Adjusters**	a. Check length of spring brake chamber push rods. Minimum length must be 1/2 in (12.7 mm). If not, adjust slack adjusters.	
			b. Lubricate grease fitting (24) at each slack adjuster with grease (Item 15, WP 0235 00) until new grease flows from pressure relief valve in pawl capscrew (25).	

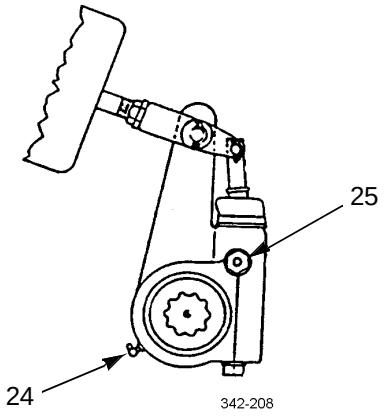


Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

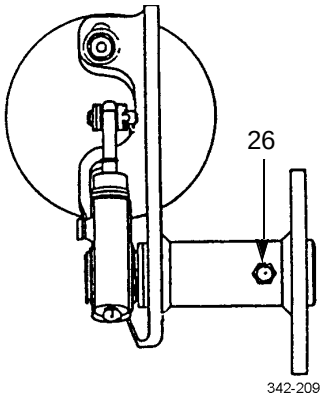
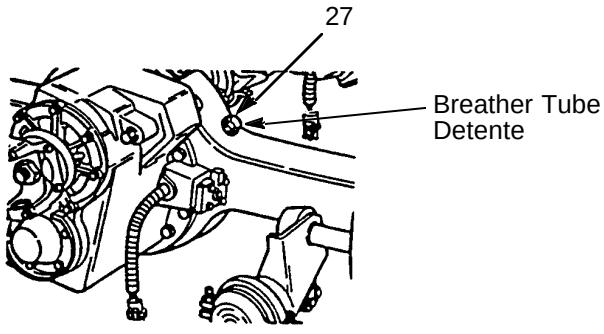
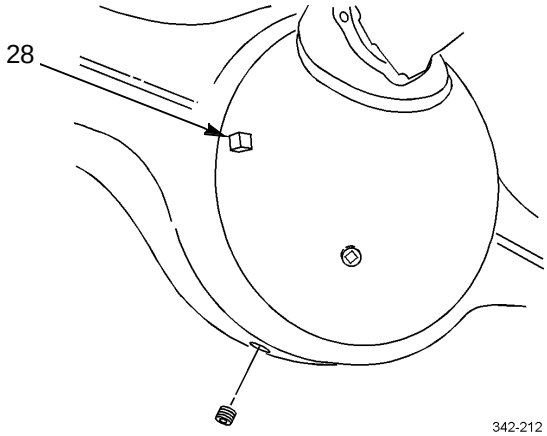
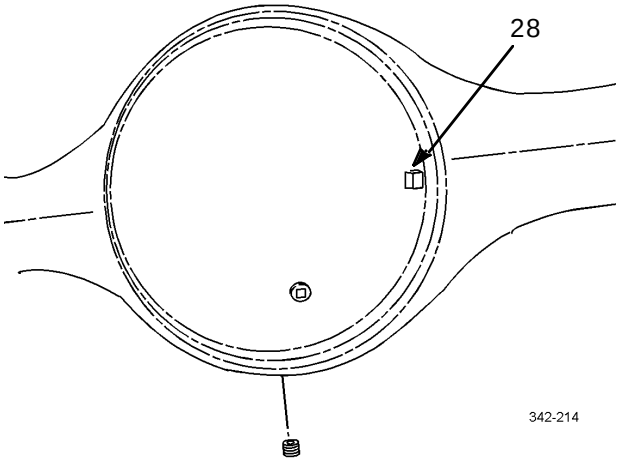
ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
33	Semi-annual	**Rear Axle Brake Components, Camshaft Bushings**	Lubricate grease fitting (26) at each camshaft bracket with grease (Item 15, WP 0235 00).	
			 342-209	
			NOTE Resinstall breather with tube detente toward wheel end of axle to prevent leakage.	
34	Semi-annual	**Rear Axles, Breathers**	Remove breather (27) from each axle. Clean and reinstall.	
			 342-211	

Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
35	Semi-annual	**Rear Axles, Differentials**	Use socket (Item 29, WP 0236 00) to remove filler plugs (28) and check level of fluid in differentials. When housing is cold, level should be even with bottom of filler plug opening. As required, add gear lubricating oil (Item 22 through 25, WP 0235 00). Install filler plugs.	





36	Semi-annual	**Rear of Vehicle, Pintle Hook**	a. Lubricate four pintle hook grease fittings (29) with grease (Item 15, WP 0235 00). b. Check pintle hook (30) for proper operation. Ensure that mounting hardware is tight.	

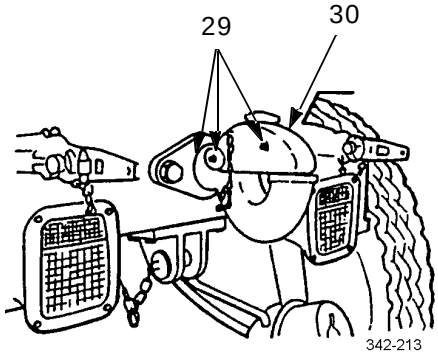
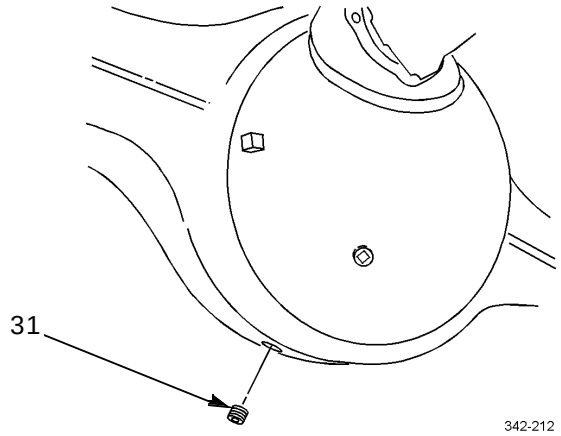


Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
37	Semi-annual	Cab Compartment, Seats and Seat Belts	Check seats and seat belts for loose mountings and damage. Replace seat/seat mounts if damaged. Replace seat belts if any seat belt system shows cuts, fraying, extreme wear, abrasions to seat belt webbing or damage to buckle or latch plate retractor hardware.	
38	Annual	Engine Compartment, Cooling System	a. Test, drain, and refill cooling system in accordance with TB 750-651. b. Change water filter element.	
39	Annual	Air Dryer	Service air dryer.	
40	Annual	Transmission	Drain transmission fluid, replace filters, and refill (WP 0123 00).	
41	Annual	Rear Axles, Differentials	a. Use socket (Item 29, WP 0236 00) to remove plugs (31) and drain fluid while assemblies are still warm from operation. Check magnetic drain plugs for excessive metal particle buildup. Notify Direct Support Maintenance if this condition exists. Clean plugs.	



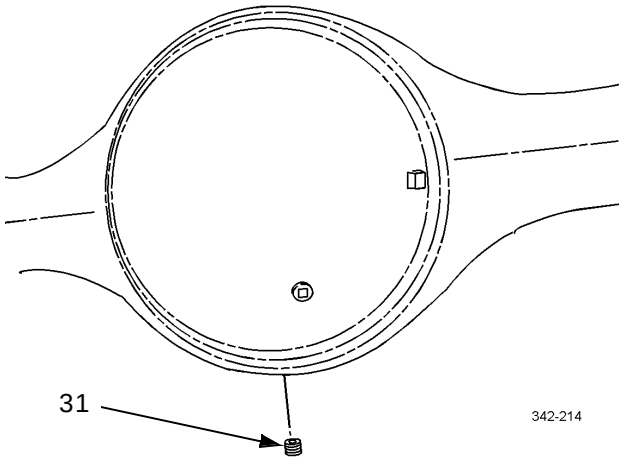
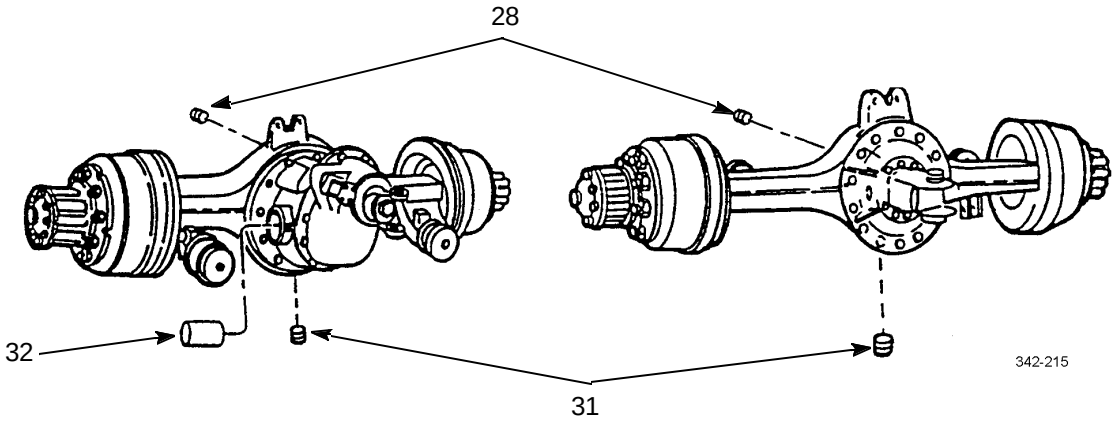


Table 1. Unit Preventive Maintenance Checks and Services (PMCS) for the M915A3 Tractor Truck - Continued.

ITEM NO.	INTERVAL	LOCATION / ITEM TO CHECK/ SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
41 (Con't)	**Annual**	**Rear Axles, Differentials**	**NOTE** There may be approximately 1 pt (0.47 l) of lubricant remaining in filter element. Be careful not to spill it when removing element. b. Use a suitable filter strap wrench to replace filter element (32) from forward-rear axle differential. c. Install plugs (31) and fill differentials with gear lubricating oil (Item 22 through 25, WP 0235 00) until level is even with filler plug (28) openings. Use the following capacities as a guide. Do not overfill: Forward-rear 13 qt (12.3 l) Rear-rear 14.5 qt (13.7 l)	



42	**Annual**	**Front and Rear Wheels, Wheel Bearings**	Remove, clean, inspect, pack, install, and adjust wheel bearings.	
43	**Annual**	**Front and Rear Wheels, Brakeshoe Linings**	Check brakeshoe linings for a minimum thickness of 1/4 in (6.5 mm). Replace worn or damaged brakeshoes.	
44	**Annual**	**Front Axle, Stop Cushions**	Check front axle stop cushions for wear or deterioration.	
45	**Annual**	**Data Plates**	Check data plates to ensure legibility.	
46	**Annual**	**Collision Warning System (CWS)**	Align CWS antenna (WP 0110 00).	

Table 2. PMCS Mandatory Replacement Parts List.

ITEM NO.	PART NUMBER	NSN	NOMENCLATURE	QTY
	Semiannual			
1	83213D	4330-01-330-8203	Power steering reservoir, filter element	1
2	R90-DDC-01TP916 (OEM)	2910-01-022-8183	Fuel filter, filter elements	2
3	25010495	2940-01-197-7106	Engine oil, filter element, fullflow	2
	Annual			
4	3280-V-8394	2940-00-586-4792	Forward-rear differential, filter element	1
5	35066	5330-01-149-9677	Front axle, oil seal	2
6	47697		Forward-rear axle, oil seal	2
7	47697		Rear-rear axle, oil seal	2
8	KAF953	4330-01-332-6058	Air dryer, canister cartridge kit	1
9	WF-2077	2910-01-274-1915	Water filter, filter element	1
10	29526899		Transmission, filter kit (first 5,000 miles thereafter 25,000 miles or 18 months)	1

OIL FILL TUBE MAINTENANCE 0022 00

THIS WORK PACKAGE COVERS

Oil Fill Tube Cap Removal, Oil Fill Tube Removal, Oil Filler Hole Cover and Gasket Removal, Oil Filler Hole Cover and Gasket Installation, Oil Fill Tube Installation, Oil Fill Tube Cap Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Gasket (P/N 8929302)

Nut, lock (P/N MS51922-1)

Materials/Parts - Continued

Compound, sealing, pipe (Item 10, WP 0235 00)

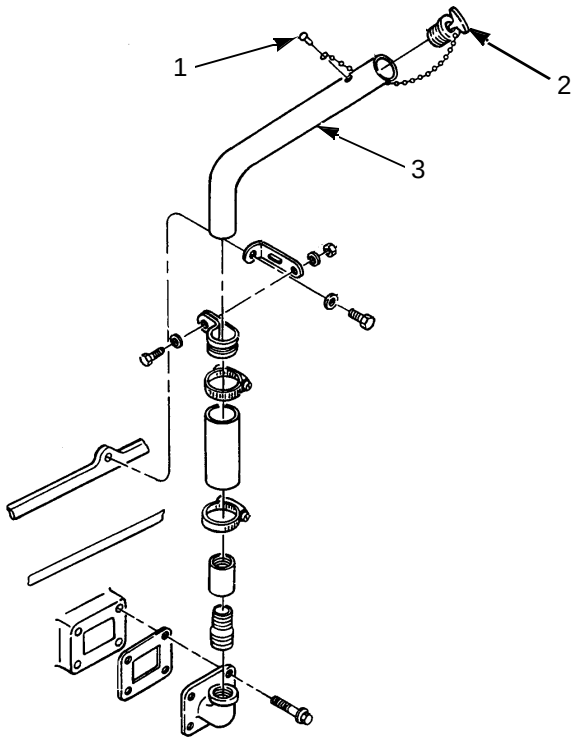
Rags, wiping (Item 28, WP 0235 00)

References

TM 9-2320-302-10

OIL FILL TUBE CAP REMOVAL

Remove screw (1) and oil fill tube cap (2) from oil fill tube (3).



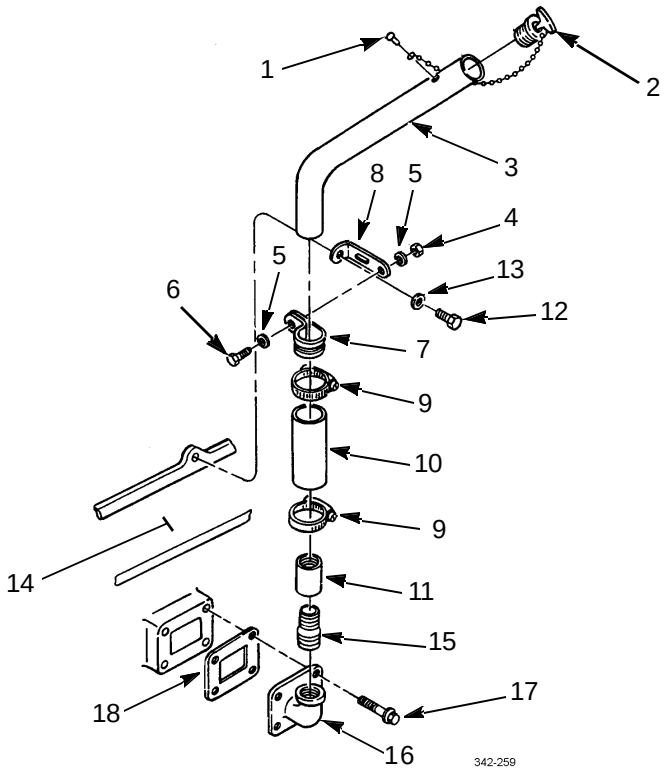
OIL FILL TUBE REMOVAL

1. Remove lock nut (4), two washers (5), screw (6), and clamp (7) from standoff bracket (8). Discard lock nut.
2. Loosen two hose clamps (9) and remove filler tube (3) and hose (10) from pipe coupling (11).

NOTE

Perform step 3 only if standoff bracket is damaged.

3. Remove screw (12),washer (13), and standoff bracket (8) from engine block (14).



OIL FILLER HOLE COVER AND GASKET REMOVAL

1. Remove pipe coupling (11) and nipple (15) from oil filler hole cover (16).
2. Remove four screws (17), oil filler hole cover (16), and gasket (18) from engine block (14). Discard gasket.

OIL FILLER HOLE COVER AND GASKET INSTALLATION

NOTE

Ensure that all old gasket material has been removed from mounting surfaces.

OIL FILLER HOLE COVER AND GASKET INSTALLATION - CONTINUED

1. Install new gasket (18) and oil filler hole cover (16) on engine block (14) with four screws (17). Torque screws to 22-28 lb-ft (30-38 Nm).

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

2. Lightly coat threads of pipe nipple (15) with pipe sealing compound. Install pipe nipple and pipe coupling (11) on oil filler hole cover (16).

OIL FILL TUBE INSTALLATION

NOTE

Perform step 1 only if standoff bracket was removed.

1. Install standoff bracket (8) on engine block (14) with washer (13) and screw (12).
2. Position two hose clamps (9) and hose (10) on pipe coupling (11). Tighten lower hose clamp.
3. Position upper hose clamp (9) on filler tube (3) and install filler tube on hose (10). Tighten upper hose clamp.
4. Install clamp (7) on standoff bracket (8) and secure in place with screw (6), two washers (5) and new lock nut (4).

OIL FILL TUBE CAP INSTALLATION.

1. Install oil fill tube cap (2) on oil fill tube (3).
2. Secure oil fill tube cap (2) retaining chain on oil fill tube (3) with screw (1).

END OF WORK PACKAGE

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OIL LEVEL DIPSTICK, TUBE, AND ADAPTER REPLACEMENT 0023 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1)

Nut, lock (P/N MS51922-17)

Compound, sealing, pipe (Item 10, WP 0235 00)

References

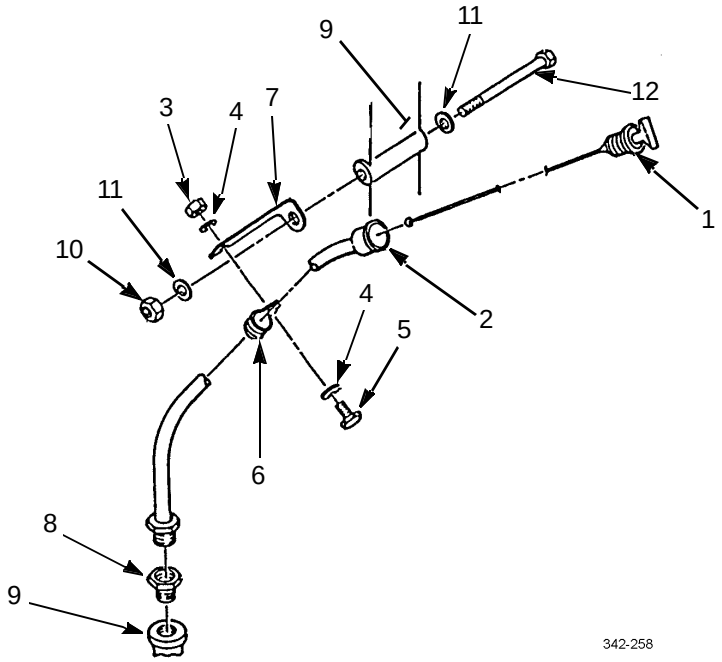
TM 9-2320-302-10

Equipment Condition

Transmission oil cooler removed (WP 0127 00)

REMOVAL

1. Turn oil level dipstick (1) counterclockwise and remove from dipstick tube (2).
2. Remove lock nut (3), two washers (4), and screw (5) from cable clamp (6) to standoff bracket (7). Discard lock nut.
3. Separate cable clamp (6) from standoff bracket (7).
4. Remove dipstick tube (2) from engine block adapter (8).
5. Remove engine block adapter (8) from engine block (9).



OIL LEVEL DIPSTICK, TUBE AND ADAPTER REPLACEMENT 0023 00

REMOVAL- CONTINUED

NOTE

Perform step 6 only if standoff bracket is damaged.

6. Remove lock nut (10), two washers (11), screw (12), and standoff bracket (7) from engine block (9). Discard lock nut.

INSTALLATION

NOTE

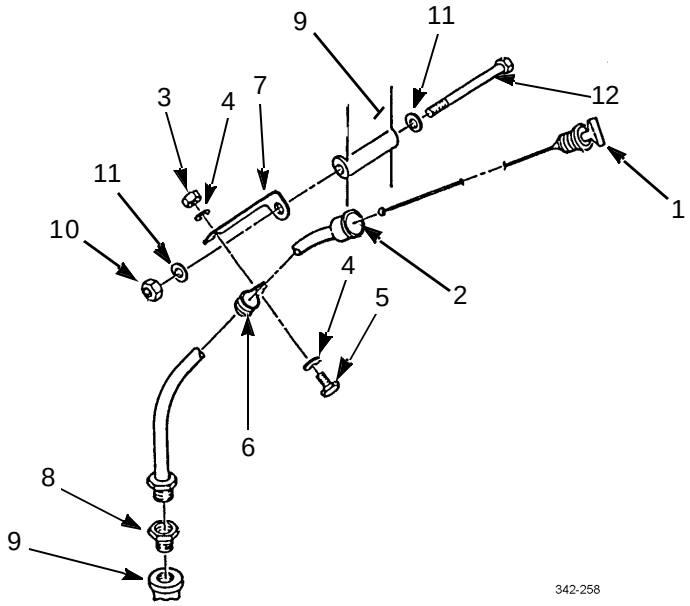
Perform step 1 only if standoff bracket was removed.

1. Install standoff bracket (7) on engine block (9) with two washers (11), screw (12), and new lock nut (10).

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

2. Lightly coat threads of engine block adapter (8) with pipe sealing compound. Install engine block adapter in engine block (9). Tighten engine block adapter to 168-216 lb-in (19-24 Nm).
3. Position cable clamp (6) on dipstick tube (2).
4. Install dipstick tube (2) on engine block adapter (8).
5. Install cable clamp (6) on standoff bracket (7) with screw (5), two washers (4), and new lock nut (3).
6. Insert oil level dipstick (1) into dipstick tube (2) and turn clockwise until locked.



7. Install transmission oil cooler (WP WP 0127 00).

END OF WORK PACKAGE

OIL FILTER ELEMENT REPLACEMENT 0024 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Wrench, strap (Item 42, WP 0236 00)

Materials/Parts

Element, full flow filter (P/N PF 2100) (2)

Oil, lubricating (Item 20, WP 0235 00)

Rags, wiping (Item 28, WP 0235 00)

References

TM 9-2320-302-10

REMOVAL

WARNING

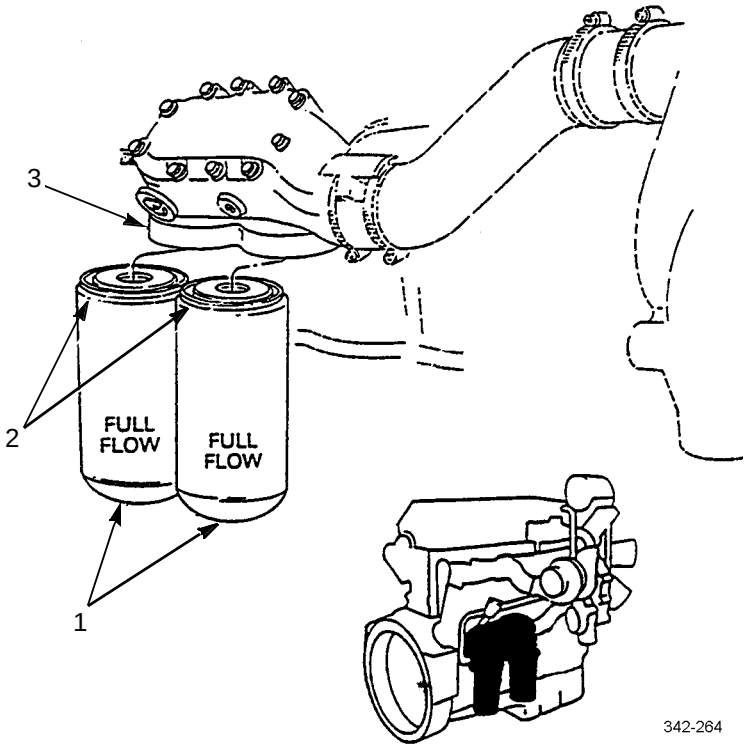
Hot oil can cause serious burns. Allow engine to cool before changing oil filter elements. Engine oil is very slippery. Immediately wipe up any spills. Failure to follow this warning may result in injury to personnel.

NOTE

Oil filter element replacement should be performed on a warm engine.

REMOVAL - CONTINUED

1. Place drain pan under two filter elements (1) to catch oil.
2. Remove two filter elements (1) with gaskets (2) from oil cooler adapter (3). Discard oil filter elements and gaskets.



INSTALLATION

1. Lightly coat two new gaskets (2) with clean lubricating oil.
2. Fill two new oil filter elements (1) with clean lubricating oil.

CAUTION

DO NOT use filter wrench for installation. Failure to follow this caution will result in damage to new filter.

3. Install oil filter elements (1) on oil cooler adapter (3) by hand until gaskets (2) touch oil cooler adapter.
4. Tighten oil filter elements (1) an additional 2/3 turn.
5. Operate engine and check for leaks (TM 9-2320-302-10).
6. Check oil level and add oil if required (TM 9-2320-302-10).

END OF WORK PACKAGE

OIL COOLER AND OIL FILTER ADAPTER MAINTENANCE 0025 00

THIS WORK PACKAGE COVERS

Removal, Disassembly, Assembly, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Gasket (P/N 23506247)

O-ring (P/N 8929289)

Retainer, packing (P/N 8929341) (3)

Seal, plain (P/N 23505902)

Materials/Parts - Continued

Compound, sealing, pipe (Item 10, WP 0235 00)

Oil, lubricating (Item 19, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Oil filters removed (WP 0024 00)

Radiator drained (WP 0041 00)

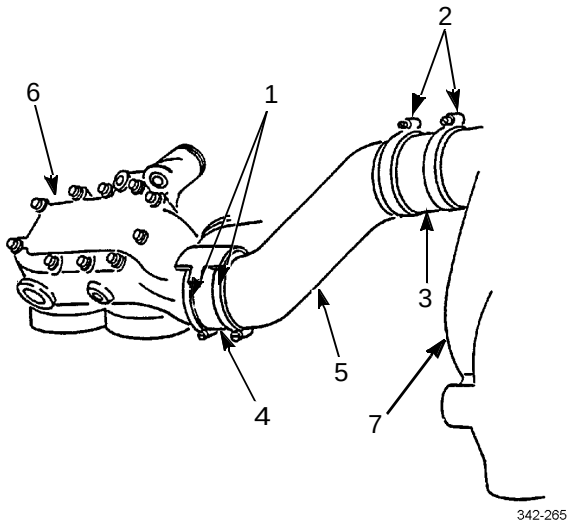
Exhaust pipe removed for access (WP 0040 00)

REMOVAL

NOTE

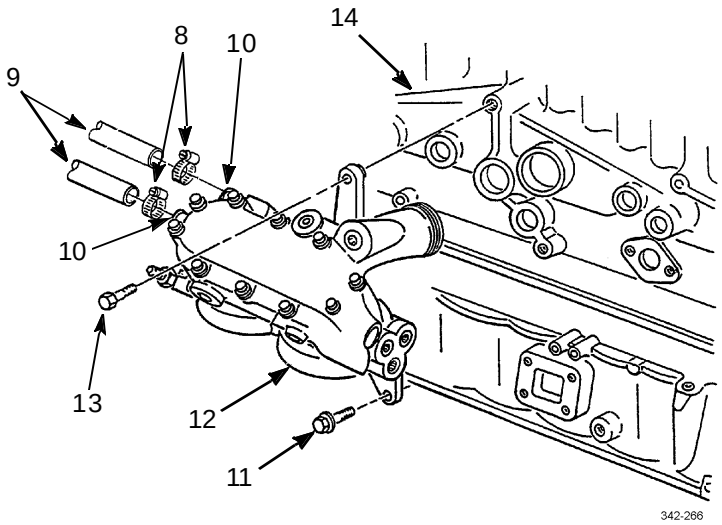
Oil cooler and oil filter adapter are removed and replaced as a single unit.

1. Loosen four hose clamps (1 and 2) and remove two inlet hoses (3 and 4) and coolant pipe (5) from oil cooler (6) and water pump (7).



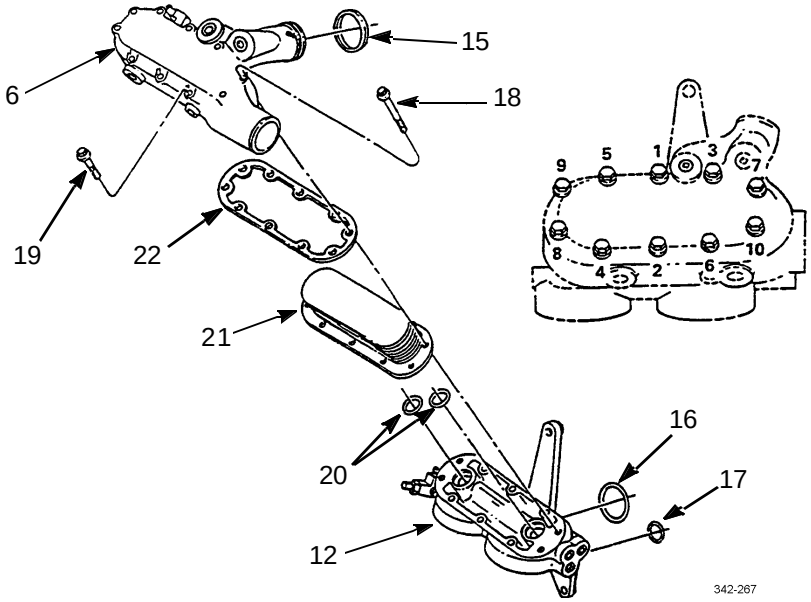
REMOVAL - CONTINUED

2. Loosen two hose clamps (8) and remove two hoses (9) from hose fittings (10).
3. Remove three mounting bolts (11), bolt (13), and oil filter adapter (12) from engine block (14).



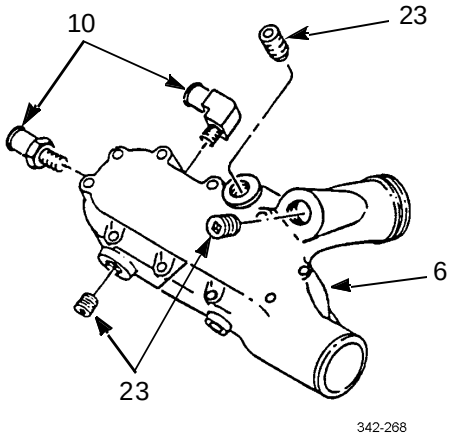
DISASSEMBLY

1. Remove seal ring (15) from oil cooler (6). Discard seal ring.
2. Remove o-ring (16) and retainer packing (17) from oil filter adapter (12). Discard o-ring and retainer packing.
3. Remove seven long bolts (18), three short bolts (19), and oil cooler (6) from oil filter adapter (12).

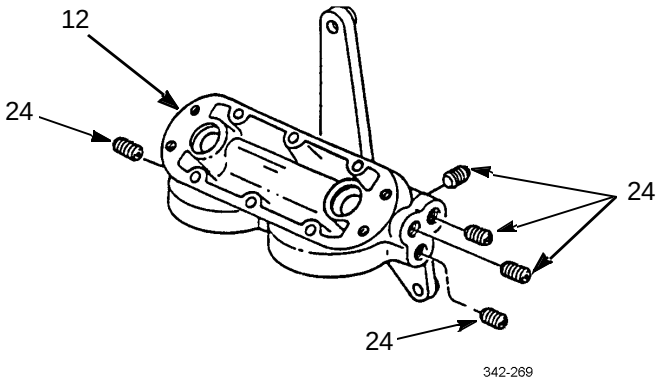


DISASSEMBLY - CONTINUED

4. Remove two retainer packings (20) from oil filter adapter (12). Discard retainer packings.
5. Remove core (21) and gasket (22) from oil cooler (6). Discard gasket.
6. Remove three pipe plugs (23) and two hose fittings (10) from oil cooler (6).



7. Remove five pipe plugs (24) from oil filter adapter (12).



ASSEMBLY

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of five pipe plugs (24) with pipe sealing compound. Install pipe plugs in oil filter adapter (12).

ASSEMBLY - CONTINUED

2. Lightly coat threads of two hose fittings (10) and three pipe plugs (23) with pipe sealing compound. Install hose fittings and pipe plugs in oil cooler (6).

3. Lightly coat two retainer packings (20) with lubricating oil. Install retainer packings in oil filter adapter (12).

CAUTION

Ensure that all old gasket material is removed from core and oil cooler mating surfaces. Failure to follow this caution could result in damage to engine.

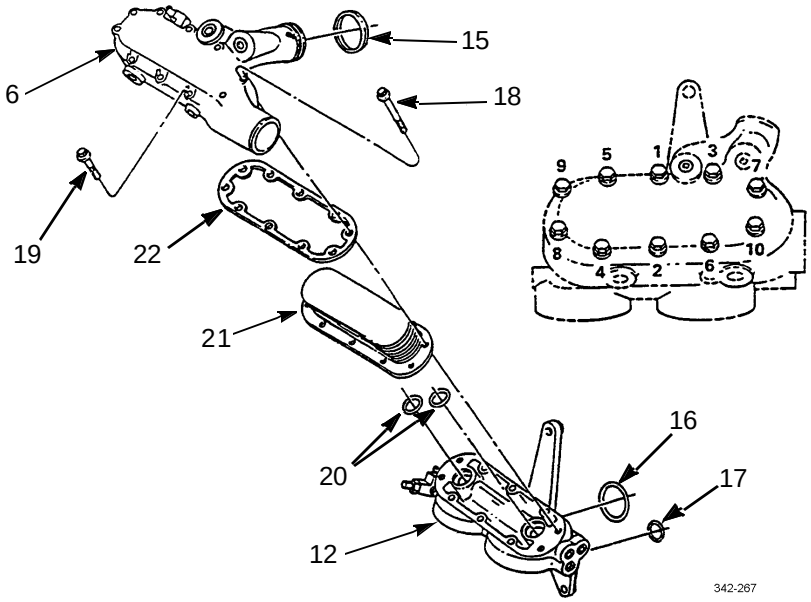
4. Install new gasket (22) and core (21) in oil cooler (6).

CAUTION

Ensure retainer packings are not dislodged when installing oil cooler on oil filter adapter. Failure to follow this could result in damage to engine.

5. Install oil cooler (6) on oil filter adapter (12) with seven long bolts (18) and three short bolts (19). Hand tighten bolts to secure oil cooler (6) to oil filter adapter (12).

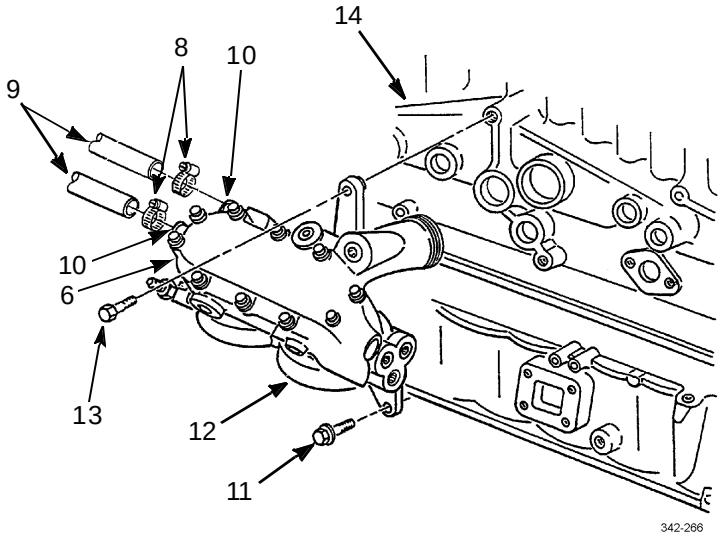
6. Torque seven long bolts (18) and three short bolts (19) to 22-28 lb-ft (30-38 Nm) in sequence shown.



7. Lightly coat new seal ring (15) with clean lubricating oil. Install seal ring on oil cooler (6).

8. Lightly coat new o-ring (16) and new retainer packing (17) with clean lubricating oil. Install o-ring and retainer packing on oil filter adapter (12).

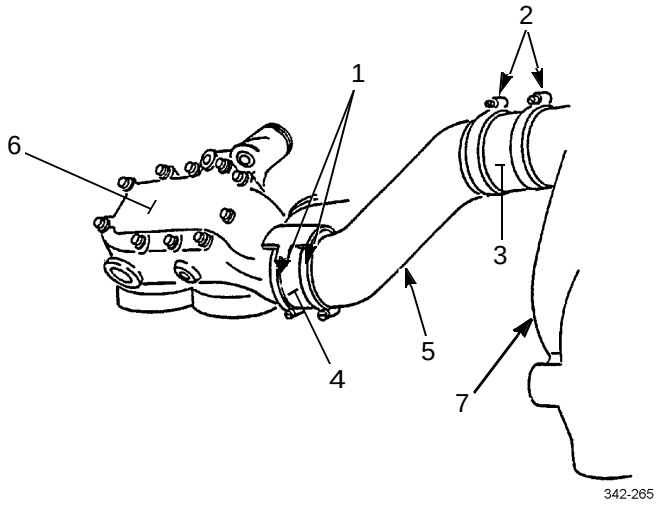
INSTALLATION



NOTE

It may be necessary to tap neck of oil cooler housing with plastic or fiber mallet to force seal ring (15) into engine block opening.

1. Install oil cooler (6) on engine block (14) with bolt (13) and three bolts (11). Torque bolts to 43-54 lb-ft (58-73 Nm).
2. Install two hoses (9) on hose fittings (10) with two hose clamps (8).
3. Install coolant pipe (5) and two inlet hoses (3 and 4) on oil cooler (6) and water pump (7) with four clamps (1 and 2).



INSTALLATION - CONTINUED

4. Install exhaust pipe (WP 0040 00).
5. Fill radiator and cooling system (WP 0041 00).
6. Install oil filters (WP 0024 00).

END OF WORK PACKAGE

OIL SAMPLE VALVES REPLACEMENT 0026 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Nut, self-locking (P/N MS51922-33)

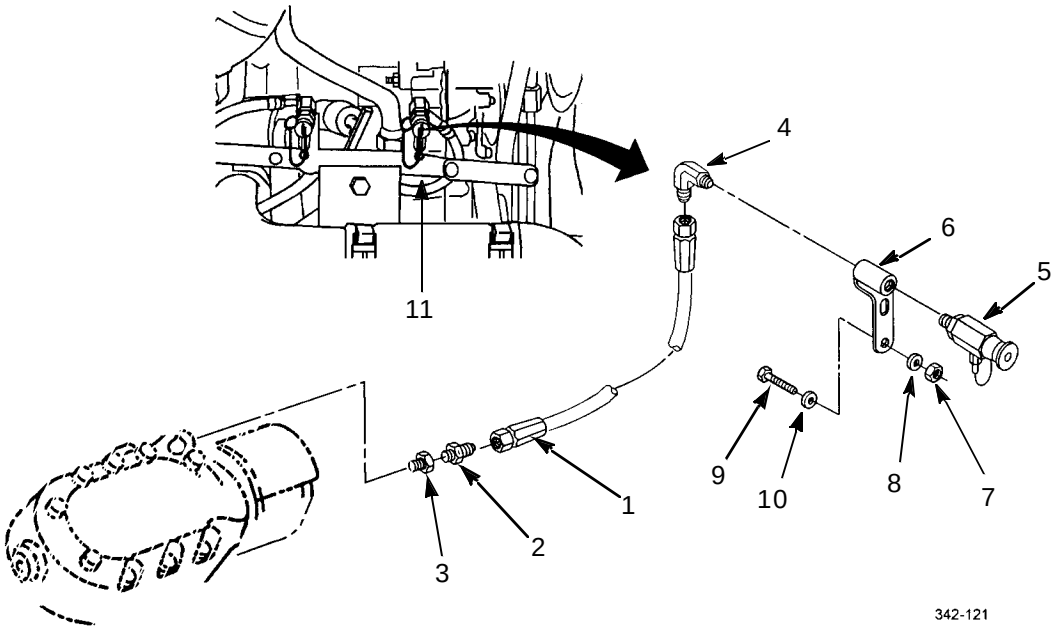
Compound, sealing, pipe (Item 10, WP 0235 00)

NOTE

Engine and transmission oil sample valves are replaced the same way. Engine oil sample valve is illustrated.

REMOVAL

1. Disconnect hose (1) from connector (2).
2. Remove connector (2) and bushing (3) from oil cooler.
3. Remove hose (1) from elbow (4).
4. Remove elbow (4) and sample valve (5) from bracket (6).
5. Remove lock nut (7), washer (8), screw (9), washer (10), and bracket (6) from mounting bracket (11). Discard lock nut.



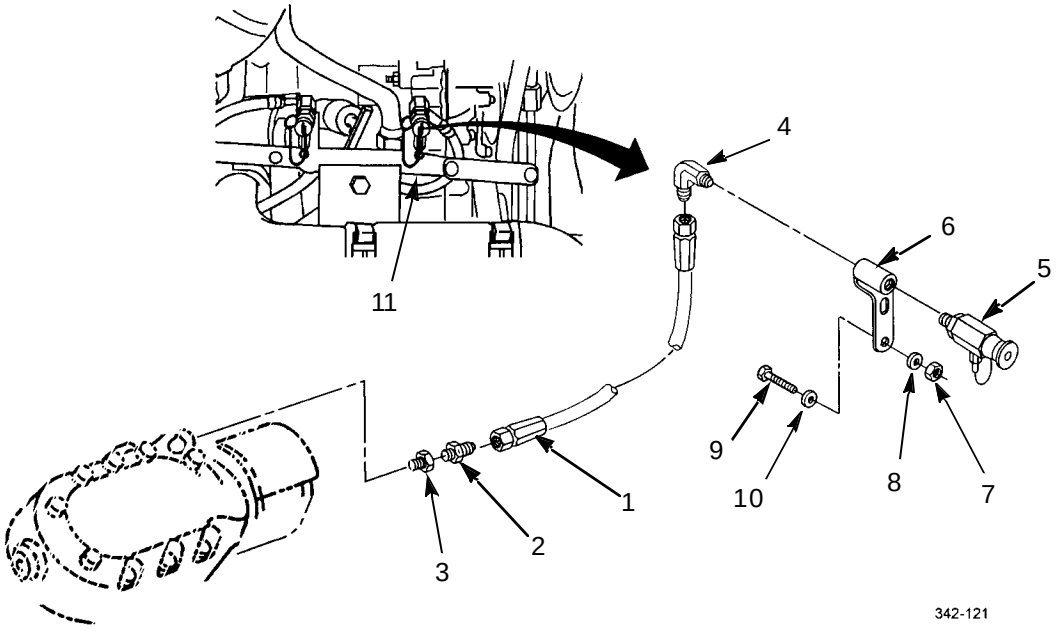
INSTALLATION

1. Install bracket (6) on mounting bracket (11) with washer (10), screw (9), washer (8), and new lock nut (7).

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

2. Lightly coat threads of sample valve (5) and elbow (4) with pipe sealing compound. Install sample valve and elbow on bracket (6).
3. Connect hose (1) to elbow (4).
4. Lightly coat threads of bushing (3) and connector (2) with pipe sealing compound. Install bushing and connector on oil cooler.
5. Connect hose (1) to connector (2).



END OF WORK PACKAGE

AIR COMPRESSOR DISCHARGE HOSE REPLACEMENT 0027 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1)

References

TM 9-2320-302-10

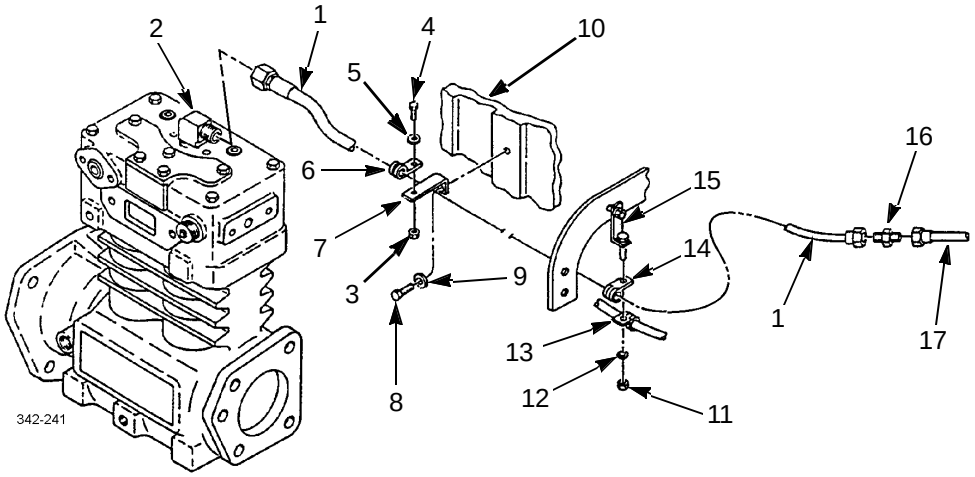
Equipment Condition

Air system drained (TM 9-2320-302-10)

Transmission tunnel access cover removed (WP 0207 00)

REMOVAL

1. Remove discharge hose (1) from air compressor elbow fitting (2).
2. Remove lock nut (3), screw (4), washer (5), and clamp (6) from mounting bracket (7). Discard lock nut.
3. Remove screw (8), washer (9), and mounting bracket (7) from engine block (10).
4. Remove nut (11), washer (12), and two hose clamps (13) and (14) from standoff bracket (15)
5. Reinstall hose clamp (13) on standoff bracket (15) with washer (12) and nut (11).



NOTE

Discharge hose from compressor to air dryer is routed in a continuous downward slope to prevent collection of moisture in line. Hose clamps, secured to standoff mounting brackets at 12-20 in (30-51 cm) intervals, are used to secure compressor discharge hose and other hoses in place. Replace damaged standoff bracket as required.

6. Remove discharge hose (1) and inline fitting (16) from air dryer hose (17).

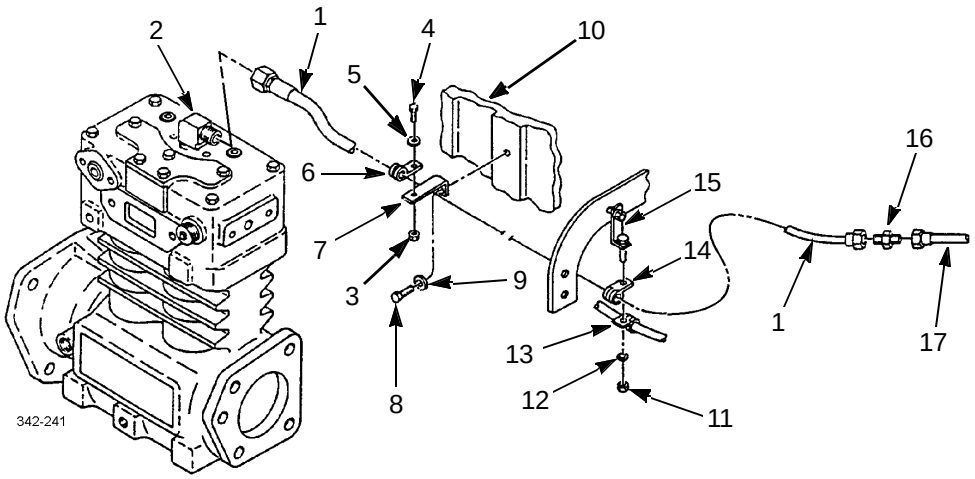
INSTALLATION

1. Install inline fitting (16) and discharge hose (1) on air dryer hose (17).

NOTE

Replace defective or damaged hose clamps and standoff mounting brackets as necessary to ensure discharge hose maintains a downward slope from compressor to air dryer.

2. Remove nut (11), washer (12), and hose clamp (13) from standoff bracket (15).
3. Install two hose clamps (13 and 14) on standoff bracket (15) with washer (12) and nut (11).
4. Install mounting bracket (7) on engine block (10) with washer (9) and screw (8).
5. Install hose clamp (6), with discharge hose (1) attached, on mounting bracket (7) with washer (5), screw (4), and new locknut (3).
6. Install air compressor discharge hose (1) on air compressor elbow fitting (2).



7. Start vehicle and allow air pressure to build (TM 9-2320-302-10). Check system for air leaks.
8. Install transmission tunnel access cover (WP 0207 00).

END OF WORK PACKAGE

AIR COMPRESSOR GOVERNOR REPLACEMENT AND ADJUSTMENT 0028 00

THIS WORK PACKAGE COVERS

Removal, Installation, Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Washer, lock (P/N MS35333-41) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Rags, wiping (Item 28, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

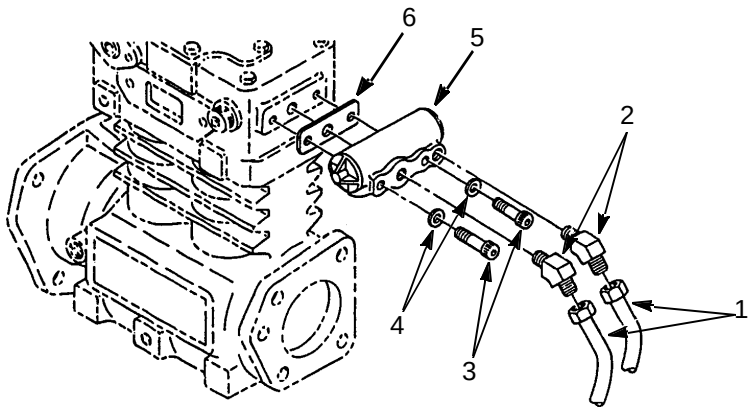
Air system drained (TM 9-2320-302-10)

REMOVAL

NOTE

Tag lines to an aid in installation.

1. Remove two lines (1) from elbows (2).
2. Remove two screws (3), lock washers (4), governor (5), and gasket (6) from air compressor. Discard lock washers.
3. Remove two elbows (2) from governor (5).

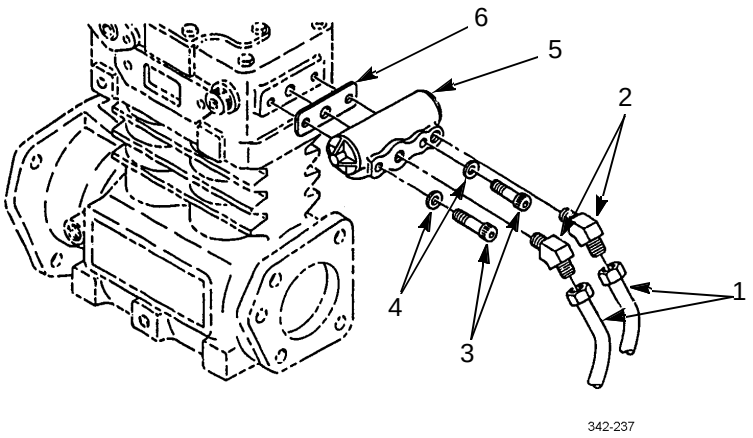


INSTALLATION

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure that all airlines and fittings are free of debris and excess pipe sealing compound does not enter airlines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

1. Lightly coat threads of two elbows (2) with pipe sealing compound. Install elbows in governor (5).
2. Install new gasket (6) and governor (5) on compressor with two new lock washers (4) and screws (3).
3. Install two air lines (1) on elbows (2).



NOTE

Perform step 4 through 6 to verify correct operation of air compressor and governor.

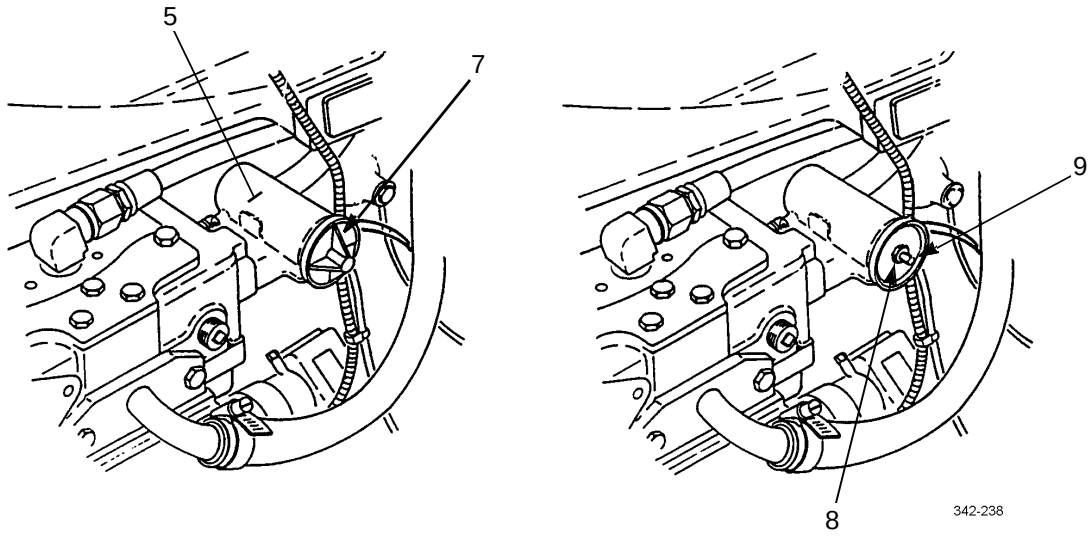
4. Start vehicle (TM 9-2320-302-10). Check for air leaks.
5. Check air pressure gages when governor cuts out, stopping compression of air by compressor. Cut-out pressure should be 115-120 psi (793-827 kPa).
6. With engine running, make a series of brake applications to reduce air pressure. Observe air pressure gages when governor cuts in compressor. Cut-in pressure should be 95-100 psi (655-690 kPa).

NOTE

Air pressure operating range is 90-120 psi (621-827 kPa). If air pressure gages do not indicate within operating range, governor requires adjustment.

ADJUSTMENT

1. Remove cover (7) from governor (5).
2. Loosen adjusting screw lock nut (8).



NOTE

Pressure range between compressor cut-in and cut-out is not adjustable. To raise pressure settings, turn adjusting screw counterclockwise. To lower pressure settings, turn adjusting screw clockwise.

3. While assistant monitors primary pressure gage, turn adjusting screw (9) until proper cut-out pressure is obtained. When proper pressure is reached, tighten adjusting screw lock nut (8).
4. Install cover (7) on governor (5).

END OF WORK PACKAGE

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AIR COMPRESSOR REPLACEMENT 0029 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, box (Item 41, WP 0236 00)

Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Gasket (P/N 5110410)

Gasket (P/N 8929299)

Washer, lock (P/N MS35338-45) (2)

Materials/Parts - Continued

Compound, sealing, pipe (Item 10, WP 0235 00)

Grease, GAA (Item 15, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

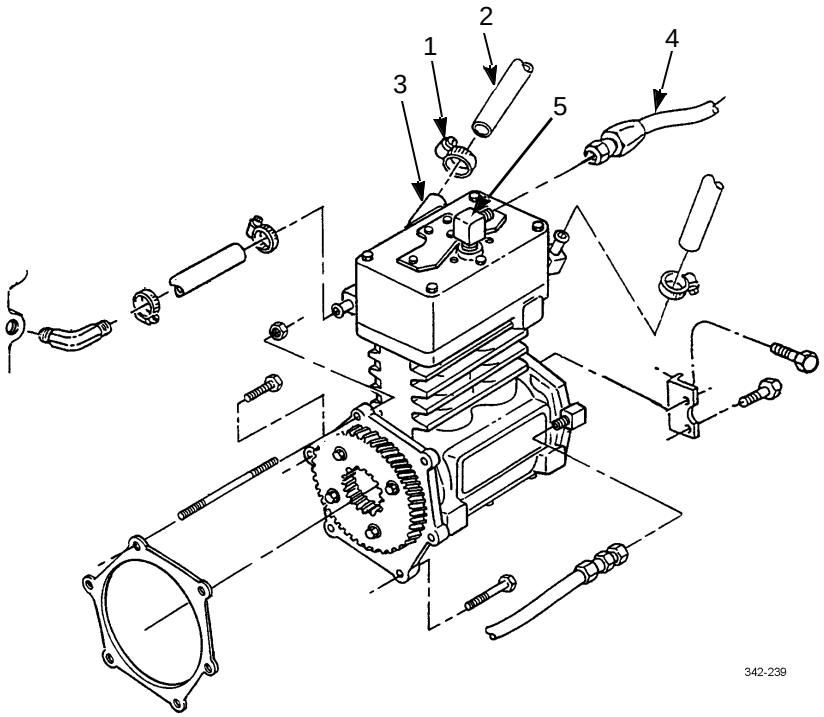
Cooling system drained (WP 0041 00)

Fuel pump removed (WP 0034 00)

Air compressor governor removed (WP 0028 00)

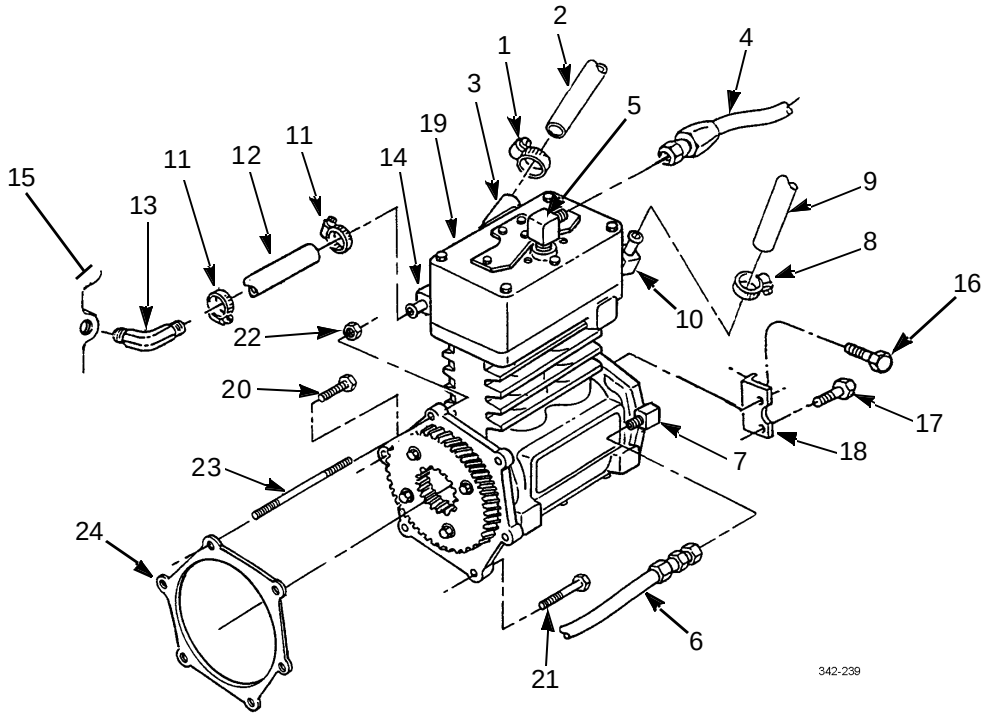
REMOVAL

1. Loosen hose clamp (1) and remove air inlet hose (2) from pipe flange (3).
2. Remove air supply hose (4) from elbow (5).



REMOVAL - CONTINUED

3. Remove oil supply hose (6) from elbow (7).
4. Loosen hose clamp (8) and remove coolant outlet hose (9) from elbow (10).
5. Loosen two hose clamps (11) and remove coolant inlet hose (12) from elbows (13 and 14).
6. Remove elbow (13) from engine block (15).
7. Remove two bolts (16), bolts (17), and support bracket (18) form air compressor (19).
8. Remove bolt (20) and four bolts (21) from air compressor (19).

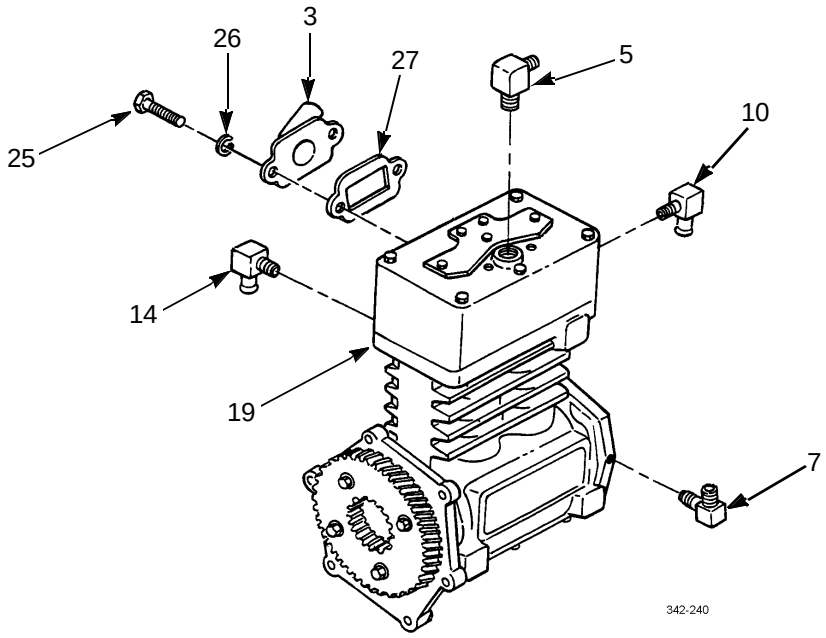


WARNING

Air compressor is heavy. Use caution during removal to prevent injury to personnel.

9. With assistance, support air compressor (19) and remove nut (22) from threaded stud (23).
10. Remove air compressor (19) and gasket (24) by sliding air compressor rearward off of threaded stud (23). Discard gasket.
11. Remove four elbows (5, 7, 10, and 14) from air compressor (19).
12. Remove two bolts (25), lock washers (26), pipe flange (3), and gasket (27) from air compressor (19). Discard lock washers and gasket.

REMOVAL - CONTINUED



INSTALLATION

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure that all airlines and fittings are free of debris and excess pipe sealing compound does not enter airlines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

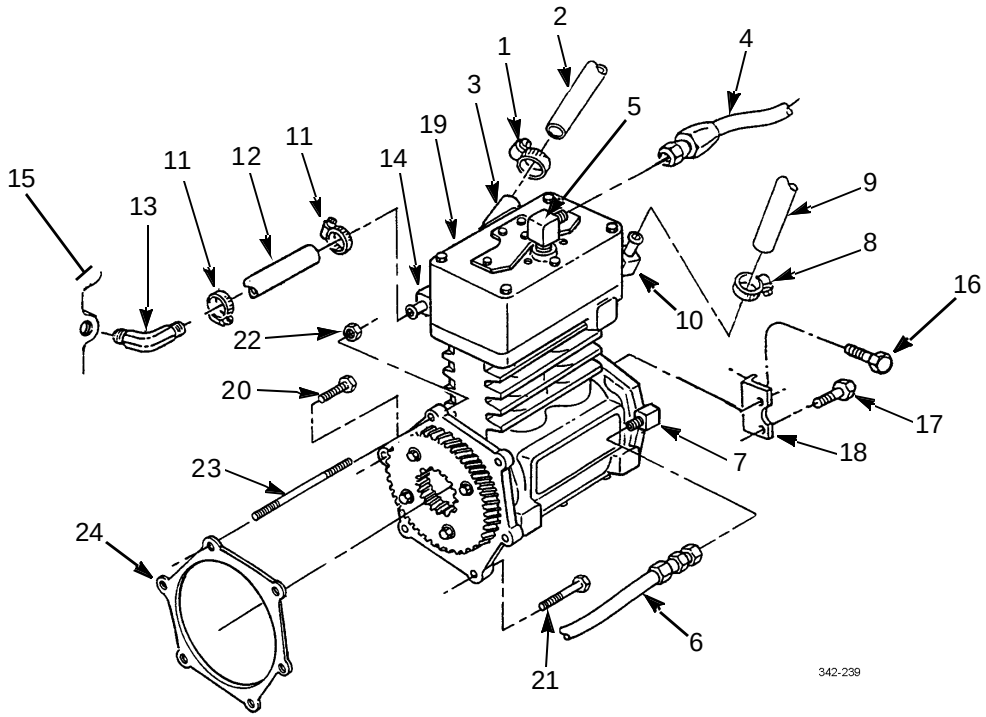
1. Lightly coat pipe threads of elbows (5, 7, 10, and 14) with pipe sealing compound. Install elbows on air compressor (19).
2. Install new gasket (27) and pipe flange (3) on air compressor (19) with two new lock washers (26) and bolts (25). Torque bolts to 156-204 lb-in (18-23 Nm).
3. Apply a light coat of grease to bolt hole locations on new gasket (24). Install gasket on air compressor (19).

INSTALLATION - CONTINUED

WARNING

Air compressor is heavy. Use caution during installation to prevent injury to personnel.

4. Slide air compressor (19) over threaded stud (23) and install nut (22). Hand tighten nut.
5. Install four bolts (21) and one bolt (20) on air compressor (19). Hand tighten bolts.
6. Torque nut (22), four bolts (21), and bolt (20) to 75-93 lb-ft (101-126 Nm).
7. Install support bracket (18) on air compressor (19) with two bolts (16). Hand tighten bolts.
8. Install two bolts (17) and torque to 43-45 lb-ft (58-73 Nm).
9. Torque two bolts (16) to 156-204 lb-in (18-23 Nm).
10. Install elbow (13) on engine block (15).
11. Slide two hose clamps (11) on coolant inlet hose (12) and position coolant inlet hose on elbows (13 and 14).
12. Slide one hose clamp (11) to each end of coolant inlet hose (12) and tighten.
13. Install oil supply hose (6) on elbow (7).
14. Slide hose clamp (8) on coolant outlet hose (9) and install coolant outlet hose on elbow (10). Tighten hose clamp.
15. Slide hose clamp (1) on air inlet hose (2) and install air inlet hose on pipe flange (3). Tighten hose clamp.
16. Install air supply hose (4) on elbow (5).



INSTALLATION - CONTINUED

17. Install air compressor governor (WP 0028 00).
18. Install fuel pump (WP 0034 00).
19. Fill cooling system (WP 0041 00).

END OF WORK PACKAGE

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FUEL HOSES AND FITTINGS REPLACEMENT 0030 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-09336-006)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Transmission tunnel access cover removed (WP 0207 00)

WARNING

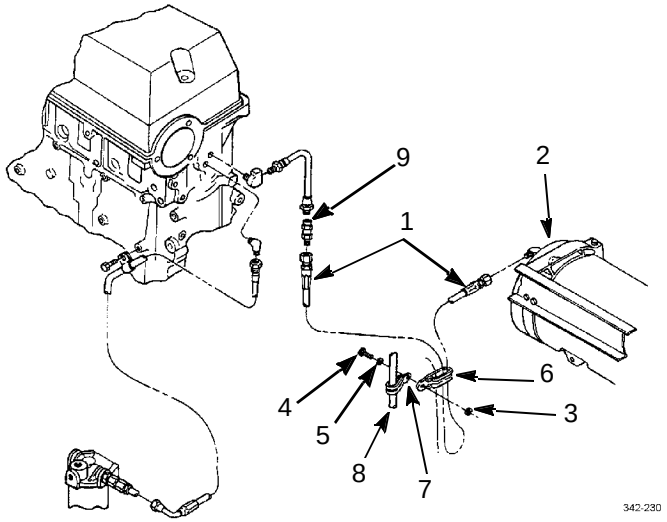
DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel and damage to vehicle.

REMOVAL

NOTE

- Ensure that drain pan is positioned to catch fuel from fuel hoses. Ensure that all spills are cleaned up.
- Tag all fuel lines and hoses to aid in installation.

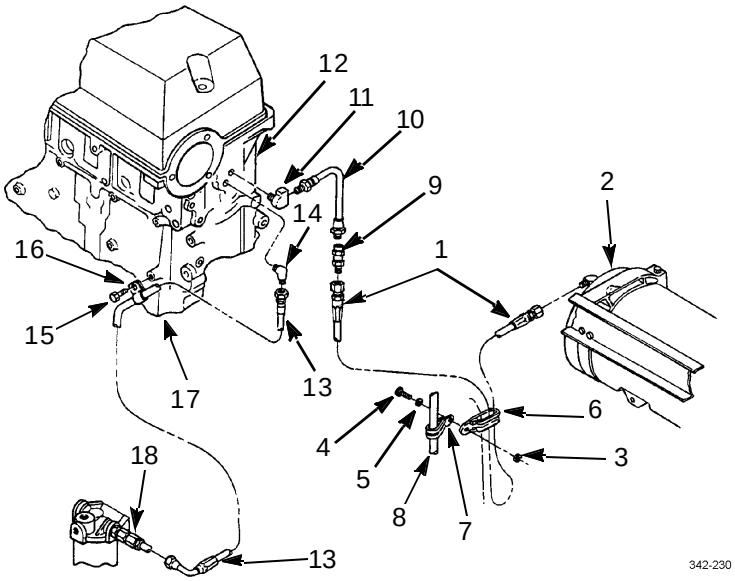
1. Remove fuel hose (1) from fuel tank (2).
2. Remove lock nut (3), screw (4), washer (5), clamp (6), and clamp (7) from transmission dipstick tube (8). Discard lock nut.
3. Remove fuel hose (1) from check valve (9).



CAUTION

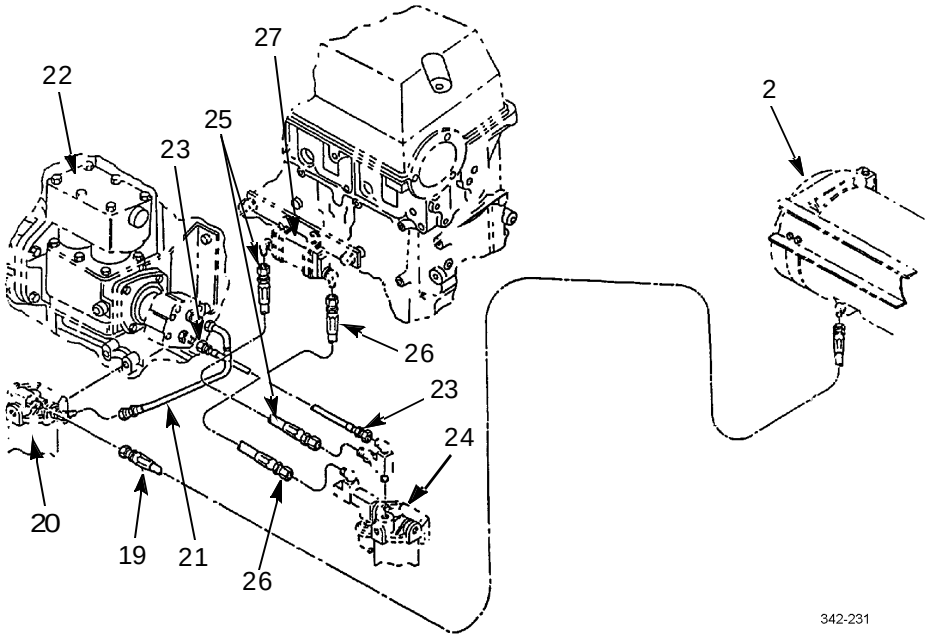
Elbow is a special orifice and should be handled carefully. Failure to follow this caution may result in damage to equipment.

4. Remove fuel line (10) and special elbow (11) from cylinder head (12).
5. Remove check valve (9) from fuel line (10).
6. Disconnect fuel hose (13) and elbow (14) from cylinder head (12).



7. Remove screw (15) and clamp (16) from engine block (17).
8. Remove fuel hose (13) from check valve (18).
9. Remove fuel hose (19) from fuel tank (2) and from primary fuel filter (20).
10. Remove fuel hose (21) from primary fuel filter (20) and fuel pump (22).
11. Remove fuel hose (23) from fuel pump (22) and secondary fuel filter (24).
12. Disconnect fuel hoses (25 and 26) from fuel pressure sensor (27) and secondary fuel filter (24).

REMOVAL - CONTINUED



INSTALLATION

1. Install fuel hoses (25 and 26) on secondary fuel filter (24) and fuel pressure sensor (27).
2. Install fuel hose (23) to secondary fuel filter (24) and fuel pump (22).
3. Install fuel hose (21) to fuel pump (22) and primary fuel filter (20).
4. Install fuel hose (19) to primary fuel filter (20) and fuel tank (2).
5. Install fuel hose (13) on check valve (18).
6. Install fuel hose (13) to engine block (17) with clamp (16) and screw (15).

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

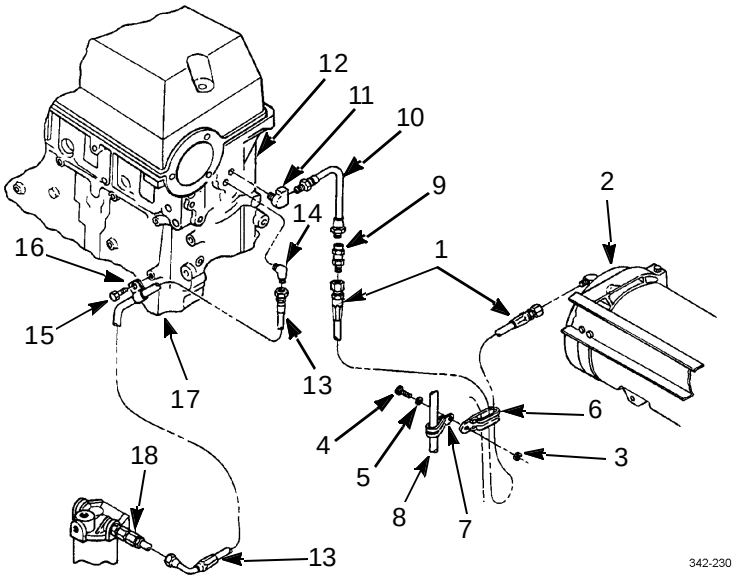
7. Lightly coat threads of elbow (14) with pipe sealing compound. Install elbow on cylinder head (12).
8. Install fuel hose (13) on elbow (14).
9. Install check valve (9) on fuel line (10).

INSTALLATION - CONTINUED

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

10. Lightly coat threads of special elbow (11) and fuel line (10) with pipe sealing compound. Install special elbow and fuel line on cylinder head (12).
11. Install fuel hose (1) on check valve (9).
12. Install fuel hoses (1 and 19) on transmission dipstick tube (8) with clamps (6 and 7), washer (5), screw (4), and new lock nut (3).
13. Install fuel hose (1) on fuel tank (2).



14. Install transmission tunnel access cover (WP 0207 00).
15. Prime fuel system (TM 9-2320-302-10).

END OF WORK PACKAGE

FUEL STRAINER AND FILTER ELEMENT REPLACEMENT 0031 00

THIS WORK PACKAGE COVERS

Fuel Strainer Element Removal, Fuel Filter Element Removal, Fuel Filter Element Installation, Fuel Strainer Element Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Element, strainer (P/N OEM R60P)

Element, Filter (P/N TP916)

Materials/Parts - Continued

Fuel, diesel (Item 14, WP 0235 00)

Oil, lubricating (Item 19, WP 0235 00)

References

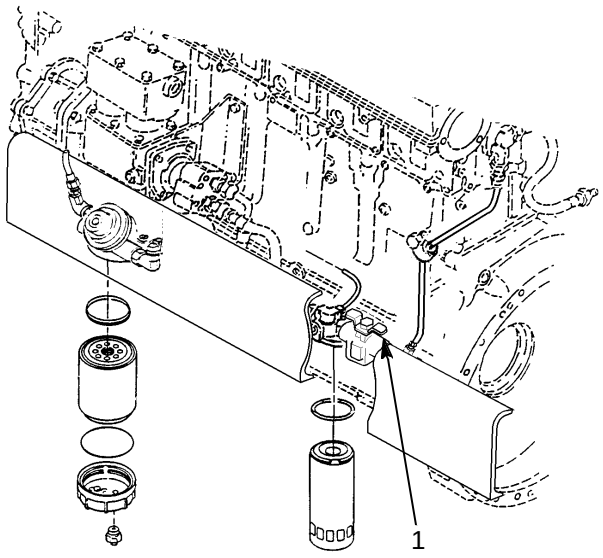
TM 9-2320-302-10

FUEL STRAINER ELEMENT REMOVAL

1. Turn fuel shut-off valve (1) to OFF position.

WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel and damage to equipment.



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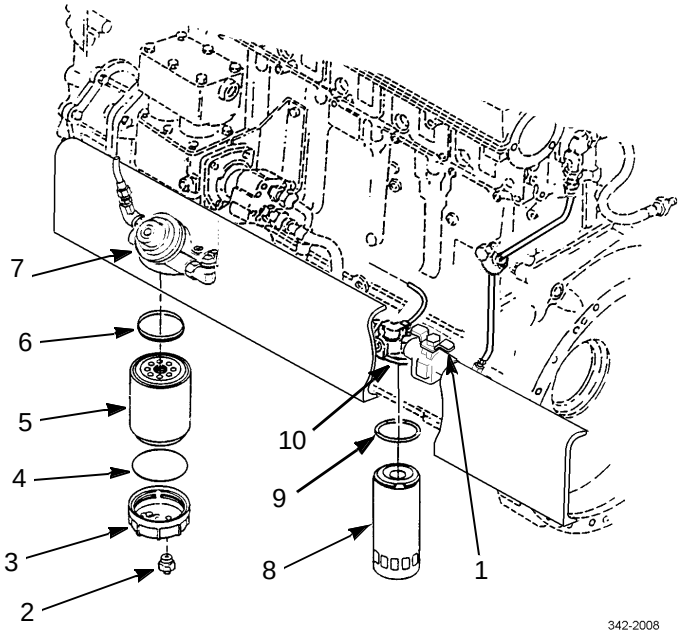
FUEL STRAINER ELEMENT REMOVAL - CONTINUED

NOTE

Ensure that drain pan is positioned to catch fuel. Ensure that all spills are cleaned up.

2. Remove plug (2) from sediment bowl (3) and allow fuel to drain.
3. Remove sediment bowl (3) and gasket (4) from strainer element (5).
4. Remove strainer element (5) and gasket (6) from adapter (7). Discard strainer element and gasket.



FUEL FILTER ELEMENT REMOVAL

1. Turn fuel shut-off valve (1) to OFF position.

WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel and damage to equipment.

2. Remove filter element (8) and gasket (9) from adapter (10). Discard filter element and gasket.

FUEL FILTER ELEMENT INSTALLATION

1. Lightly coat new gasket (9) with lubricating oil. Set gasket aside.
2. Fill filter element (8) 2/3 full with clean diesel fuel.
3. Install new gasket (9) and filter element (8) on adapter (10) until gasket just contacts adapter.
4. Tighten filter element (8) by hand additional 1/2 turn.

FUEL STRAINER ELEMENT INSTALLATION

1. Lightly coat new gasket (6) with lubricating oil. Set gasket aside.
2. Install gasket (4) and plug (2) on sediment bowl (3).
3. Install sediment bowl (3) on new strainer element (5).
4. Fill strainer element (5) 2/3 full with clean diesel fuel.
5. Install gasket (6) and strainer element (5) on adapter (7) until gasket just contacts adapter.
6. Tighten strainer element (5) by hand an additional 1/2 turn.
7. Turn fuel shut-off valve (1) to ON position.
8. Prime fuel system (TM 9-2320-302-10).

END OF WORK PACKAGE

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FUEL FILTER ADAPTERS REPLACEMENT 0032 00

THIS WORK PACKAGE COVERS

Fuel Strainer Adapter Removal, Fuel Filter Adapter Removal, Fuel Filter Adapter Installation, Fuel Strainer Adapter Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Fuel strainer and filter elements removed (WP 0031 00)

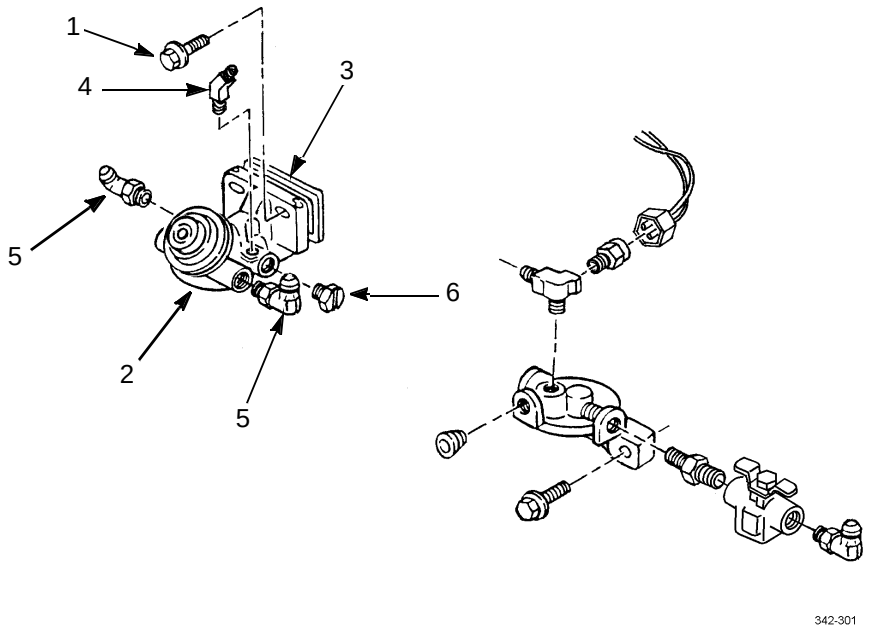
Fuel hoses and fittings removed (WP 0030 00)

FUEL STRAINER ADAPTER REMOVAL

WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel and damage to equipment.

1. Remove two screws (1), fuel strainer adapter (2), and spacer plate (3) from left side of engine.
2. Remove elbow (4), two elbows (5), and plug (6) from fuel strainer adapter (2).

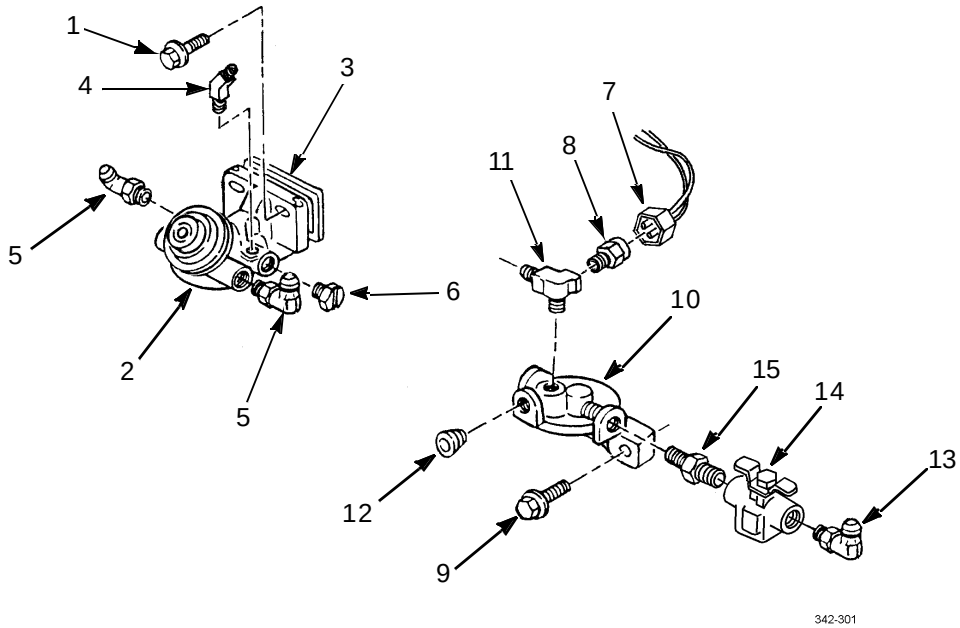


FUEL FILTER ADAPTER REMOVAL

WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. Remove engine wiring harness connector (7) from fuel pressure sensor (8).
2. Remove two screws (9) and fuel filter adapter (10) from left side of engine.
3. Remove fuel pressure sensor (8), pipe tee (11), and pipe plug (12) from fuel filter adapter (10).
4. Remove elbow (13), fuel shut-off valve (14), and connector (15) from fuel filter adapter (10).



FUEL FILTER ADAPTER INSTALLATION

1. Install connector (15), fuel shut-off valve (14), and elbow (13) on fuel filter adapter (10).
2. Install pipe plug (12), pipe tee (11), and fuel pressure sensor (8) on fuel filter adapter (10).
3. Install fuel filter adapter (10) on left side of engine with two screws (9).
4. Install engine wiring harness connector (7) on fuel pressure sensor (8).
5. Install fuel hoses and fittings (WP 0030 00).
6. Install fuel filter element (WP 0031 00).

FUEL STRAINER ADAPTER INSTALLATION

1. Install plug (6), two elbows (5), and elbow (4) on fuel strainer adapter (2).
2. Install spacer plate (3) and fuel strainer adapter (2) on left side of engine with two screws (1).

NOTE

Perform following steps if one or both adapters were replaced.

3. Install fuel hoses and fittings (WP 0030 00).
4. Install fuel strainer element (WP 0031 00).

END OF WORK PACKAGE

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FUEL TANK AND MOUNTING BRACKETS REPLACEMENT 0033 00

THIS WORK PACKAGE COVERS

Fuel Tank Removal, Mounting Bracket Removal, Mounting Bracket Installation, Fuel Tank Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Pin, cotter (P/N MS24665-387) (2)

Rags, wiping (Item 28, WP 0235 00)

Personnel Required

Two

Equipment Condition

Right step removed (WP 0171 00)

Fuel level sending unit removed (WP 0094 00)

FUEL TANK REMOVAL

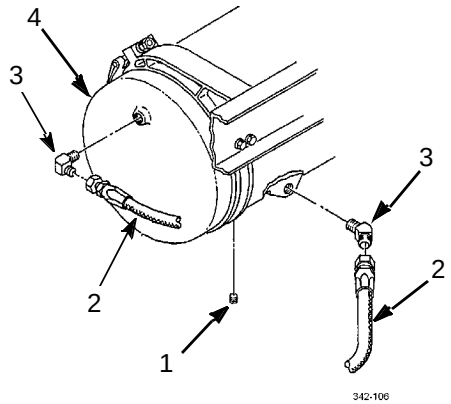
WARNING

- DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel and damage to equipment.
- Fuel vapors are toxic. Avoid prolonged exposure or breathing of fumes. Work in a well-ventilated area. Failure to follow this warning could result in serious injury to personnel.

NOTE

Ensure that drain pan is positioned to catch fuel. Ensure that all spills are cleaned up.

1. Remove plug (1) and allow fuel to drain.
2. Remove two fuel hoses (2) and elbows (3) from fuel tank (4).

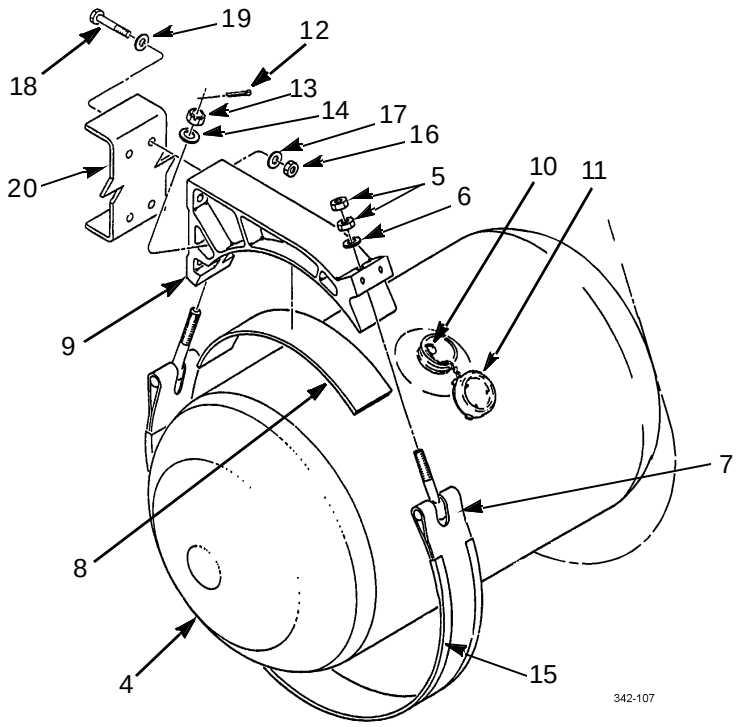


FUEL TANK REMOVAL - CONTINUED

NOTE

Perform step 3 for each strap.

3. With assistance, support fuel tank (4) and remove two nuts (5) and washer (6). Loosen strap (7) and remove bracket insulator (8) from fuel tank (4).
4. Move two straps (7) aside and remove fuel tank (4) from mounting brackets (9).
5. Compress spring clip (10) and remove filler cap (11).



MOUNTING BRACKET REMOVAL

1. Remove two cotter pins (12), nuts (13), washers (14), and straps (7) from two mounting brackets (9). Discard cotter pins.
2. Remove two insulators (15) from straps (7).
3. Remove eight nuts (16), washers (17), screws (18), washers (19), and two mounting brackets (14) from frame rail (20).

MOUNTING BRACKET INSTALLATION

1. Install two brackets (14) on frame rail (20) with eight washers (19), screws (18), washers (17), and nuts (16).
2. Install two insulators (15) on straps (7).

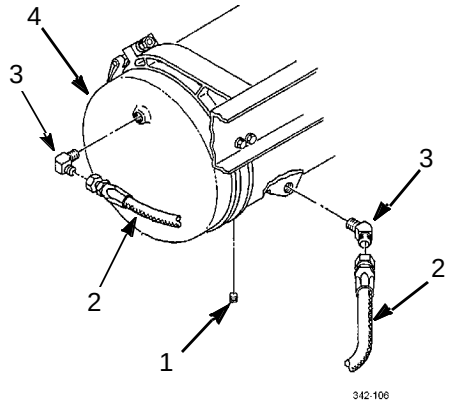
NOTE

Perform step 3 at far end of each bracket.

3. Install two straps (7) on mounting brackets (9) with washer (14), nut (13), and new cotter pin (12).

FUEL TANK INSTALLATION

1. Install filler cap (11) on fuel tank (4) with spring clip (10).
2. With assistance, position fuel tank (4) on two mounting brackets (9) and straps (7). Position ends of straps through brackets.
3. Install two bracket insulators (8) on straps (7) with two washers (6) and four nuts (5).
4. Install two elbows (3) and hoses (2) on fuel tank (4).
5. Install plug (1) on fuel tank (4).



6. Install fuel level sending unit (WP 0094 00).
7. Install right step (WP 0171 00).

END OF WORK PACKAGE

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FUEL PUMP REPLACEMENT 0034 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Gasket (P/N 23505248)

Rags, wiping (Item 28, WP 0235 00)

References

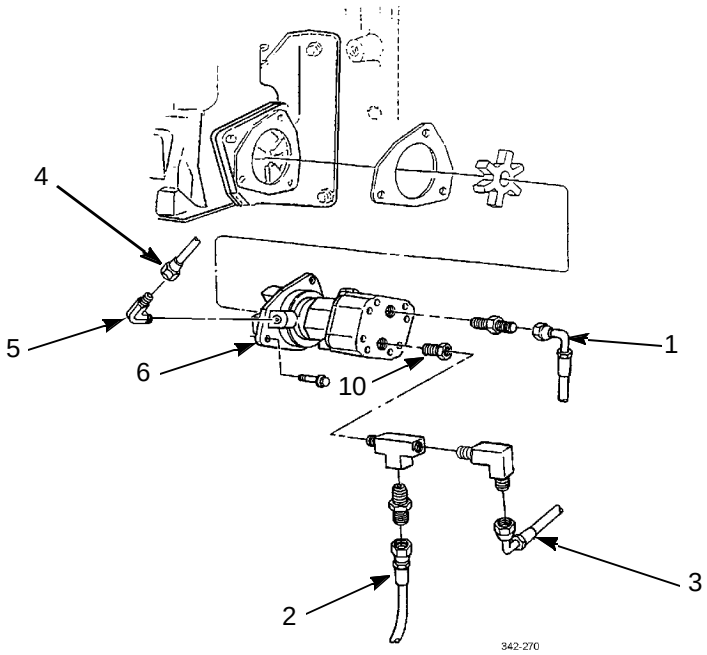
TM 9-2320-302-10

REMOVAL

WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. Disconnect fuel inlet line (1).
2. Disconnect fuel pump-to-secondary fuel filter line (2).
3. Disconnect fuel pump-to-fuel water separator line (3).
4. Disconnect fuel pump lubrication line (4).
5. Remove elbow (5) from lubrication port of fuel pump (6).



FUEL PUMP REPLACEMENT - CONTINUED **0034 00**

REMOVAL - CONTINUED

6. Remove elbow (7), adapter (8), tee (9), and bushing (10) from outlet port of fuel pump (6).
7. Remove adapter (11) from inlet port of fuel pump (6).
8. Remove three bolts (12) securing fuel pump (6) to air compressor (13).
9. Remove fuel pump (6), drive coupling (14), and gasket (15). Discard gasket.

INSTALLATION

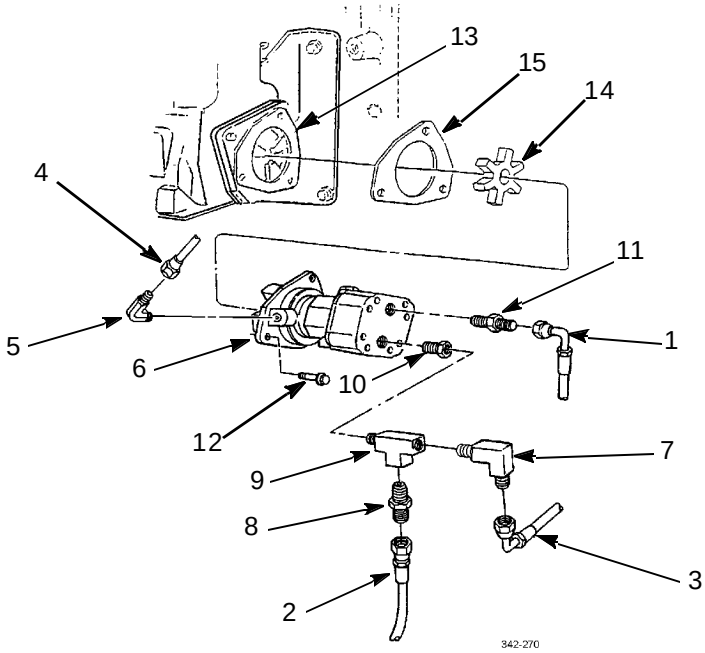
WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. Install adapter (11) in inlet port of fuel pump (6).
2. Install bushing (10), tee (9), adapter (8), and elbow (7) in outlet port of fuel pump (6).
3. Install elbow (5) to lubrication port of fuel pump (6).
4. Install new gasket (15) and drive coupling (14) on fuel pump (6).

NOTE

Fuel pump is correctly oriented for mounting when outlet fitting is in approximately 8 o'clock position as viewed from rear. Drain opening in pump body is facing down.



5. Index drive coupling (14) with drive hub on end of air compressor (13) crankshaft and align fuel pump (6) mounting holes with those in air compressor rear cover.
6. Seat fuel pump (6) squarely against the air compressor (13) and secure in place with three bolts (12).

INSTALLATION - CONTINUED

7. Tighten mounting bolts (12) to 22-28 lb-ft (30-38 Nm).
8. Connect and tighten pump inlet line (1), fuel pump-to-secondary fuel filter line (2), fuel pump-to-fuel water separator line (3), and pump lubrication line (4).
9. Prime fuel system and start vehicle (TM 9-2320-302-10). Check for proper operation of fuel pump.

END OF WORK PACKAGE

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AUTOMATIC ETHER STARTING AID MAINTENANCE 0035 00

THIS WORK PACKAGE COVERS

Fuel Cylinder Removal, Automatic Starting Aid Removal, Automatic Starting Aid Installation, Fuel Cylinder Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Oil, lubricating (Item 19, WP 0235 00)

FUEL CYLINDER REMOVAL

WARNING

Ether fuel is extremely flammable and toxic. DO NOT smoke and make sure you are in a well-ventilated area away from heat, open flames or sparks. Wear eye protection. Avoid contact with skin and eyes and avoid breathing ether fumes. If fluid enters or fumes irritate the eyes, wash immediately with large quantities of clean water for 15 minutes. Seek medical attention immediately if ether is inhaled or causes eye irritation. Failure to follow this warning may cause death or serious injury to personnel.

FUEL CYLINDER REMOVAL - CONTINUED

1. Loosen clamp (1) and unscrew fuel cylinder (2) from valve (3).
2. Remove gasket (4) from valve (3). Discard gasket.

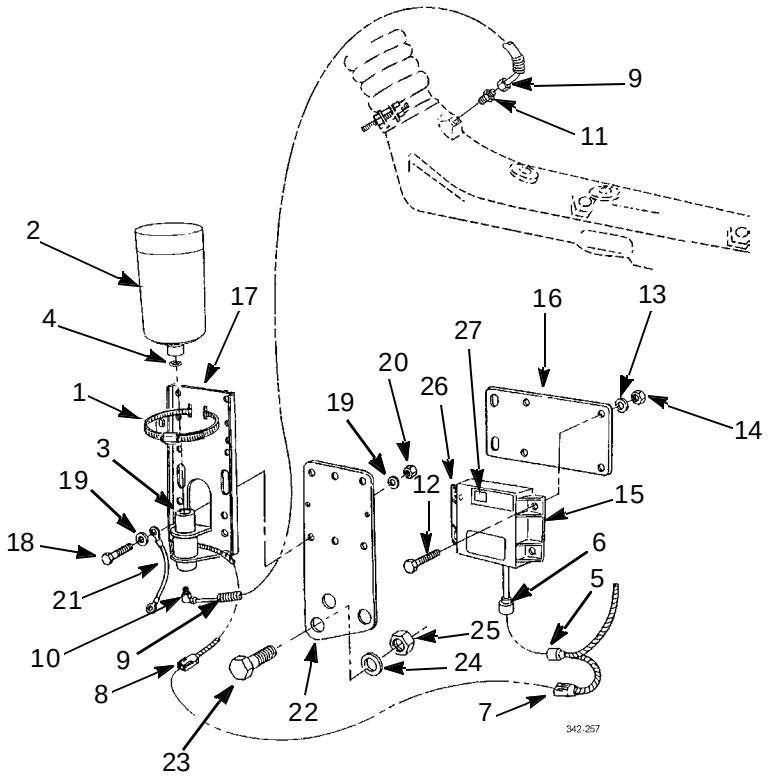
AUTOMATIC STARTING AID REMOVAL

1. Disconnect main harness connector (5) from ether control relay harness connector (6).
2. Disconnect main harness connector (7) from harness connector (8).
3. Disconnect ether tube (9) from fitting (10).

NOTE

Fitting has left-hand threads. Turn right to remove fitting.

4. Remove fitting (10) from valve (3).
5. Disconnect ether tube (9) from atomizer (11) on intake manifold.



CAUTION

Note orientation of atomizer nozzle prior to removal. Orientation mark must be positioned so that orifice is facing against air flow of intake manifold. This will ensure proper dispersal of ether. Failure to install atomizer nozzle with orifice orientated properly may cause damage to engine from improper dispersal of ether.

6. Remove atomizer (11) from intake manifold.
7. Remove four bolts (12), washers (13), nuts (14), and either control relay (15) from ether control relay bracket (16).

AUTOMATIC STARTING AID REMOVAL - CONTINUED

8. Remove ether control relay bracket (16) from fuel cylinder bracket (17) by removing two bolts (18), four washers (19), and two nuts (20) on right side of fuel cylinder bracket.

NOTE

- Valve with harness attached is permanently attached to fuel cylinder bracket.
- Remove fuel cylinder bracket only if damaged.

9. Remove two remaining bolts (18), four washers (19), two nuts (20), ground wire (21), and fuel cylinder bracket (17) from frame bracket (22).
10. Remove three bolts (23), washers (24), nuts (25), and frame bracket (22) from frame.

AUTOMATIC STARTING AID INSTALLATION

1. Position frame bracket (22) on frame and install three bolts (23), washers (24), and nuts (25).

NOTE

Perform step 2 if fuel cylinder bracket was removed.

2. Position fuel cylinder bracket (17) on frame bracket (22) and install two bolts (18), ground wire (21), four washers (19) and two nuts (20) on left side of bracket.
3. Position ether control relay bracket (16) on fuel cylinder bracket (17) and install remaining two bolts (18), four washers (19), and two nuts (20).
4. Install clamp (1) on fuel cylinder bracket (17).

WARNING

Ether fuel is extremely flammable and toxic. DO NOT smoke and make sure you are in a well-ventilated area away from heat, open flames or sparks. Wear eye protection. Avoid contact with skin and eyes and avoid breathing ether fumes. If fluid enters or fumes irritate the eyes, wash immediately with large quantities of clean water for 15 minutes. Seek medical attention immediately if ether is inhaled or causes eye irritation. Failure to follow this warning may cause death or serious injury to personnel.

NOTE

Fitting has left-hand threads. Turn left to install fitting.

5. Install fitting (10) on valve (3) with opening in fitting toward rear of vehicle.
6. Position ether control relay (15) on ether control relay bracket (16) and install four bolts (12), washers (13), and nuts (14).

CAUTION

Orientation mark of atomizer nozzle must be positioned so that orifice is facing against air flow of intake manifold. This will ensure proper dispersal of ether. Failure to install atomizer nozzle with orifice oriented properly may cause damage to engine from improper dispersal of ether.

7. Install atomizer (11) on intake manifold.

AUTOMATIC STARTING AID INSTALLATION - CONTINUED

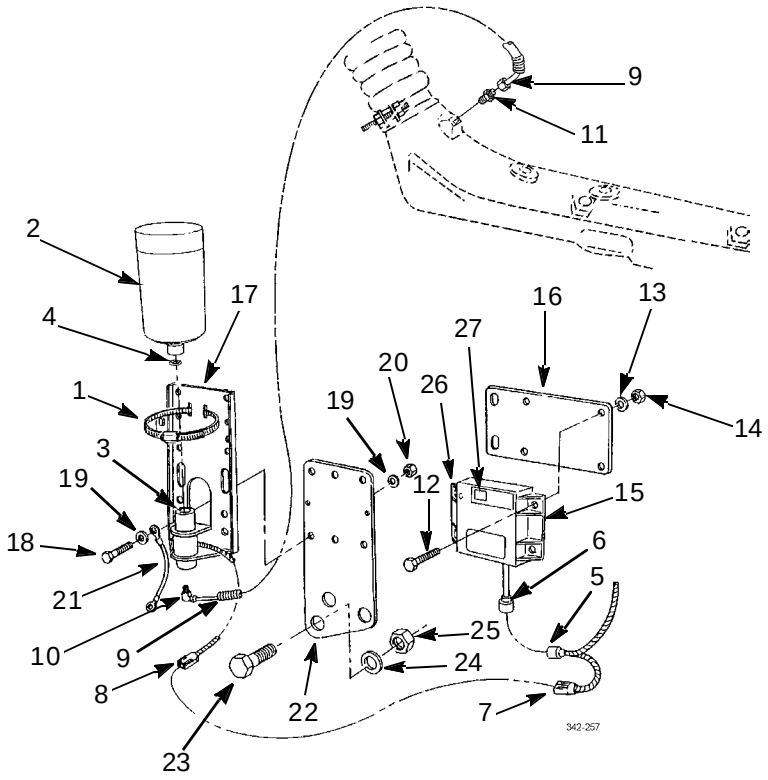
8. Connect ether tube (9) to atomizer (11).
9. Connect ether tube (9) to fitting (10).
10. Connect ether control relay harness connector (6) to main harness connector (5).
11. Connect harness connector (8) to main harness connector (7).
12. Turn on ignition (TM 9-2320-302-10).
13. Red indicator light (26) on ether control relay (15) should be ON.
14. Run a magnet over plate (27) on ether control relay (15). Red indicator light (26) should go OFF.

FUEL CYLINDER INSTALLATION

NOTE

Replacement fuel cylinder comes with a new gasket.

1. Apply thin coat of lubricating oil to new gasket (4) and threads of new fuel cylinder (2).
2. Install gasket (4) and fuel cylinder (2) to valve (3). Tighten clamp (1).
3. Turn on ignition (TM 9-2320-302-10).
4. Red indicator light (26) on ether control relay (15) should be ON.
5. Run a magnet over plate (27) on ether control relay (15). Red indicator light (26) should go OFF.



END OF WORK PACKAGE

AIR CLEANER, AIR INTAKE DUCT, AND TURBO BYPASS VALVE MAINTENANCE 0036 00

THIS WORK PACKAGE COVERS

Air Cleaner Element Removal, Air Cleaner and Intake Duct Removal, Air Cleaner and Intake Duct Disassembly, Air Cleaner and Intake Duct Assembly, Air Cleaner and Intake Duct Installation, Air Cleaner Element Installation, Turbo Bypass Valve Replacement

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (6)

Nut, lock (P/N MS51922-17) (4)

Materials/Parts - Continued

Compound, sealing, pipe (Item 10, WP 0235 00)

Rags, wiping (Item 28, WP 0235 00)

References

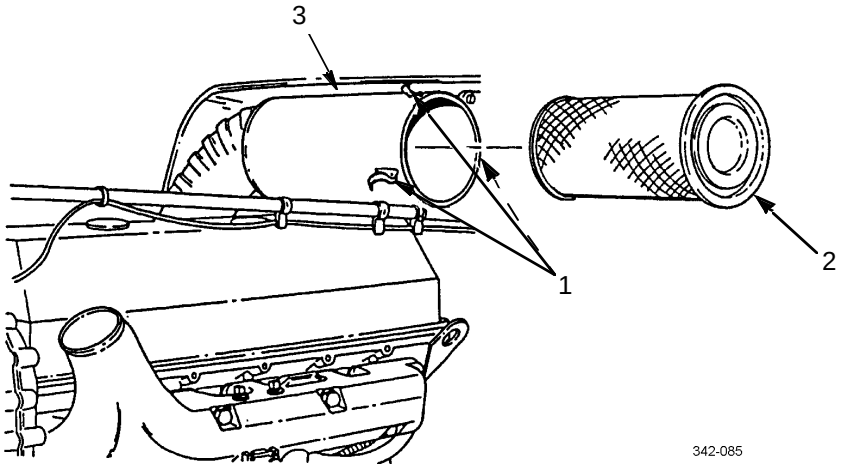
TM 9-2320-302-10

WARNING

If NBC exposure is suspected, all air cleaner media should be handled by personnel wearing protective equipment. Consult your NBC Officer or NBC NCO for appropriate handling or disposal procedures.

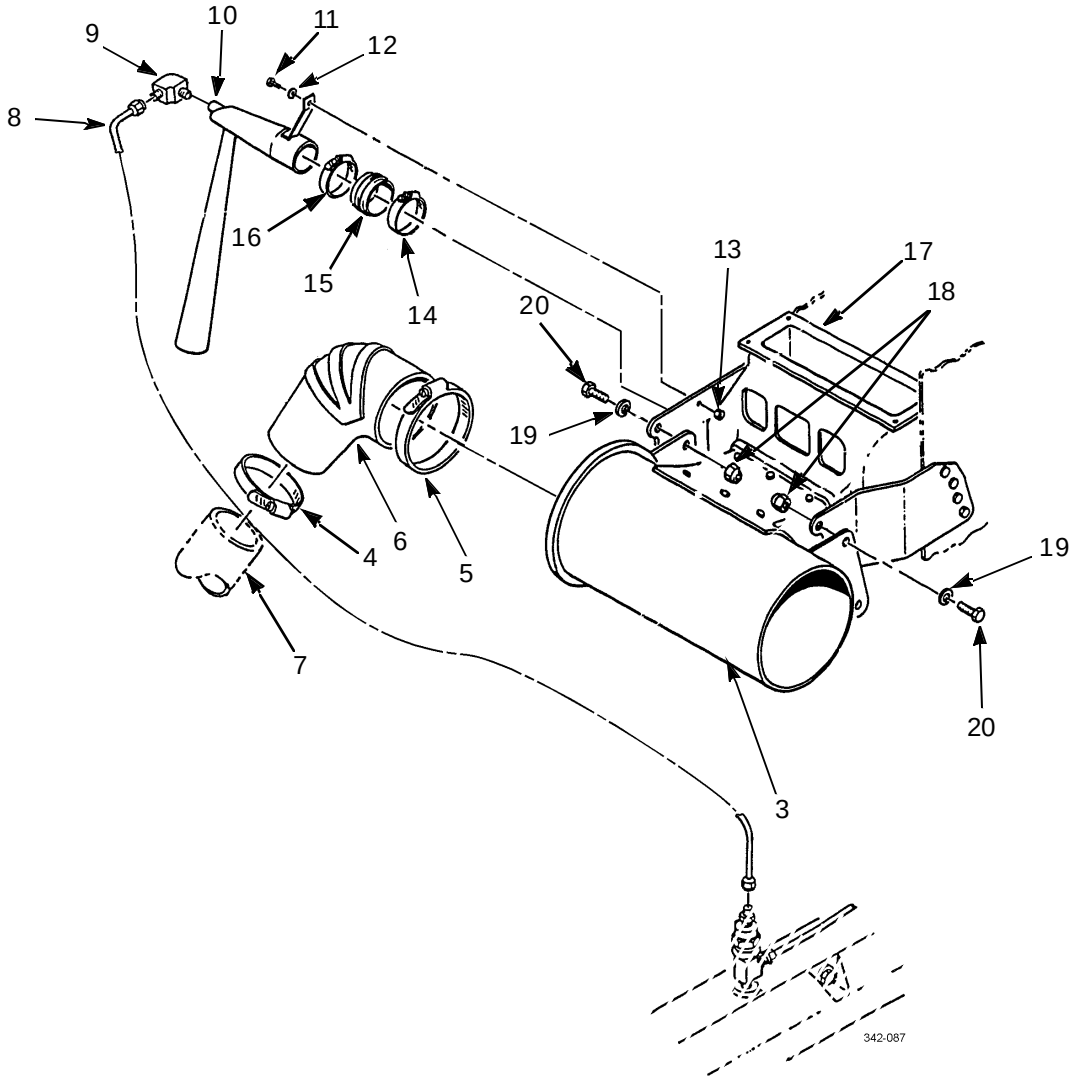
AIR CLEANER ELEMENT REMOVAL

Open engine compartment and release three latches (1) and remove air cleaner element (2) from air cleaner (3).



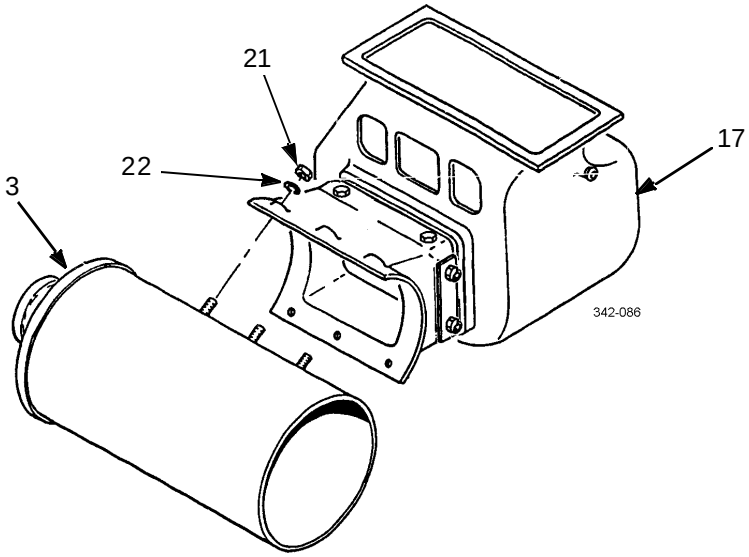
AIR CLEANER AND INTAKE DUCT REMOVAL

1. Loosen hose clamps (4 and 5) and remove elbow (6) from air cleaner (3) and air duct tube (7).
2. Remove tubing (8) and adapter fitting (9) from tube assembly (10).
3. Remove screw (11), washer (12), lock nut (13), hose clamps (14 and 16), hose (15), and tube assembly (10) from air intake duct assembly (17). Discard lock nut.
4. Support air cleaner (3) and remove four lock nuts (18), washers (19), screws (20), air cleaner (3), and air intake duct assembly (7). Discard lock nuts.



AIR CLEANER AND INTAKE DUCT DISASSEMBLY

Remove six lock nuts (21), washers (22), and air cleaner (3) from air intake duct assembly (17). Discard lock nuts.



AIR CLEANER AND INTAKE DUCT ASSEMBLY

CAUTION

Ensure air cleaner and air intake duct assembly have been thoroughly cleaned. DO NOT leave any dirt or foreign matter inside air cleaner or air intake duct assembly. Dirt or other foreign matter may get into turbocharger or engine and cause damage to equipment.

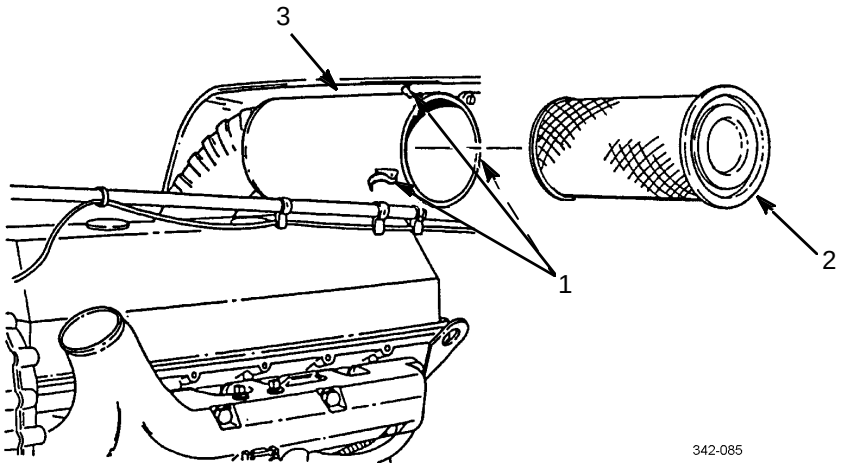
Install air cleaner (3) on air intake duct assembly (17) with six washers (22) and new lock nuts (21).

AIR CLEANER AND INTAKE DUCT INSTALLATION

1. Install air cleaner (3) and intake duct assembly (17) with four new lock nuts (18), washers (19), and screws (20). Torque lock nuts to 25-35 lb-ft (33-47 Nm).
2. Position hose clamps (14 and 16), hose (15), and tube assembly (10) on air intake duct assembly (17). Tighten hose clamps.
3. Install screw (11), washer (12), and new lock nut (13) on tube assembly (10).
4. Install tube adapter (9) and tubing (8) on tube assembly (10).
5. Position elbow (6) and hose clamps (4 and 5) on air cleaner (3) and air duct tube (7). Tighten hose clamps.

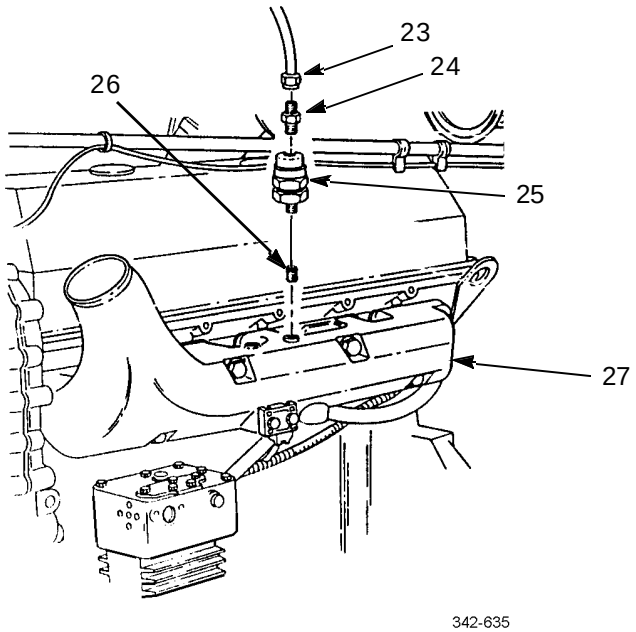
AIR CLEANER ELEMENT INSTALLATION

Install air cleaner filter element (2) on air cleaner (3) and close three latches (1).



TURBO BYPASS VALVE REPLACEMENT

1. Disconnect air line connector (23) from fitting (24).
2. Remove fitting (24), turbo bypass valve (25), and nipple (26) from air intake manifold (27).
3. Coat threads of fitting (24) and nipple (26) with pipe sealing compound and install nipple, turbo bypass valve (25) and fitting on air intake manifold (27).
4. Connect air line connector (23) to fitting (24).



END OF WORK PACKAGE

AIR INTAKE TUBES AND HOSES REPLACEMENT 0037 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

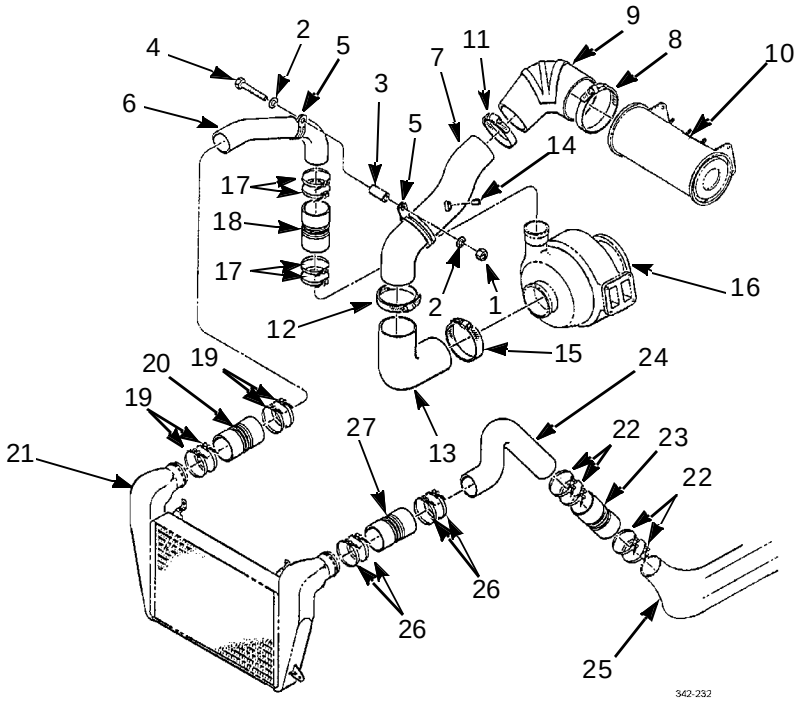
Nut, lock (P/N MS 51922-1)

References

TM 9-2320-302-10

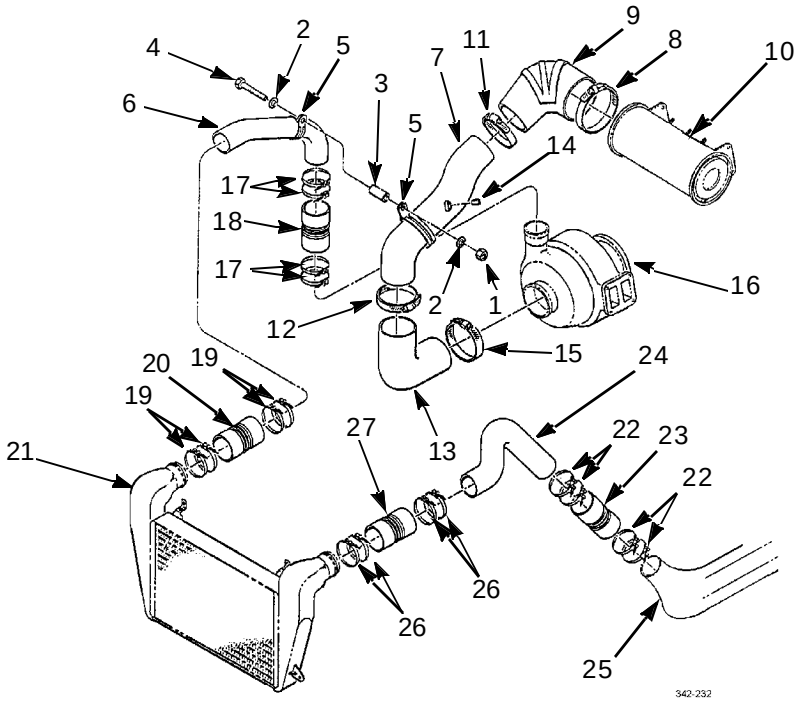
REMOVAL

1. Remove lock nut (1), two washers (2), spacer (3), screw (4) and two clamps (5) from air intake tubes (6 and 7). Discard lock nut.
2. Remove clamp (8) and reducer (9) from air cleaner (10).
3. Remove clamp (11) and reducer (9) from air intake tube (7).
4. Remove clamp (12) and air intake tube (7) from elbow (13). Remove pipe plug (14).
5. Remove clamp (15) and elbow (13) from turbocharger (16).
6. Remove four clamps (17), hose (18), and air intake tube (6) from turbocharger (16).
7. Remove four clamps (19), hose (20), and air intake tube (6) from charge air cooler (21).
8. Remove four clamps (22), hose (23), and air intake tube (24) from manifold (25).
9. Remove four clamps (26), hose (27), and air intake tube (24) from charge air cooler (21).



INSTALLATION

1. Install air intake tube (24) to charge air cooler (21) with hose (27) and four clamps (26).
2. Install air intake tube (24) to manifold (25) with hose (23) and four clamps (22).
3. Install air intake tube (6) to charge air cooler (21) with hose (20) and four clamps (19).
4. Install air intake tube (6) to turbocharger (16) with hose (18) and four clamps (17).
5. Install elbow (13) to turbocharger (16) with clamp (15).
6. Install pipe plug (14) to air intake tube (7) and install air intake tube to elbow (13) with clamp (12).
7. Install reducer (9) to air intake tube (17) with clamp (11).
8. Install reducer (9) to air cleaner (10) with clamp (8).
9. Install two clamps (5), screw (4), spacer (3), two washers (2) and new lock nut (1) to air intake tubes (6 and 7).



END OF WORK PACKAGE

CHARGE AIR COOLER AND AIR RECIRCULATION SHIELD REPLACEMENT 0038 00

THIS WORK PACKAGE COVERS

Charge Air Cooler Removal, Air Recirculation Shield Removal, Air Recirculation Shield Installation, Charge Air Cooler Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Personnel Required

Two

Materials/Parts

Nut, lock (P/N 23-11020-006) (4)

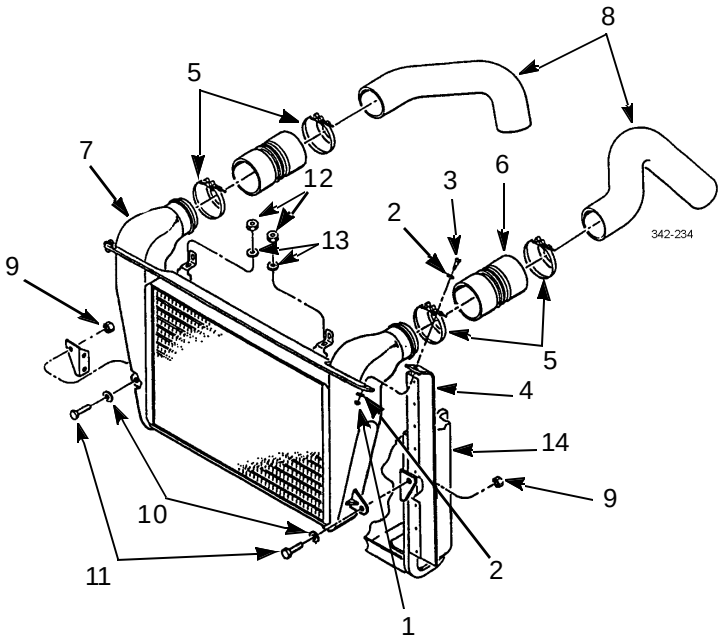
CHARGE AIR COOLER REMOVAL

1. Remove two lock nuts (1), four washers (2), and two screws (3) from two side shields (4). Discard lock nuts.
2. Loosen four clamps (5) and remove two hoses (6) from charge air cooler (7) and air intake tubes (8).

CAUTION

Secure charge air cooler in position before performing steps 3 and 4. Failure to follow this warning will result in damage to equipment.

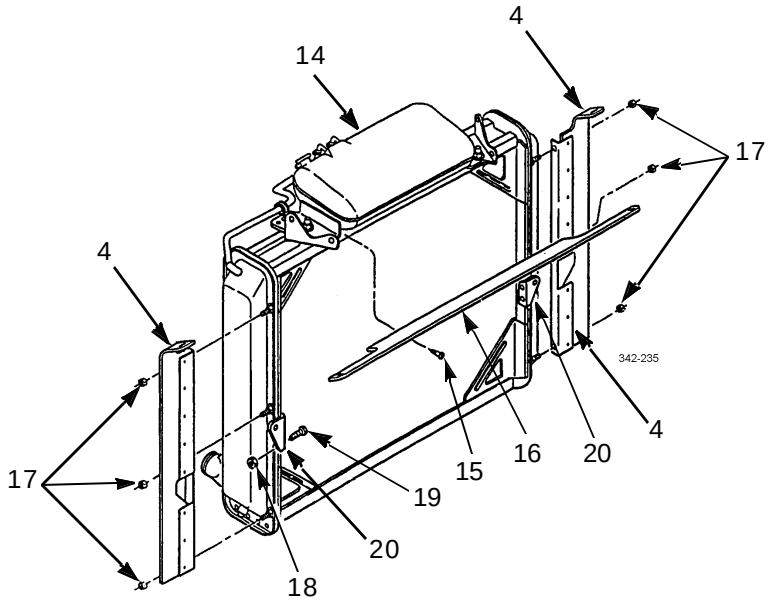
3. Remove two lock nuts (9), screws (11), and washers (10) from charge air cooler (7). Discard lock nuts.
4. Remove two nuts (12), washers (13), and charge air cooler (7) from radiator (14).



CHARGE AIR COOLER AND AIR RECIRCULATION SHIELD REPLACEMENT - CONTINUED 0038 00

AIR RECIRCULATION SHIELD REMOVAL

1. Remove four screws (15) and top shield (16) from radiator (14).
2. Remove six nuts (17) and two side shields (4) from radiator (14).
3. Remove four nuts (18), screws (19), and two brackets (20) from radiator (14).



AIR RECIRCULATION SHIELD INSTALLATION

1. Install two brackets (20) on radiator (14) with four screws (19) and nuts (18).
2. Install two side shields (4) on radiator (14) with six nuts (17).
3. Install top shield (16) on radiator (14) with four screws (15).

CHARGE AIR COOLER INSTALLATION

1. Install charge air cooler (7) on radiator (14) with two washers (13) and nuts (12).
2. Install two screws (11), washers (10), and new lock nuts (9) on charge air cooler (7).
3. Position two hoses (6) and four clamps (5) on air intake tubes (8) and charge air cooler (7). Tighten clamps.
4. Install two screws (3), four washers (2), and two new lock nuts (1) on side shields (4).

END OF WORK PACKAGE

EXHAUST SYSTEM MUFFLER, STACK, AND HEAT SHIELD REPLACEMENT 0039 00

THIS WORK PACKAGE COVERS

Heat Shield Removal, Exhaust Stack Removal, Muffler Removal, Muffler Mounting Brackets Removal, Muffler Mounting Brackets Installation, Muffler Installation, Exhaust Stack Installation, Heat Shield Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Bushing (P/N 1449-380-55640) (4)

Clamp, seal (P/N 04-19249-000)

Nut, lock (P/N 23-09900-108) (4)

Personnel Required

Two

References

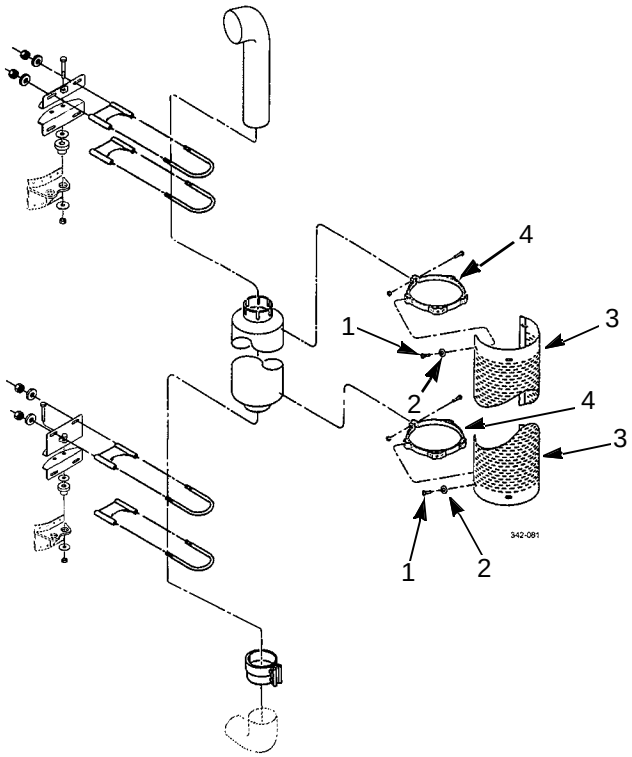
TM 9-2320-302-10

WARNING

Allow exhaust sytem components to cool before performing maintenance. Handling hot exhaust system components could cause serious burns.

HEAT SHIELD REMOVAL

1. With assistance, remove eight bolts (1), washers (2), and heat shield (3) from retaining clamps (4).



EXHAUST STACK REMOVAL

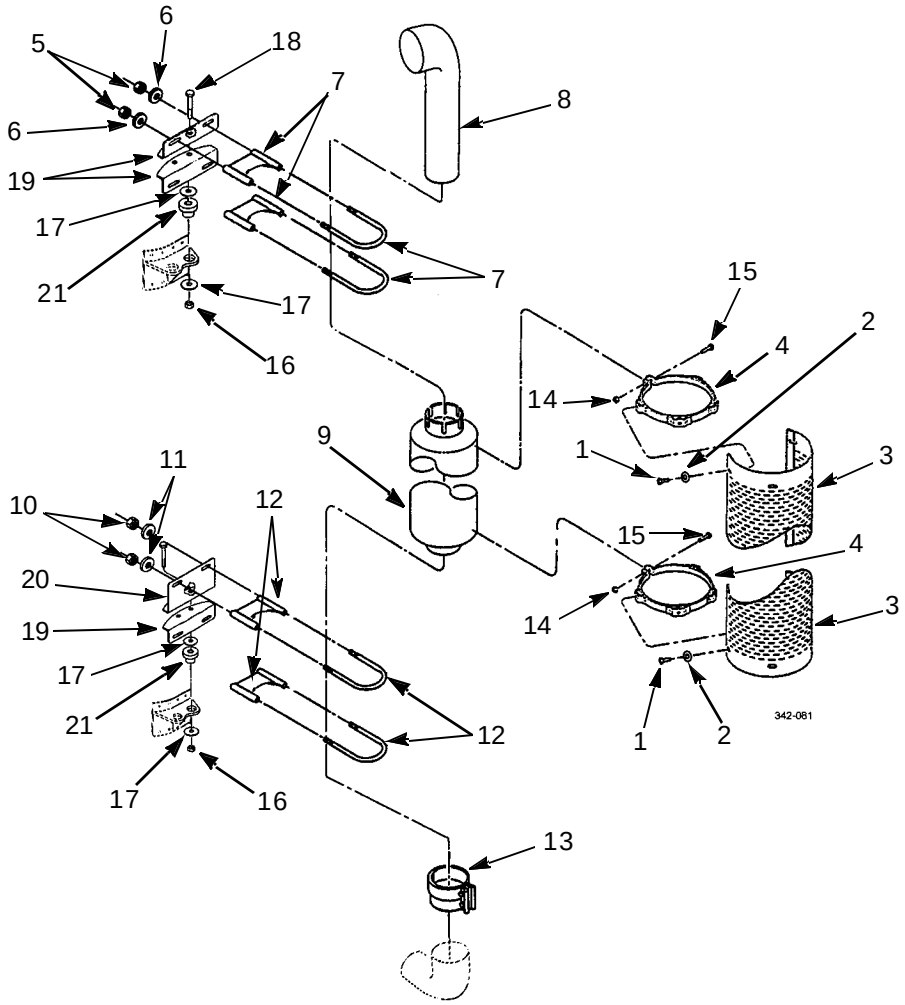
Remove four nuts (5), washers (6), two saddle clamps (7), and exhaust stack (8) from muffler (9).

MUFFLER REMOVAL

NOTE

Assistance is required to hold muffler steady while removing hardware.

1. Remove four nuts (10), washers (11), two saddle clamps (12), muffler (9), and seal clamp (13) from exhaust pipe. Discard seal clamp.
2. Remove two nuts (14), bolts (15), and retaining clamps (4) from muffler (9).



MUFFLER MOUNTING BRACKETS REMOVAL

1. Remove four lock nuts (16), eight washers (17), four screws (18), and two muffler mounting brackets (19 and 20) from vehicle. Discard lock nuts.
2. Remove four bushings (21) from two muffler mounting brackets (19 and 20). Discard bushings.

MUFFLER MOUNTING BRACKETS INSTALLATION

1. Position four new bushings (21) on mounting locations.
2. Install two muffler mounting brackets (19 and 20) with four screws (18), eight washers (17), and four new lock nuts (16).

MUFFLER INSTALLATION

1. Install two retaining clamps (4) on muffler (9) with two bolts (15) and nuts (14).

NOTE

- New seal clamp may leak until exhaust system is thoroughly heated and sealed.
- Ensure muffler with heat shield retaining clamps are positioned to allow mounting of heat shield.

2. Install new seal clamp (13) and muffler (9) on exhaust pipe with two saddle clamps (12), four washers (11), and nuts (10). Tighten seal clamp.

EXHAUST STACK INSTALLATION

NOTE

Ensure opening of exhaust stack is to the rear of the vehicle.

With assistance, install exhaust stack (8) on muffler (9) with two saddle clamps (7), four washers (6), and nuts (5).

HEAT SHIELD INSTALLATION

1. Ensure retaining clamps (4) are in place and secure.
2. With assistance, install heat shield (3) on retaining clamps (4) with eight washers (2) and bolts (1).

END OF WORK PACKAGE

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EXHAUST SYSTEM FLEX PIPE, CLAMPS, AND HEAT SHIELD REPLACEMENT 0040 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Clamp, seal (P/N 04-19249-000) (6)

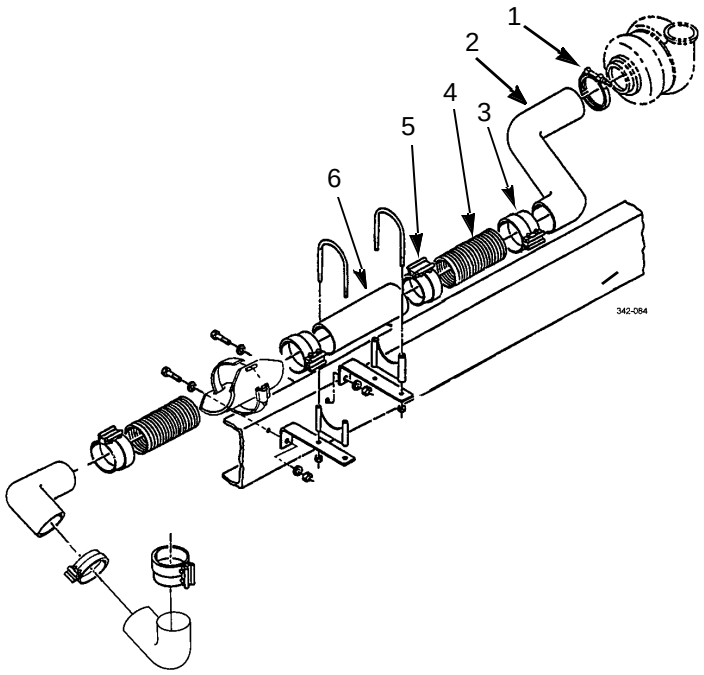
Nut, lock (P/N MS 51922-33) (2)

WARNING

Allow exhaust sytem components to cool before performing maintenance. Handling hot exhaust system components could cause serious burns.

REMOVAL

1. Open engine compartment and loosen grooved coupling clamp (1) at turbocharger exhaust outlet of exhaust pipe (2).
2. Loosen seal clamp (3) and remove exhaust pipe (2) from turbocharger exhaust outlet and exhaust hose (4). Retain grooved coupling clamp (1).
3. Loosen seal clamp (5) and remove exhaust hose (4) and seal clamps (3 and 5) from exhaust pipe (6). Discard seal clamps.



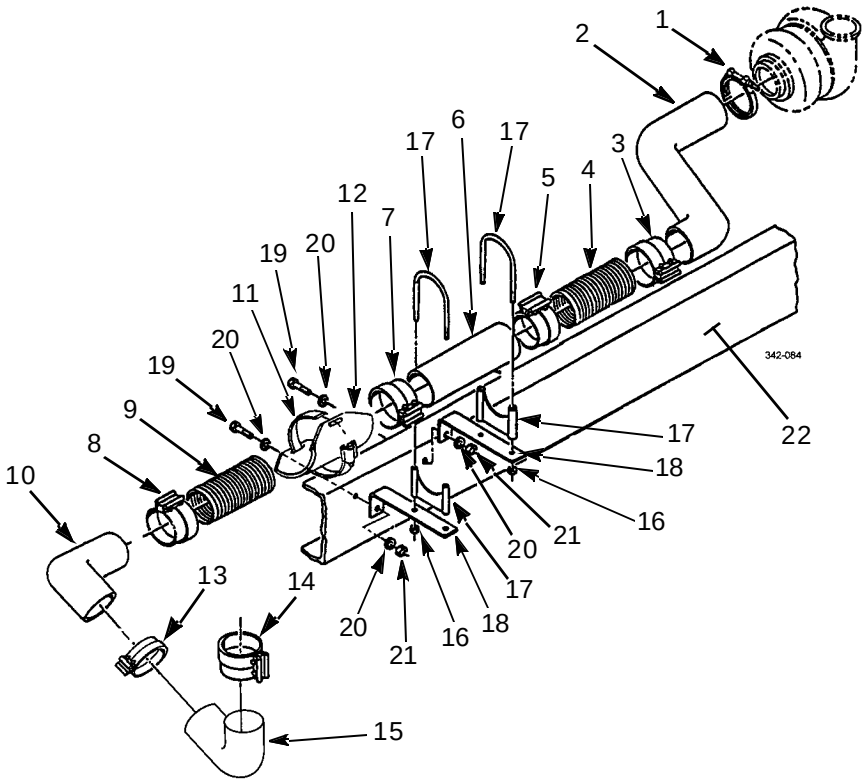
REMOVAL - CONTINUED

4. Loosen seal clamps (7 and 8) and remove exhaust hose (9) from exhaust pipe (6) and exhaust connector (10). Discard seal clamps.
5. Loosen hose clamp (11) and remove heat shield (12) from exhaust hose (9).
6. Loosen two seal clamps (13 and 14) and remove exhaust connectors (10 and 15) from muffler. Discard seal clamps.
7. Remove four nuts (16), two saddle clamps (17), and exhaust pipe (6) from two hanger brackets (18).

NOTE

Perform step 8 only if hanger brackets are damaged.

8. Remove two screws (19), four washers (20), two lock nuts (21), and two hanger brackets (18) from frame rail (22). Discard lock nuts.



INSTALLATION

NOTE

Perform step 1 only if hanger brackets were removed.

1. Install two new hanger brackets (18) on frame rail (22) with two screws (19), four washers (20), and two new lock nuts (21).

NOTE

Ensure loop clamps and seal clamps are only hand tight when installed. Tighten all clamps after exhaust system is completely installed.

2. Install exhaust pipe (6) on two hanger brackets (18) with two saddle clamps (17) and four nuts (16).
3. Install two exhaust connectors (10 and 15) and new seal clamps (13 and 14) on muffler.

WARNING

Ensure heat shield is positioned on exhaust hose between exhaust and fuel tank inlet. Failure to position heat shield correctly could result in serious injury to personnel and damage to equipment.

4. Install heat shield (12) on exhaust hose (9) with hose clamp (11).
5. Position exhaust hose (9) and new seal clamps (7 and 8) on exhaust pipe (6) and exhaust connector (10).
6. Install new seal clamp (5) and exhaust hose (4) on exhaust pipe (6). Slide seal clamp to end of exhaust hose and tighten.
7. Position new seal clamp (3), grooved coupling clamp (1), and exhaust pipe (2) on turbo charger exhaust outlet and exhaust hose (4). Slide seal clamp and grooved coupling clamp to ends of exhaust pipe and tighten.

NOTE

Tighten all seal clamps, saddle clamps, and grooved coupling clamp securely. New seal clamps may leak until exhaust system is thoroughly heated and sealed.

8. Operate vehicle (TM 9-2320-302-10) and allow exhaust system to heat up and seal.

END OF WORK PACKAGE

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DRAIN AND FILL COOLING SYSTEM 0041 00

THIS WORK PACKAGE COVERS

Draining, Filling

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Antifreeze, ethylene glycol (Item 4, WP 0235 00)

Rags, wiping (Item 28, WP 0235 00)

References

TM 9-2320-302-10

DRAINING

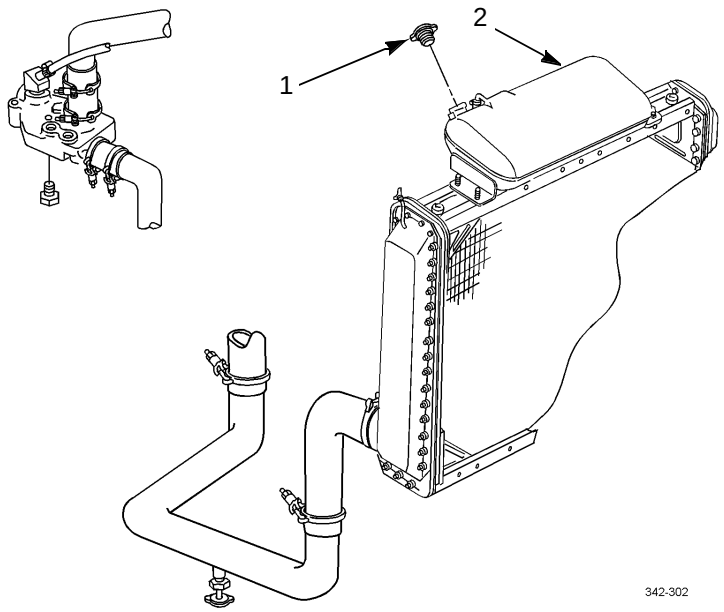
WARNING

DO NOT remove radiator cap or drain antifreeze unless engine is cold. Remove radiator cap in two steps. First, place a thick cloth over cap and slowly turn cap left to first stop. Pause and allow pressure to escape. Turn cap further left until it can be removed. This is a pressurized cooling system and escaping steam, hot water or coolant will cause serious burns.

1. Remove radiator cap (1) from radiator (2).

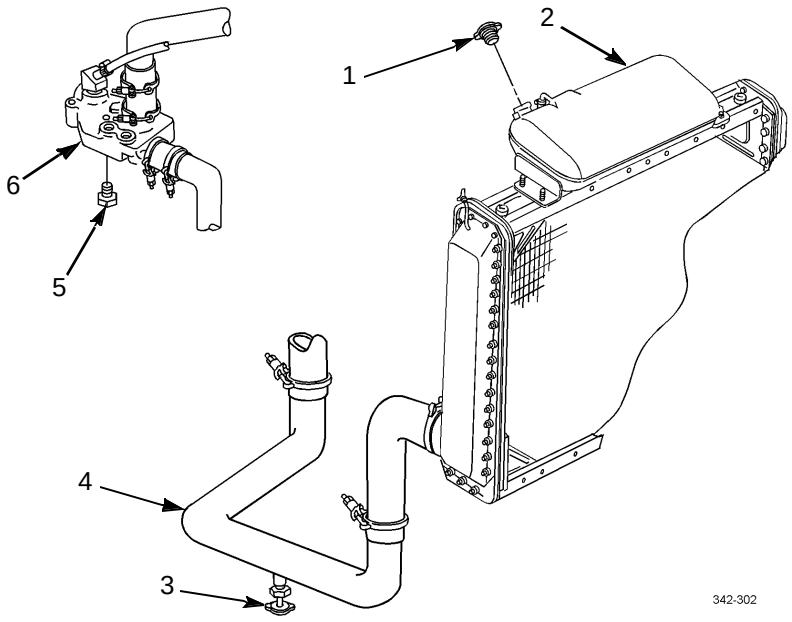
NOTE

Cooling system capacity is 65 qt. (61.51 l). Have suitable drain pans available.



DRAINING - CONTINUED

2. Open draincock (3) on lower radiator pipe (4). Allow antifreeze to drain.
3. Remove plug (5) from thermostat housing (6). Allow antifreeze to drain.
4. Close draincock (3) and install plug (5).



FILLING

1. Fill radiator (2) with antifreeze in accordance with WP 0021 00.
2. Install radiator cap (1) on radiator (2).
3. Start engine and allow engine to reach operating temperature (TM 9-2320-302-10).
4. Allow antifreeze to circulate through cooling system. Check for coolant leaks.
5. Shut off engine and allow engine to cool.

WARNING

DO NOT remove radiator cap or drain antifreeze unless engine is cold. Remove radiator cap in two steps. First, place a thick cloth over cap and slowly turn cap left to first stop. Pause and allow pressure to escape. Turn cap further left until it can be removed. This is a pressurized cooling system and escaping steam, hot water or coolant will cause serious burns.

6. Remove radiator cap (1) and check antifreeze level. Add antifreeze, if necessary, in accordance with WP 0021 00.
7. Install radiator cap (1).

END OF WORK PACKAGE

COOLANT HOSES, PIPES, AND CLAMPS REPLACEMENT 0042 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pliers, slip joint (Item 50, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

References

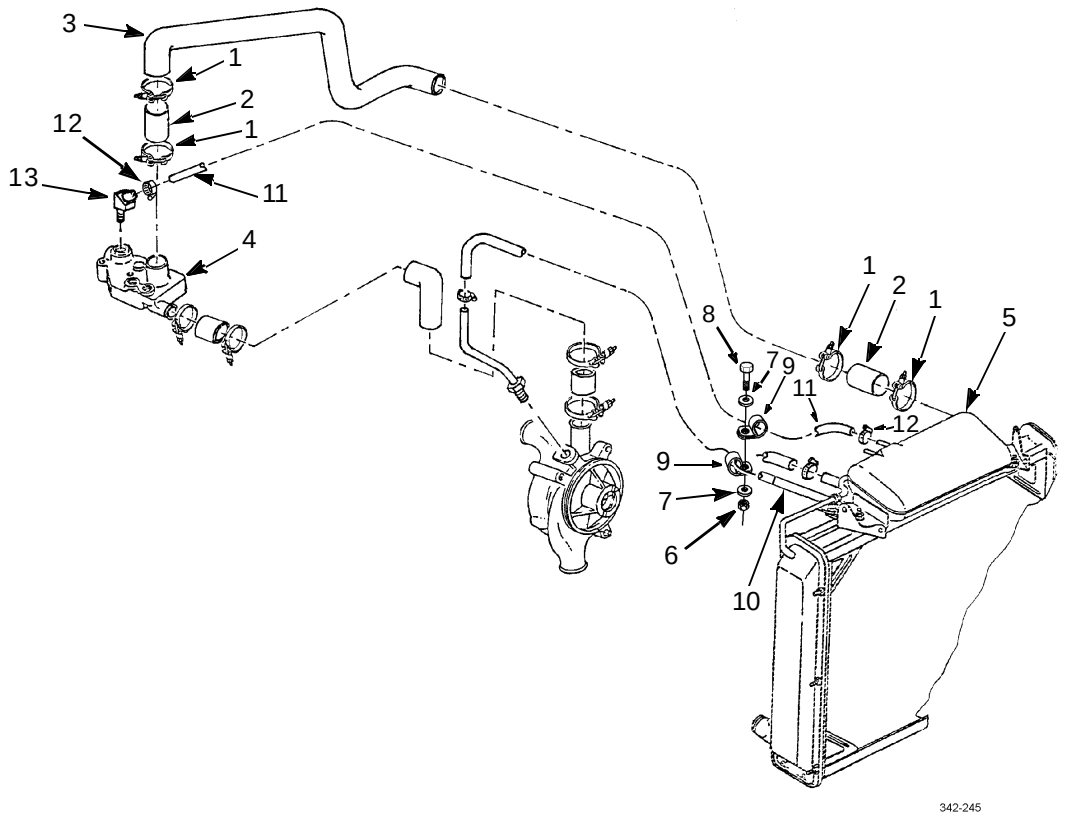
TM 9-2320-302-10

Equipment Condition

Cooling system drained (WP 0041 00)

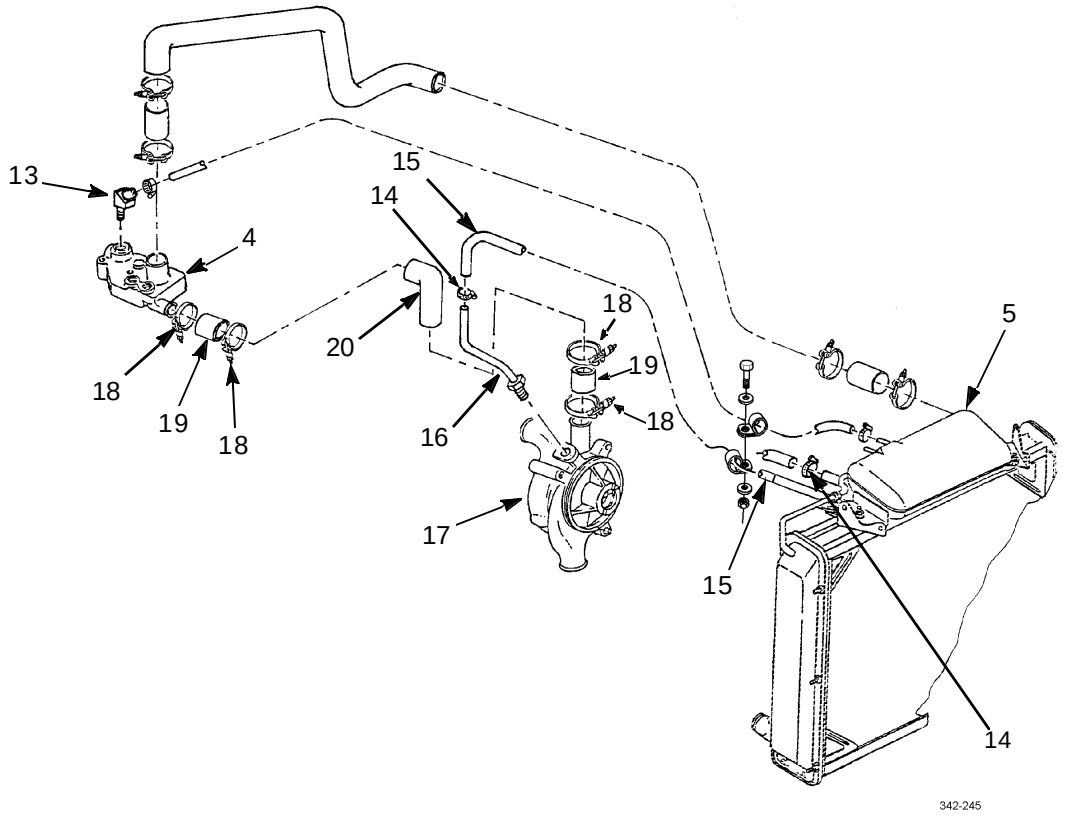
REMOVAL

1. Loosen four clamps (1) and remove two hoses (2) and pipe (3) from thermostat housing (4) and radiator (5).
2. Remove two lock nuts (6), four washers (7), two screws (8), and four clamps (9) from radiator support rod (10) and hose (11). Discard lock nuts.
3. Loosen two clamps (12) and remove hose (11) from radiator (5) and elbow (13).



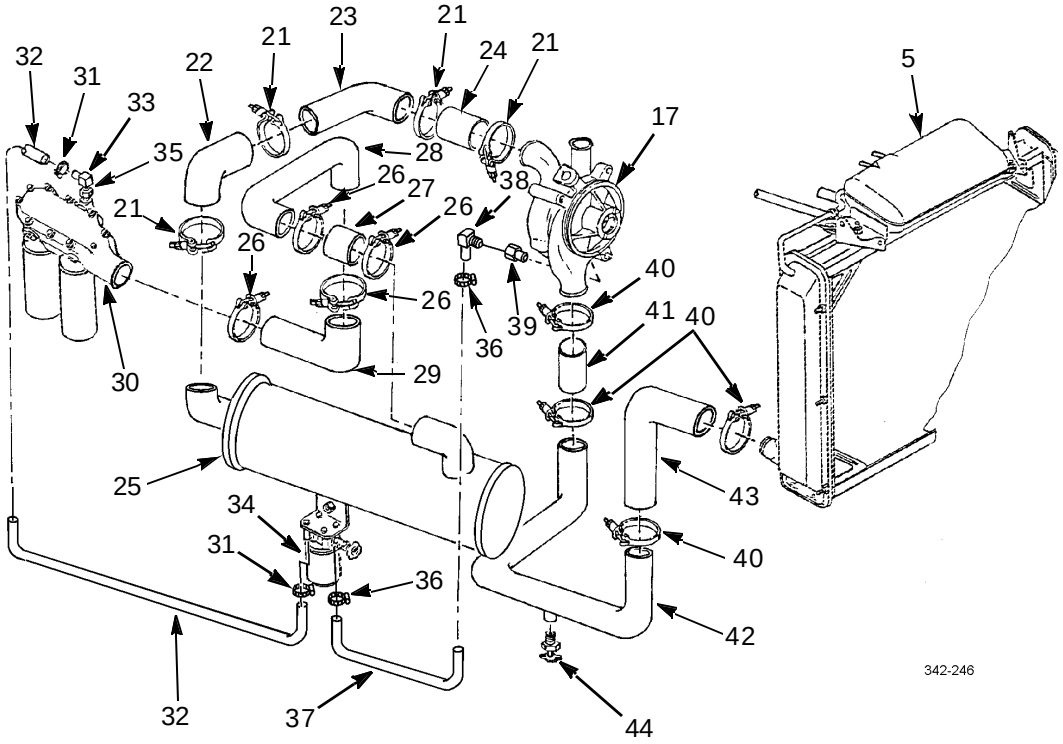
REMOVAL - CONTINUED

4. Remove elbow (13) from thermostat housing (4).
5. Loosen two clamps (14) and remove hose (15) from radiator (5) and water pump tube (16).
6. Remove water pump tube (16) from water pump (17).
7. Loosen four clamps (18) and remove two hoses (19) and pipe (20) from thermostat housing (4) and water pump (17).



8. Loosen four clamps (21) and remove hose (22), pipe (23), and hose (24) from transmission oil cooler (25) and water pump (17).
9. Loosen four clamps (26) and remove hose (27), pipe (28), and hose (29) from engine oil cooler (30) and transmission oil cooler (25).
10. Loosen two clamps (31) and remove hose (32) from elbow (33) and water filter (34).
11. Remove elbow (33) and adapter (35) from engine oil cooler (30).
12. Loosen two clamps (36) and remove hose (37) from water filter (34) and elbow (38).
13. Remove elbow (38) and adapter (39) from water pump (17).
14. Loosen four clamps (40) and remove hose (41), pipe (42), and hose (43) from water pump (17) and radiator (5).
15. Remove draincock (44) from pipe (42).

REMOVAL - CONTINUED



INSTALLATION

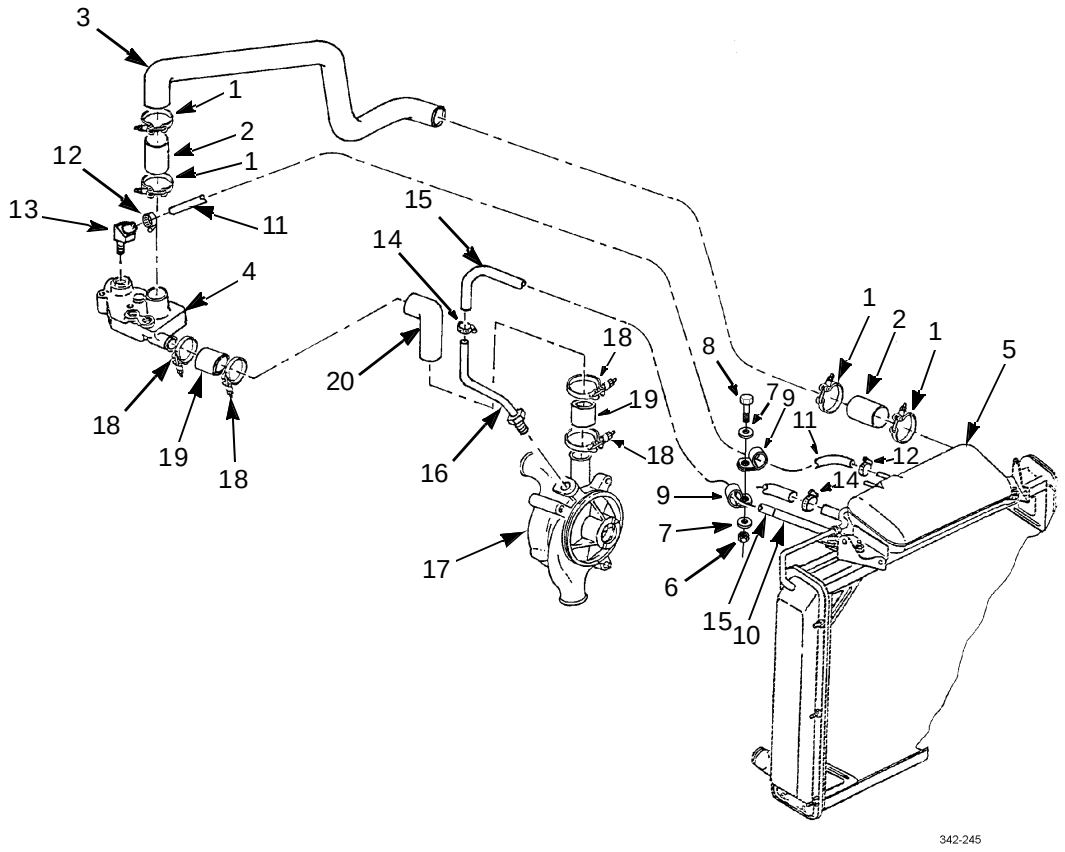
WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contact skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of draincock (44) with pipe sealing compound. Install draincock on pipe (42).
2. Install hose (43), pipe (42), and hose (41) on radiator (5) and water pump (17) with four clamps (40).
3. Lightly coat threads of adapter (39) and elbow (38) with pipe sealing compound. Install adapter and elbow on water pump (17).
4. Install hose (37) on elbow (38) and water filter (34) with two clamps (36).
5. Lightly coat threads of adapter (35) and elbow (33) with pipe sealing compound. Install adapter and elbow on engine oil cooler (30).
6. Install hose (32) on water filter (34) and elbow (33) with two clamps (31).
7. Install hose (29), pipe (28), and hose (27) on transmission oil cooler (25) and engine oil cooler (30) with four clamps (26).
8. Install hose (24), pipe (23), and hose (22) on water pump (17) and transmission oil cooler (25) with four clamps (21).

INSTALLATION - CONTINUED

9. Install pipe (20) and two hoses (19) on water pump (17) and thermostat housing (4) with four clamps (18).
10. Light coat threads of water pump tube (16) with pipe sealing compound. Install water pump tube on water pump (17).
11. Install hose (15) on water pump tube (16) and radiator (5) with two clamps (14).
12. Lightly coat threads of elbow (13) with pipe sealing compound. Install elbow on thermostat housing (4).
13. Install hose (11) on elbow (13) and radiator (5) with two clamps (12).
14. Install four clamps (9) on hose (11) and radiator support rod (10) with two screws (8), four washers (7), and two new lock nuts (6).
15. Install pipe (3) and two hoses (2) on radiator (5) and thermostat housing (4) with four clamps (1).



16. Fill cooling system (WP 0041 00).

END OF WORK PACKAGE

THERMOSTAT AND THERMOSTAT HOUSING COVER REPLACEMENT 0043 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Handle, installer (Item 15, WP 0236 00)

Installer, seal (Item 20, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Seal, thermostat (P/N 3S9643-00) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Oil, lubricating (Item 19, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Coolant hoses, pipes, and clamps removed (WP 0042 00)

REMOVAL

1. Remove nut (1), lock washer (2), and wire (3) from temperature sending unit (4).
2. Remove two screws (5), lock washers (6), and wires (7) from temperature sending unit (8).
3. Remove four bolts (9) and thermostat housing cover (10) from cylinder head (11).
4. Remove two temperature sending units (4 and 8) from thermostat housing cover (10).
5. Remove two thermostats (12) and thermostat seals (13) from thermostat housing cover (10). Discard thermostat seals.
6. Remove draincock (14) from thermostat housing cover (10).
7. Remove two pipe plugs (15) from thermostat housing cover (10).

INSTALLATION

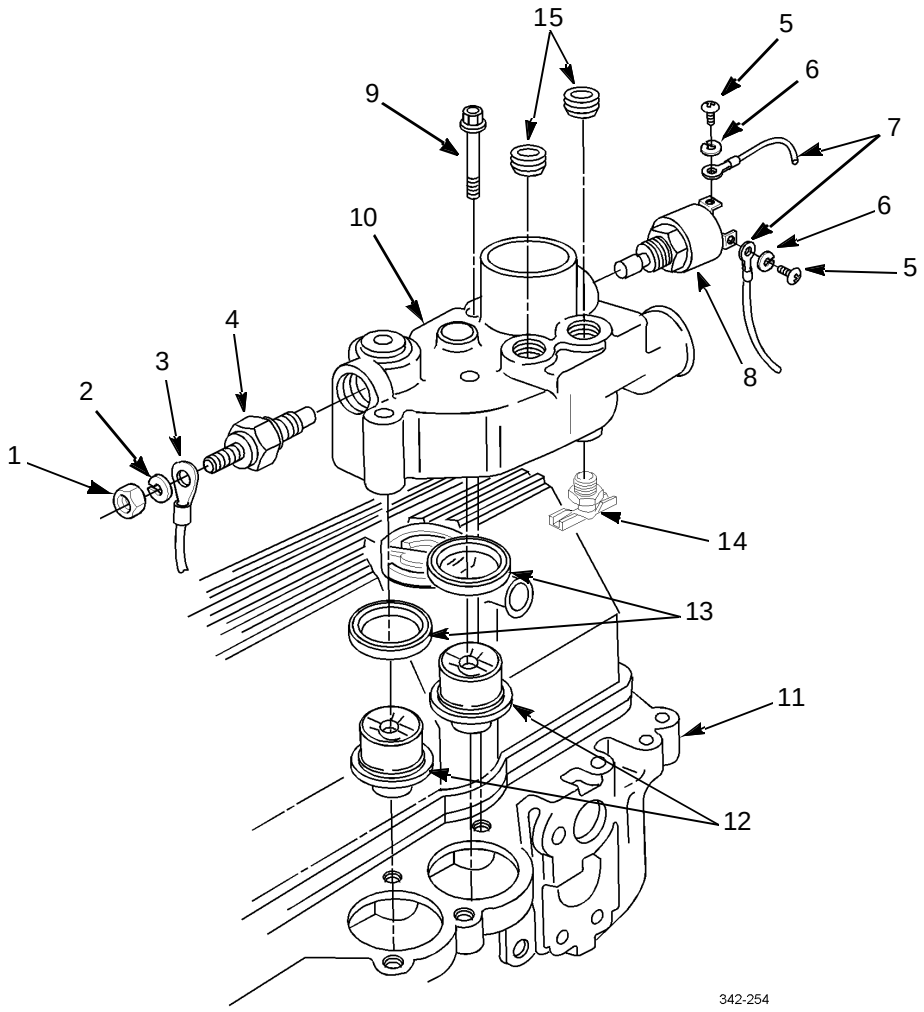
WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of two pipe plugs (15) with pipe sealing compound. Install pipe plugs in thermostat housing cover (10).
2. Lightly coat threads of draincock (14) with pipe sealing compound. Install draincock in thermostat housing cover (10).

INSTALLATION - CONTINUED

3. Support thermostat housing cover (10), contact side up, level on workbench.
4. Using seal installer and handle, install new thermostat seal (13) on thermostat housing cover (10).
5. Using hammer, drive thermostat seal (13) into thermostat housing cover (10) bore until tool lip is flush against housing cover.
6. Repeat steps 4 and 5 for other new thermostat seal (13).
7. Lightly coat lips of two thermostat seals (13) with lubricating oil.
8. Install two thermostats (12) on thermostat housing cover (10), spring side up. Press thermostats into housing cover.



9. Install two temperature sending units (4 and 8) in thermostat housing cover (10).

NOTE

Ensure that machined mating surfaces of thermostat housing cover and cylinder head are clean and dry.

10. Install thermostat housing cover (10) on cylinder head (11) with four bolts (9). Tighten bolts to 43-54 lb-ft (58-73 Nm).
11. Install two wires (7) on temperature sending unit (8) with two new lock washers (6) and screws (5).

INSTALLATION - CONTINUED

12. Install wire (3) on temperature sending unit (4) with new lock washer (2) and nut (1).
13. Install coolant hoses, pipes, and clamps (WP 0042 00).

END OF WORK PACKAGE

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RADIATOR SUPPORT ROD REPLACEMENT 0044 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Trestle, hoist, portable (Item 38, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (2)

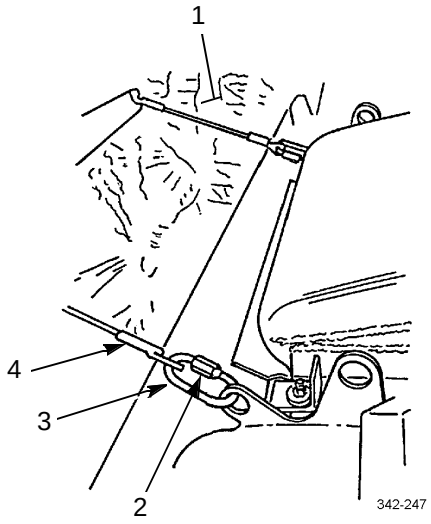
Nut, lock (P/N MS51922-33) (4)

Personnel Required

Two

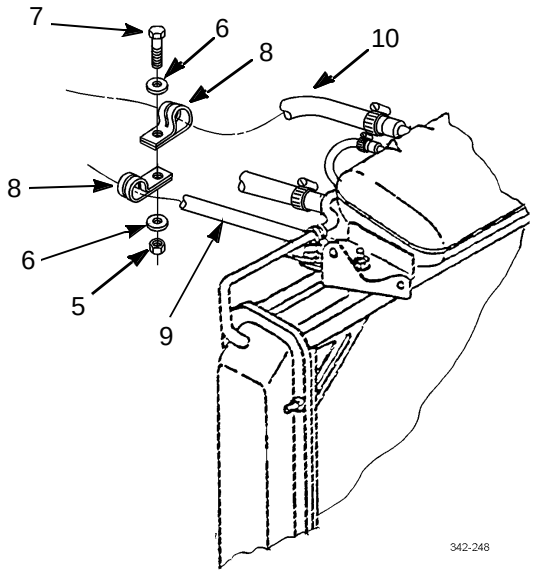
REMOVAL

1. With hood (1) in opened position, place trestle under center of hood. Adjust height of trestle to support weight of hood.
2. Loosen two nuts (2) and open two chain links (3).
3. Remove two cables (4) from chain links (3).



REMOVAL - CONTINUED

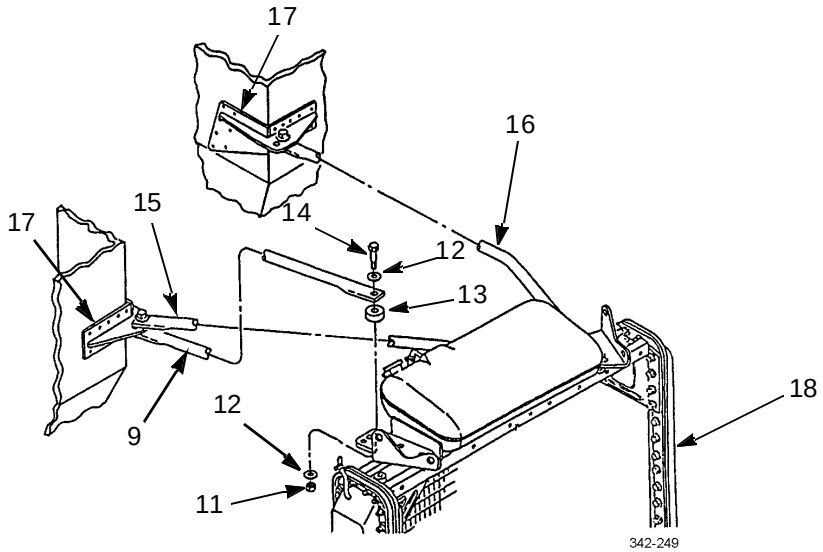
4. Remove two lock nuts (5), four washers (6), two screws (7), and four clamps (8) from radiator support rod (9) and hose (10). Discard lock nuts.



NOTE

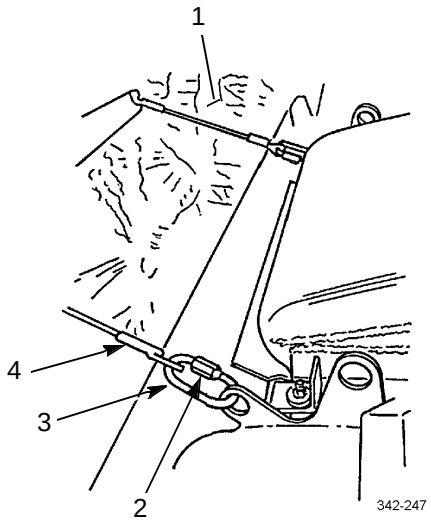
Note position of washers and spacer to aid in installation.

5. Remove four locknuts (11), nine washers (12), spacer (13), four screws (14), and three radiator support rods (9, 15, and 16) from two support brackets (17) and radiator (18).



INSTALLATION

1. Install three radiator support rods (9, 15, and 16) on radiator (18) and two support brackets (17) with four screws (14), spacer (13), nine washers (12), and four new lock nuts (11).
2. Install four clamps (8) on hose (10) and radiator support rod (9) with two screws (7), four washers (6), and two new locknuts (5).
3. Install two cables (4) on two chain links (3).
4. Tighten two nuts (2) and close chain links (3).
5. Remove trestle from under hood (1).



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RADIATOR REPLACEMENT 0045 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 32WLF51618) (3)

Nut, lock (P/N MS51922-11) (4)

Nut, lock (P/N MS51922-17) (4)

Nut, lock (P/N MS51922-49) (2)

Straps, tiedown (Item 30, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

Engine hood removed (WP 0185 00)

Coolant hoses, pipes, and clamps removed (WP 0042 00)

Water level probe removed (WP 0081 00)

Charge air cooler and air recirculation shield removed (WP 0038 00)

Radiator support rod removed (WP 0044 00)

REMOVAL

NOTE

Air conditioner condenser must be removed and set aside prior to removal of radiator. This must be done without disconnecting, removing or opening air conditioning lines which would allow refrigerant to escape.

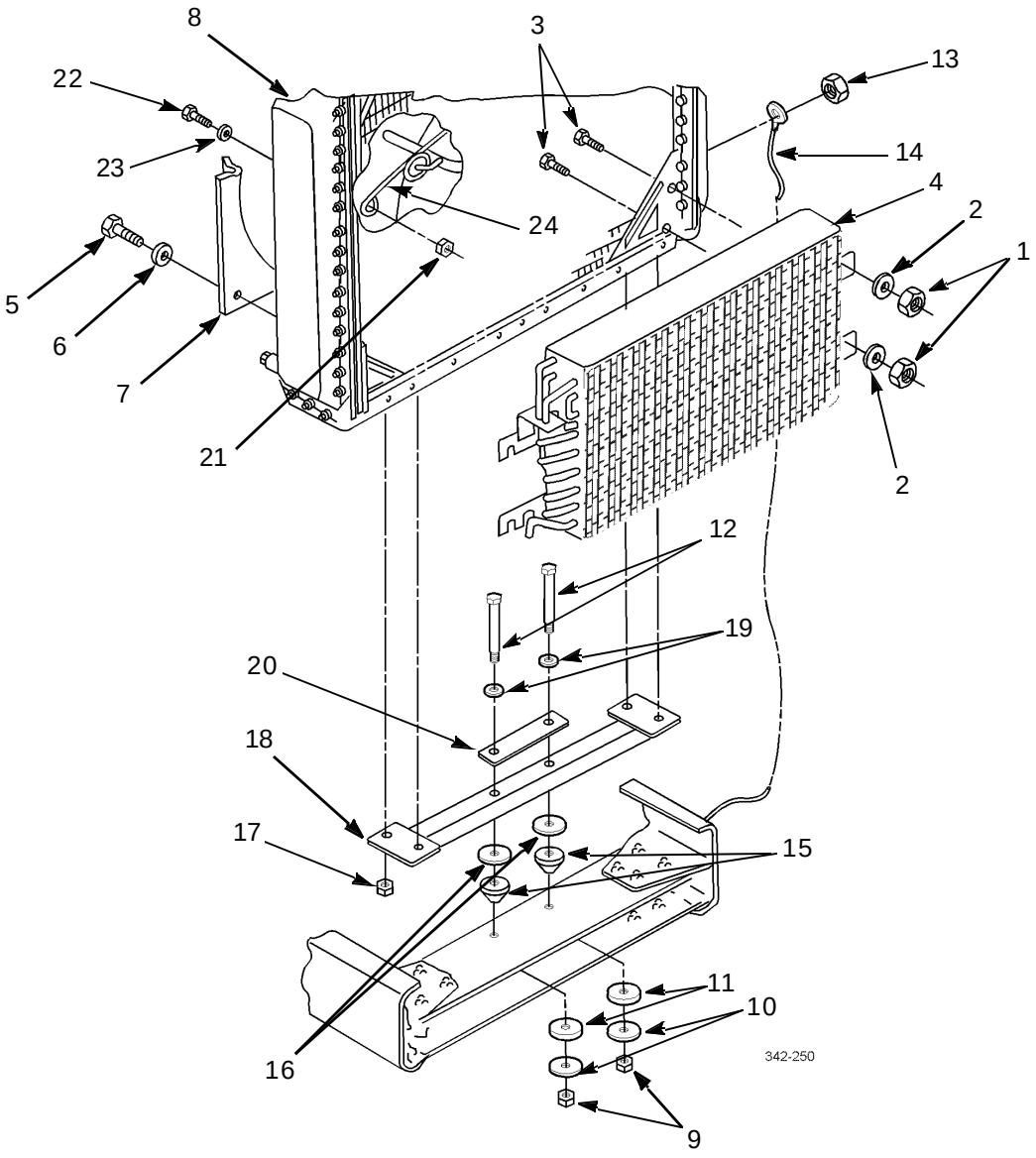
1. Remove four lock nuts (1), washers (2), and screws (3) from condenser (4).
2. With assistance, remove condenser (4) and cooling lines. Place condenser with coolant lines attached in engine compartment away from radiator.
3. Remove four screws (5), washers (6), and fan shroud (7) from radiator (8).

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Ensure that any lifting device used is in good condition and of suitable load capacity. Keep clear of heavy parts supported only by lifting device. Failure to follow this warning may result in death or injury to personnel.

4. Using suitable lifting device, support radiator (8).
5. Remove two lock nuts (9), washers (10), and isolators (11) from screws (12). Discard lock nuts.
6. Remove lock nut (13) and ground cable (14) from radiator (8). Discard lock nut.

REMOVAL - CONTINUED



NOTE

Remove tiedown straps, as necessary.

7. Lift radiator (8) from vehicle and remove two isolators (15) and washers (16). Place radiator in safe area.
8. Remove four lock nuts (17) and mounting plate (18) from radiator (8). Discard lock nuts.
9. Remove two screws (12), washers (19), and plate (20) from mounting plate (18).
10. Remove two lock nuts (21), screws (22), washers (23), and air line support (24) from radiator (8). Discard lock nuts.

INSTALLATION

NOTE

Install new tiedown straps, as necessary.

1. Install air line support (24) on radiator (8) with two washers (23), screws (22), and new lock nuts (21).
2. Loosely install plate (20) on mounting plate (18) with two washers (19) and screws (12).
3. Install mounting plate (18) on radiator (8) with four new lock nuts (17).

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Ensure that any lifting device used is in good condition and of suitable load capacity. Keep clear of heavy parts supported only by lifting device. Failure to follow this warning may result in death or injury to personnel.

4. Position two isolators (15), washers (16), and radiator (8) on vehicle. Remove lifting device
5. Install ground cable (14) on radiator (8) with new lock nut (13).
6. Install two isolators (11), washers (10), and new locknuts (9) on screws (12).
7. Install fan shroud (7) on radiator (8) with four washers (6) and screws (5).
8. Install radiator support rod (WP 0044 00).
9. Install charge air cooler and air recirculation shield (WP 0038 00).
10. Install condenser (4) in engine compartment with four screws (3), washers (2), and new lock nuts (1).
11. Install water level probe (WP 0081 00).
12. Install coolant hoses, pipes and clamps (WP 0042 00).
13. Install engine hood (WP 0185 00).

END OF WORK PACKAGE

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FAN BELT REPLACEMENT AND ADJUSTMENT 0046 00

THIS WORK PACKAGE COVERS

Removal, Installation, Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Tensiometer, dial indicating (Item 32, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

References

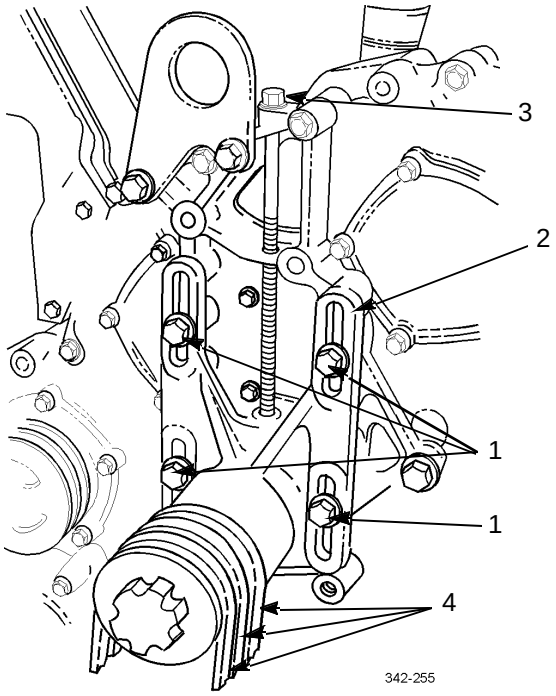
TM 9-2320-302-10

Equipment Condition

Fan impeller and shroud removed (WP 0047 00)

REMOVAL

1. Loosen four screws (1) on spindle and housing (2).
2. Loosen adjusting screw (3) and allow slack in three fan belts (4).
3. Remove three fan belts (4) from vehicle.



INSTALLATION

NOTE

Fan belts should only be replaced in matched sets. DO NOT mix old and new fan belts.

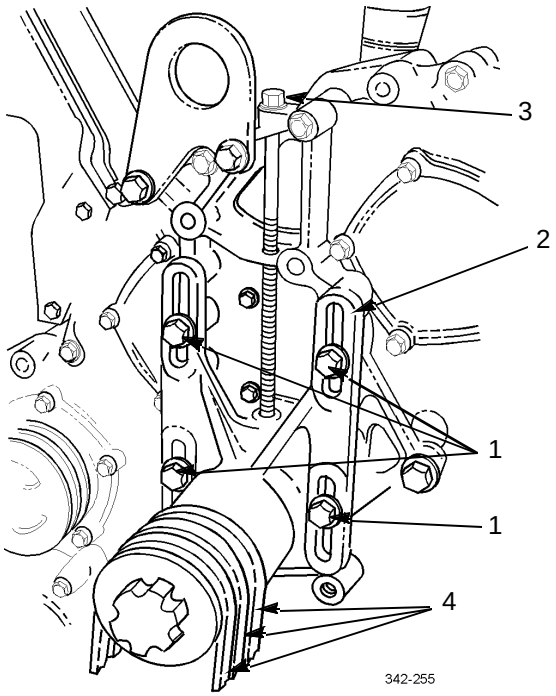
1. Position three fan belts (4) on vehicle.

INSTALLATION - CONTINUED

2. Install fan impeller and shroud (WP 0047 00).

ADJUSTMENT

1. With tensiometer placed midway between two pulleys, tighten adjusting screw (3) until fan belt (4) tension is 60-80 lbs (266-355 N).
2. Tighten four screws (1) on spindle and housing (2) to 75-83 lb-ft (100-112 Nm).
3. Operate engine for about 30 minutes (or 15 miles) and check fan belt (4) tension. Adjust tension, as necessary.
4. Check fan belt (4) tension after 8 hours (or 250 miles). Adjust tension, as necessary.



END OF WORK PACKAGE

FAN IMPELLER AND SHROUD REPLACEMENT 0047 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Washer, lock (P/N 3059-00870-06) (6)

Straps, tiedown (Item 30, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Radiator removed (WP 0045 00)

REMOVAL

NOTE

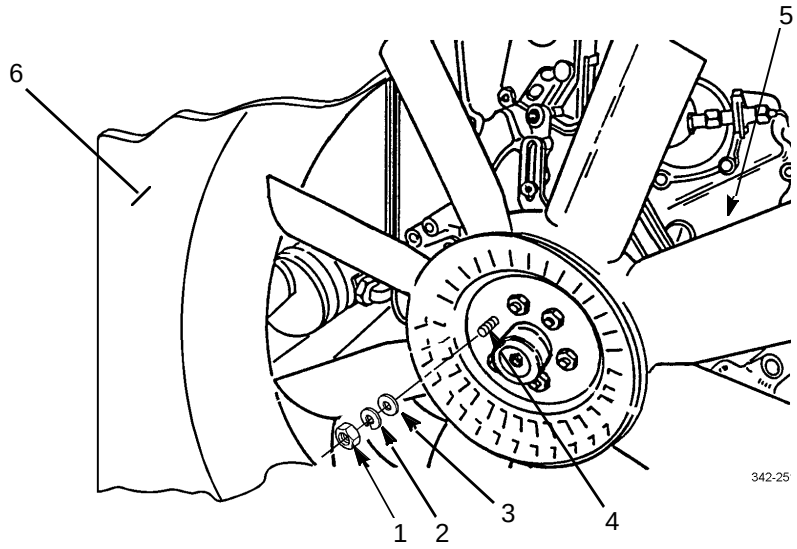
Remove tiedown straps, as necessary.

1. Remove six nuts (1), lock washers (2), and washers (3) from six studs (4). Discard lock washers.

NOTE

Note position of fan impeller and shroud to aid in installation.

2. Remove fan impeller (5) and radiator shroud (6) from vehicle.

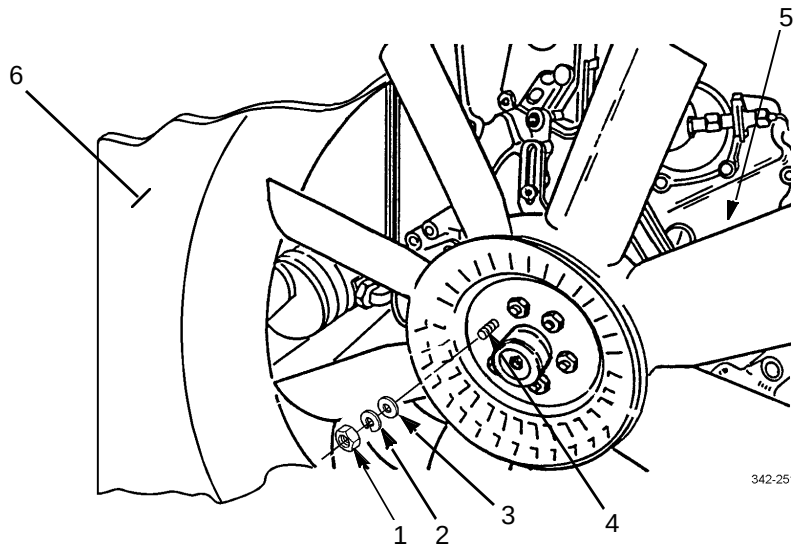


INSTALLATION

NOTE

Install new tiedown straps, as necessary.

1. Position radiator shroud (6) and fan impeller (5) on vehicle.
2. Install fan impeller (5) on six studs (4) with six washers (3), new lock washers (2), and nuts (1).



3. Install radiator (WP 0045 00).

END OF WORK PACKAGE

FAN CLUTCH SOLENOID REPLACEMENT 0048 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

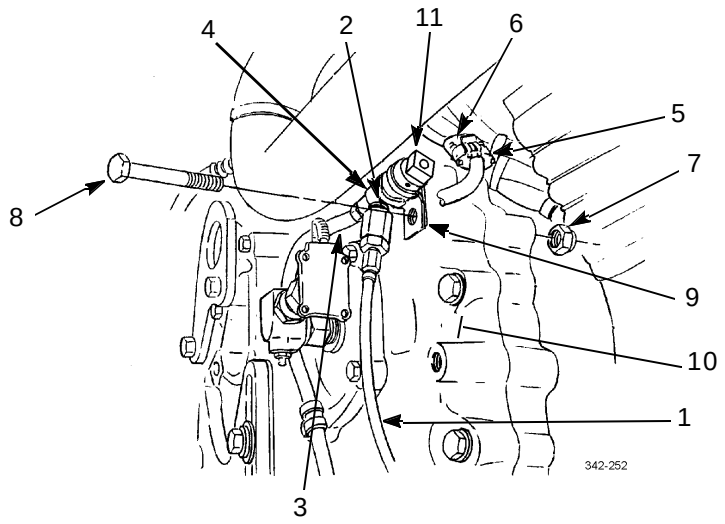
Air system drained (TM 9-2320-302-10)

References

TM 9-2320-302-10

REMOVAL

1. Disconnect air line (1) from air filter (2).
2. Disconnect air line (3) from fan clutch solenoid (4).
3. Disconnect connector (5) of fan clutch solenoid (4) from engine wiring harness connector (6).
4. Remove nut (7), screw (8), clamp (9), and fan clutch solenoid (4) from engine block (10).
5. Remove vent (11) from fan clutch solenoid (4).



INSTALLATION

1. Install vent (11) on fan clutch solenoid (4).
2. Install fan clutch solenoid (4) on engine block (10) with clamp (9), screw (8), and nut (7).
3. Connect connector (5) of fan clutch solenoid (4) to engine wiring harness connector (6).
4. Connect air line (3) to fan clutch solenoid (4).
5. Connect air line (1) to air filter (2).

END OF WORK PACKAGE

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FAN CLUTCH AND DRIVE PULLEY REPLACEMENT 0049 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Equipment Condition

Fan impeller and shroud removed (WP 0047 00)

Fan belts removed (WP 0046 00)

Air system drained (TM 9-2320-302-10)

REMOVAL

1. Disconnect air line (1) from spindle behind drive pulley (2).

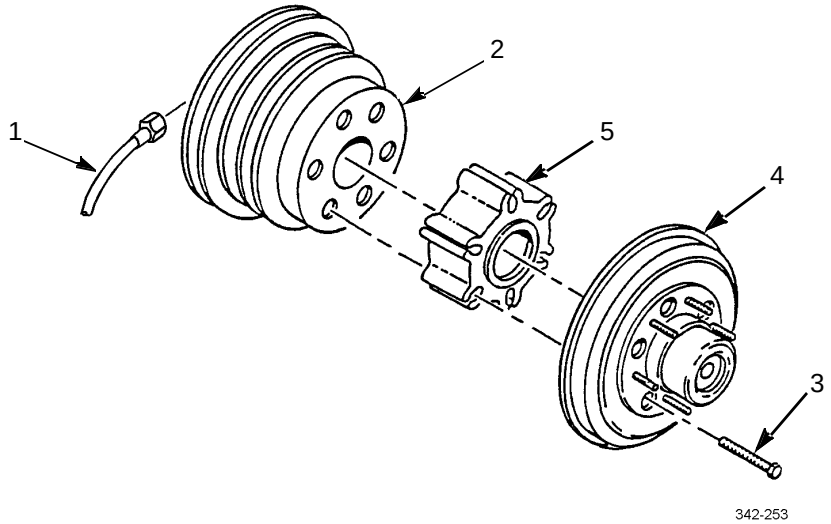
WARNING

Compressed air used for cleaning or drying purposes, or for cleaning restrictions, should never exceed 30 psi (207 kPa). Wear protective clothing (goggles/shield, gloves, etc.) and use caution to avoid injury to personnel.

NOTE

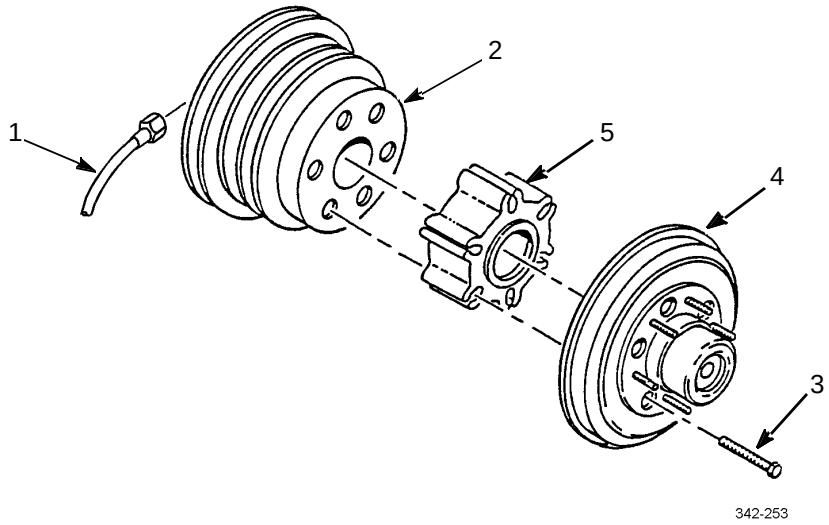
Perform step 2 if six screws of fan clutch are not accessible.

2. Apply air pressure to fitting of spindle behind drive pulley (2) to access heads of six screws (3).
3. Remove six screws (3), fan clutch (4), spacer (5), and drive pulley (2) from vehicle.



INSTALLATION

1. Install drive pulley (2), spacer (5), and fan clutch (4) on vehicle with six screws (3).
2. Connect air line (1) to spindle behind drive pulley (2).



3. Install fan belts (WP 0046 00).
4. Install fan impeller and shroud (WP 0047 00).

END OF WORK PACKAGE

WATER FILTER ELEMENT REPLACEMENT 0050 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Element, filter (P/N WF-2077)

Oil, lubricating (Item 19, WP 0235 00)

Rags, wiping (Item 28, WP 0235 00)

References

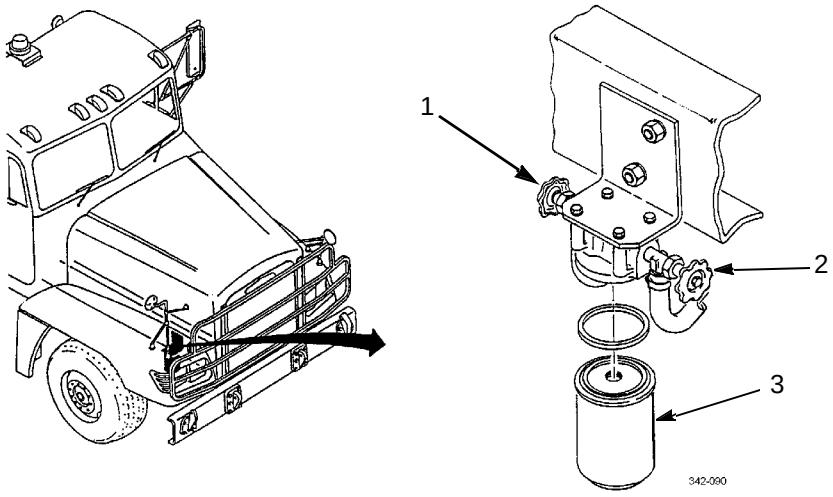
TM 9-2320-302-10

REMOVAL

NOTE

Use a suitable container to catch any spilled liquid.

1. Close two shutoff valves (1 and 2).
2. Remove water filter element (3) and gasket (4) from filter adapter (5). Discard water filter element and gasket.



INSTALLATION

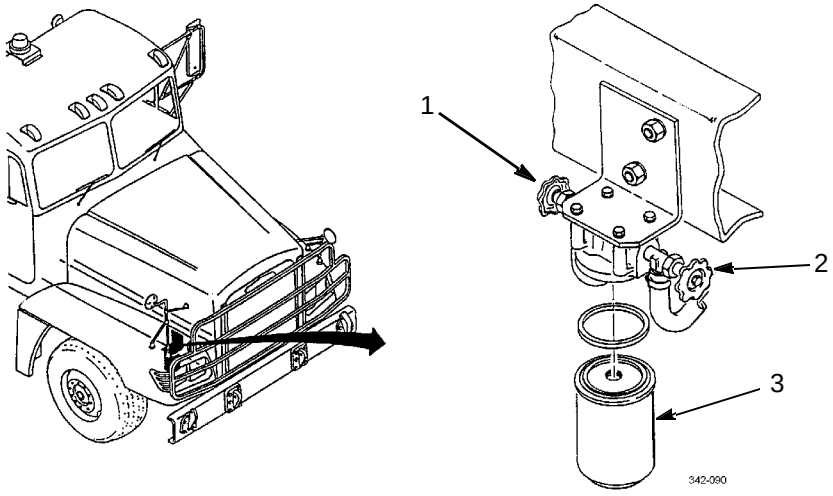
1. Position new gasket (4) on top of new water filter element (3). Lightly coat gasket with lubricating oil.
2. Install water filter element (3) and gasket (4) on adapter (5). Hand tighten until filter side movement is not present.

INSTALLATION - CONTINUED

CAUTION

DO NOT use a filter wrench to tighten water filter element. Failure to follow this caution may result in damage to water filter element.

3. Tighten water filter element (3) an additional 2/3 turn.
4. Open two shutoff valves (1 and 2).
5. Check coolant level (TM 9-2320-302-10).



END OF WORK PACKAGE

WATER FILTER ADAPTER AND BRACKET REPLACEMENT 0051 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Rags, wiping (Item 28, WP 0235 00)

References

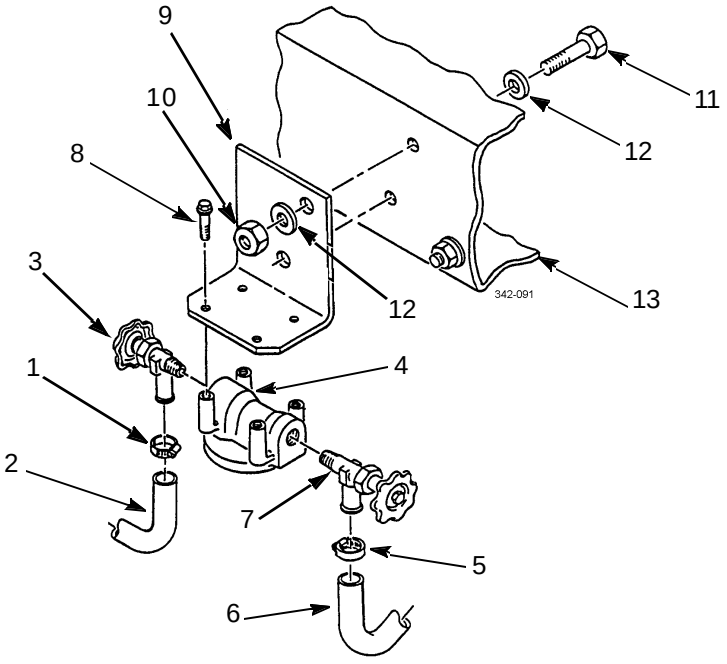
TM 9-2320-302-10

Equipment Condition

Cooling system drained (WP 0041 00)
Water filter element removed (WP 0050 00)
Transmission oil cooler removed (WP 0127 00)

REMOVAL

1. Loosen hose clamp (1) and remove hose (2) from angle valve (3) on oil cooler side of filter adapter (4).
2. Loosen hose clamp (5) and remove hose (6) from angle valve (7) on water pump side of filter adapter (4).
3. Remove four screws (8) and filter adapter (4) from mounting bracket (9).
4. Remove two angle valves (3 and 7) from filter adapter (4).



REMOVAL - CONTINUED

NOTE

Perform step 6 only if mounting bracket is damaged.

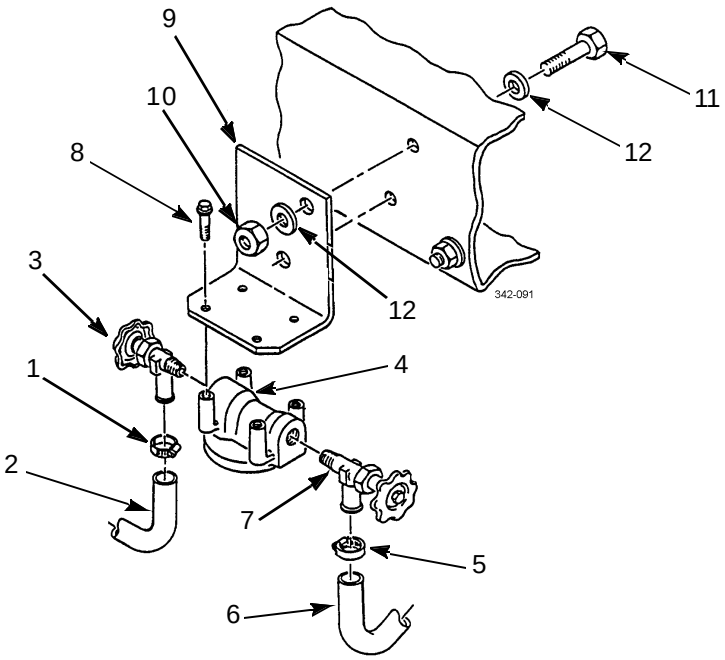
5. Remove two nuts (10), bolts (11), four washers (12), and mounting bracket (9) to frame (13).

INSTALLATION

NOTE

Perform step 1 only if mounting bracket was removed.

1. Install mounting bracket (9) on frame (13) with two bolts (11), four washers (12), and two nuts (10).
2. Install two angle valves (3 and 7) on filter adapter (4).
3. Install filter adapter (4) on mounting bracket (9) with four screws (8).
4. Install hose (6) on angle valve (7) on water pump side of filter adapter (4) with hose clamp (5).
5. Install hose (2) on angle valve (3) on oil cooler side of filter adapter (4) with hose clamp (1).



6. Install water filter element (WP 0050 00).
7. Install transmission oil cooler (WP 0127 00).
8. Fill coolant system and check for leaks (WP 0041 00).

END OF WORK PACKAGE

WATER PUMP MAINTENANCE 0052 00

THIS WORK PACKAGE COVERS

Water Pump Removal, Water Pump Seal Removal, Water Pump Seal Installation, Water Pump Installation

INITIAL SETUP

Tools and Special tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pliers, retaining ring (Item 26, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Gasket (P/N 23520377)

Seal (P/N 5101160)

Antifreeze, ethylene glycol (Item 4, WP 0235 00)

Oil, lubricating (Item 19, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

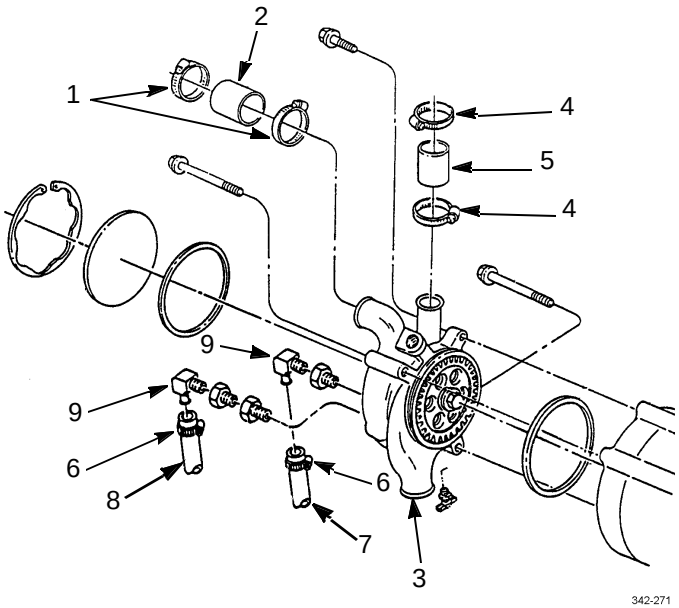
Oil level dipstick removed (WP 0023 00)

Cooling system drained (WP 0041 00)

Radiator-to-water pump coolant line removed (WP 0042 00)

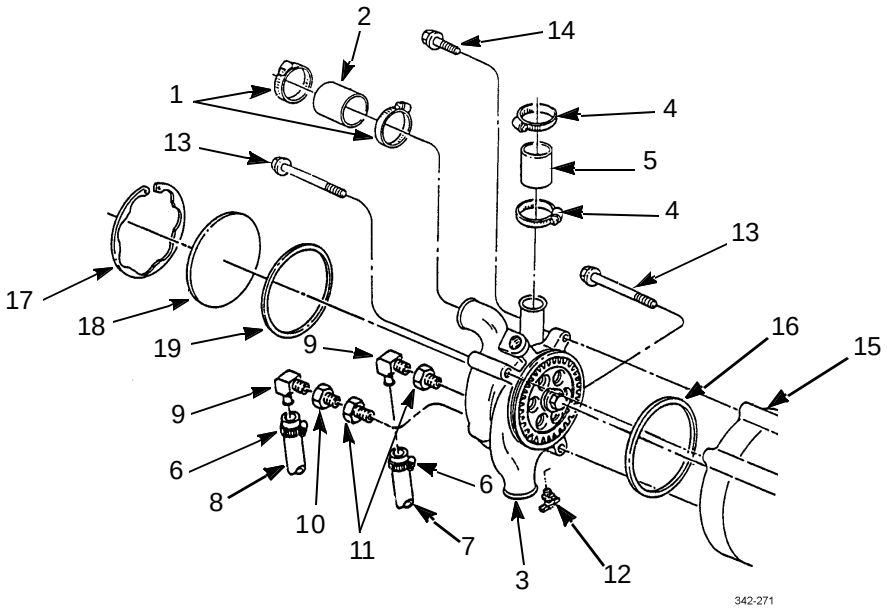
WATER PUMP REMOVAL

1. Loosen two hose clamps (1) and remove oil cooler hose (2) from back from water pump (3).
2. Loosen two hose clamps (4) and remove water bypass hose (5) from water pump (3).
3. Loosen two hose clamps (6) and remove water filter hose (7) and heater hose (8) from two elbows (9).



WATER PUMP REMOVAL - CONTINUED

4. Remove two elbows (9), adapter (10), and two bushings (11) from water pump (3).
5. Remove drain valve (12) from water pump (3).
6. Remove two long bolts (13) and short bolt (14) from water pump (3) and gear case (15).
7. Pull water pump (3) straight out of gear case (15).
8. Remove gasket (16). Discard gasket.



WATER PUMP SEAL REMOVAL

WARNING

Size and tension of snap ring could cause injury to personnel if snap ring slips off snap ring pliers. Wear face shield when removing water pump cover snap ring.

1. Remove water pump cover snap ring (17) from water pump (3).
2. Remove water pump cover (18) and seal (19) from water pump (3). Discard seal.

WATER PUMP SEAL INSTALLATION

1. Support impeller side of water pump (3) on workbench and install new seal (19) in bore of water pump (3).
2. Install water pump cover (18) on water pump (3).

WATER PUMP SEAL INSTALLATION - CONTINUED

WARNING

Size and tension of snap ring could cause injury to personnel if snap ring slips off snap ring pliers. Wear face shield when installing water pump cover snap ring.

3. Install water pump cover snap ring (17) in groove of water pump (3). Tap around inside rim of snap ring to fully seat in groove of water pump.

WATER PUMP INSTALLATION

1. Apply a light coat of clean lubricating oil to new gasket (16). Install gasket in groove on water pump (3).
2. Position water pump (3) on gear housing (15), meshing water pump gear with gear train. Install water pump with two long bolts (13) and short bolt (14). Tighten bolts to 43-54 lb-ft (58-73 Nm).
3. Install drain valve (12) on water pump (3).
4. Install two bushings (11), adapter (10), and two elbows (9) on water pump (3).
5. Position two hose clamps (6), heater hose (8), and water filter hose (7) on two elbows (9). Tighten hose clamps.
6. Position two hose clamps (4) and water bypass hose (5) on water pump (3). Tighten hose clamps.
7. Position two hose clamps (1) and oil coo1er hose (2) on back of water pump (3). Tighten hose clamps.
8. Install oil level dipstick (WP 0023 00).
9. Install radiator-to-water pump coolant line (WP 0042 00).
10. Fill cooling system (WP 0041 00).
11. Operate vehicle (TM 9-2320-302-10) and check for coolant leaks.

END OF WORK PACKAGE

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SPINDLE AND HOUSING REPLACEMENT 0053 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

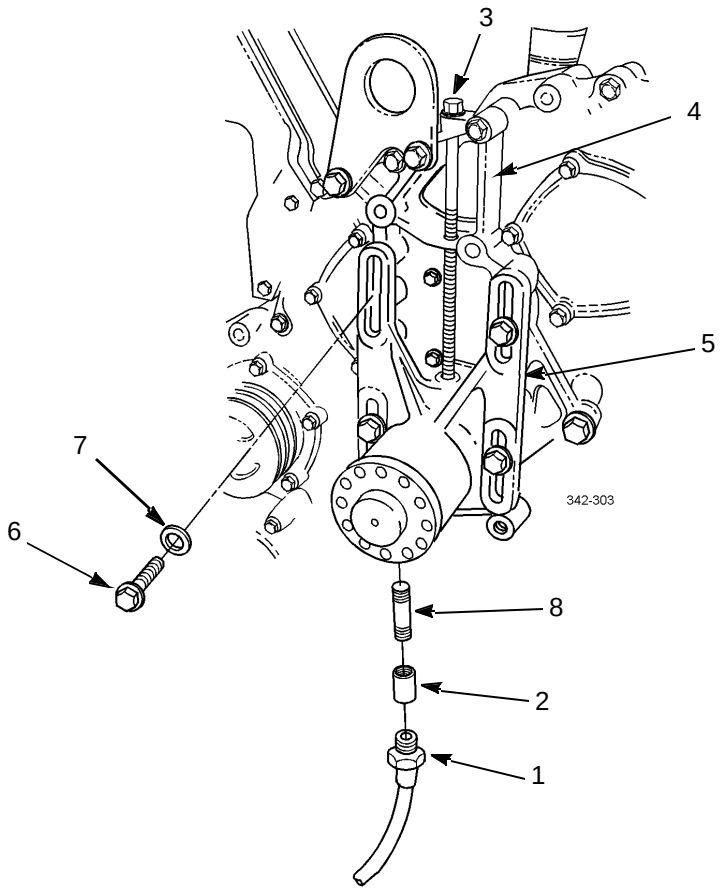
Equipment Condition

Air system drained (TM 9-2320-302-10)

Fan clutch and drive pulley removed (WP 0049 00)

REMOVAL

1. Remove air hose connector (1) from coupling (2).
2. Remove adjuster bolt (3) from fan mounting support (4) and spindle housing (5).
3. Remove four screws (6), washers (7), and spindle housing (5) from fan mounting support (4).
4. Remove coupling (2) and pipe nipple (8) from spindle housing (5).



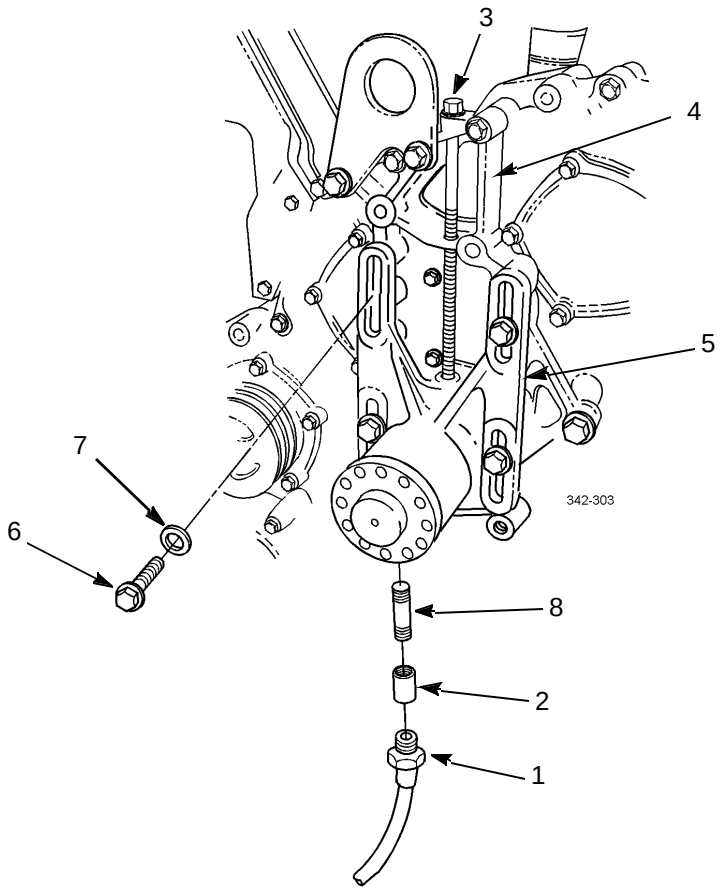
INSTALLATION

1. Install pipe nipple (8) and coupling (2) on spindle housing (5).

NOTE

DO NOT fully tighten screws.

2. Install spindle housing (5) on fan mounting support (4) with four washers (7) and screws (6).
3. Loosely install adjuster bolt (3) on fan mounting support (4) and spindle housing (5).
4. Install air hose connector (1) on coupling (3).



5. Install fan clutch and drive pulley (WP 0049 00).

END OF WORK PACKAGE

ALTERNATOR BELT REPLACEMENT AND ADJUSTMENT 0054 00

THIS WORK PACKAGE COVERS

Removal, Installation, and Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)
Tensiometer, dial indicating (Item 32, WP 0236 00)
Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

References

TM 9-2320-302-10

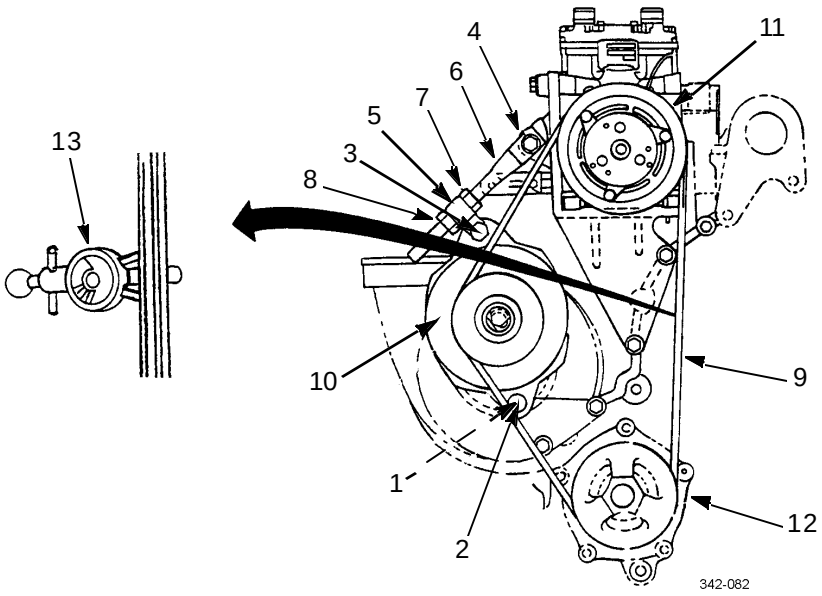
REMOVAL

1. Hold self-locking nut (1) and loosen hex cap screw (2).
2. Loosen two cap screws (3 and 4) securing adjusting rod link (5) and rod (6) to engine.
3. Loosen hex nut (7) and tighten hex nut (8) to loosen tension on drive belt (9).

NOTE

After loosening tension drive belt remains tight or is difficult to remove from pulleys, proceed to step 5.

4. Remove drive belt (9) from alternator pulley (10), air conditioning compressor pulley (11), and accessory drive pulley (12).
5. Remove cap screw (3) and rotate alternator until drive belt (9) can be removed.

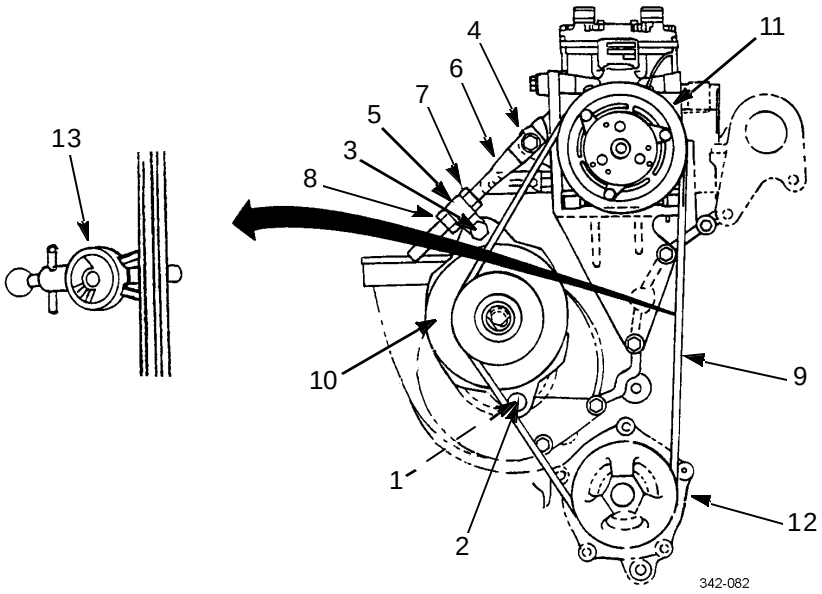


INSTALLATION

1. Position drive belt (9) on alternator pulley (10), air conditioning compressor pulley (11), and accessory drive pulley (12).
2. Install cap screw (3) if removed. If not, proceed to step 3.
3. Tighten drive belt tension by loosening hex nut (8) and tightening hex nut (7) on adjusting rod (6) and link (5) until drive belt is tight. Tighten hex nut (8).
4. Tighten three cap screws (2, 3, and 4) to 60-70 ft-lb (81-95 Nm).

ADJUSTMENT

1. Back off hex nut (8) and tighten hex nut (7) until belt tension measures 90-100 lb (400 N) on tensiometer (13).
2. Start engine (TM 9-2320-302-10) and operate engine for 30 minutes (or 15 miles).
3. Check belt tension and adjust as required to maintain 80-100 lb-ft (36-45 Nm). Recheck belt tension again after 8 hours of operation and adjust as required.



END OF WORK PACKAGE

ALTERNATOR REPLACEMENT 0055 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-33)

Washer, lock (Din 127-B10.1-4310)

Tags, marker (Item 31, WP 0235 00)

Equipment Condition

Alternator belt removed (WP 0054 00)

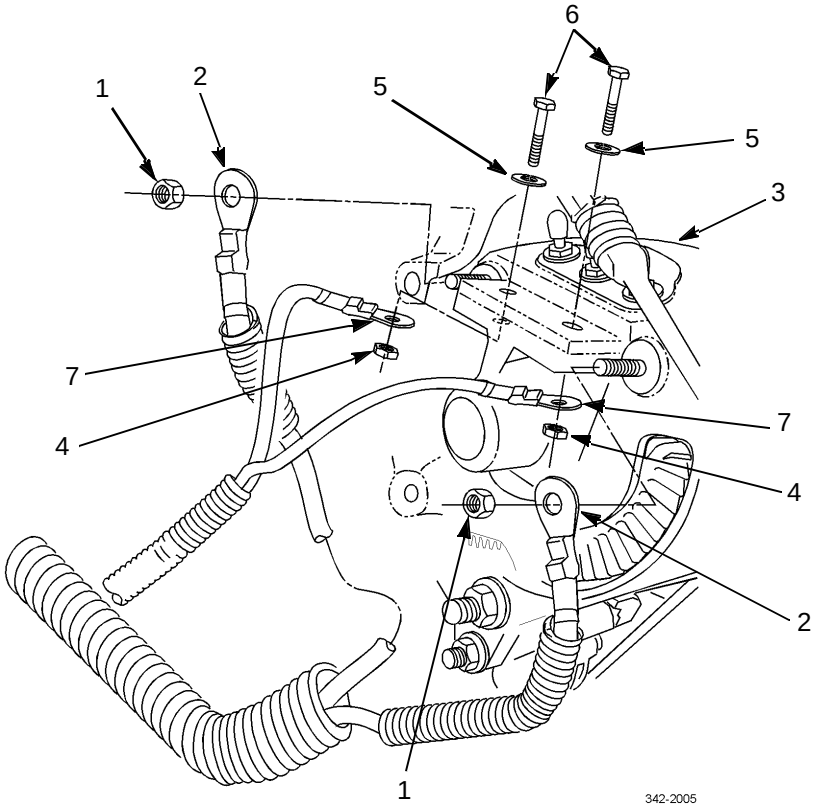
Master battery switch OFF (TM 9-2320-302-10)

NOTE

Tag all electrical leads to aid in installation.

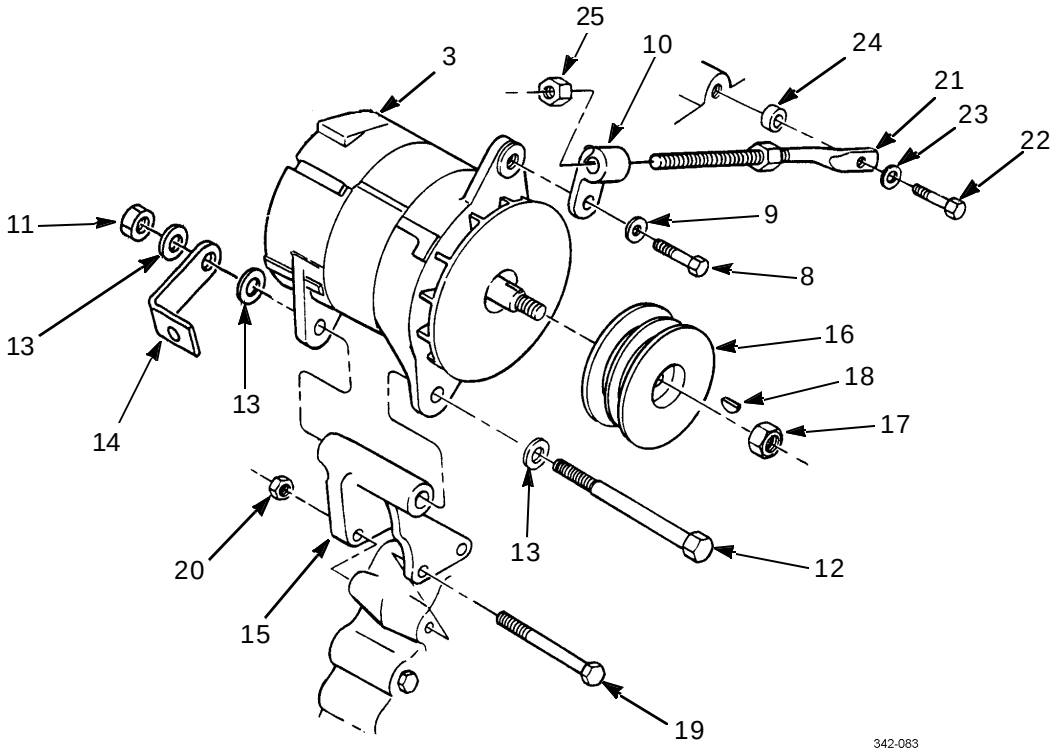
REMOVAL

1. Remove two nuts (1) and electrical leads (2) from alternator (3).
2. Remove two nuts (4), two washers (5), two bolts (6), and two electrical leads (7) from alternator (3).



REMOVAL - CONTINUED

3. Remove cap screw (8), bearing washer (9), and adjusting rod link (10) from alternator (3).



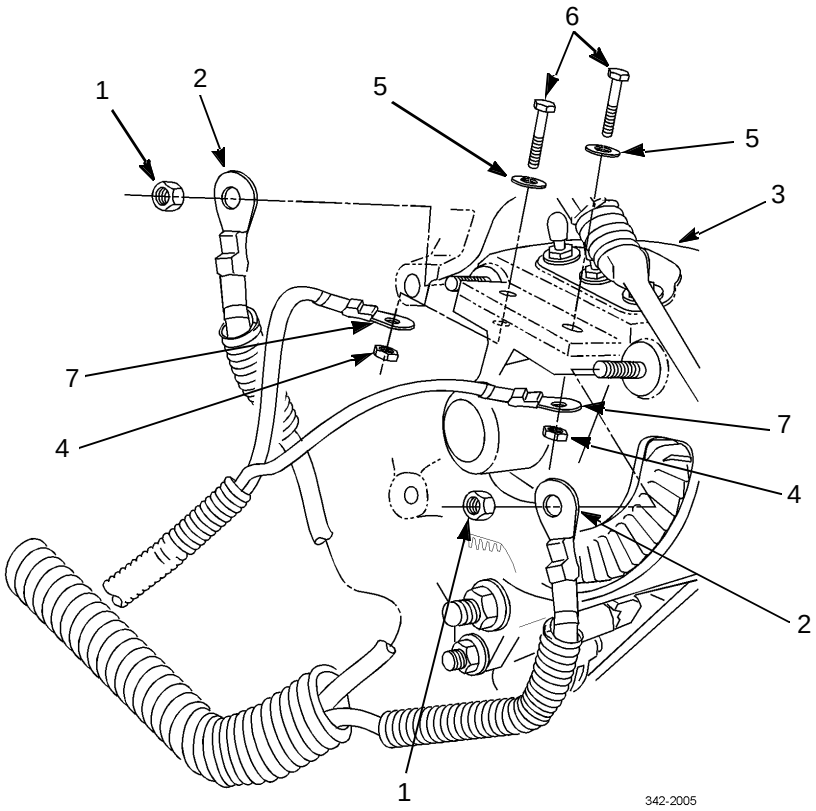
4. Support alternator (3) and remove lock nut (11), cap screw (12), three bearing washers (13), alternator, and angle bracket (14) from lower mount (15). Discard lock nut.
5. Hold alternator pulley (16) in vise and remove hex nut (17), key (18), and pulley from alternator (3). Retain pulley for use on new alternator.
6. Inspect lower mounting bracket (15) for damage. If damaged, remove two bolts (19), nuts (20) and lower mounting bracket.
7. Inspect adjusting rod (21) for damage. If damaged, remove cap screw (22), lock washer (23), spacer (24), and adjusting rod. Discard lock washer.
8. Remove two hex nuts (25) and adjusting rod link (10) from adjusting rod (21).

INSTALLATION

1. Install pulley (16) and key (18) on alternator (3) with hex nut (17).
2. If removed, install lower mounting bracket (15) with two bolts (19) and nuts (20).
3. If removed, install adjusting rod (21), with two hex nuts (25) and adjusting rod link (10), with new lock washer (23), spacer (24), and cap screw (22).
4. Support alternator (4) and secure to lower mounting bracket (15) with cap screw (12), three bearing washers (13), angle bracket (14), and new lock nut (11). Do not tighten at this time.
5. Install alternator (3) on adjusting rod link (10) with bearing washer (9) and cap screw (8).

INSTALLATION - CONTINUED.

6. Install two electrical leads (7) on alternator (3) with two washers (5), two bolts (6), and nuts (4).
7. Install electrical leads (2) on alternator (3) with two nuts (1).



8. Install and adjust alternator belt (WP 0054 00).

END OF WORK PACKAGE

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STARTER REPLACEMENT 0056 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)
Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)
Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)
Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Personnel Required

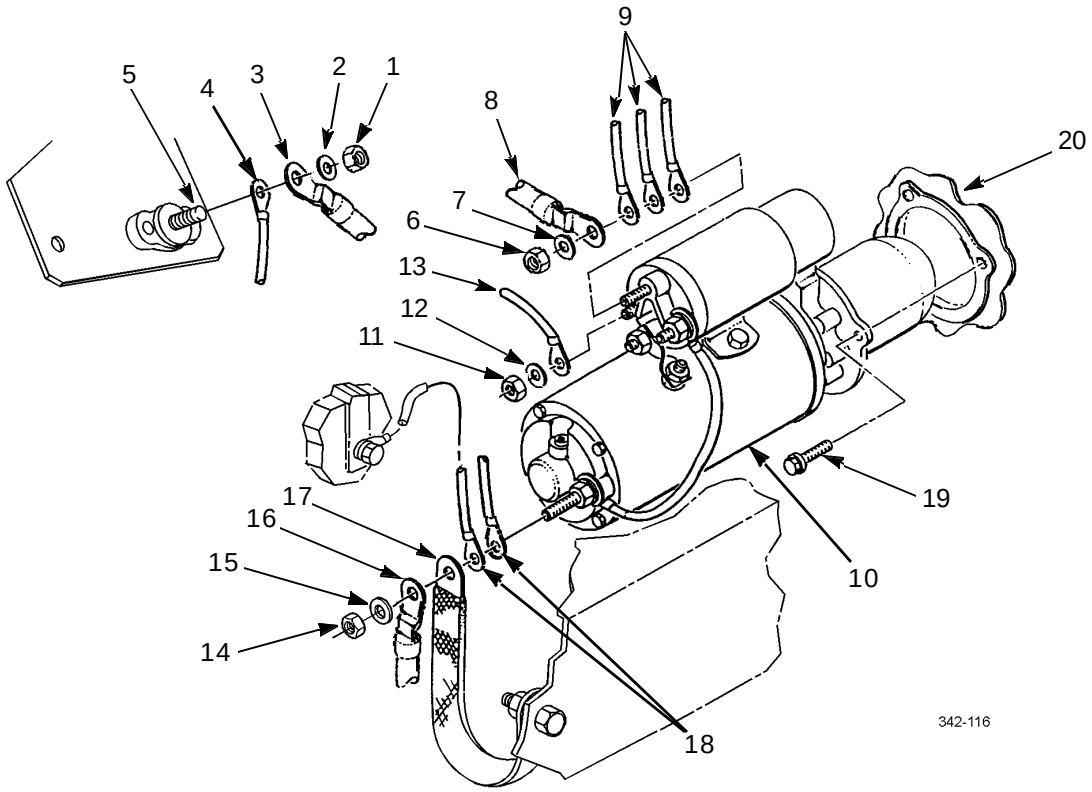
Two

Equipment Condition

Master battery switch OFF (TM 9-2320-302-10)

REMOVAL

1. Remove nut (1), washer (2), cable (3), and wire (4) from threaded stud (5).
2. Remove nut (6), washer (7), cable (8), and three wires (9) from starter (10).
3. Remove nut (11), washer (12), and wire (13) from starter (10).
4. Remove nut (14), washer (15), cable (16), ground strap (17), and two wires (18) from starter (10).
5. While supporting starter (10), remove three screws (19). Remove starter from engine flywheel housing (20).



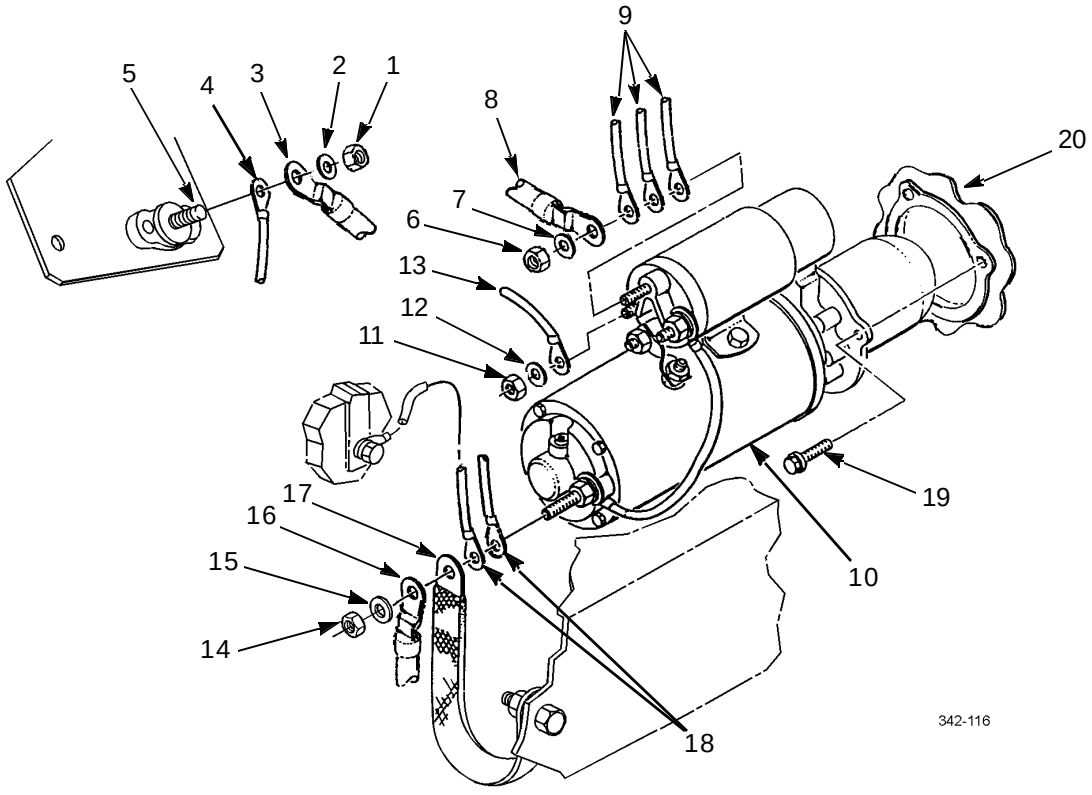
INSTALLATION

1. While supporting starter (10), install starter on engine flywheel housing (20) with three screws (19). Do not fully tighten screws.

NOTE

For aluminum flywheel housings, tighten screws to 138-154 lb-ft (187-209 Nm). For cast iron flywheel housings, tighten screws to 181-226 lb-ft (245-306 Nm).

2. Tighten three screws (19).
3. Install two wires (18), ground strap (17), cable (16), washer (15), and nut (14) on starter (10). Tighten nut to 20-25 lb-ft (27-34 Nm).
4. Install wire (13), washer (12), and nut (11) on starter (10). Tighten nut to 16-30 lb-ft (1.8-3.4 Nm).
5. Install three wires (9), cable (8), washer (7), and nut (6) on starter (10). Tighten nut to 16-30 lb-ft (1.8-3.4 Nm).
6. Install wire (4), cable (3), washer (2), and nut (1) on threaded stud (5). Tighten nut to 16-30 lb-ft (1.8-3.4 Nm).



END OF WORK PACKAGE

VOLTAGE REGULATOR REPLACEMENT 0057 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

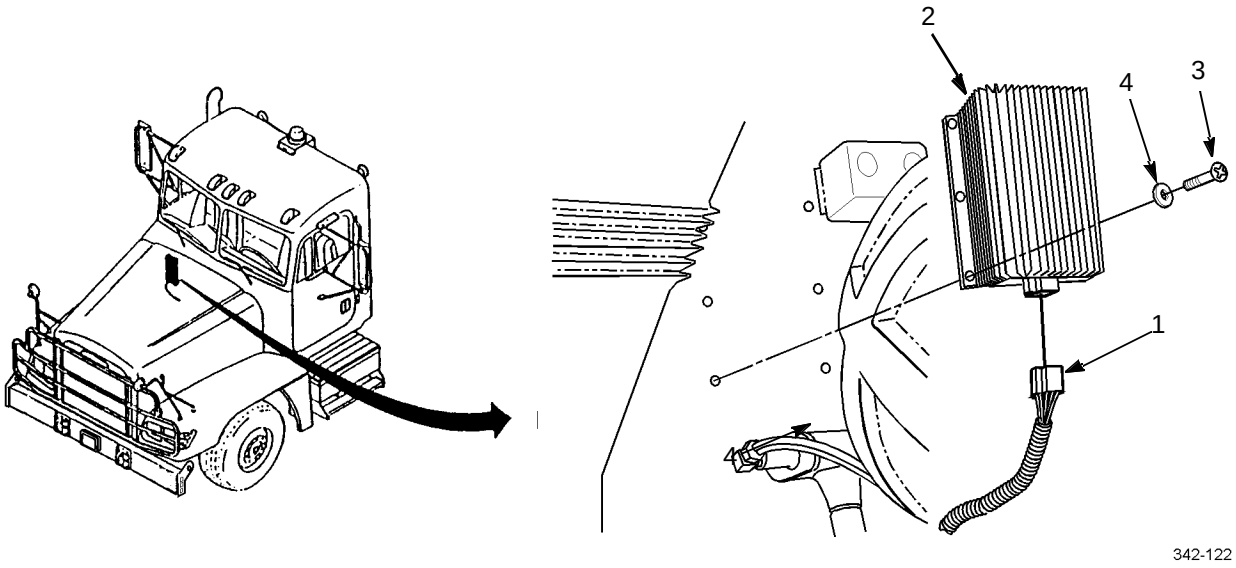
Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Battery cables disconnected (WP 0115 00)

REMOVAL

1. Disconnect plug (1) from voltage regulator (2).
2. Remove six screws (3), six washers (4), and voltage regulator (2).



INSTALLATION

1. Install voltage regulator (2) with six washers (4), and six screws (3).
2. Connect plug (1) on voltage regulator (2).

END OF WORK PACKAGE

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BATTERY EQUALIZER REPLACEMENT 0058 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

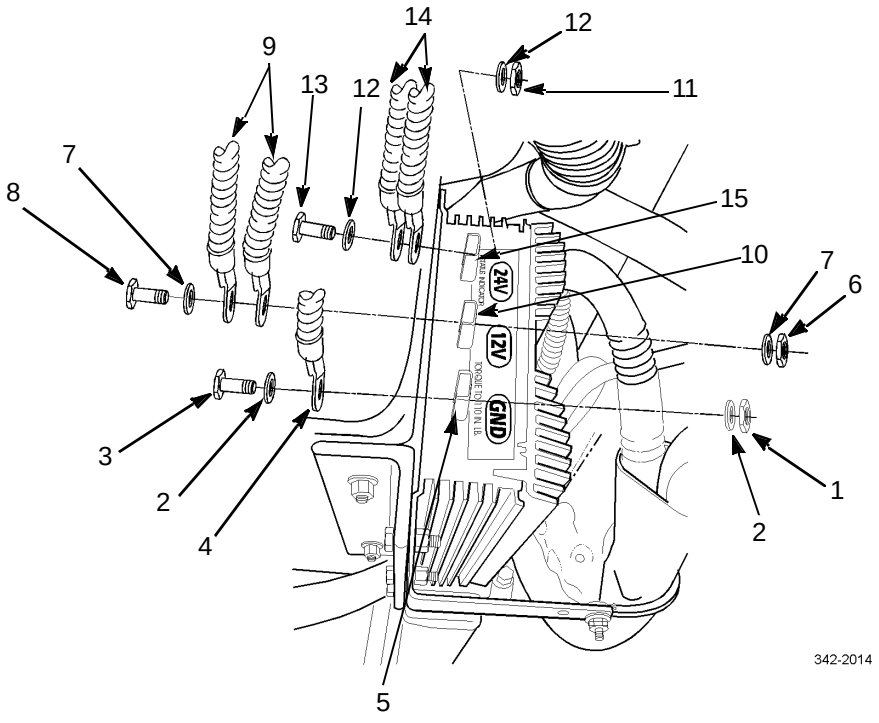
Battery cables disconnected (WP 0115 00)

REMOVAL

NOTE

Tag wires to aid in installation.

1. Remove nut (1), two washers (2), bolt (3), and cable lead (4) from GND terminal (5).
2. Remove nut (6), two washers (7), bolt (8), and two cable leads (9) from 12V terminal (10).
3. Remove nut (11), two washers (12), bolt (13), and two cable leads (14) from 24V terminal (15).



BATTERY EQUALIZER REPLACEMENT - CONTINUED **0058 00**

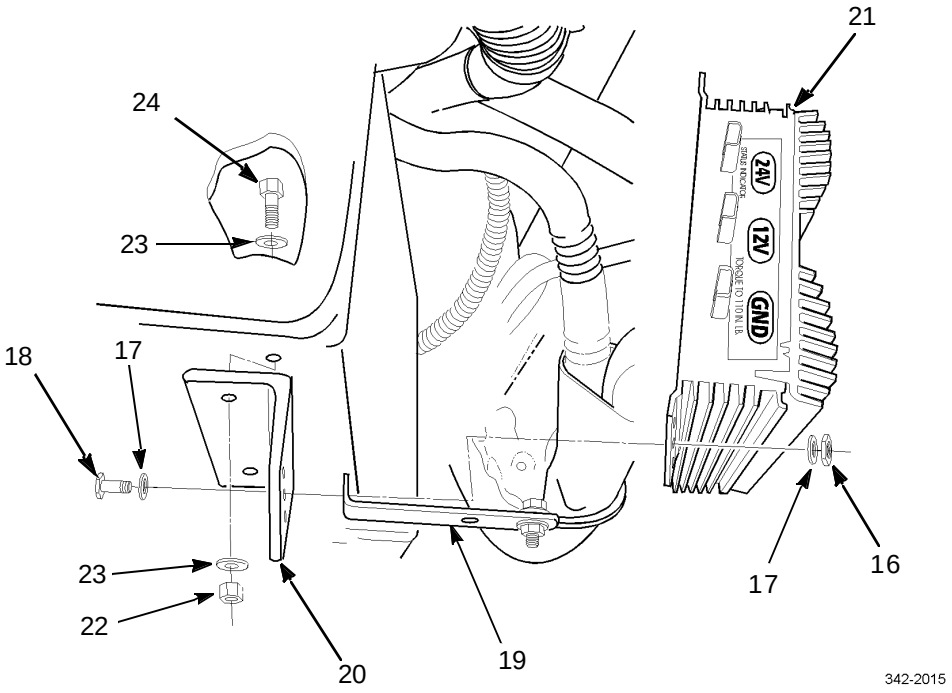
REMOVAL - CONTINUED

4. Remove nut (16), two washers (17), and bolt (18) securing cable bracket (19) to equalizer bracket (20).
5. Remove remaining five nuts (16), ten washers (17), five bolts (18), and battery equalizer (21).

NOTE

Perform step 6, only if bracket is damaged.

6. Remove two nuts (22), four washers (23), two bolts (24), and bracket (20).



INSTALLATION

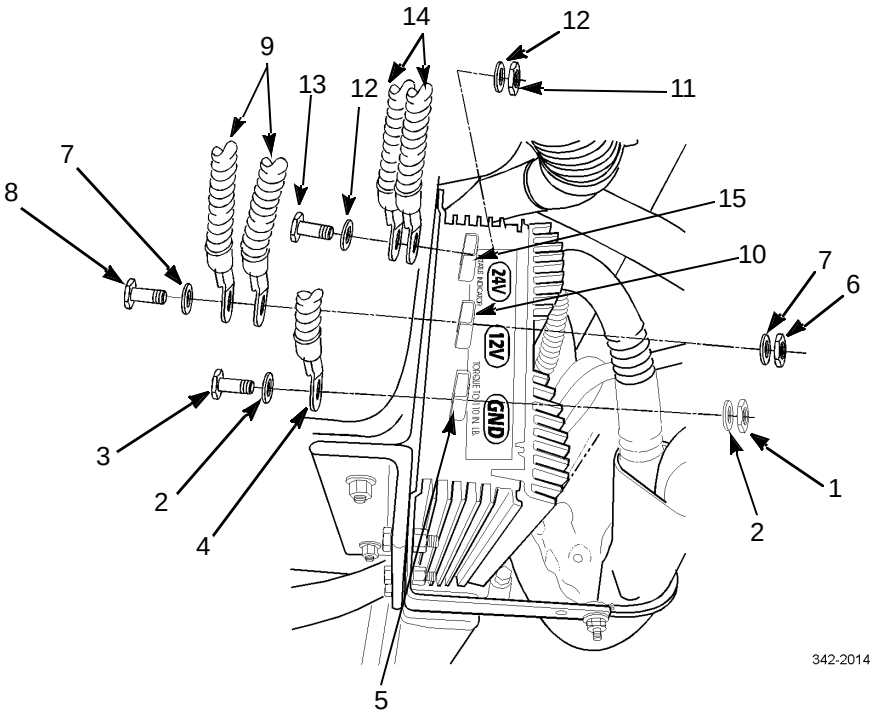
NOTE

Perform step 1, only if bracket was removed.

1. Position bracket (20) and handtighten two bolts (24), four washers (23), and two nuts (22).
2. Position battery equalizer (21) and handtighten top three nuts (16), six washers (17), and three bolts (18).
3. Position cable bracket (19) on bottom center hole and handtighten one nut (16), two washers (17), and one bolt (18).
4. Handtighten remaining two bolts (18), four washers (17), and two nuts (16).
5. Tighten eight nuts (16 and 22).

REMOVAL - CONTINUED

6. Install two cable leads (14), bolt (13), two washers (12), and nut (11) to 24V terminal (15).
7. Install two cable leads (9), bolt (8), two washers (7), and nut (6) to 12V terminal (10).
8. Install cable lead (4), bolt (3), two washers (2), and nut (1) to GND terminal (5).



END OF WORK PACKAGE

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STARTER RELAY REPLACEMENT 0059 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

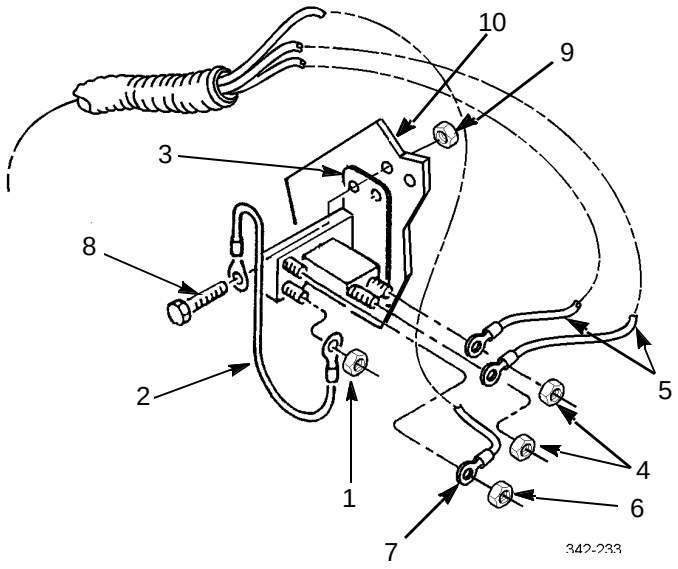
Tags, marker (Item 31, WP 0235 00)

NOTE

Tag wires to aid in installation.

REMOVAL

1. Remove lock nut (1) and wire (2) from starter relay (3).
2. Remove two nuts (4) and wires (5) from starter relay (3).
3. Remove lock nut (6) and wire (7) from starter relay (3).
4. Remove two bolts (8), nuts (9), wire (2), and starter relay (3) from vehicle firewall (10).



INSTALLATION

1. Install starter relay (3) and wire (2) on vehicle firewall (10) with two bolts (8) and nuts (9).
2. Install wire (7) on starter relay (3) with lock nut (6).
3. Install two wires (5) on starter relay (3) with two nuts (4).
4. Install wire (2) on starter relay (3) with lock nut (1).

END OF WORK PACKAGE

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LEFT PANEL GAGES AND LAMPS REPLACEMENT 0060 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

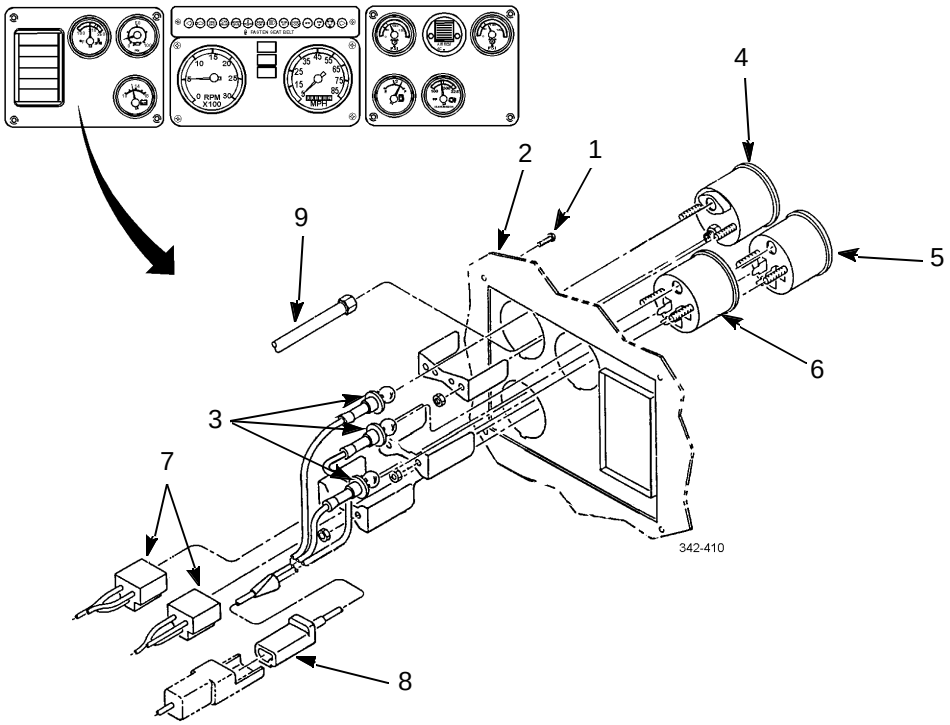
REMOVAL

1. Remove four screws (1) and pull panel (2) away from dashboard.
2. Remove three lamp holders (3) from engine oil pressure gage (4), engine water temperature gage (5), and voltmeter (6).

NOTE

Tag all plugs and tubes to aid in installation.

3. Remove two plugs (7), connector (8), and two tubes (9) from engine oil pressure gage (4), engine water temperature gage (5), and voltmeter (6). Remove panel (2).

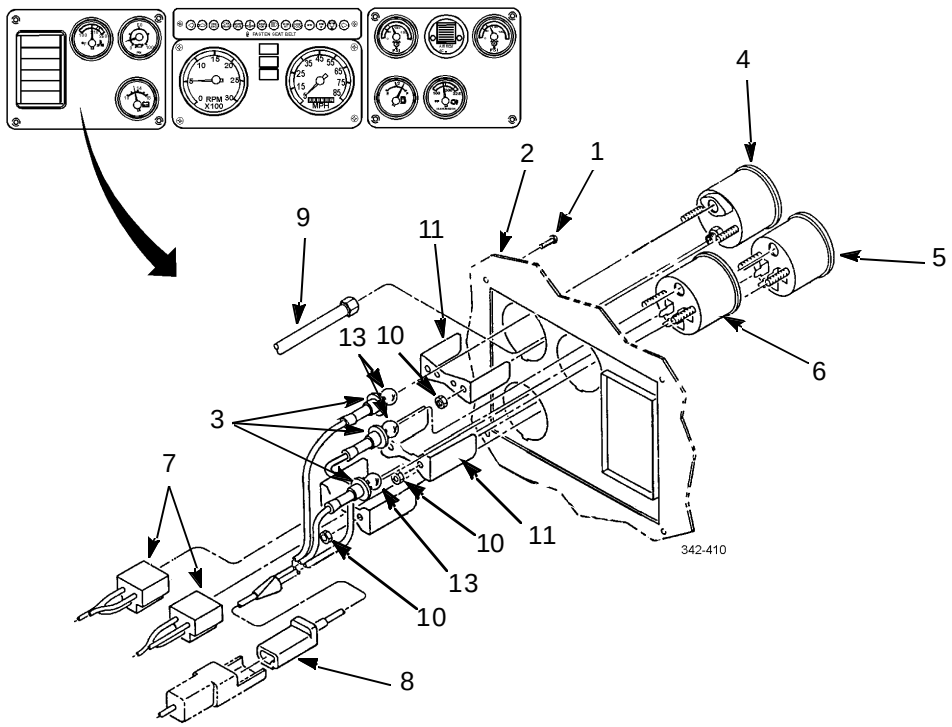


REMOVAL - CONTINUED

NOTE

Note location of gages to aid in installation.

4. Remove two lock nuts (10), bracket (11), and engine oil pressure gage (4) from panel (2).
5. Repeat step 4 for engine water temperature gage (5) and voltmeter (6).
6. Remove air vent (12) from panel (2).
7. Turn three lamps (13) to left and remove from lamp holders (3).



INSTALLATION

1. Install three lamps (13) in lamp holders (3). Turn lamps to right to lock in place.
2. Install air vent (12) on panel (2).
3. Install engine oil pressure gage (4) and bracket (11) on panel (2) with two lock nuts (10).
4. Repeat step 3 for engine water temperature gage (5) and voltmeter (6).
5. Install three lamp holders (3) on engine oil pressure gage (4), engine water temperature gage (5), and voltmeter (6).
6. Install two tubes (9), connector (8), and two plugs (7) on engine oil pressure gage (4), engine water temperature gage (5), and voltmeter (6).
7. Install panel (2) on dashboard with four screws (1).
8. Run vehicle and build air pressure to proper level (TM 9-2320-302-10). Check operation of gages and check for air system leaks.

END OF WORK PACKAGE

CENTER GAGE PANEL MAINTENANCE 0061 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

REMOVAL

1. Remove four screws (1) and pull panel (2) away from dashboard.

NOTE

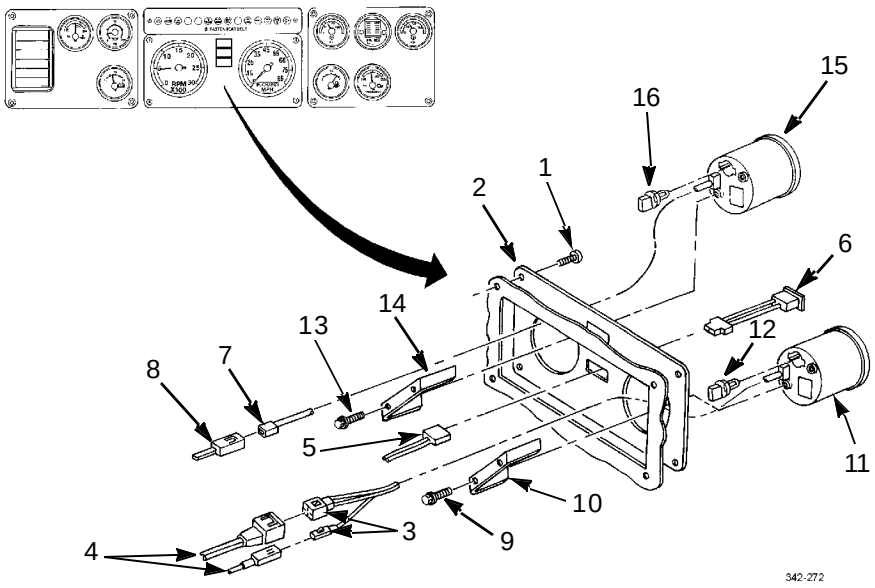
Tag connectors to aid in installation.

2. Disconnect two connectors (3) from cab wiring harness connectors (4).

NOTE

Center gage panel has three indicator lights: parking brake, tractor ABS, and trailer ABS.

3. Remove cab wiring harness connectors (5) from indicator lights (6). Remove indicator lights.
4. Remove connector (7) from cab wiring harness connector (8). Remove panel (2).
5. Remove two screws (9), bracket (10), and tachometer (11) from panel (2). Remove lamp (12) from tachometer.
6. Remove two screws (13), bracket (14), and speedometer (15) from panel (2). Remove lamp (16) from speedometer.

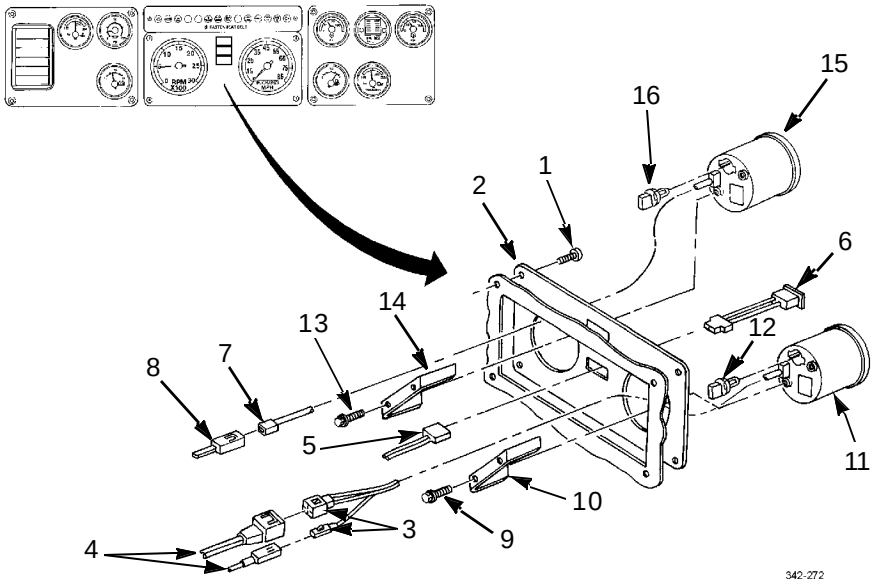


INSTALLATION

NOTE

Panel has three indicator lights: parking brake, tractor ABS, and trailer ABS.

1. Install indicator lights (6) on panel (2).
2. Install speedometer (15) on panel (2) with bracket (14) and two screws (13). Install lamp (16) in speedometer.
3. Install tachometer (11) to panel (2) with bracket (10) and two screws (9). Install lamp (12) in tachometer.
4. Install connector (7) on cab wiring harness connector (8).
5. Install cab wiring harness connectors (5) to indicator lights (6).
6. Connect two connectors (3) to cab wiring harness connectors (4).
7. Install panel (2) on dashboard with four screws (1).



END OF WORK PACKAGE

RIGHT GAGE PANEL AND LAMPS REPLACEMENT 0062 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

Equipment Condition

Air system drained (TM 9-2320-302-10)

References

TM 9-2320-302-10

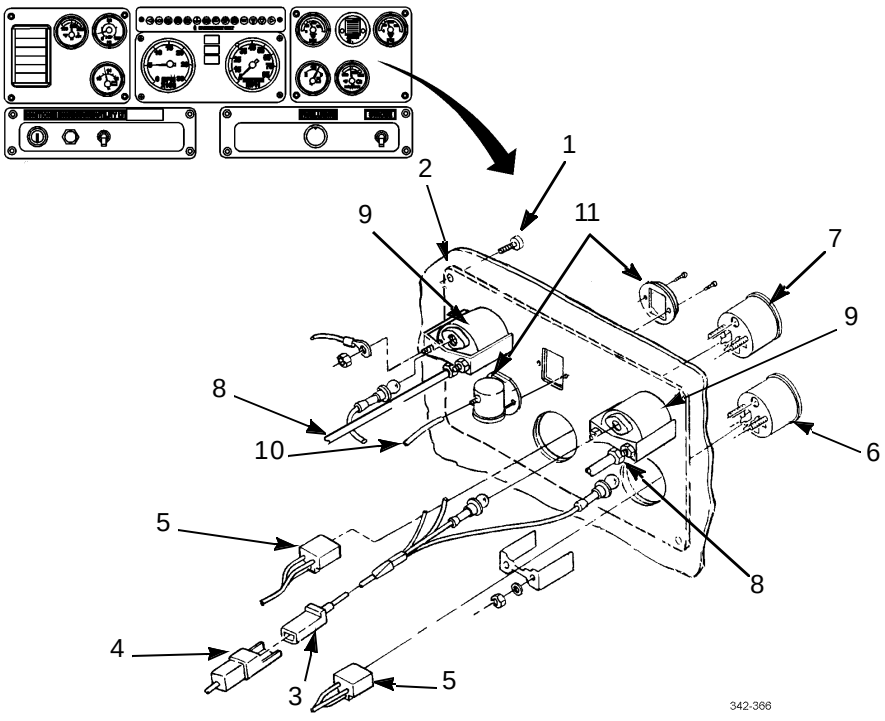
REMOVAL

1. Remove four screws (1) and pull panel (2) away from dashboard.

NOTE

Tag all air tubes, connectors, and gages prior to removal to aid in installation.

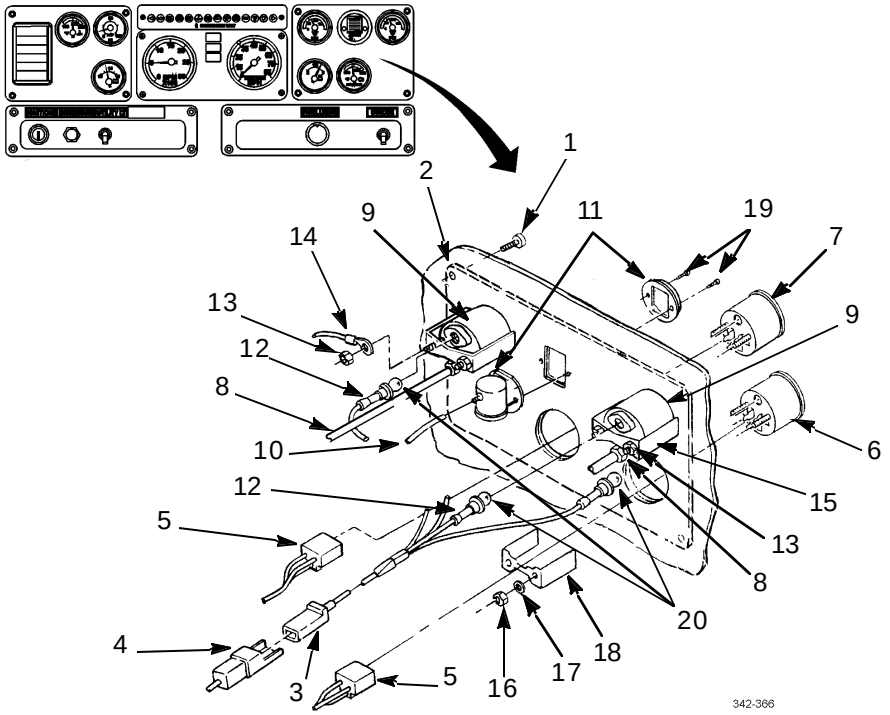
2. Remove connector (3) from cab wiring harness connector (4).
3. Remove two connectors (5) from fuel level gage (6) and transmission oil temperature gage (7).
4. Remove two tubes (8) from air pressure gages (9). Disconnect tube (10) from air cleaner restriction indicator gage (11).
5. Remove panel (2) from dashboard.



RIGHT GAGE PANEL AND LAMPS REPLACEMENT - CONTINUED 0062 00

REMOVAL - CONTINUED

6. Remove four lamp holders (12) from fuel level gage (6), transmission oil temperature gage (7), and two air pressure gages (9).
7. Remove four lock nuts (13), ground wire (14), two brackets (15), and two air pressure gages (9) from panel (2).
8. Remove four nuts (16), washers (17), two brackets (18), fuel level gage (6), and transmission oil temperature gage (7) from panel (2).
9. Remove two screws (19) and air cleaner restriction indicator gage (11) from panel (2).
10. Turn four lamps (20) to left and remove from lamp holders (12).



INSTALLATION

1. Install four lamps (20) in lamp holders (12). Turn lamps to right to lock in place.
2. Install air cleaner restriction indicator gage (11) on panel (2) with two screws (19).
3. Install fuel level gage (6) and transmission oil temperature gage (7) on panel (2) with two brackets (18), four washers (17), and nuts (16).
4. Install two air pressure gages (9) on panel (2) with two brackets (15), ground wire (14), and four new lock nuts (13).
5. Install four lamp holders (12) on fuel level gage (6), transmission oil temperature gage (7), and two air pressure gages (9).
6. Install two tubes (8) to air pressure gages (9). Connect tube (10) to air cleaner restriction indicator gage (11).
7. Install two connectors (5) on fuel level gage (6) and transmission oil temperature gage (7).
8. Install connector (3) on cab wiring harness connector (4).
9. Install panel (2) on dashboard with four screws (1).

END OF WORK PACKAGE

UPPER RIGHT DASH PANEL REPLACEMENT 0063 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

Equipment Condition

Parking brake and trailer air supply valve removed (WP 0160 00)

References

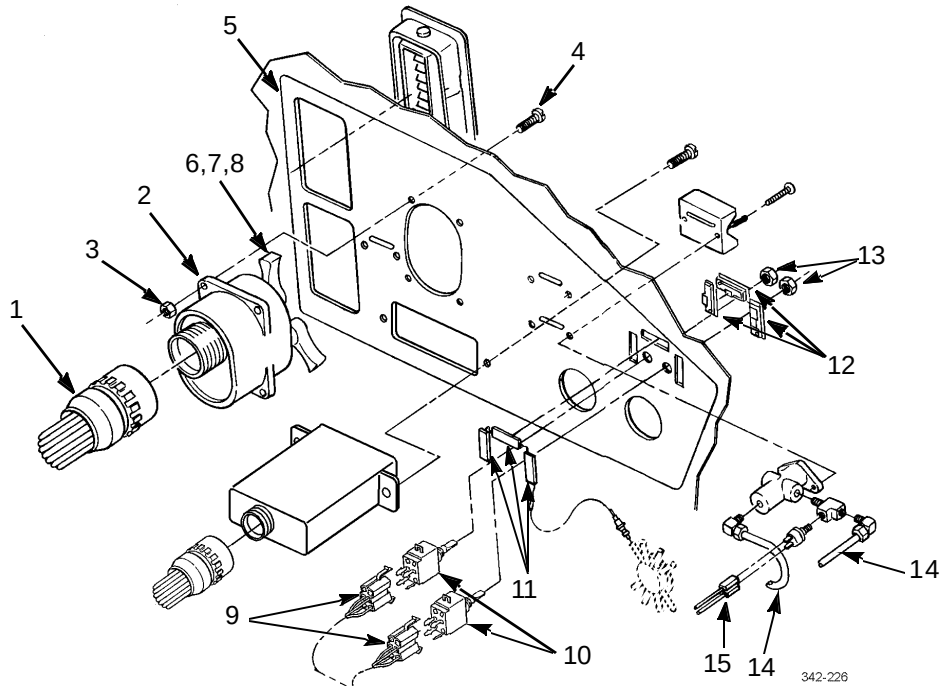
TM 9-2320-302-10

NOTE

Tag air tubes and electrical connectors to aid in installation.

REMOVAL

1. Remove connector (1) from light switch (2).
2. Remove four nuts (3), screws (4), and light switch (2) from panel (5).
3. As required, remove three screws (6), knobs (7), and washers (8) from light switch (2).
4. Remove two connectors (9) from switches (10).
5. Remove three fiber optic labels (11) from panel (5).
6. Remove three label holders (12), two nuts (13), and two switches (10) from panel (5).
7. Remove two tubes (14) and connector (15).



REMOVAL - CONTINUED

NOTE

Two control valves are removed the same way. One control valve is illustrated. Perform steps 8 and 9 for all control valves.

8. Remove two screws (16), guard (17), and control valve (18) from panel (5).
9. Remove two elbows (19), sending unit (20), and tee (21) from control valve (18).
10. Remove connector (22) from driver display unit (23).
11. Remove two nuts (24), screws (25), and driver display unit (23) from panel (5).
12. Remove two air vents (26) from panel (5).
13. Remove panel (5) from dashboard.

INSTALLATION

1. Install two air vents (26) on panel (5).
2. Position panel (5) to dashboard.
3. Install driver display unit (23) to panel (5) with two screws (25) and nuts (24).
4. Install connector (22) to driver display unit (23).

WARNING

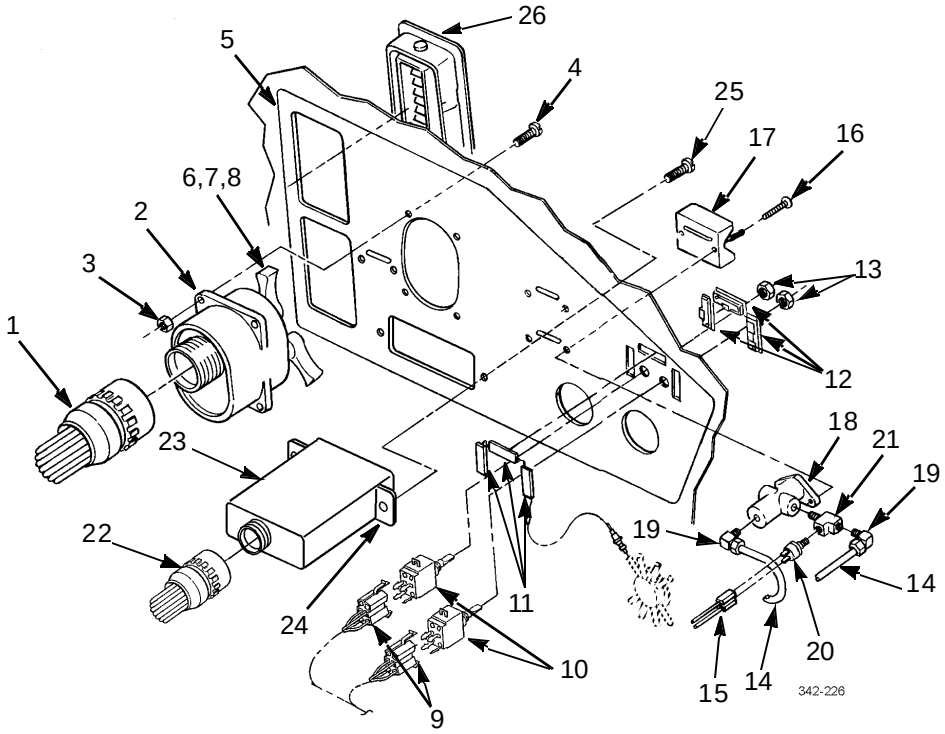
Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

NOTE

- Two control valves are installed the same way. One control valve is illustrated. Perform steps 5 and 6 for all control valves.
- Apply pipe sealing compound to threads of all fittings before installation.

5. Install tee (21), two elbows (19), and sending unit (20) on control valve (18).
6. Install control valve (18) and guard (17) on panel (5) with two screws (16).
7. Install two tubes (14). Install connector (15) on sending unit (20).
8. Install three label holders (12) on panel (5).
9. Install two switches (10) on panel (5) with two nuts (13).
10. Install three fiber optic labels (11) on panel (5).
11. Install two connectors (9) on switches (10).
12. If removed, install three washers (8), knobs (7), and screws (6) on light switch (2).
13. Install light switch (2) on panel (5) with four screws (4) and nuts (3).
14. Install connector (1) on light switch (2).

INSTALLATION - CONTINUED



15. Install parking brake and trailer air supply valve (WP 0160 00).

END OF WORK PACKAGE

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LEFT HAND SWITCH PANEL MAINTENANCE 0064 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

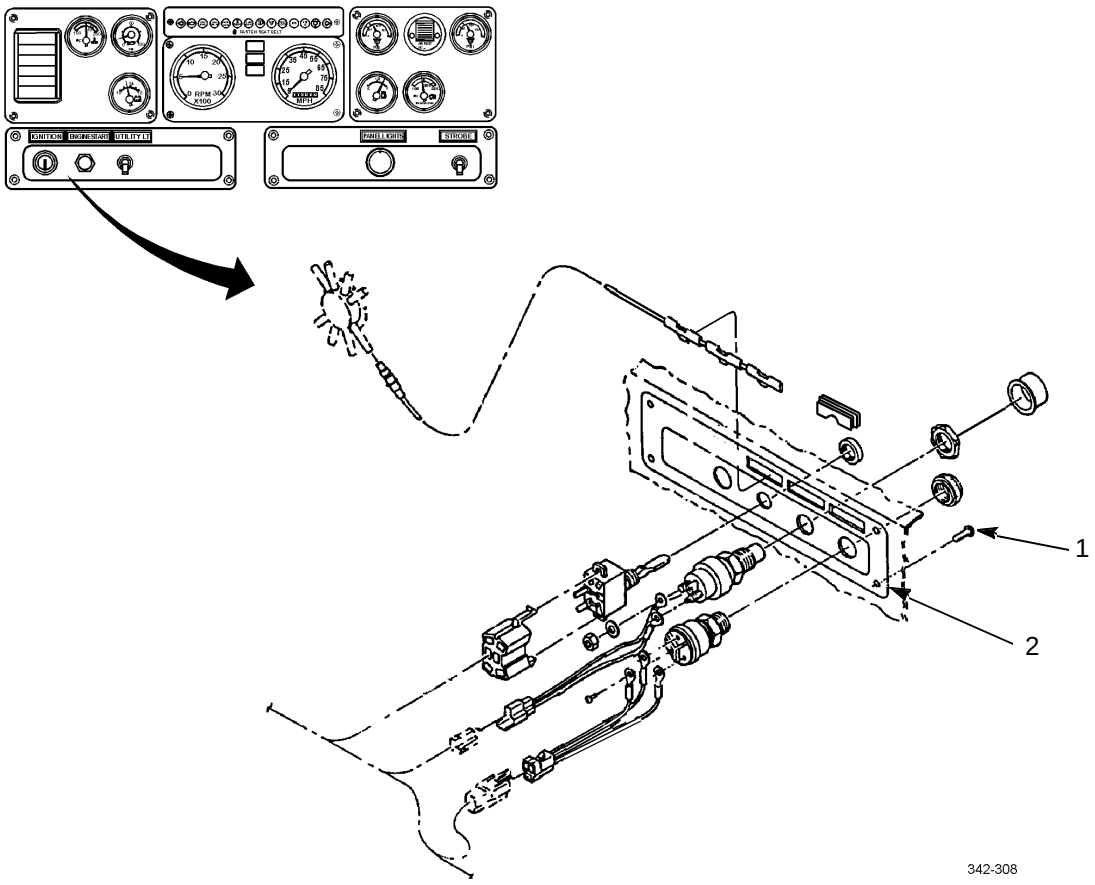
Tags, marker (Item 31, WP 0235 00)

NOTE

Tag all connectors to aid in installation.

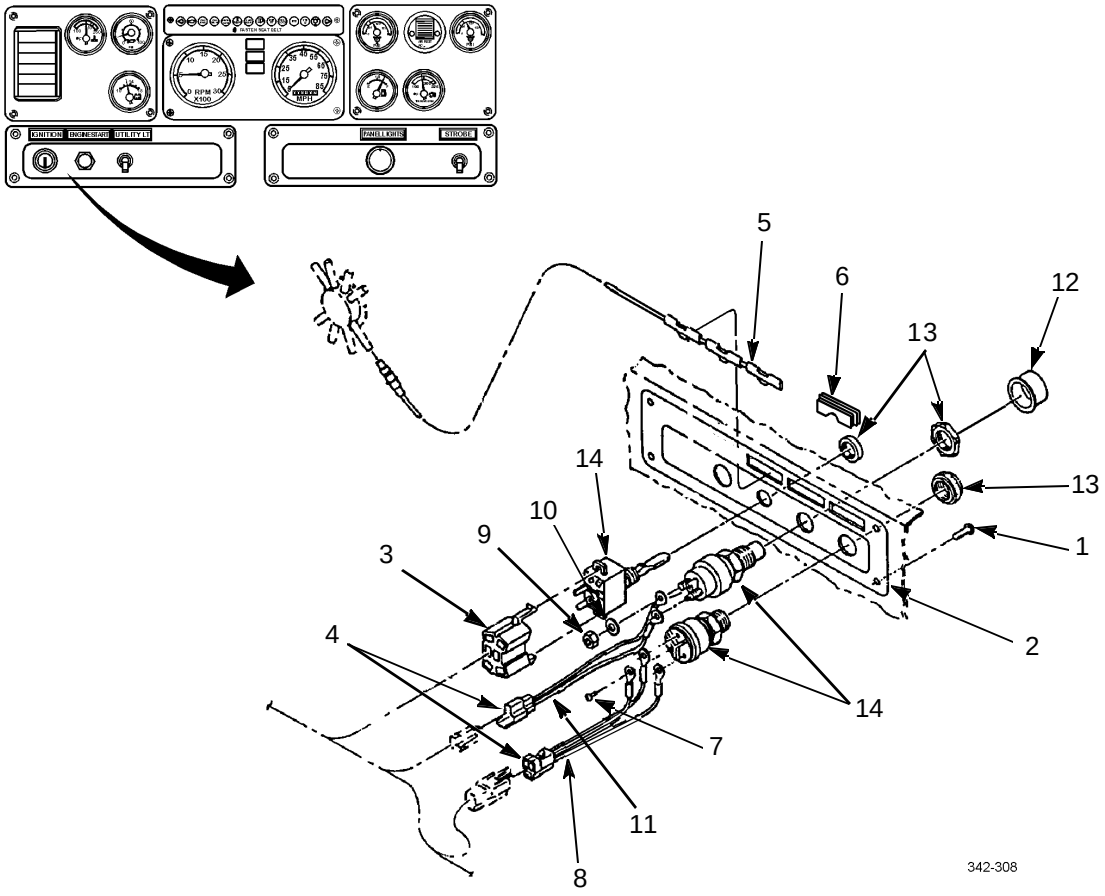
REMOVAL

1. Remove four screws (1) and pull panel (2) out of dashboard.



REMOVAL - CONTINUED

2. Remove plug (3) and two connectors (4) and remove panel (2).
3. Remove three fiber optic labels (5) and label holders (6) from panel (2).
4. Remove three screws (7), pigtail (8), two nuts (9), washers (10), and pigtail (11) from panel (2).
5. Remove boot (12), three nuts (13), and switches (14) from panel (2).



INSTALLATION

1. Install three switches (14) on panel (2) with three nuts (13) and boot (12).
2. Install pigtail (11), two washers (10), nuts (9), pigtail (8), and three screws (7) on panel (2).
3. Install two connectors (4) and plug (3).
4. Install three label holders (6) and fiber optic labels (5) on panel (2).
5. Install panel (2) on dashboard with four screws (1).

END OF WORK PACKAGE

RIGHT HAND SWITCH PANEL REPLACEMENT 0065 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

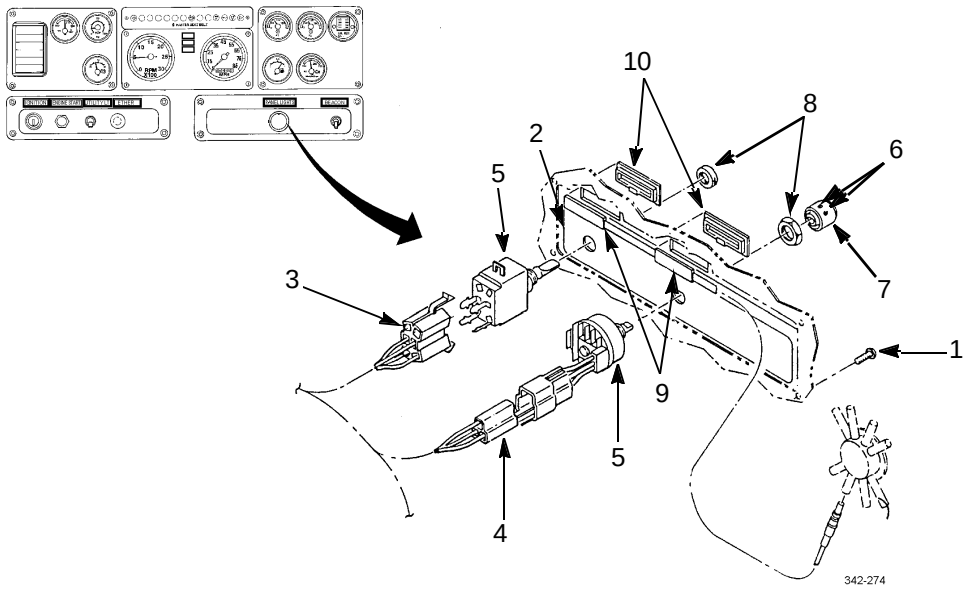
Tags, marker (Item 31, WP 0235 00)

NOTE

Tag all wires and connectors to aid in installation.

REMOVAL

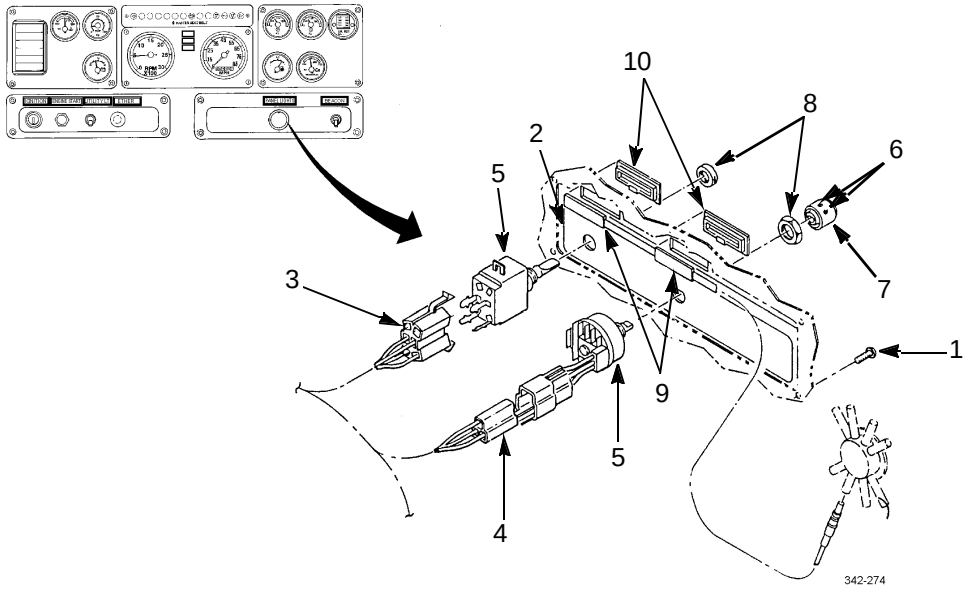
1. Remove four screws (1) and pull panel (2) away from dashboard.
2. Disconnect plug (3) and connector (4) from two switches (5).
3. Loosen two setscrews (6) and remove knob (7), two nuts (8), and switches (5) from panel (2).
4. Remove two fiber optic labels (9) and label holders (10) from panel (2).



RIGHT HAND SWITCH PANEL REPLACEMENT - CONTINUED 0065 00

INSTALLATION

1. Install two label holders (10) and fiber optic labels (9) on panel (2).
2. Install two switches (5) on panel (2) with two nuts (8).
3. Install knob (7) on panel (2) and tighten two setscrews (6).
4. Install connector (4) and plug (3) on two switches (5).
5. Install panel (2) on dashboard with four screws (1).



END OF WORK PACKAGE

CONTROL MODULE REPLACEMENT 0066 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

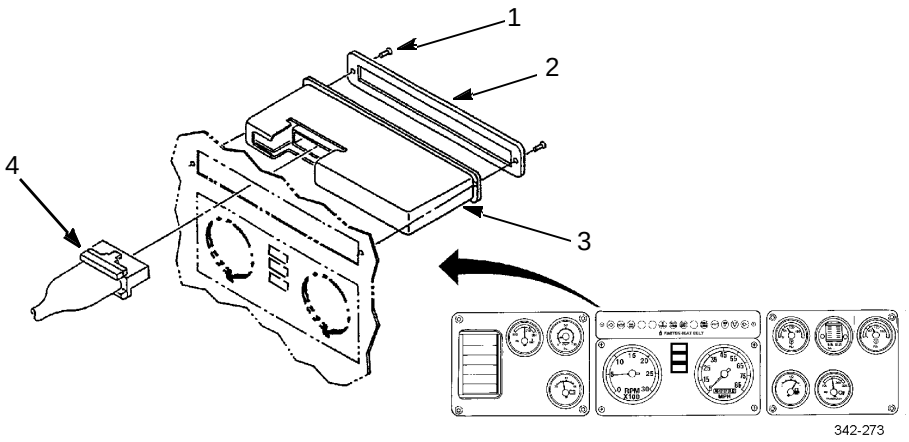
Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

REMOVAL

1. Remove two screws (1), cover (2), and control module (3) from dashboard.
2. Remove plug (4) from control module (3).



INSTALLATION

NOTE

Observe keyways and guide pins on plug when making connection. DO NOT force connection.

1. Install plug (4) on control module (3).
2. Position control module (3) on dashboard and install cover (2) with two screws (1).

END OF WORK PACKAGE

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HEATER AND AIR CONDITIONING CONTROL PANEL REPLACEMENT 0067 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

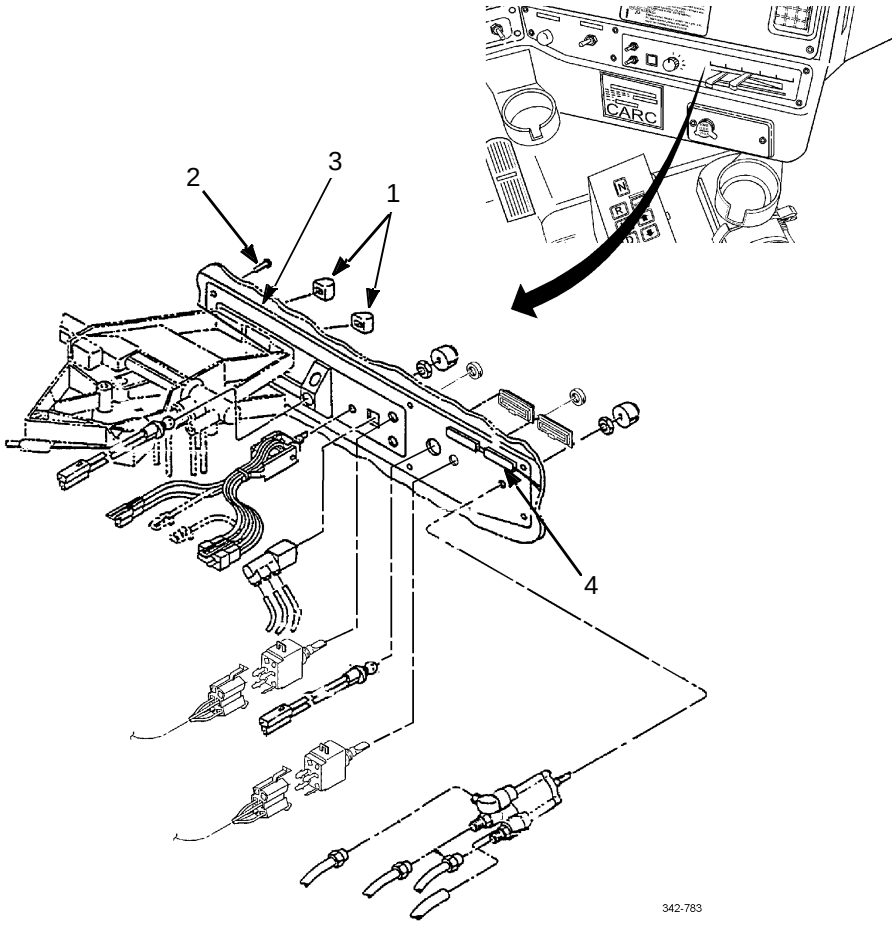
TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

REMOVAL

1. Remove two heater control knobs (1) and six screws (2). Pull control panel (3) out from dashboard.
2. Remove fiber optic labels (4).

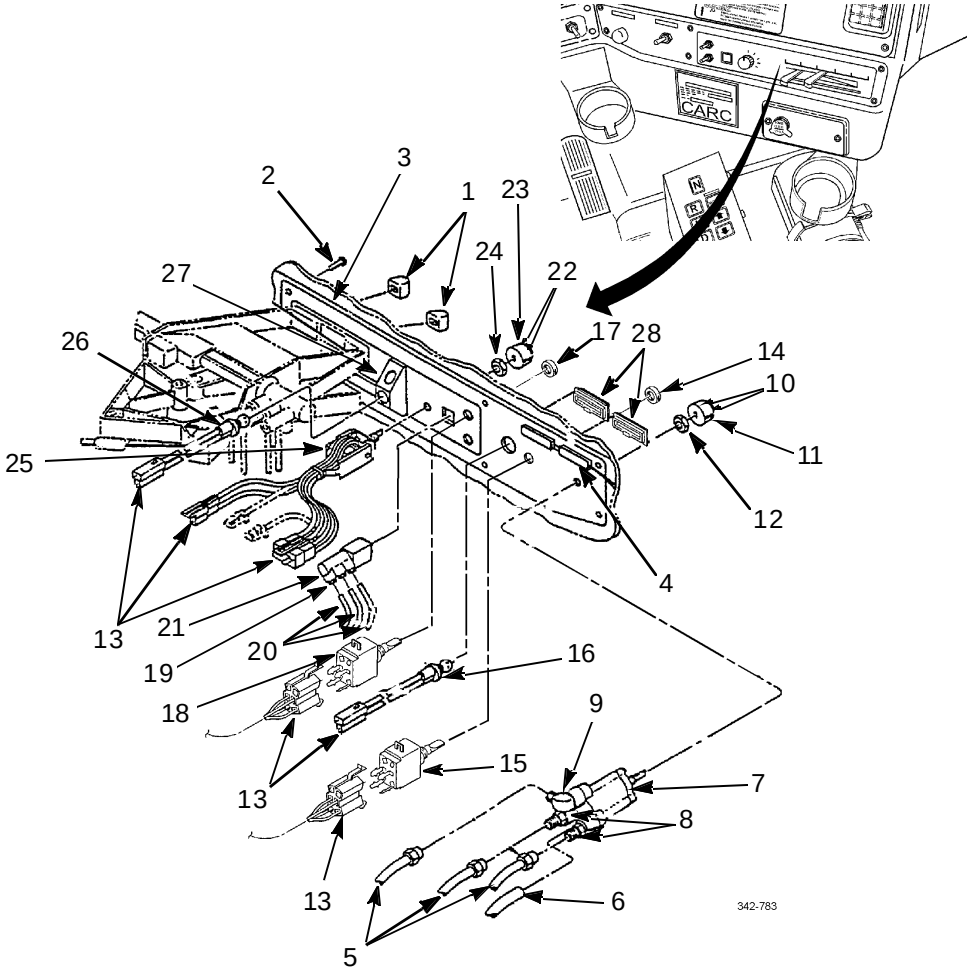


REMOVAL - CONTINUED

NOTE

Tag tubes and wire connectors prior to removal to aid in installation.

3. Disconnect three hoses (5) and hose (6) from wiper valve (7).
4. Remove two connectors (8) and elbow (9) from wiper valve (7).
5. Loosen two setscrews (10) and remove knob (11), nut (12), and wiper valve (7) from control panel (3).
6. Disconnect six connectors (13).
7. Remove nut (14) and mirror heat switch (15) from control panel (3).



8. Remove heater indicator light (16).
9. Remove two nuts (17) and auxiliary heater switches (18).
10. Press three plastic discs (19) and disconnect three tubes (20) from air switch (21).
11. Remove air switch (21).
12. Loosen two setscrews (22) and remove knob (23), nut (24), and fan speed switch (25).
13. Remove indicator light (26).

REMOVAL - CONTINUED

14. Remove ac/heater panel (27) and two label holders (28) from control panel (3).

INSTALLATION

1. Install two label holders (28) and ac/heater panel (27) to control panel (3).
2. Install indicator light (26).
3. Install fan speed switch (25), nut (24), and knob (23). Tighten two setscrews (22).
4. Install air switch (21).
5. Press three plastic discs (19) and connect three tubes (20) to air switch (21).
6. Install two auxiliary heater switches (18) with two nuts (17).
7. Install heater indicator light (16).
8. Install mirror heat switch (15) with nut (14).
9. Connect six connectors (13).
10. Install wiper valve (7), nut (12), and knob (11). Tighten two setscrews (10).

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

11. Apply pipe sealing compound to threads of elbow (9) and two connectors (8) and install elbow and connectors to wiper valve (7).
12. Connect hose (6) and three hoses (5) to wiper valve (7).
13. Install fiber optic labels (4).
14. Install control panel (3) to dashboard with six screws (2). Install two heater control knobs (1).

END OF WORK PACKAGE

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12V POWER RECEPTACLE REPLACEMENT 0068 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

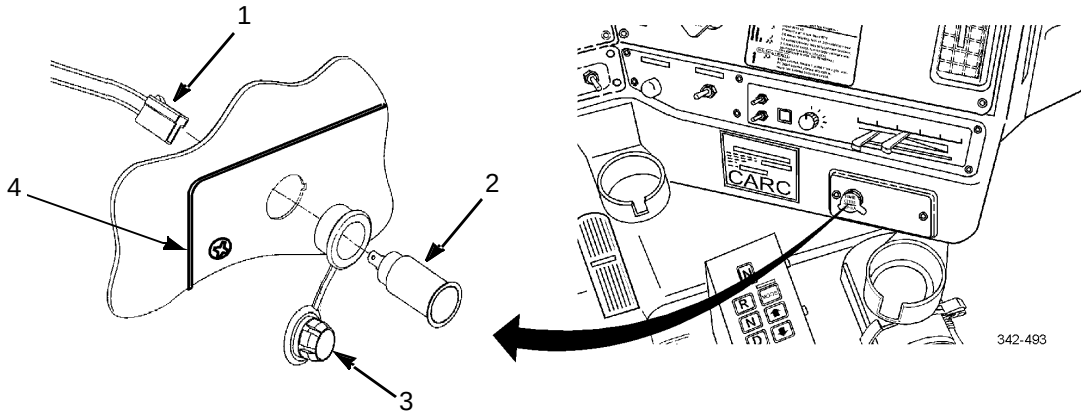
Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

REMOVAL

1. Remove wiring harness connector (1) from 12V power receptacle (2).
2. Remove 12V power receptacle (2) from cap assembly (3).
3. Remove cap assembly (3) from auxiliary panel (4).



INSTALLATION

1. Install cap assembly (3) on auxiliary panel (4).
2. Install 12V power receptacle (2) on cap assembly (3).
3. Install wiring harness connector (1) on 12V power receptacle (2).

END OF WORK PACKAGE

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FIBER OPTIC LIGHT SOURCE REPLACEMENT 0069 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

Straps, tiedown (Item 30, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Center gage panel removed (WP 0061 00)

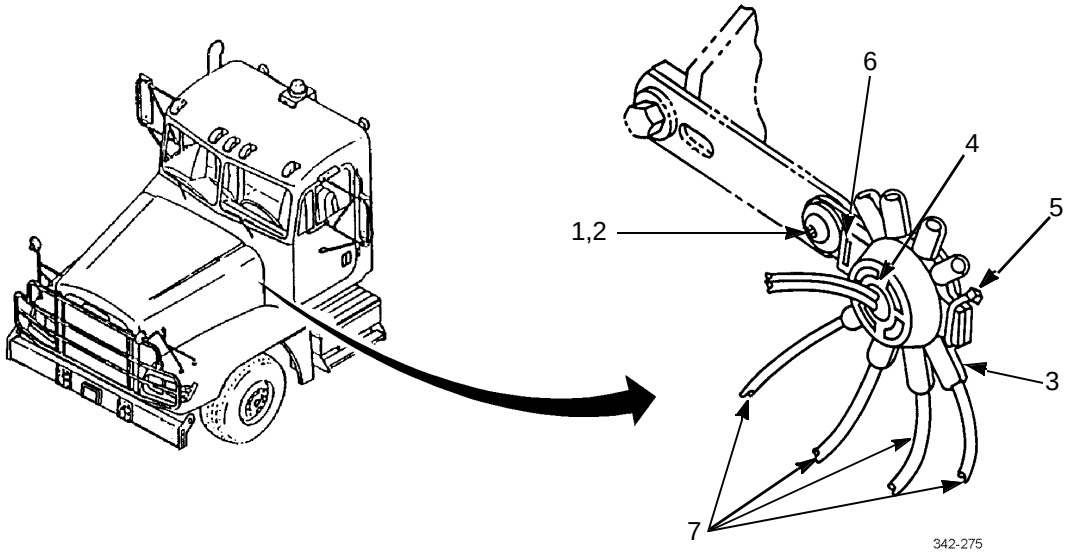
REMOVAL

1. Remove nut (1), torx screw (2), and fiber optic light source (3).
2. Turn light socket (4) to left and remove from fiber optic light source (3).
3. Remove tiedown strap (5) and discard.

CAUTION

Do not crimp fiber optic lines. Crimping could cause lines to break internally, resulting in instrument light failure.

4. Release two latches (6) on rear of fiber optic light source (3) and remove four fiber optic lines (7).

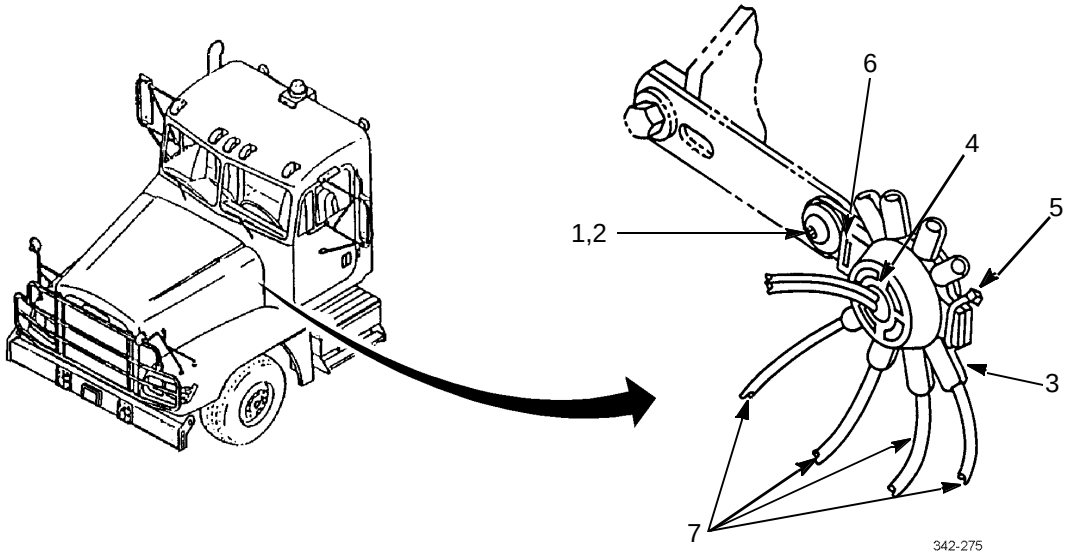


INSTALLATION

CAUTION

Do not crimp fiber optic lines. Crimping could cause lines to break internally, resulting in instrument light failure.

1. Position four fiber optic lines (7) on rear of fiber optic light source (3) and engage two latches (6).
2. Install new tiedown strap (5).
3. Install light socket (4) on fiber optic light source (3) and turn light socket to right.
4. Install fiber optic light source (3) with torx screw (2) and nut (1).



5. Install center gage panel (WP 0061 00).

END OF WORK PACKAGE

CHECK ENGINE SWITCH AND JUMPER HARNESS REPLACEMENT 0070 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

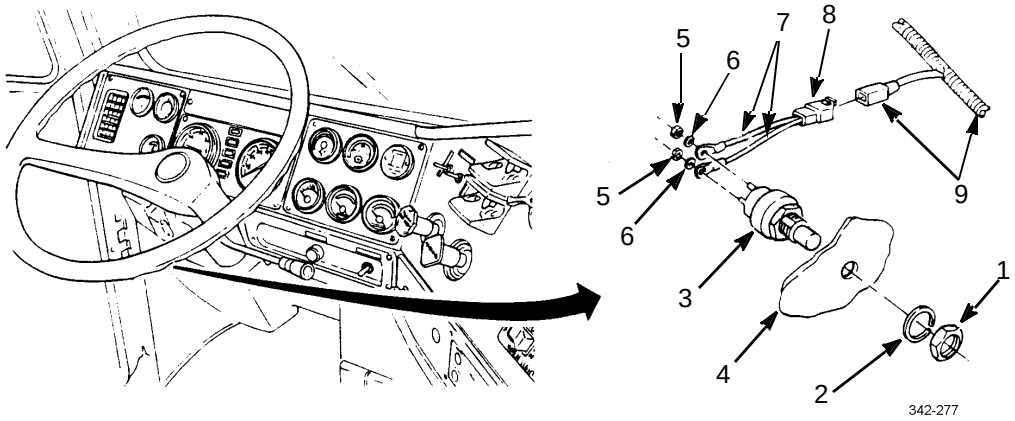
REMOVAL

1. Remove nut (1) and washer (2) from switch (3).
2. Remove three screws and pull lower dash cover (4) away from dashboard.
3. Remove switch (3) from lower dash cover (4).

NOTE

Tag wires to aid in installation.

4. Remove two nuts (5), lock washers (6), and wires (7) from switch (3).
5. Remove jumper harness connector (8) from vehicle harness (9).



INSTALLATION

1. Install jumper harness connector (8) on vehicle harness (9).
2. Install two wires (7) on switch (3) with two lock washers (6) and nuts (5).
3. Install switch (3) on lower dash cover (4) with washer (2) and nut (1).
4. Install lower dash cover (4) on dashboard with three screws.

END OF WORK PACKAGE

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FUSE, RELAY, CIRCUIT BREAKER, AND HOLDER REPLACEMENT 0071 00

THIS WORK PACKAGE COVERS

Fuse Removal, Relay Removal, Circuit Breaker Removal, Holder Removal, Holder Installation, Circuit Breaker Installation, Relay Installation, Fuse Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

NOTE

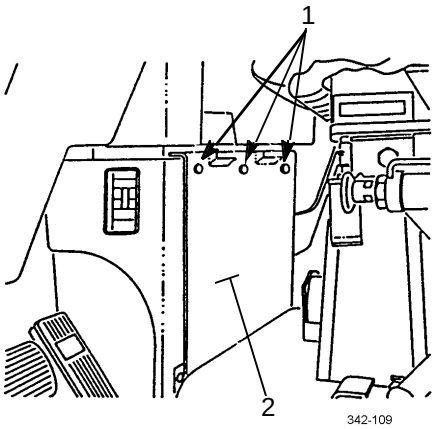
- For location of fuses, relays, and circuit breakers inside cab, refer to page 0071 00-5.
- Tag or note position of all fuses, relays, circuit breakers, and connectors to aid in installation.

FUSE REMOVAL

NOTE

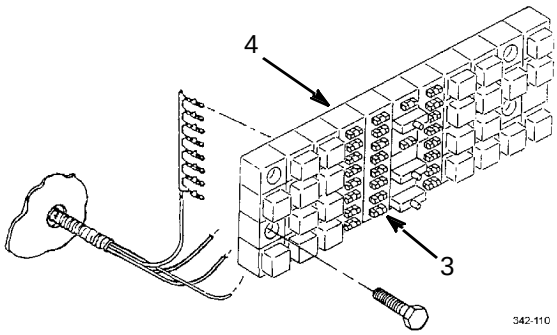
- To remove fuses in cab, perform steps 1 and 2.
- To remove battery box fuse, perform steps 3 and 4.

1. Rotate three turnlock fasteners (1) and remove cover (2) from cab.

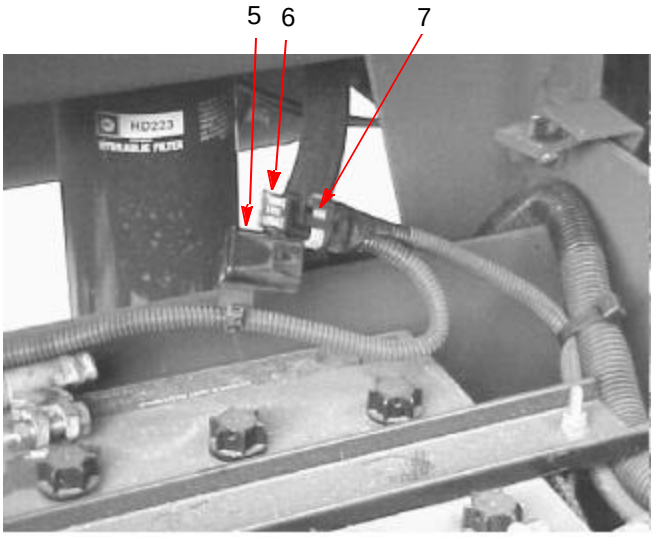


FUSE REMOVAL - CONTINUED

2. Remove fuses (3) from holder (4).



3. Inside battery box, remove cover (5) from fuse (6).
4. Remove fuse (6) from fuse holder (7).



RELAY REMOVAL

Remove relays (8) from holder (4).

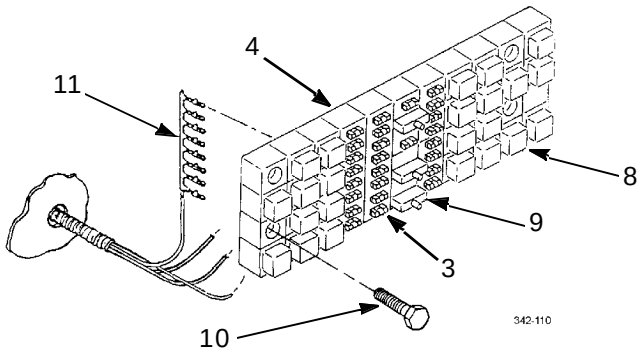
CIRCUIT BREAKER REMOVAL

Remove circuit breakers (9) from holder (4).

HOLDER REMOVAL

1. Remove four screws (10) and holder (4) from cab.
2. Remove connectors (11) from holder (4).

HOLDER REMOVAL - CONTINUED



HOLDER INSTALLATION

1. Install connectors (11) on holder (4).
2. Install holder (4) on cab with four screws (10).

CIRCUIT BREAKER INSTALLATION

Install circuit breakers (6) on holder (4).

RELAY INSTALLATION

Install relays (5) on holder (4).

FUSE INSTALLATION

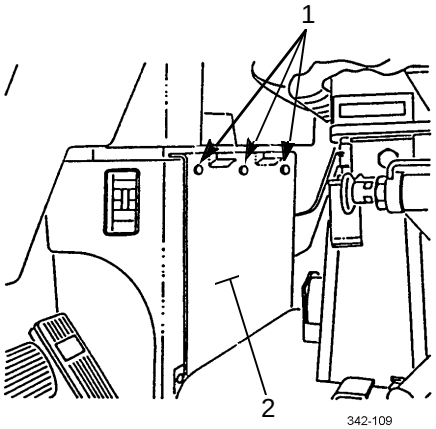
WARNING

When replacing fuses, ensure that replacement fuses are correct amperage. Fuses with incorrect amperage could result in injury to personnel or damage to equipment.

NOTE

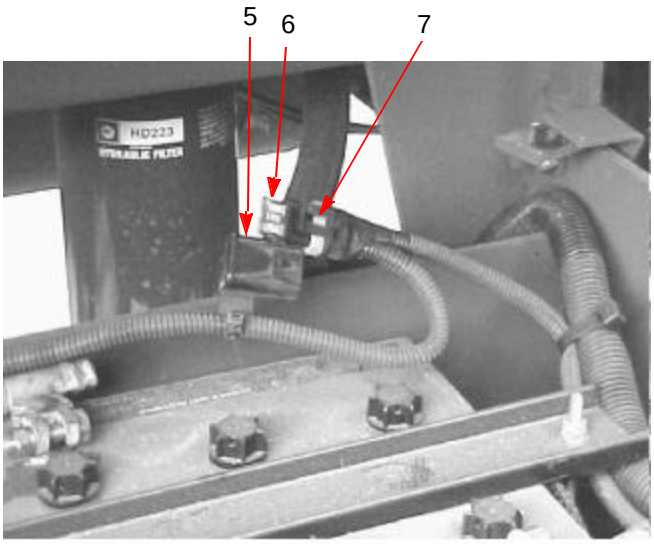
- To install fuses in cab, perform steps 1 and 2.
- To install battery box fuse, perform steps 3 and 4.

1. Install fuses (3) on holder (4).
2. Position cover (2) in cab and rotate three turnlock fasteners (1).



FUSE INSTALLATION - CONTINUED

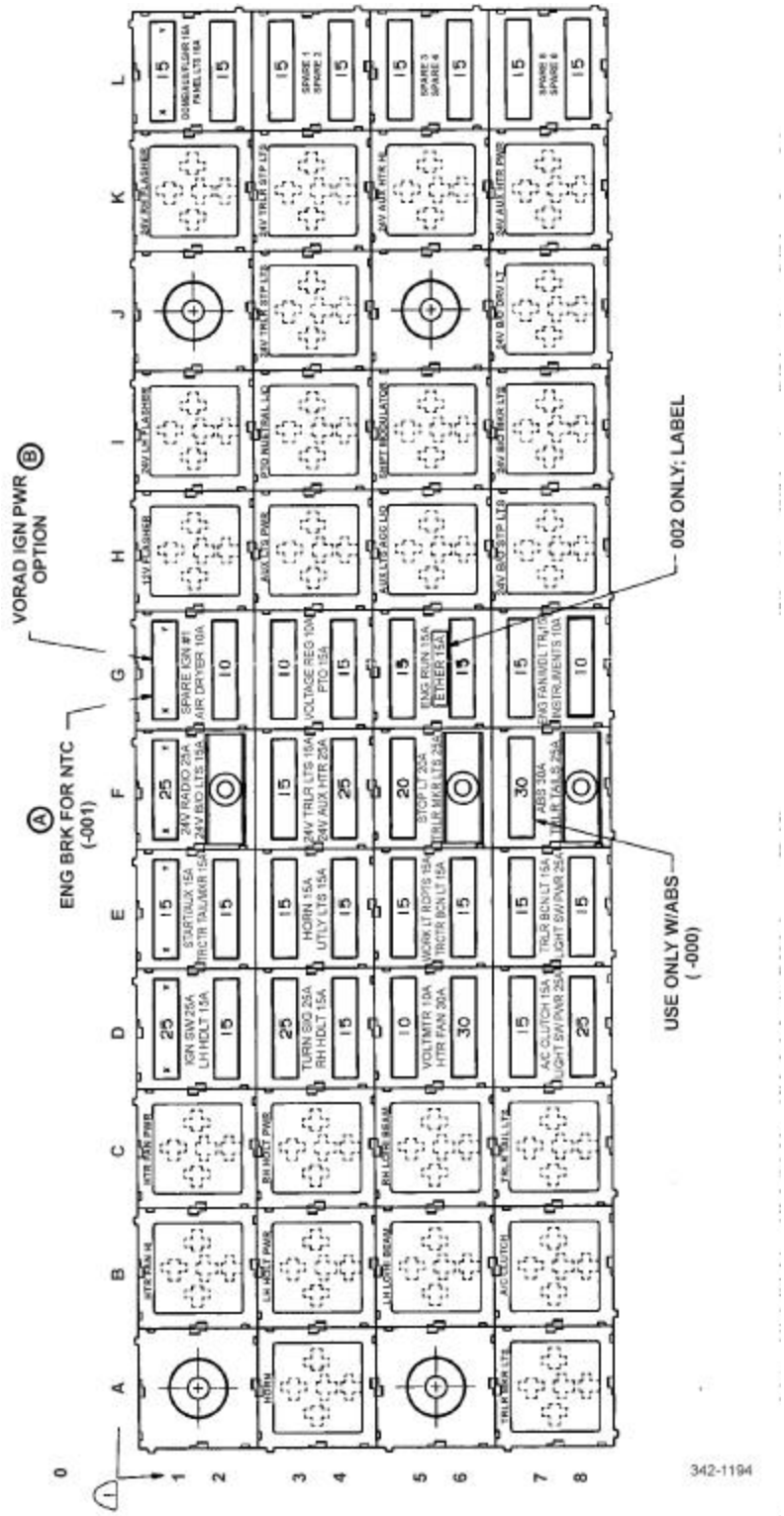
3. Install fuse (6) on holder (7).
4. Install cover (5) on fuse (6).



342-1191.

FUSE, RELAY, CIRCUIT BREAKER, AND HOLDER REPLACEMENT - CONTINUED **0071 00**

FUSE INSTALLATION - CONTINUED



END OF WORK PACKAGE

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MASTER BATTERY SWITCH REPLACEMENT 0072 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Battery cables disconnected (WP 0115 00)

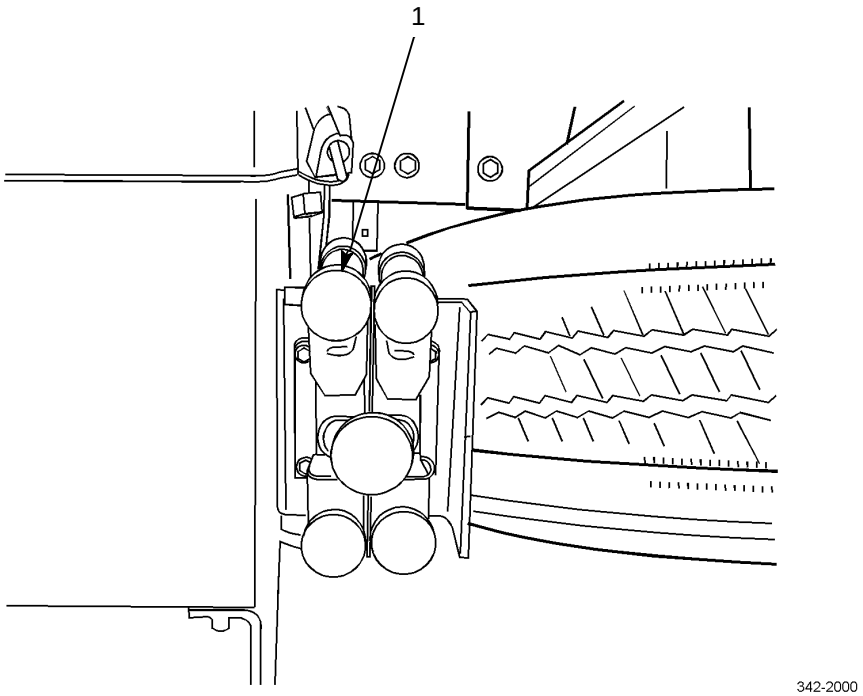
Materials/Parts

Tags, marker (Item 31, WP 0235 00)

Washer, lock (P/N 23-09318-013) (4)

REMOVAL

1. Remove four rubber boots (1).



REMOVAL - CONTINUED

NOTE

Tag cables to aid in installation.

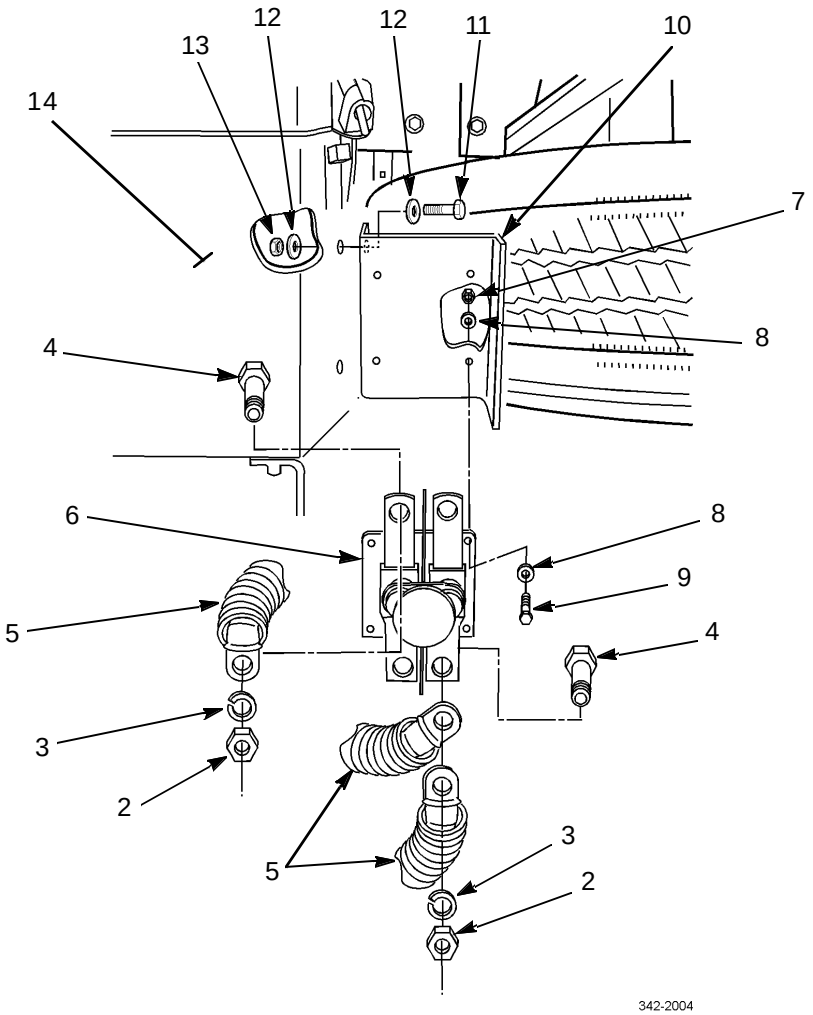
2. Remove four nuts (2), four lockwashers (3), and four bolts (4) disconnecting six cables (5) from master battery switch (6). Discard lockwashers.

3. Remove four nuts (7), eight washers (8), and four bolts (9) securing master battery switch (6) to bracket (10).

NOTE

Perform step 4, only if bracket is damaged.

4. Remove two bolts (11), four washers (12), two nuts (13), and bracket (10) from battery box (14).



INSTALLATION

NOTE

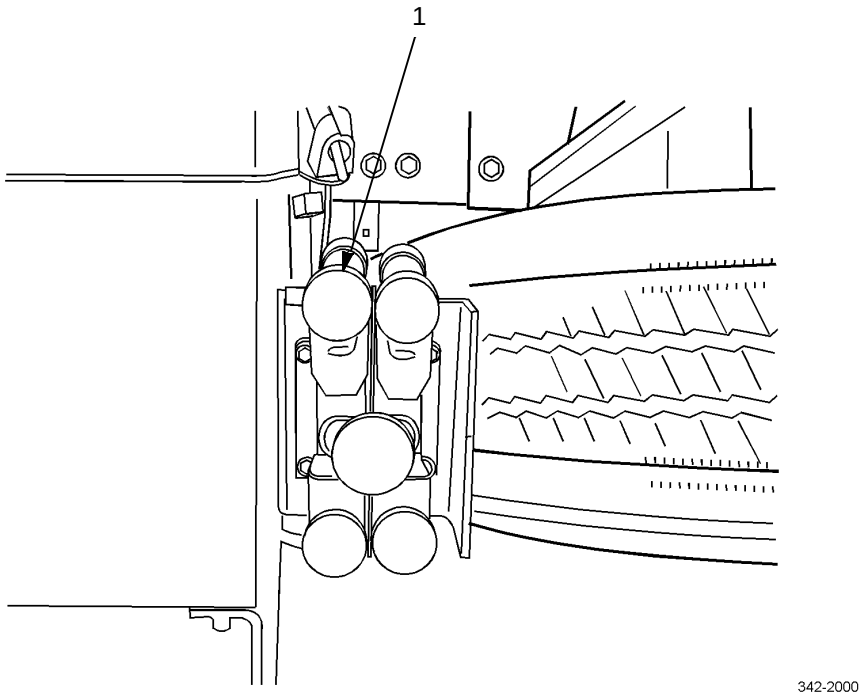
Perform step 1, only if bracket was removed.

1. Position bracket (10) on battery box (14) and install two bolts (11), four washers (12), and two nuts (13).

NOTE

Cables must be connected to master switch prior to master switch being mounted to bracket.

2. Install four bolts (4), six cables (5), four new lockwashers (3), and four nuts (2) securing cables to master battery switch (6). Remove tags from cables.
3. Position master battery switch (6) on bracket (10) and install four bolts (9), eight washers (8), and four nuts (7).
4. Install four boots (1).



5. Connect battery cables (WP 0115 00).

END OF WORK PACKAGE

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TURN SIGNAL SWITCH REPLACEMENT 0073 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

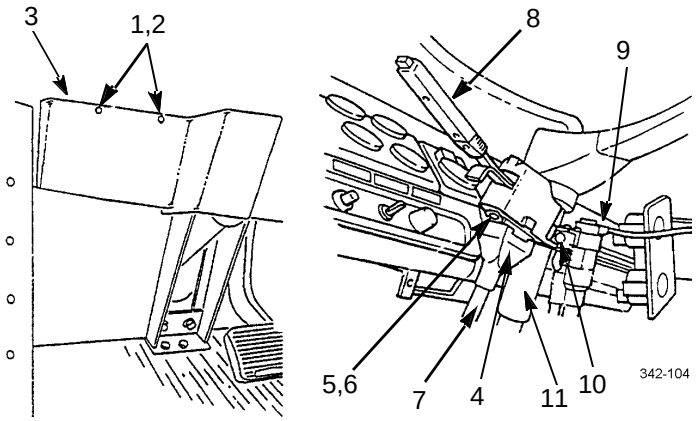
Check engine switch removed (WP 0070 00)

References

TM 9-2320-302-10

REMOVAL

1. Remove five screws (1), washers (2) and cover (3).
2. Pull rubber cover (4) downward and remove screw (5) and clip (6).
3. Remove cable (7) from turn signal switch (8).
4. Remove clamp (9), turn signal switch (8), and trailer brake valve (10) from steering column (11). Set trailer brake valve aside.



INSTALLATION

1. Install trailer brake valve (10) and turn signal switch (8) on steering column (11) with clamp (9). Tighten clamp.
2. Install cable (7) on turn signal switch (8).
3. Install clip (6) and screw (5). Push rubber cover (4) upward.
4. Install cover (3) with five washers (2) and screws (1).
5. Install check engine switch (WP 0070 00).

END OF WORK PACKAGE

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ELECTRONIC THROTTLE REPLACEMENT 0074 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N 23-09900-104)

Nut, lock (P/N MS51922-1) (3)

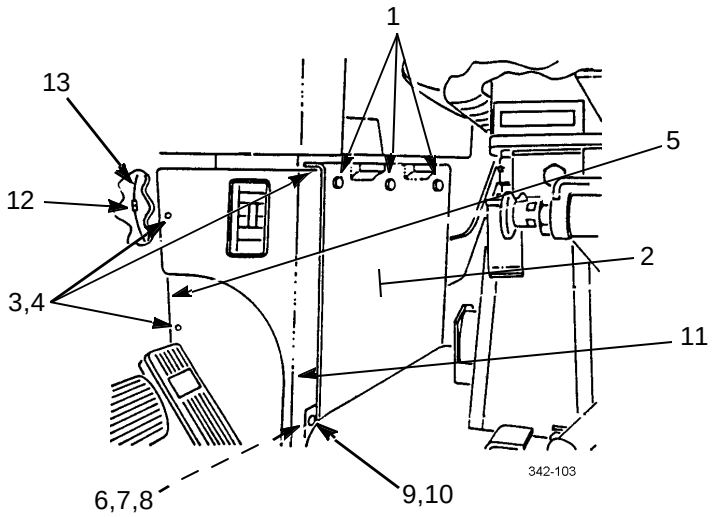
REMOVAL

1. Rotate three turnlock fasteners (1) and remove cover (2).

NOTE

Note position of fasteners to aid in installation.

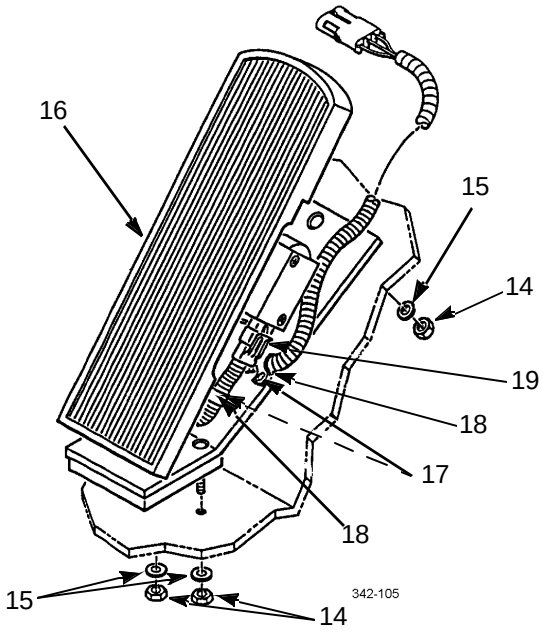
2. Remove three screws (3) and washers (4) from cover (5).
3. Remove lock nut (6), washer (7), spacer (8), screw (9), washer (10), and two covers (5 and 11). Discard lock nut.
4. Remove throttle cable connector (12) from wiring harness (13).



ELECTRONIC THROTTLE REPLACEMENT - CONTINUED 0074 00

REMOVAL - CONTINUED

5. Remove three locknuts (14), washers (15), and electronic throttle (16) from vehicle. Discard lock nuts.
6. Remove two screws (17), clamps (18), and cable (19) from electronic throttle (16).

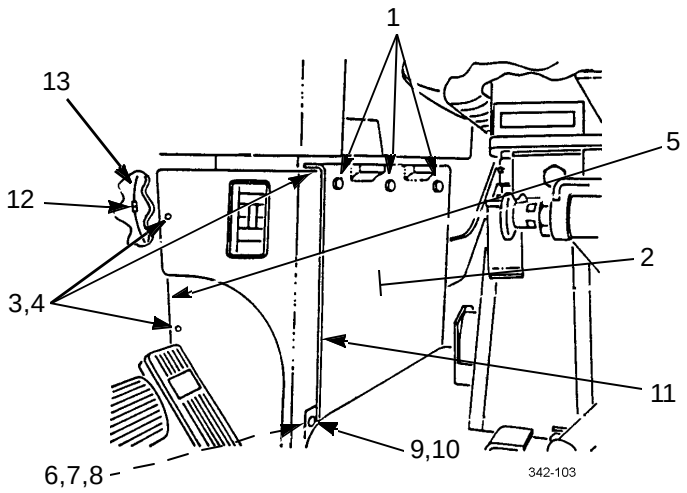


INSTALLATION

1. Install cable (19) on electronic throttle (16) with two clamps (18) and screws (17).
2. Install electronic throttle (16) on vehicle with three washers (15) and new lock nuts (14).
3. Install throttle cable connector (12) to wiring harness (13).
4. Install two covers (5 and 11) with washer (10), screw (9), spacer (8), washer (7), and new lock nut (6).
5. Install three washers (4) and screws (3) on cover (5).
6. Install cover (2) and rotate three turnlock fasteners (1).

ELECTRONIC THROTTLE REPLACEMENT - CONTINUED **0074 00**

INSTALLATION - CONTINUED



END OF WORK PACKAGE

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ELECTRONIC CONTROL MODULE REPLACEMENT 0075 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

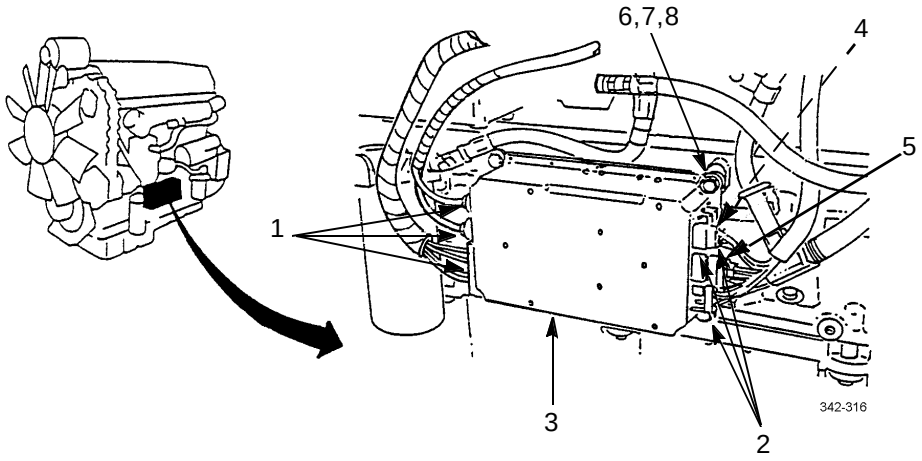
Tags, marker (Item 31, WP 0235 00)

NOTE

Tag all connectors to aid in installation.

REMOVAL

1. Remove three connectors (1 and 2) from electronic control module (3).
2. Loosen two screws (4) and remove two connectors (5) from electronic control module (3).
3. Remove four bolts (6), electronic control module (3), four isolators (7), and spacers (8) from engine.
4. Remove four isolators (7) from bolts (6).



INSTALLATION

1. Install four isolators (7) on bolts (6).
2. Install four spacers (8), isolators (7), and electronic control module (3) on engine with four bolts (6).
3. Install two connectors (5) on electronic control module (3) and tighten two screws (4).
4. Install three connectors (1 and 2) on electronic control module (3).

END OF WORK PACKAGE

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NATO SLAVE RECEPTACLE REPLACEMENT 0076 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-09336-005) (4)

Nut, lock (P/N MS51922-1) (3)

Materials/Parts - Continued

Tags, marker (Item 31, WP 0235 00)

References

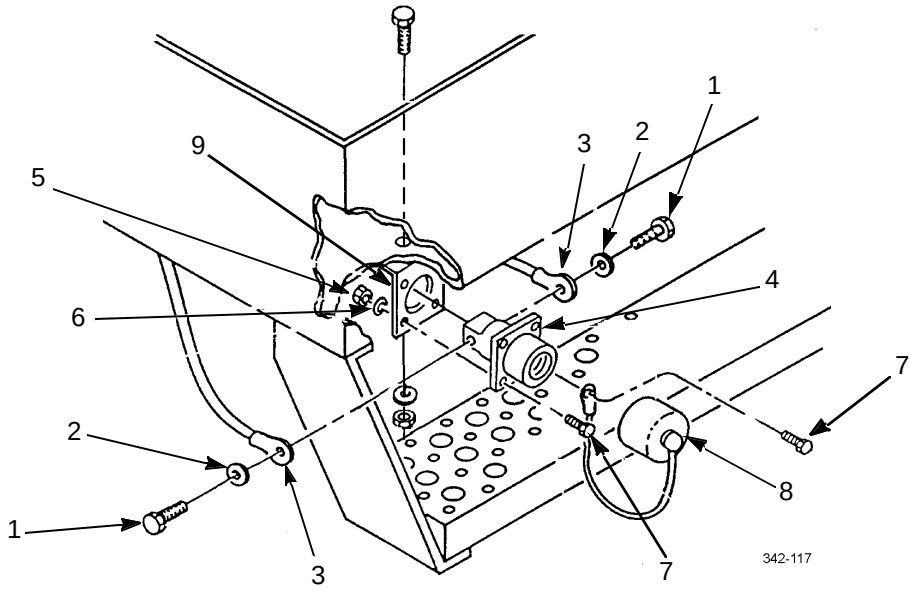
TM 9-2320-302-10

NOTE

Tag cables prior to removal to aid in installation.

REMOVAL

1. Remove two screws (1), lock washers (2), and cables (3) from NATO slave receptacle (4).
2. Remove four lock nuts (5), washers (6), screws (7), cap (8) and NATO slave receptacle (4) from angle bracket (9). Discard lock nuts.



REMOVAL - CONTINUED

NOTE

Perform steps 3 and 4 only if angle bracket is damaged.

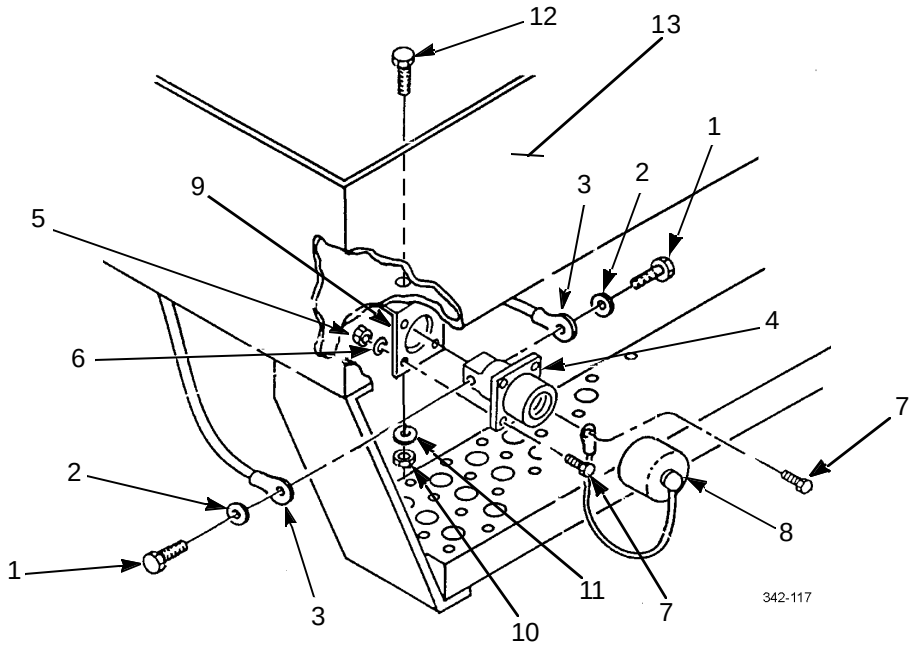
3. Remove batteries (WP 0113 00).
4. Remove three lock nuts (10), washers (11), screws (12), and angle bracket (9) from battery box (13). Discard lock nuts.

INSTALLATION

NOTE

Perform steps 1 and 2 only if angle bracket was removed.

1. Install angle bracket (9) on battery box (13) with three screws (12), washers (11), and new lock nuts (10).
2. Install batteries (WP 0113 00).
3. Install NATO slave receptacle (4) and cap (8) on angle bracket (9) with four screws (7), washers (6), and new lock nuts (5).
4. Install two cables (3) on NATO slave receptacle (4) with two lock washers (2) and screws (1).



END OF WORK PACKAGE

UTILITY POWER RECEPTACLE REPLACEMENT 0077 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Riveter, blind, hand (Item 28, WP 0236 00)

Materials/Parts

Rivet, blind (P/N 23-09990-104) (2)

Washer, lock (P/N 23-09318-006) (4)

Adhesive (Item 1, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Cab liners removed (WP 0202 00)

NOTE

- Cab has two utility power receptacles.
- Tag wires prior to removal to aid in installation.

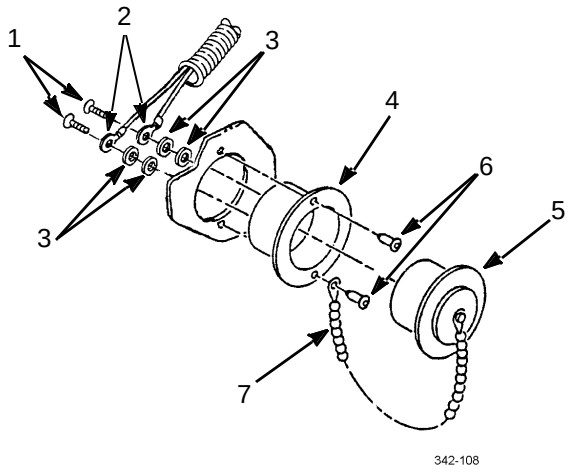
REMOVAL

1. Remove two screws (1), wires (2), and four lock washers (3) from receptacle (4). Discard lock washers.
2. Remove cover (5) from receptacle (4).

NOTE

Note position of receptacle for installation.

3. Remove two rivets (6), receptacle (4), and chain (7) from cab. Discard rivets.

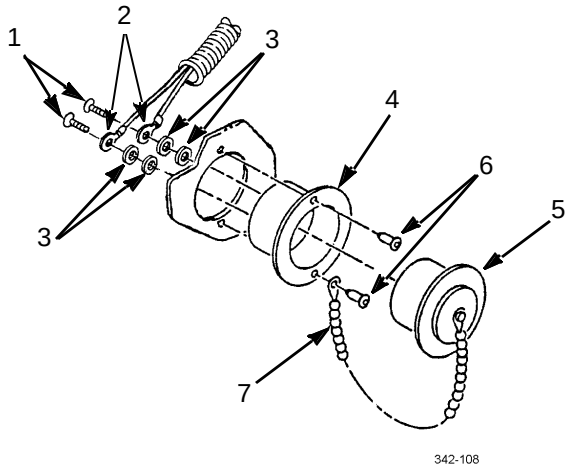


INSTALLATION

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat mating surfaces of receptacle (4) and cab with adhesive.
2. Install receptacle (4) and chain (7) on cab with two new rivets (6).
3. Install cover (5) on receptacle (4).
4. Install four new lockwashers (3) and two wires (2) on receptacle (4) with two screws (1).
5. Install cab liners (WP 0202 00).



END OF WORK PACKAGE

TRAILER ELECTRICAL RECEPTACLES REPLACEMENT 0078 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

WP 0119 00

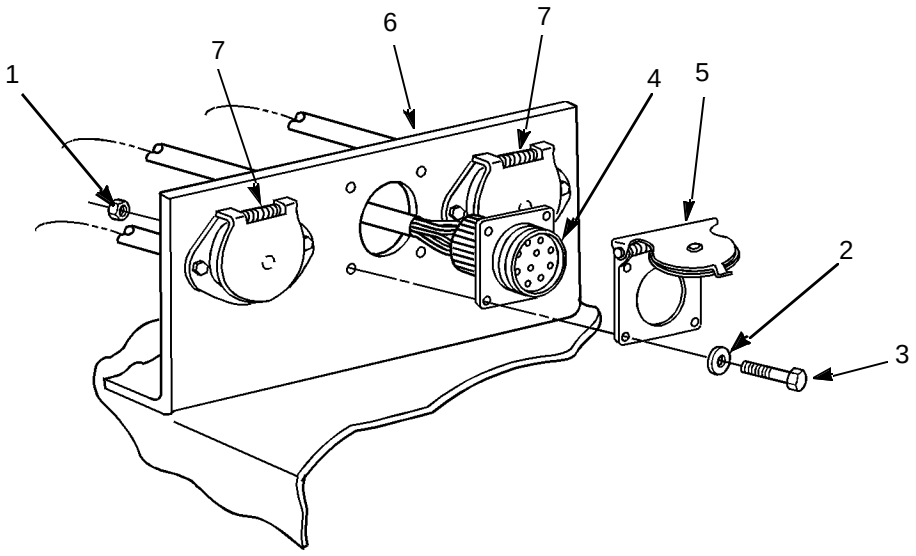
REMOVAL

1. Remove four nuts (1), washers (2), and screws (3) from trailer electrical receptacle (4).
2. Remove trailer electrical receptacle (4) and cover (5) from bracket (6).

NOTE

Other two electrical receptacles use two nuts, washers, and screws.

3. Repeat steps 1 and 2 for each of two other electrical receptacles (7).
4. Refer to WP 0119 00 to remove electrical receptacles (4 or 7) from electrical cable.



342-130

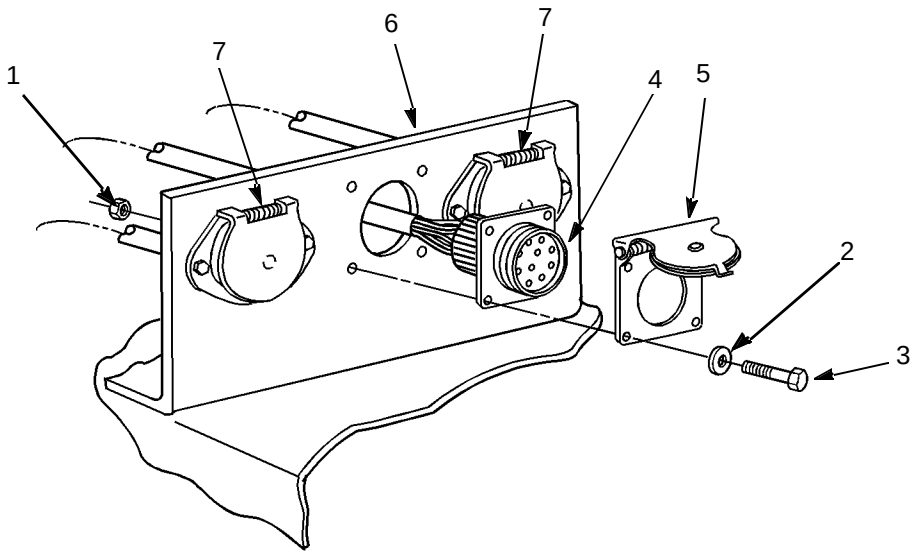
INSTALLATION

1. Refer to WP 0119 00 to install electrical receptacles (4 or 7) on electrical cable.
2. Install electrical receptacle (4) and cover (5) on bracket (6) with four screws (3), washers (2), and nuts (1).

NOTE

Other two electrical receptacles use two nuts, washers, and screws.

3. Repeat step 2 for each of two other electrical receptacles (7).



342-130

END OF WORK PACKAGE

PARKING BRAKE PRESSURE SWITCH REPLACEMENT 0079 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

References

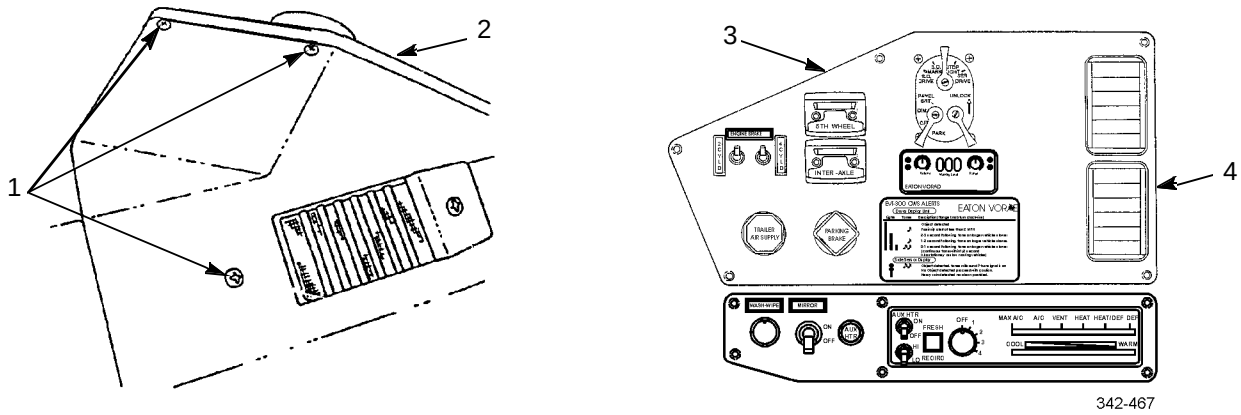
TM 9-2320-302-10

Equipment Condition

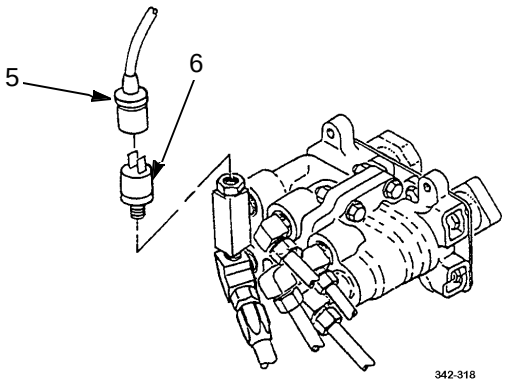
Air system drained (TM 9-2320-302-10)

REMOVAL

1. Remove three torx screws (1) and dashboard cover (2) from dashboard.
2. Remove five torx screws (3) and dash panel cover (4).



3. Remove wiring harness connector (5) from parking brake pressure switch (6).



REMOVAL - CONTINUED

WARNING

- DO NOT disconnect any air system lines or fittings unless vehicle engine is shut down and air system pressure is relieved. Failure to follow this warning could result in serious injury to personnel.
- Always wear eye protection when disconnecting air lines. Residual air will be expelled. Failure to follow this warning may result in serious eye injury.

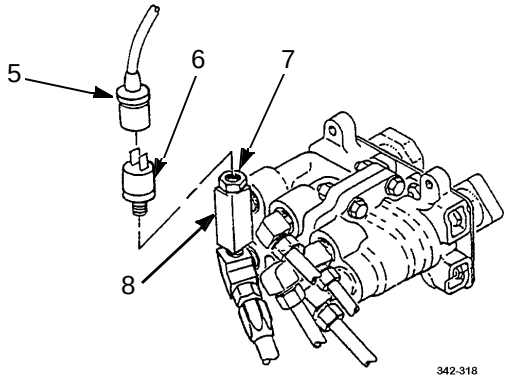
4. Remove parking brake pressure switch (6) from adapter fitting (7) on tee (8).

INSTALLATION

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure that all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

1. Lightly coat male threads on parking brake pressure switch (6) with pipe sealing compound.
2. Install parking brake pressure switch (6) on adapter fitting (7) on tee (8).
3. Install wiring harness connector (5) on parking brake pressure switch (6).



4. Start vehicle, pressurize air system, apply parking brake and check for air leaks (TM 9-2320-302-10).

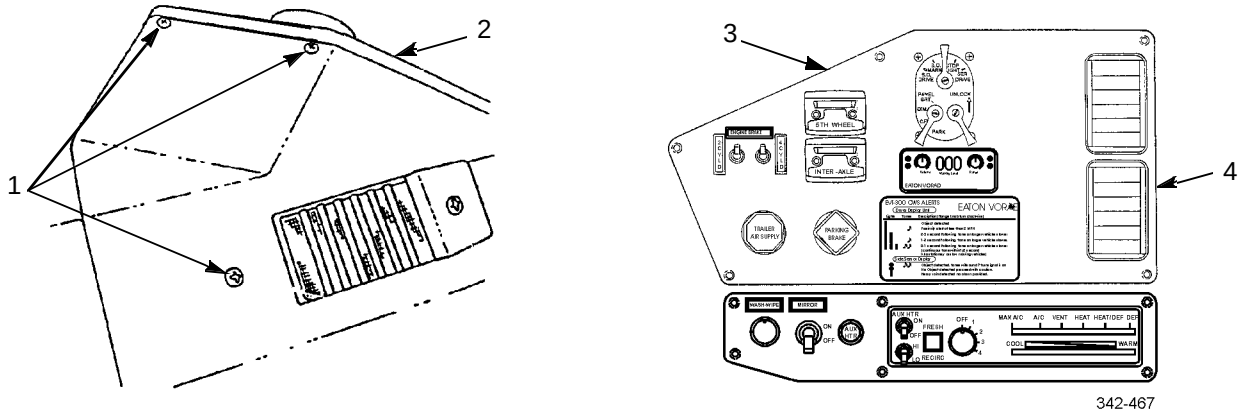
NOTE

Ensure that parking brake light illuminates when parking brake is applied.

PARKING BRAKE PRESSURE SWITCH REPLACEMENT - CONTINUED 0079 00

INSTALLATION - CONTINUED

5. Shut vehicle off (TM 9-2320-302-10).
6. Install dash panel cover (4) with five torx screws (3).
7. Install dashboard cover (2) on dashboard with three torx screws (1).



END OF WORK PACKAGE

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WATER LEVEL MODULE REPLACEMENT 0080 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

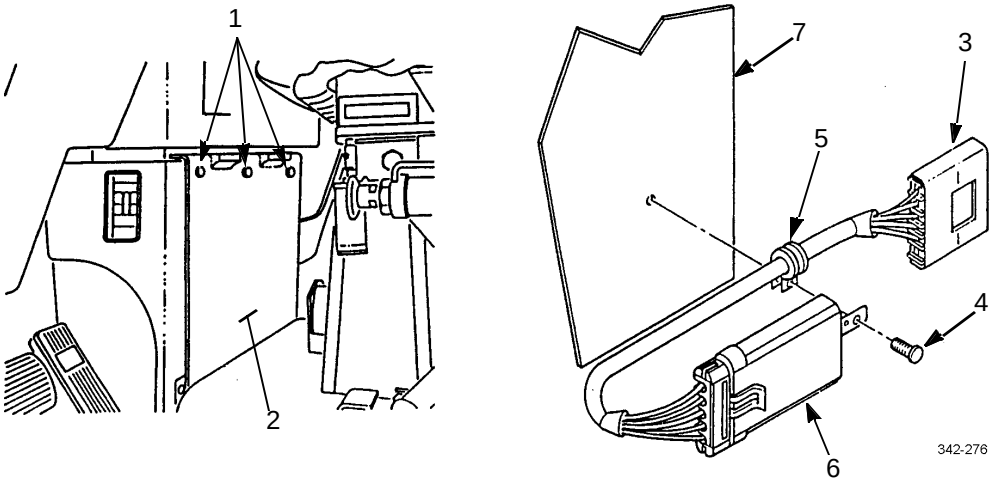
Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

REMOVAL

1. Unlock three fasteners (1) and remove cover (2).
2. Remove connector (3) from vehicle wiring.
3. Remove screw (4), clamp (5), and module (6) from firewall (7).



INSTALLATION

1. Install module (6) on firewall (7) with clamp (5) and screw (4).
2. Install connector (3) on vehicle wiring.
3. Install cover (2) and lock three fasteners (1).

END OF WORK PACKAGE

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WATER LEVEL PROBE REPLACEMENT 0081 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

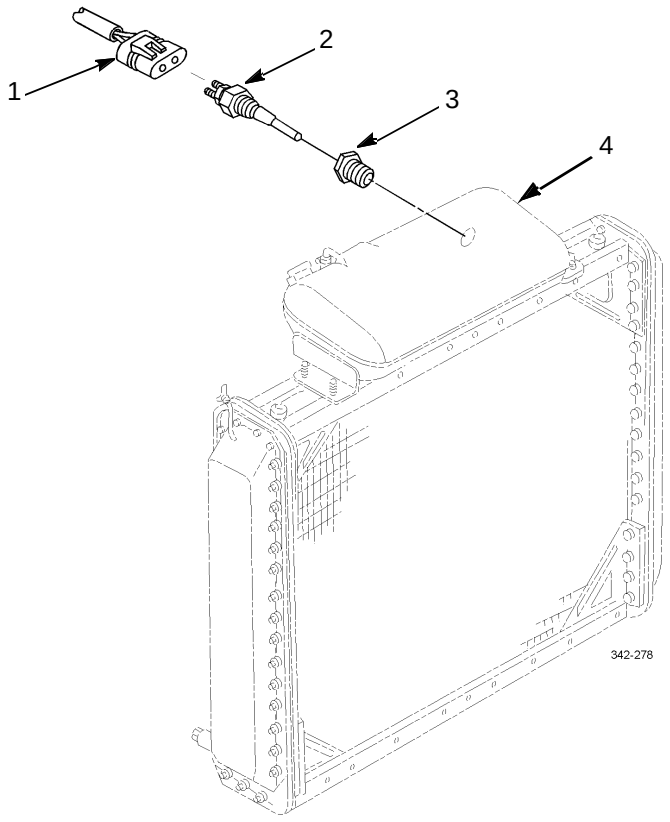
Compound, sealing, pipe (Item 10, WP 0235 00)

Equipment Condition

Cooling system drained (WP 0041 00)

REMOVAL

1. Disconnect wiring harness connector (1) from water level probe (2).
2. Remove water level probe (2) and bushing (3) from radiator (4).

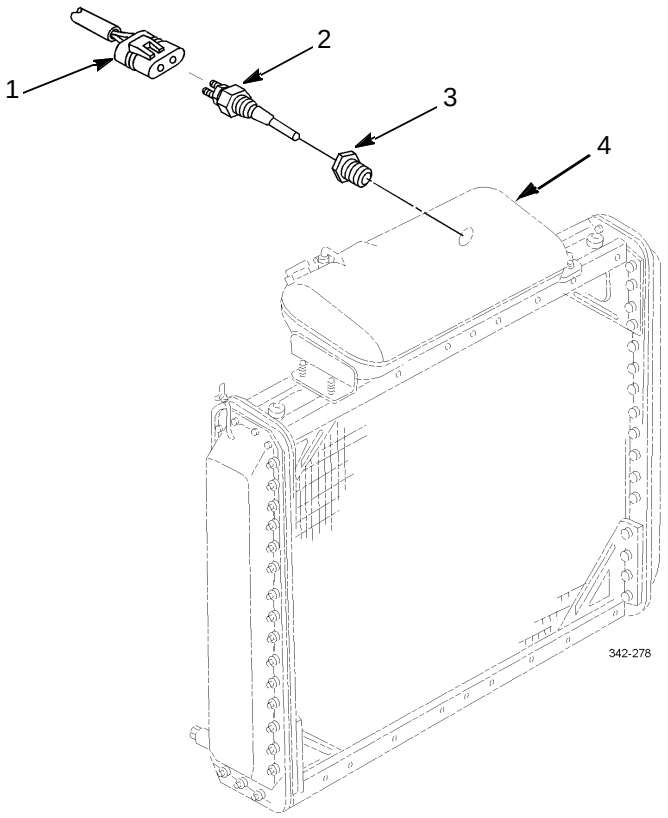


INSTALLATION

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of bushing (3) and water level probe (2) with pipe sealing compound. Install bushing and water level probe on radiator (4).
2. Connect wiring harness connector (1) to water level probe (2).



3. Fill cooling system (WP 0041 00).

END OF WORK PACKAGE

HEADLAMP ADJUSTMENT 0082 00

THIS WORK PACKAGE COVERS

Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Tape, measuring, 50 feet (Item 31, WP 0236 00)

References

TM 9-2320-302-10

Equipment Condition

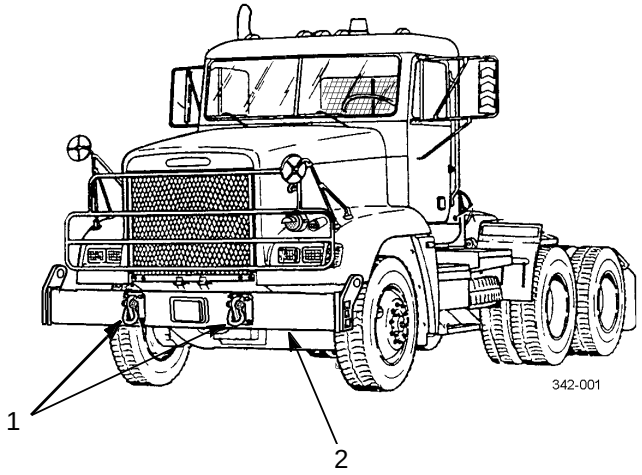
Tires inflated to recommended pressure (TM 9-2320-302-10)

NOTE

Perform adjustment procedures with no load on vehicle.

ADJUSTMENT

1. Determine center of vehicle by measuring distance between two tow brackets (1) and dividing distance by 2.
2. Measure distance determined in step 1 from either of two tow brackets (1) to center of bumper (2). Mark bumper.



3. Drive vehicle close to a light-colored wall with front bumper (2) parallel to wall.
4. Transfer center mark of bumper (2) to wall.

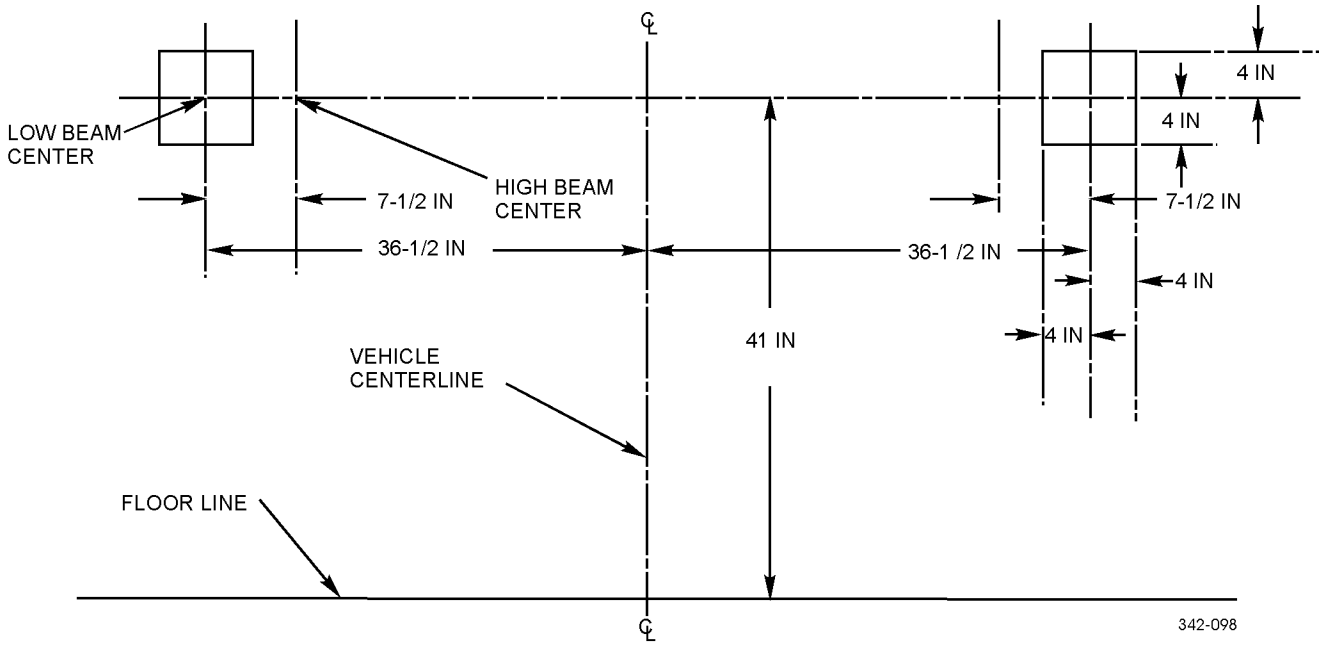
ADJUSTMENT - CONTINUED

5. Back vehicle in a STRAIGHT line away from wall until vehicle is 25 ft (7.63 m) from wall. Park vehicle.
6. Extend mark on wall upward and downward to floor. Ensure that line is vertical. This is vehicle centerline.
7. On vehicle centerline, measure upward 41 in (104.1 cm) from floor. Make a horizontal line parallel to floor.
8. Determine low-beam headlight center by measuring outward 36.5 in (92.7 cm) on each side of vehicle centerline. Mark center.
9. Measure 4 in (10.2 cm) in all four directions from mark to make an 8 in (20.3 cm) square.
10. Repeat step 9 on other side of vehicle centerline.
11. Determine high-beam headlamp center by measuring inward 7.5 in (19.1 cm) on each side of vehicle center line. Mark center.

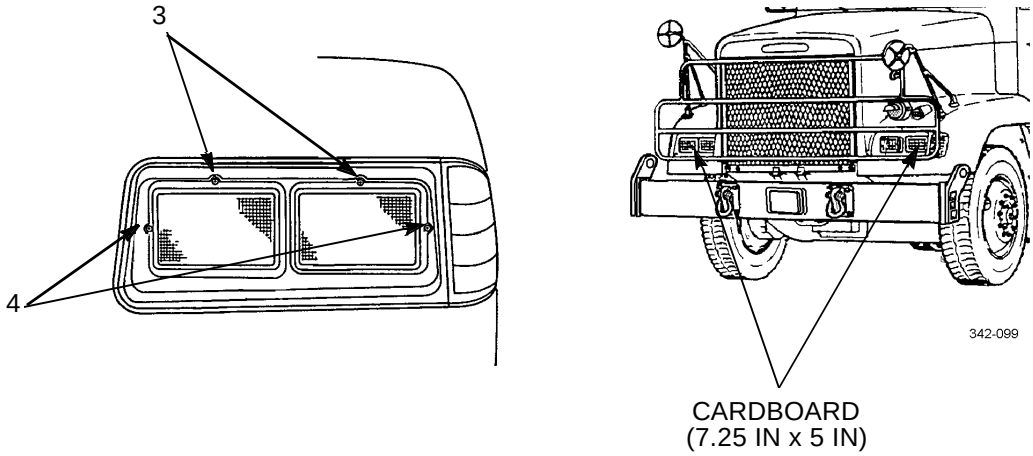
NOTE

Low-beam and high-beam squares will overlap slightly.

12. Measure 4 in (10.2 cm) in all four directions from each mark to make two more 8 in (20.3 cm) squares.



ADJUSTMENT - CONTINUED



13. With low-beam headlamps on, adjust each headlamp until highest intensity point is slightly to right and slightly below headlamp centerlines +/- 4 in (+/- 10.2 cm). To adjust intensity point up or down, rotate center adjusting screw (3) left or right. To adjust intensity point left or right, rotate side adjusting screw (4) left or right.
14. With high-beam headlamps on, cover each low-beam headlamp with cardboard cut to 7.25 in x 5 in (18.4 cm x 13 cm).
15. Adjust each headlamp until highest intensity point is over centerline mark +/- 4 in (+/- 10.2 cm). To adjust intensity point up or down, rotate center adjusting screw (3) left or right. To adjust intensity point left or right, rotate side adjusting screw (4) left or right.

END OF WORK PACKAGE

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HEADLAMP AND HEADLIGHT REPLACEMENT 0083 00

THIS WORK PACKAGE COVERS

Headlamp Removal, Headlight Removal, Headlight Installation, Headlamp Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1)

Adhesive, silicone rubber (Item 3, WP 0235 00)

References

TM 9-2320-302-10

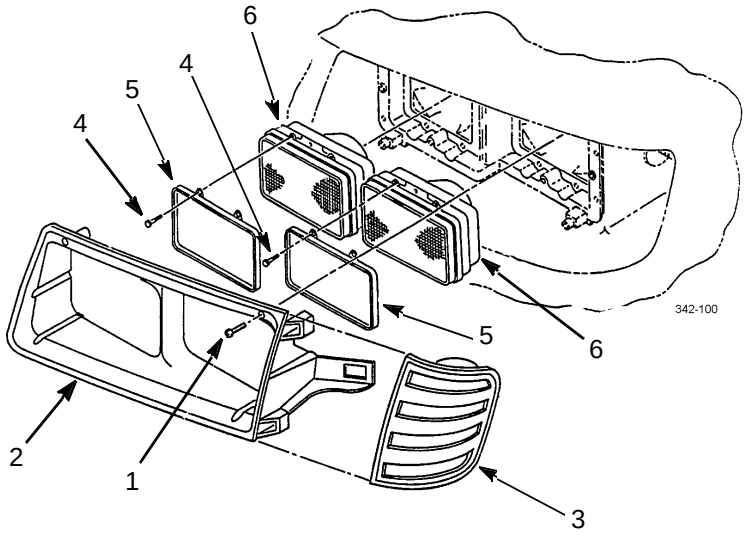
WP 0082 00

HEADLAMP REMOVAL

NOTE

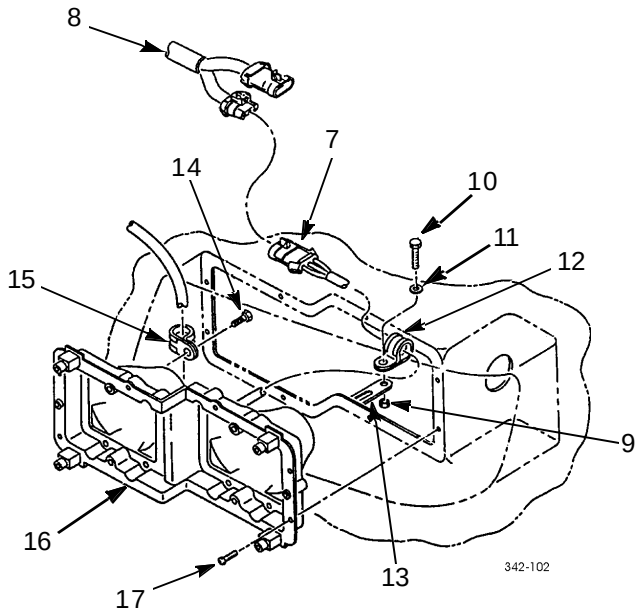
Both headlamps are replaced the same way. One headlamp is illustrated.

1. Remove four screws (1) from bezel (2).
2. Disconnect turn signal light (3) and remove bezel (2) from vehicle.
3. Remove four screws (4) and headlamp retainer (5) from headlamp (6).
4. Remove headlamp (6) from vehicle.

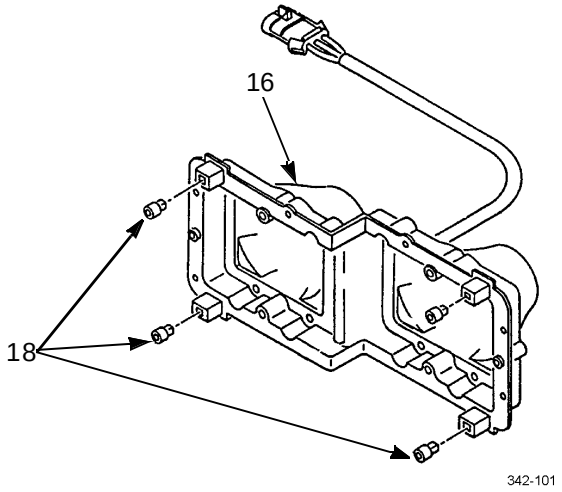


HEADLIGHT REMOVAL

1. Remove connector (7) from wiring harness (8).
2. Remove lock nut (9), screw (10), washer (11), and clamp (12) from bracket (13). Discard lock nut.
3. Remove screw (14) and clamp (15) from headlight assembly (16).
4. Remove eight screws (17) and headlight assembly (16) from vehicle.



5. Remove four grommets (18) from headlight assembly (16).



HEADLIGHT INSTALLATION

1. Install four grommets (18) on headlight assembly (16).

HEADLIGHT INSTALLATION - CONTINUED

WARNING

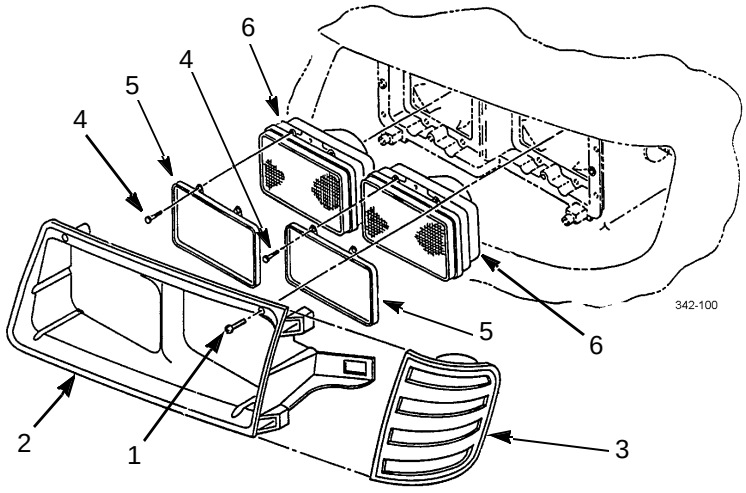
Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

2. Apply adhesive to mating surface of headlight assembly (16). Install headlight assembly on vehicle with eight screws (17).
3. Install clamp (15) and screw (14) on headlight assembly (16).
4. Install clamp (12) on bracket (13) with washer (11), screw (10), and new lock nut (9).
5. Connect connector (7) on wiring harness (8).

HEADLAMP INSTALLATION

NOTE

Procedure is the same for all headlamps.



1. Install headlamp (6) on vehicle.
2. Install headlamp retainer (5) on headlamp (6) and four screws (4).
3. Position bezel (2) on vehicle and connect turn signal light (3).
4. Install four screws (1) on bezel (2).
5. Adjust headlamps (6) (WP 0082 00).

END OF WORK PACKAGE

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BLACKOUT DRIVE, MARKER LIGHT, AND WIRING HARNESS REPLACEMENT 0084 00

THIS WORK PACKAGE COVERS

Removal, Disassembly, Assembly, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 233774) (2)

Nut, lock (P/N MS51922-1) (3)

Materials/Parts - Continued

Washer, lock (P/N 104J005-29)

Straps, tiedown (Item 30, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

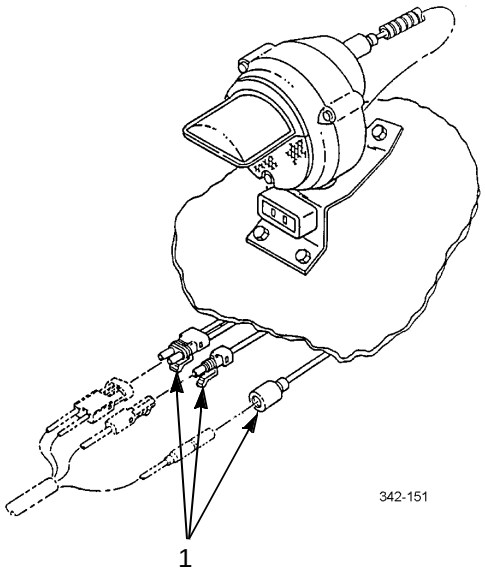
TM 9-2320-302-10

REMOVAL

NOTE

Tag connectors prior to removal to aid in installation.

1. Disconnect three connectors (1).



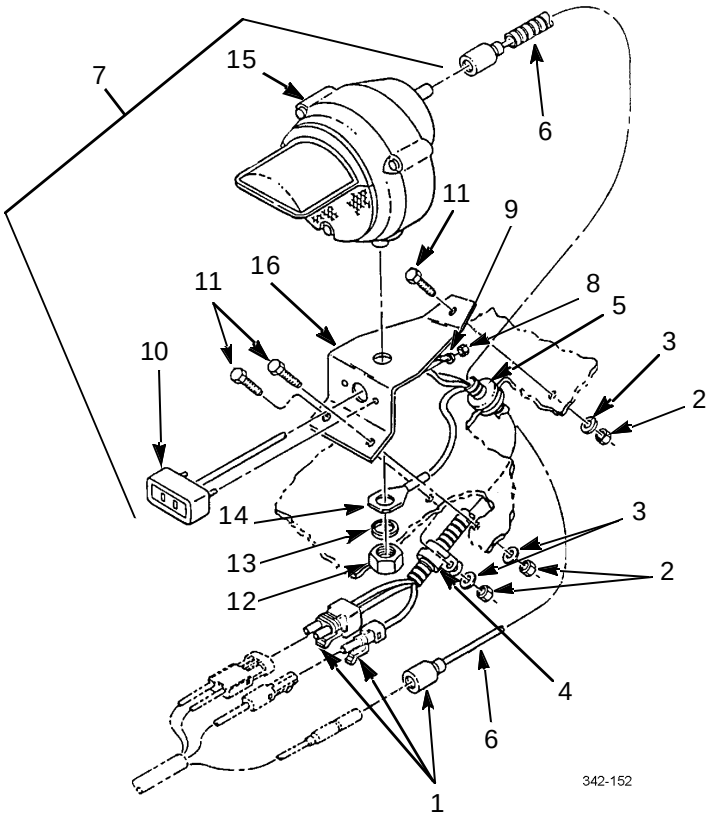
REMOVAL - CONTINUED

2. Remove three lock nuts (2), washers (3), and clamp (4). Discard lock nuts.

NOTE

Quantity of wire tiedown straps may vary. Remove tiedown straps as needed and discard.

3. Remove grommet (5) and pull harness (6) through fender while removing blackout light assembly (7) from fender.
4. Remove two lock nuts (8), wire (9), marker light (10), and three screws (11). Discard lock nuts.



5. Remove nut (12), lock washer (13), ground wire (14), and blackout drive light (15) from bracket (16). Discard lock washer.
6. Remove harness (6) from blackout drive light (15).

DISASSEMBLY

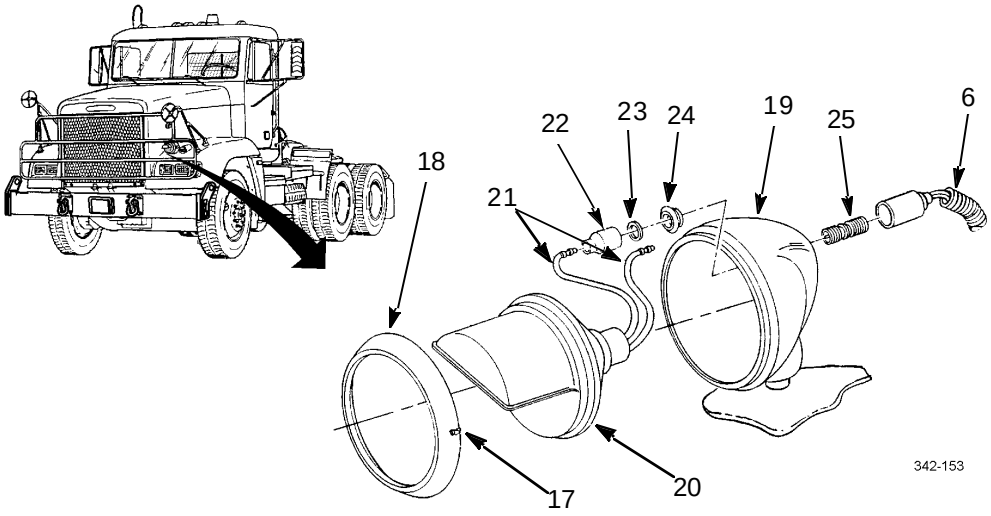
1. Loosen three screws (17) and remove door (18) from enclosure (19).

NOTE

Tag wires to aid in installation.

2. Remove lamp unit (20) from enclosure (19) and disconnect two wires (21). Remove shell (22).
3. Remove washer (23), grommet (24), and adapter (25) from enclosure (19).

DISASSEMBLY - CONTINUED



ASSEMBLY

1. Install adapter (25), grommet (24), and washer (23) on enclosure (19).
2. Install shell (22), connect two wires (21), and install lamp unit (20) on enclosure (19).
3. Position door (18) on enclosure (19) and tighten three screws (17).

INSTALLATION

NOTE

Quantity of wire tiedown straps may vary. Install new tiedown staps as needed.

4. Install blackout drive light (15) and ground wire (14) on bracket (16) with new lock washer (13) and nut (12).
5. Install harness (6) on blackout drive light (15).
6. Install three screws (11), marker light (10), wire (9), and two new lock nuts (8) on bracket (16).
7. Insert harness (6) through fender and install blackout light assembly (7), grommet (5), clamp (4), three washers (3), and new lock nuts (2).
8. Connect three connectors (1).

END OF WORK PACKAGE

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RIGHT FRONT BLACKOUT MARKER REPLACEMENT 0085 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 233774) (2)

Nut, lock (P/N MS51922-1) (3)

Materials/Parts - Continued

Straps, tiedown (Item 30, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

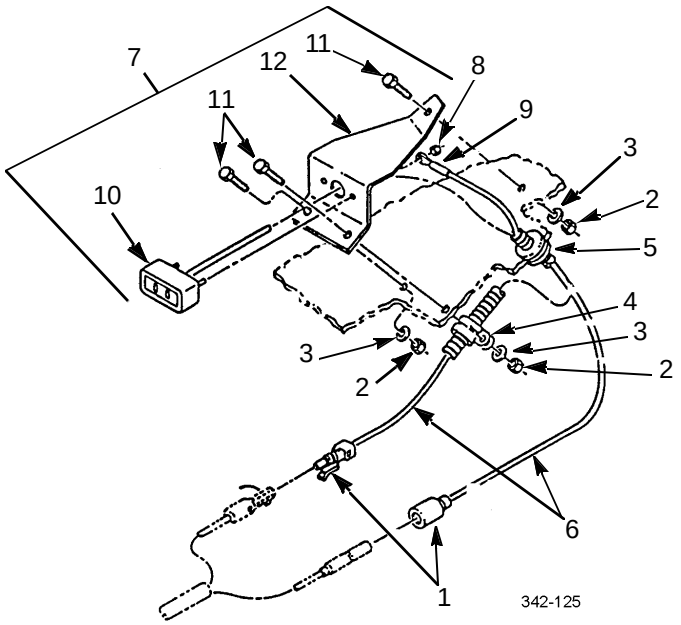
TM 9-2320-302-10

REMOVAL

NOTE

- Tag connectors and wire to aid in installation.
- Quantity of tiedown straps may very. Remove tiedown straps as needed and discard.

1. Disconnect two connectors (1).
2. Remove three locknuts (2), washers (3), and clamp (4). Discard locknuts.
3. Remove grommet (5) and feed harness (6) through fender while removing blackout marker light assembly (7) from fender.
4. Remove two lock nuts (8) and wire (9). Discard lock nuts.
5. Remove blackout marker (10) and three screws (11) from bracket (12).

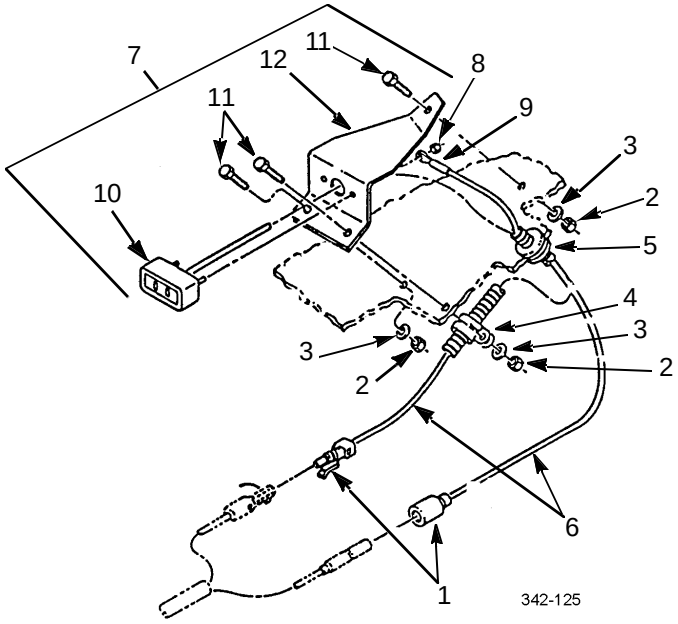


INSTALLATION

NOTE

Quantity of tiedown straps may vary. Install new tiedown straps as needed.

1. Install three screws (11) and blackout marker (10) on bracket (12).
2. Install wire (9) and two new lock nuts (8).
3. Insert harness (6) through fender and install blackout marker light assembly (7), grommet (5), clamp (4), three washers (3), and new lock nuts (2).
4. Connect two connectors (1).



END OF WORK PACKAGE

REAR BLACKOUT MARKER REPLACEMENT 0086 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N 233774) (2)

Tags, marker (Item 31, WP 0235 00)

NOTE

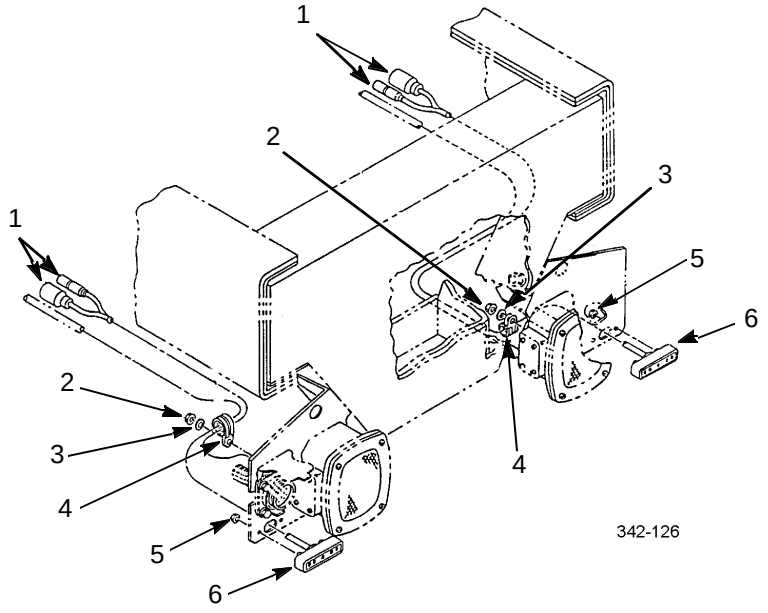
Rear blackout marker lights are replaced the same. Perform procedure for each rear blackout marker as required.

REMOVAL

NOTE

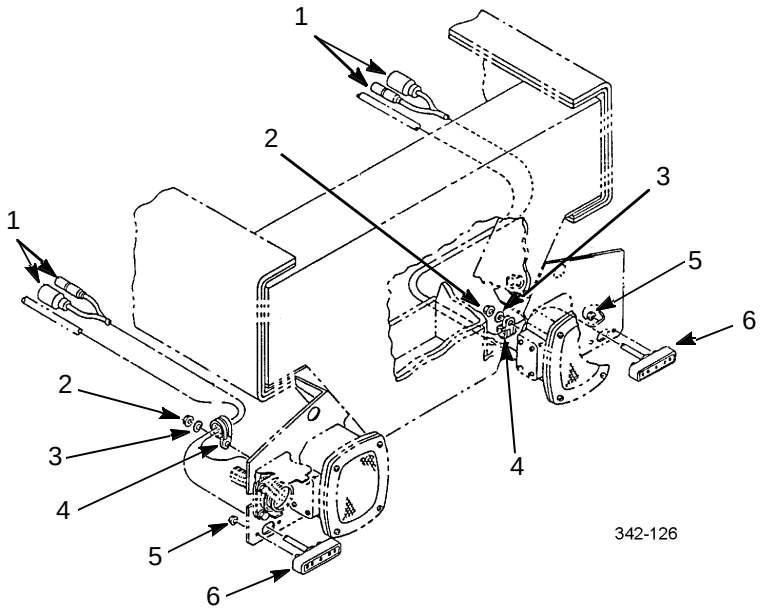
Tag connectors to aid in installation.

1. Disconnect two connectors (1).
2. Remove nut (2), washer (3), and clamp (4).
3. Remove two lock nuts (5) and blackout marker (6). Discard lock nuts.



INSTALLATION

1. Install blackout marker (6) with two new lock nuts (5).
2. Install clamp (4), washer (3), and nut (2).
3. Connect two connectors (1).



END OF WORK PACKAGE

TAILLIGHT MAINTENANCE 0087 00

THIS WORK PACKAGE COVERS

Lamp Replacement, Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

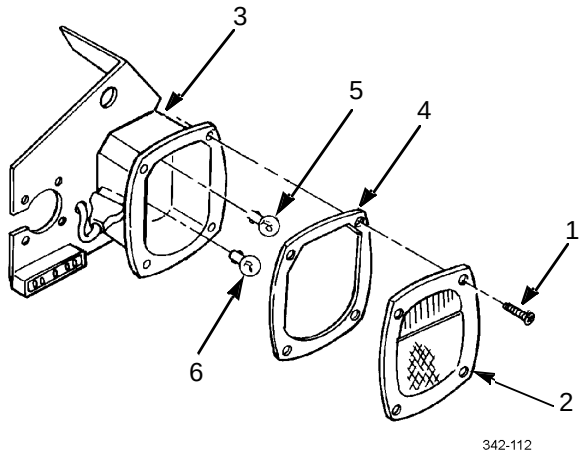
TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N 23-10340-125) (3)

LAMP REPLACEMENT

1. Remove four screws (1) and lens (2) from taillight housing (3).
2. Inspect gasket (4) for damage. Replace gasket if damaged.
3. Remove lamps (5 and 6) by pushing in and turning clockwise.
4. Install lamps (5 and 6) by pushing in and turning clockwise.
5. Install lens (2) on taillight housing (3) with four screws (1).

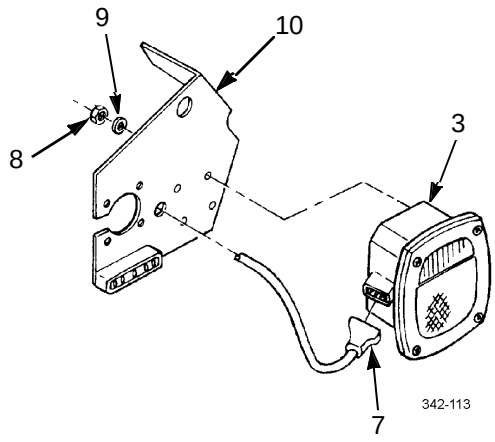


NOTE

Left and right taillights are replaced the same way. Left taillight is shown.

REMOVAL

1. Disconnect taillight wiring harness connector (7) from taillight housing (3).
2. Remove three lock nuts (8), washers (9), and taillight housing (3) from bracket (10). Discard lock nuts.



INSTALLATION

1. Install taillight housing (3) on bracket (10) with three washers (9) and new lock nuts (8).
2. Connect taillight wiring harness connector (7) to taillight housing (3).

END OF WORK PACKAGE

SIDE MARKER/TURN SIGNAL LIGHT REPLACEMENT 0088 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Gasket (P/N GNI 9700G1)

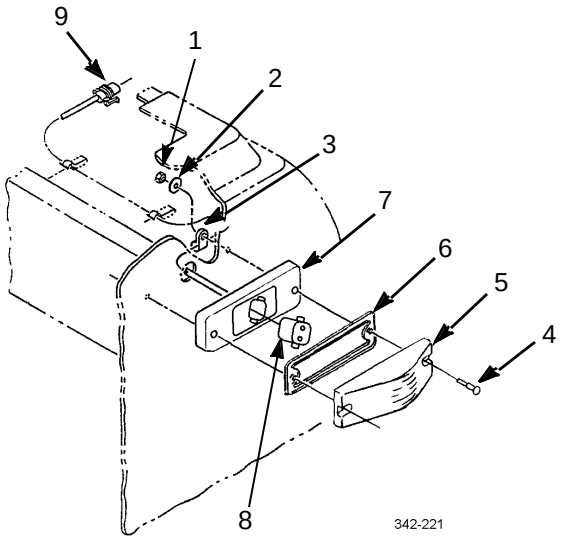
Nut, lock (P/N 23-09336-005) (2)

NOTE

Left and right side marker/turn signal lights are replaced the same way. Left side marker/turn signal light is shown.

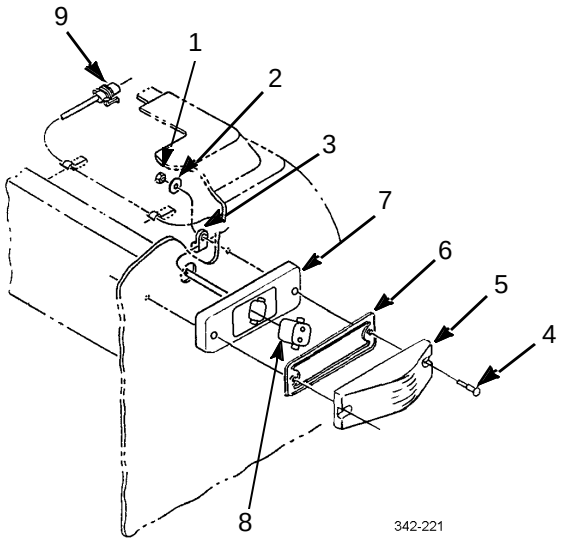
REMOVAL

1. Remove two lock nuts (1), washers (2), clamp (3), two screws (4), lens cover (5), and gasket (6) from side marker/turn signal light (7). Discard lock nuts and gasket.
2. Remove lamp (8) from side marker/turn signal light (7).
3. Disconnect connector (9) from side marker/turn signal light (7). Remove side marker/turn signal light from vehicle.



INSTALLATION

1. Position side marker/turn signal light (7) on vehicle and connect connector (9).
2. Install lamp (8) on side marker/turn signal light (7).
3. Install new gasket (6), lens cover (5), and clamp (3) on side marker/turn signal light (7) with two screws (4), washers (2), and new lock nuts (1).



END OF WORK PACKAGE

CLEARANCE LIGHT REPLACEMENT 0089 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Head liners removed (WP 0203 00)

References

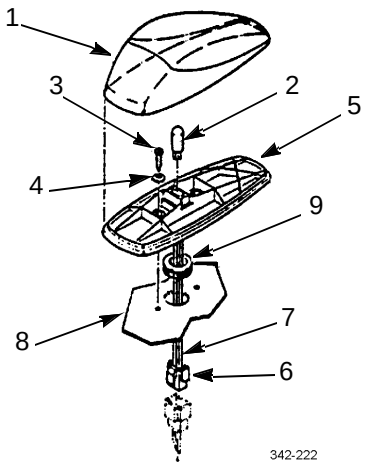
TM 9-2320-302-10

NOTE

Five clearance lights are replaced the same way. One clearance light is shown.

REMOVAL

1. Remove lens cover (1), lamp (2), two screws (3), and washers (4) from clearance light (5).
2. Remove clearance light (5).
3. Disconnect connector (6) and pull harness (7) through hole in cab (8).
4. Remove grommet (9) from cab (8).



INSTALLATION

1. Install grommet (9) on cab (8).
2. Feed harness (7) through hole in cab (8).
3. Connect connector (6).
4. Install clearance light (5), two washers (4), screws (3), lamp (2), and lens cover (1).
5. Install head liners (WP 0203 00).

END OF WORK PACKAGE

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UTILITY LIGHT MAINTENANCE 0090 00

THIS WORK PACKAGE COVERS

Lamp Removal, Light Removal, Light Installation, Lamp Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 115307A)

Nut, lock (P/N MS51922-1) (6)

Washer, lock (P/N MS35335-36)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Conditions

Cab liners removed (WP 0202 00)

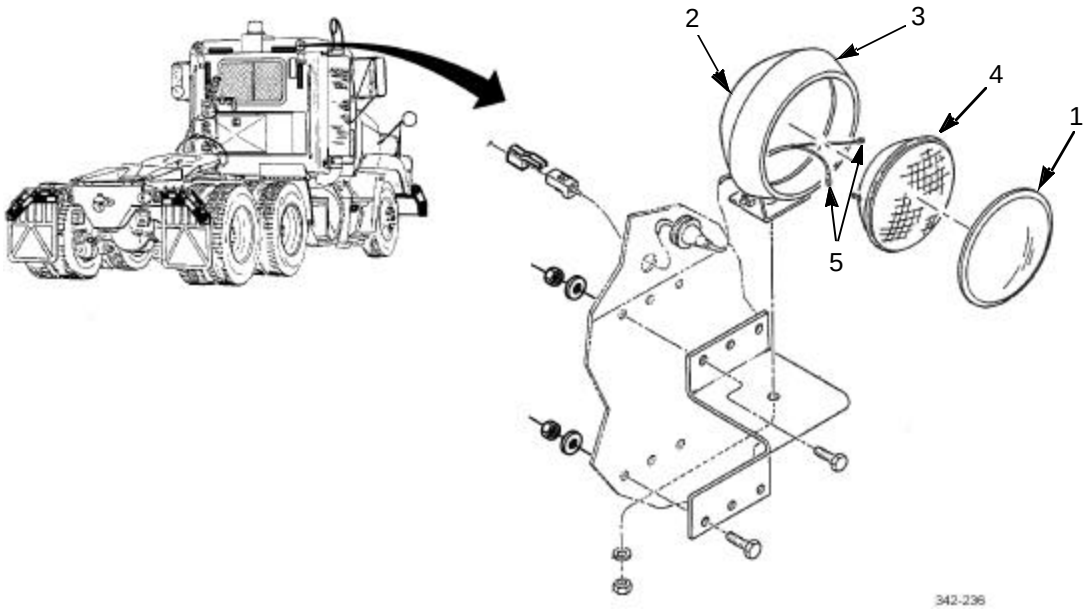
Head liners removed (WP 0203 00)

NOTE

Right and left side utility lights are maintained the same way. Right side utility light is shown.

LAMP REMOVAL

1. Remove lens retainer (1) from utility light assembly (2).
2. Roll back rubber seal (3) and remove lamp (4), with two wires (5) attached, from utility light assembly (2).
3. Disconnect two wires (5) from lamp (4).



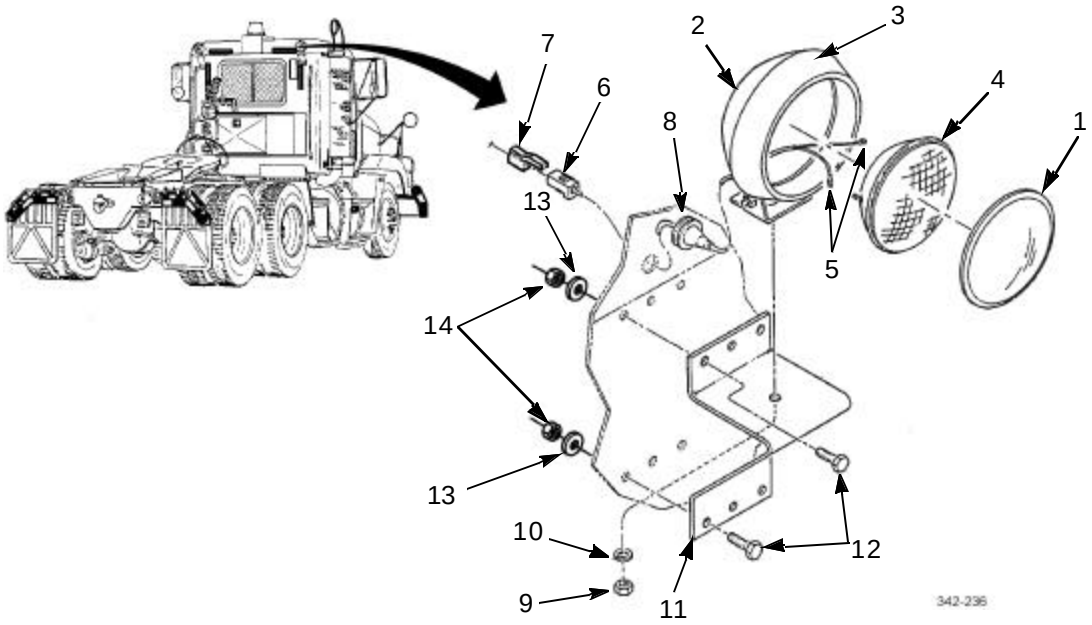
LIGHT REMOVAL

1. Disconnect utility light wiring connector (6) from cab wiring connector (7).
2. Remove rubber grommet (8) and pull utility light wiring out from inside cab.
3. Remove lock nut (9), lock washer (10), and utility light (2) from mounting bracket (11). Discard lock nut and lock washer.

NOTE

Perform step 4 only if bracket is damaged.

4. Remove six screws (12), washers (13), lock nuts (14), and mounting bracket (11) from cab. Discard lock nuts.



LIGHT INSTALLATION

NOTE

Perform step 1 only if mounting bracket was removed.

1. Install mounting bracket (11) on cab with six screws (12), washers (13), and new lock nuts (14).
2. Install light (2) on mounting bracket (11) with new lock nut (9) and lock washer (10).
3. Feed utility light connector (6) through cab access and connect to cab wiring harness (7). Install grommet (8).

LAMP INSTALLATION

1. Connect two wires (5) to lamp (4). Position lamp in utility light assembly (2) and roll rubber seal (3) over lamp.
2. Install lens retainer (1) on utility light assembly (2).
3. Install cab liners (WP 0202 00).
4. Install head liners (WP 0203 00).

END OF WORK PACKAGE

INTERIOR LIGHT UNIT AND BULB REPLACEMENT 0091 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

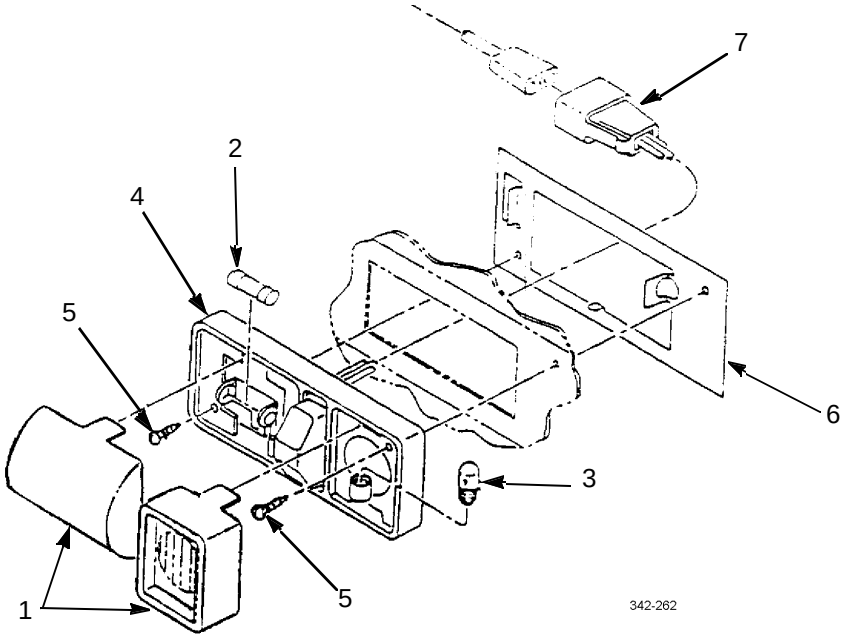
Materials/Parts

Lamp, incandescent (P/N 561)

Lamp, incandescent (P/N AN3121-1816)

REMOVAL

1. Remove two covers (1) and incandescent lamps (2 and 3) from light unit (4).
2. Remove two screws (5) and light unit (4) from mounting bracket (6).
3. Pull light unit (4) down and disconnect connector (7) from cab wiring harness.



INSTALLATION

1. Connect connector (7) to cab wiring harness.
2. Install light unit (4) on mounting bracket (6) with two screws (5).
3. Install two incandescent lamps (2 and 3) on light unit (4).
4. Install two covers (1) on light unit (4).

INSTALLATION - CONTINUED

5. Check lamp for operation (TM 9-2320-302-10).

END OF WORK PACKAGE

FUEL PRESSURE SENSOR REPLACEMENT 0092 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

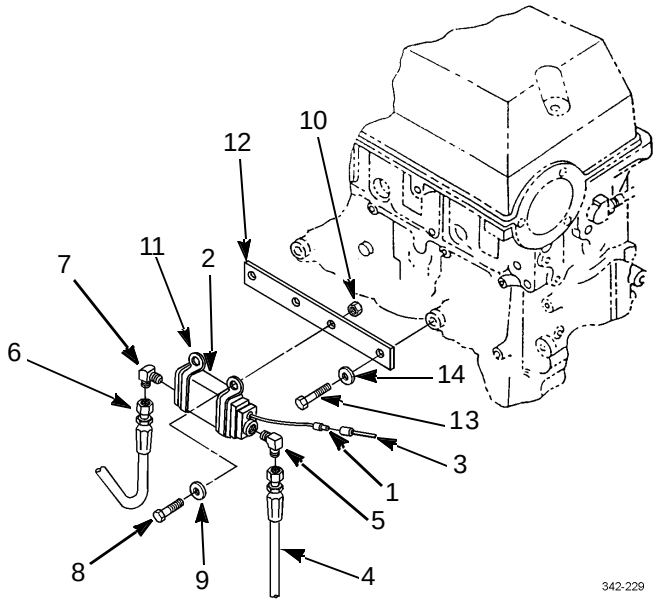
Materials/Parts

Nut, lock (P/N MS51922-1) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

REMOVAL

1. Disconnect connector (1) of fuel pressure sensor (2) from wiring harness (3).
2. Remove fuel hose (4) and elbow (5) from fuel pressure sensor (2).
3. Remove fuel hose (6) and elbow (7) from fuel pressure sensor (2).
4. Remove two screws (8), washers (9), lock nuts (10), clamps (11), and fuel pressure sensor (2) from mounting plate (12). Discard lock nuts.
5. Remove two screws (13), washers (14), and mounting plate (12) from side of engine.



INSTALLATION

1. Install mounting plate (12) on side of engine with two washers (14) and screws (13).
2. Install fuel pressure sensor (2) on mounting plate (12) with two clamps (11), screws (8), washers (9), and new lock nuts (10).

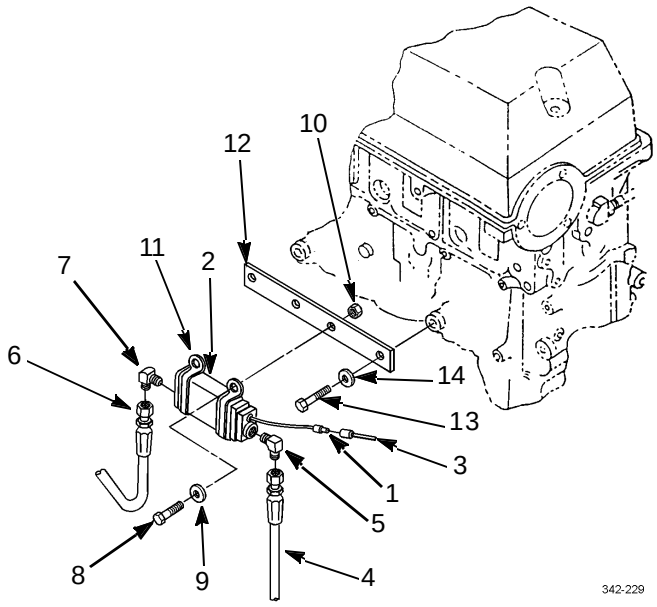
WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

CAUTION

Ensure that all fittings are clear of debris and excess pipe sealing compound does not enter fittings or fuel lines. Failure to follow this caution could result in damage to equipment.

3. Lightly coat threads of elbow (7) with pipe sealing compound. Install elbow and fuel hose (6) on fuel pressure sensor (2).
4. Lightly coat threads of elbow (5) with pipe sealing compound. Install elbow and fuel hose (4) on fuel pressure sensor (2).
5. Connect connector (1) to wiring harness (3).



END OF WORK PACKAGE

FUEL TEMPERATURE SENSOR REPLACEMENT 0093 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

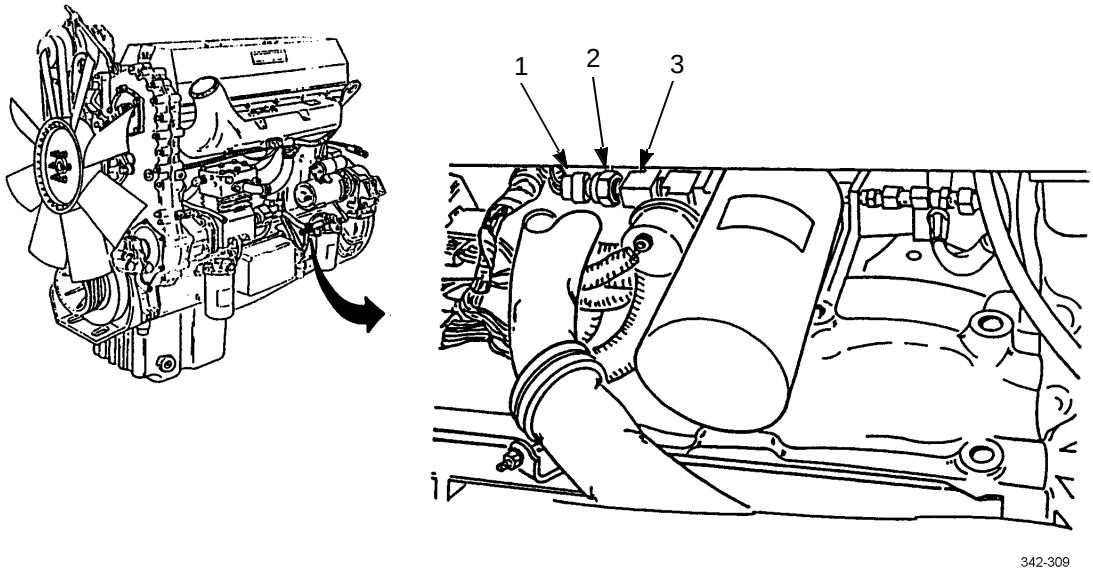
TM 9-2320-302-10

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

REMOVAL

1. Disconnect engine wiring harness connector (1) from fuel temperature sensor (2).
2. Remove fuel temperature sensor (2) from elbow (3).



INSTALLATION

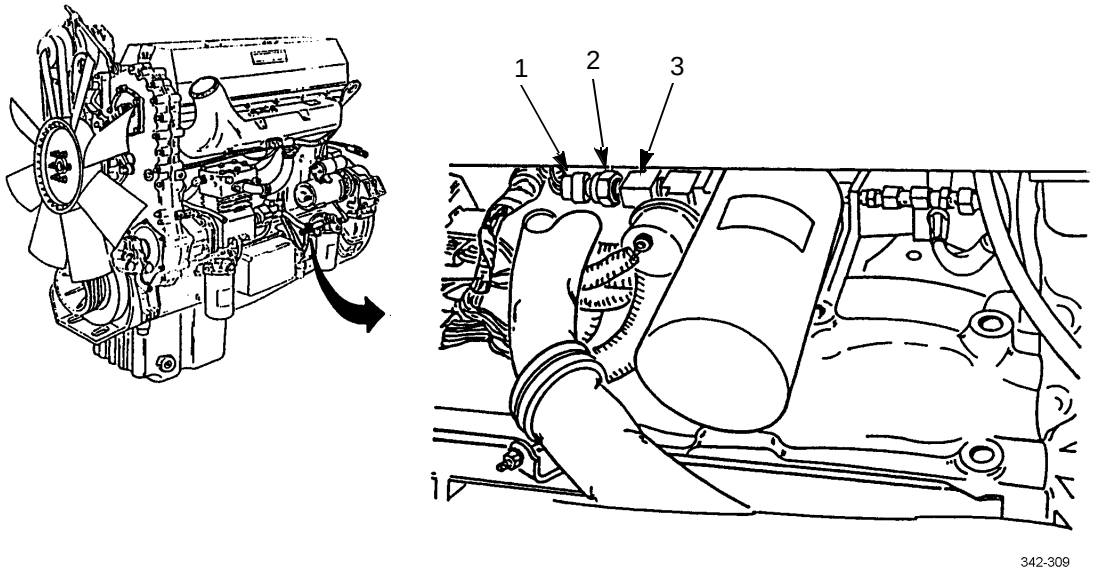
WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

CAUTION

Ensure that all fittings are clear of debris and excess pipe sealing compound does not enter fittings or fuel lines. Failure to follow this caution could result in damage to equipment.

1. Lightly coat threads of fuel temperature sensor (2) with pipe sealing compound. Install fuel temperature sensor on elbow (3).
2. Connect engine wiring harness connector (1) to fuel temperature sensor (2).



END OF WORK PACKAGE

FUEL LEVEL SENDING UNIT REPLACEMENT 0094 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Seal (P/N 22-27156-000)

Tags, marker (Item 31, WP 0235 00)

REMOVAL

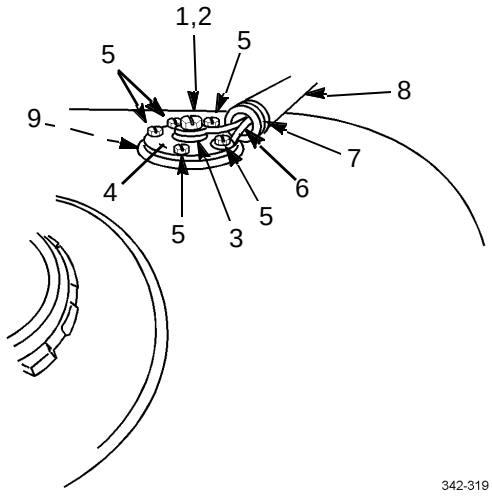
WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

NOTE

Tag wires to aid in installation.

1. Remove screw (1), washer (2), and wire lead (3) from fuel level sending unit (4).



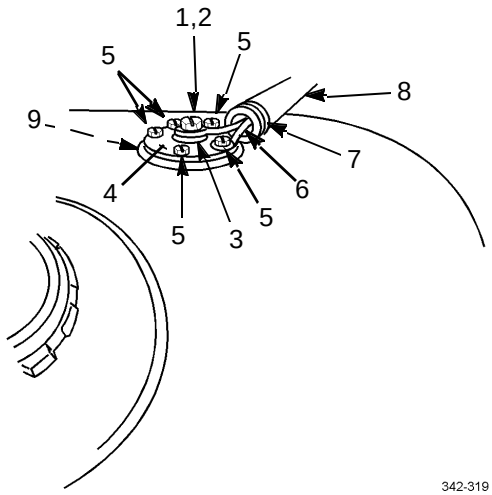
NOTE

Note cable and clamp position and tag wire lead to aid in installation.

2. Remove screw (5), ground lead (6), and clamp (7) from fuel level sending unit (4).
3. Remove cable (8) and clamp (7) from fuel level sending unit (4).
4. Remove four remaining screws (5), fuel level sending unit (4), and seal (9). Discard seal.

INSTALLATION

1. Install new seal (9) and fuel level sending unit (4) with float toward rear of vehicle.
2. Install cable (8), clamp (7), and ground lead (6) on fuel level sending unit (4) with screw (5).
3. Install four remaining screws (5) on fuel level sending unit (4).
4. Install wire lead (3) on fuel level sending unit (4) with screw (1) and washer (2).



END OF WORK PACKAGE

OIL PRESSURE SENSOR REPLACEMENT 0095 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

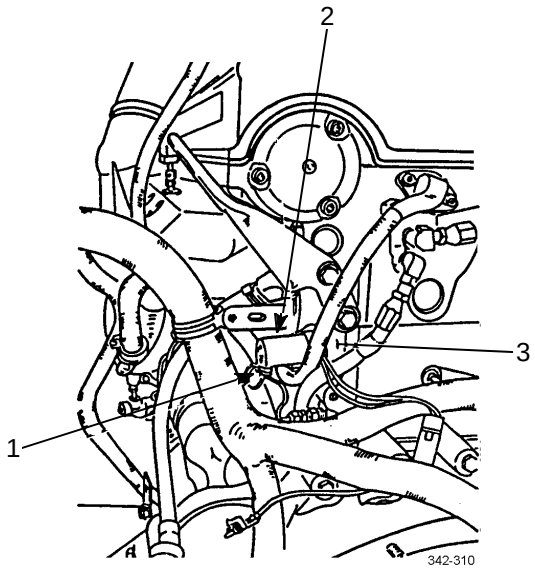
TM 9-2320-302-10

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

REMOVAL

1. Disconnect engine wiring harness connector (1) from oil pressure sensor (2) on left rear side of engine.
2. Remove oil pressure sensor (2) from engine block (3).



INSTALLATION

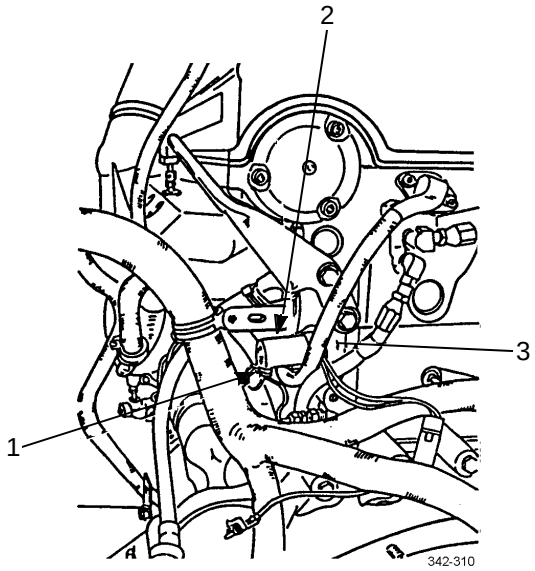
WARNINGS

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

CAUTION

Ensure that all fittings are clear of debris and excess pipe sealing compound does not enter fittings or lines. Failure to follow this caution could result in damage to equipment.

1. Lightly coat threads of oil pressure sensor (2) with pipe sealing compound. Install oil pressure sensor in engine block (3).
2. Connect engine wiring harness connector (1) to oil pressure sensor (2).



END OF WORK PACKAGE

OIL TEMPERATURE SENSOR REPLACEMENT 0096 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

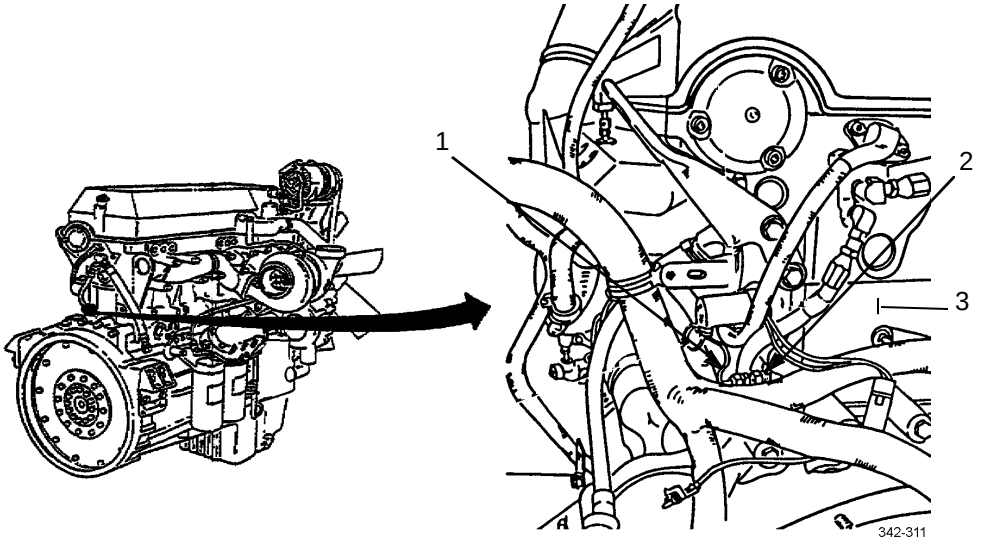
TM 9-2320-302-10

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

REMOVAL

1. Disconnect engine wiring harness connector (1) from oil temperature sensor (2).
2. Remove oil temperature sensor (2) from engine block (3).



INSTALLATION

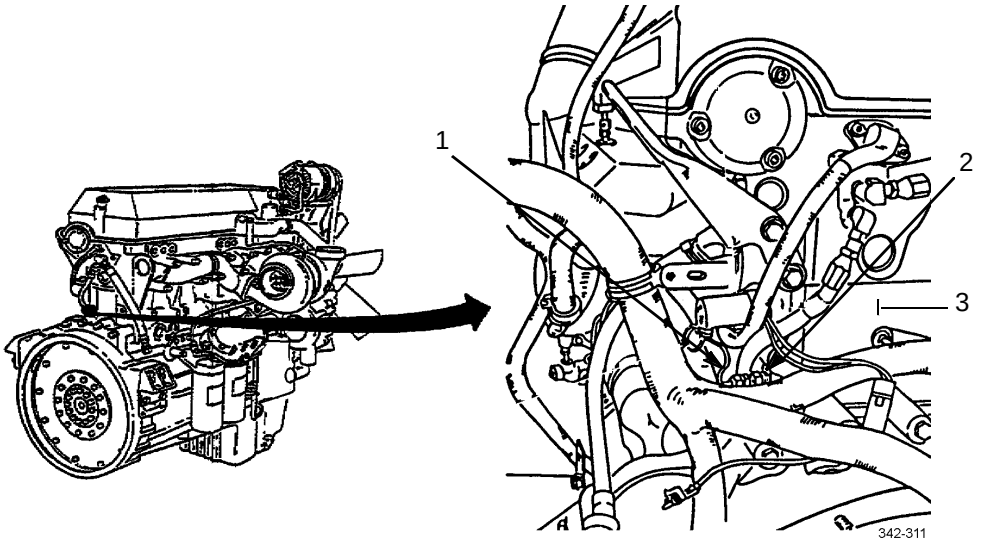
WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

CAUTION

Ensure that fittings are clear of debris and excess pipe sealing compound does not enter fittings or lines. Failure to follow this caution could result in damage to equipment.

1. Lightly coat threads of oil temperature sensor (2) with pipe sealing compound. Install oil temperature sensor on engine block (3).
2. Connect engine wiring harness connector (1) to oil temperature sensor (2).



END OF WORK PACKAGE

OIL PRESSURE SENDING UNIT REPLACEMENT 0097 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

References

TM 9-2320-302-10

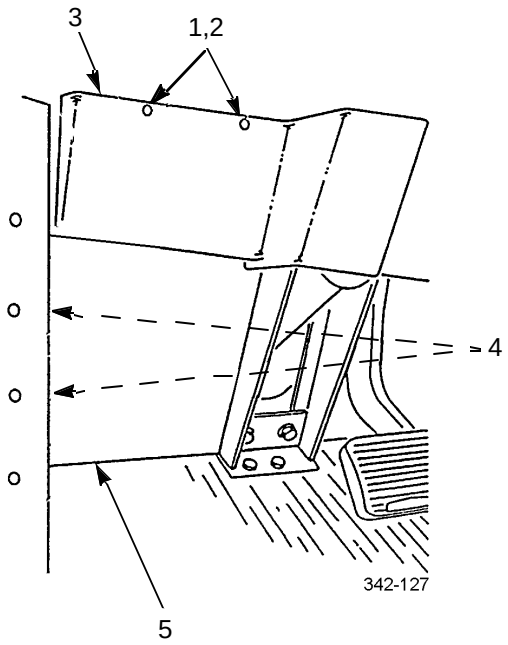
Equipment Condition

Air system drained (TM 9-2320-302-10)

Check engine switch removed (WP 0070 00)

REMOVAL

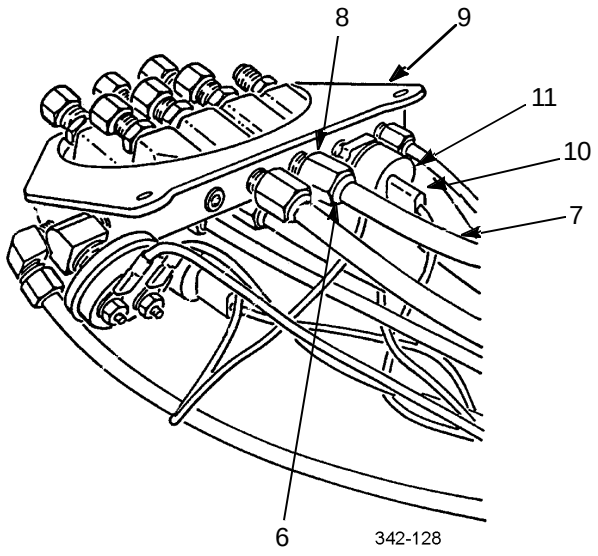
1. Remove five screws (1), washers (2), and cover (3).
2. Remove two screws (4) and cover (5).



3. If necessary, remove cab air junction block (WP 0149 00) to access oil pressure sending unit.

REMOVAL - CONTINUED

4. Depress collar (6) and remove air line (7) from fitting (8).
5. Remove fitting (8) from cab air junction block (9).
6. Disconnect electrical connector (10) from oil pressure sending unit (11).
7. Remove oil pressure sending unit (11) from cab air junction block (9).



INSTALLATION

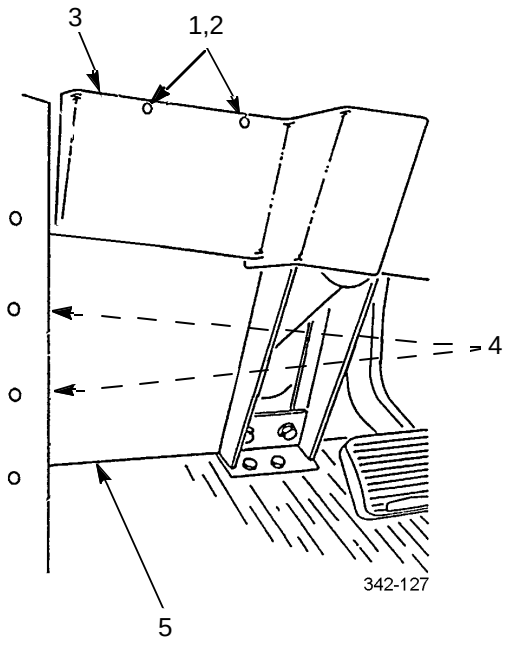
WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure that all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure follow this warning could result in injury to personnel or damage to equipment.

1. Lightly coat threads of oil pressure sending unit (11) with pipe sealing compound. Install sending unit on cab air junction block (9).
2. Connect electrical connector (10) to oil pressure sending unit (11).
3. Lightly coat threads of fitting (8) with sealing compound. Install fitting on cab air junction block (9).
4. Install air line (7) on fitting (8), completely in collar (6).

INSTALLATION - CONTINUED

5. If removed, install cab air junction block (WP 0149 00).
6. Install cover (5) with two screws (4).
7. Install cover (3) with five washers (2) and screws (1).



8. Install check engine switch (WP 0070 00).

END OF WORK PACKAGE

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WATER TEMPERATURE SENSOR REPLACEMENT 0098 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

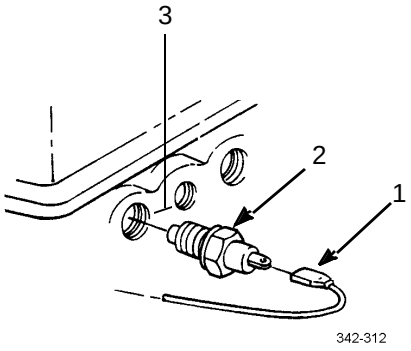
Compound, sealing, pipe (Item 10, WP 0235 00)

Equipment Condition

Cooling system drained (WP 0041 00)

REMOVAL

1. Disconnect connector (1) from water temperature sensor (2).
2. Remove water temperature sensor (2) from cylinder head (3).

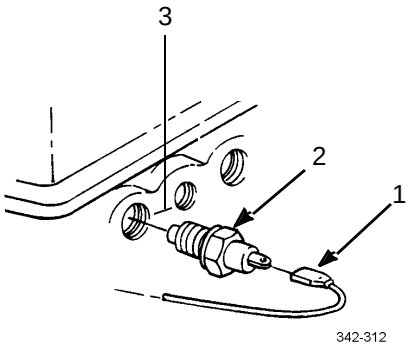


INSTALLATION

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of water temperature sensor (2) with pipe sealing compound. Install water temperature sensor in cylinder head (3).
2. Connect connector (1) to water temperature sensor (2).
3. Fill cooling system (WP 0041 00).



END OF WORK PACKAGE

WATER LEVEL SENSOR REPLACEMENT 0099 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Washer, lock (P/N 3059-00874-02)

Compound, sealing, pipe (Item 10, WP 0235 00)

References

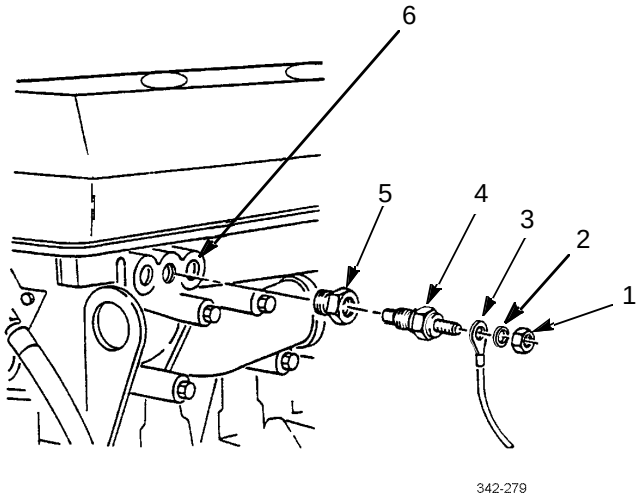
TM 9-2320-302-10

Equipment Condition

Cooling system drained (WP 0041 00)

REMOVAL

1. Remove nut (1), lock washer (2), and wire (3) from water level sensor (4). Discard lock washer.
2. Remove water level sensor (4) and adapter (5) from engine block (6).

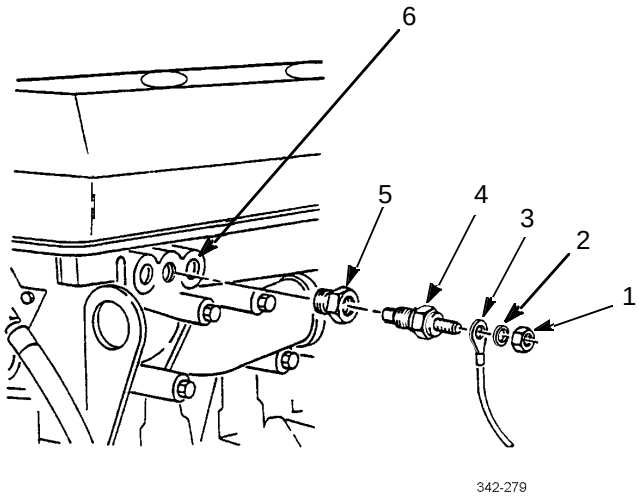


INSTALLATION

WARNINGS

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of adapter (5) and water level sensor (4) with pipe sealing compound. Install adapter and water level sensor in engine block (6).
2. Install wire (3) on water level sensor (4) with new lock washer (2) and nut (1).
3. Fill cooling system (WP 0041 00).



END OF WORK PACKAGE

FAN TEMPERATURE SENSOR REPLACEMENT 0100 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

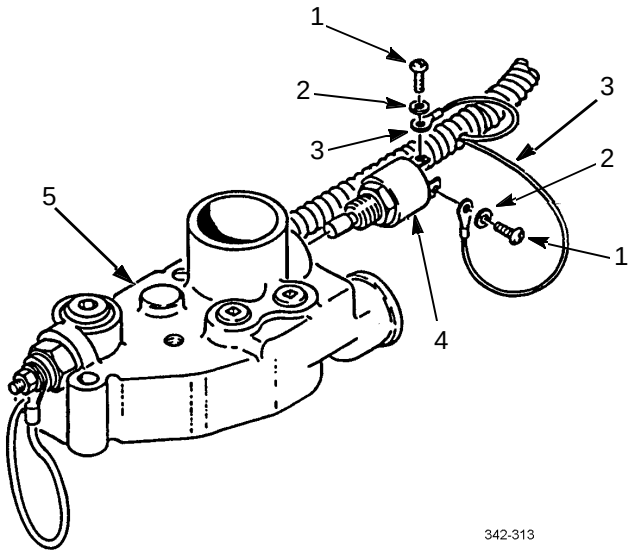
Compound, sealing, pipe (Item 10, WP 0235 00)

Equipment Condition

Thermostat housing drained (WP 0041 00)

REMOVAL

1. Remove two screws (1), lock washers (2), and wires (3) from fan temperature sensor (4).
2. Remove fan temperature sensor (4) from thermostat housing (5).

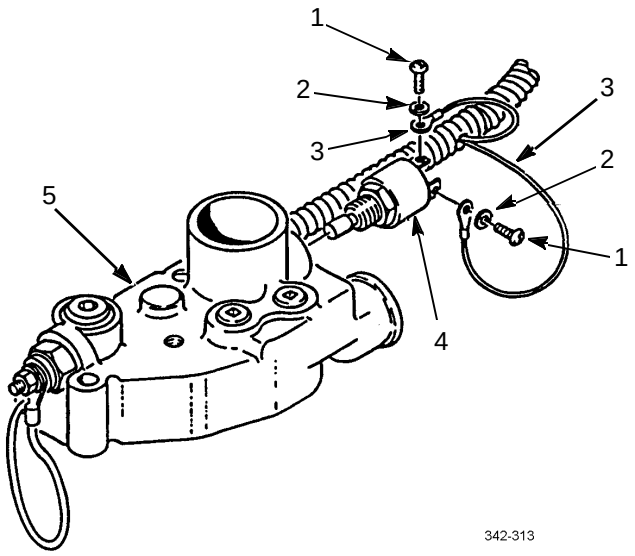


INSTALLATION

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of fan temperature sensor (4) with pipe sealing compound. Install in thermostat housing (5).
2. Install two wires (3) on fan temperature sensor (4) with two lock washers (2) and screws (1).



3. Fill cooling system (WP 0041 00).

END OF WORK PACKAGE

AIR TEMPERATURE SENSOR REPLACEMENT 0101 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

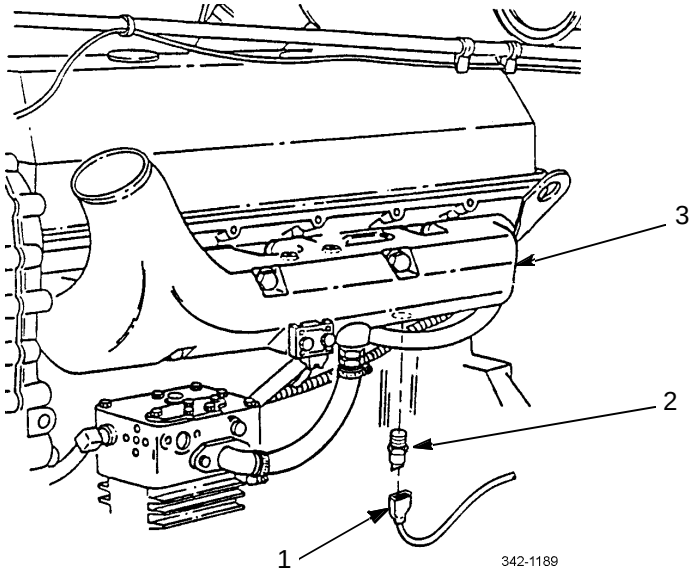
TM 9-2320-302-10

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

REMOVAL

1. Disconnect wiring harness connector (1) from sensor (2).
2. Remove sensor (2) from intake manifold (3).

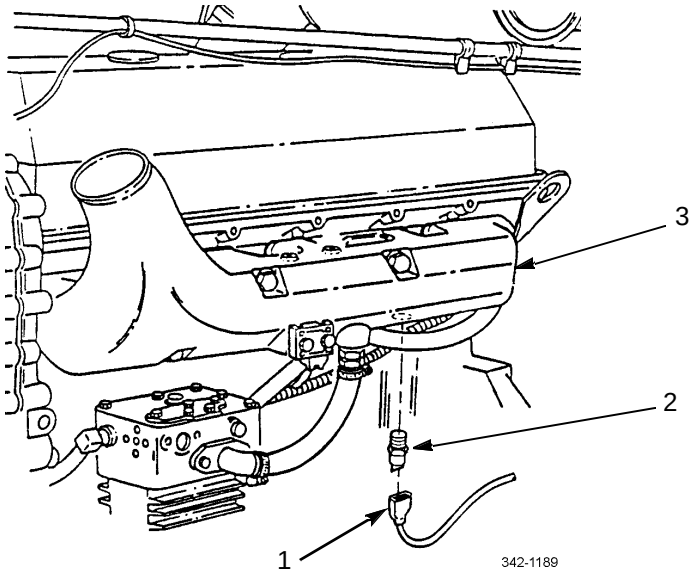


INSTALLATION

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of sensor (2) with pipe sealing compound.
2. Install sensor (2) on intake manifold (3).
3. Connect wiring harness connector (1) to sensor (2).



END OF WORK PACKAGE

TURBO BOOST SENSOR (TBS) REPLACEMENT 0102 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-200 lb-in (Item 43, WP 0236 00)

Materials/Parts

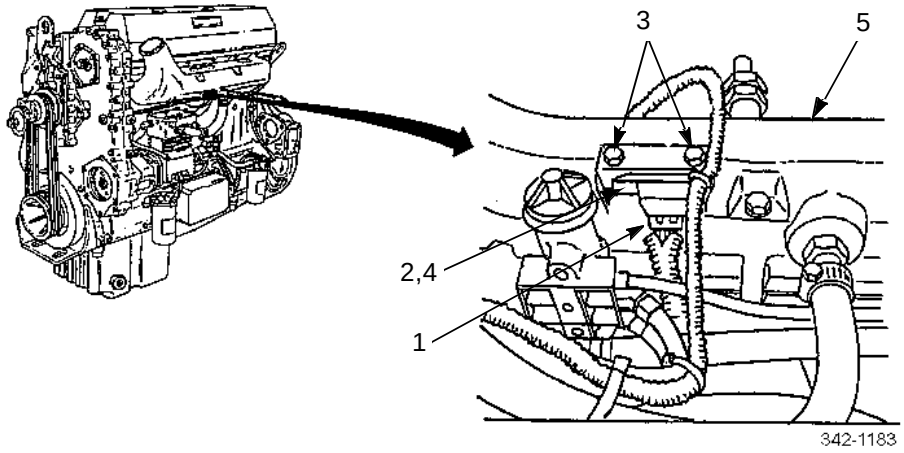
Seal (P/N 5182977)

References

TM 9-2320-302-10

REMOVAL

1. Disconnect engine wiring harness connector (1) from turbo boost sensor (2).
2. Remove two capscrews (3), turbo boost sensor (2), and seal (4) from intake manifold (5).



INSTALLATION

1. Install new seal (4) and turbo boost sensor (2) on intake manifold (5) with two capscrews (3). Torque capscrews to 21-26 lb-in (2.4-3.0 Nm).
2. Connect engine wiring harness connector (1) to turbo boost sensor (2).

END OF WORK PACKAGE

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TIMING REFERENCE SENSOR REPLACEMENT 0103 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

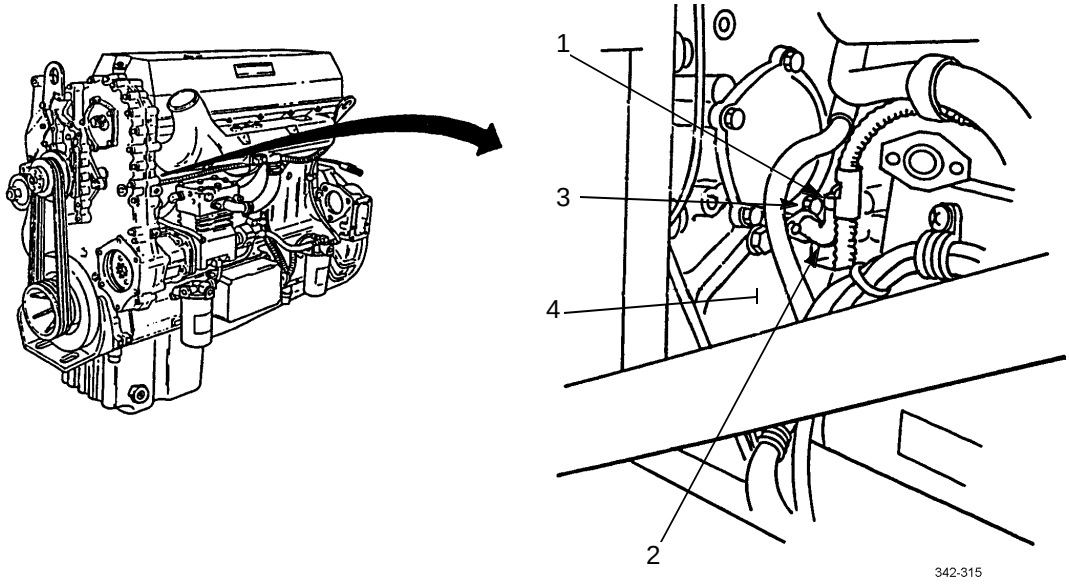
Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

References

TM 9-2320-302-10

REMOVAL

1. Disconnect engine wiring harness connector (1) from timing reference sensor (2).
2. Remove capscrew (3) and timing reference sensor (2) from gear housing assembly (4).



INSTALLATION

1. Install timing reference sensor (2) in gear housing assembly (4) with capscrew (3). Tighten capscrew to 22-28 lb-ft (30-38 Nm).
2. Connect engine wiring harness connector (1) to timing reference sensor (2).

END OF WORK PACKAGE

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SYNCHRONOUS REFERENCE SENSOR REPLACEMENT 0104 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

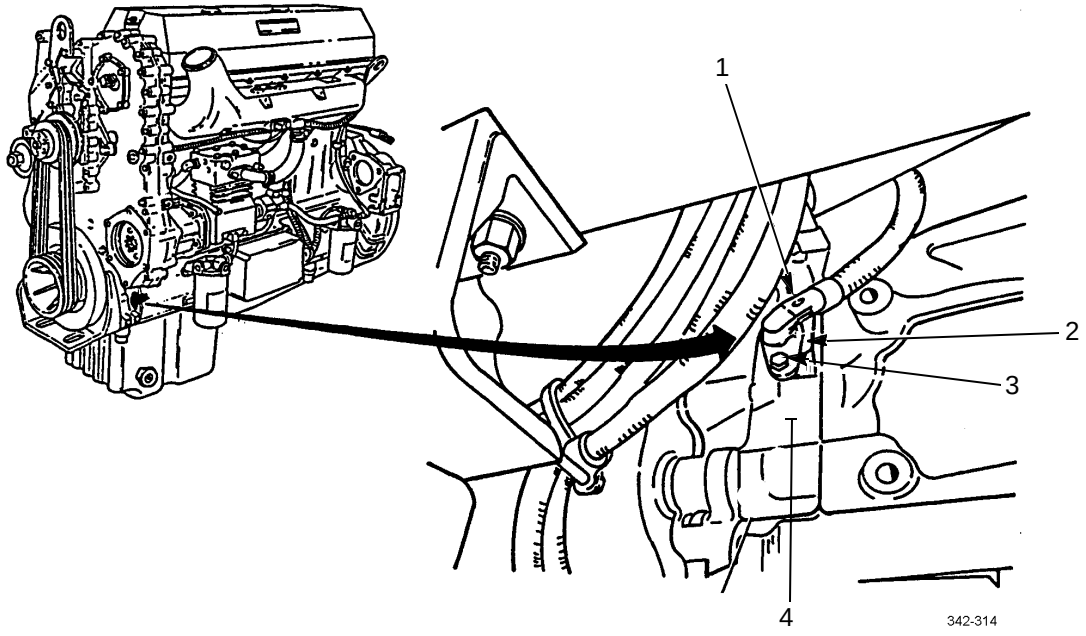
Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

References

TM 9-2320-302-10

REMOVAL

1. Disconnect engine wiring harness connector (1) from synchronous reference sensor (2).
2. Remove capscrew (3) and synchronous reference sensor (2) from gear housing assembly (4).



INSTALLATION

1. Install synchronous reference sensor (2) in gear housing assembly (4) with capscrew (3). Tighten capscrew to 22-28 lb-ft (30-38 Nm).
2. Connect engine wiring harness connector (1) to synchronous reference sensor (2).

END OF WORK PACKAGE

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AIR PRESSURE SENDING UNITS (PRIMARY/SECONDARY) REPLACEMENT 0105 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

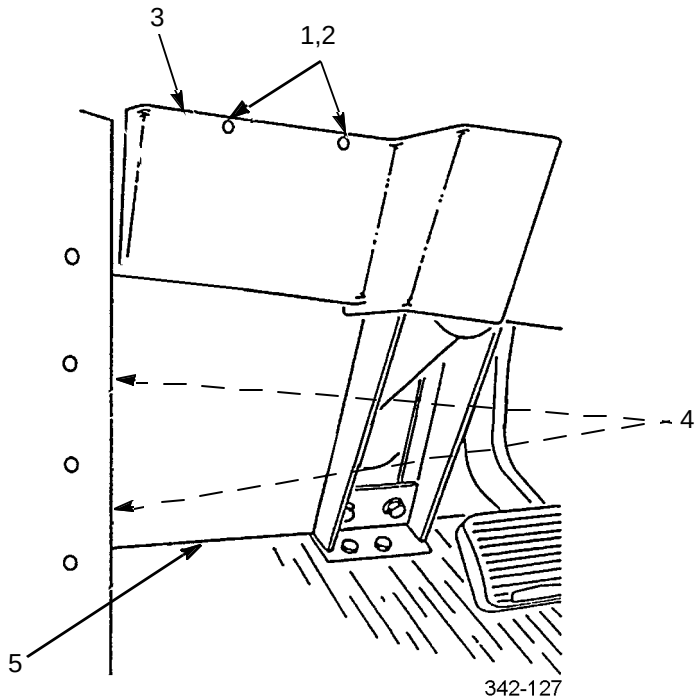
Check engine switch removed (WP 0070 00)

REMOVAL

NOTE

Tag air lines and wires to aid in installation.

1. Disconnect engine wiring harness connector (1) from synchronous reference sensor (2).
2. Remove capscrew (3) and synchronous reference sensor (2) from gear housing assembly (4).



NOTE

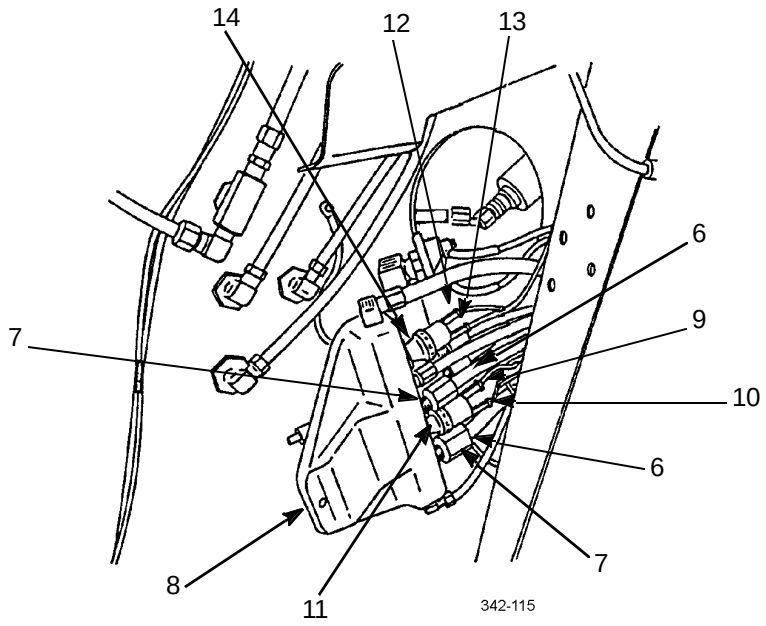
If necessary, remove cab air junction block (WP 0149 00) for access to sensors.

REMOVAL - CONTINUED

NOTE

Perform steps 3 through 5 to remove primary air pressure sending units.

3. Remove two air lines (6) and fittings (7) from cab air junction block (8).
4. Disconnect two electrical connectors (9 and 10) from primary air pressure sending unit (11).
5. Remove primary air pressure sending unit (11) from air junction block (8).



NOTE

Perform steps 6 and 7 to remove secondary air pressure sending unit.

6. Disconnect two electrical connectors (12 and 13) from secondary air pressure sending unit (14).
7. Remove secondary air pressure sending unit (14) from cab air junction block (8).

INSTALLATION

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure that all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

INSTALLATION - CONTINUED

NOTE

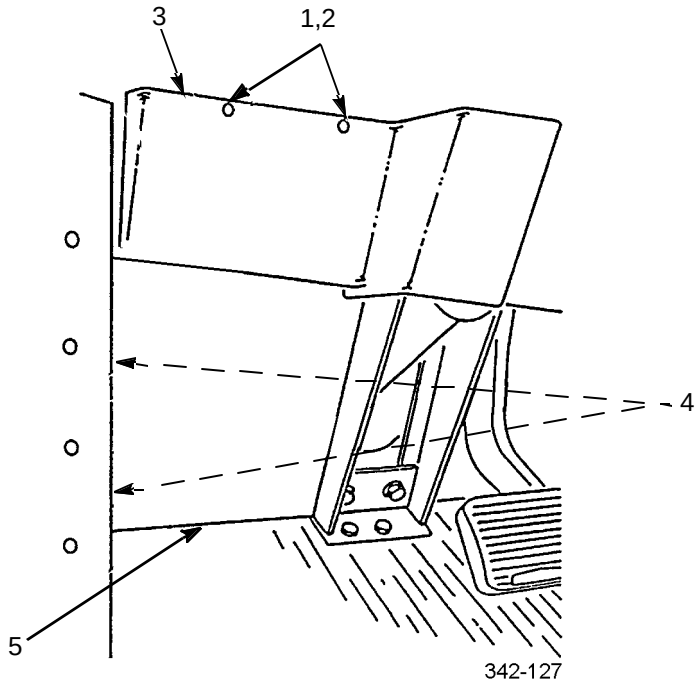
Perform steps 1 and 2 to install secondary air pressure sending unit.

1. Lightly coat threads of secondary air pressure sending unit (14) with pipe sealing compound. Install sending unit on cab air junction block (8).
2. Connect two electrical connectors (12 and 13) to secondary air pressure sending unit (14).

NOTE

Perform steps 3 through 6 to install primary air pressure sending unit.

3. Lightly coat threads of primary air pressure sending unit (11) with pipe sealing compound. Install sending unit on air junction block (8).
4. Connect two electrical connectors (9 and 10) to primary air pressure sending unit (11).
5. Lightly coat threads of two fittings (7) with pipe sealing compound. Install fittings on cab air junction block (8).
6. Install two air lines (6) on fittings (7).
7. If removed, install cab air junction block (WP 0149 00).
8. Install cover (5) with two screws (4).
9. Install cover (3) with five washers (2) and screws (1).



10. Install check engine switch (WP 0070 00).

END OF WORK PACKAGE

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FRONT ANTI-LOCK BRAKE SYSTEM (ABS) SENSOR REPLACEMENT 0106 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Bushing (P/N 10-12026-000)

Nut, lock (P/N MS 1922-1)

Materials/Parts - Continued

Grease, molybdenum disulfide (Item 17, WP 0235 00)

Straps, tiedown (Item 30, WP 0235 00)

References

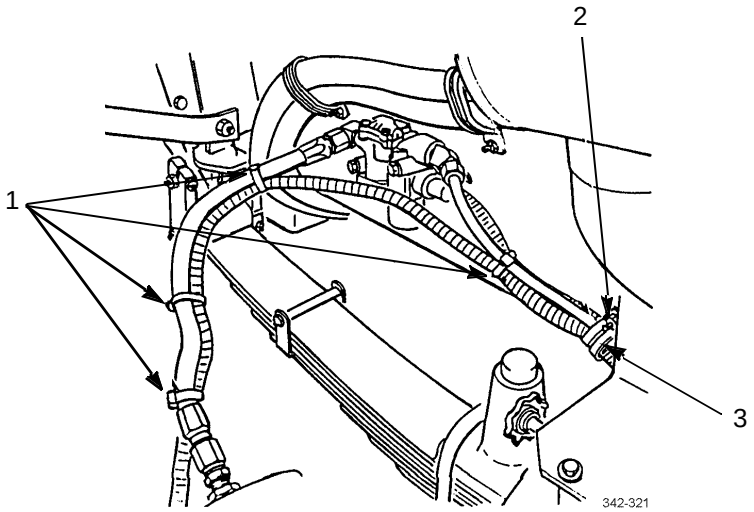
TM 9-2320-302-10

NOTE

Right- and left-front anti-lock brake system (ABS) sensors are replaced the same way. Right-front ABS sensor is shown.

REMOVAL

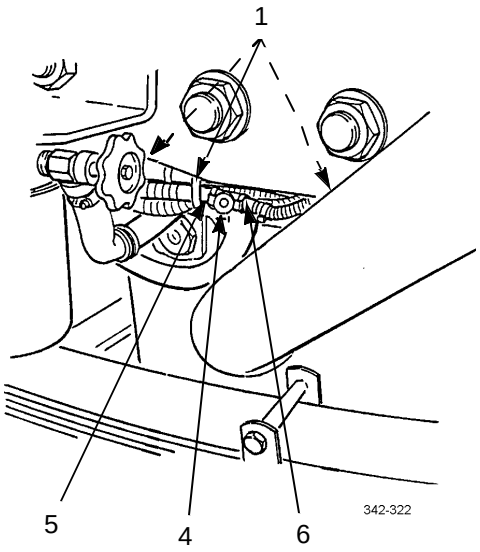
1. Remove tiedown straps (1). Discard tiedown straps.
2. Remove lock nut (2) and clamp (3). Discard lock nut.



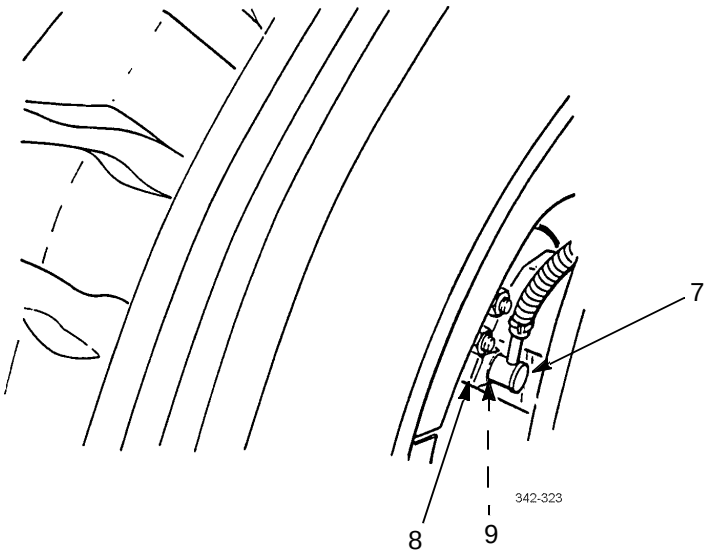
FRONT ANTI-LOCK BRAKE SYSTEM (ABS) SENSOR REPLACEMENT - CONTINUED 0106 00

REMOVAL - CONTINUED

3. Remove tiedown straps (1). Discard tiedown straps.
4. Remove clamp (4) from ABS connector (5) and wiring harness connector (6).
5. Disconnect ABS connector (5) from wiring harness connector (6).

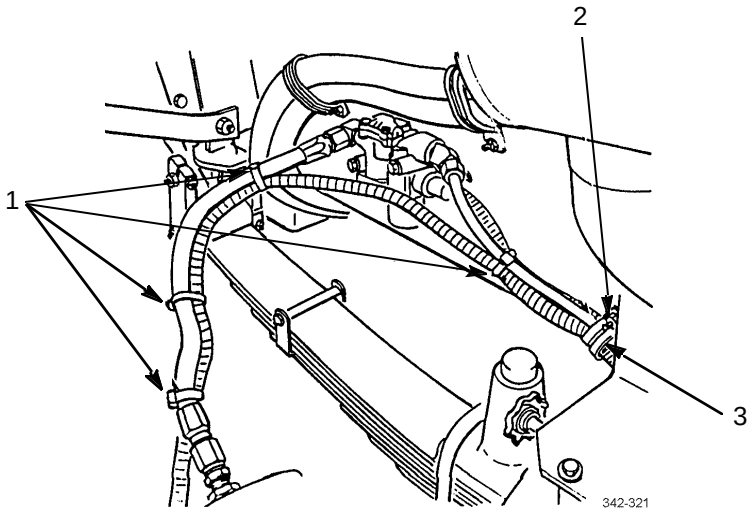


6. Carefully pull body of sensor (7) from steering knuckle (8).
7. Remove bushing (9) from steering knuckle (8). Discard bushing.



INSTALLATION

1. Install new bushing (9) on steering knuckle (8).
2. Coat outside of sensor (7) with grease.
3. Carefully push body of sensor (7) on steering knuckle (8) until sensor is stopped by ABS tone ring.
4. Connect ABS connector (5) to wiring harness connector (6).
5. Install clamp (4) on ABS connector (5) and wiring harness connector (6).
6. Install clamp (3) and new lock nut (2).
7. Install new tiedown straps (1) as needed to secure wiring harness.



END OF WORK PACKAGE

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REAR ANTI-LOCK BRAKE SYSTEM (ABS) SENSOR REPLACEMENT 0107 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (2)

Grease, molybdenum disulfide (Item 17, WP 0235 00)

Straps, tiedown (Item 30, WP 0235 00)

References

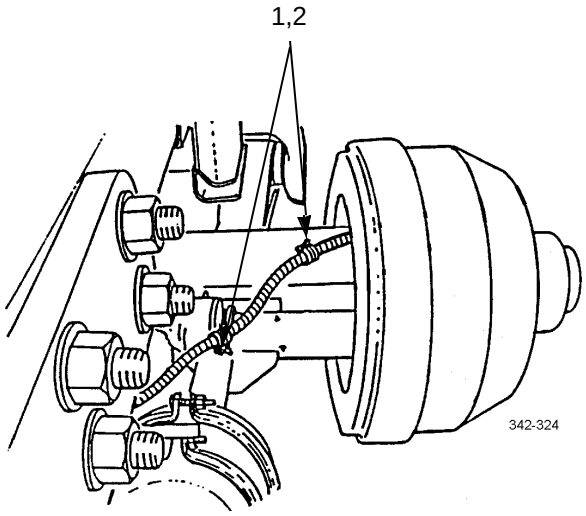
TM 9-2320-302-10

Equipment Condition

Rear dual wheels removed (TM 9-2320-302-10)

REMOVAL

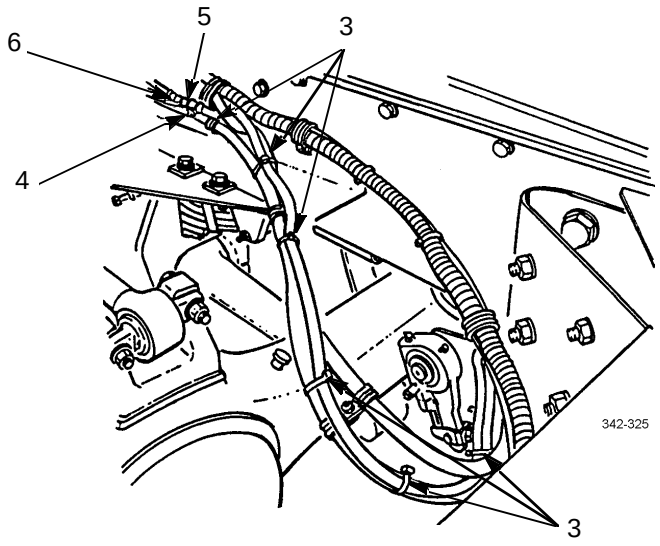
1. Remove two lock nuts (1) and clamps (2). Discard lock nuts.



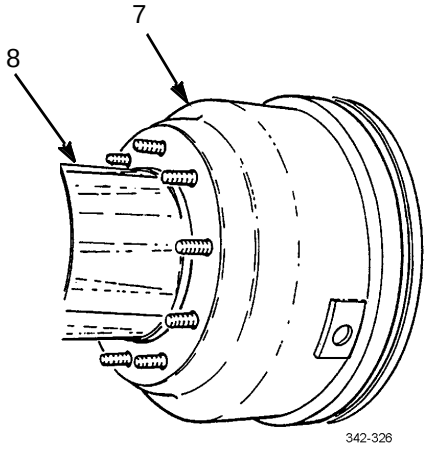
REAR ANTI-LOCK BRAKE SYSTEM (ABS) SENSOR REPLACEMENT - CONTINUED 0107 00

REMOVAL - CONTINUED

2. Remove tiedown straps (3). Discard tiedown straps.
3. Remove clamp (4) from ABS connector (5) and wiring harness connector (6).
4. Disconnect ABS connector (5) from wiring harness connector (6).

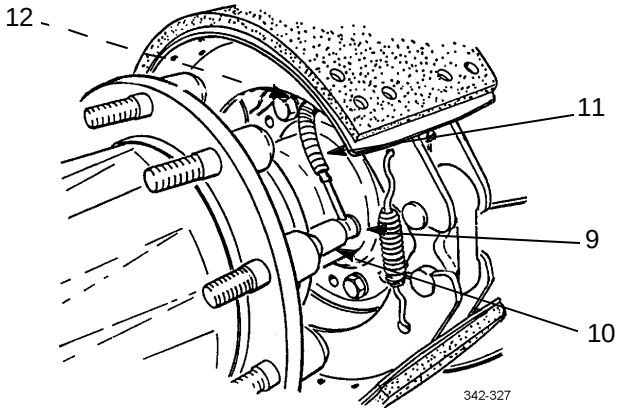


5. Remove drum (7) from axle (8).



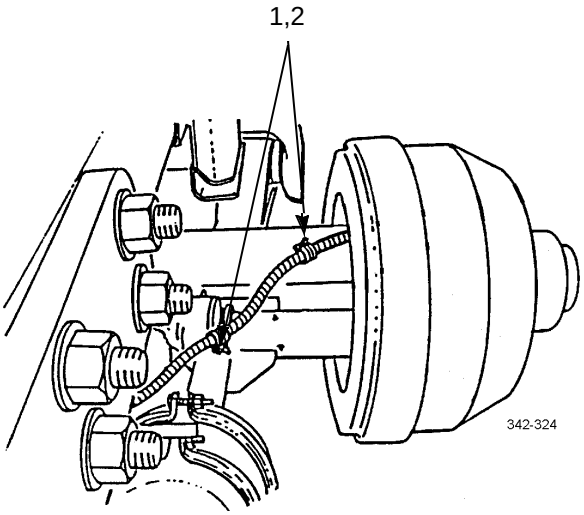
6. Remove sensor (9) from mounting bracket (10).
7. Pull sensor assembly (11) through brake spider (12).

REMOVAL - CONTINUED



INSTALLATION

1. Install sensor assembly (11) through brake spider (12).
2. Coat outside of sensor (9) with grease.
3. Carefully install sensor (9) on mounting bracket (10) until sensor is stopped by ABS tone ring.
4. Install drum (7) on axle (8).
5. Connect ABS connector (5) to wiring harness connector (6).
6. Install clamp (4) on ABS connector (5) and wiring harness connector (6).
7. Install new tiedown straps (3) as needed to secure harnesses.
8. Install two clamps (2) and secure with two new lock nuts (1).



INSTALLATION - CONTINUED

9. Install rear dual wheels (TM 9-2320-302-10).

END OF WORK PACKAGE

ANTI-LOCK BRAKE SYSTEM (ABS) ELECTRONIC CONTROL UNIT REPLACEMENT 0108 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

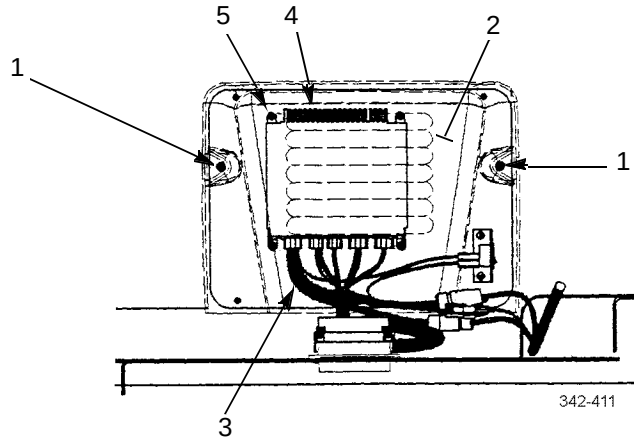
Passenger seat as far forward as possible

REMOVAL

NOTE

Tag all cables to aid in installation.

1. Remove two screws (1) and cover (2).
2. Remove cable connectors (3) from electronic control unit (4).
3. Remove four screws (5) and electronic control unit (4).



INSTALLATION

1. Install electronic control unit (4) with four screws (5).
2. Install cable connectors (3) on electronic control unit (4).
3. Install cover (2) with two screws (1).

END OF WORK PACKAGE

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BRAKE LIGHT/TRAILER BRAKE LIGHT SENDING UNIT REPLACEMENT 0109 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

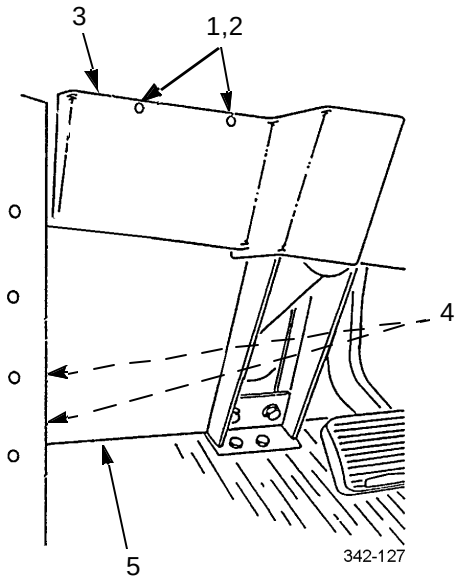
Equipment Condition

Air system drained (TM 9-2320-302-10)

Engine check switch removed (WP 0070 00)

REMOVAL

1. Remove five screws (1), washers (2), and cover (3).
2. Remove two screws (4) and cover (5).



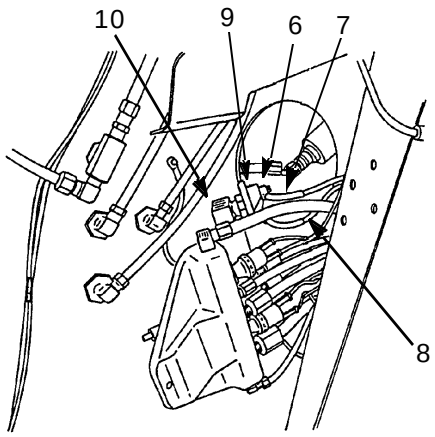
3. If necessary, remove cab air junction block (WP 0149 00) to access brake light/trailer brake light sending unit.

NOTE

Tag electrical wires to aid in installation.

REMOVAL - CONTINUED

4. Remove two lock nuts (6) and electrical wires (7 and 8) from brake light/trailer brake light sending unit (9). Discard lock nuts.
5. Remove brake light/trailer brake light sending unit (9) from elbow (10).



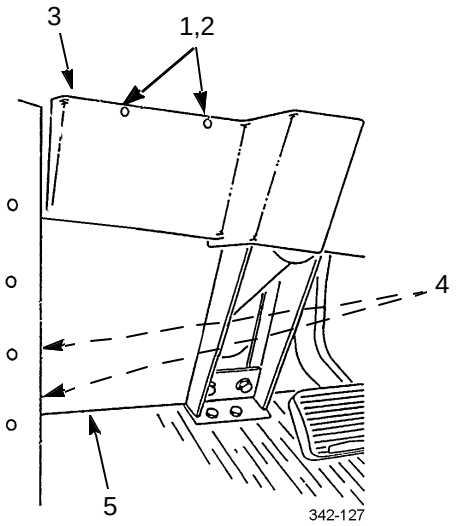
INSTALLATION

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure that all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

1. Lightly coat threads of brake light/trailer brake light sending unit (9) with pipe sealing compound. Install sending unit on elbow (10).
2. Install two electrical wires (7 and 8) on brake light/trailer brake light sending unit (9) with two new lock nuts (6).

INSTALLATION - CONTINUED



3. If removed, install cab air junction block (WP 0149 00).
4. Install cover (5) with two screws (4).
5. Install cover (3) with five washers (2) and screws (1).
6. Install engine check switch (WP 0070 00).
7. Check air system for leaks.

END OF WORK PACKAGE

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COLLISION WARNING SYSTEM (CWS) ANTENNA ALIGNMENT 0110 00

THIS WORK PACKAGE COVERS

Vertical Alignment, Horizontal Alignment

INITIAL SETUP

Test Equipment

Cartridge, CWS (Item 7, WP 0236 00)

Pro-link MPSI Reader (Item 33, WP 0236 00)

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Level, digital (Item 23, WP 0236 00)

Personnel Required

Three

Equipment Condition

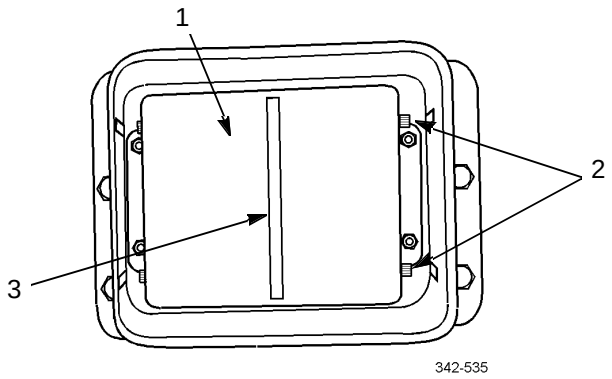
Vehicle parked on level ground (TM 9-2320-302-10)

NOTE

- To ensure accurate alignment of CWS antenna, vertical and horizontal ground surface angles must be known in relation to level and compensated for during antenna alignment.
- Always perform vertical alignment first.

VERTICAL ALIGNMENT

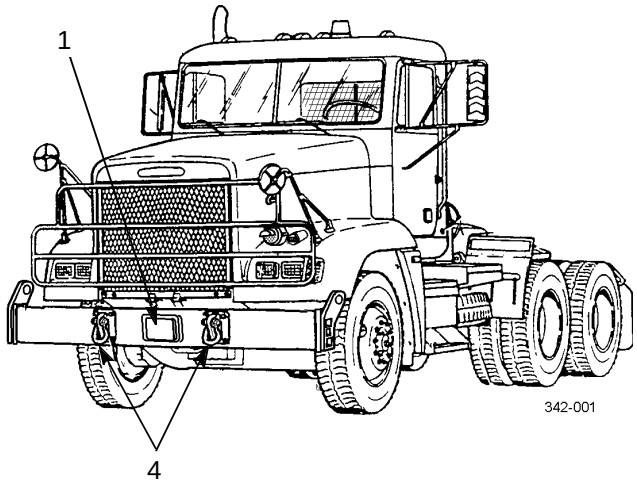
1. Place digital level (3) vertically on CWS antenna (1). Take reading to determine which direction antenna must be adjusted.
2. Loosen four screws (2) on side of CWS antenna (1) enough to allow repositioning of antenna without free travel.



3. Holding digital level (3) vertically on CWS antenna (1), pivot top or bottom of antenna until reading on level is 1 degree below vertical (89 degrees if ground surface is level).
4. Tighten four screws (2).

HORIZONTAL ALIGNMENT

1. Using two towing eye brackets (4) as reference points, place a straight edge horizontally across face and center of CWS antenna (1).



2. Measure distance between reference points and face of straight edge.
3. Adjust CWS antenna (1) until measurements are equal to within +/- 0.1 in (2.54 mm).
4. Determine from measurement which side of CWS antenna (1) needs adjustment.
5. If right side of CWS antenna (1) needs to come forward to make measurements equal, loosen only two right-side screws. Pull antenna forward until measurements are equal, then tighten two screws.
6. If left side of CWS antenna (1) needs to come forward, perform step 5 on left side of antenna.
7. On Pro-link, go to Diagnostic menu.
8. Select CHECKOUT and press ENTER.
9. Select ANTENNA TEST and press ENTER.

NOTE

To perform following alignment accurately, a flat, straight stretch of road is required and both vehicles must maintain consistent and constant lane position.

10. With support vehicle driving in front of host vehicle, observe azimuth reading on Pro-link. Reading must be +/- 0.02.
11. If reading is greater than +/- 0.02, perform steps 5 through 7.
12. Repeat vertical and horizontal alignment until criteria for both alignments are met without adjustments.

END OF WORK PACKAGE

COLLISION WARNING SYSTEM (CWS) MAINTENANCE 0111 00

THIS WORK PACKAGE COVERS

Antenna Assembly Replacement, Central Processing Unit (CPU) Replacement, Driver Display Unit (DDU) Replacement, Side Sensor Replacement, Side Sensor Display Replacement

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

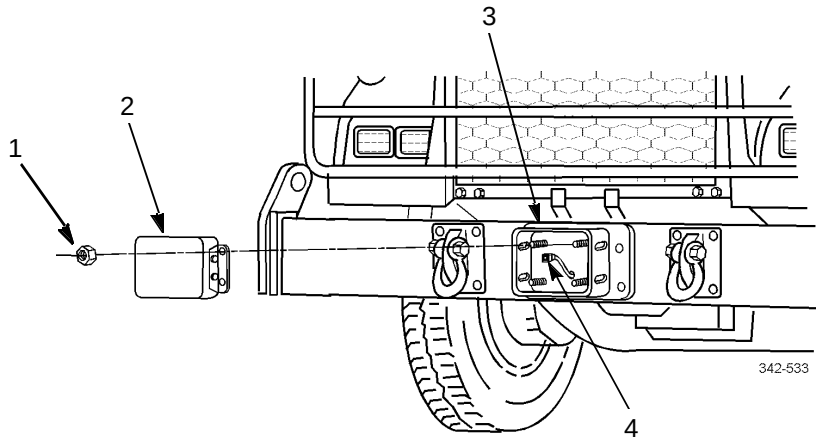
TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N TBD) (4)

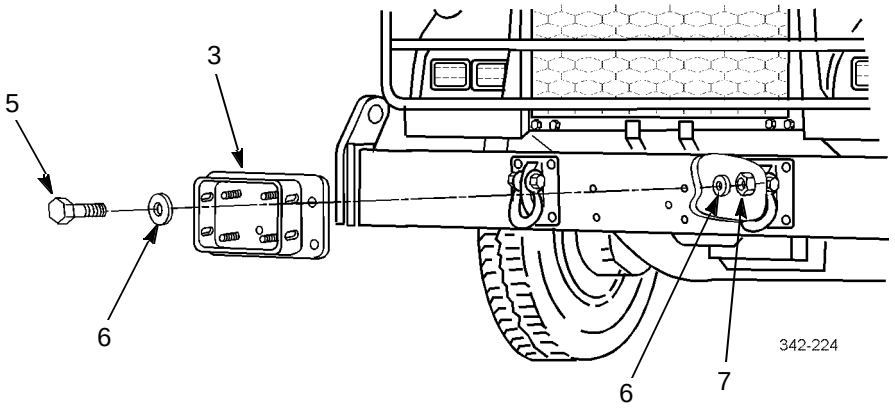
ANTENNA ASSEMBLY REPLACEMENT

1. Remove four nuts (1) and pull CWS antenna (2) out from bracket (3).
2. Disconnect harness connector (4) from CWS antenna (2). Remove antenna.



ANTENNA ASSEMBLY REPLACEMENT - CONTINUED

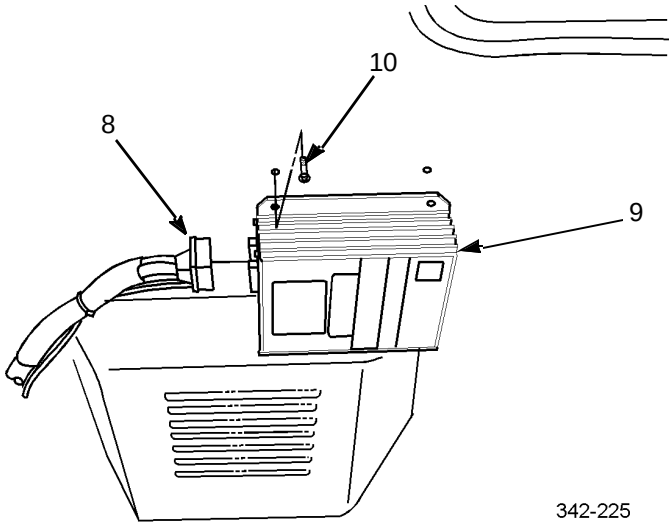
3. If damaged, remove four bolts (5), eight flat washers (6), four lock nuts (7), and bracket (3) from vehicle. Discard lock nuts.



4. If removed, install bracket (3) on vehicle with four bolts (5), eight flat washers (6) and four new lock nuts (7).
5. Connect harness connector (4) to CWS antenna (2).
6. Install CWS antenna (2) on bracket (3) with four nuts (1).
7. Align antenna assembly (WP 0110 00).

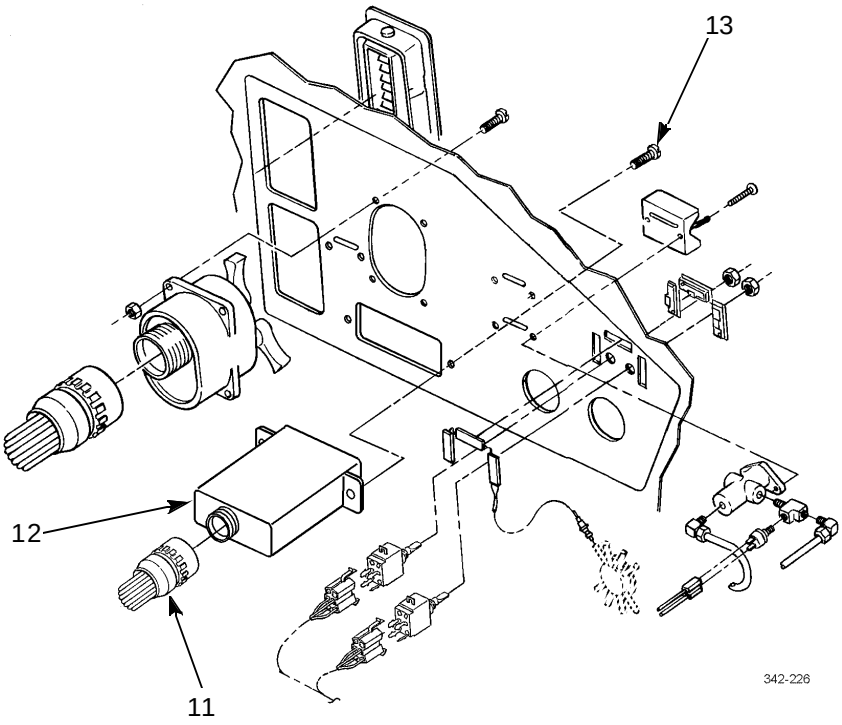
CENTRAL PROCESSING UNIT (CPU) REPLACEMENT

1. Disconnect harness connector (8) from CPU (9).
2. Remove four screws (10) and CPU (9) from cab wall.
3. Install CPU (9) on cab wall with four screws (10).
4. Connect harness connector (8) to CPU (9)
5. Align antenna assembly (WP 0110 00).



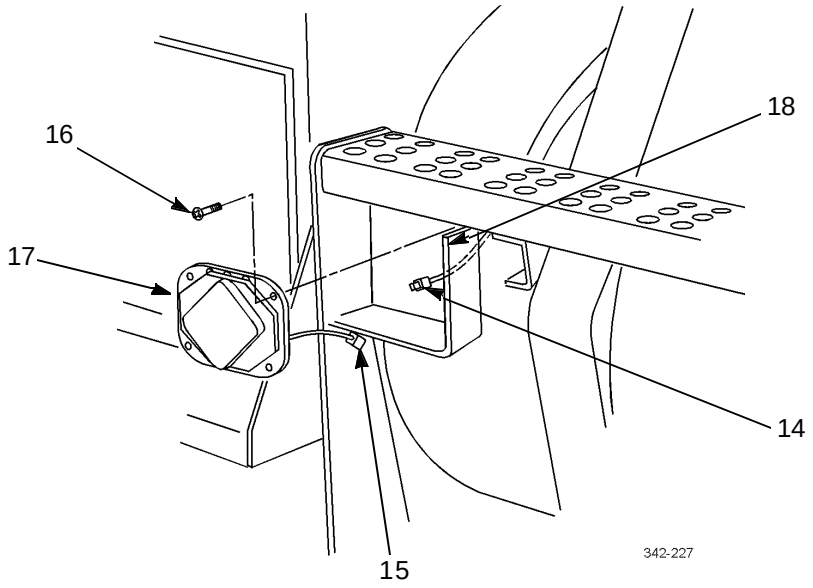
DRIVER DISPLAY UNIT (DDU) REPLACEMENT

1. Drain vehicle air system (TM 9-2320-302-10).
2. Disconnect parking brake and trailer air supply valves (WP 0160 00).
3. Disconnect harness connector (11) from DDU (12).
4. Remove two screws (13) and DDU (12) from dash panel.
5. Install DDU (12) on dash panel with two screws (3).
6. Connect harness connector (11) to DDU (12).
7. Connect parking brake and trailer air supply valves (WP 0160 00)
8. Perform CWS self-test (TM 9-2320-302-10).



SIDE SENSOR REPLACEMENT

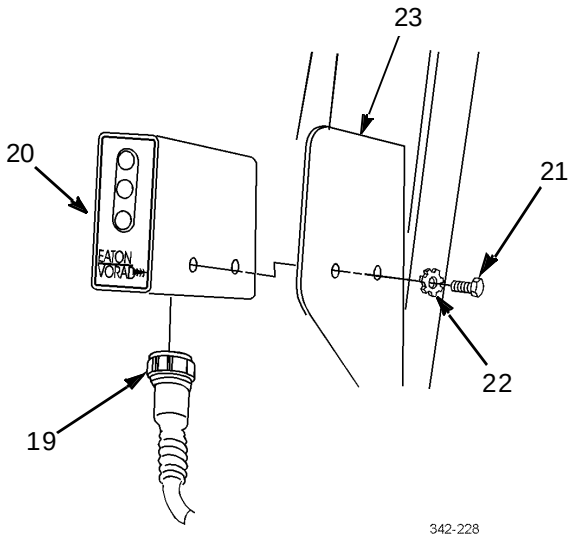
1. Disconnect harness connector (14) from side sensor connector (15).
2. Remove four screws (16) and side sensor (17) from bracket (18).
3. Install side sensor (17) on bracket (18) with four screws (16).
4. Connect harness connector (14) to side sensor connector (15).
5. Perform CWS self-test (TM 9-2320-302-10).



SIDE SENSOR DISPLAY REPLACEMENT

1. Disconnect harness connector (19) from side sensor display (20).
2. Remove two screws (21), star washers (22), and side sensor display (20) from bracket (23).
3. Install side sensor display (20) on bracket (23) with two star washers (22) and screws (21).
4. Connect harness connector (19) to side sensor display (20).
5. Perform CWS self-test (TM 9-2320-302-10).

SIDE SENSOR DISPLAY REPLACEMENT - CONTINUED



END OF WORK PACKAGE

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ELECTRIC HORN REPLACEMENT 0112 00

THIS WORK PACKAGE COVERS

Horn Removal, Bracket Removal, Bracket Installation, Horn Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

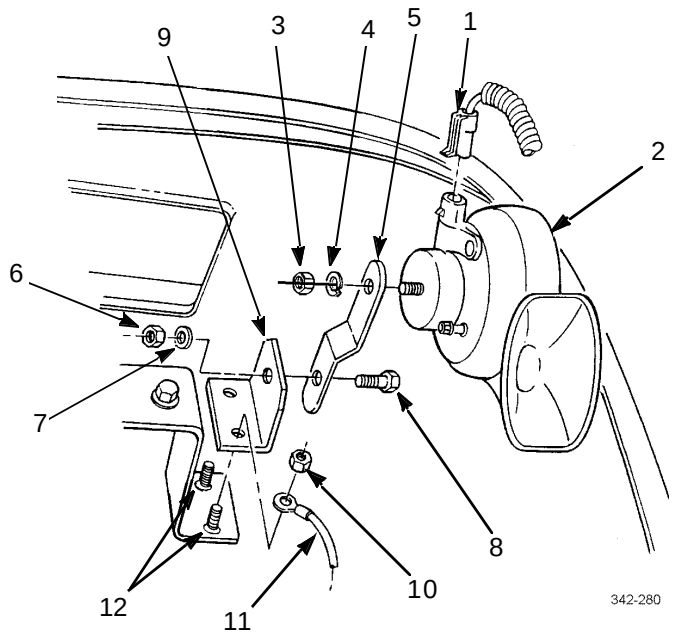
Washer, lock (P/N MS35333-40)

HORN REMOVAL

1. Disconnect connector (1) from horn (2).
2. Remove nut (3), lock washer (4), and horn (2) from bracket (5). Discard lock washer.

BRACKET REMOVAL

1. Remove nut (6), washer (7), screw (8), and bracket (5) from bracket (9).
2. Remove two nuts (10), wire (11), and bracket (9) from two studs (12).

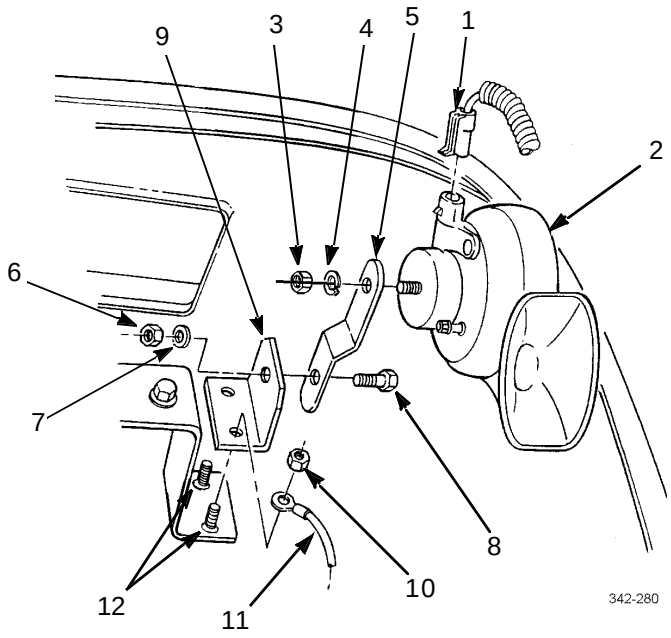


BRACKET INSTALLATION

1. Install bracket (9) and wire (11) to two studs (12) with two nuts (10).
2. Install bracket (5) on bracket (9) with screw (8), washer (7), and nut (6).

HORN INSTALLATION

1. Install horn (2) on bracket (5) with new lock washer (4) and nut (3).
2. Connect connector (1) to horn (2).



END OF WORK PACKAGE

BATTERY REPLACEMENT 0113 00

THIS WORK PACKAGE COVERS

Battery Removal, Battery Hold-down Pin Removal, Battery Hold-down Pin Installation, Battery Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-09336-007) (6)

References

TM 9-2320-302-10

Equipment Condition

Battery cables removed (WP 0115 00)

WARNING

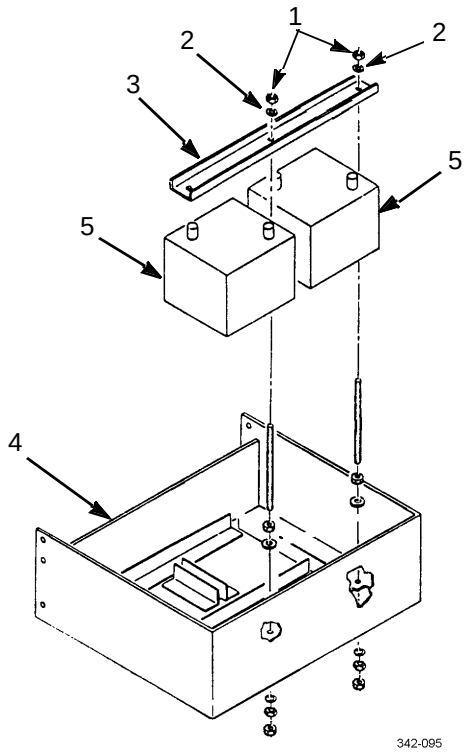
- To avoid eye injury, eye protection is required when working around batteries. DO NOT smoke, use open flame, make sparks or create other ignition sources around batteries. If a battery is giving off gases, it can explode and cause injury to personnel. Remove all jewelry such as rings, ID tags, watches, and bracelets. If jewelry or a tool contacts a battery terminal, a direct short will result in instant heating, injury to personnel, and damage to equipment.
- Sulfuric acid contained in batteries can cause serious burns. If battery corrosion or electrolyte makes contact with skin, eyes or clothing, take immediate action to stop the corrosive burning effects. Failure to follow these procedures may result in death or serious injury to personnel.

BATTERY REMOVAL

NOTE

Note position of batteries for installation.

1. Remove six lock nuts (1), washers (2), and two retaining straps (3) from battery box (4). Discard lock nuts.
2. Remove four batteries (5) from battery box (4).



BATTERY HOLD-DOWN PIN REMOVAL

If damaged, remove 18 lock nuts (6), 12 washers (7), and six pins (8) from battery box (4). Discard lock nuts.

BATTERY HOLD-DOWN PIN INSTALLATION

If removed, install six pins (8) on battery box (4) with 12 washers (7) and 18 new lock nuts (6).

BATTERY INSTALLATION

1. Position four batteries (5) in battery box (4).
2. Install two retaining straps (3) on battery box (4) with six washers (2) and new lock nuts (1).
3. Install battery cables (WP 0115 00).

END OF WORK PACKAGE

BATTERY BOX REPLACEMENT 0114 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Jack, hydraulic, hand (Item 21, WP 0236 00)

Materials/Parts

Nut, kep (P/N 23-10340-125) (2)

References

TM 9-2320-302-10

Equipment Condition

Batteries and battery hold-down pins removed (WP 0113 00)

Left step removed (WP 0172 00)

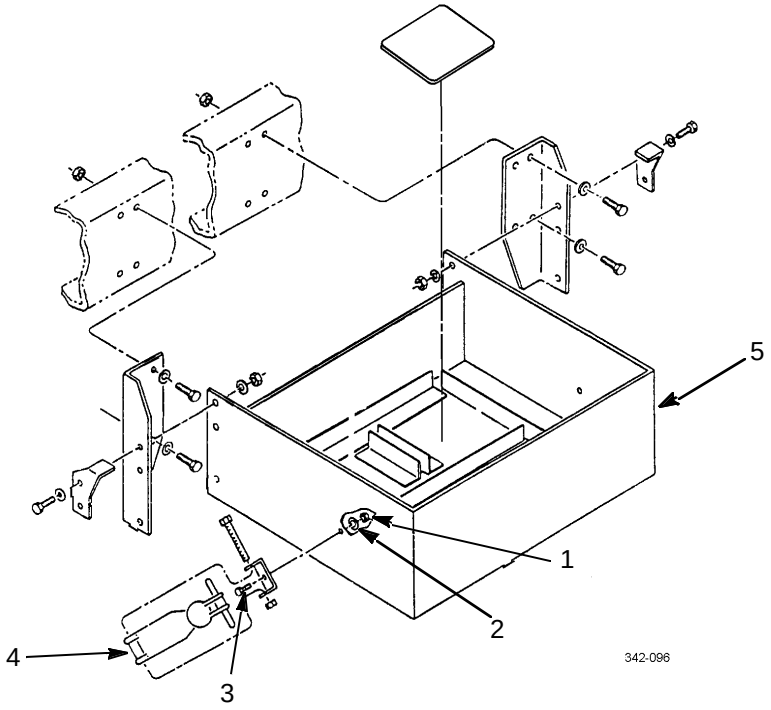
NATO slave receptacle removed (WP 0076 00)

REMOVAL

NOTE

Perform step 1 at each side of battery box.

1. Remove kep nut (1), washer (2), screw (3), and rubber latch assembly (4) from battery box (5).
2. Using suitable jack, support battery box (5).



REMOVAL - CONTINUED

NOTE

Perform step 3 at each side of battery box.

3. Remove three nuts (6), six washers (7), three screws (8), and bracket (9) holding battery box (5) on bracket (10).
4. Remove battery box (5) from vehicle and remove four plywood liners (11).

NOTE

Perform step 5 to remove each of two brackets from vehicle.

5. Remove four nuts (12), washers (13), screws (14), and bracket (10) from vehicle.

INSTALLATION

NOTE

Perform step 1 to install each of two brackets to vehicle.

1. Install bracket (10) on vehicle with four screws (14), washers (13), and nuts (12).
2. Install four plywood liners (11) in battery box (5).
3. Using suitable jack, position battery box on two brackets (10).

NOTE

Perform step 4 at each side of battery box.

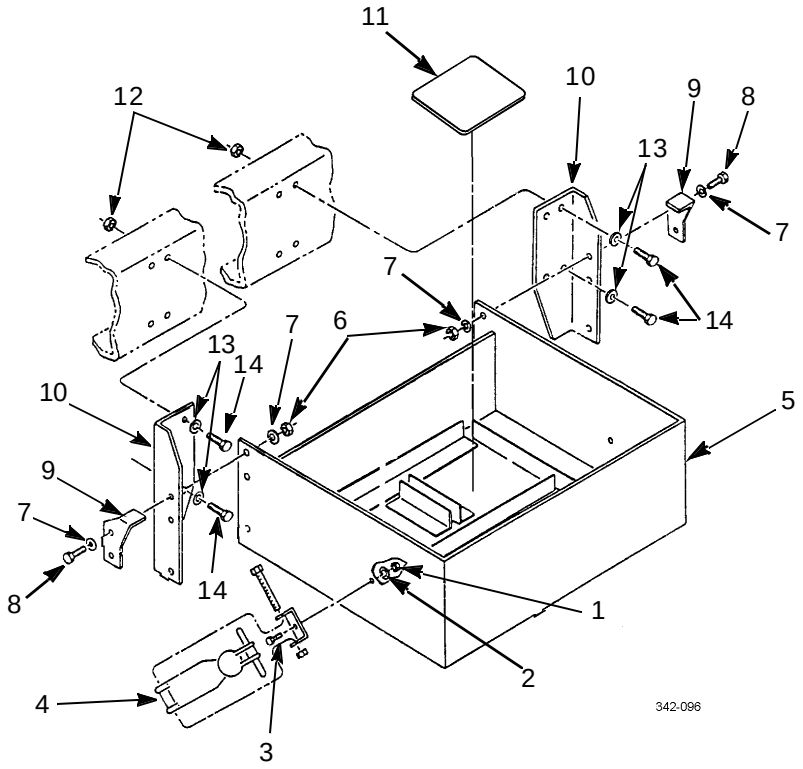
4. Install battery box (5) and bracket (9) on bracket (10) with three screws (8), six washers (7), and three nuts (6).
5. Remove jack from battery box (5).

NOTE

Perform step 6 at each side of battery box.

6. Install rubber latch assembly (4) on battery box (5) with screw (3), washer (2), and new kep nut (1).
7. Install NATO slave receptacle (WP 0076 00).
8. Install left step (WP 0172 00).
9. Install battery hold-down pins and batteries (WP 0113 00).

INSTALLATION - CONTINUED



END OF WORK PACKAGE

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BATTERY CABLES REPLACEMENT 0115 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Battery box cover removed (WP 0114 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

WARNING

- To avoid eye injury, eye protection is required when working around batteries. DO NOT smoke, use open flame, make sparks or create other ignition sources around batteries. If a battery is giving off gases, it can explode and cause injury to personnel. Remove all jewelry such as rings, ID tags, watches, and bracelets. If jewelry or a tool contacts a battery terminal, a direct short will result in instant heating, injury to personnel, and damage to equipment.
- Sulfuric acid contained in batteries can cause serious burns. If battery corrosion or electrolyte makes contact with skin, eyes or clothing, take immediate action to stop the corrosive burning effects. Failure to follow these procedures may result in death or serious injury to personnel.

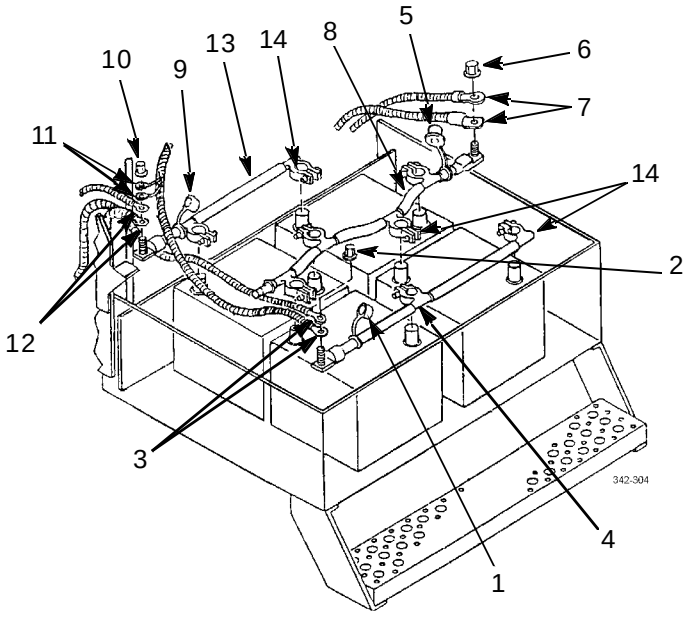
REMOVAL

NOTE

- Perform steps 1 and 2 to safely disconnect battery cables from batteries in order to perform vehicle electrical maintenance.
- Tag cables to aid in installation.

REMOVAL - CONTINUED

1. Lift cap (1) and remove nut (2) and two cables (3) from negative battery cable (4).
2. Lift cap (5) and remove nut (6) and two cables (7) from positive battery cable (8).



3. Lift cap (9) and remove nut (10), two wires (11), and two cables (12) from battery cable (13).
4. Loosen eight nuts (14) and remove battery cables (4, 8, and 13) from batteries.

INSTALLATION

NOTE

Perform steps 3 through 5 to safely connect battery cables to batteries after performing vehicle electrical maintenance.

1. Install battery cables (4, 8, and 13) on batteries and tighten eight nuts (14).
2. Install two cables (12) and wires (11) on battery cable (13) with nut (10). Install cap (9).
3. Install two cables (7) on positive battery cable (8) with nut (6). Install cap (5).
4. Install two cables (3) on negative battery cable (4) with nut (2). Install cap (1).
5. Install battery box cover (WP 0114 00).

END OF WORK PACKAGE

STOP/TAIL/BACKUP LIGHTS WIRING HARNESS REPLACEMENT 0116 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Straps, tiedown (Item 30, WP 0235 00)

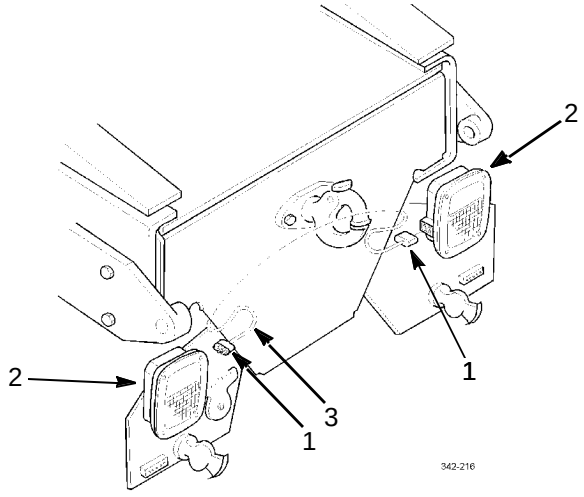
REMOVAL

1. Disconnect stop/tail/backup lights wiring harness connectors (1) from taillights (2).

NOTE

Wiring harness is secured in place with tiedown straps.

2. Remove tiedown straps. Discard tiedown straps.
3. Remove stop/tail/backup lights wiring harness (3) from vehicle.



INSTALLATION

1. Connect stop/tail/backup lights wiring harness connectors (1) to taillights (2).

NOTE

Install new wire tiedown straps, as necessary, to secure wiring harness.

2. Position stop/tail/backup lights wiring harness (3) on vehicle and secure with new tiedown straps.

END OF WORK PACKAGE

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AUTOMATIC ETHER STARTING AID WIRING HARNESSES REPLACEMENT 0117 00

THIS WORK PACKAGE COVERS

Main Wiring Harness Removal, Jumper Wiring Harness Removal, Main Wiring Harness Installation, Jumper Wiring Harness Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Straps, tiedown (Item 30, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

NOTE

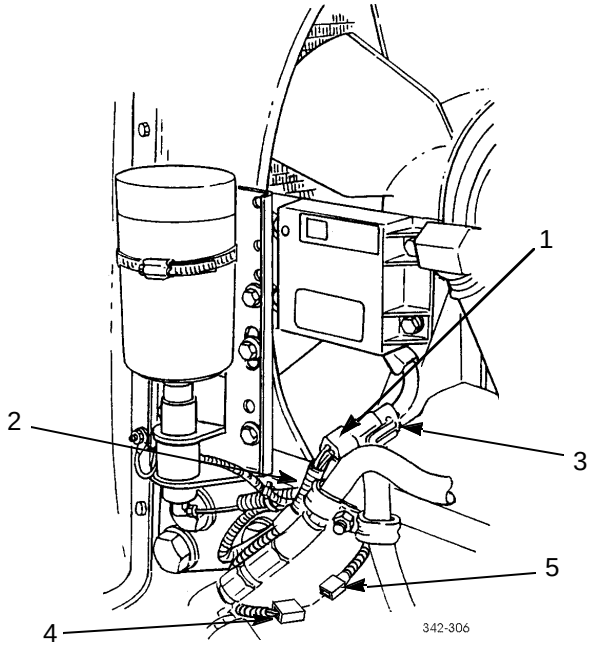
Tag wires and connectors to aid in installation.

MAIN WIRING HARNESS REMOVAL

NOTE

Remove tiedown straps, as necessary, and discard.

1. Disconnect connector (1) of main harness (2) from ether control relay harness connector (3).
2. Disconnect main harness connector (4) from valve harness connector (5).

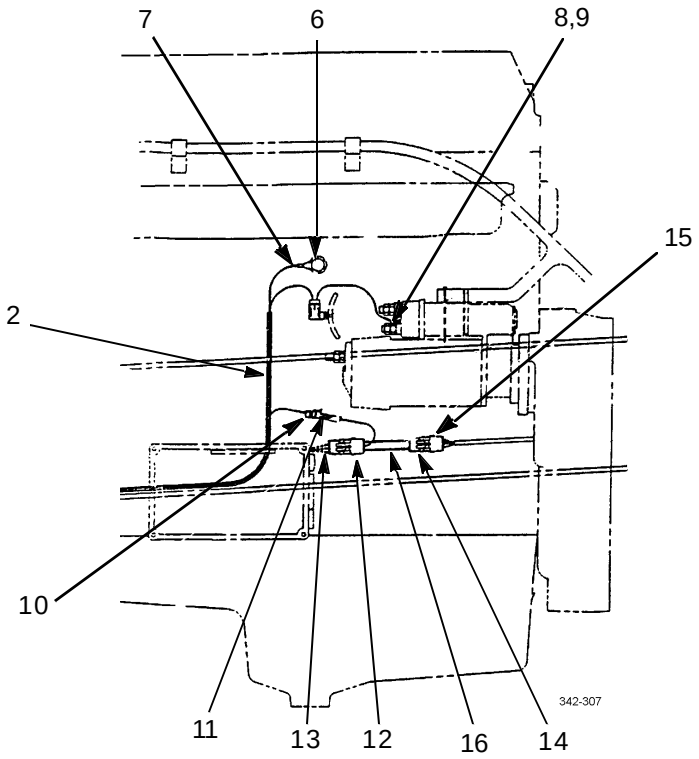


MAIN WIRING HARNESS REMOVAL - CONTINUED

3. Remove screw (6) and terminal (7) of main harness (2) from side of engine.
4. Remove nut (8) and terminal (9) of main harness (2) from starter.
5. Disconnect main harness connector (10) from jumper harness connector (11).
6. Remove main harness (2) from vehicle.

JUMPER WIRING HARNESS REMOVAL

1. Disconnect jumper harness connector (11) from main harness connector (10).
2. Disconnect jumper harness connector (12) from ECU connector (13).
3. Disconnect jumper harness connector (14) from ECU harness connector (15).
4. Remove jumper harness (16) from vehicle.



MAIN WIRING HARNESS INSTALLATION

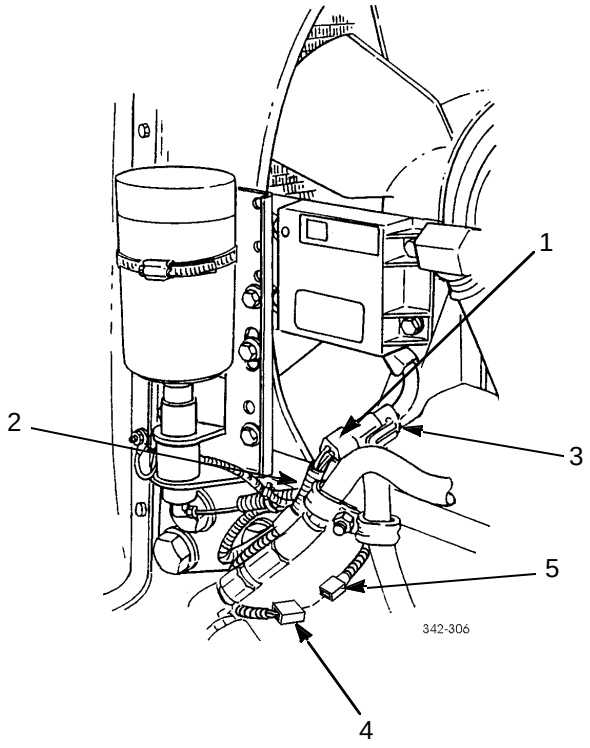
1. Position main harness (2) on vehicle.
2. Connect main harness connector (10) to jumper harness connector (11).
3. Install terminal (9) of main harness (2) to starter with nut (8).
4. Install terminal (7) of main harness (2) to side of engine with screw (6).
5. Connect main harness connector (4) to valve harness connector (5).

MAIN WIRING HARNESS INSTALLATION - CONTINUED

6. Connect connector (1) of main harness (2) to ether control relay harness connector (3).
7. Install new tiedown straps, as necessary.

JUMPER WIRING HARNESS INSTALLATION

1. Position jumper harness (16) on vehicle.
2. Connect jumper harness connector (14) to ECU harness connector (15).
3. Connect jumper harness connector (12) to ECU connector (13).
4. Connect jumper harness connector (11) to main harness connector (10).



END OF WORK PACKAGE

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CAB-TO-FRAME GROUND WIRE REPLACEMENT 0118 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

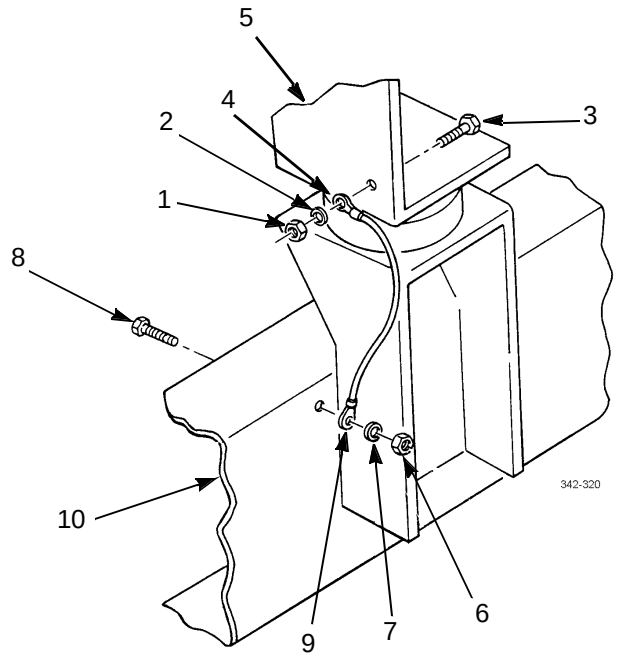
TM 9-2320-302-10

Material/Parts

Nut, lock (P/N MS51922-1) (2)

REMOVAL

1. Remove lock nut (1), washer (2), screw (3), and cab-to-frame ground wire terminal (4) from cab (5). Discard lock nut.
2. Remove lock nut (6), washer (7), screw (8), and cab-to-frame ground wire terminal (9) from frame (10). Discard lock nut.



INSTALLATION

1. Install cab-to-frame ground wire terminal (9) on frame (10) with screw (8), washer (7), and new lock nut (6).
2. Install cab-to-frame ground wire terminal (4) on cab (5) with screw (3), washer (2), and new lock nut (1).

END OF WORK PACKAGE

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ELECTRICAL CONNECTORS MAINTENANCE 0119 00

THIS WORK PACKAGE COVERS

Standard Military Connector Repair, Commercial Connector Repair, Splicing

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Gun, heat (Item 16, WP 0236 00)

Tool kit, electrical connector repair (Item 35, WP 0236 00)

Materials/Parts

Flux, soldering (Item 12, WP 0235 00)

Solder (Item 29, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TB SIG 222

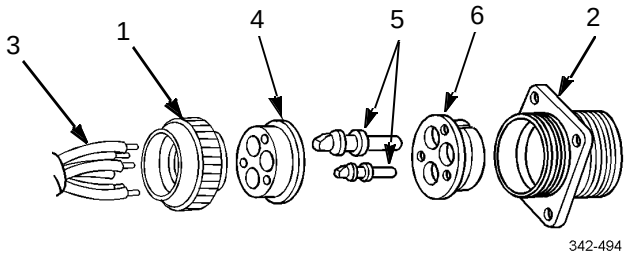
TM 9-2320-302-10

NOTE

Tag cables and wires to aid in installation.

STANDARD MILITARY CONNECTOR REPAIR

1. **Panel Mounting Receptacle Disassembly.**
   a. Unscrew nut (1) from shell (2) assembly and slide back on cable leads (3).
   b. Push grommet (4) back on cable leads (3).
   c. Drive contacts (5) out through rear of insert (6) with pin extractor.
   d. Push insert (6) out through rear of shell (2).
   e. Unsolder cable leads (3) from contacts (5).



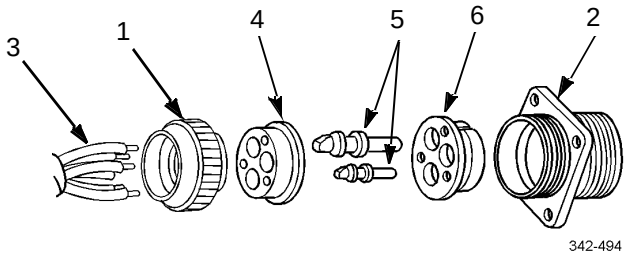
2. **Panel Mounting Receptacle Assembly.**
   a. Strip cable insulation equal to depth of solder wells of contacts (5).
   b. Slide nut (1) over cable leads (3).
   c. Slide grommet (4) over cable leads (3).
   d. Insert cable leads (3) into solder wells of contacts (5) and solder.
   e. Push insert (6) into shell (2) from rear until seated. Groove in insert must be aligned with guide in shell to ensure proper fit.

STANDARD MILITARY CONNECTOR REPAIR - CONTINUED

f. Push contacts (5) into insert (6) from rear until seated.

g. Push grommet (4) down cable leads (3) and over solder wells of contacts (5).

h. Screw nut (1) onto shell (2) assembly.



3. **Plug Disassembly.**

a. Unscrew nut (7) from shell (8) assembly and slide back on cable leads (9).

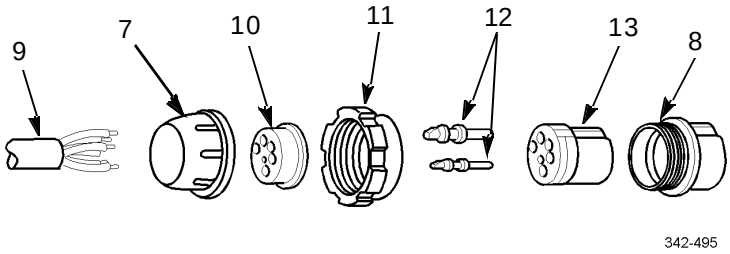
b. Push grommet (10) back on cable leads (9).

c. Slide coupling nut (11) off shell (8) assembly.

d. Drive contacts (12) out through rear of insert (13) with pin extractor.

e. Push insert (13) out through rear of shell (8).

f. Unsolder cable leads (9) from contacts (12).



4. **Plug Assembly.**

a. Strip cable insulation equal to depth of solder wells of contacts (12).

b. Slide nut (7) over cable leads (9).

c. Slide grommet (10) over cable leads (9).

d. Insert cable leads (9) into solder wells of contacts (12) and solder.

e. Push insert (13) into shell (8) from rear until seated. Groove in insert must be aligned with guide in shell to ensure proper fit.

f. Push contacts (12) into insert (13) from rear until seated.

g. Slide coupling nut (11) onto shell (8) assembly.

h. Push grommet (10) down cable leads (9) and over solder wells of contacts (12).

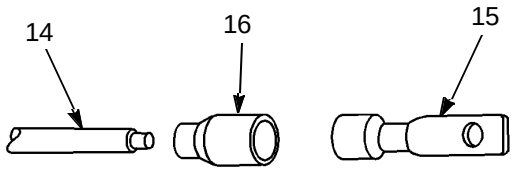
i. Screw nut (7) onto shell (8) assembly.

STANDARD MILITARY CONNECTOR REPAIR - CONTINUED

NOTE

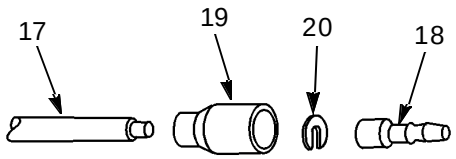
The following procedures cover assembly of new terminals and connectors. Prepare cable by cutting off damaged or defective terminal or connector.

5. **Terminal-type Cable Connector.**
   a. Strip cable (14) insulation equal to depth of terminal (15) well.
   b. Slide insulation (16) over cable (14).
   c. Insert cable (14) into terminal (15) well and crimp.
   d. Slide insulation (16) over crimped end of terminal (15).



342-496

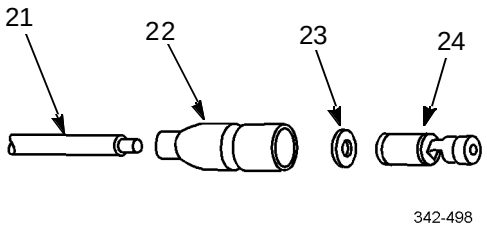
6. **Male Cable Connector With C-washer.**
   a. Strip cable (17) insulation equal to depth of terminal (18) well.
   b. Slide shell (19) over cable (17).
   c. Insert cable (17) into terminal (18) well and crimp.
   d. Place C-washer (20) over cable (17) at crimped junction and slide shell (19) over C-washer and terminal (18).



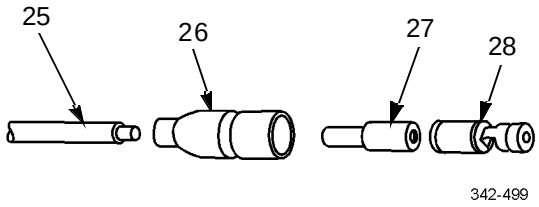
342-497

STANDARD MILITARY CONNECTOR REPAIR - CONTINUED

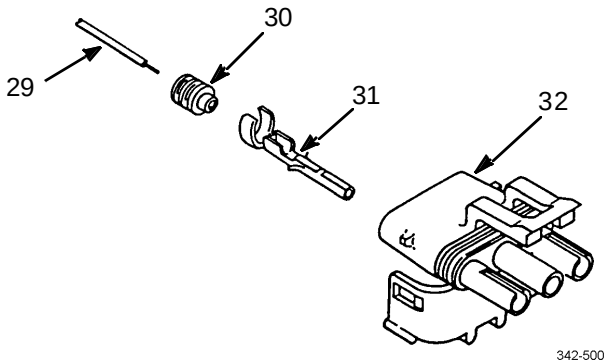
7. **Female Cable Connector With Washer.**
   a. Strip cable (21) insulation approximately 1/8 in (3.2 mm).
   b. Slide shell (22) and washer (23) over cable (21).
   c. Place cable (21) in cylindrical end of terminal (24) and crimp.
   d. Slide shell (22) and washer (23) over terminal (24).



8. **Female Cable Connector With Sleeve.**
   a. Strip cable (25) insulation approximately 1/8 in (3.2 mm).
   b. Slide shell (26) and sleeve (27) over cable (25).
   c. Place cable (25) in cylindrical end of terminal (28) and crimp.
   d. Slide shell (26) and sleeve (27) over terminal (28).



9. **Sealed Connector.**
   a. Strip cable (29) insulation approximately 1/8 in (3.2 mm).
   b. Slide seal (30) onto cable (29).
   c. Crimp terminal (31) onto cable (29).
   d. Insert terminal (31) into connector (32) and close lock.



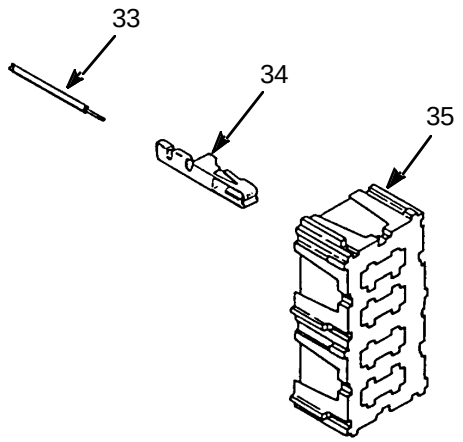
STANDARD MILITARY CONNECTOR REPAIR - CONTINUED

10. **Panel Connector**:

    a. Strip cable (33) insulation.

    b. Crimp terminal (34) onto cable (33).

    c. Insert terminal (34) into connector (35).



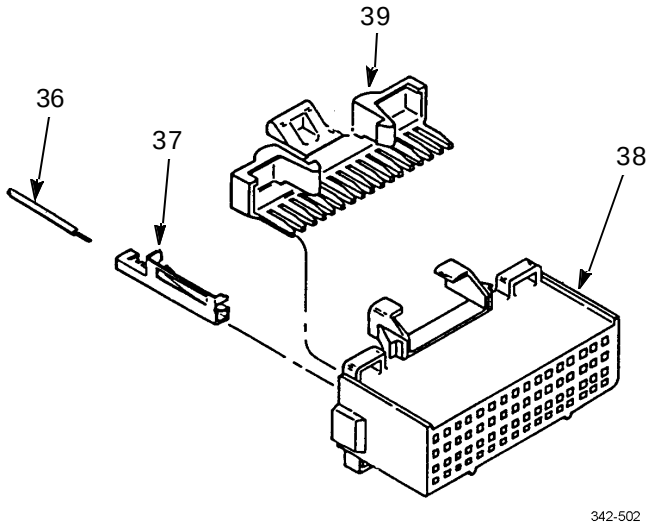
11. **Harness Connector**.

    a. Strip cable (36) insulation.

    b. Crimp terminal (37) onto cable (36).

    c. Insert terminal (37) into connector (38).

    d. Install lock (39) in connector (38).



COMMERCIAL CONNECTOR REPAIR

1. **Crimp and Removal Tools.** Crimp tools and connector removal tools can be purchased from Kent-Moore. Tools and associated part numbers are listed in Table 1.

Table 1. Crimp and Removal Tools.

CONNECTOR	TOOL	PART NUMBER
Metri-Pack 150	Removing	J35689
	Crimp	J35123
Weather Pack	Removing	J36400-5
	Crimp	J35606
Metri-Pack 280	Removing (18 AWG)	J33095
	Crimp (18 AWG)	J38125-6
	Removing (12 AWG - Used for power harness)	J33095
	Crimp (12 AWG - Used for power harness)	J39848
Deutsch	Removing (12 AWG)	J37451
	Removing (16-18 AWG)	J34513
	Crimp	J34182

2. **Metri-Pack 150 Connectors.**

   a. Connector Part Numbers.

   (1) Metri-Pack 150 series connectors are “pull-to-seat” connectors. Each wire must be pushed through the connector prior to crimping the terminal. Cable seals are inserted into the shell of the connector and hold many wires.

   (2) Metri-Pack 150 connectors are listed in Table 2.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

Table 2. Metri-Pack 150 Connector Part Numbers.

ECM ENGINE HARNESS		**ECM VEHICLE INTERFACE HARNESS**	
Connector	P/N: 12034400	Connector	P/N: 12034398
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: 12034413	Plug	P/N: 12034413
ECM COMMUNICATION HARNESS CONNECTOR		**TEMPERATURE SENSOR HARNESS**	
Connector	P/N: 12066317	Connector	P/N: 12162193
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: 12034413	Plug	P/N: Not Applicable
PRESSURE SENSOR HARNESS		**FIRE TRUCK PRESSURE SENSOR (PGS)**	
Connector	P/N: 12047909	Connector	P/N: 12065287
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable
SRS HARNESS		**TRS HARNESS**	
Connector	P/N: 12162193	Connector	P/N: 12162197
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	In Connector	Seal	In Connector
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable
INJECTOR (GRAY)		**INJECTOR (BLACK)**	
Connector	P/N: 12162830	Connector	P/N: 12040947
Terminal	P/N: 12103881	Terminal	P/N: 12103881
Seal	P/N: Not Applicable	Seal	P/N: Not Applicable
Plug	P/N: 12034413	Plug	P/N: 12034413

COMMERCIAL CONNECTOR REPAIR - CONTINUED

b. **Installation.** Metri-Pack 150 connectors are “pull-to-seat” design. The cable is pushed through seal and correct cavity of connector before crimping terminal to cable. It should be stripped of insulation AFTER it is placed through seal and connector body. Use the following instructions for terminal installation:

(1) Position cable through seal and correct cavity of connector (Figure 1).

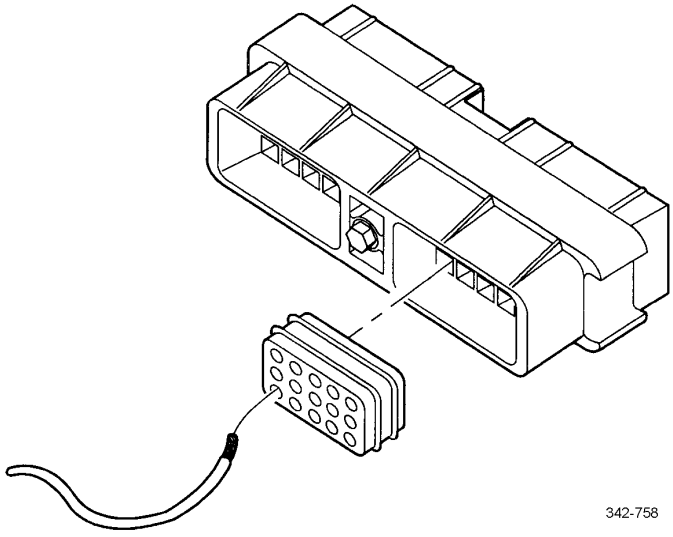


Figure 3. Inserting Wire in Connector.

(2) Strip end of cable using wire strippers to leave 0.2 +/- 0.02 in (5.0 +/- 0.5 mm) of bare conductor.

(3) Squeeze handles of crimping tool together firmly to cause jaws to automatically open.

(4) Hold “wire side” facing you.

(5) Push terminal holder to open position and insert terminal until wire attaching portion of terminal rests on 20-22 anvil. Be sure wire core wings and insulation wings of terminal are pointing toward upper jaw of crimping tool (Figure 2).

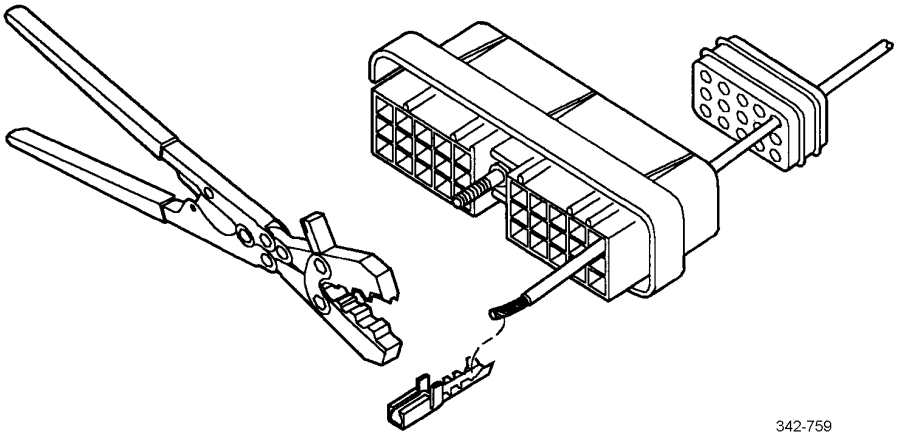


Figure 4. Terminal and Crimping Tool Position.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(6) Insert cable into terminal until stripped portion is positioned in wire core wings and insulation portion ends just forward of insulation wings (Figure 3).

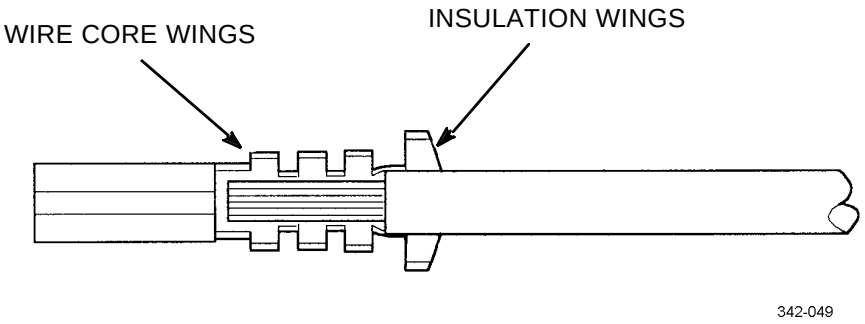


Figure 5. Cable to Terminal Alignment.

(7) Compress handles of crimping tool until ratchet automatically releases and crimp is complete.

NOTE

For faster, more efficient crimping operation, a bracket or bench rest may be used to cradle one handle of tool. Operator can apply terminals by grasping and actuating only one handle of tool (Figure 4).

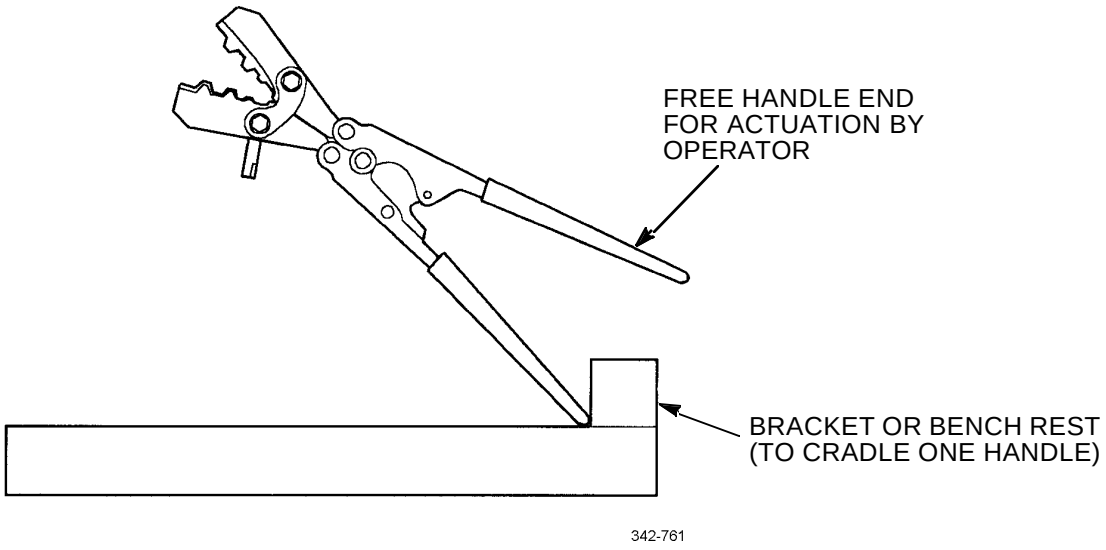


Figure 6. Crimping Operation.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(8) Release crimping tool with lock lever located between handles, in case of jamming.

NOTE

For ECM 30-pin connectors, put locking tang opposite lettered side.

(9) Align locking tang of terminal with lettered side of connector.

(10) Pull cable back through connector until a click is heard (Figure 5). Position seal into connector.

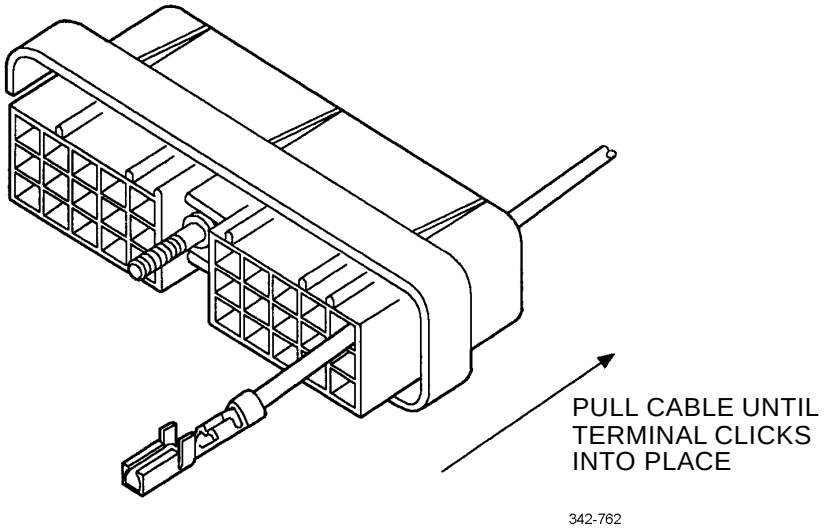


Figure 7. Pulling Terminal to Seat.

c. **Removal and Repair.** A tang on terminal locks into a tab molded into plastic connector to retain cable assembly. Remove Metri-Pack 150 terminals using the following instructions:

(1) Insert removal tool into cavity of connector, placing tip of tool between locking tang of terminal and wall of cavity (Figure 6).

COMMERCIAL CONNECTOR REPAIR - CONTINUED

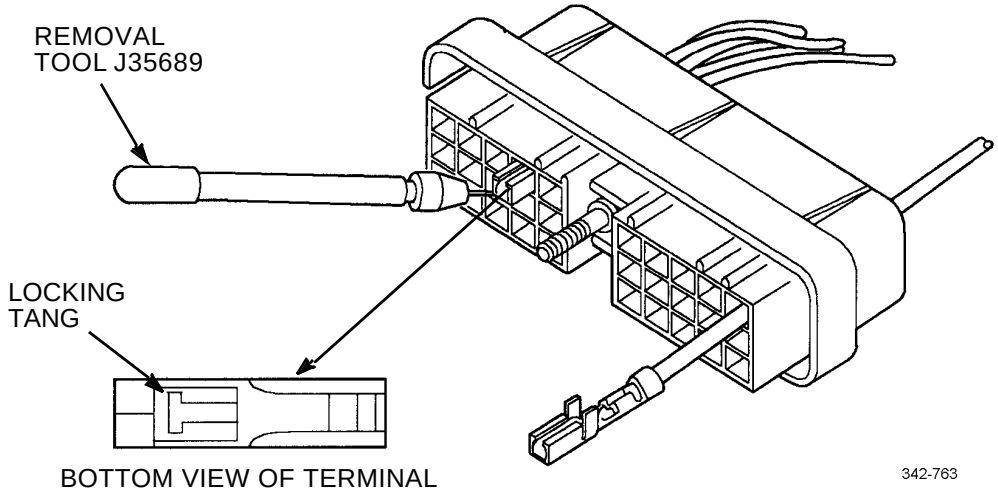


Figure 8. Terminal Removal.

(2) Depress locking tang of terminal to release from connector.

(3) Push cable forward through terminal until complete crimp is exposed.

(4) Cut cable immediately behind damaged terminal to repair.

(5) Follow installation instructions for crimping terminal and inserting into connector.

3. **Weather Pack and Metri-Pack 280 Connectors.**

a. **Connector Part Numbers.**

(1) Weather Pack and Metri-Pack 280 series connectors are “push-to-seat design”. The terminal is crimped onto each wire before it is inserted into the connector. A cable seal is crimped on each wire at the same time the terminal is crimped onto the wire. Weather Pack connectors use a secondary lock on both male and female connector bodies and the lock snaps into place over the cable seals after installation. Some Metri-Pack connectors have secondary locks as well.

(2) Weather Pack connectors and their associated part numbers are listed in Table 3.

(3) Metri-Pack 280 connectors and their associated part numbers are listed in Table 4.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

Table 3. Weather Pack Connectors and Part Numbers.

TURBO BOOST PRESSURE SENSOR HARNESS		**ENGINE BRAKE CONNECTOR, SERIES 60**	
Connector	P/N: 12015384	Connector	P/N: 12010973/12162000
Terminal	P/N: 12089040	Terminal	P/N: 12048074/12045773
Seal	P/N: 12015323		
THROTTLE POSITION SENSOR - HARNESS SIDE		**THROTTLE POSITION SENSOR - SENSOR SIDE**	
Connector	P/N: 12015793	Connector	P/N: 12010717
Terminal	P/N: 12089188	Terminal	P/N: 12089040
Seal	P/N: 12015323	Seal	P/N: 12015323
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable
IGNITION CONNECTOR POWER HARNESS SIDE		**IGNITION CONNECTOR VEHICLE INTERFACE HARNESS SIDE**	
Connector	P/N: 12034074	Connector	P/N: 12015378
Terminal	P/N: 12089040	Terminal	P/N: 12089188
ALLISON INTERFACE MODULE		**ALLISON INTERFACE MODULE MAXIMUM FEATURE**	
Connector	P/N: 12015791	Connector	P/N: 12015799
Terminal	P/N: 12089188	Terminal	P/N: 12089188
Seal	P/N: 12015323	Seal	P/N: 12015323
		Plug	P/N: 12010300

Table 4. Metri-Pack 280 Connectors and Part Numbers.

COOLANT LEVEL SENSOR CONNECTOR		**POWER HARNESS**	
Connector	P/N: 15300027	Connector	P/N: 12124634
Terminal	P/N: 12077411	Terminal	P/N: 12077413
Seal	P/N: 12015323	Seal	P/N: 12015193
Secondary Lock	P/N: 15300014	Secondary Lock	P/N: 12052816
Plug	P/N: Not Applicable	Plug	P/N: Not Applicable

COMMERCIAL CONNECTOR REPAIR - CONTINUED

b. **Installation.** Use the following instructions for terminal installation:

(1) Insert terminal into locating hole of crimping tool using proper hole according to gage of cable to be used (Figure 7).

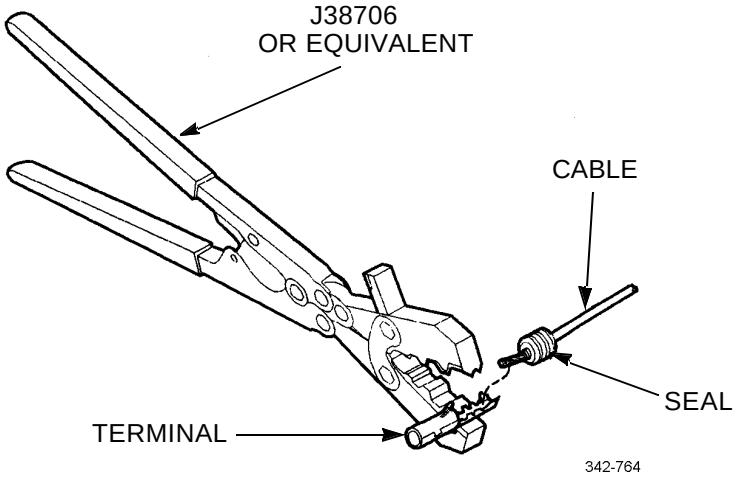


Figure 9. Terminal Position.

(2) Insert cable into terminal until stripped position is positioned in cable core wings, and seal and insulated portion of cable are in insulation wings (Figure 8).

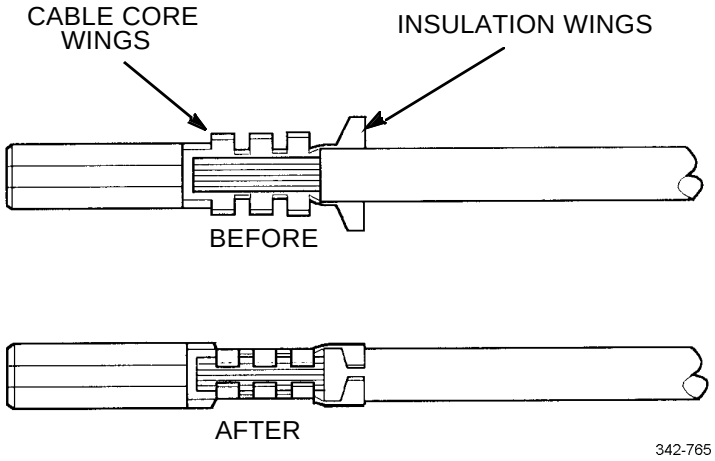


Figure 10. Cable and Terminal Position Before and After Crimping.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(3) Compress handles of crimping tool until ratchet automatically releases and crimp is complete. A properly crimped terminal is shown (Figure 8).

(4) Release crimping tool with lock lever located between handles, in case of jamming.

(5) Push crimped terminal into connector until it clicks into place. Gently tug on cable to make sure it is secure (Figure 9).

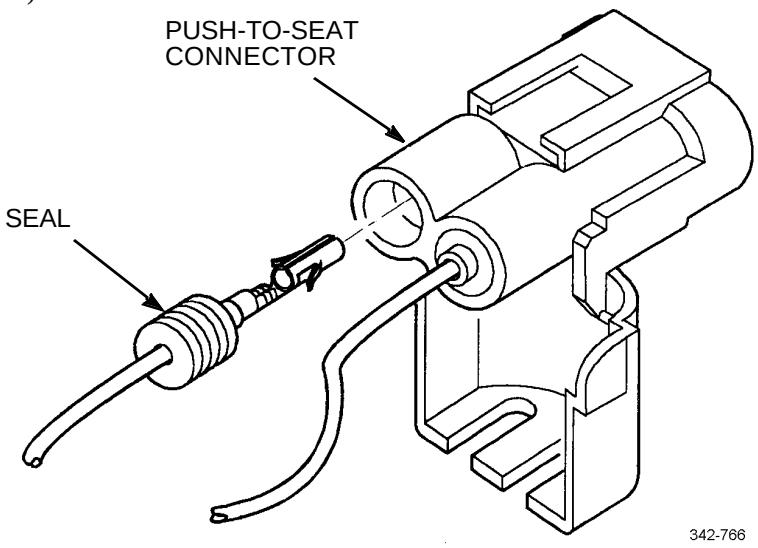


Figure 11. Inserting Terminal in Connector.

c. **Removal and Repair.** Two locking tangs are used on terminals to secure them to the connector body. Use the following instructions for removing terminals from connector body:

(1) Disengage locking tang securing connector bodies to each other. Grasp one half of connector in each hand and gently pull apart.

(2) Unlatch and open secondary lock on connector (Figure 10).

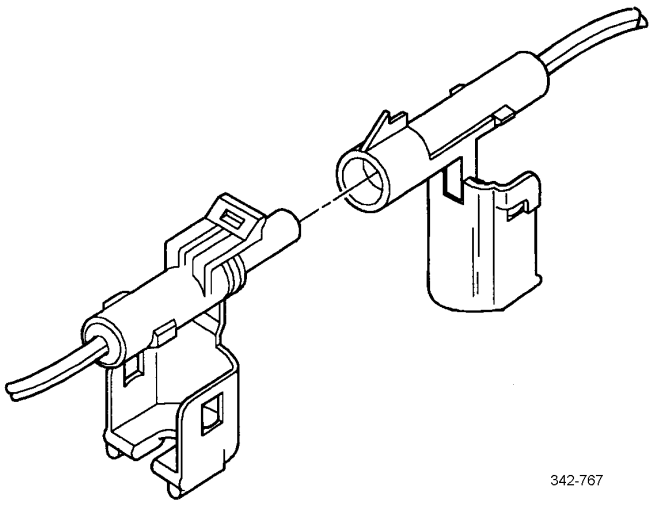


Figure 12. Unlatched Secondary Lock.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(3) Grasp cable to be removed and push terminal to forward position.

(4) Insert removal tool straight into front of connector cavity until it rests on cavity shoulder.

(5) Grasp cable and push forward through connector cavity into tool while holding tool securely in place (Figure 11).

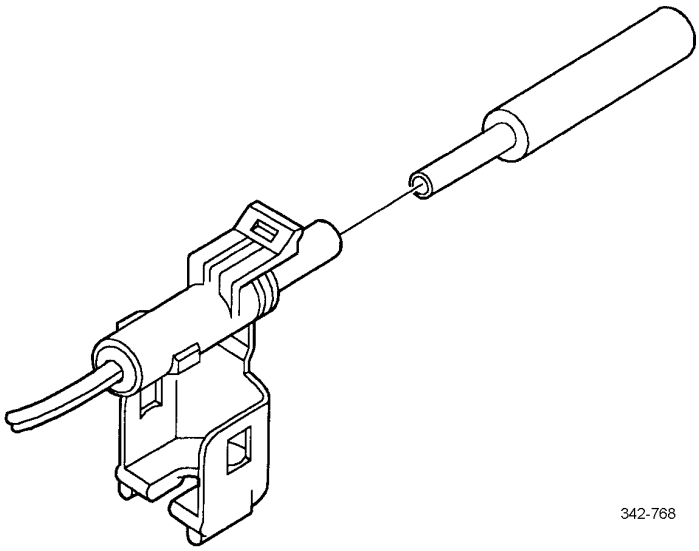


Figure 13. Removal Tool Procedure.

(6) Tool will press locking tangs of terminal. Pull cable rearward (back through connector). Remove tool from connector cavity.

(7) Cut wire immediately behind cable seat and slip new cable seal onto wire.

(8) Strip end of cable using strippers to leave 0.2 +/- 0.02 in (5.0 +/- 0.5 mm) of bare conductor. Position cable seal as shown (Figure 12).

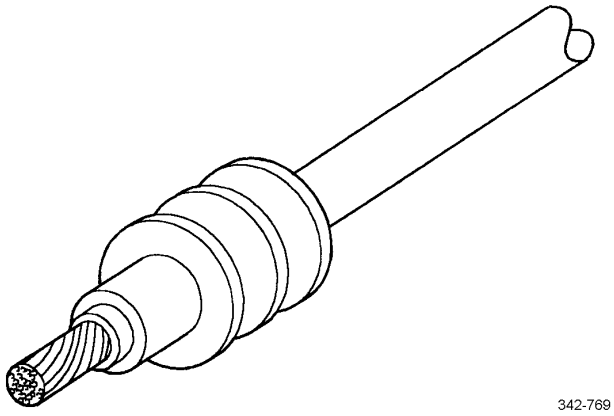


Figure 14. Proper Cable Seal Position.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(9) Crimp new terminal onto wire using crimp tool (Figure 13).

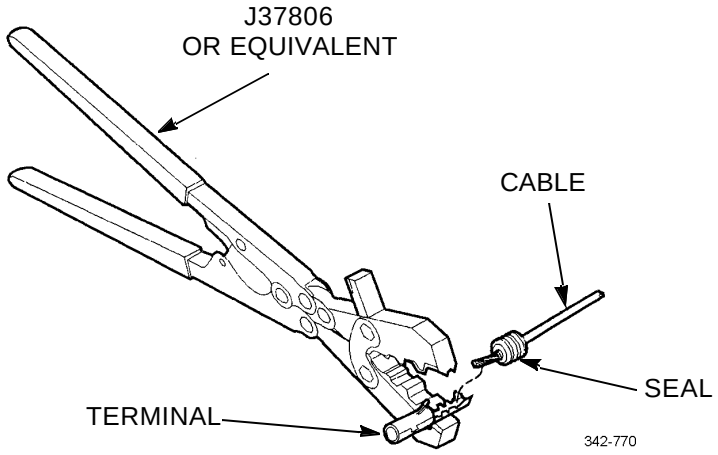


Figure 15. Crimping Procedure.

4. **Deutsch Connectors.**

a. **Connector Part Numbers.**

(1) Deutsch connectors have cable seals molded into the connector. These connectors are “push-to-seat” connectors with cylindrical terminals. The diagnostic connector terminals are gold plated for clarity.

(2) Deutsch connectors and their associated part numbers are listed in Table 5.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

Table 5. Deutsch Connectors and Part Numbers.

DIAGNOSTIC CONNECTOR	
Connector	P/N: 23513052
Terminal	P/N: 23513053
Protective Cap	P/N: 23413054
Plug	P/N: 23507136
ENGINEMINDER	
Connector	P/N: 23512222
Terminal	P/N: 23507132
Plug	P/N: 23507136
MASTERMIND - POWER AND COMMUNICATION LINK	
Connector	P/N: 23512221
Terminal	P/N: 23507132
Plug	P/N: 23507136
MASTERMIND - INPUTS AND OUTPUTS	
Connector	P/N: 23512223
Terminal	P/N: 23507066
Plug	P/N: 23507136

b. **Installation.**

(1) Strip approximately 1/4 in (6.4 mm) of insulation from cable.

(2) Remove lock clip, raise wire gage selector, and rotate knob to number matching gage wire being used.

(3) Lower selection and insert lock clip.

(4) Position contact so that the crimp barrel is 1/32 in (0.8 mm) above four indenters (Figure 14). Crimp cable.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

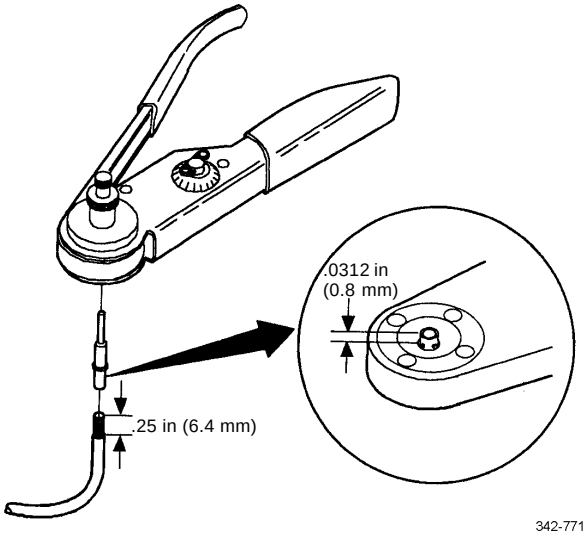


Figure 16. Setting Wire Gage Selector and Positioning Contact.

(5) Grasp contact approximately 1 in (2.54 mm) behind contact crimp barrel.

(6) Hold connector with rear grommet facing you (Figure 15).

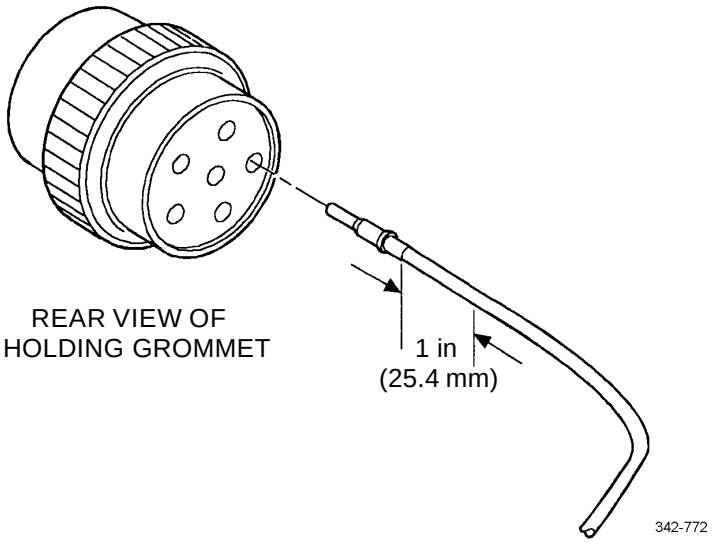


Figure 17. Pushing Contact into Grommet.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(7) Push contact into grommet until a positive stop is felt (Figure 15). A slight tug will confirm that it is properly locked into place (Figure 16).

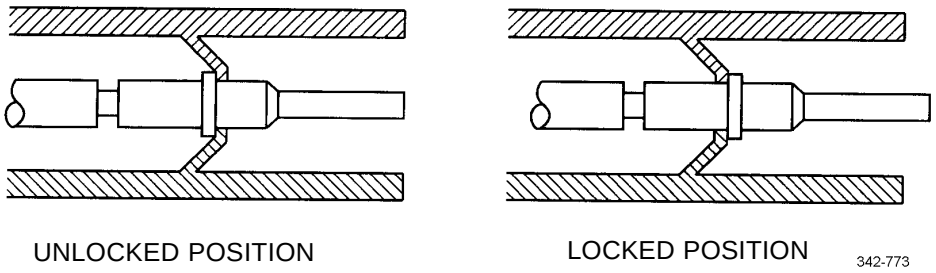


Figure 18. Locking Terminal into Connector.

c. **Removal.** The appropriate size removal tool should be used when removal cables from connectors. The proper removal tool size is listed in Table 1.

(1) With rear insert toward you, snap appropriate size removal tool over cable of contact to be removed (Figure 17).

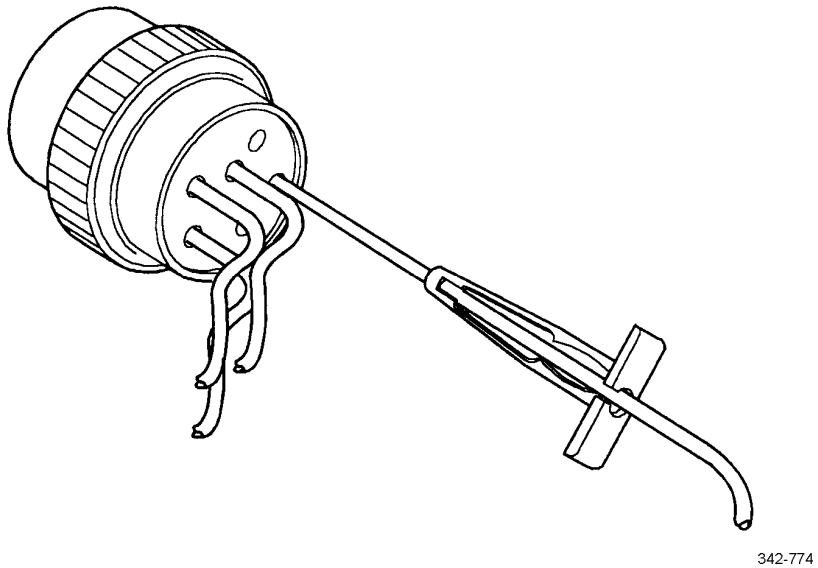


Figure 19. Removal Tool Position.

COMMERCIAL CONNECTOR REPAIR - CONTINUED

(2) Slide tool along cable into insert cavity until it engages and resistance is felt. DO NOT twist or insert tool at an angle (Figure 18).

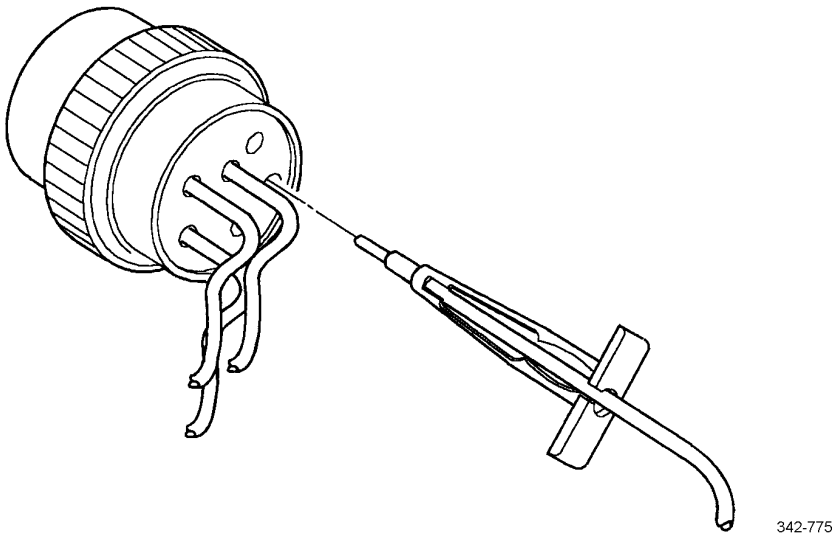


Figure 20. Removal Tool Insertion.

(3) Pull contact cable assembly out of connector. Keep reverse tension on cable and forward tension on tool.

SPLICING

1. **Splicing Guidelines.**

   a. The following are guidelines which may be used for splices. The methods described are not the only acceptable methods. Any method should produce a high quality, tight splice with durable insulation which can be expected to last the life of the vehicle.

   b. The selection of crimpers and splice connectors is optional. Select a high quality crimper equivalent to Kent-Moore tool J38706 and commercially available splice clips.

   c. The following is a list of tools required for splicing wires:

      - Soldering iron
      - Rosin core solder
      - Wire strippers
      - Heat shrink tubing
      - Splice clips
      - Crimp pliers

2. **Splicing Straight Leads.**

   a. Locate broken wire.

   b. Remove insulation as required. Ensure exposed wire is clean and not corroded.

   c. Slide a sleeve of shrink wrap on wire long enough to cover splice and overlap wire insulation, about 1/4 in (6.4 mm) on both sides.

SPLICING - CONTINUED

d. Insert one wire into splice clip (P/N: 0597428 or equivalent) and crimp.

e. Insert other wire into splice and crimp (Figure 19).

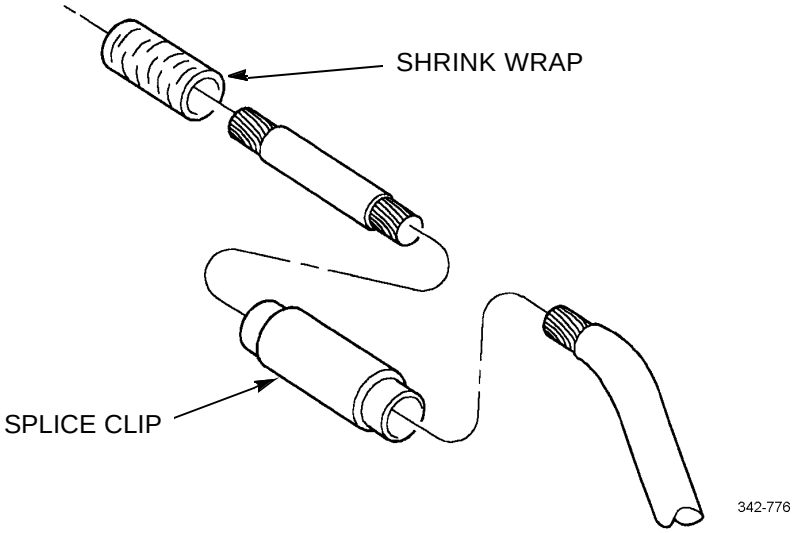


Figure 21. Spliced Wire.

3. **Soldering Splice Connectors.** Soldering splice connectors is optional. To solder splice connectors:

a. You MUST use rosin core solder.

b. Check exposed wire before splice is crimped in connector. Exposed wire MUST be clean before splice is crimped.

c. Use a suitable electronic soldering iron to heat wires. Apply solder to heated wire (not to soldering iron) allowing sufficient solder flow into splice joint.

d. Pull on connection to ensure crimping and soldering integrity.

4. **Heat Shrinkable Tubing.**

a. Shrink wrap is required. Alpha FIT-300, Raychem TAT-125 or any equivalent heat shrink dual wall epoxy encapsulating adhesive polyolefin is required. The following are sources of supply:

Alpha Wire Corp
711 Lidgerwood Ave
P.O. Box 711
Elizabeth, New Jersey 07207-0711
1-800-5 2ALPHA

Raychem Corporation, Thermofit Div
300 Constitution Drive, Bldg. B
Menlo Park, CA 94025
415-361-3860

SPLICING - CONTINUED

b. To heat shrink wrap a splice:

(1) Select correct diameter to allow a tight wrap when heated. Heat shrink wrap MUST be long enough to overlap wire insulation about 1/4 in (6.4 mm) on both sides of splice.

(2) Heat shrink wrap with a heat gun; do not concentrate heat in one location, but play heat over entire length of shrink wrap until joint is complete.

5. **Splicing Multiple Broken Wires.**

a. Stagger position of each splice as illustrated (Figure 20).

b. You MUST stagger positions to prevent a large bulge in harness and to prevent wires from chafing against each other.

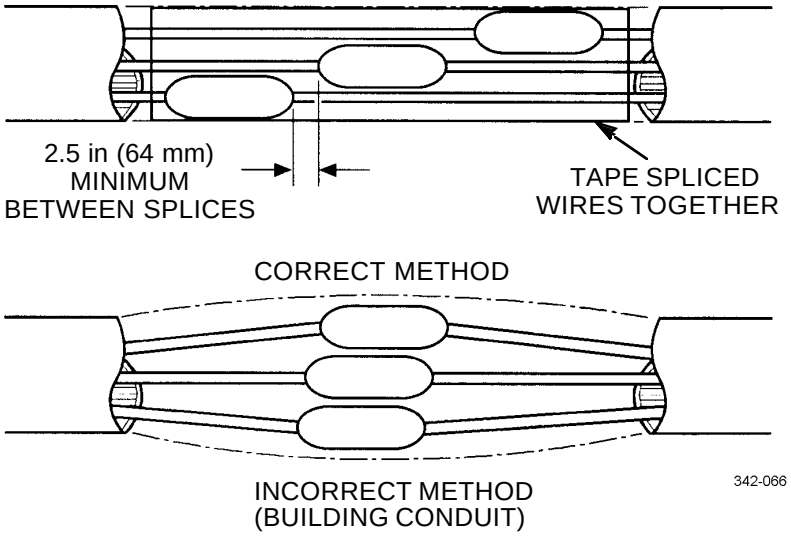


Figure 22. Multiple Splices.

SPLICING - CONTINUED

6. **Three-Wire Splices.**
   a. Three-way splice connectors are commercially available to accommodate three-wire splices.
   b. The technique is the same as a single butt splice connector (Figure 21).

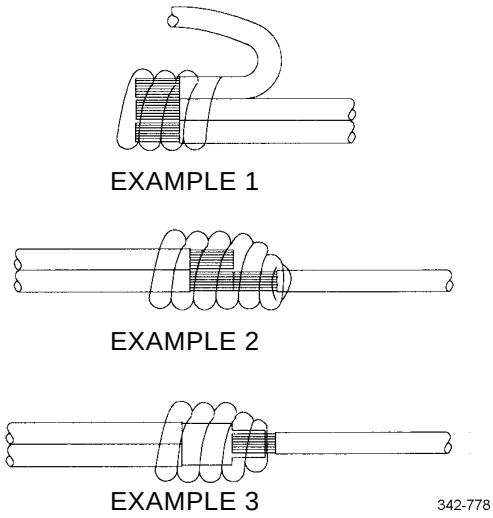


Figure 23. Three-way Splices.

END OF WORK PACKAGE

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SHIFT SELECTOR AND SHIFT TOWER REPLACEMENT 0120 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

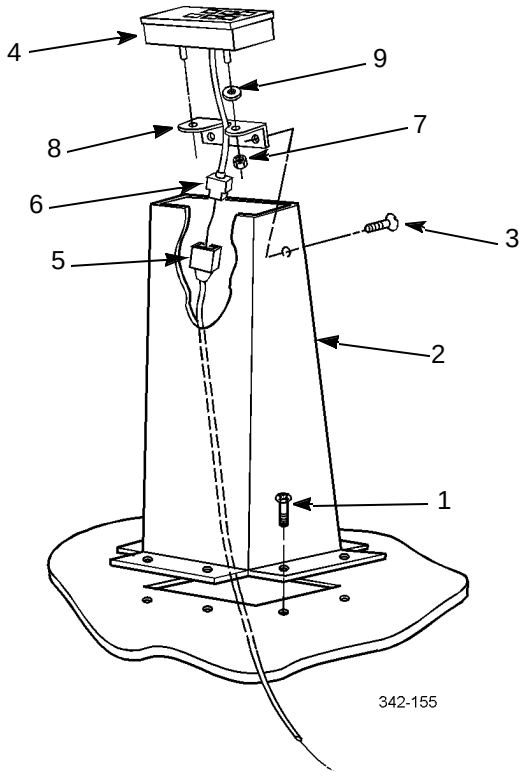
Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

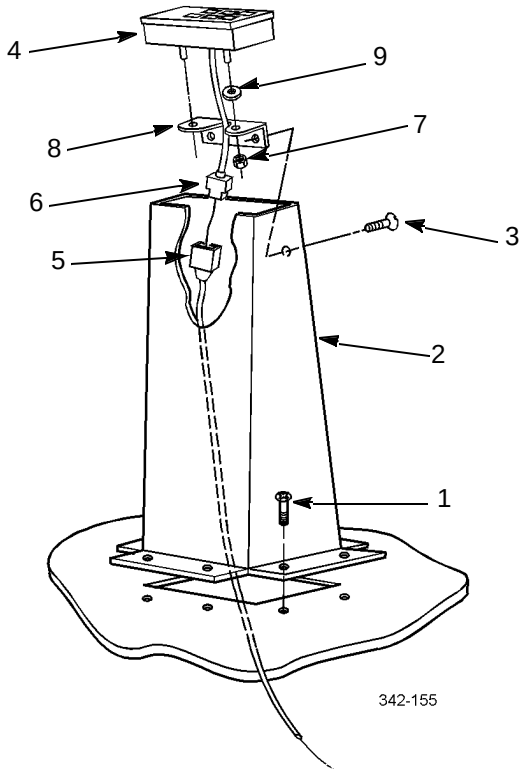
REMOVAL

1. Remove eight screws (1) and separate shift tower (2) from cab floor.
2. Remove two screws (3) from rear of shift tower (2) and pull out shift selector (4).
3. Disconnect transmission wiring harness connector (5) from shift selector connector (6).
4. Remove two nuts (7), bracket (8), and two washers (9) from shift selector (4).



INSTALLATION

1. Install two washers (9) and shift selector (4) on bracket (8) with two nuts (7).
2. Connect transmission wiring harness connector (5) to shift selector connector (6).
3. Install shift selector (4) on shift tower (2) with two screws (3).
4. Install shift tower (2) on cab floor with eight screws (1).



END OF WORK PACKAGE

TRANSMISSION OIL FILL/LEVEL CHECK TUBE REPLACEMENT 0121 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Washer, lock (P/N 23-09317-009) (2)

References

TM 9-2320-302-10

Equipment Condition

Transmission dipstick removed (TM 9-2320-302-10)

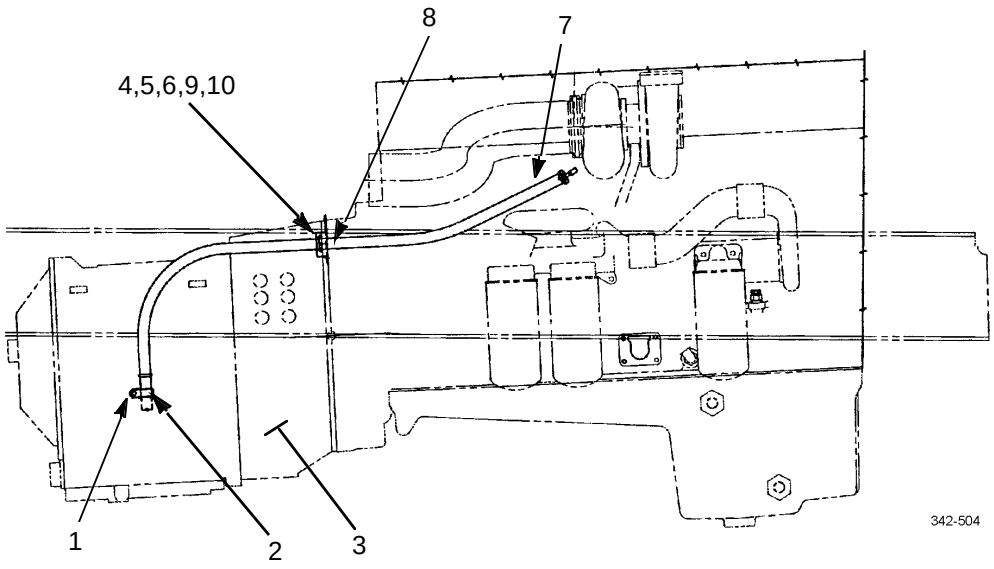
REMOVAL

1. Remove screw (1) and clamp (2) from right side of transmission (3).
2. Remove two nuts (4), lock washers (5), U-bolt (6), and transmission oil fill/level check tube (7) from transmission bracket (8) and transmission (3).

NOTE

Perform step 3 only if transmission bracket is damaged.

3. Remove two screws (9), washers (10), and transmission bracket (8) from transmission (3).

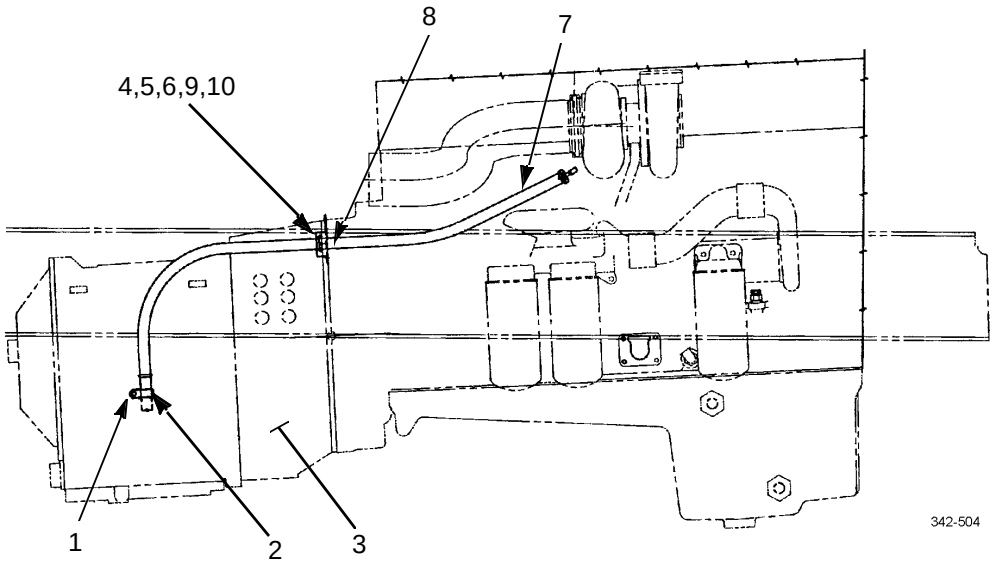


INSTALLATION

NOTE

Perform step 1 if transmission bracket was removed.

1. Install transmission bracket (8) on transmission (3) with two washers (10) and screws (9). Tighten screws to 54-65 lb-ft (73-88 Nm).
2. Position clamp (2) on transmission oil fill/level check tube (7) and install transmission oil fill/level check tube on transmission (3) and transmission bracket (8) with U-bolt (6), two new lock washers (5), and nuts (4).
3. Install clamp (2) on right side of transmission (3) with screw (1).



4. Install transmission dipstick (TM 9-2320-302-10).

END OF WORK PACKAGE

TRANSMISSION OIL COOLER LINES AND FITTINGS REPLACEMENT 0122 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Packing, preformed (P/N 316N552-9) (4)

Compound, sealing, pipe (Item 10, WP 0235 00)

Materials/Parts - Continued

Oil, lubricating (Item 19, WP 0235 00)

Straps, tiedown (Item 30, WP 0235 00)

Equipment Condition

Transmission oil drained (WP 0021 00)

REMOVAL

NOTE

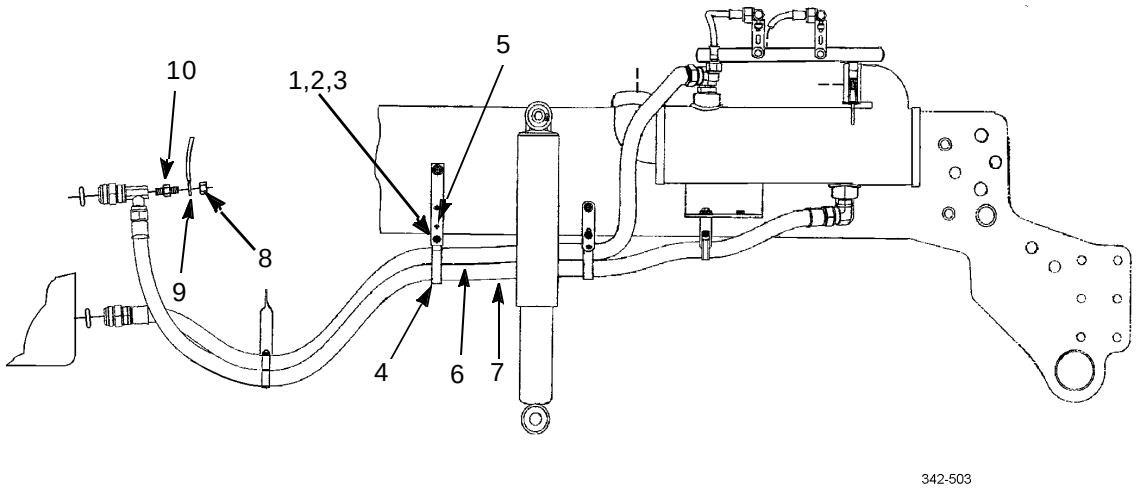
Perform steps 1 and 2 to free two transmission oil cooler lines from each of four support brackets.

1. Remove nut (1), two washers (2), screw (3), and clamp (4) from support bracket (5).
2. Remove clamp (4) from two transmission oil cooler lines (6 and 7).

NOTE

Perform steps 3 thru 7 at front of transmission.

3. Remove nut (8) and wire terminal (9) from temperature sensor (10).



REMOVAL - CONTINUED

4. Remove temperature sensor (10) from elbow fitting (11).
5. Disconnect transmission oil cooler lines (6 and 7) from elbow fitting (11) and fitting (12).
6. Loosen jamnuts (13 and 14) of elbow fitting (11) and fitting (12) and remove from transmission (15).
7. Remove two preformed packings (16). Discard preformed packings.

NOTE

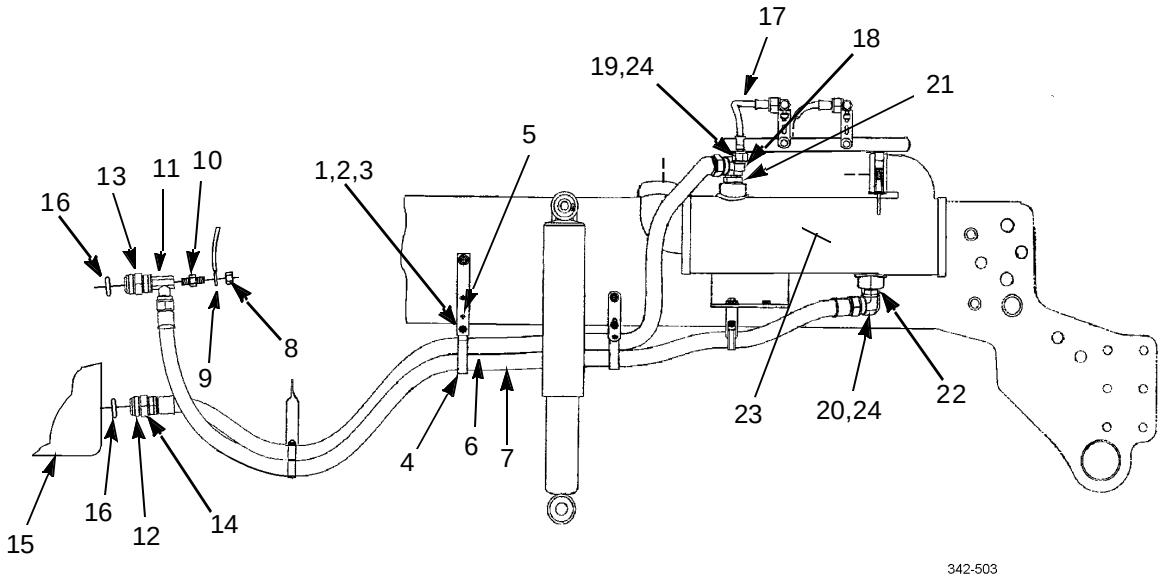
Perform steps 8 thru 12 at transmission oil cooler.

8. Disconnect transmission oil sample line (17) from elbow (18).
9. Remove elbow (18) from elbow (19).
10. Disconnect transmission oil cooler lines (6 and 7) from elbows (19 and 20).

NOTE

Remove tiedown straps as necessary and discard.

11. Remove transmission oil cooler lines (6 and 7) from vehicle.
12. Loosen jamnuts (21 and 22) of elbow fittings (19 and 20) and remove from transmission oil cooler (23).
13. Remove two preformed packings (24). Discard preformed packings.



INSTALLATION

NOTE

- Lightly lubricate new preformed packings with lubricating oil before installing packings.
- Perform steps 1 through 6 at transmission oil cooler.

1. Install two new preformed packings (24) to elbow fittings (19 and 20).

INSTALLATION - CONTINUED

2. Install two elbow fittings (19 and 20) to transmission oil cooler (23) and tighten jamnuts (21 and 22).
3. Position transmission oil cooler lines (6 and 7) to vehicle.
4. Connect transmission oil cooler lines (6 and 7) to two elbow fittings (19 and 20).

WARNINGS

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

5. Apply pipe sealing compound to threads of elbow (18) and install elbow to elbow (19).
6. Connect transmission oil sample line (17) to elbow (18).

NOTE

Perform steps 7 through 11 at front of transmission.

7. Install two new preformed packings (16) to elbow fitting (11) and fitting (12).
8. Install elbow fitting (11) and fitting (12) to transmission (15) and tighten jamnuts (13 and 14).
9. Connect transmission oil cooler lines (6 and 7) to fitting (12) and elbow fitting (11).
10. Apply pipe sealing compound to threads of temperature sensor (10) and install temperature sensor to elbow fitting (11).
11. Install wire terminal (9) to temperature sensor (10) with nut (8).

NOTE

Perform steps 12 and 13 to attach two transmission oil cooler lines to each of four support brackets.

12. Position clamp (4) around transmission oil cooler lines (6 and 7).
13. Install clamp (4) to support bracket (5) with screw (3), two washers (2), and nut (1). Install new tiedown straps as necessary.
14. Fill transmission oil (WP 0021 00).

END OF WORK PACKAGE

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TRANSMISSION OIL FILTER ELEMENTS REPLACEMENT 0123 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Filter kit (P/N 29526898) (2)

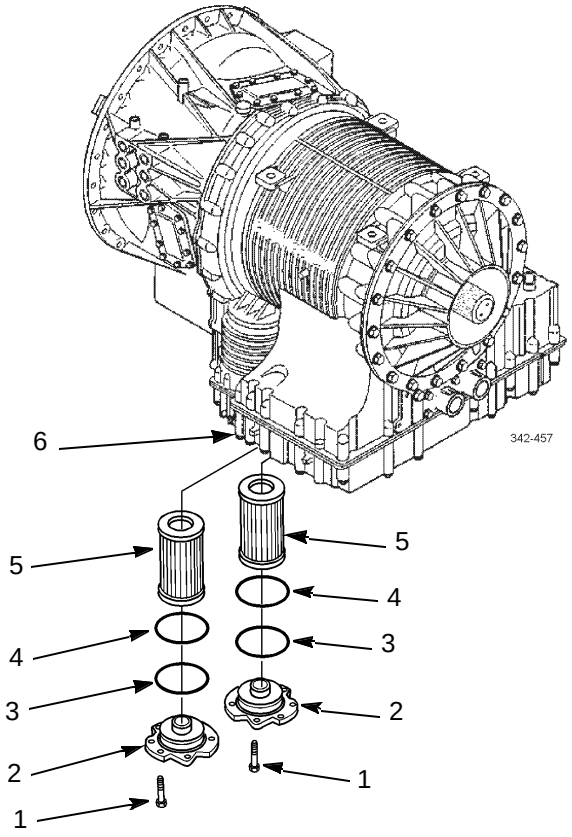
Oil, lubricating (Item 19, WP 0235 00)

NOTE

- It is not necessary to drain transmission oil if only transmission oil filter elements are being replaced.
- Perform this procedure for two transmission oil filter elements.

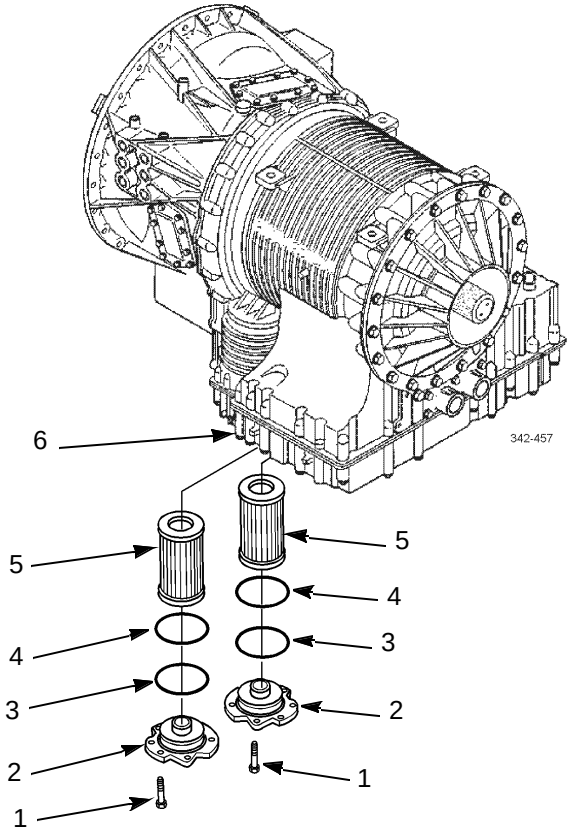
REMOVAL

Remove six screws (1), cover (2), preformed packing (3), seal (4), and transmission oil filter element (5) from bottom of transmission (6). Discard preformed packing, seal, and transmission oil filter element.



INSTALLATION

1. Apply a light coat of lubricating oil to new performed packing (3) and sealing surface of new transmission oil filter element (5).
2. Position preformed packing (3), new seal (4), and transmission oil filter element (5) on cover (2).
3. Install cover (2) on transmission (6) with six screws (1). Tighten screws to 38-45 lb-ft (52-61 Nm).



END OF WORK PACKAGE

TRANSMISSION ELECTRONIC CONTROL UNIT (ECU) REPLACEMENT 0124 00

THIS WORK PACKAGE COVERS

Removal, Installation

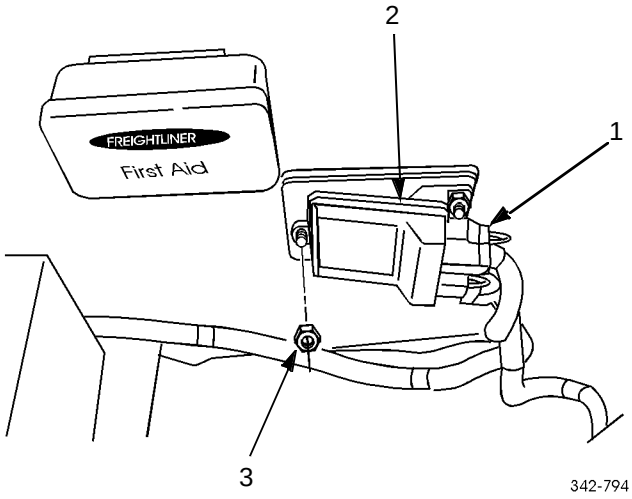
INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

REMOVAL

1. Disconnect wiring harness (1) from ECU (2).
2. Remove three nuts (3) and ECU (2) from cab wall.



INSTALLATION

1. Install ECU (2) on cab wall with three nuts (3).
2. Connect wiring harness (1) to ECU (2).

END OF WORK PACKAGE

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TRANSMISSION ELECTRONIC CONTROL UNIT (ECU) WIRING HARNESS REPLACEMENT 0125 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

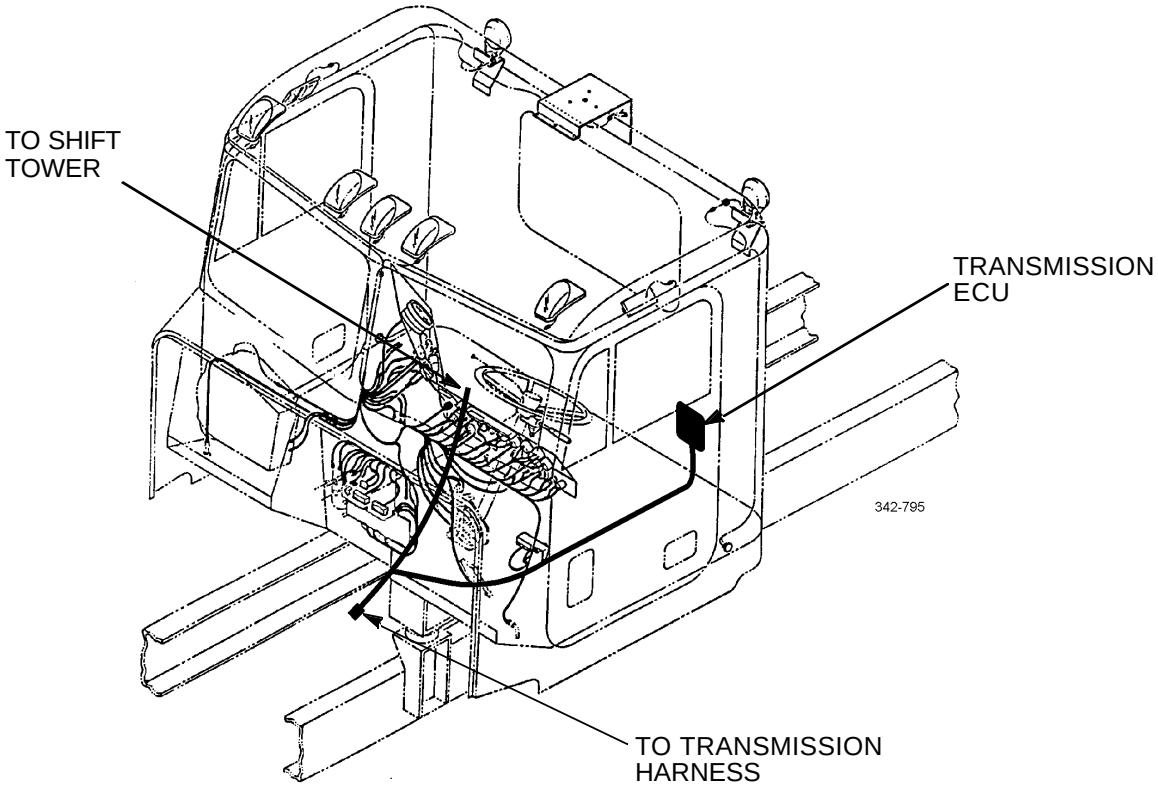
Tool kit, general mechanic's (Item 36, WP 0236 00)

REMOVAL

NOTE

Wiring harness and leads are secured in place by cushion clamps and screw terminals. Only remove hardware securing harness or lead to be removed.

Disconnect and remove transmission ECU wiring harness using illustration as a guide.



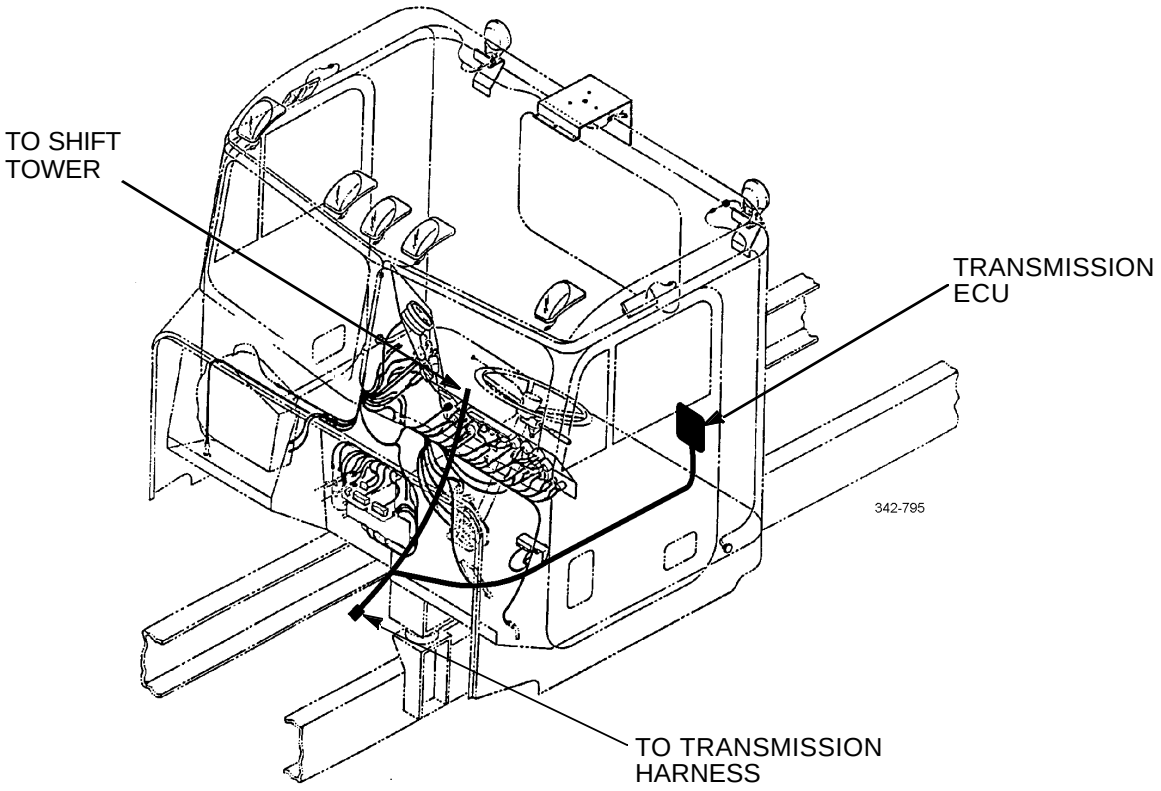
TRANSMISSION ELECTRONIC CONTROL UNIT (ECU)
WIRING HARNESS REPLACEMENT - CONTINUED **0125 00**

INSTALLATION

NOTE

Wiring harness and leads are secured in place by cushion clamps and screw terminals. Ensure that harness is secure and all hardware is tight.

Install, connect, and secure transmission ECU wiring harness using illustration as a guide.



END OF WORK PACKAGE

TRANSMISSION SPEED SENSOR REPLACEMENT 0126 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

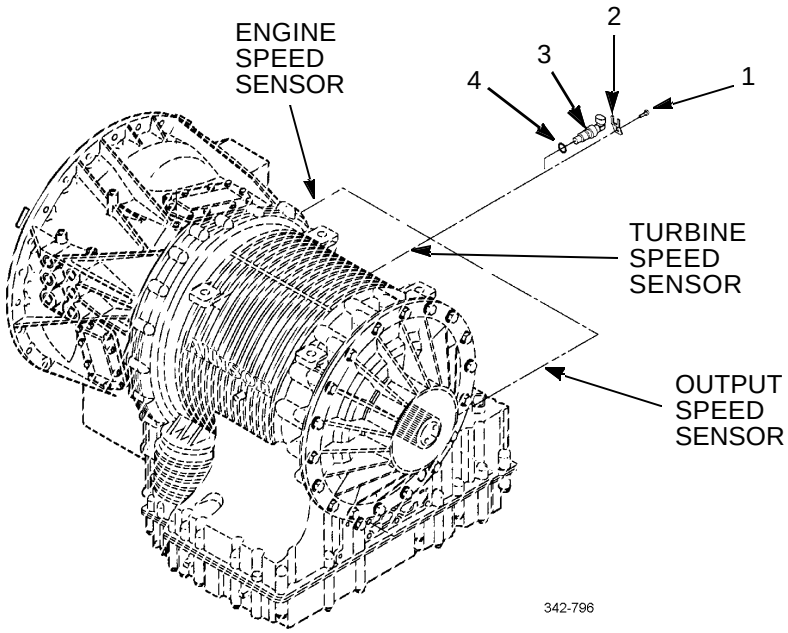
Materials/Parts

Packing, preformed (P/N 29503383)

Oil, lubricating (Item 19, WP 0235 00)

REMOVAL

1. Locate speed sensor to be replaced.
2. Remove bolt (1), retainer (2), sensor (3), and preformed packing (4) from transmission. Discard preformed packing.



INSTALLATION

1. Lightly coat new preformed packing (4) with lubricating oil.
2. Install preformed packing (4) and speed sensor (3) on transmission with retainer (2) and bolt (1).

END OF WORK PACKAGE

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TRANSMISSION OIL COOLER REPLACEMENT 0127 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-33) (4)

Rags, wiping (Item 28, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

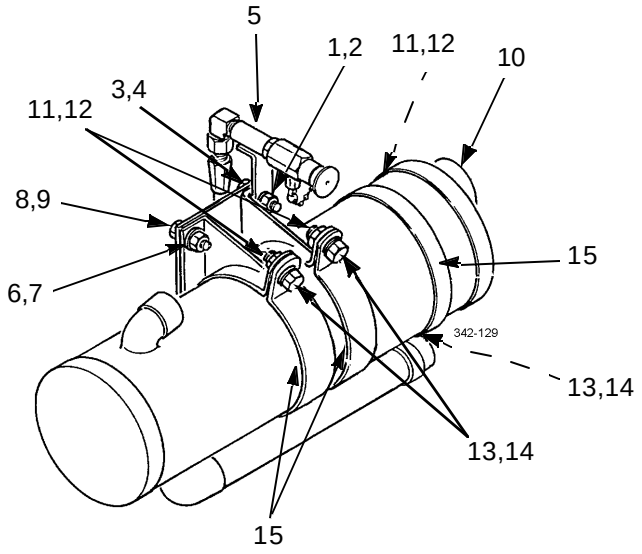
Transmission oil cooler lines and fittings removed (WP 0122 00)

REMOVAL

WARNING

Spilled oil is very slippery. Wipe up any spilled fluid immediately. Failure to follow this warning could result in serious injury to personnel.

1. Remove lock nut (1), washer (2), screw (3), washer (4), and oil sample valve (5). Set oil sample valve aside. Discard lock nut.
2. Remove three lock nuts (6), washers (7), screws (8), washers (9), and transmission oil cooler (10). Discard lock nuts.
3. Remove three nuts (11), washers (12), cap screws (13), washers (14), and brackets (15).



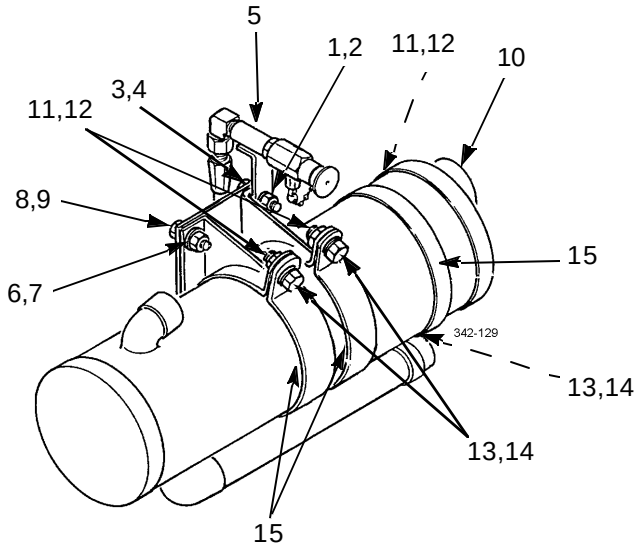
INSTALLATION

1. Install three brackets (15) with washers (14), cap screws (13), washers (12), and nuts (11).

WARNING

Spilled oil is very slippery. Wipe up any spilled fluid immediately. Failure to follow this warning could result in serious injury to personnel.

2. Install transmission oil cooler (10) with three washers (9), screws (8), washers (7), and new lock nuts (6).
3. Install oil sample valve (5) with washer (4), screw (3), washer (2), and new lock nut (1).



4. Install transmission oil cooler lines and fittings (WP 0122 00).

END OF WORK PACKAGE

TRANSMISSION BREATHER REPLACEMENT 0128 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

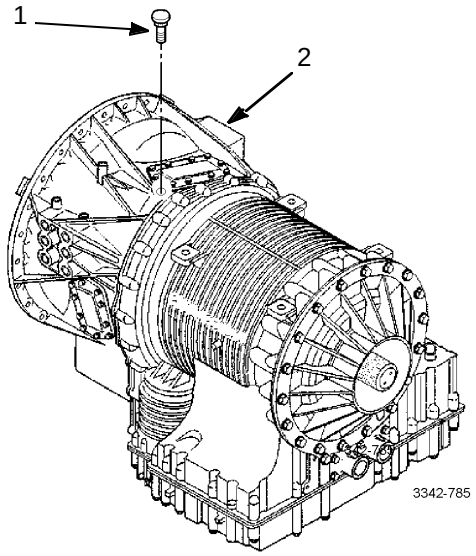
Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Transmission tunnel access cover removed (WP 0207 00)

REMOVAL

Remove transmission breather (1) from transmission (2).



INSTALLATION

1. Install transmission breather (1) on transmission (2).
2. Install transmission tunnel access cover (WP 0207 00).

END OF WORK PACKAGE

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DRIVELINE REPLACEMENT 0129 00

THIS WORK PACKAGE COVERS

Main Driveline Removal, Inter-axle Driveline Removal, Main Driveline Installation, Inter-axle Driveline Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Screw, lock (P/N 8-73-209) (8)

Screw, lock (P/N 8-73-316) (8)

Grease, GAA (Item 15, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

Vehicle wheels chocked

Transmission shift lever set to N (TM 9-2320-302-10)

MAIN DRIVELINE REMOVAL

WARNING

Driveline is heavy. Support end of driveline as bearing straps are removed to prevent driveline from falling. Failure to follow this warning may cause serious injury to personnel.

MAIN DRIVELINE REMOVAL - CONTINUED

NOTE

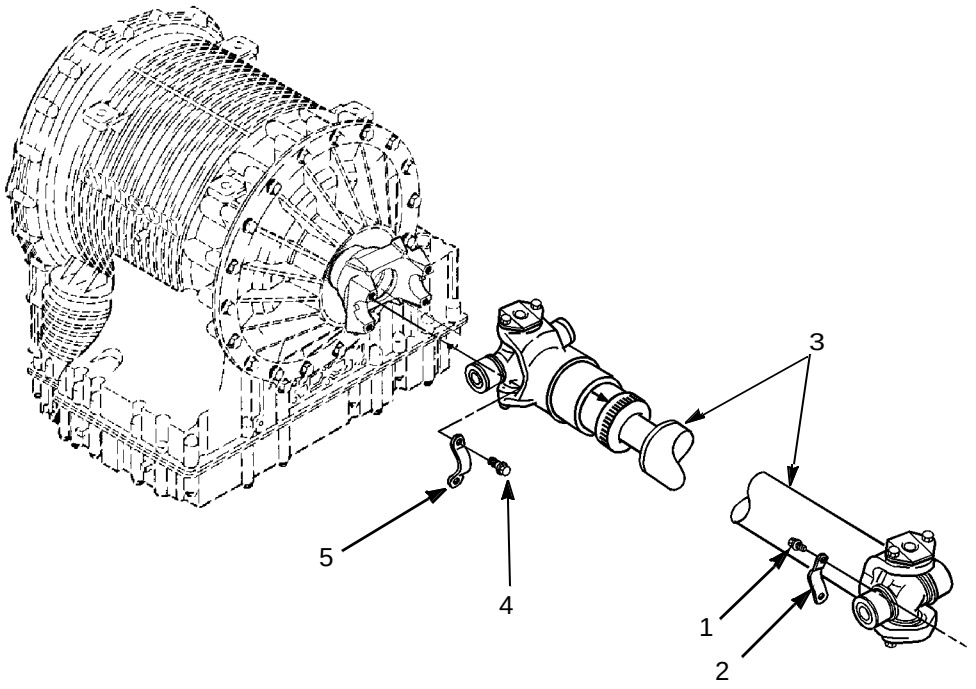
Perform following step at front end of main driveline.

1. Remove four screws (1) and two bearing straps (2) from universal joint of main driveline (3). Discard screws.

NOTE

Perform following step at rear end of main driveline.

2. Remove four screws (4) and two bearing straps (5) from universal joint of main driveline (3). Discard screws.
3. Remove main driveline (3) from vehicle.



342-296

INTER-AXLE DRIVELINE REMOVAL

WARNING

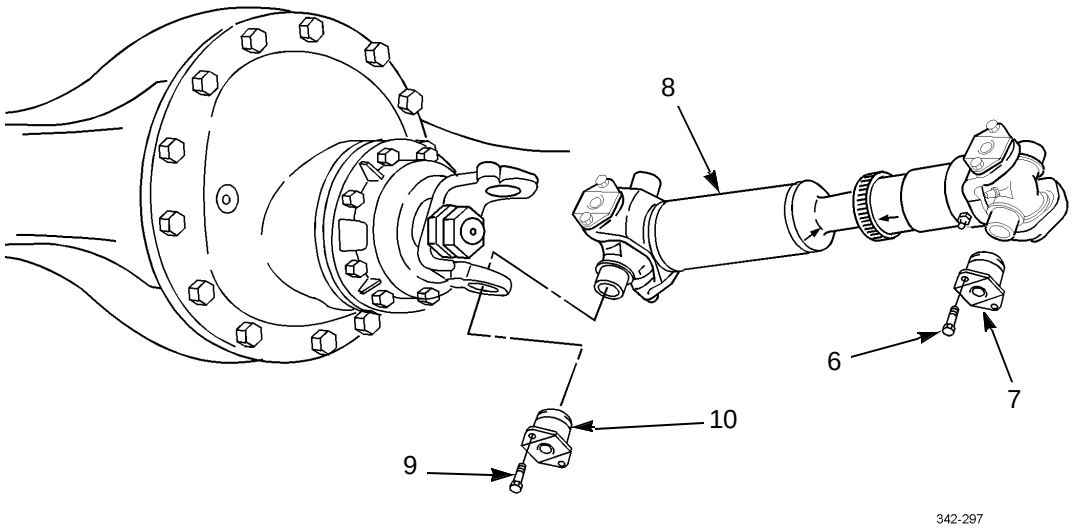
Driveline is heavy. Support end of driveline as bearing straps are removed to prevent driveline from falling. Failure to follow this warning may cause serious injury to personnel.

INTER-AXLE DRIVELINE REMOVAL - CONTINUED

NOTE

Perform following steps at front end of inter-axle driveline.

1. Remove two screws (6) from each of two bearing caps (7). Discard screws.
2. Remove two bearing caps (7) from universal joint of inter-axle driveline (8).



NOTE

Perform following steps at rear end of inter-axle driveline.

3. Remove two screws (9) from each of two bearing caps (10). Discard screws.
4. Remove two bearing caps (10) from universal joint of inter-axle driveline (8).
5. Remove inter-axle driveline (8) from vehicle.

MAIN DRIVELINE INSTALLATION

NOTE

Perform following steps at rear end of main driveline.

1. Position main driveline (3) to vehicle.
2. Install two bearings straps (5) and four new screws (4) to universal joint of main driveline (3). Tighten screws to 125 lb-ft (170 Nm).

NOTE

Perform following step at front end of main driveline.

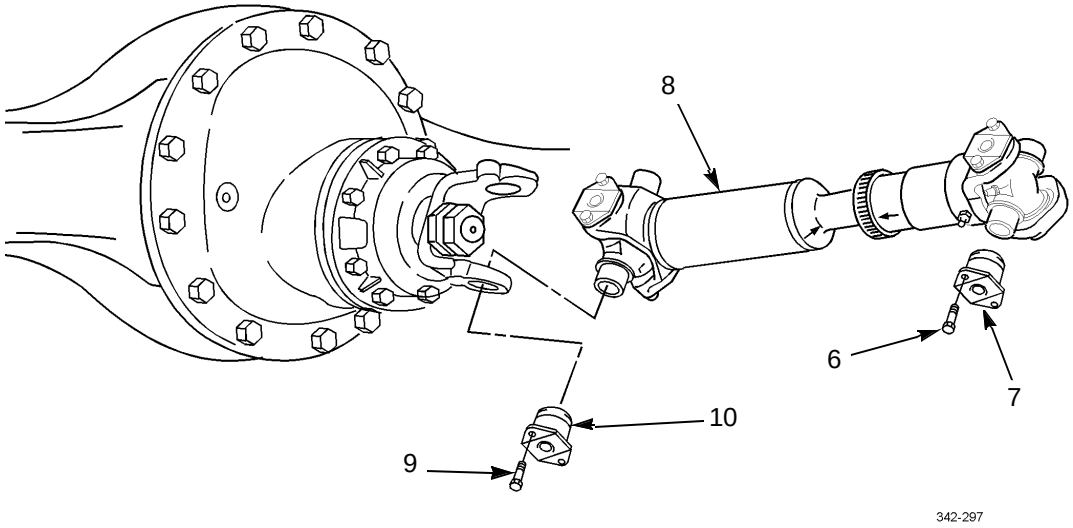
3. Install two bearing straps (2) and four new screws (1) to universal joint of main driveline (3). Tighten screws to 125 lb-ft (170 Nm).
4. Lubricate driveline (WP 0021 00).

INTER-AXLE DRIVELINE INSTALLATION

NOTE

Perform following steps at rear end of inter-axle driveline.

1. Position inter-axle driveline (8) to vehicle and install two bearing caps (10).
2. Install two new screws (9) to each of two bearing caps (10). Tighten screws to 36 lb-ft (49 Nm).



NOTE

Perform following steps at front end of inter-axle driveline.

3. Position inter-axle driveline (8) to vehicle and install two bearing caps (7).
4. Install two new screws (6) to each of two bearing caps (7). Tighten screws to 36 lb-ft (49 Nm).
5. Lubricate driveline (WP 0021 00).

END OF WORK PACKAGE

DRIVELINE U-JOINTS AND BEARINGS REPLACEMENT 0130 00

THIS WORK PACKAGE COVERS

Main Driveline U-joints Removal, Inter-Axle Driveline U-joints Removal, Main Driveline U-joints Installation, Inter-Axle Driveline U-joints Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Screw, lock (P/N 8-73-209) (16)

Grease, GAA (Item 15, WP 0235 00)

Equipment Condition

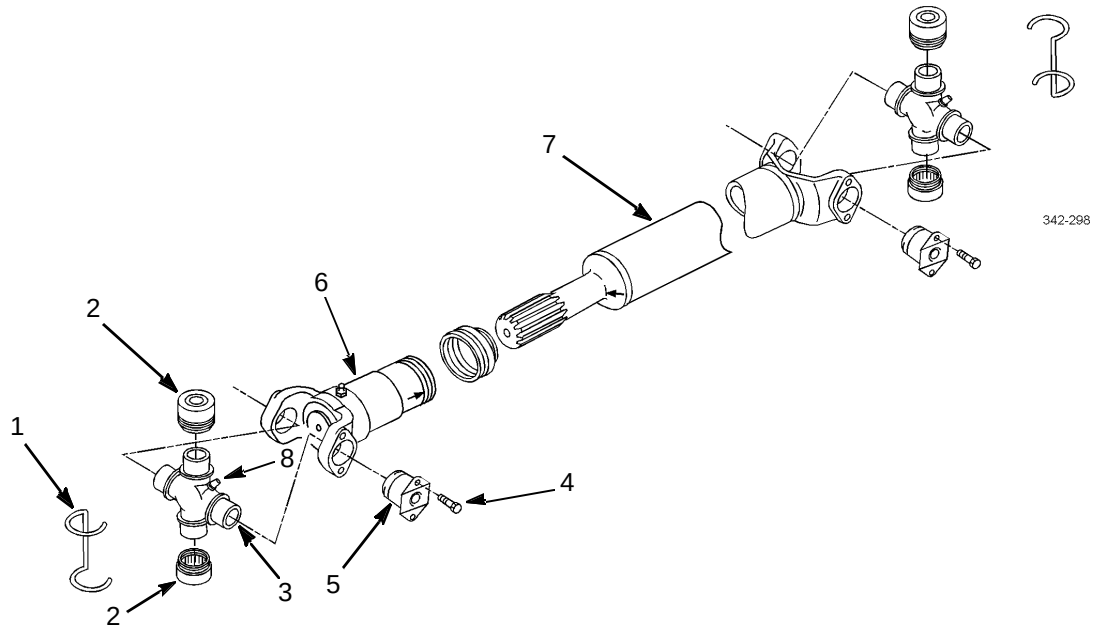
Drivelines removed from vehicle (WP 0129 00)

MAIN DRIVELINE U-JOINTS REMOVAL

NOTE

Perform following steps at front end of main driveline.

1. Remove retaining wire (1) from groove of two bearings (2).
2. Remove two bearings (2) from universal joint (3).
3. Remove two screws (4) from each of two bearing caps (5). Discard screws.
4. Remove two bearing caps (5) and universal joint (3) from yoke (6) of main driveline (7).
5. Remove two grease fittings (8) from universal joint (3).



MAIN DRIVELINE U-JOINTS REMOVAL - CONTINUED

NOTE

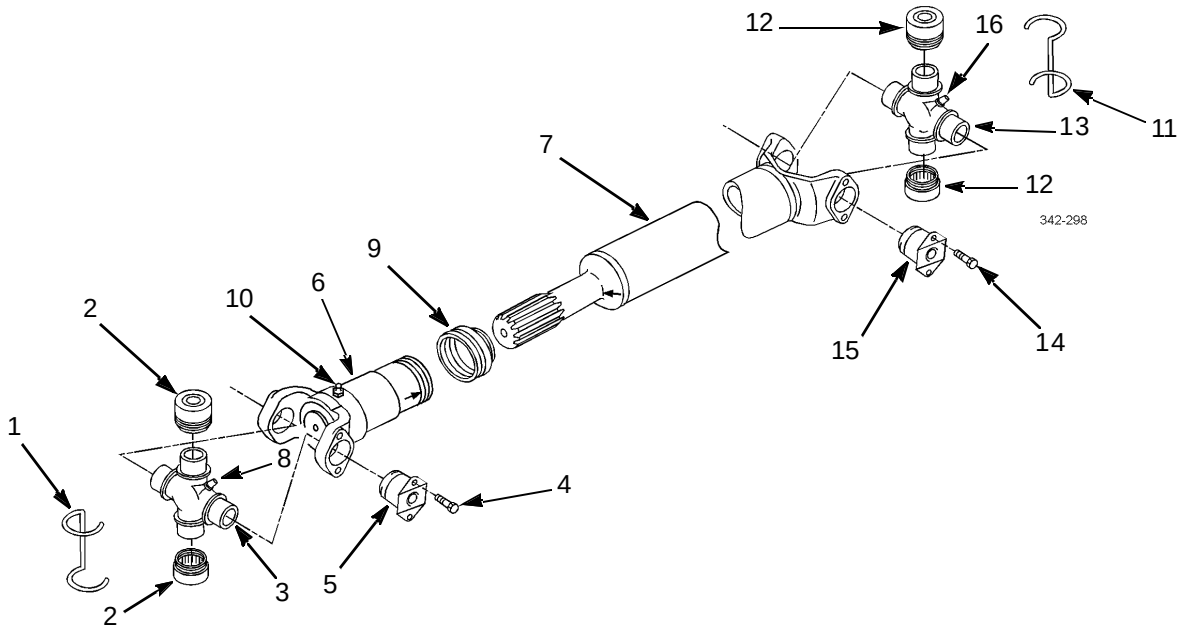
Note matchmarks on each half of main driveline for installation. Scribe or paint matchmarks on driveline if matchmarks are missing.

6. Remove dust seal (9) and yoke (6) from main driveline (7).
7. Remove grease fitting (10) from yoke (6).

NOTE

Perform following steps at rear end of main driveline.

8. Remove retaining wire (11) from groove of two bearings (12).
9. Remove two bearings (12) from universal joint (13).
10. Remove two screws (14) from each of two bearing caps (15). Discard screws.
11. Remove two bearing caps (15) and universal joint (13) from main driveline (7).
12. Remove two grease fittings (16) from universal joint (13).



INTER-AXLE DRIVELINE U-JOINTS REMOVAL

NOTE

Perform the following steps at front end of inter-axle driveline.

1. Remove two screws (17) from each of two bearing caps (18). Discard screws.
2. Remove two bearing caps (18) and universal joint (19) from yoke (20) of inter-axle driveline (21).

INTER-AXLE DRIVELINE U-JOINTS REMOVAL - CONTINUED

3. Remove two grease fittings (22) from universal joint (19).

NOTE

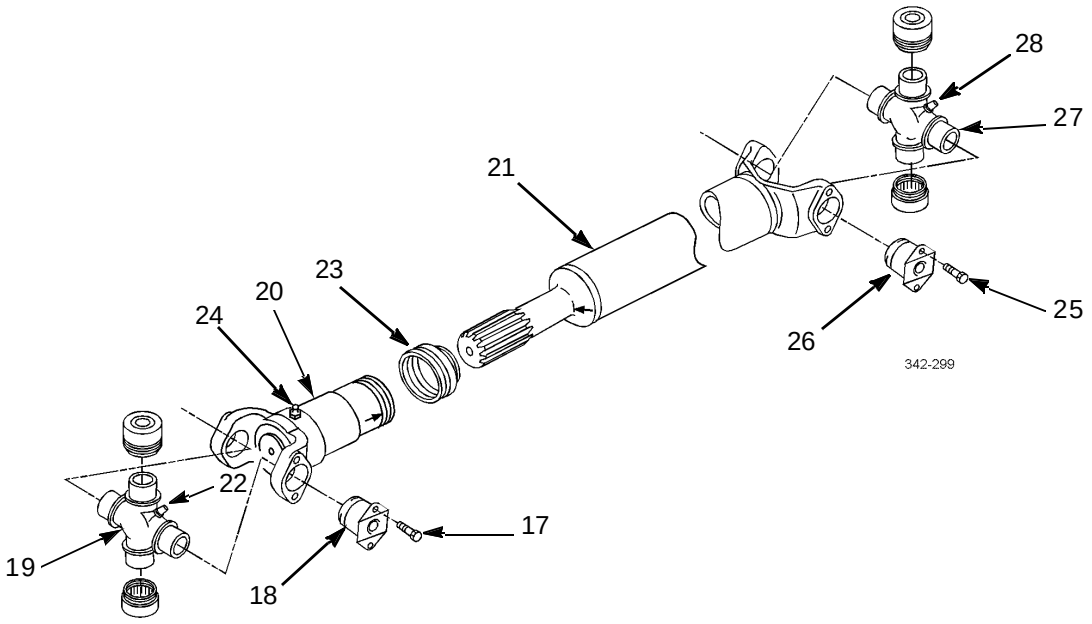
Note matchmarks on each half of inter-axle driveline for installation. Scribe or paint matchmarks on driveline if matchmarks are missing.

4. Remove dust seal (23) and yoke (20) from inter-axle driveline (21).
5. Remove grease fitting (24) from yoke (20).

NOTE

Perform the following steps at rear end of inter-axle driveline.

6. Remove two screws (25) from each of two bearing caps (26). Discard screws.
7. Remove two bearing caps (26) and universal joint (27) from inter-axle driveline (21).
8. Remove two grease fittings (28) from universal joint (27).



MAIN DRIVELINE U-JOINTS INSTALLATION

NOTE

Perform the following steps at rear end of main driveline.

1. Install two grease fittings (16) on universal joint (13).
2. Position universal joint (13) and two bearing caps (15) to main driveline (7).

MAIN DRIVELINE U-JOINTS INSTALLATION - CONTINUED

3. Install two new screws (14) on each of two bearing caps (15). Tighten screws to 36 lb-ft (49 Nm).
4. Install two bearings (12) on universal joint (13).
5. Install retaining wire (11) in groove of two bearings (12).
6. Lubricate universal joint (13) (WP 0021 00).

NOTE

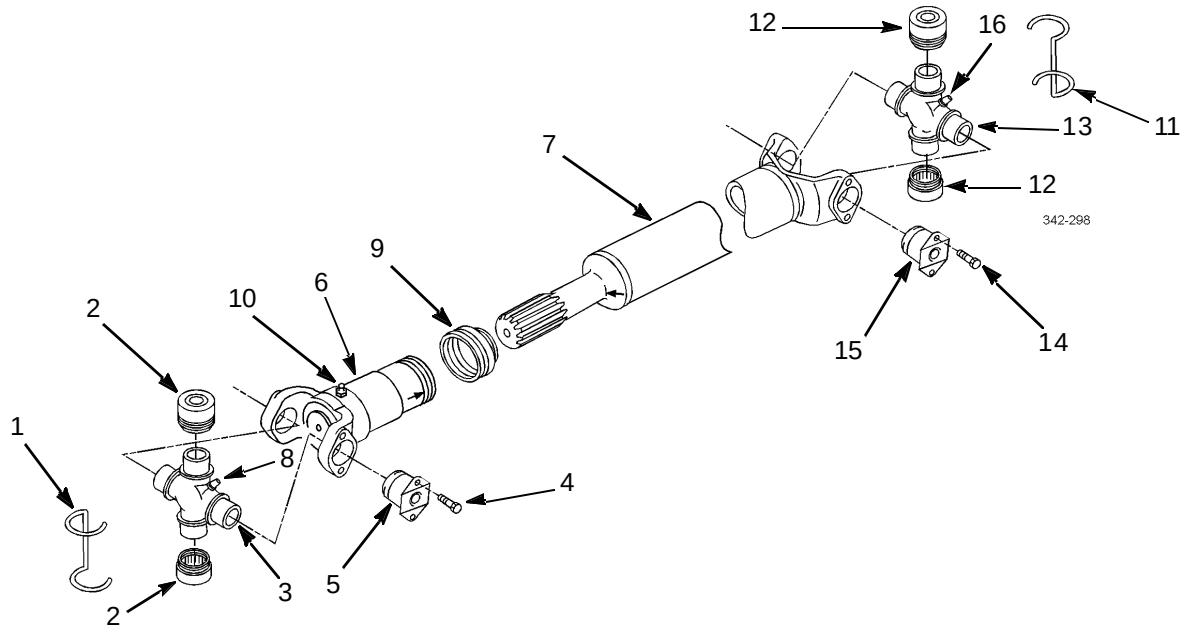
Perform the following steps at front end of main driveline.

7. Install grease fitting (10) on yoke (6).

NOTE

Align matchmarks on each half of main driveline.

8. Install dust seal (9) and yoke (6) on main driveline (7). Tighten dust seal.
9. Install two grease fittings (8) on universal joint (3).
10. Position universal joint (3) and two bearing caps (5) on main driveline (7).
11. Install two new screws (4) on each of two bearing caps (5). Tighten screws to 36 lb-ft (49 Nm).
12. Install two bearings (2) on universal joint (3).
13. Install retaining wire (1) in groove of two bearings (2).
14. Lubricate yoke (6) and universal joint (3) (WP 0021 00).
15. Install main driveline (WP 0129 00).



INTER-AXLE DRIVELINE U-JOINTS INSTALLATION

NOTE

Perform the following steps at rear end of inter-axle driveline.

1. Install two grease fittings (28) on universal joint (27).
2. Position universal joint (27) and two bearing caps (26) on inter-axle driveline (21).
3. Install two new screws (25) on each of two bearings caps (26). Tighten screws to 36 lb-ft (49 Nm).
4. Lubricate universal joint (27) (WP 0021 00).
5. Install grease fitting (24) on yoke (20).

NOTE

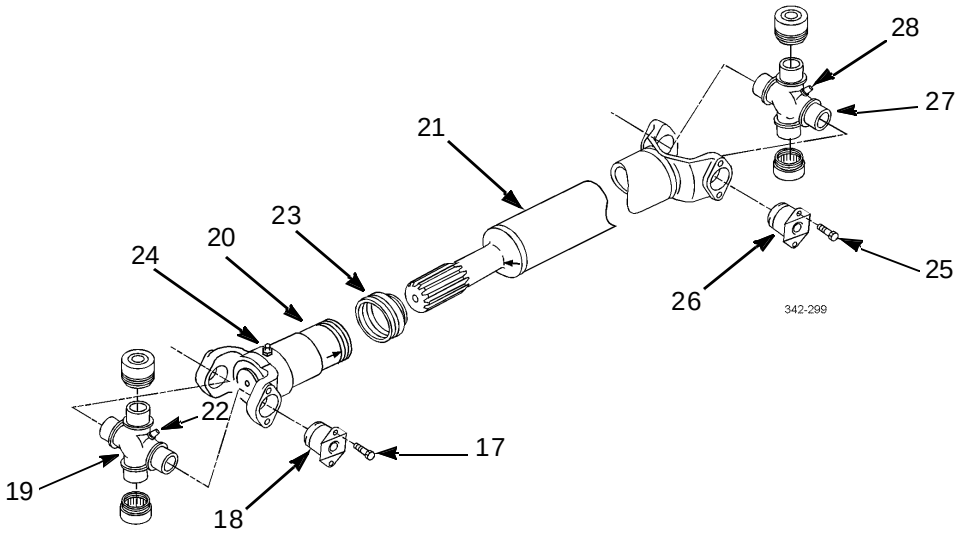
Align matchmarks on each half of inter-axle driveline.

6. Install dust seal (23) and yoke (20) on inter-axle driveline (21). Tighten dust seal.

NOTE

Perform the following steps at front end of inter-axle driveline.

7. Install two grease fittings (22) to universal joint (19).
8. Position universal joint (19) and two bearing caps (18) on yoke (20) of inter-axle driveline (21).
9. Install two new screws (17) on each of two bearing caps (18). Tighten screws to 36 lb-ft (19 Nm).
10. Lubricate yoke (20) and universal joint (19) (WP 0021 00).
11. Install inter-axle driveline (WP 0129 00).



END OF WORK PACKAGE

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FRONT AXLE TOE-IN ALIGNMENT 0131 00

THIS WORK PACKAGE COVERS

Alignment Check, Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Jack, hydraulic, hand (Item 21, WP 0236 00)

Tape, measuring, 50 feet (Item 31, WP 0236 00)

Trestle, hoist, portable (2) (Item 38, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Paint, white (Item 27, WP 0235 00)

Personnel Required

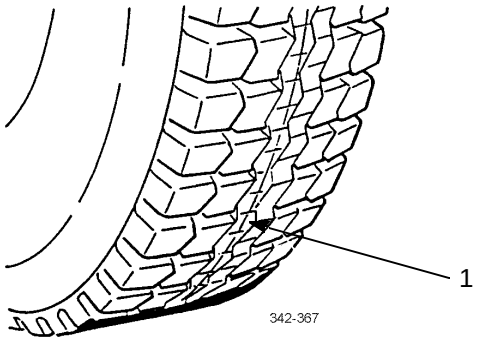
Two

References

TM 9-2320-302-10

ALIGNMENT CHECK

1. Block rear wheels and raise front end of vehicle so that front tires can be rotated. Support front of vehicle on two trestles.
2. Slowly rotate front tire and whiten center of tire around complete circumference using spray paint. Repeat for opposite tire.
3. Rotate tire and scribe line (1) around complete circumference near center so that line is visible in whitened area. Repeat for opposite tire.



4. Lower vehicle and remove trestles.
5. Remove chocks. Back up vehicle a few feet, then drive forward approximately 10 feet.
6. Place transmission in neutral and set parking brake (TM 9-2320-302-10).
7. At front of tires, use tape measure held at axle height to measure distance between scribed lines (1) and front of each tire. Record measurement to nearest 1/32 in.
8. At rear of tires, use tape measure held at axle height to measure distance between scribed lines (1) on rear of each tire. Record measurement to nearest 1/32 in.

ALIGNMENT CHECK - CONTINUED

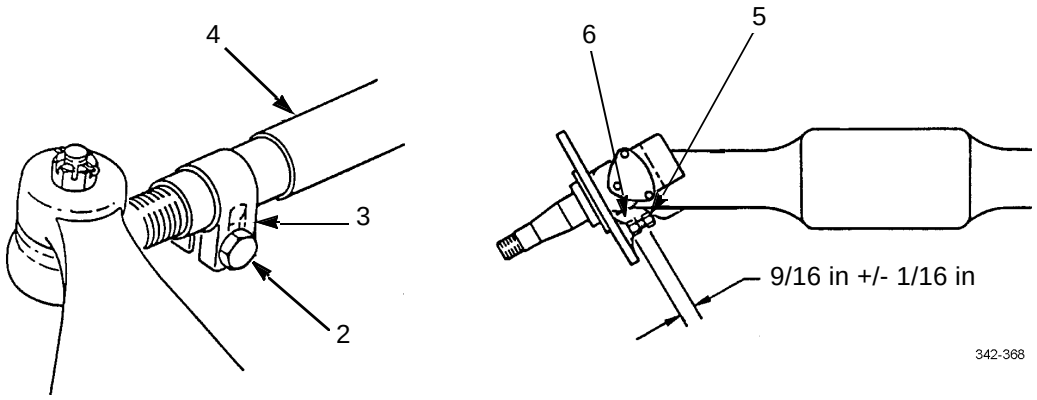
9. Measurement at front of tires must be 1/16 inch or less than rear measurement for proper toe-in alignment. If measurement is not as specified, perform alignment procedure.

ADJUSTMENT

NOTE

Perform steps 1 through 4 to adjust toe-in alignment.

1. Loosen screws (2) at clamps (3) on each end of tie rod (4).
2. Rotate tie rod (4) toward front of vehicle to increase toe-in or rotate tie rod toward rear of vehicle to decrease toe-in.
3. Tighten screws (2) to 40-55 lb-ft (54-75 Nm).



4. Repeat alignment check procedure.

NOTE

- Perform steps 5 through 7 to adjust turn stop bolts.
- Steps 5 through 7 are the same for both sides.

5. Measure length of stop bolt (5). Length must be 9/16 in +/- 1/16 in (14 mm +/- 1.6 mm).
6. If measurement from step 5 is not within tolerance, loosen locknut (6) and adjust stop bolt (5) to required length.
7. Tighten locknut (6) to 28 lb-ft (38 Nm).

END OF WORK PACKAGE

FRONT AXLE STOP CUSHION REPLACEMENT 0132 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

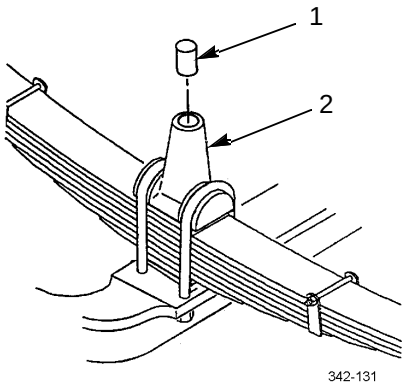
Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Adhesive (Item 2, WP 0235 00)

REMOVAL

Remove stop cushion (1) from front axle stop (2).



INSTALLATION

1. Apply adhesive to inside diameter of front axle stop (2).
2. Install stop cushion (1) in front axle stop (2).

END OF WORK PACKAGE

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REAR AXLE BREATHER REPLACEMENT 0133 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Equipment Condition

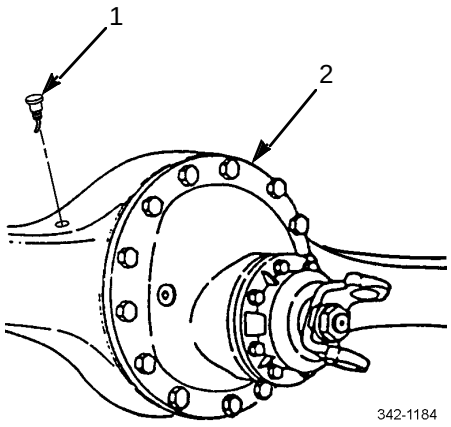
Vehicle wheels chocked

NOTE

Rear axle breathers are replaced the same way on both rear axles. One rear axle is shown.

REMOVAL

Remove rear axle breather (1) from rear axle (2).



INSTALLATION

WARNINGS

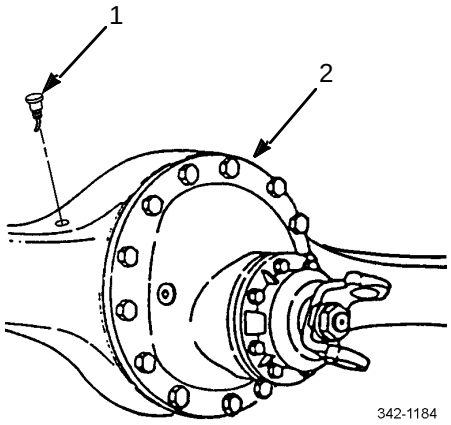
Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Lightly coat threads of rear axle breather (1) with pipe sealing compound.

NOTE

Position of rear axle breather is important. Install rear axle breather so that mark and tube of breather face AWAY from differential.

2. Install rear axle breather (1) on rear axle (2).



END OF WORK PACKAGE

BRAKE PEDAL REPLACEMENT 0134 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

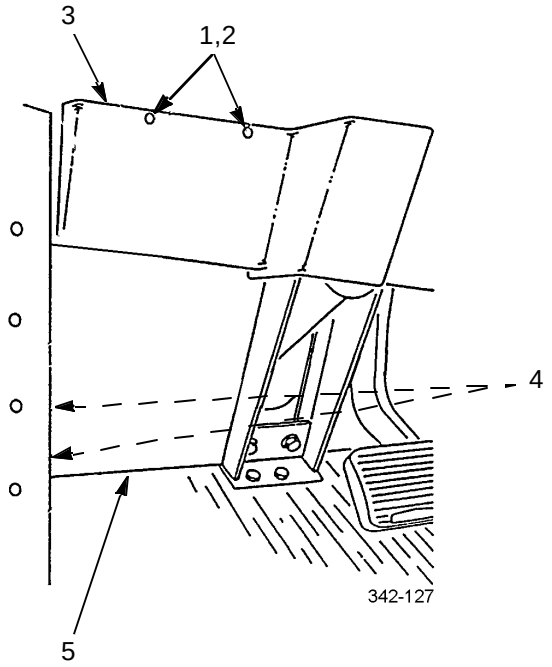
Materials/Parts

Pin, cotter (P/N 213)

Straps, tiedown (Item 30, WP 0235 00)

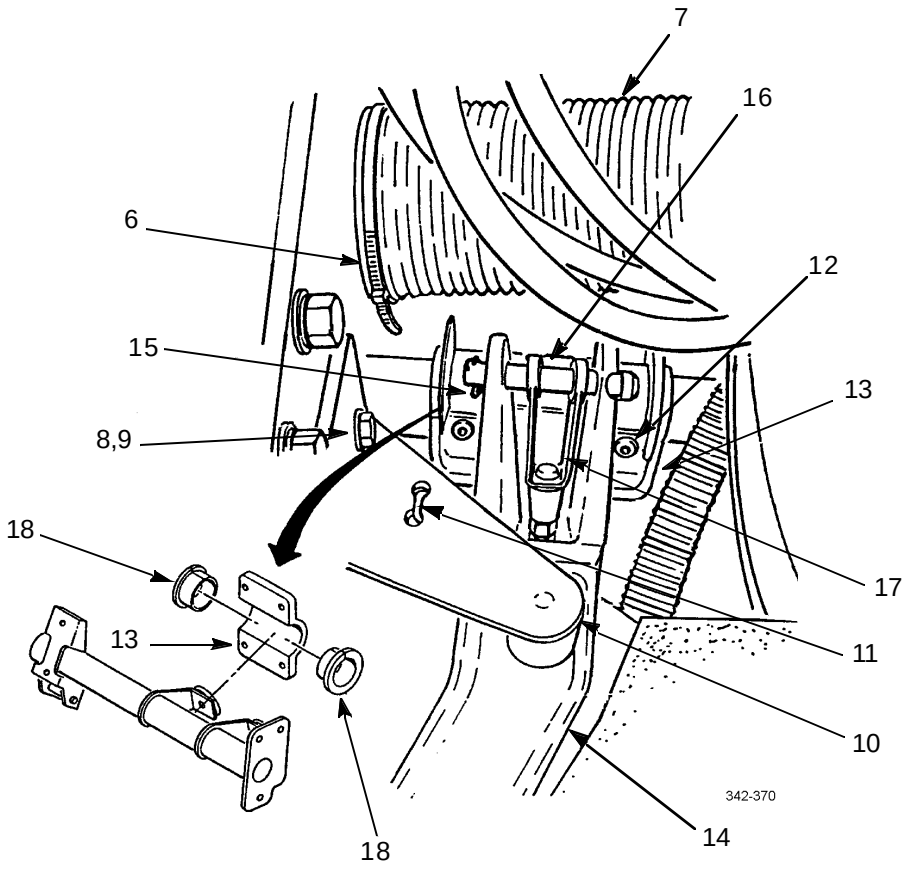
REMOVAL

1. Remove five screws (1), washers (2), and cover (3).
2. Remove two screws (4) and cover (5).



REMOVAL - CONTINUED

3. Remove tiedown strap (6) and disconnect defroster hose (7). Discard tiedown strap.
4. Remove two screws (8), washers (9), bracket (10), and spring (11).
5. Remove four screws (12), cap (13), and brake pedal (14).
6. Remove cotter pin (15), straight pin (16), and clevis (17) from brake pedal (14). Discard cotter pin.
7. Remove two bearings (18) from cap (13).

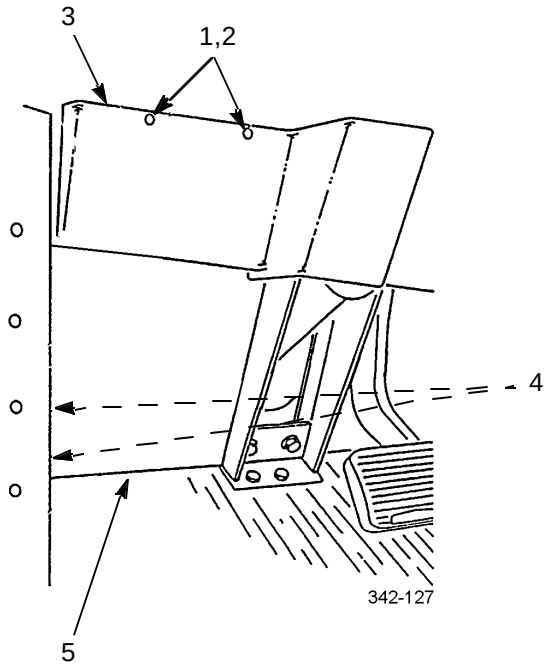


INSTALLATION

1. Install two bearings (18) on cap (13).
2. Install clevis (17) on brake pedal (14) with straight pin (16) and new cotter pin (15).
3. Install brake pedal (14) and cap (13) with four screws (12).
4. Install spring (11) and bracket (10) with two washers (9) and screws (8).
5. Connect defroster hose (7) and install new tiedown strap (6).

INSTALLATION - CONTINUED

6. Install cover (5) with two screws (4).
7. Install cover (3) with five washers (2) and screws (1).



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FRONT BRAKESHOE REPLACEMENT 0135 00

THIS WORK PACKAGE COVERS

Removal, Cleaning and Inspection, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

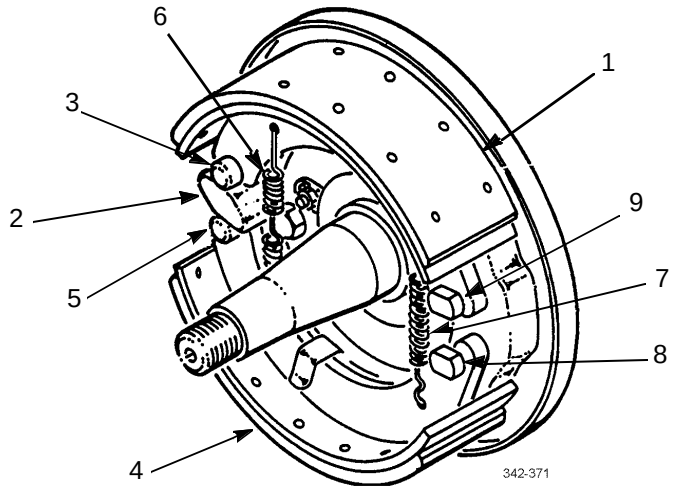
Compound, antiseize (Item 6, WP 0235 00)

Equipment Condition

Front hub and drum removed (WP 0165 00)

REMOVAL

1. Lift upper brakeshoe (1) away from s-cam (2) and remove upper cam roller (3).
2. Push lower brakeshoe (4) away from s-cam (2) and remove lower cam roller (5).
3. Remove release spring (6) from upper and lower brakeshoes (1 and 4).
4. Grasp upper and lower brakeshoes (1 and 4) and pull to open position. Remove two brakeshoes and retaining spring (7) from two spider anchor pins (8 and 9).
5. Remove retaining spring (7) from upper and lower brakeshoes (1 and 4).

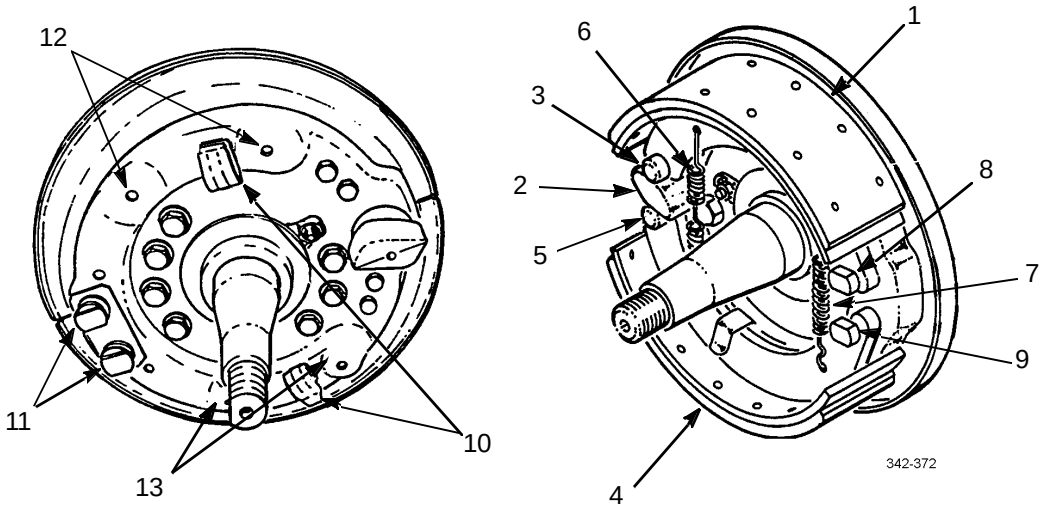


CLEANING AND INSPECTION

1. Clean front brakeshoes and components in accordance with WP 0228 00.
2. Measure brake lining thickness. Thickness must be NO LESS than 1/4 in (6.4 mm). If brake lining is less than 1/4 in (6.4 mm), replace brakeshoes.
3. Measure clearance between top of brake lining and top of all rivet heads. Clearance must be a minimum of 1/32 in (0.8 mm). If clearance is less than 1/32 in (0.8 mm), replace brakeshoes.
4. Inspect remaining brakeshoe parts in accordance with WP 0228 00.

INSTALLATION

1. Apply a thin film of antiseize compound to contact points (10, 11, 12, and 13), two spider anchor pins (8 and 9), and small diameter of upper and lower cam rollers (3 and 5).
2. Install retaining spring (7) on each brakeshoe (1 and 4).
3. Install upper and lower brakeshoes (1 and 4) on two spider anchor pins (8 and 9).
4. Install release spring (6) on upper and lower brakeshoes (1 and 4).
5. Install upper cam roller (3) between upper brakeshoe (1) and s-cam (2).
6. Install lower cam roller (5) between lower brakeshoe (4) and s-cam (2).



7. Install front hub and drum (WP 0165 00).

END OF WORK PACKAGE

FRONT BRAKE SPIDER AND BRAKE CHAMBER BRACKET REPLACEMENT 0136 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 50, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-49) (7)

Seal (P/N A-1205-D-2110) (2)

Washer, lock (P/N 1229-R-512) (4)

Grease, GAA (Item 15, WP 0235 00)

Materials/Part - Continued

Oil, lubricating (Item 19, WP 0235 00)

References

WP 0021 00

Equipment Condition

Front brakeshoes removed (WP 0135 00)

Front air brake chamber removed (WP 0141 00)

Front ABS sensor removed (WP 0106 00)

Front slack adjuster and s-cam removed (WP 0140 00)

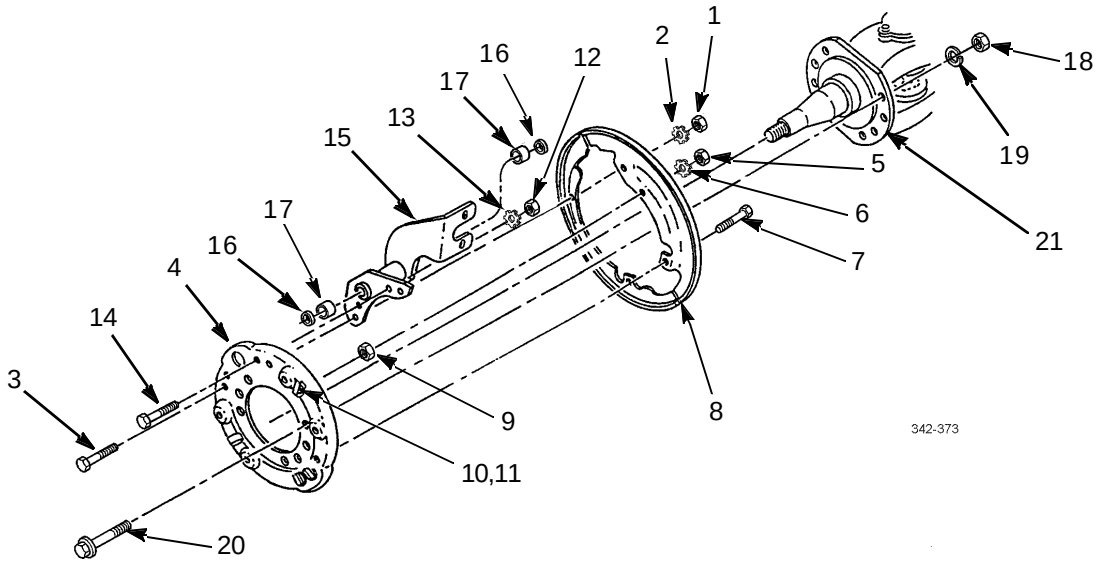
REMOVAL

1. Remove two nuts (1), lock washers (2), and screws (3) from brake spider (4). Discard lock washers.
2. Remove two nuts (5) and lock washers (6) from brake spider (4). Discard lock washers.
3. Remove two screws (7) and 2-piece dust shield (8) from brake spider (4).
4. Remove two nuts (9), screws (10), and clamps (11) from brake spider (4).

NOTE

Note position of brake chamber bracket to aid in installation.

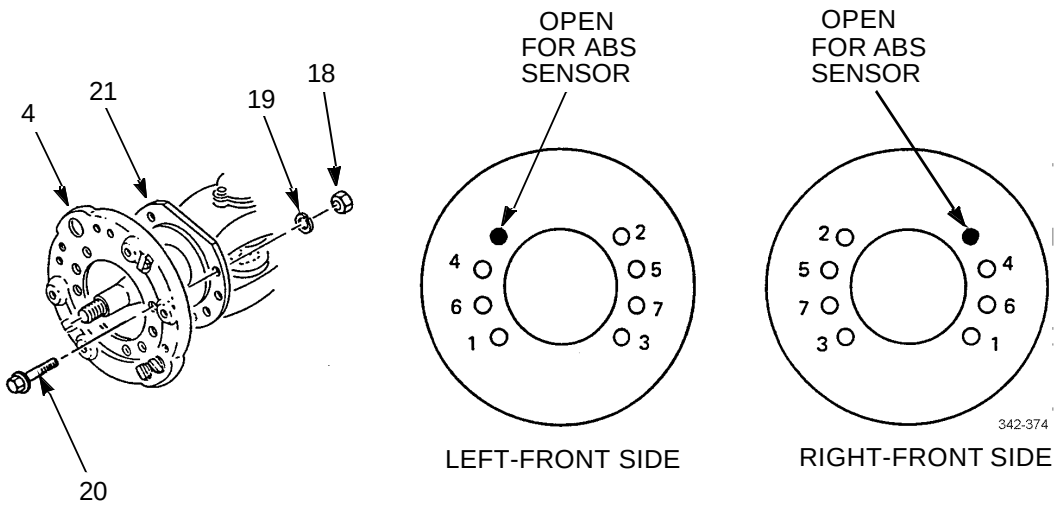
5. Remove two nuts (12), lock washers (13), screws (14), and brake chamber bracket (15) from brake spider (4). Discard lock washers.
6. Remove two seals (16) and bushings (17) from brake chamber bracket (15). Discard seals.
7. Remove seven lock nuts (18), washers (19), screws (20), and brake spider (4) from axle flange (21). Discard lock nuts.



FRONT BRAKE SPIDER AND BRAKE CHAMBER BRACKET REPLACEMENT - CONTINUED 0136 00

INSTALLATION

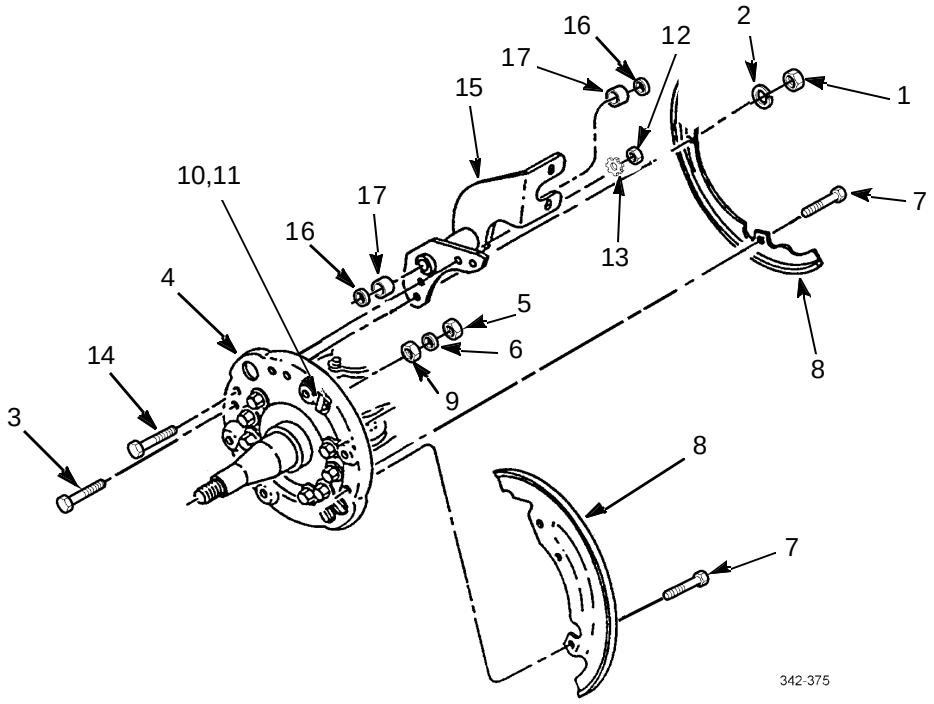
1. Install brake spider (4) on axle flange (21) with seven screws (20), washers (19), and new lock nuts (18). Tighten lock nuts to 75 lb-ft (102 Nm) in sequence shown. Tighten lock nuts again to 150-175 lb-ft (203-237 Nm) in sequence shown.



2. Apply a light coat of lubricating oil to two bushings (17) and two new seals (16).
3. Install two bushings (17), with label ends facing each other, on brake chamber bracket (15) to a depth of 3/8 in (9.5 mm) from each end of brake chamber bracket.
4. Install two new seals (16) in brake chamber bracket (15) with lip of both seals facing toward vehicle.
5. Install brake chamber bracket (15) on brake spider (4) with two screws (14), new lock washers (13), and nuts (12).
6. Apply a light coat of GAA grease to two bushings (17) in brake chamber bracket (15).
7. Install 2-piece dust shield (8) on brake spider (4) with two screws (7).
8. Install two clamps (11), screws (10), and nuts (9) on brake spider (4).
9. Install two new lock washers (5) and nuts (4) on brake spider (4).
10. Install two screws (3), new lock washers (2), and nuts (1) on brake spider (4).

FRONT BRAKE SPIDER AND BRAKE CHAMBER BRACKET REPLACEMENT - CONTINUED **0136 00**

INSTALLATION - CONTINUED



11. Install front slack adjuster and s-cam (WP 0140 00).
12. Install front air brake chamber (WP 0141 00).
13. Install front ABS sensor (WP 0106 00).
14. Install front brakeshoes (WP 0135 00).
15. Apply GAA grease to brake chamber bracket (15) (WP 0021 00).

END OF WORK PACKAGE

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REAR BRAKESHOE REPLACEMENT 0137 00

THIS WORK PACKAGE COVERS

Removal, Cleaning and Inspection, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

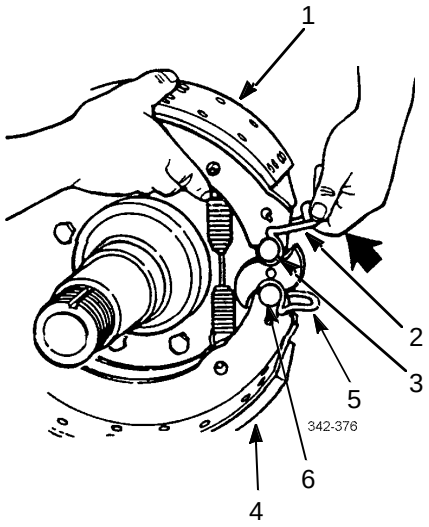
Compound, antiseize (Item 6, WP 0235 00)

Equipment Condition

Rear hub, drum, wheel bearings, and seal removed (WP 0166 00)

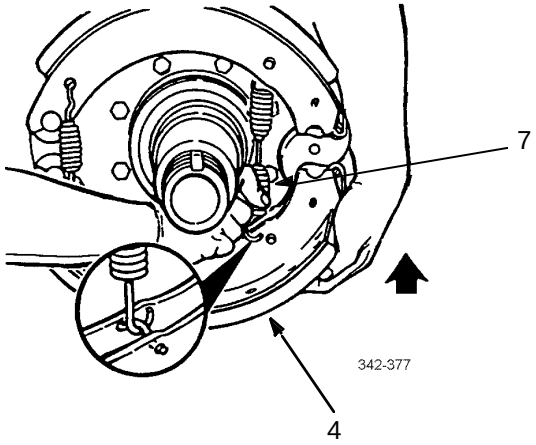
REMOVAL

1. Lift upper brakeshoe (1) and pull roller retaining clip (2).
2. Remove cam roller (3) and roller retaining clip (2).
3. Push on lower brakeshoe (4) and pull roller retaining clip (5).
4. Remove cam roller (6) and roller retaining clip (5).

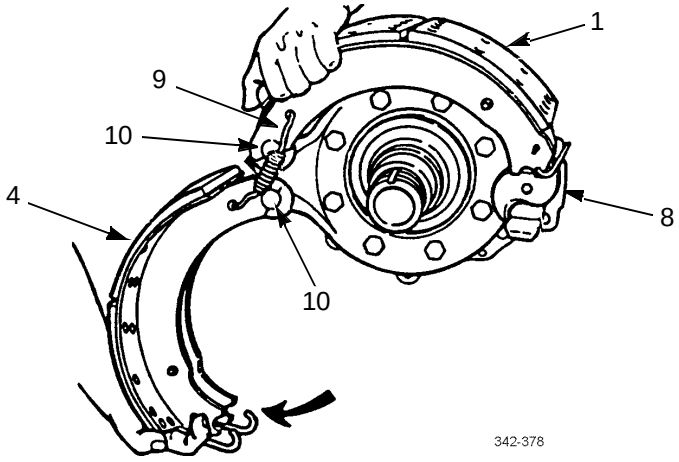


REMOVAL - CONTINUED

5. Lift lower brakeshoe (4) and remove return spring (7).



6. Rotate lower brakeshoe (4) away from s-cam (8).
7. Remove two retaining springs (9), upper and lower brakeshoes (1 and 4), and two anchor pins (10).



CLEANING AND INSPECTION

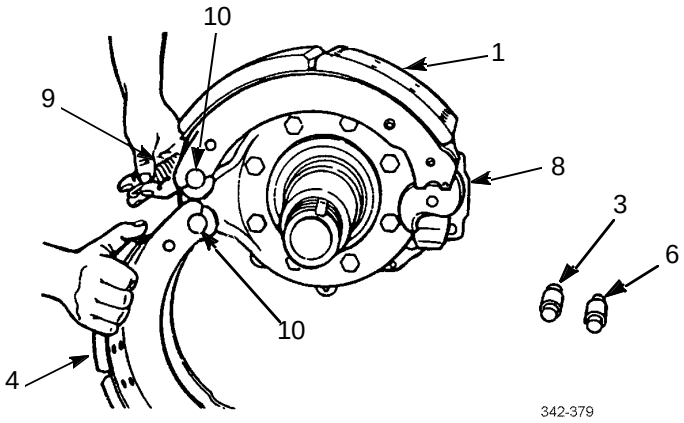
1. Clean rear brakeshoes and components in accordance with WP 0228 00.
2. Measure brake lining thickness. Thickness must be NO LESS than 1/4 in (6.4 mm). If brake lining is less than 1/4 in (6.4 mm), replace brakeshoes.
3. Measure clearance between top of brake lining and top of all rivet heads. Clearance must be a minimum of 1/32 in (0.8 mm). If clearance is less than 1/32 in (0.8 mm), replace brakeshoes.
4. Inspect all remaining brakeshoe parts in accordance with WP 0228 00.

INSTALLATION

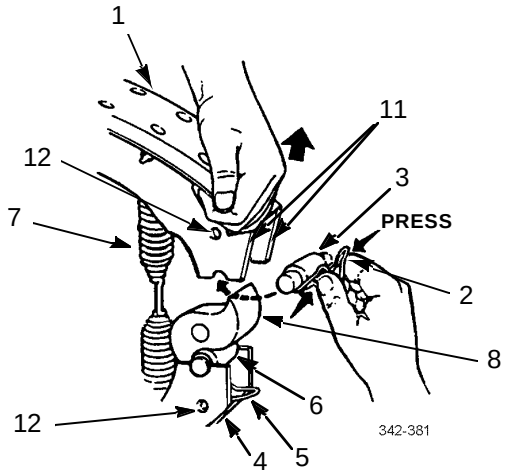
1. Apply a thin film of antiseize compound to each anchor pin (10) and small diameter of two cam rollers (3 and 6).
2. Install two anchor pins (10).

INSTALLATION - CONTINUED

3. Install upper brakeshoe (1) on upper anchor pin (10).
4. Install two retaining springs (9).
5. Install lower brakeshoe (4) on lower anchor pin (10).
6. Rotate lower brakeshoe (4) toward s-cam (8).



7. Install return spring (7) between upper and lower brakeshoes (1 and 4).
8. Pull upper and lower brakeshoes (1 and 4) away from s-cam (8).
9. Install two cam rollers (3 and 6) and two roller retaining clips (2 and 5).



NOTE

Press ears of roller retaining clips together so that retainer fits between brakeshoe webs.

10. Press each roller retaining clip (2 and 5) between brakeshoe webs (11) until ears of roller retaining clips lock in holes (12) of brakeshoe webs.
11. Install rear hub, drum, wheel bearings, and seal (WP 0166 00).

END OF WORK PACKAGE

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REAR BRAKE SPIDER AND BRAKE CHAMBER BRACKET REPLACEMENT 0138 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-49) (8)

Seal (P/N A-1205-V-1556) (2)

Grease, GAA (Item 15, WP 0235 00)

Equipment Condition

Rear brakeshoes removed (WP 0137 00)

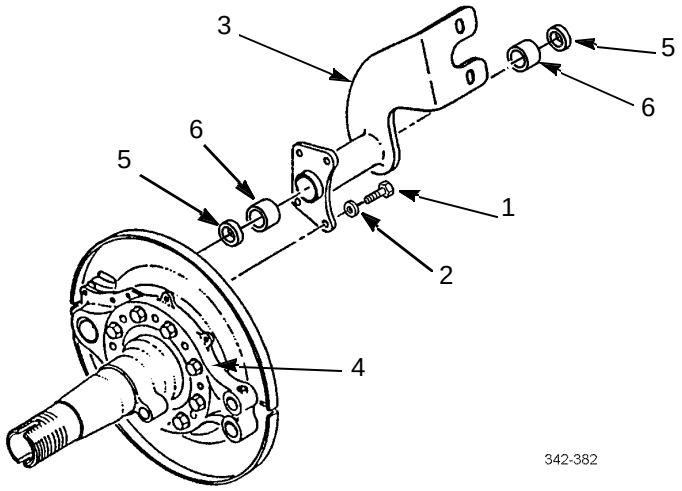
Rear air brake chamber removed (WP 0142 00)

Rear ABS sensor removed (WP 0107 00)

Rear slack adjuster and s-cam removed (WP 0140 00)

REMOVAL

1. Remove four screws (1), washers (2), and brake chamber bracket (3) from spider (4).
2. Remove two seals (5) and bushings (6) from brake chamber bracket (3). Discard seals.



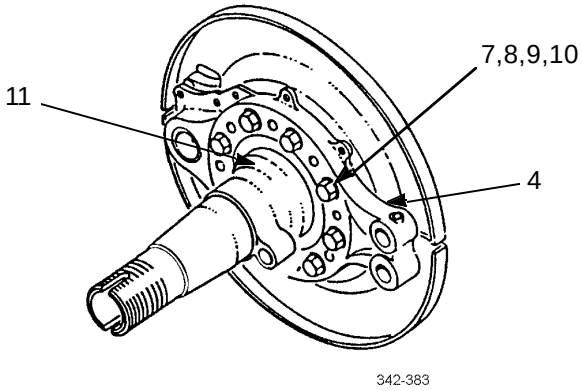
REAR BRAKE SPIDER AND BRAKE CHAMBER BRACKET REPLACEMENT - CONTINUED 0138 00

REMOVAL - CONTINUED

NOTE

Matchmark spider position prior to removal from axle flange to aid in installation.

3. Remove eight lock nuts (7), washers (8), flange bolts (9), washers (10), and spider (4) from axle flange (11). Discard lock nuts.

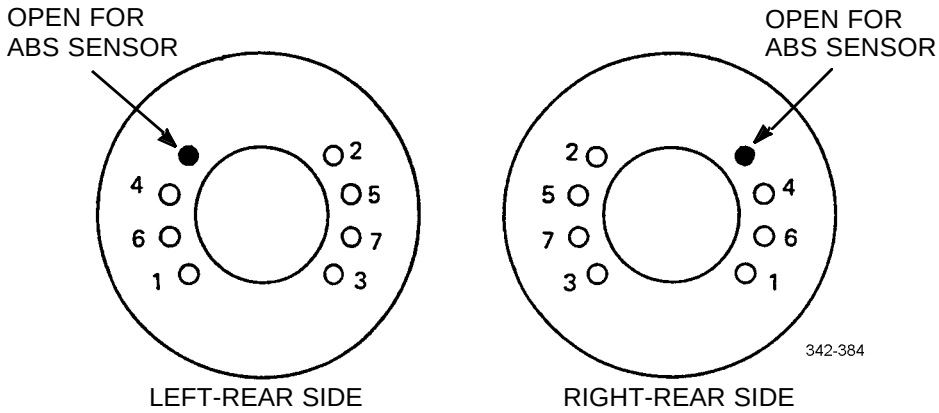


INSTALLATION

NOTE

Position spider as matchmarked during removal.

1. Install spider (4) on axle flange (11) with eight washers (10), flange bolts (9), washers (8), and new lock nuts (7). Tighten lock nuts to 150-175 lb-ft (203-237 Nm) in sequence shown.



2. Apply a light coat of GAA grease to two bushings (6) and new seals (5).

NOTE

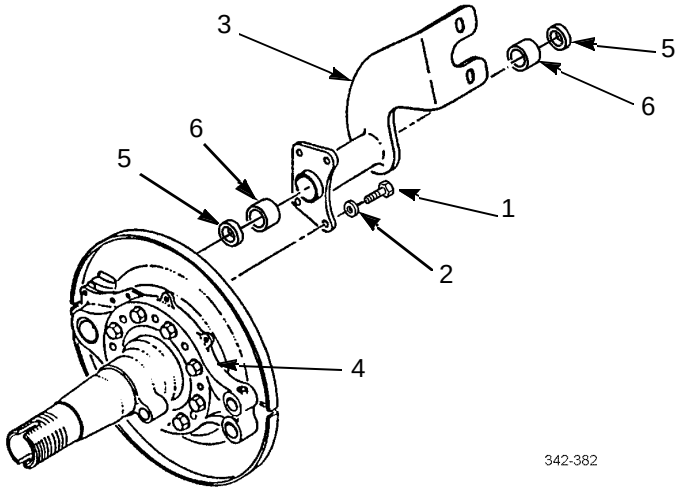
Install bushings with label ends facing each other. Install bushings to a depth of 3/8 in (9.5 mm) from each end. Install each seal with lip facing slack adjuster.

3. Install two bushings (6) and seals (5) on spider (4).

REAR BRAKE SPIDER AND BRAKE CHAMBER BRACKET REPLACEMENT - CONTINUED 0138 00

INSTALLATION - CONTINUED

4. Install brake chamber (3) on spider (4) with four washers (2) and screws (1).



5. Install rear slack adjuster and s-cam (WP 0140 00).
6. Install rear air brake chamber (WP 0142 00).
7. Install rear ABS sensor (WP 0107 00).
8. Install rear brakeshoes (WP 0137 00).
9. Apply GAA grease to brake chamber bracket (3).

END OF WORK PACKAGE

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SLACK ADJUSTER ADJUSTMENT 0139 00

THIS WORK PACKAGE COVERS

Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Jack, hydraulic, hand (Item 21, WP 0236 00)

Slack adjuster tool (WP 0230 00)

Trestle, hoist, portable (Item 38, WP 0236 00)

Wrench, torque, 00-300 lb-in (Item 44, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

References

TM 9-2320-302-10

Equipment Condition

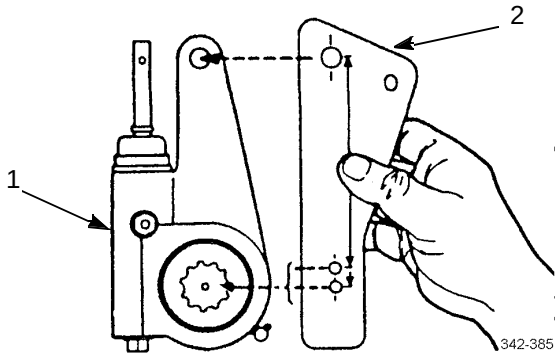
Wheel jacked up and axle supported by trestle

ADJUSTMENT

NOTE

Whenever a new slack adjuster or air brake chamber has been installed, perform steps 1 through 7 using a manufactured slack adjuster template (WP 0230 00).

1. Compare length of slack adjuster (1) with template (2). Marks by holes in small end of template indicate length of slack adjuster.

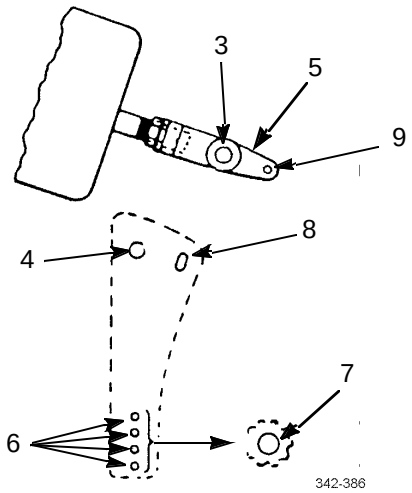


ADJUSTMENT - CONTINUED

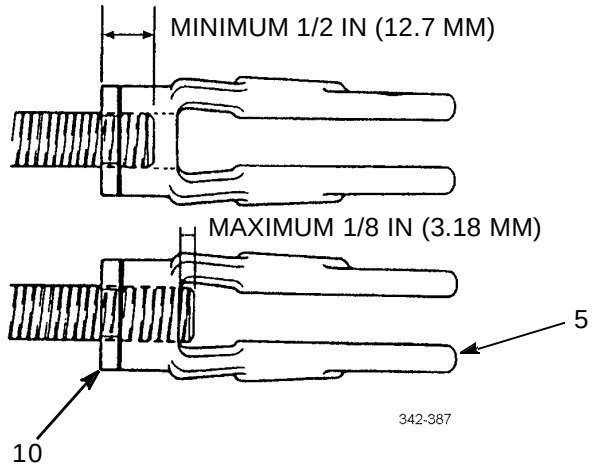
CAUTION

To ensure that slack adjuster adjusts brake properly, clevis must be installed in correct position on push rod.

2. Insert large clevis pin (3) through large hole (4) of template and large holes of clevis (5).
3. Select hole (6) of template that matches length of slack adjuster. Hold that hole on center of camshaft or powershaft (7).



4. Look through slot (8) in template. Small hole (9) in clevis (5) MUST be completely visible.
5. If necessary, adjust position of clevis (5) on push rod until small hole (9) in clevis is completely visible through slot (8) in template.
6. Tighten jamnut (10) against clevis (5) to hold clevis in correct position. For 1/2-20 threads, tighten jamnut to 20-30 lb-ft (27-41 Nm). For 5/8-18 threads, tighten jamnut to 25-50 lb-ft (34-68 Nm).



ADJUSTMENT - CONTINUED

7. There must be at least 1/2 in (12.7 mm) of thread engagement between clevis and push rod. Push rod must not extend through clevis more than 1/8 in (3.18 mm).

8. If adjustment cannot be obtained, install new air brake chamber.

9. Remove screw (11), spring (12), and pawl (13).

10. Rotate wheel and tighten screw (14) until wheel does not rotate.

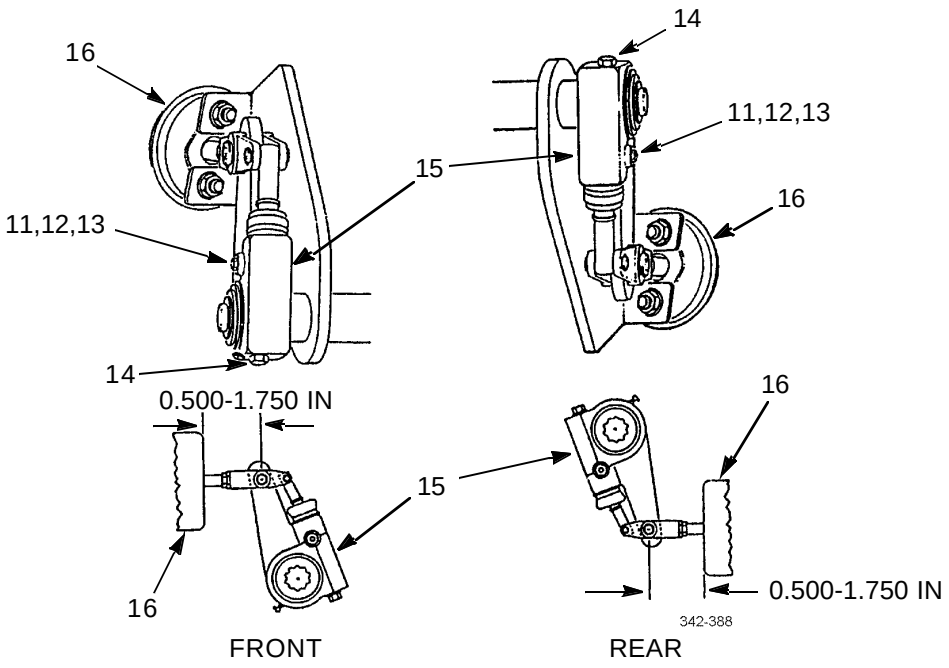
NOTE

A slight amount of drag will be felt during wheel rotation.

11. Loosen screw (14) 1/4 turn and rotate wheel.

12. Install pawl (13), spring (12), and screw (11). Tighten screw to 180-240 lb-in (20-27 Nm).

13. Using flat tip screwdriver, pull slack adjuster (15) in direction away from brake chamber (16) while measuring total distance of travel between slack adjuster and brake chamber.



14. If total distance of travel exceeds 1-3/4 in (44.45 mm), or if total distance is not minimum of 1/2 in (12.7 mm), repeat steps 9 through 13.

15. Remove trestle from axle.

END OF WORK PACKAGE

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SLACK ADJUSTER AND S-CAM REPLACEMENT 0140 00

THIS WORK PACKAGE COVERS

Front Slack Adjuster Removal, Rear Slack Adjuster Removal, Front Slack Adjuster Installation, Rear Slack Adjuster Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Indicator, dial (Item 18, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Pin, cotter (P/N 2257-B-1094)

Pin, cotter (P/N 2257-C-1095)

Compound, antiseize (Item 6, WP 0235 00)

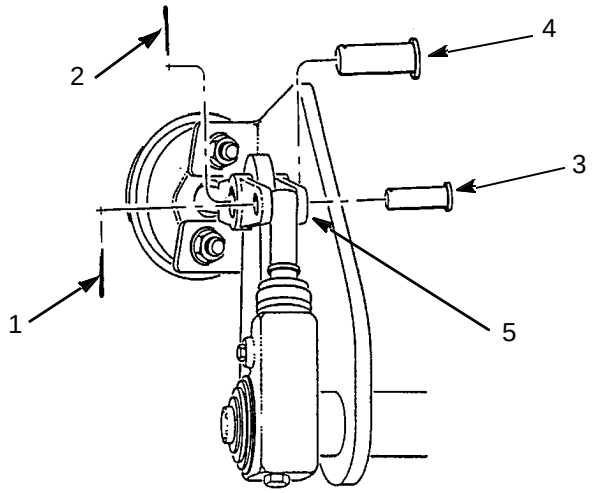
Equipment Condition

Front brakeshoe removed (WP 0135 00)

Rear brakeshoe removed (WP 0137 00)

FRONT SLACK ADJUSTER REMOVAL

1. Remove cotter pins (1 and 2) and clevis pins (3 and 4) from front brake chamber clevis (5). Discard cotter pins.



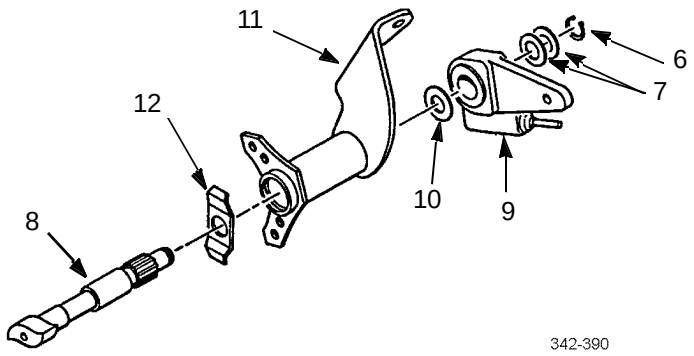
342-391

FRONT SLACK ADJUSTER REMOVAL - CONTINUED

NOTE

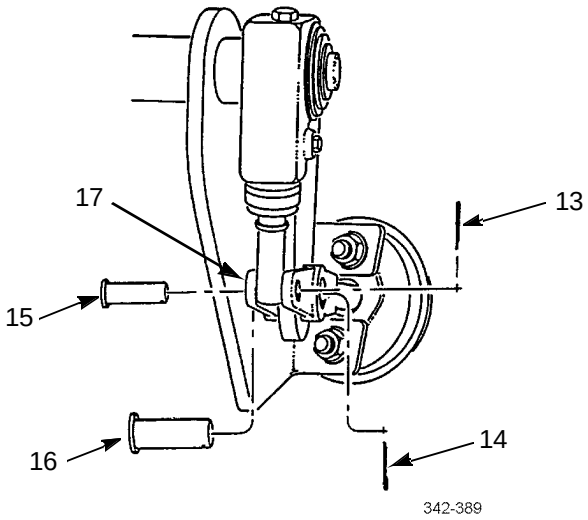
Note position of washers for installation.

2. Remove retaining ring (6) and washers (7) from s-cam (8).
3. Remove slack adjuster (9) and washer (10) from splined shaft of s-cam (8).
4. Mark position of s-cam (8) on mounting bracket (11) and remove s-cam and special washer (12) from mounting bracket.



REAR SLACK ADJUSTER REMOVAL

1. Remove cotter pins (13 and 14) and clevis pins (15 and 16) from rear brake chamber clevis (17). Discard cotter pins.

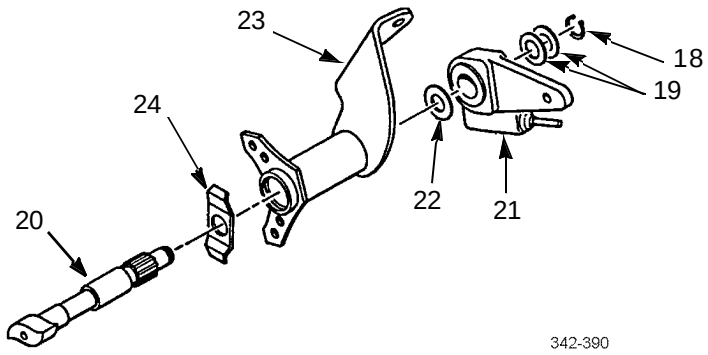


NOTE

Note position of washers for installation.

2. Remove retaining ring (18) and washers (19) from s-cam (20).
3. Remove slack adjuster (21) and washer (22) from splined shaft of s-cam (20).
4. Mark position of s-cam (20) on mounting bracket (23) and remove s-cam and special washer (24) from mounting bracket.

REAR SLACK ADJUSTER REMOVAL - CONTINUED



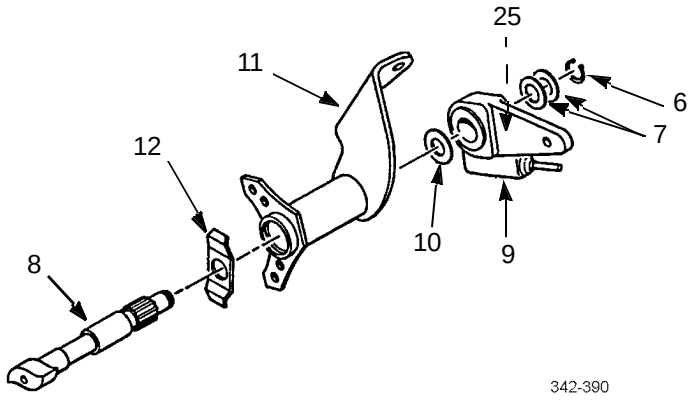
FRONT SLACK ADJUSTER INSTALLATION

1. Lightly coat splines of s-cam (8) with antiseize compound.
2. Install s-cam (8) and special washer (12) on mounting bracket (11).
3. Install washer (10) and slack adjuster (9) on s-cam (8) with head of screw (25) toward vehicle.

NOTE

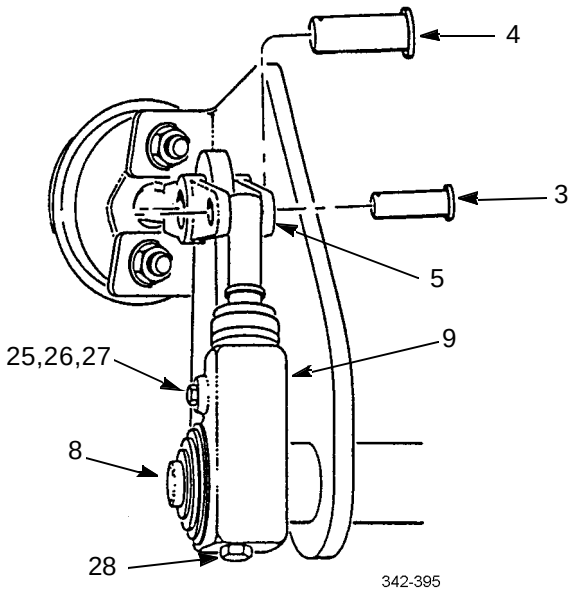
If repeating installation because measurement in step 12 exceeded 0.06 in (1.5 mm), add another washer as a spacer.

4. Install washers (7) and retaining ring (6) on s-cam (8).

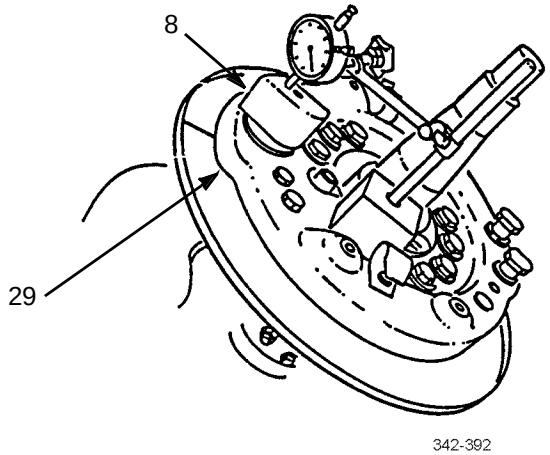


FRONT SLACK ADJUSTER INSTALLATION - CONTINUED

5. Remove screw (25), spring (26), and pawl (27) from slack adjuster (9).
6. Rotate adjusting screw (28) to align slack adjuster (9) with front brake chamber clevis (5).
7. Hold s-cam (8) in position and rotate adjusting screw (28) to align slack adjuster (9) with clevis (5).
8. Install clevis pins (4 and 3).
9. Install pawl (27), spring (26), and screw (25) on slack adjuster (9). Tighten screw to 15-20 lb-ft (20-27 Nm).
10. Ensure that s-cam (8) is against brake spider (29).

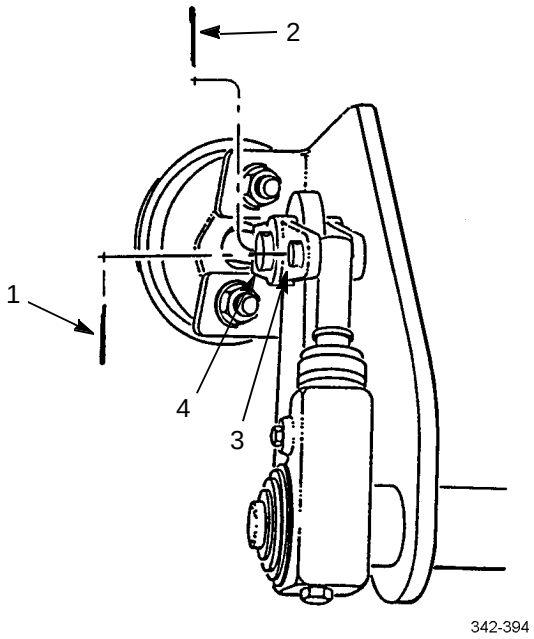


11. Attach magnetic base of dial indicator to brake spider (29) with indicator point on end surface of s-cam (8). Set dial indicator to zero.
12. Push s-cam (8) outward to end of travel and check new reading on dial indicator. If reading is more than 0.06 in (1.5 mm), perform Removal steps 2 through 4 and Installation steps 1 through 12.



FRONT SLACK ADJUSTER INSTALLATION - CONTINUED

13. Install new cotter pins (2 and 1) on clevis pins (4 and 3).



14. Install front brakeshoe (WP 0135 00).

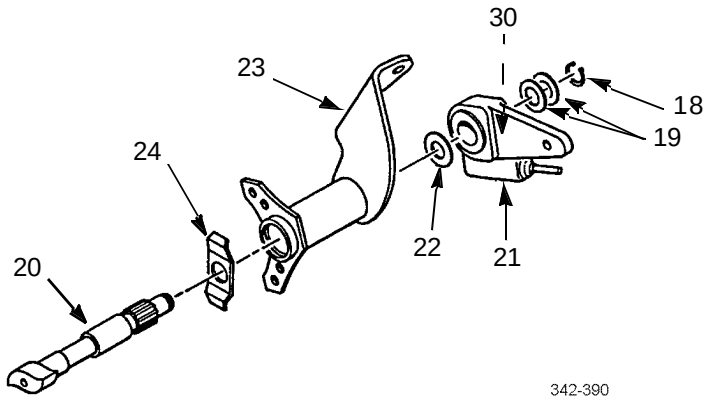
REAR SLACK ADJUSTER INSTALLATION

1. Lightly coat splines of s-cam (20) with antiseize compound.
2. Install s-cam (20) and special washer (24) on mounting bracket (23).
3. Install washer (22) and slack adjuster (21) on s-cam (20) with head of screw (3) toward vehicle.

NOTE

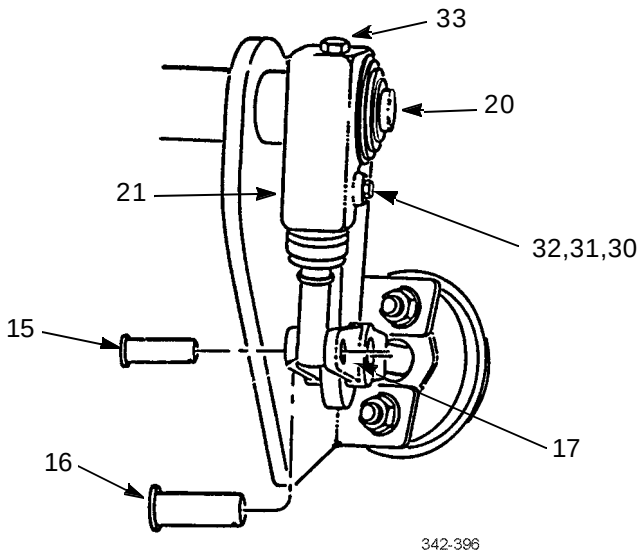
If repeating installation because measurement in step 11 exceeded 0.06 in (1.5 mm), add another washer as a spacer.

4. Install washers (19) and retaining ring (18) on s-cam (20).

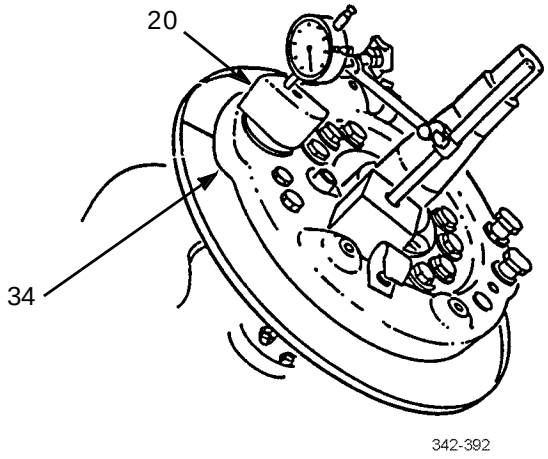


REAR SLACK ADJUSTER INSTALLATION - CONTINUED

5. Remove screw (30), spring (31), and pawl (32) from slack adjuster (21).
6. Hold s-cam (20) in position and rotate adjusting screw (33) to align slack adjuster (21) with rear brake chamber clevis (17).
7. Install two clevis pins (16 and 15) on rear brake chamber clevis (17).
8. Install pawl (32), spring (31), and screw (30) on slack adjuster (21). Tighten screw to 15-30 lb-ft (20-27 Nm).

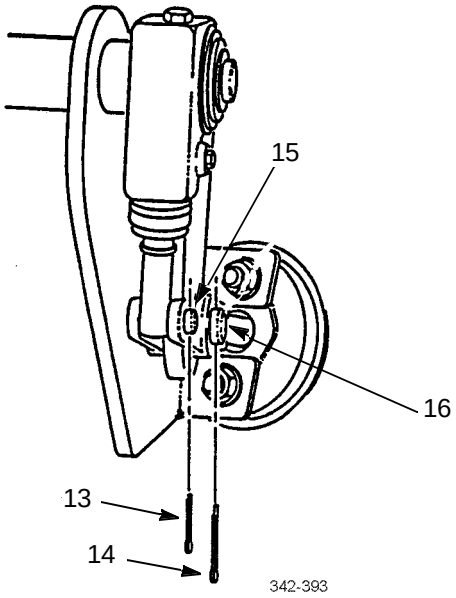


9. Ensure that s-cam (20) is against brake spider (34).
10. Attach magnetic base of dial indicator to brake spider (34) with indicator point on end surface of s-cam (20). Set dial indicator to zero.
11. Push s-cam (20) outward to end of travel and check new reading on dial indicator. If reading is more than 0.06 in (1.5 mm), perform Removal steps 2 through 4 and Installation steps 1 through 11.



12. Install new cotter pins (13 and 14) on clevis pins (15 and 16).

REAR SLACK ADJUSTER INSTALLATION - CONTINUED



13. Install rear brakeshoe (WP 0137 00).

END OF WORK PACKAGE

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FRONT AIR BRAKE CHAMBER REPLACEMENT 0141 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Air system drained (TM 9-2320-302-10)

Materials/Parts

Pin, cotter (P/N 2257-B-1094)

Pin, cotter (P/N 2257-C-1095)

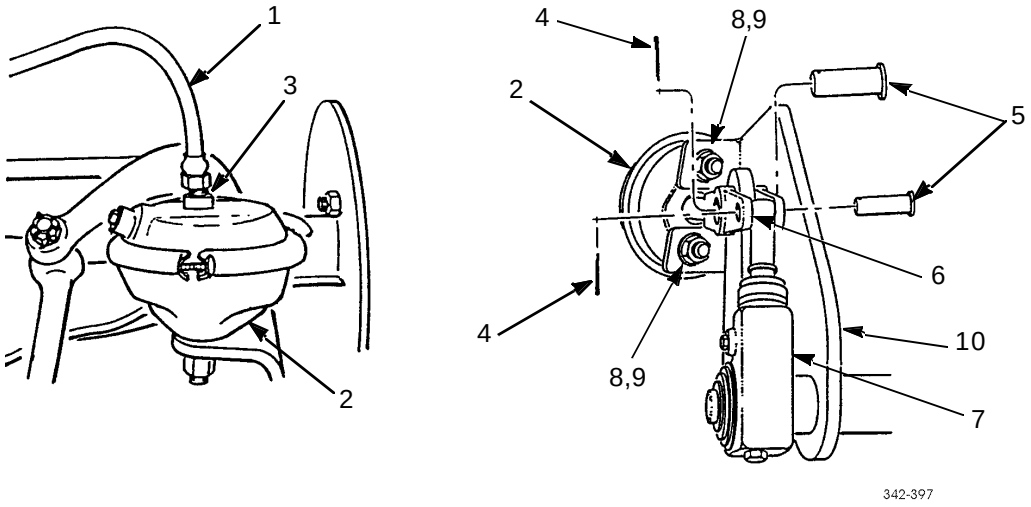
Compound, sealing, pipe (Item 10, WP 0235 00)

REMOVAL

WARNING

DO NOT disconnect any air system lines or fittings unless vehicle engine is shut off and air system pressure is relieved. Failure to follow this warning could result in serious injury to personnel.

1. Disconnect air hose (1) from brake chamber (2).
2. Remove fitting (3) from brake chamber (2).
3. Remove two cotter pins (4) and two clevis pins (5) connecting brake chamber clevis (6) to slack adjuster (7). Discard cotter pins.
4. Remove two nuts (8), washers (9), and brake chamber (2) from mounting bracket (10).



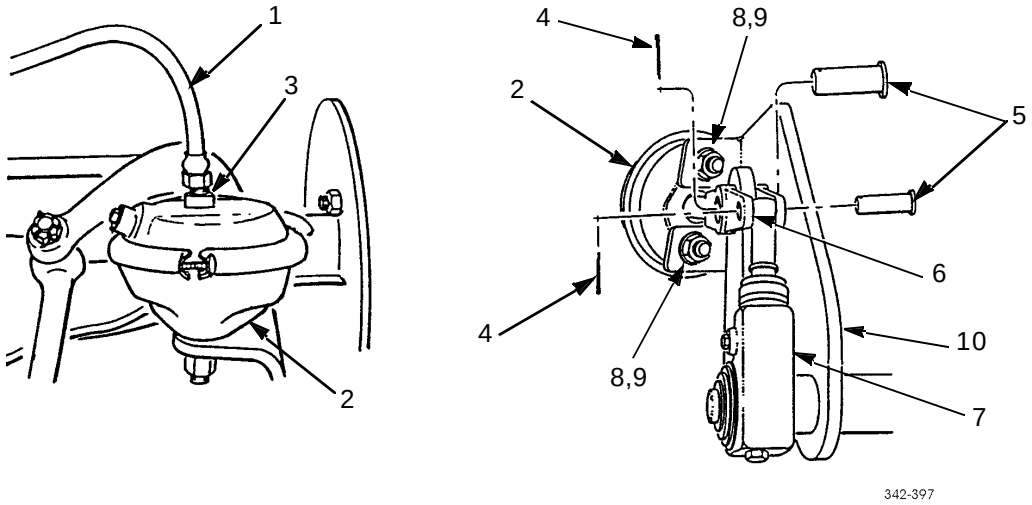
INSTALLATION

1. Install brake chamber (2) on mounting bracket (10) with two washers (9) and nuts (8).
2. Align brake chamber clevis (6) on slack adjuster (7) and install two clevis pins (5) and new cotter pins (4).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure that all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

3. Lightly coat threads of fitting (3) with pipe sealing compound. Install fitting on brake chamber (2).
4. Connect air hose (1) to fitting (3).



5. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

REAR AIR BRAKE CHAMBER REPLACEMENT 0142 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Pin, cotter (P/N 2257-B-1094)

Pin, cotter (P/N 2257C-1095)

Nut, lock (P/N 9002001) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Brakes caged (TM 9-2320-302-10)

Parking brake released (TM 9-2320-302-10)

Vehicle blocked

Air system drained (TM 9-2320-302-10)

WARNING

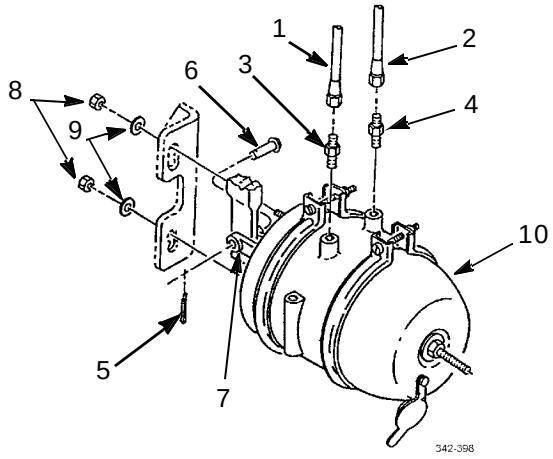
Air brake chamber contains a powerful spring. DO NOT remove clamp rings or disassemble chambers even with compression spring caged. Failure to follow this warning could result in serious injury to personnel.

REMOVAL

NOTE

Tag air hoses to aid in installation.

1. Disconnect service brake hose (1) and spring brake hose (2) from service brake fitting (3) and spring brake fitting (4).
2. Remove two cotter pins (5) and clevis pins (6) from brake chamber clevis (7). Discard cotter pins.
3. Remove two lock nuts (8) and washers (9). Discard lock nuts.
4. Remove brake chamber (10).
5. Remove service brake fitting (3) from brake chamber (10).
6. Remove spring brake fitting (4) from brake chamber (10).



INSTALLATION

WARNING

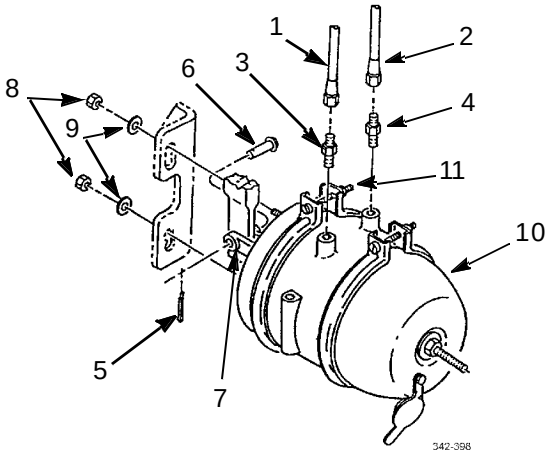
- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

1. Lightly coat threads of service brake fitting (3) with pipe sealing compound. Install fitting on brake chamber (10).
2. Lightly coat spring brake fitting (4) with pipe sealing compound. Install fitting on brake chamber (10).

NOTE

Brake chamber is mounted in upper part of figure 8 hole.

3. Install brake chamber (10) so that service brake fitting (3) and spring brake fitting (4) are accessible.
4. Install two washers (9) and new lock nuts (8).
5. If service brake fitting (3) and spring brake fitting (4) are not properly alined with hoses (1 and 2), loosen nut (11) and rotate brake chamber (10) until fittings and hoses are alined. Tighten nut.
6. Connect brake chamber clevis (7) to slack adjuster (12) with two clevis pins (6) and new cotter pins (5).
7. Connect service brake hose (1) and spring brake hose (2) to service brake fitting (3) and spring brake fitting (4).
8. Uncage brakes (TM 9-2320-302-10).



9. Start vehicle and build air pressure (Tm 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

PRIMARY I AIR TANK AND FITTINGS REPLACEMENT 0143 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-17) (6)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

Rear platform removed (WP 0200 00)

REMOVAL

NOTE

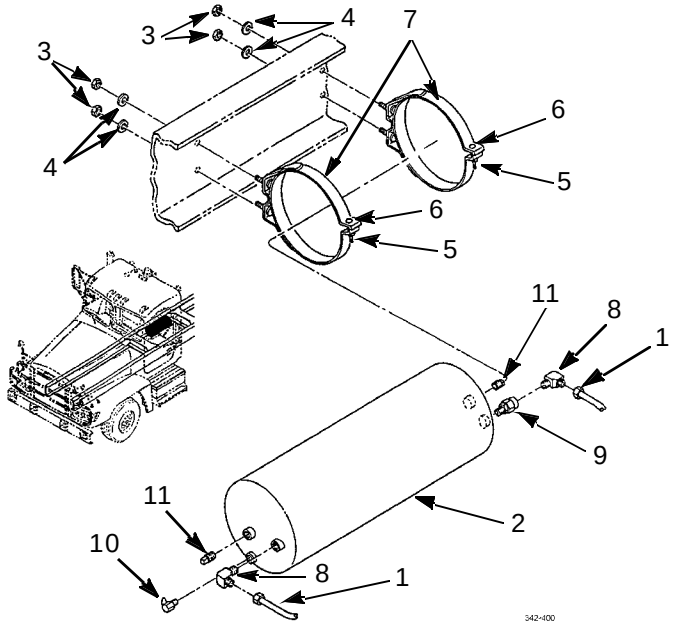
Tag tubes to aid in installation.

1. Disconnect two tubes (1) from air tank (2).
2. Remove four lock nuts (3), washers (4), and air tank (2). Discard lock nuts.

NOTE

Perform steps 3 and 4 only if fittings or air tank are to be replaced.

3. Remove two lock nuts (5), screws (6), and mounting brackets (7) from air tank (2). Discard lock nuts.
4. Remove two elbows (8), check valve (9), drain valve (10), and two plugs (11) from air tank (2).



INSTALLATION

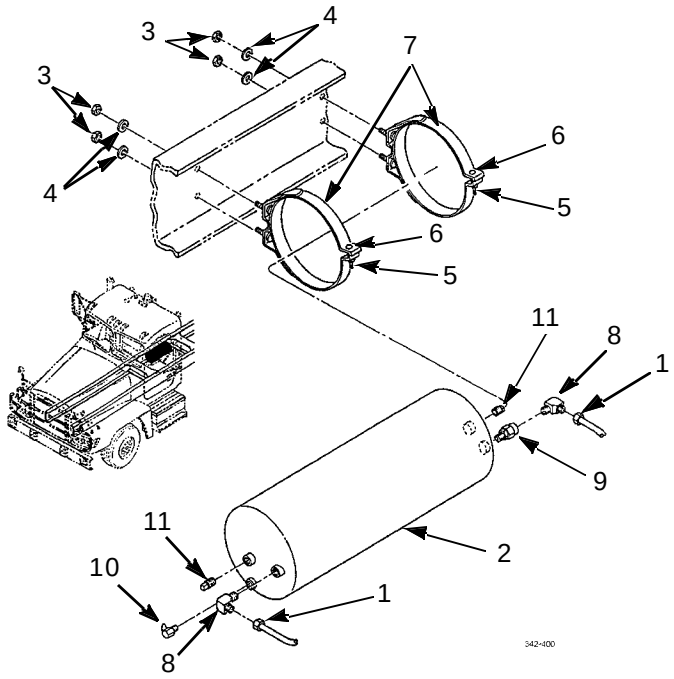
WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

NOTE

Perform steps 1 and 2 only if fittings or air tank were replaced.

1. Lightly coat pipe threads of two plugs (11), drain valve (10), check valve (9) and two elbows (8) with pipe sealing compound. Install plugs, drain valve, check valve, and elbows on air tank (2).
2. Install air tank (2) to two mounting brackets (7) with two screws (6) and new lock nuts (5).
3. Install air tank (2) with four washers (4) and new lock nuts (3).
4. Connect two tubes (1) to air tank (2).



5. Perform air system PMCS leak test (WP 0021 00).
6. Install rear platform (WP 0200 00).

END OF WORK PACKAGE

PRIMARY II AIR TANK AND FITTINGS REPLACEMENT 0144 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-17) (6)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

Spare tire removed (TM 9-2320-302-10)

REMOVAL

NOTE

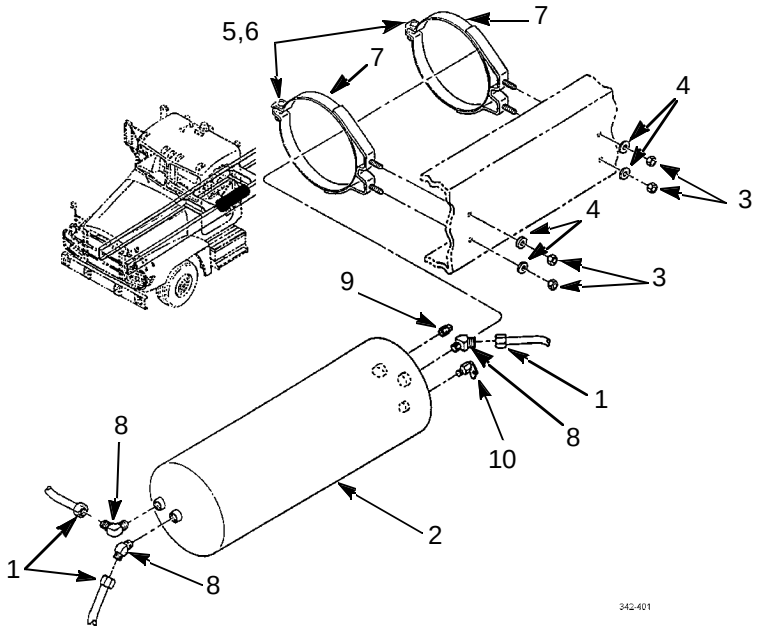
Tag tubes to aid in installation.

1. Disconnect three tubes (1) from air tank (2).
2. Remove four lock nuts (3), washers (4), and air tank (2). Discard lock nuts.

NOTE

Perform steps 3 and 4 only if fittings or air tank are to be replaced.

3. Remove two lock nuts (5), screws (6), and mounting brackets (7) from air tank (2). Discard lock nuts.
4. Remove three elbows (8), plug (9), and drain valve (10) from air tank (2).



INSTALLATION

NOTE

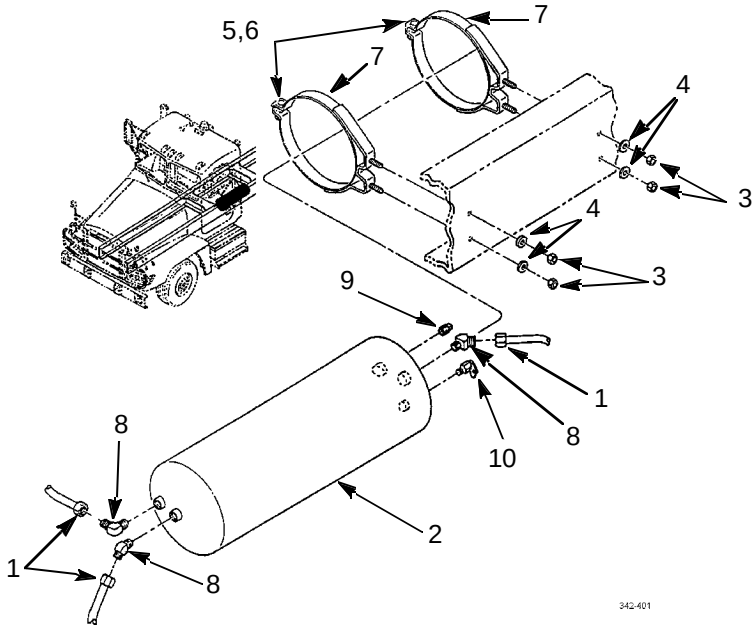
Perform steps 1 and 2 only if fittings or air tank were replaced.

1. Install two mounting brackets (7) on air tank (2) with two screws (6) and new lock nuts (5).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

2. Lightly coat threads of drain valve (10), plug (9), and three elbows (8) with pipe sealing compound. Install drain valve, plug, and three elbows on air tank (2).
3. Install air tank (2) with four washers (4) and new lock nuts (3).
4. Connect three tubes (1) to air tank (2).



5. Perform air system PMCS leak test (WP 0021 00).
6. Install spare tire (TM 9-2320-302-10).

END OF WORK PACKAGE

SECONDARY AIR TANK AND FITTINGS REPLACEMENT 0145 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (2)

Nut, lock (P/N MS51922-17) (8)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

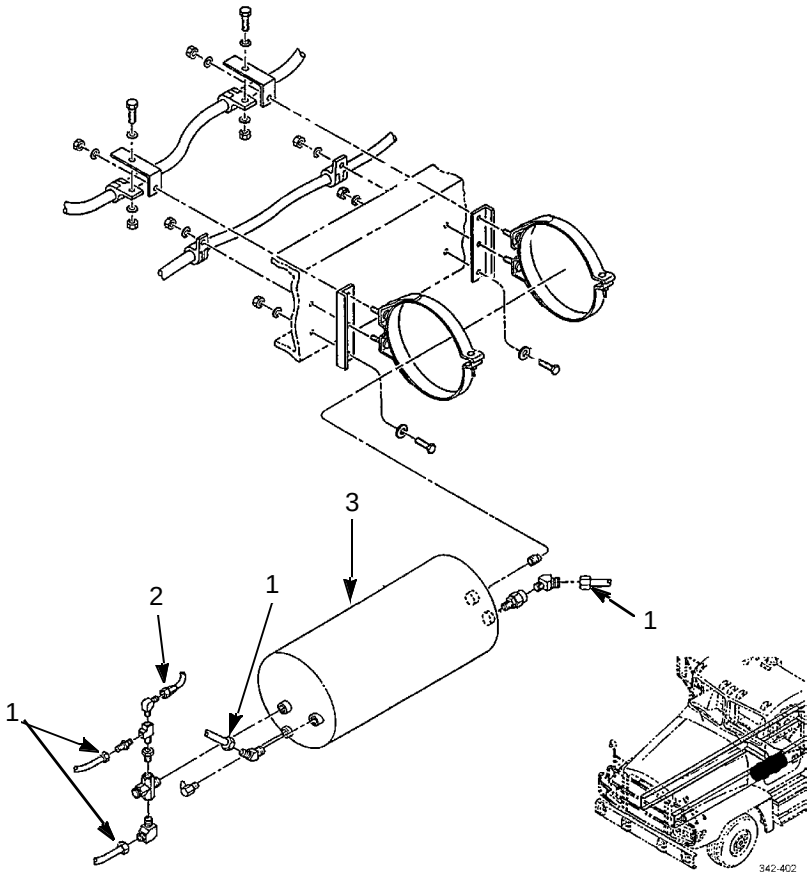
Air system drained (TM 9-2320-302-10)

REMOVAL

NOTE

Tag tubes to aid in installation.

1. Disconnect four tubes (1) and hose (2) from air tank (3).



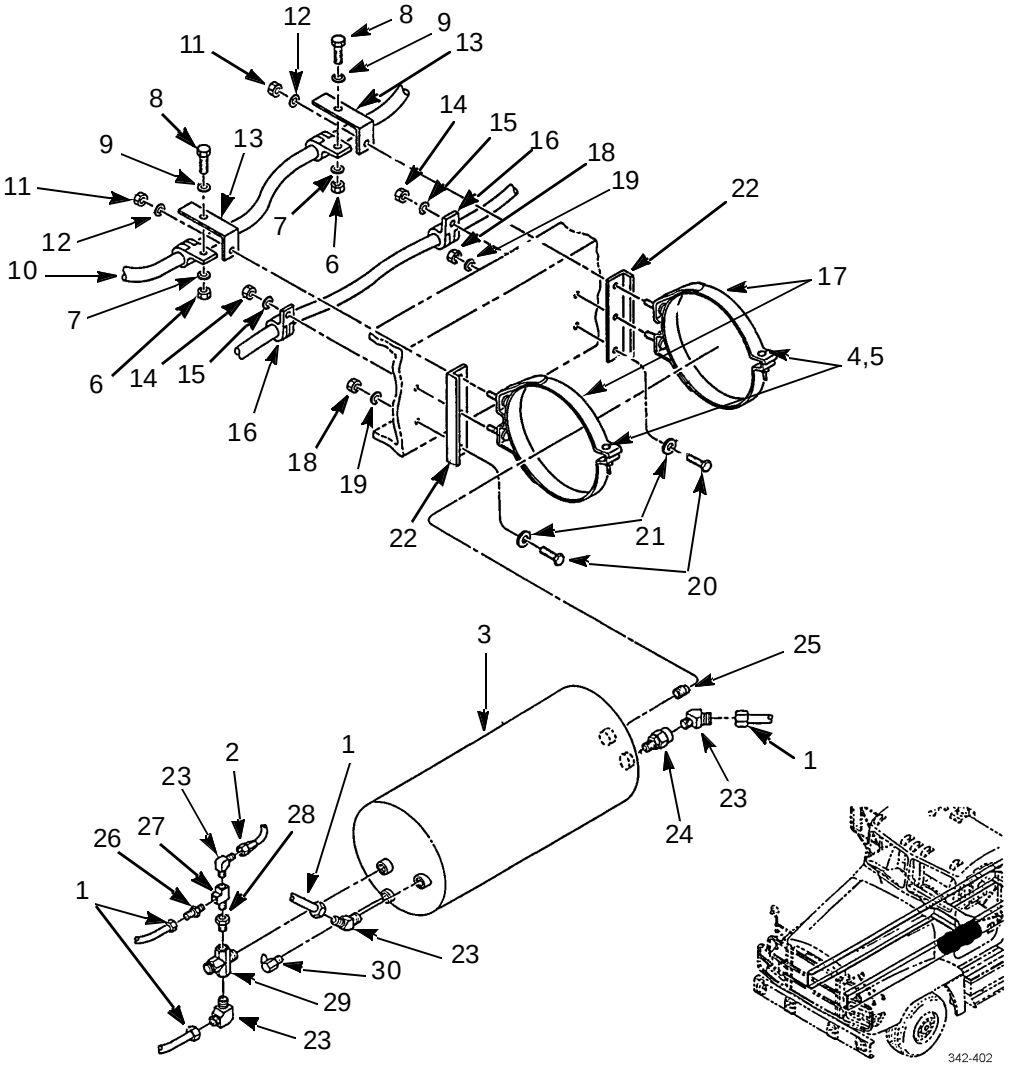
REMOVAL - CONTINUED

2. Remove two lock nuts (4), screws (5), and air tank (3). Discard lock nuts.
3. Remove two lock nuts (6), washers (7), screws (8), and washers (9) and set cable (10) aside. Discard lock nuts.
4. Remove two lock nuts (11), washers (12), and brackets (13). Discard lock nuts.
5. Remove two lock nuts (14), washers (15), clamps (16), and mounting brackets (17). Discard lock nuts.
6. Remove two lock nuts (18), washers (19), screws (20), washers (21), and brackets (22). Discard lock nuts.

NOTE

Perform step 7 only if fittings or air tank are to be replaced.

7. Remove four elbows (23), check valve (24), plug (25), connector (26), tee (27), bushing (28), pressure protect valve (29), and drain valve (30).



INSTALLATION

WARNINGS

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

NOTE

Perform steps 1 and 2 only if fittings were removed from air tank.

1. Coat pipe threads of drain valve (30), pressure protect valve (29), bushing (28), tee (27), connector (26), plug (25), check valve (24), and four elbows (23) with pipe sealing compound.
2. Install drain valve (30), pressure protect valve (29), bushing (28), tee (27), connector (26), plug (25), check valve (24) and four elbows (23) in air tank (3).
3. Install two brackets (22) with two washers (21), screws (20), washers (19), and new lock nuts (18).
4. Install two mounting brackets (17), clamps (16), washers (15), and new lock nuts (14).
5. Install two brackets (13), washers (12), and new lock nuts (11).
6. Install cable (10), two washers (9), screws (8), washers (7), and new lock nuts (6).
7. Install air tank (3) with two screws (5), and new lock nuts (4).
8. Connect hose (2) and four tubes (1) to air tank (3).
9. Perform air system PMCS leak test (WP 0021 00).

END OF WORK PACKAGE

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AIR SUPPLY TANK AND FITTINGS REPLACEMENT 0146 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Pin, cotter (P/N MS 24665-326)

Nut, lock (P/N MS51922-17) (8)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

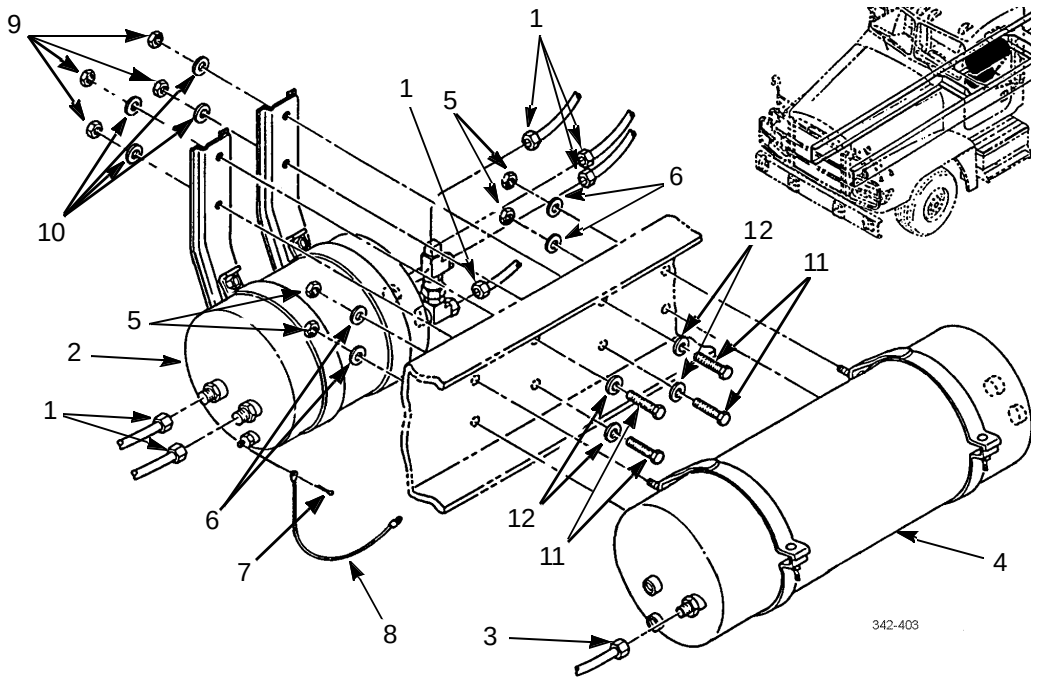
Rear platform removed (WP 0200 00)

REMOVAL

NOTE

Tag tubes to aid in installation.

1. Disconnect six tubes (1) from air supply tank (2).
2. Disconnect tube (3) from primary I air tank (4).
3. Remove four lock nuts (5) and washers (6) and set primary I air tank (4) aside. Discard lock nuts.
4. Remove cotter pin (7) and disconnect cable (8). Discard cotter pin.
5. Remove four lock nuts (9), washers (10), screws (11), washers (12), and air supply tank (2). Discard lock nuts.

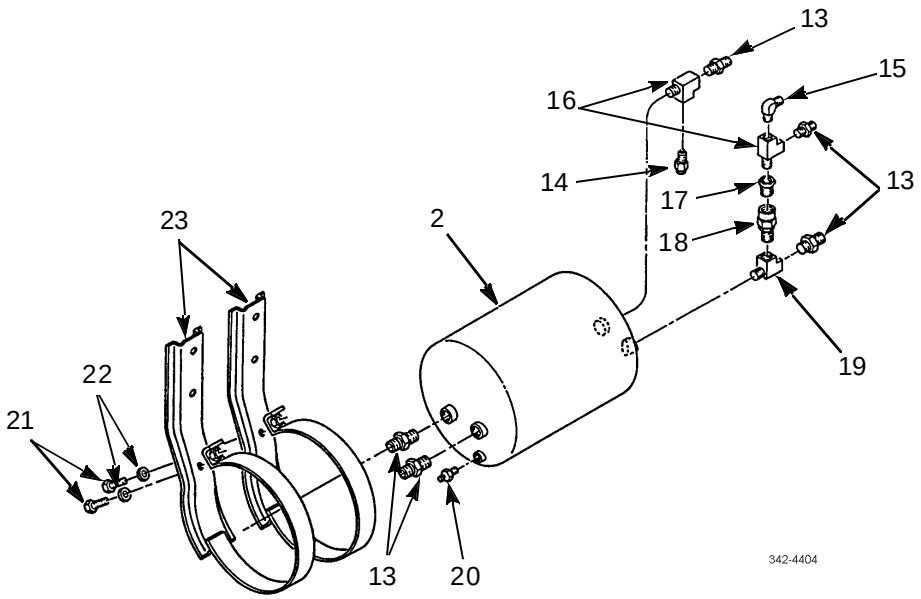


REMOVAL - CONTINUED

NOTE

Perform steps 6 and 7 only if fittings or air tank are to be replaced.

6. Remove five connectors (13), safety valve (14), elbow (15), two tees (16), bushing (17), check valve (18), tee (19), and drain valve (20) from air supply tank (2).
7. Remove two screws (21), washers (22), and mounting brackets (23) from air supply tank (2).



INSTALLATION

NOTE

Perform steps 1 through 3 only if fittings or air tank were replaced.

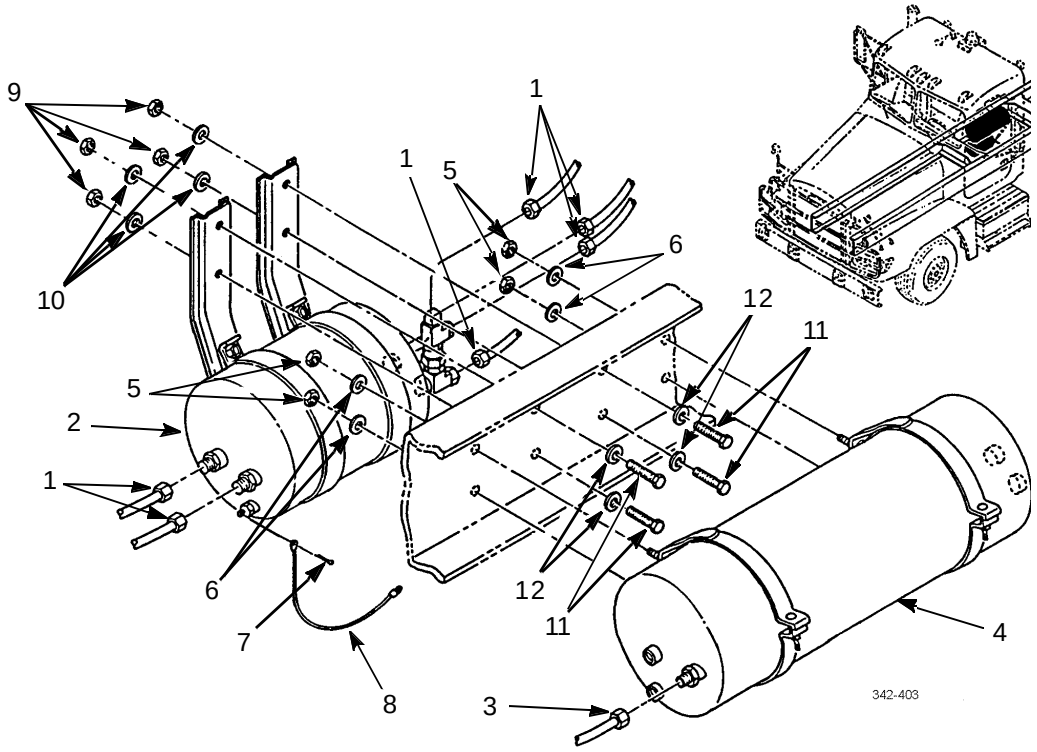
1. Install two mounting brackets (23), washers (22), and screws (21) on air supply tank (2).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

INSTALLATION - CONTINUED

2. Coat pipe threads of drain valve (20), tee (19), check valve (18), bushing (17), two tees (16), elbow (15), safety valve (14), and five connectors (13) with pipe sealing compound.
3. Install drain valve (20), tee (19), check valve (18), bushing (17), two tees (16), elbow (15), safety valve (14), and five connectors (13) in air supply tank (2).
4. Install air supply tank (2), four washers (12), screws (11), washers (10) and new lock nuts (9).
5. Connect cable (8) and install new cotter pin (7).
6. Install primary I air tank (4), four washers (6) and new lock nuts (5).
7. Connect tube (3) to primary I air tank (4).
8. Connect six tubes (1) to air supply tank (2).



9. Perform air system PMCS leak test (WP 0021 00).
10. Install rear platform (WP 0200 00).

END OF WORK PACKAGE

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AIR TUBE REPLACEMENT 0147 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Materials/Parts - Continued

Straps, tiedown (Item 30, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

Equipment Condition

Air system drained (TM 9-2320-302-10)

REMOVAL

NOTES

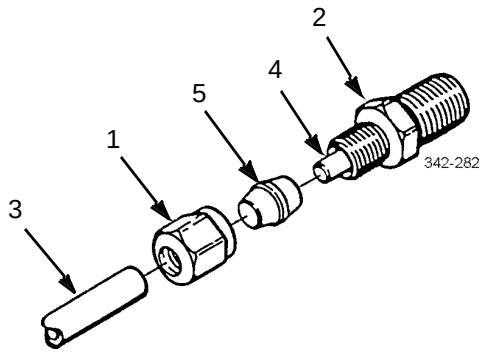
- Air tubes are replaced the same way.
- For location of air tubes, refer to Table 1, Air Tube Locator Table.
- Tag all air tubes and fittings to aid in installation.
- Remove and discard plastic tiedown straps. Install new tiedown straps.
- When replacing air tube, remove tube from vehicle and cut new tube 1/4-1/2 in (6.4 - 12.7 mm) longer than air tube being replaced.

1. Remove nut (1) from fitting (2).
2. Remove air tube (3) from fitting (2).

NOTE

If insert remains in fitting, do not remove. Cut air tube to remove ferrule.

3. Remove insert (4), ferrule (5), and nut (1) from air tube (3). Discard ferrule.



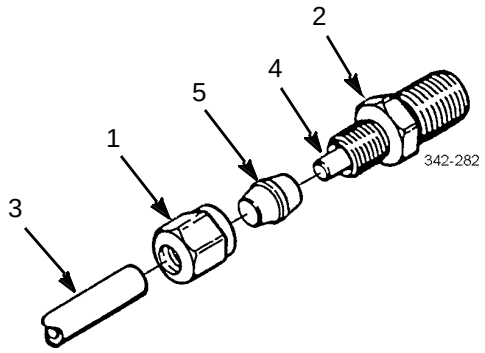
INSTALLATION

1. Position nut (1), new ferrule (5), and insert (4) on air tube (3).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contact skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

2. Lightly coat threads of fitting (2) with pipe sealing compound. Install fitting (2) on air tube (3).
3. Install nut (1) on fitting (2).



4. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

Table 1. Air Tube Locator Table.

TUBE NO.	FROM	FROM/TO	TO
001	Foot Brake Valve, D2 (1)		Quick Release Valve (2)
002	Quick Release Valve (2)		ABS Solenoid Valve (3)
003	ABS Solenoid Valve (3)		Front Brake Chamber (4)

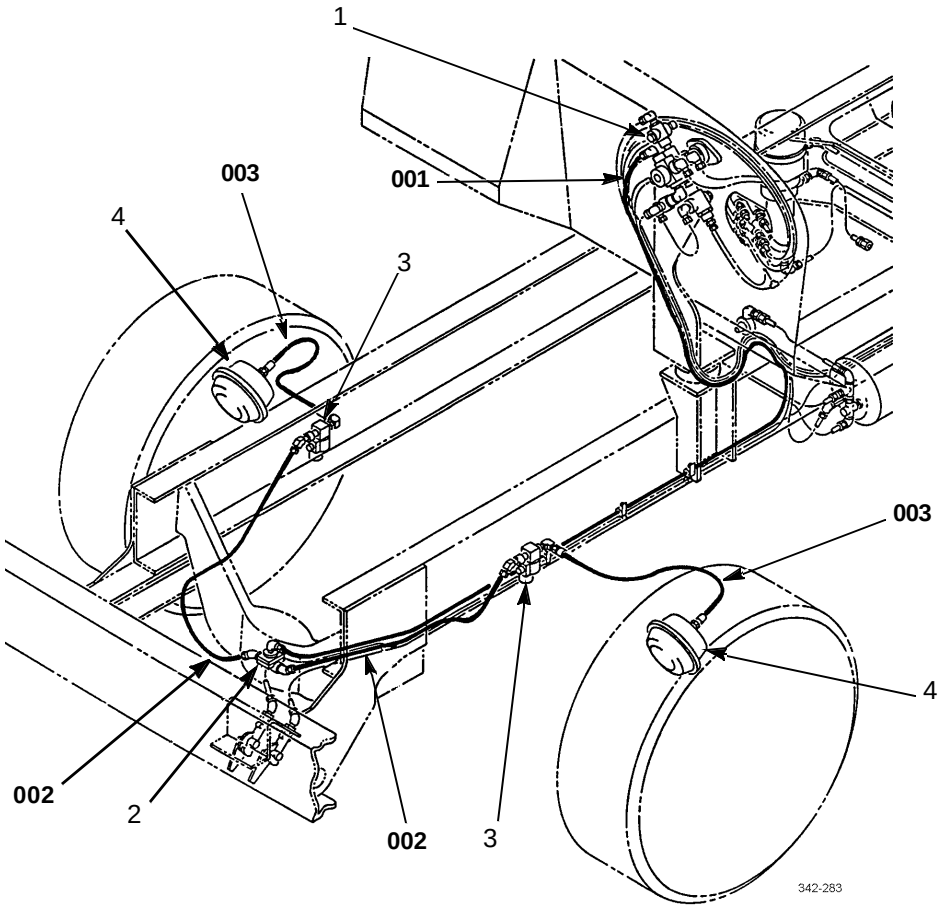


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
004	Foot Brake Valve, D2 (1)		Rear Relay Valve, SER (5)
005	Air Junction Block, No. 18 (6)		Rear Relay Valve, CONT (5)
006	Primary II Air Tank (7)		Rear Relay Valve, SUP (5)
007	Rear Relay Valve, DEL (5)		ABS Solenoid Valve (8)
008	ABS Solenoid Valve (8)		Rear Brake Chamber (9)

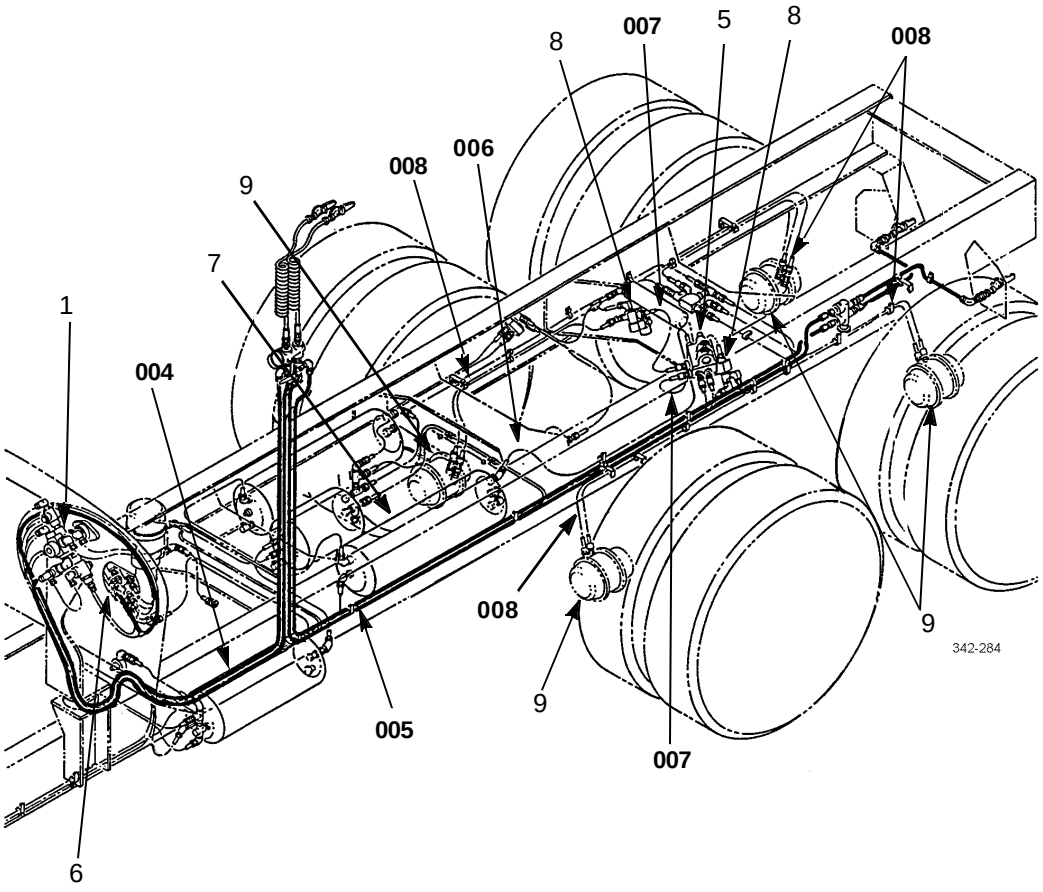


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
009	Air Junction Block, No. 18 (6)		Tractor Protection Valve, E (10)
010	Foot Brake Valve, D2 (1)		Tractor Protection Valve, S (10)
011	Tractor Protection Valve, E (10)		Rear Protection Valve, E (11)
012	Tractor Protection Valve, S (10)		Rear Protection Valve, S (11)
013	Rear Protection Valve, E (11)		Emergency Gladhand (12)
014	Rear Protection Valve, S (11)		Service Gladhand (13)

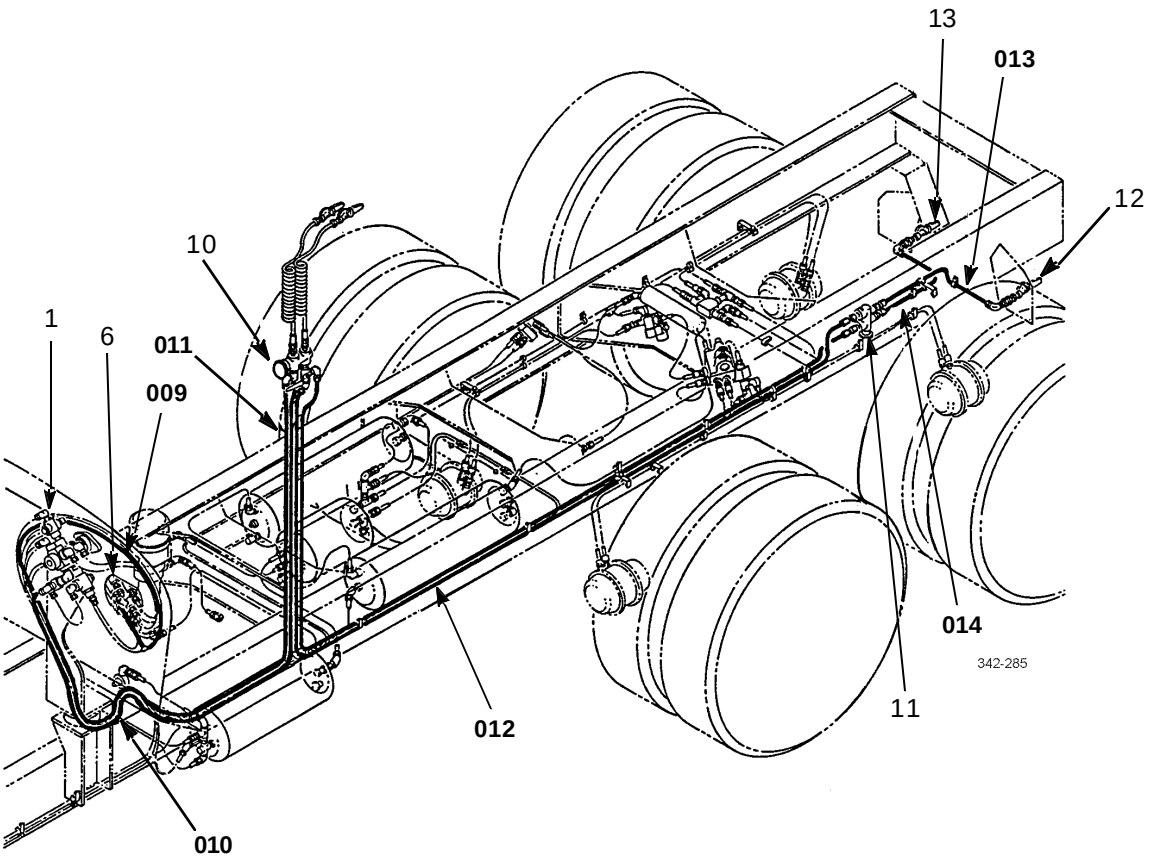


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
015	Rear Quick Release Valve (14)		Rear Brake Chamber (9)
016	Rear Quick Release Valve (14)		Supply Air Tank (15)
017	Rear Quick Release Valve (14)		Air Junction Block, No. 21 (6)

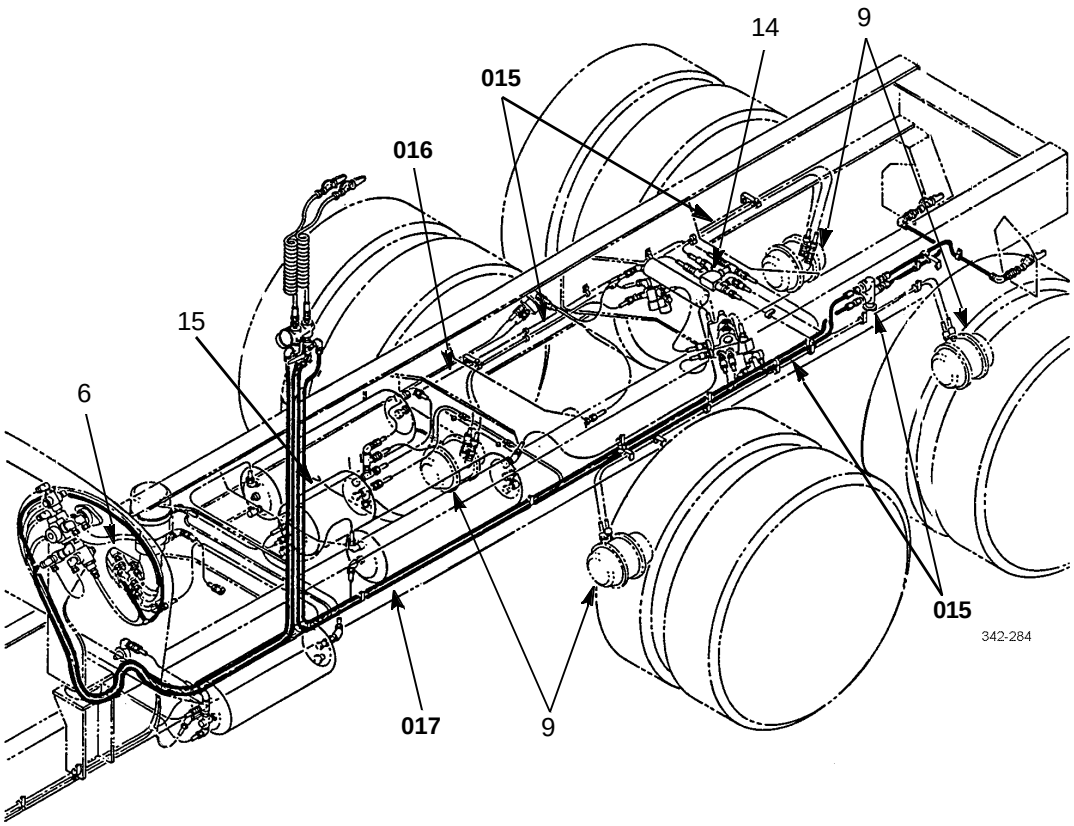


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
018	Air Junction Block, No. 17 (6)		Foot Brake Valve, D1 (1)
019	Air Junction Block, No. 19 (6)		Foot Brake Valve, D2 (1)
020	Air Junction Block, No. 13 (6)		Foot Brake Valve, S1 (1)
021	Air Junction Block, No. 22 (6)		Foot Brake Valve, S2 (1)

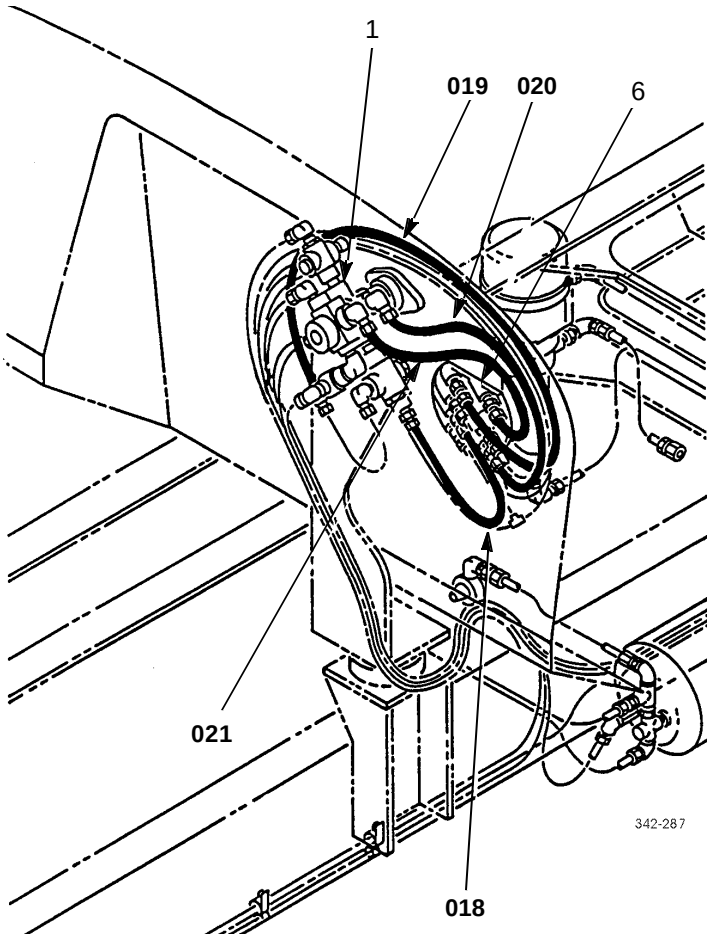


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
022	Air Compressor (16)		Air Dryer (17)
023	Air Compressor (16)		Air Dryer (17)
024	Air Compressor (16)		Supply Air Tank (15)
025	Air Dryer (17)		Supply Air Tank (15)

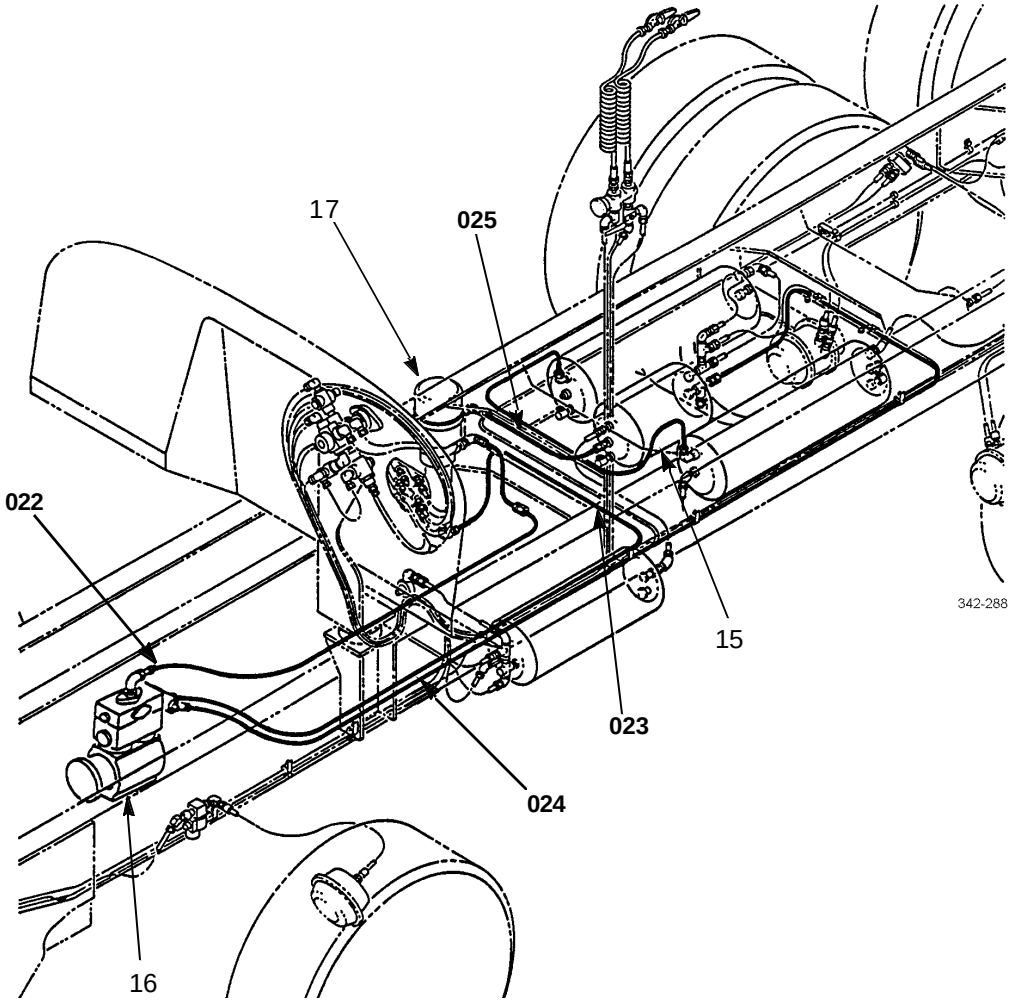


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
026	Secondary Air Tank (18)		Foot Brake Valve (1)
027	Primary II Air Tank (7)		Foot Brake Valve (1)
028	Primary II Air Tank (7)		Primary I Air Tank (19)
029	Supply Air Tank (15)		Secondary Air Tank (18)
030	Supply Air Tank (15)		Primary I Air Tank (19)

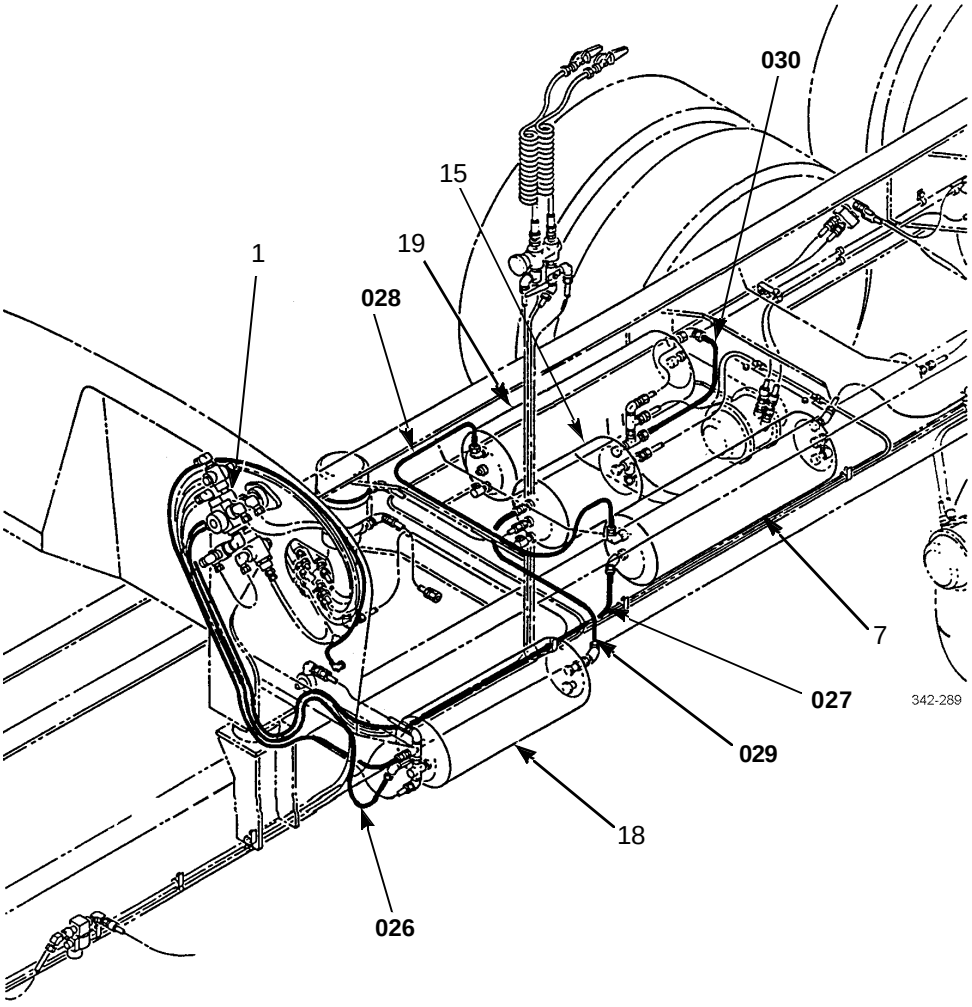


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
031	Secondary Air Tank (18)		Firewall (20)
032	Fifth Wheel (21)	Junction Block	Firewall (20)
033	Axle Interlock (22)	Junction Block	Firewall (20)
034	Front Service Gladhand (23)		Foot Brake Valve (1)
035	Front Emergency Gladhand (24)		Supply Air Tank (15)

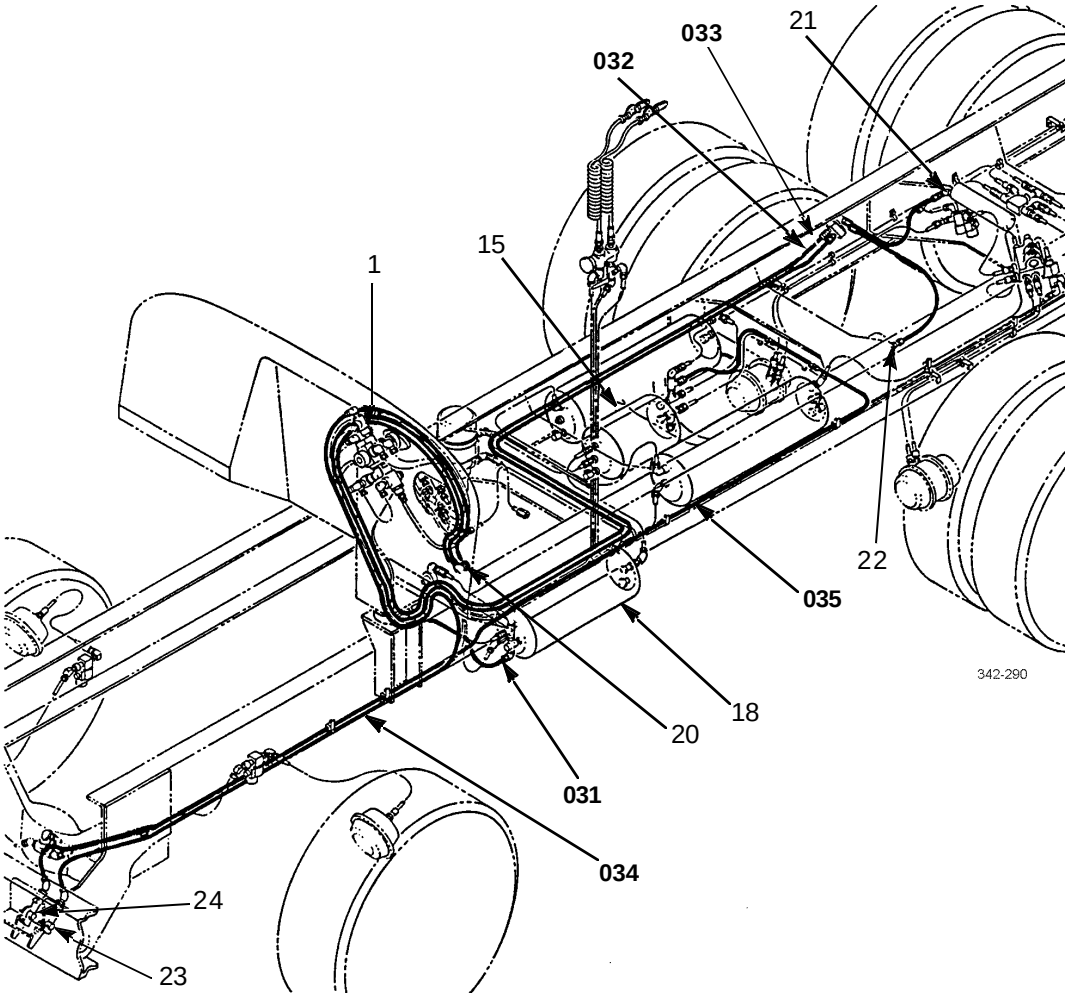


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
036	Air Junction Block, No. 15 (6)		Primary Air Pressure Gage (25)
037	Air Junction Block, No. 11 (6)		Secondary Air Pressure Gage (26)
038	Firewall Tee (27)		Constant Air Junction Block (28)

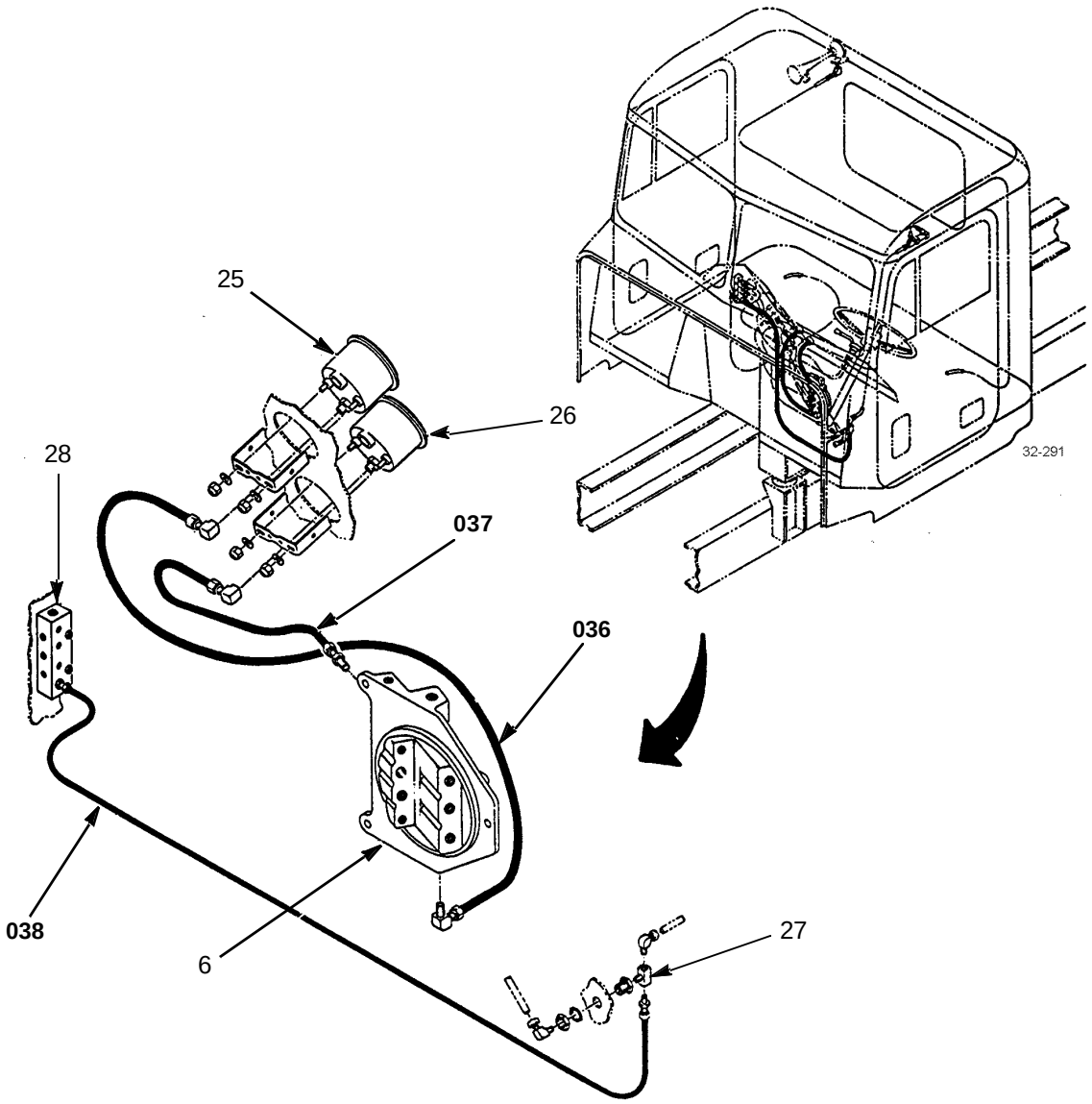


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
039	Firewall Tee (27)		Air Horn Tee (29)
040	Air Horn Tee (29)		Driver Seat Air Cylinder (30)
041	Air Horn Tee (29)	Air Horn Valve (31)	Air Horn (32)
042	Constant Air Junction Block (28)		Passenger Seat Air Cylinder (33)

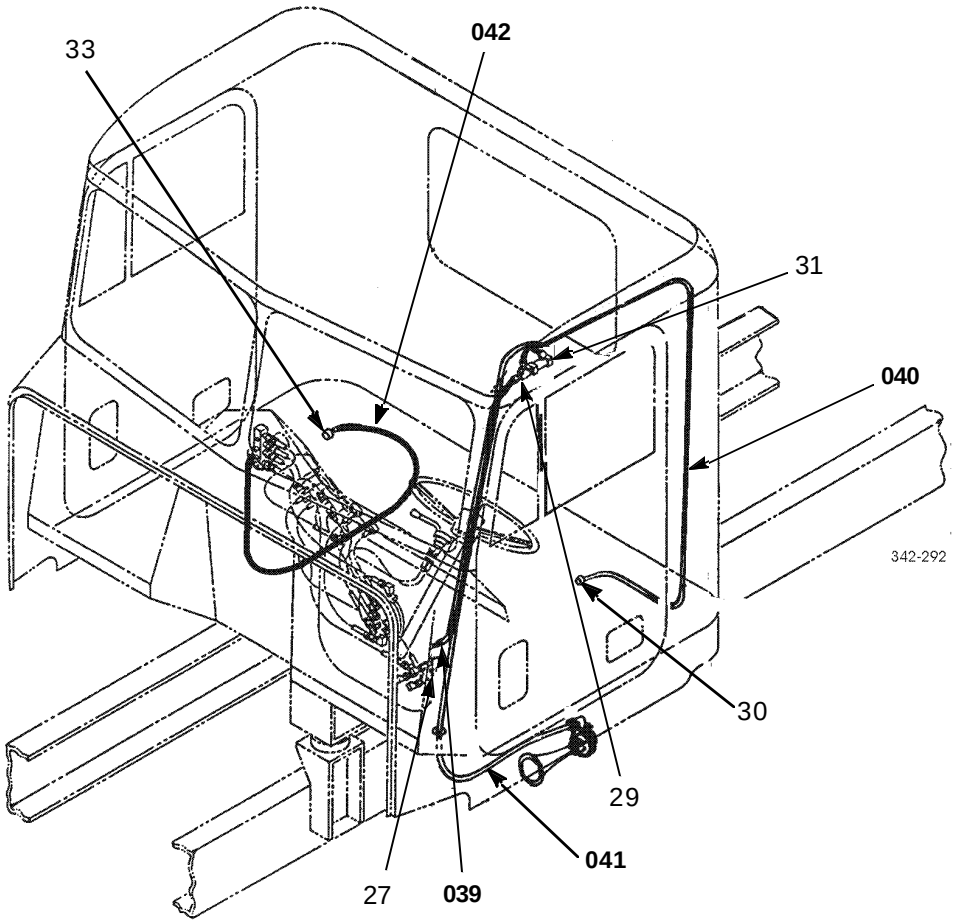
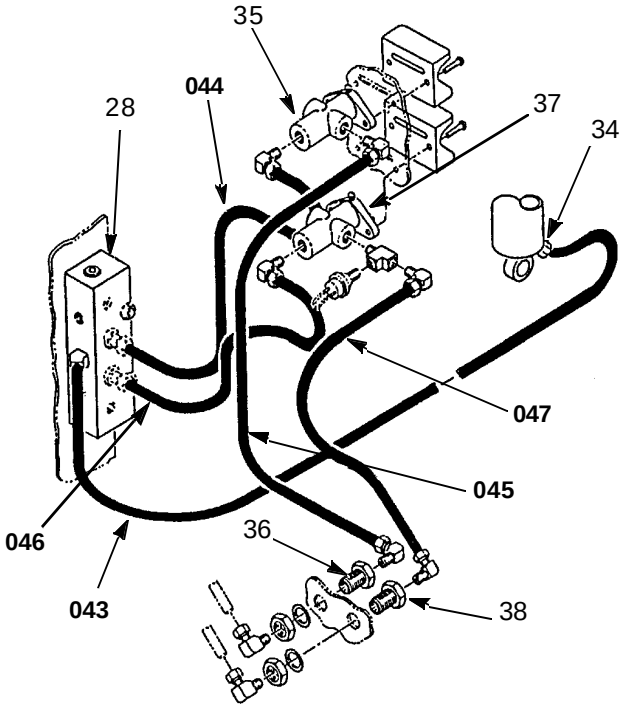


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
043	Constant Air Junction Block (28)		Passenger Seat Air Cylinder (34)
044	Constant Air Junction Block (28)		Interaxle Lockup Valve (35)
045	Interaxle Lockup Valve (34)		Firewall Fitting, No. 1 (36)
046	Constant Air Junction Block (28)		Fifth Wheel Slide Valve (37)
047	Fifth Wheel Slide Valve (37)		Firewall Fitting, No. 2 (38)



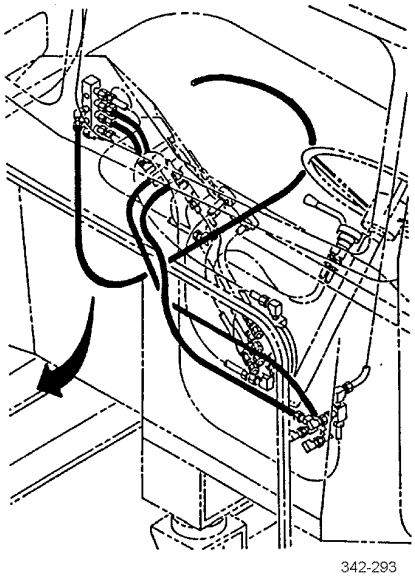


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
048	Air Junction Block, No. 14 (6)		Parking Brake/Trailer Air Supply, S1 (39)
049	Air Junction Block, No. 9 (6)		Parking Brake/Trailer Air Supply, S2 (39)
050	Parking Brake/Trailer Air Supply, DEL TRC (39)		Air Junction Block, No. 12 (6)
051	Parking Brake/Trailer Air Supply, DEL TRL (39)		Air Junction Block, No. 4 (6)
052	Parking Brake/Trailer Air Supply, EXH (39)	Firewall	Not Connected

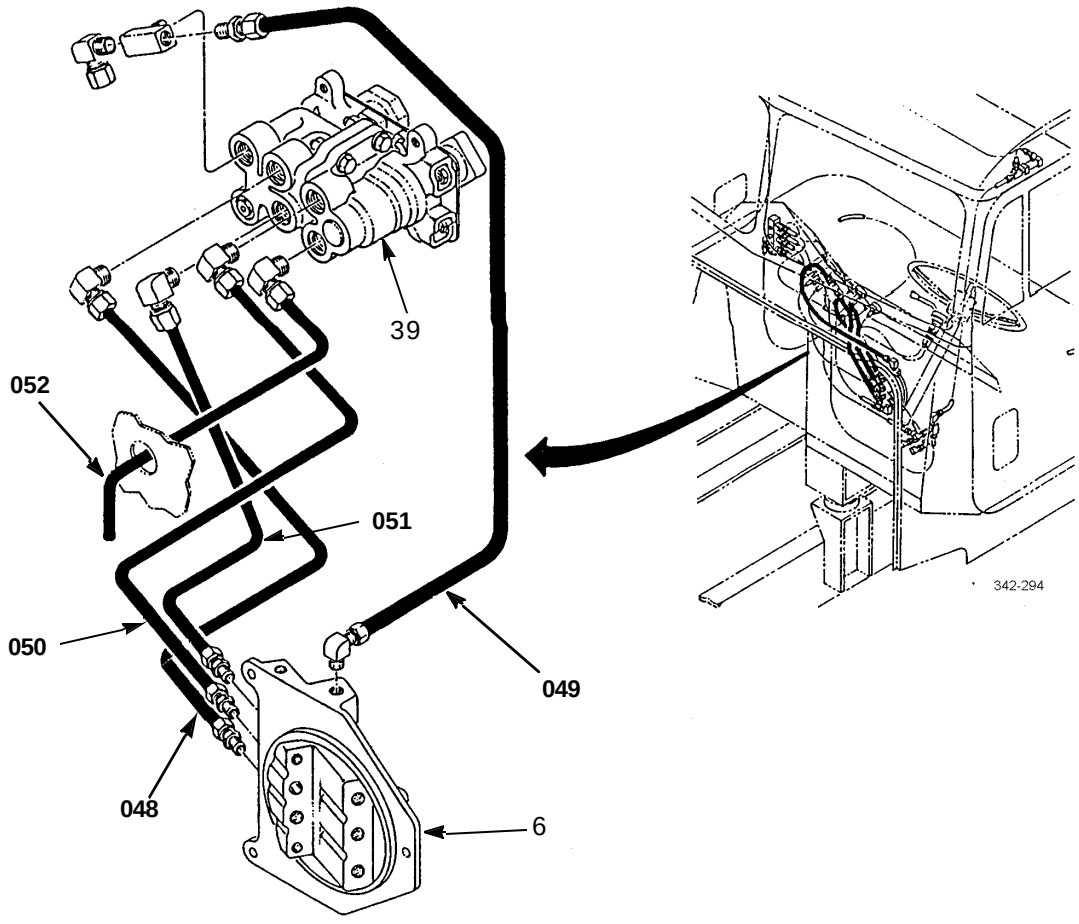
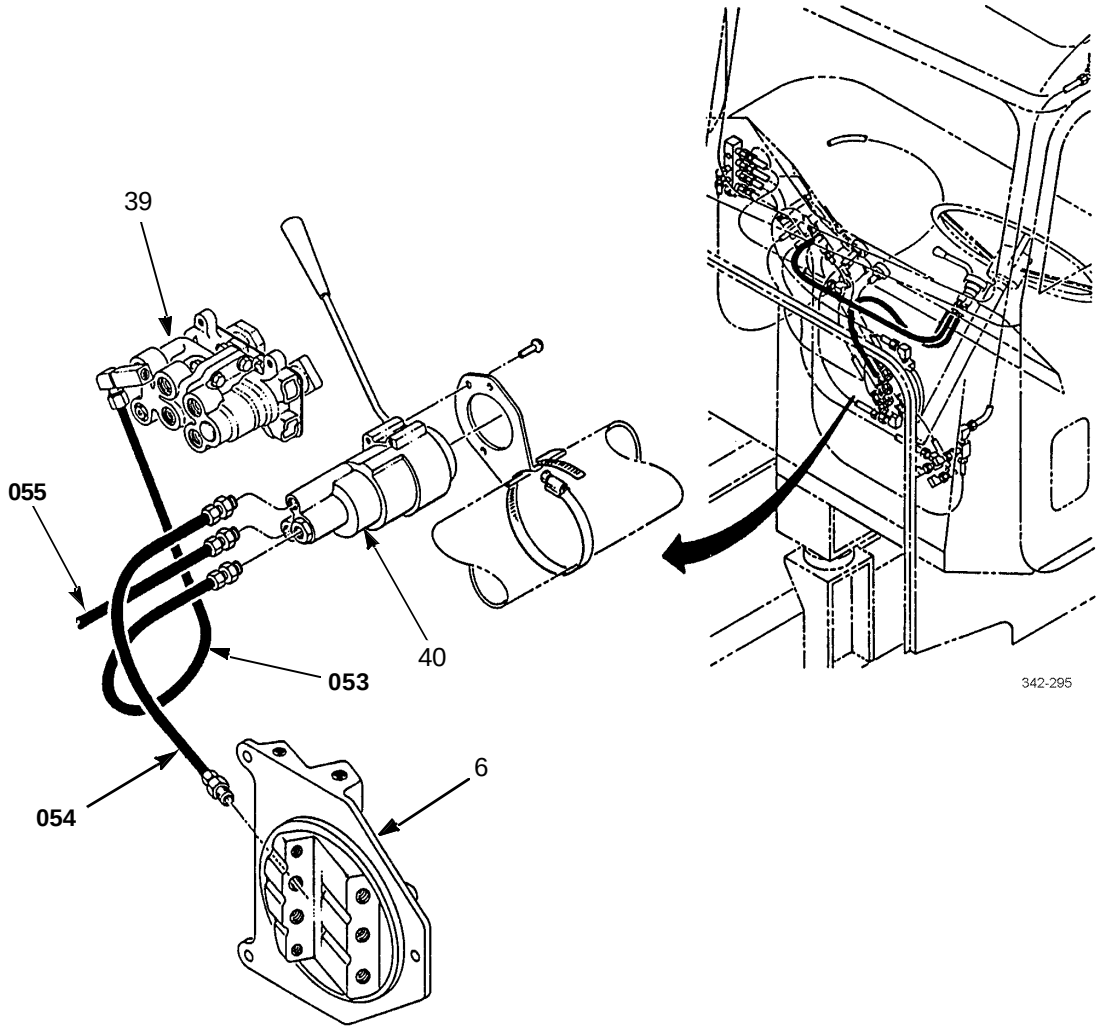


Table 1. Air Tube Locator Table - Continued.

TUBE NO.	FROM	FROM/TO	TO
053	Parking Brake/Trailer Air Supply, S2 (38)		Trailer Hand Brake, S (40)
054	Trailer Hand Brake, D (40)		Air Junction Block, No. 5 (6)
055	Trailer Hand Brake, E (40)	Firewall	Not Connected



END OF WORK PACKAGE

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CONSTANT AIR JUNCTION BLOCK REPLACEMENT 0148 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

References

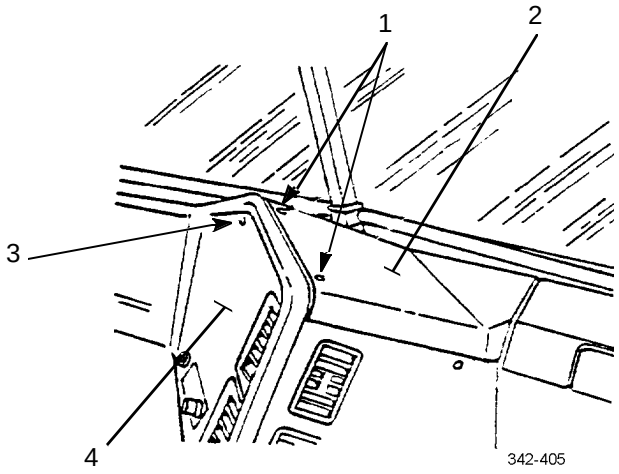
TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

REMOVAL

1. Remove six torx screws (1), dash top cover (2), and five torx screws (3). Set instrument panel (4) aside.



REMOVAL - CONTINUED

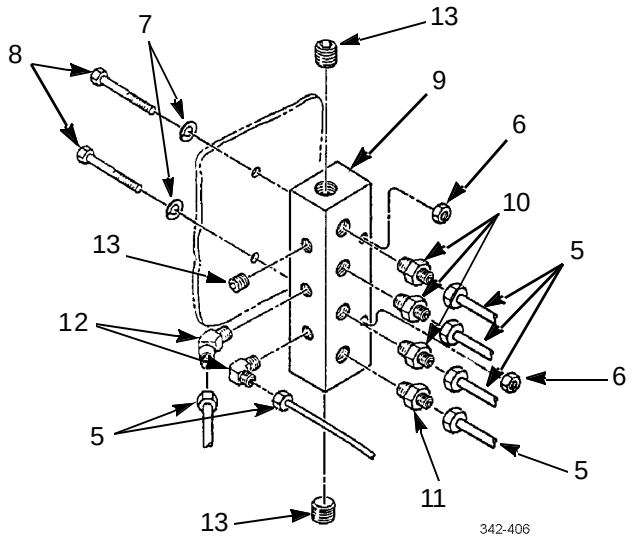
NOTE

Tag all tubes, connectors and plugs prior to disconnecting/removal to aid in installation/connecting.

2. Disconnect six tubes (5).

3. Remove two nuts (6), washers (7), screws (8), and constant air junction block (9).

4. Remove three connectors (10), connector (11), two elbows (12), and three plugs (13) from constant air junction block (9).



INSTALLATION

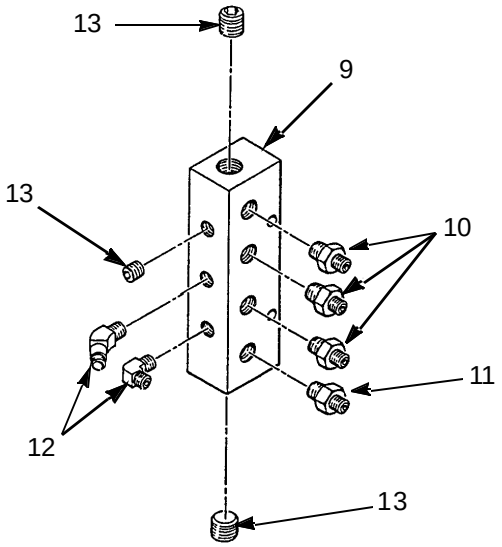
WARNINGS

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

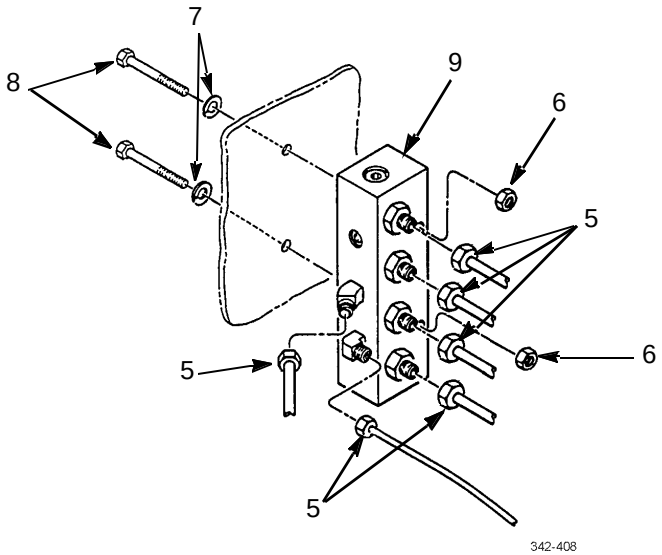
1. Coat threads with pipe sealing compound and install three plugs (13), two elbows (12), three connectors (10), and connector (11) in constant air junction block (9).

CONSTANT AIR JUNCTION BLOCK REPLACEMENT - CONTINUED 0148 00

INSTALLATION - CONTINUED



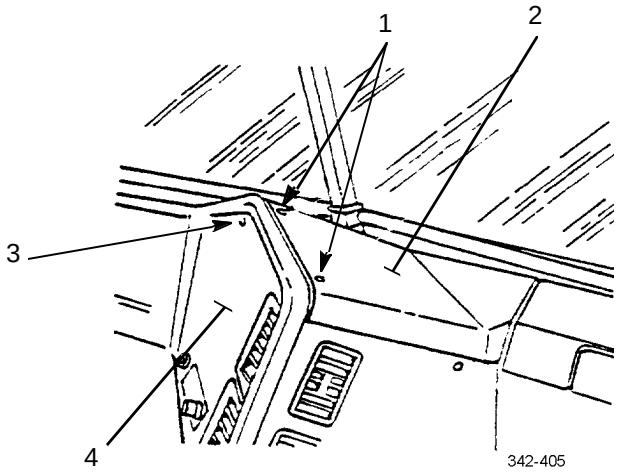
2. Install constant air junction block (9) with two screws (8), washers (7), and nuts (6).
3. Connect six tubes (5) to constant air junction block (9).



4. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

INSTALLATION - CONTINUED

5. Position instrument panel (4) and install five torx screws (3), dash top cover (2), and six torx screws (1).



END OF WORK PACKAGE

CAB AIR JUNCTION BLOCK REPLACEMENT 0149 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-10340-125) (3)

Compound, caulking (Item 7, WP 0235 00)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

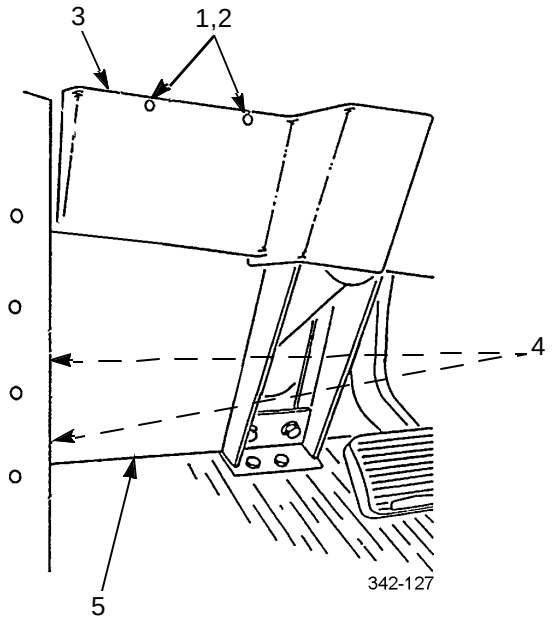
Equipment Condition

Air system drained (TM 9-2320-302-10)

Check engine switch removed (WP 0070 00)

REMOVAL

1. Remove five screws (1), washers (2), and cover (3).
2. Remove two screws (4) and cover (5).

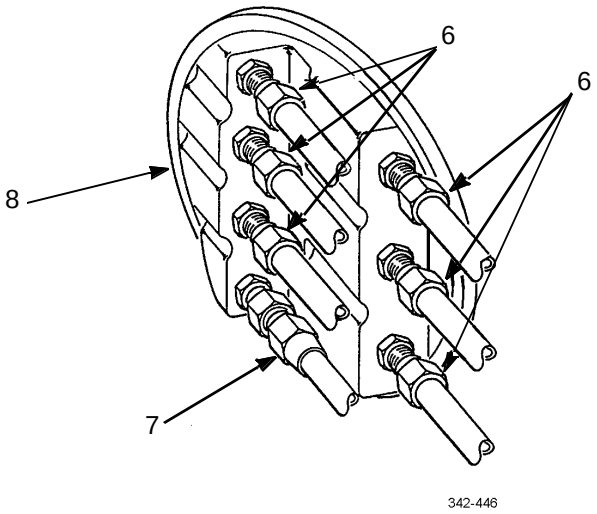


REMOVAL - CONTINUED

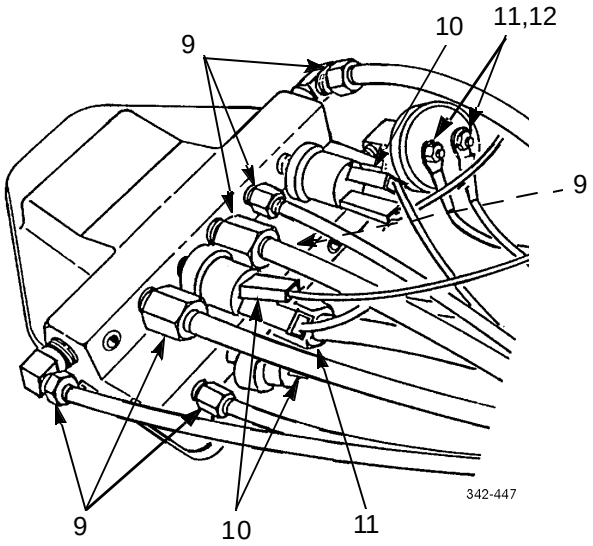
NOTE

Tag all tubes, fittings, and wires to aid in installation.

3. Disconnect six tubes (6) and oil line (7) from cab air junction block (8).

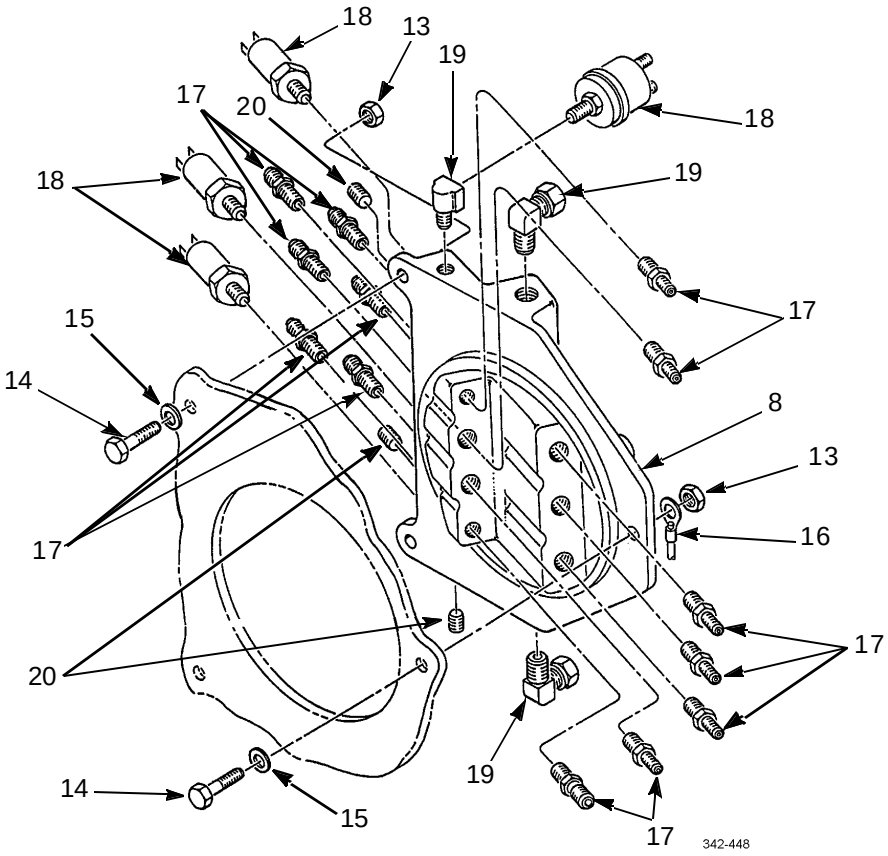


4. Disconnect eight tubes (9) and three plug connectors (10).
5. Remove two lock nuts (11) and two wires (12).



6. Remove three lock nuts (13), screws (14), washers (15), ground wire (16), and cab air junction block (8). Discard lock nuts.
7. Remove 13 connectors (17), four sending units (18), three elbows (19), and three pipe plugs (20) from cab air junction block (8).

REMOVAL - CONTINUED



INSTALLATION

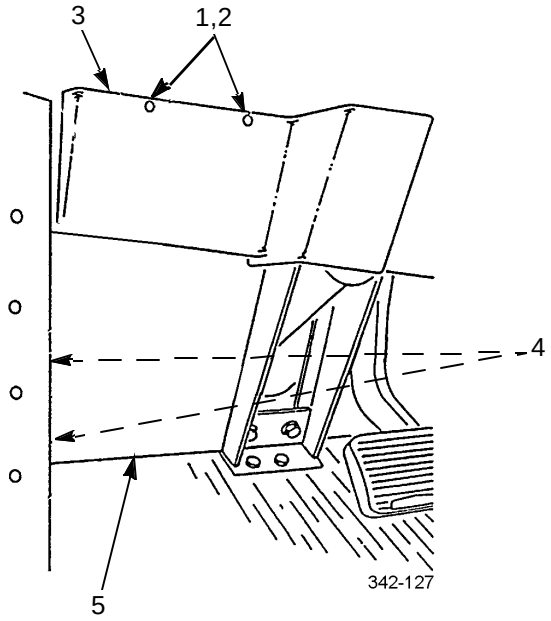
WARNINGS

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

1. Coat threads with pipe sealing compound and install 13 connectors (17), four sending units (18), three elbows (19), and three pipe plugs (20) in cab air junction block (8).
2. Apply caulking compound to mating surface of cab air junction block (8).
3. Install cab air junction block (8), ground wire (16), three washers (15), screws (14), and new lock nuts (13).
4. Install two wires (12) with new lock nuts (11).
5. Connect three plug connectors (10) and eight tubes (9).
6. Connect six tubes (6) and oil line (7) to cab air junction block (8).

INSTALLATION - CONTINUED

7. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.
8. Install cover (5) and two screws (4).
9. Install cover (3) with five washers (2) and screws (1).
10. Install check engine switch (WP 0070 00).



END OF WORK PACKAGE

TRACTOR PROTECTION VALVES REPLACEMENT 0150 00

THIS WORK PACKAGE COVERS

Front Tractor Protection Valve Removal, Rear Tractor Protection Valve Removal, Front Tractor Protection Valve Installation, Rear Tractor Protection Valve Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-11) (4)

Compound, sealing, pipe (Item 10, WP 0235 00)

Materials/Parts - Continued

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

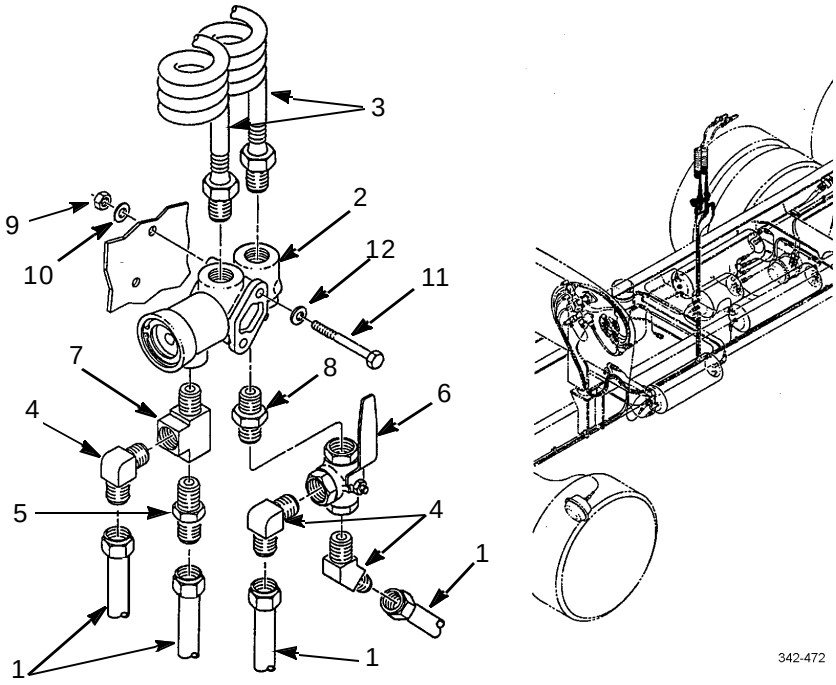
Air system drained (TM 9-2320-302-10)

FRONT TRACTOR PROTECTION VALVE REMOVAL

NOTE

Tag tubes to aid in installation.

1. Disconnect four tubes (1) from tractor protection valve (2).
2. Remove two coupling hoses (3), three elbows (4), connector (5), valve (6), tee (7,) and adapter (8).
3. Remove two lock nuts (9), washers (10), screws (11), washers (12), and tractor protection valve (2). Discard lock nuts.

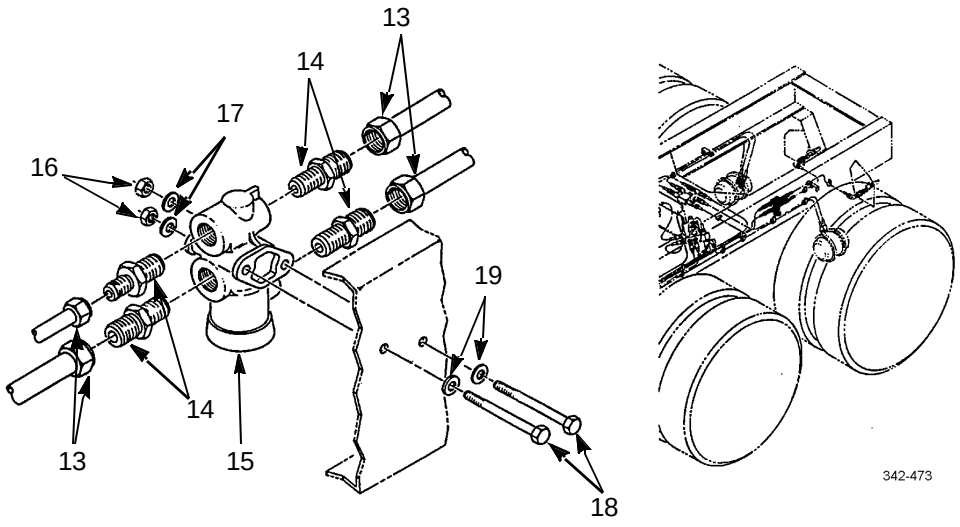


REAR TRACTOR PROTECTION VALVE REMOVAL

NOTE

Tag tubes to aid in installation.

1. Disconnect four tubes (13) and remove four connectors (14) from tractor protection valve (15).
2. Remove two lock nuts (16), washers (17), screws (18), washers (19), and tractor protection valve (15). Discard lock nuts.



FRONT TRACTOR PROTECTION VALVE INSTALLATION

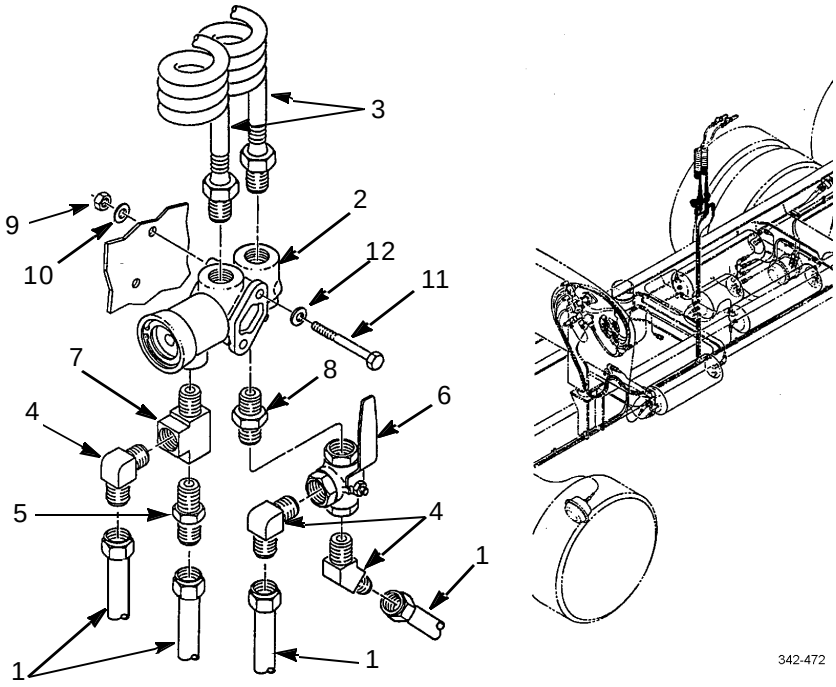
WARNINGS

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

1. Install tractor protection valve (2) with two washers (12), screws (11), washers (10), and new lock nuts (9).
2. Coat threads with pipe sealing compound and install adapter (8), tee (7), valve (6), connector (5), three elbows (4), and two coupling hoses (3).

FRONT TRACTOR PROTECTION VALVE INSTALLATION - CONTINUED

3. Connect four tubes (1) to tractor protection valve (2).
4. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.



REAR TRACTOR PROTECTION VALVE INSTALLATION

1. Install tractor protection valve (15) with two washers (19), screws (18), washers (17), and new lock nuts (16).

WARNINGS

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

2. Coat threads with pipe sealing compound and install four connectors (14) to tractor protection valve (15). Connect four tubes (13).
3. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

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REAR RELAY VALVE REPLACEMENT 0151 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS 51922-1) (4)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

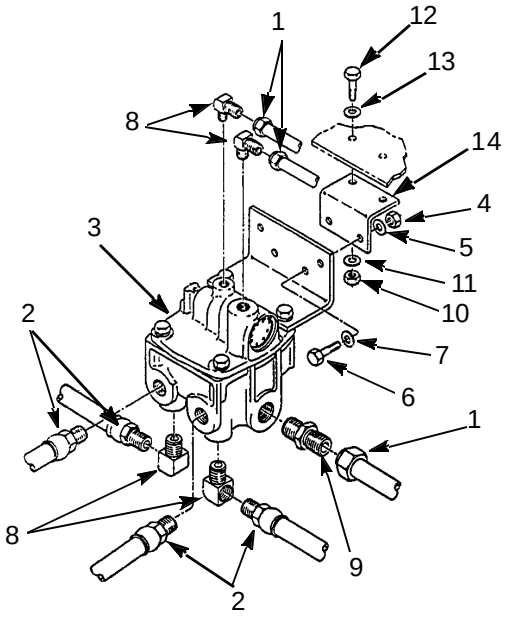
Air system drained (TM 9-2320-302-10)

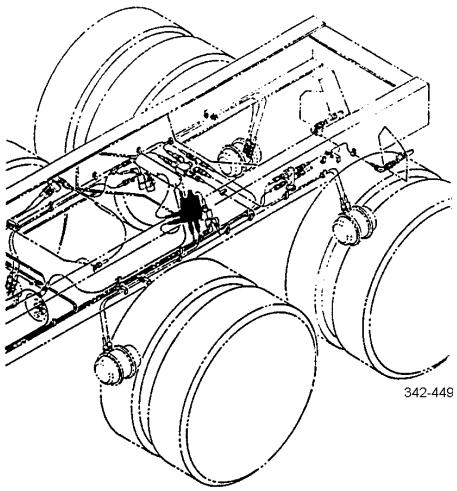
REMOVAL

NOTE

Tag tubes to aid in installation.

1. Disconnect three tubes (1) and four hoses (2) from relay valve (3).
2. Remove two lock nuts (4), washers (5), screws (6), washers (7), and relay valve (3). Discard lock nuts.
3. Remove four elbows (8) and connector (9).
4. Remove two lock nuts (10), washers (11), screws (12), washers (13), and mounting bracket (14). Discard lock nuts.





INSTALLATION

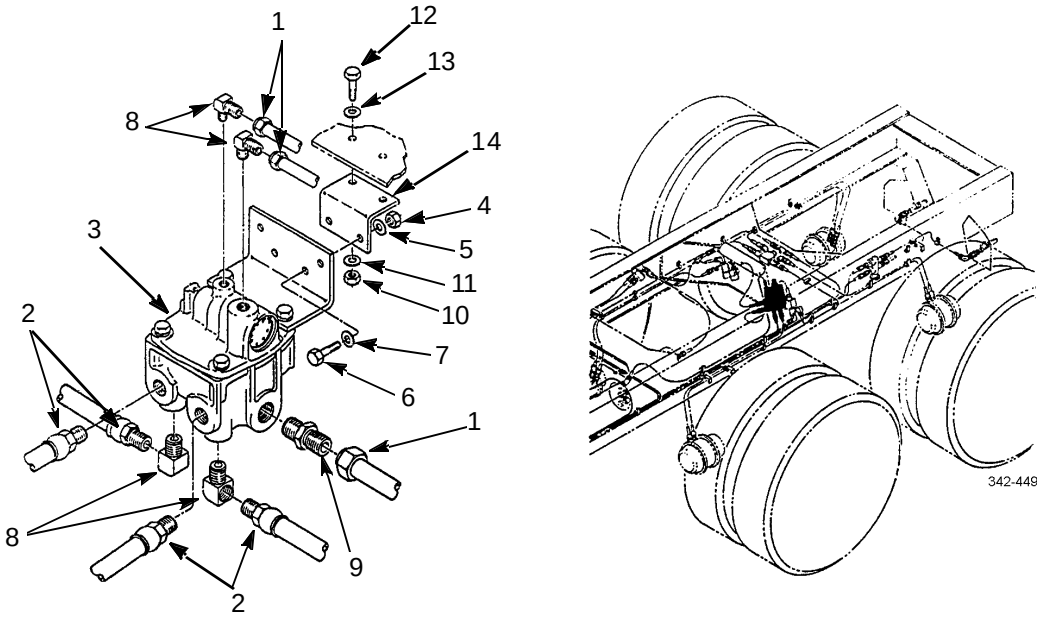
1. Install mounting bracket (14) with two washers (13), screws (12), washers (11), and new lock nuts (10).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

2. Lightly coat pipe threads of four elbows (8) and connector (9) with pipe sealing compound.

3. Install four elbows (8) and connector (9) on relay valve (3).



4. Install relay valve (3) with two washers (7), screws (6), washers (5), and new lock nuts (4).

5. Connect three tubes (1) and four hoses (2) to relay valve (3).

6. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

FRONT SERVICE BRAKE RELAY VALVE REPLACEMENT 0152 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS 51922-1) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

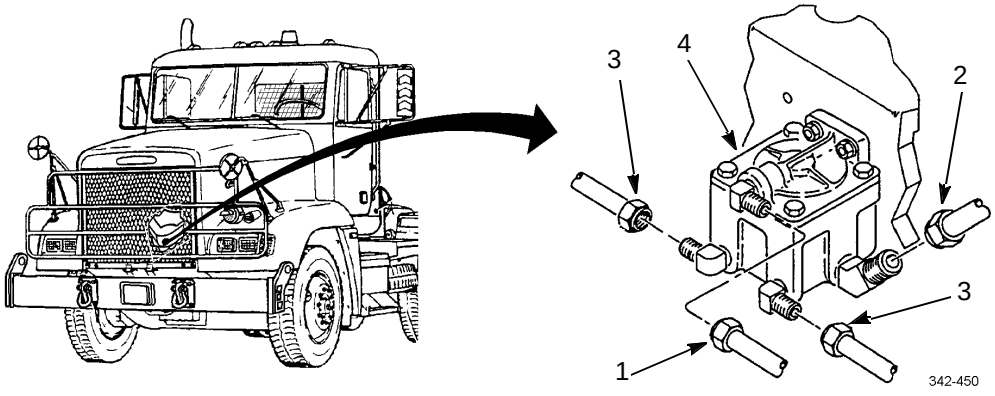
Air system drained (TM 9-2320-302-10)

REMOVAL

NOTE

Tag tubes to aid in installation.

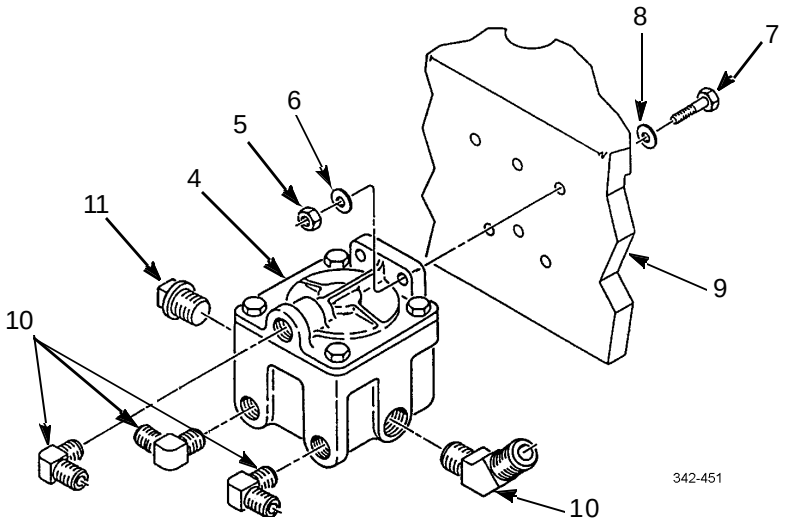
1. Disconnect control tube (1), supply tube (2), and two delivery tubes (3) from relay valve (4).



REMOVAL - CONTINUED

2. Remove two lock nuts (5), washers (6), screws (7), washers (8), and relay valve (4) from crossmember (9). Discard lock nuts.

3. Remove four elbows (10) and plug (11) from relay valve (4).



INSTALLATION

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel and damage to equipment.

1. Coat pipe threads of four elbows (10) and plug (11) with pipe sealing compound.

2. Install four elbows (10) and plug (11) in relay valve (4).

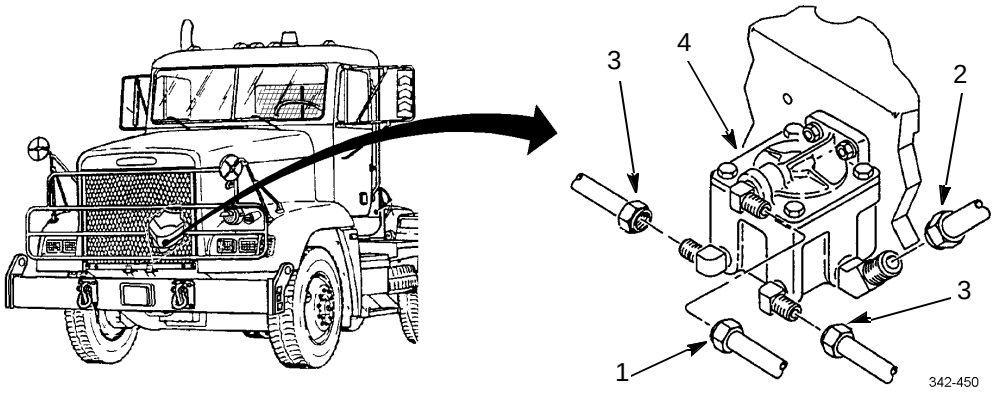
3. Install relay valve (4) on crossmember (9) with two washers (8), screws (7), washers (6), and new lock nuts (5).

4. Connect two delivery tubes (3), supply tube (2), and control tube (1) to relay valve (4).

5. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

FRONT SERVICE BRAKE RELAY VALVE REPLACEMENT - CONTINUED **0152 00**

INSTALLATION - CONTINUED



END OF WORK PACKAGE

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FRONT GLADHANDS REPLACEMENT 0153 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-10340-125) (2)

Washer, lock (P/N MS 35333-49) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

NOTE

Tag tubes and fittings to aid in installation.

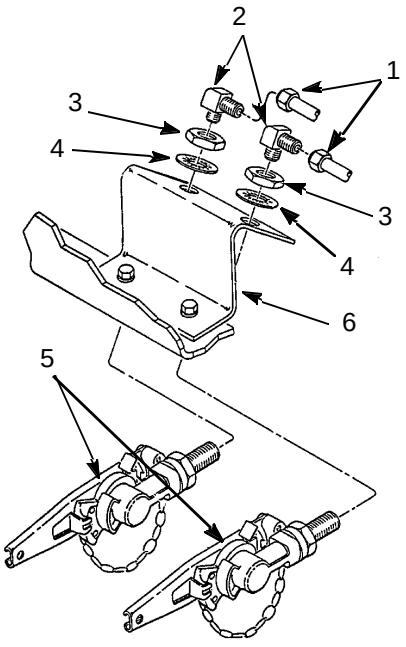
REMOVAL

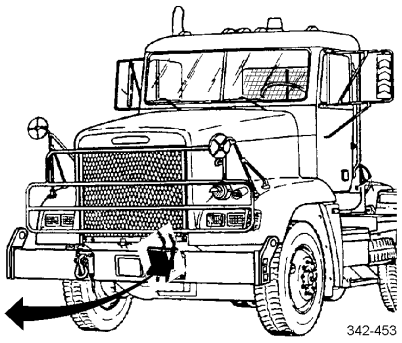
1. Disconnect two tubes (1) from elbows (2).

NOTE

Note position of washers to aid in installation.

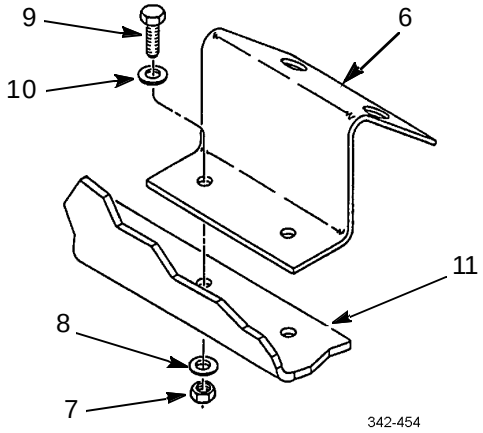
2. Remove two elbows (2), nuts (3), lock washers (4), and gladhands (5) from mounting bracket (6). Discard lock washers.



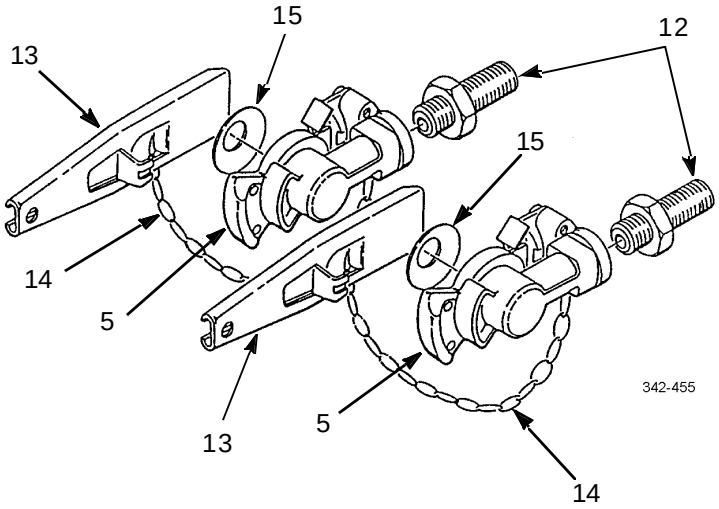


REMOVAL - CONTINUED

3. Remove two lock nuts (7), washers (8), screws (9), washers (10), and mounting bracket (6) from bumper (11). Discard lock nuts.



4. Remove two bulkhead fittings (12), dummy couplings (13), chains (14), and seals (15) from gladhands (5).



INSTALLATION

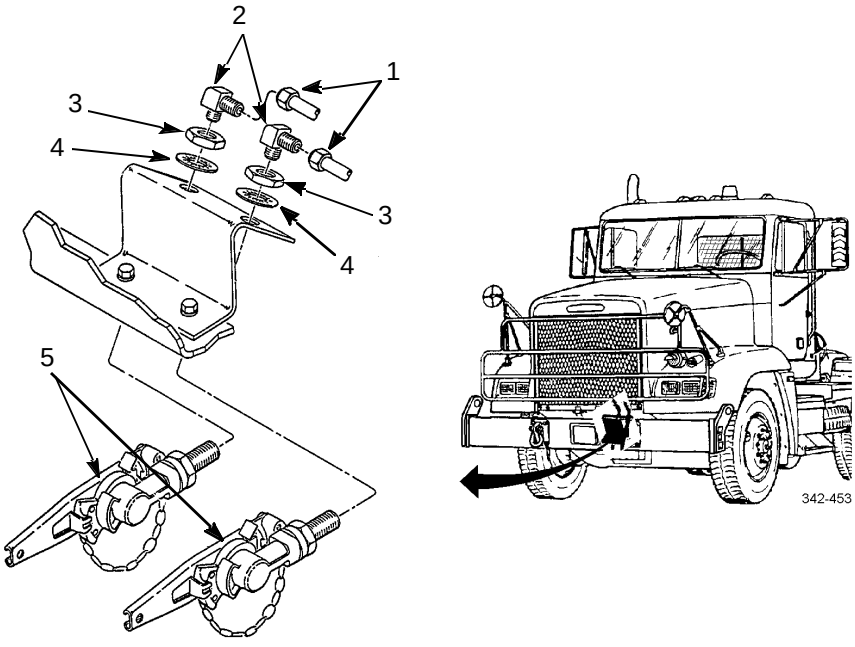
1. Install two seals (15), chains (14), and dummy couplings (13) on gladhands (5).

INSTALLATION - CONTINUED

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

2. Lightly coat threads of two bulkhead fittings (12) with pipe sealing compound. Install bulkhead fittings on gladhands (5).
3. Install mounting bracket (6) on bumper (11) with two washers (10), screws (9), washers (8), and new lock nuts (7).
4. Install two gladhands (5) on mounting bracket (6) with two new lock washers (4) and nuts (3).
5. Lightly coat threads of two elbows (2) with pipe sealing compound. Install elbows on two bulkhead fittings (12).
6. Conect two tubes (1) to elbows (2).
7. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.



END OF WORK PACKAGE

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REAR GLADHAND REPLACEMENT 0154 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Washer, lock (P/N MS 35333-49)

Compound, sealing, pipe (Item 10, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

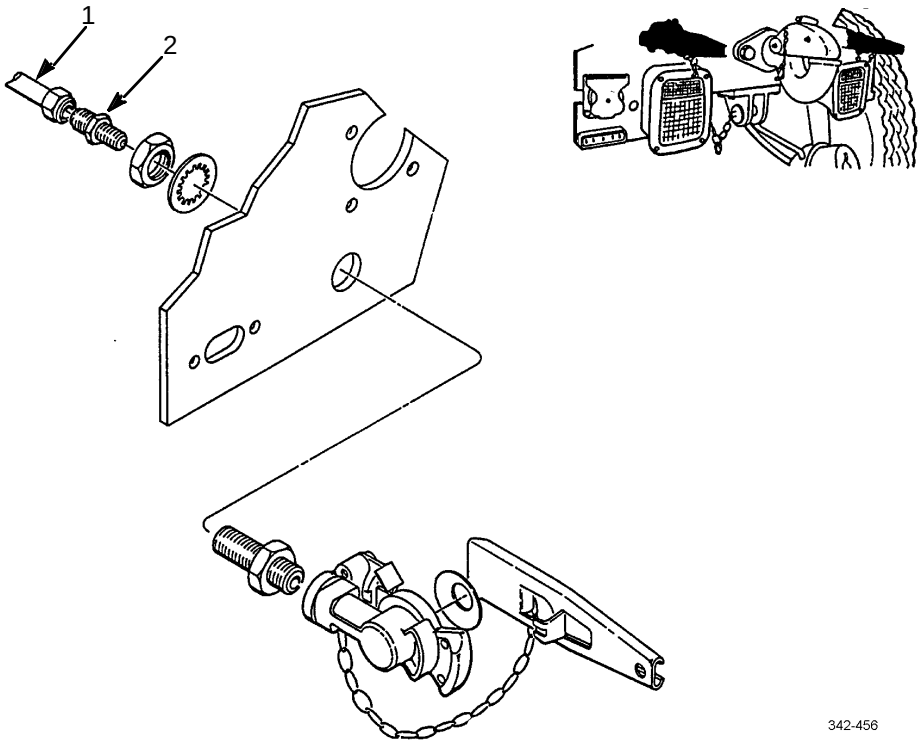
Air system drained (TM 9-2320-302-10)

NOTE

Emergency gladhand and service gladhand are replaced the same way. Emergency gladhand is shown.

REMOVAL

1. Disconnect tube (1) from connector (2).



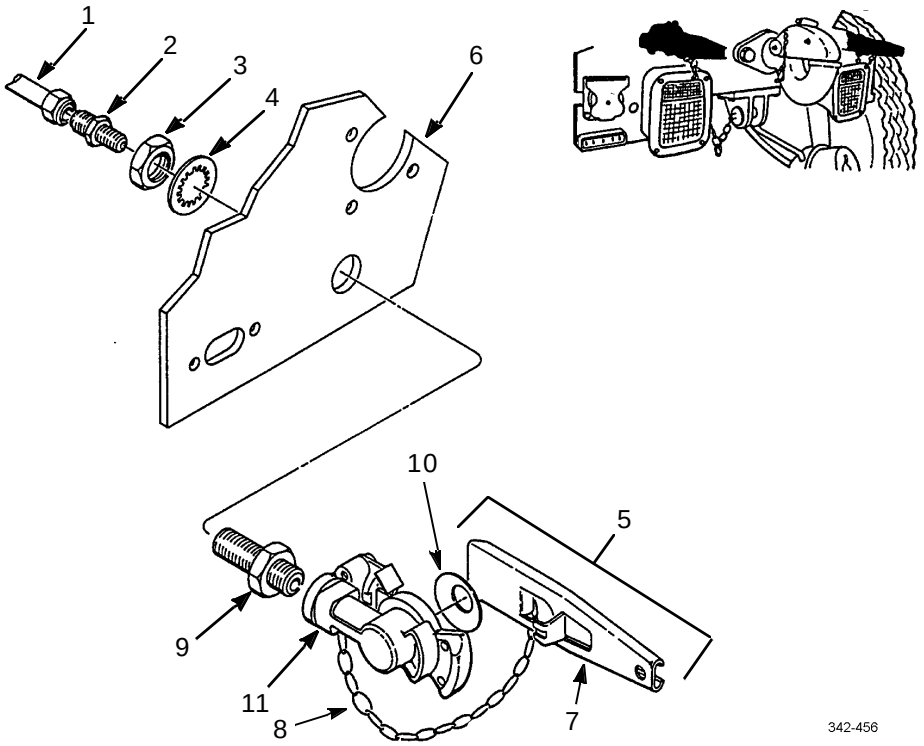
REMOVAL - CONTINUED

NOTE

It is not necessary to remove gladhand to replace gladhand seal.

2. Remove connector (2), nut (3), lock washer (4), and gladhand assembly (5) from bracket (6). Discard lock washer.

3. Remove dummy coupling (7), chain (8), bulkhead fitting (9), and seal (10) from gladhand (11).



INSTALLATION

1. Install seal (10), chain (8), and dummy coupling (7) on gladhand (11).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

2. Lightly coat threads of bulkhead fitting (9) with pipe sealing compound. Install bulkhead fitting on gladhand (11).

INSTALLATION - CONTINUED

3. Install gladhand assembly (5) on bracket (6) with new lock washer (4) and nut (3).
4. Lightly coat threads of connector (2) with pipe sealing compound. Install connector on bulkhead fitting (9).
5. Connect tube (1) to connector (2).
6. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

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FRONT QUICK-RELEASE VALVE REPLACEMENT 0155 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS 519221-1) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

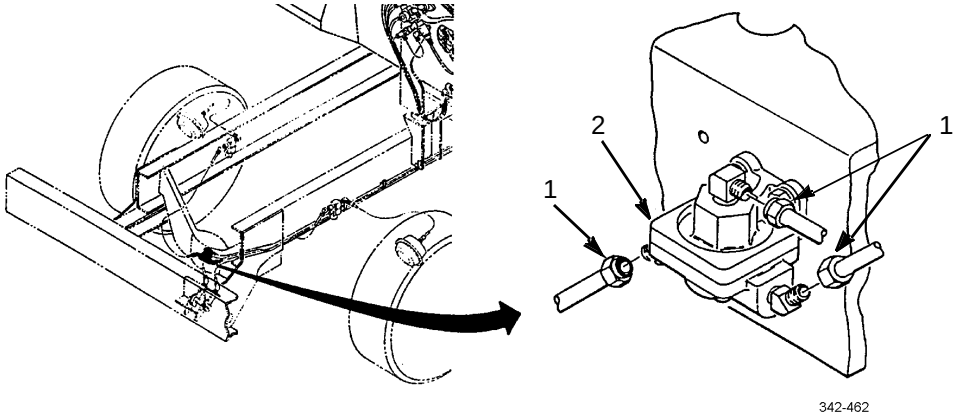
Air system drained (TM 9-2320-302-10)

REMOVAL

NOTE

Tag tubes to aid in installation.

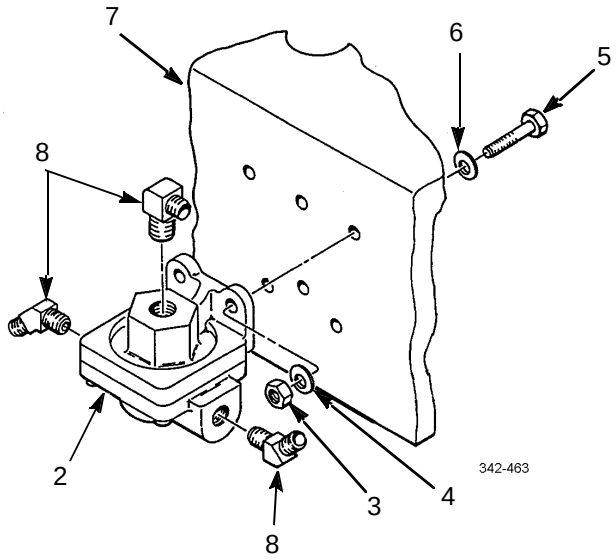
1. Disconnect three tubes (1) from quick-release valve (2).



FRONT QUICK-RELEASE VALVE REPLACEMENT - CONTINUED 0155 00

REMOVAL - CONTINUED

2. Remove two lock nuts (3), washers (4), screws (5), washers (6), and quick-release valve (2) from crossmember (7). Discard lock nuts.
3. Remove three elbows (8) from quick-release valve (2).

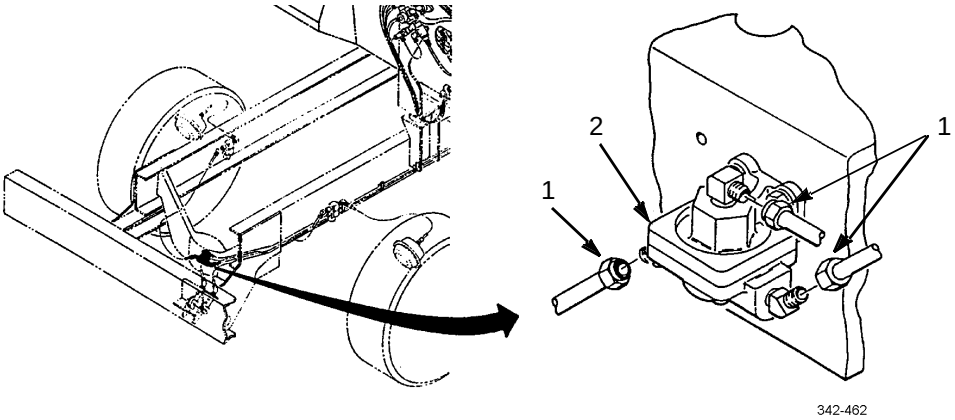


INSTALLATION

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

1. Lightly coat threads of three elbows (8) with pipe sealing compound. Install elbows in quick-release valve (2).
2. Install quick-release valve (2) on crossmember (7) with two washers (6), screws (5), washers (4), and new lock nuts (3).
3. Connect three tubes (1) to quick-release valve (2).
4. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

INSTALLATION - CONTINUED



END OF WORK PACKAGE

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REAR QUICK-RELEASE VALVE REPLACEMENT 0156 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS 519221-1) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

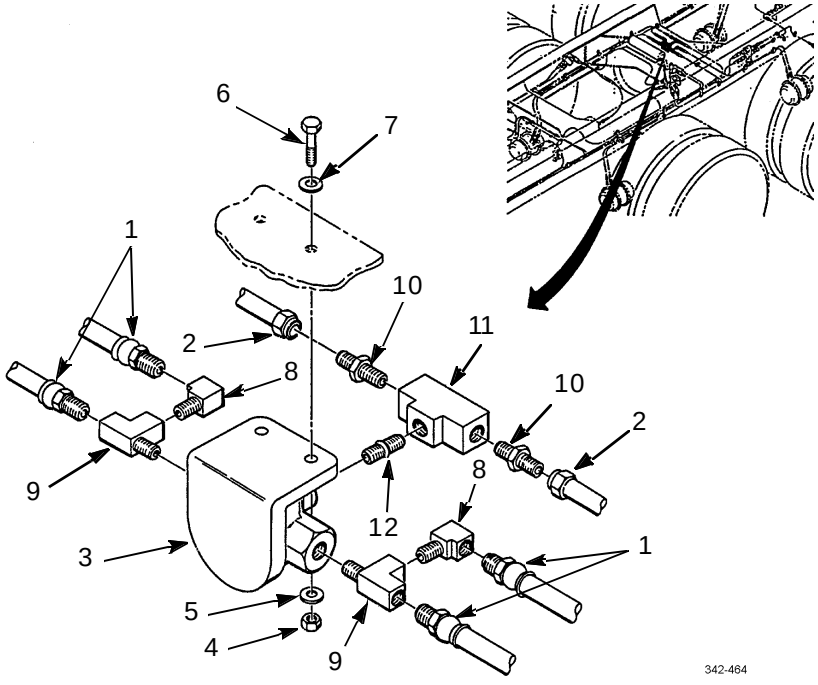
Air system drained (TM 9-2320-302-10)

REMOVAL

NOTE

Tag hoses and tubes to aid in installation.

1. Disconnect four hoses (1) and two tubes (2) from quick-release valve (3).
2. Remove two lock nuts (4), washers (5), screws (6), washers (7), and quick-release valve (3). Discard lock nuts.
3. Remove two elbows (8), tees (9), connectors (10), two-way check valve (11), and pipe nipple (12) from quick-release valve (3).

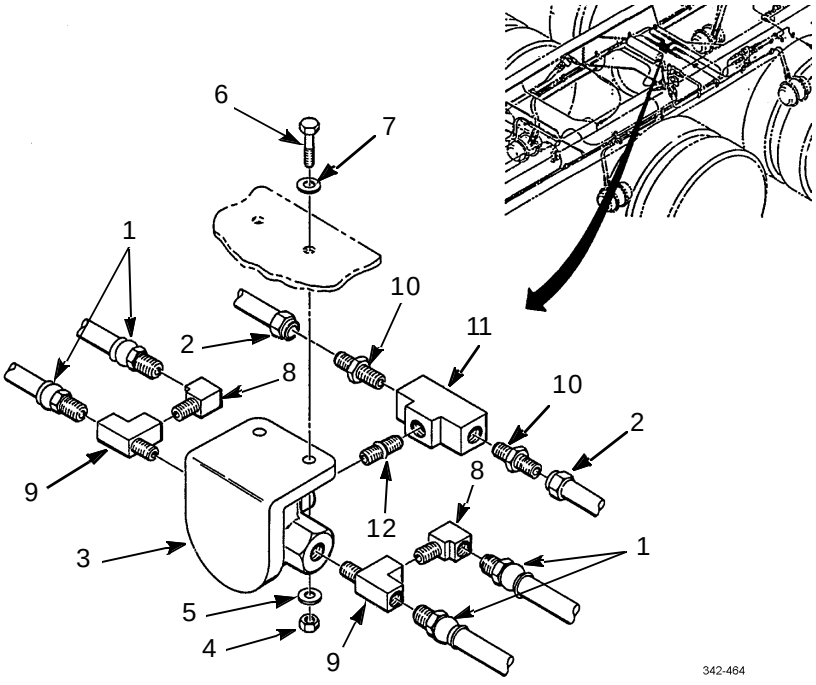


INSTALLATION

WARNINGS

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

1. Coat threads with pipe sealing compound and install pipe nipple (12), two-way check valve (11), two connectors (10), tees (9), and elbows (8) in quick-release valve (3).
2. Install quick-release valve (3) with two washers (7), screws (6), washers (5), and new lock nuts (4).
3. Connect four hoses (1) and two tubes (2) to quick-release valve (3).
4. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.



END OF WORK PACKAGE

AIR DRYER REPLACEMENT 0157 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-17) (4)

Nut, lock (P/N MS51922-49) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

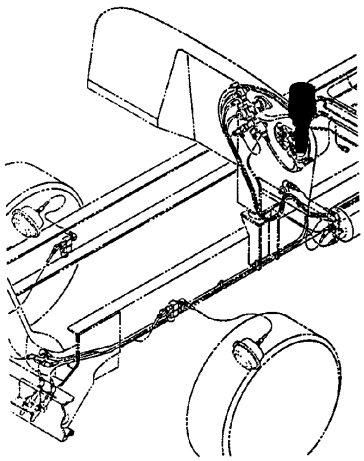
Air system drained (TM 9-2320-302-10)

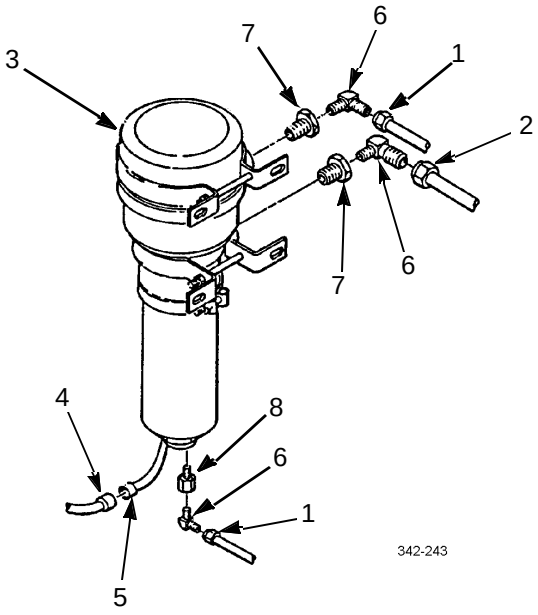
REMOVAL

NOTE

Tag air lines to aid in installation.

1. Disconnect two tubes (1) and hose (2) from air dryer (3).
2. Disconnect electrical connector (4) from air dryer wiring harness connector (5).
3. Remove three elbows (6), two bushings (7), and adapter (8) from air dryer (3).



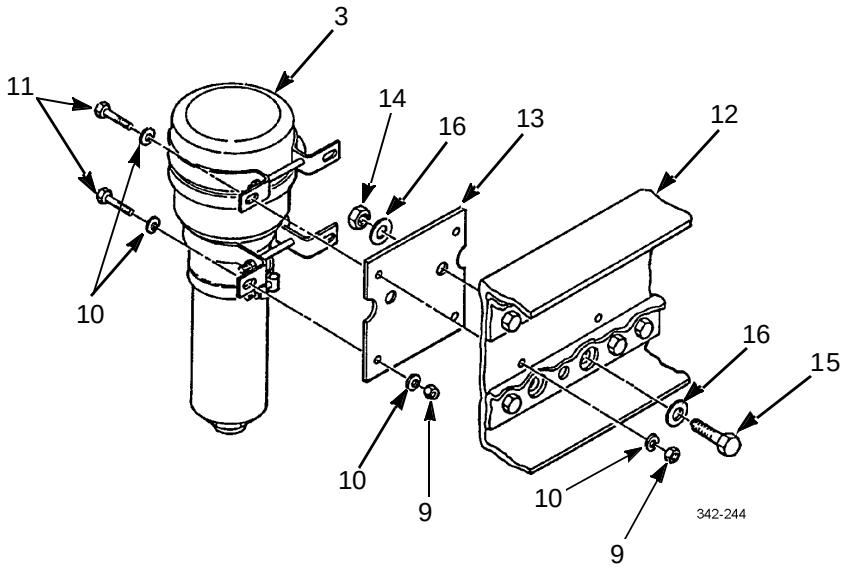


REMOVAL - CONTINUED

NOTE

Assistance is needed to support air dryer while removing mounting hardware.

4. Support air dryer (3) and remove four lock nuts (9), eight washers (10), and four screws (11) securing air dryer to frame rail (12). Remove air dryer and discard lock nuts.
5. If mounting plate (13) is damaged, remove two lock nuts (14), two screws (15), four washers (16), and mounting plate (13). Discard lock nuts.



INSTALLATION

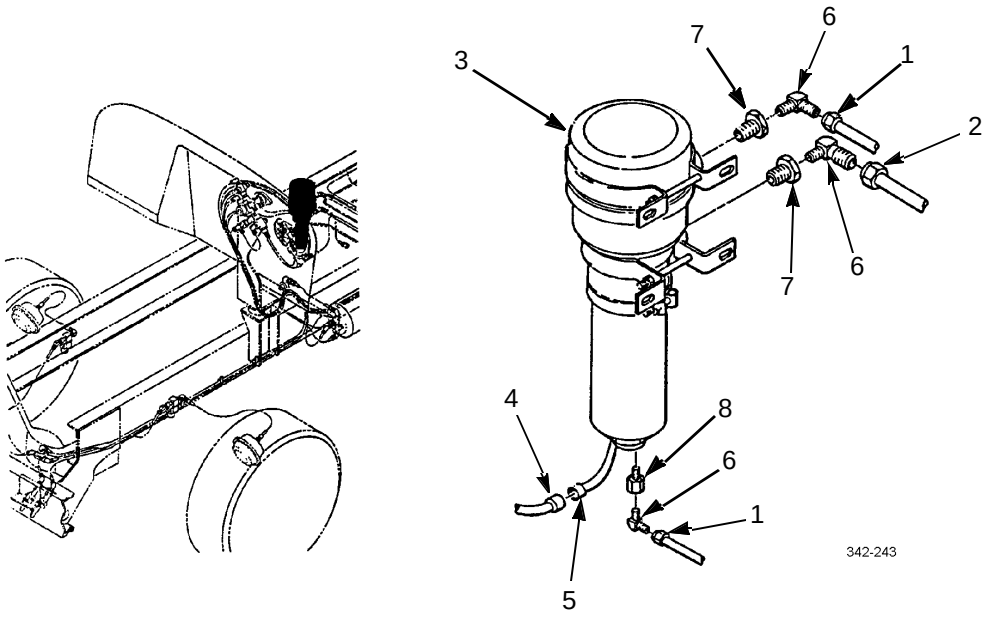
1. If removed, install mounting plate (13), four washers (16), two screws (15), and new lock nuts (14).
2. With assistance, install air dryer (3) on frame rail (12) with four screws (11), eight washers (10), and four new lock nuts (9).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound gets on skin or clothing, wash immediately with soap and water.
- Ensure air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to to follow this warning could result in injury to personnel or damage to equipment.

3. Apply pipe sealing compound to pipe threads and install adapter (8), two bushings (7), and three elbows (6) on air dryer (3).

INSTALLATION - CONTINUED



4. Connect two tubes (1) and hose (2) to air dryer (3).
5. Connect electrical connector (4) to air dryer wiring harness connector (5).
6. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

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AIR DRYER CANISTER REPLACEMENT 0158 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Kit, cartridge (P/N RN953)

Grease, GAA (Item 15, WP 0235 00)

Straps, tiedown (Item 30, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

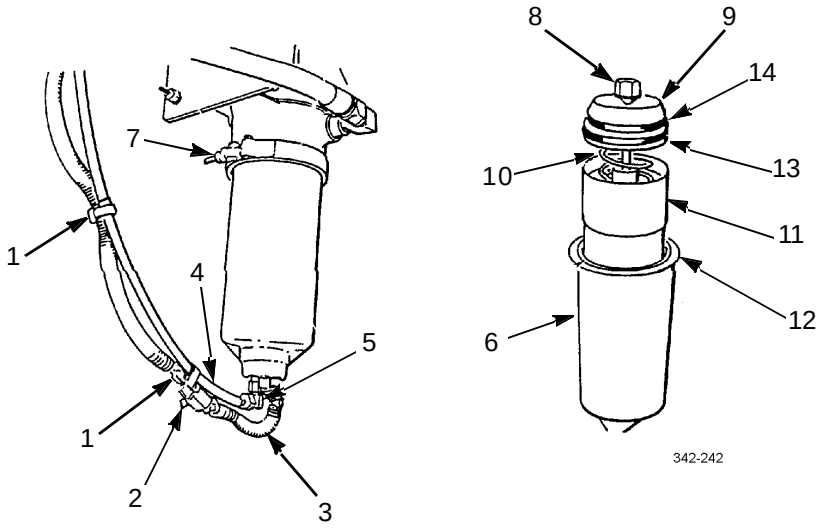
REMOVAL

1. Remove tiedown strap (1) and disconnect connector (2) from air dryer harness (3). Discard tiedown strap.
2. Disconnect air line (4) from elbow (5) on bottom of air dryer canister housing (6).

NOTE

Note position of elbow to aid in installation for proper orientation of air dryer canister.

3. Remove clamp (7) and canister housing (6) from air dryer.
4. Remove nut (8), purge plate (9), spring (10), and canister (11) from air dryer.
5. Remove packing (12) from canister housing (6). Discard packing.
6. Remove packing (13 and 14) from purge plate (9). Discard packings.



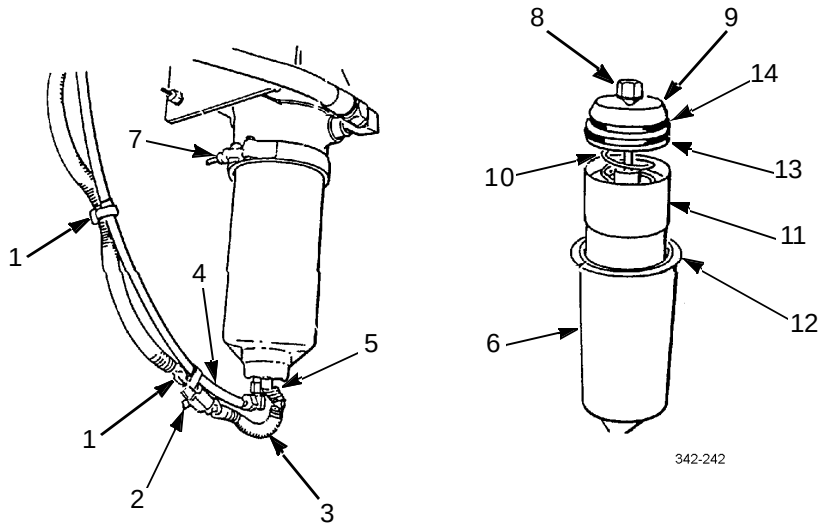
INSTALLATION

1. Lightly coat new packings (13 and 14) with GAA grease. Install packings on purge plate (9).
2. Install canister (11) in air dryer canister housing (6).
3. Install spring (10) and purge plate (9) on canister housing (6) with nut (8).
4. Install new packing (12) on canister housing (6).

NOTE

Ensure elbow is positioned as noted during removal.

5. Place canister housing (6) on air dryer and tighten clamp (7).
6. Connect air line (4) to elbow (5).
7. Connect connector (2) to air dryer harness (3). Install new tiedown strap (1).



8. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

TRAILER HAND BRAKE REPLACEMENT 0159 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

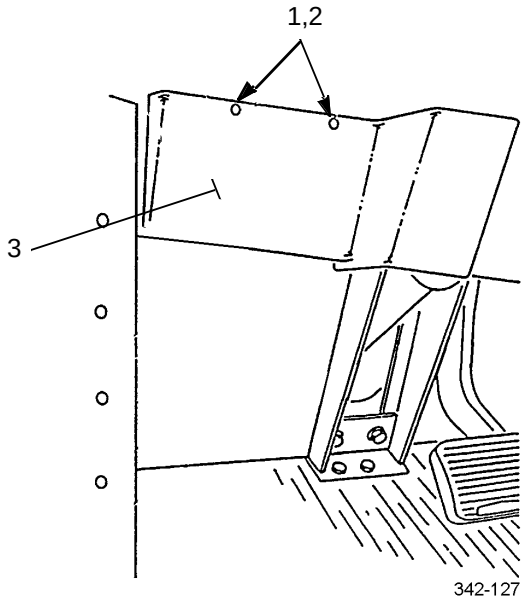
TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

REMOVAL

1. Remove six screws (1), washers (2), and cover (3).

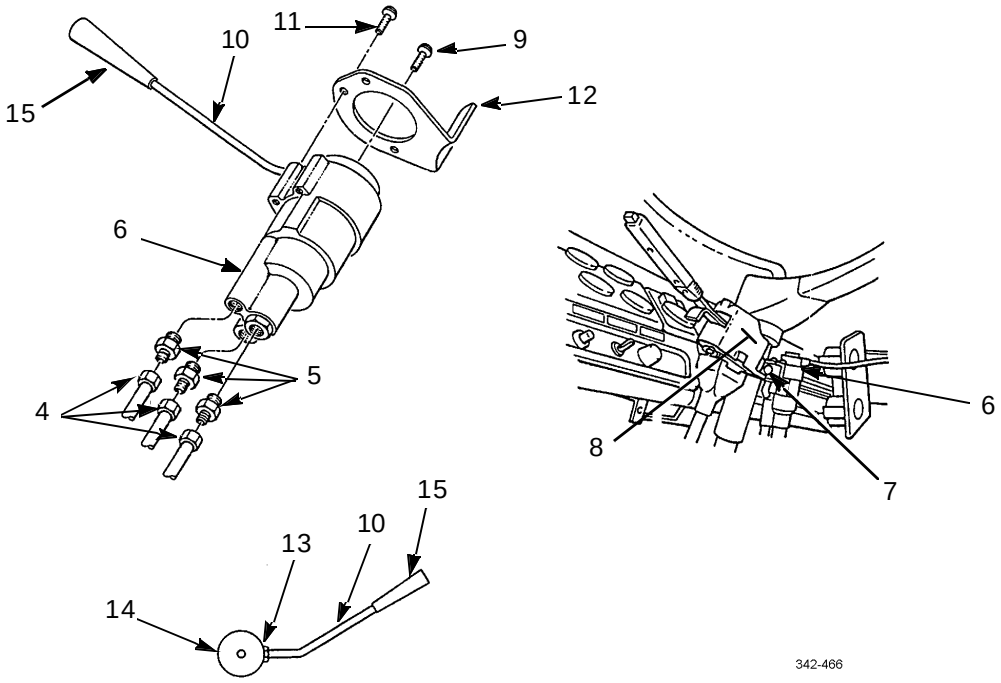


REMOVAL - CONTINUED

NOTE

Tag tubes and connectors to aid in installation.

2. Remove three tubes (4) and connectors (5) from trailer hand brake (6).
3. Remove clamp (7), trailer hand brake (6), and turn signal switch assembly (8). Set turn signal switch assembly aside.
4. Remove screw (9), handle (10), three screws (11), and bracket (12) from trailer hand brake (6).
5. Back off jamnut (13) and remove handle base (14), jamnut, and knob (15) from handle (10).



INSTALLATION

1. Install knob (15), jamnut (13), and handle base (14) on handle (10). Tighten jamnut.
2. Install bracket (12), three screws (11), handle (10), and screw (9) on trailer hand brake (6).
3. Install trailer hand brake (6) and turn signal switch assembly (8). Tighten clamp (7).

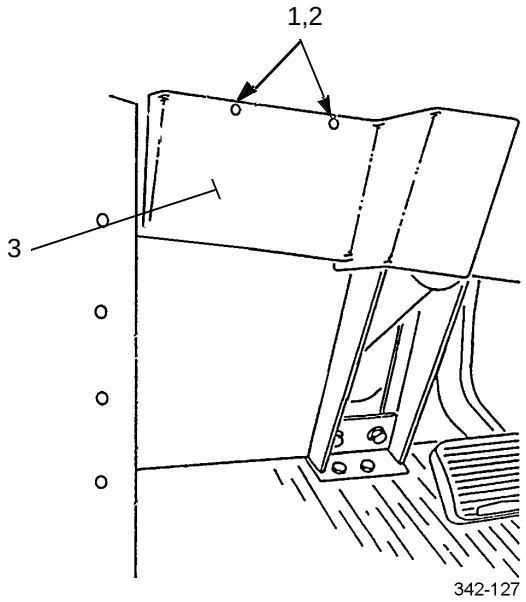
WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

TRAILER HAND BRAKE REPLACEMENT - CONTINUED 0159 00

INSTALLATION - CONTINUED

4. Lightly coat threads of three connectors (5) with pipe sealing compound. Install connectors and tubes (4) on trailer hand brake (6).
5. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.
6. Install cover (3) with six washers (2) and screws (1).



END OF WORK PACKAGE

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PARKING BRAKE AND TRAILER AIR SUPPLY VALVE REPLACEMENT 0160 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

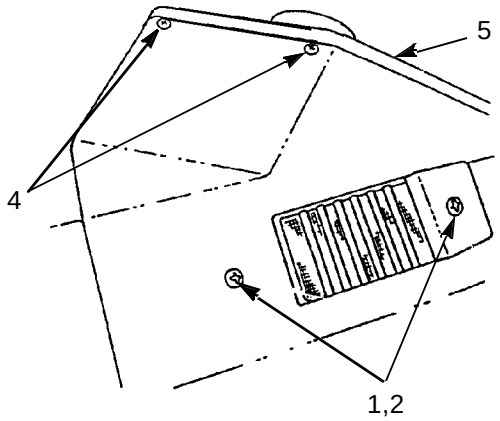
TM 9-2320-302-10

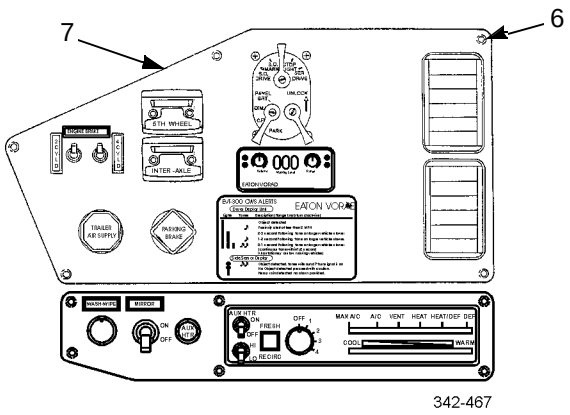
Equipment Condition

Air system drained (TM 9-2320-302-10)

REMOVAL

1. Remove two torx screws (1), washers (2), and defroster vent (3).
2. Remove four torx screws (4) and cover (5).
3. Remove five torx screws (6) and move panel (7) aside.



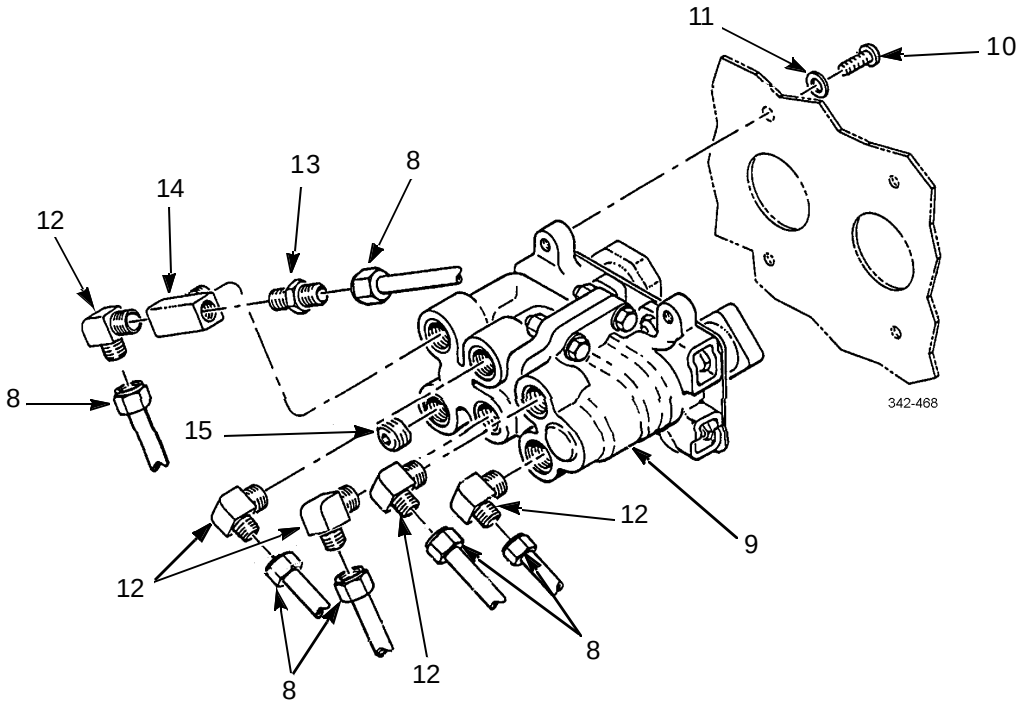


REMOVAL - CONTINUED

NOTE

Tag tubes and connectors to aid in installation.

4. Disconnect six tubes (8) from valve (9).
5. Remove four screws (10), washers (11), and valve (9).
6. Remove five elbows (12), adapter (13), tee (14), and plug (15) from valve (9).



INSTALLATION

WARNINGS

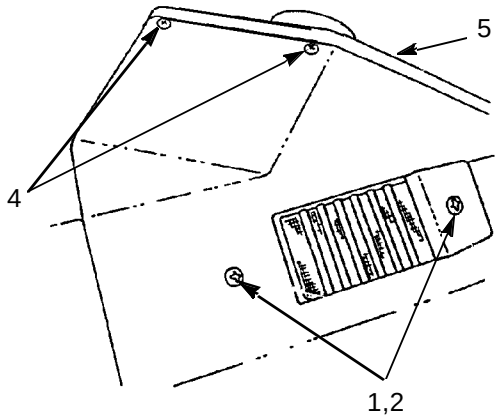
- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage and equipment.

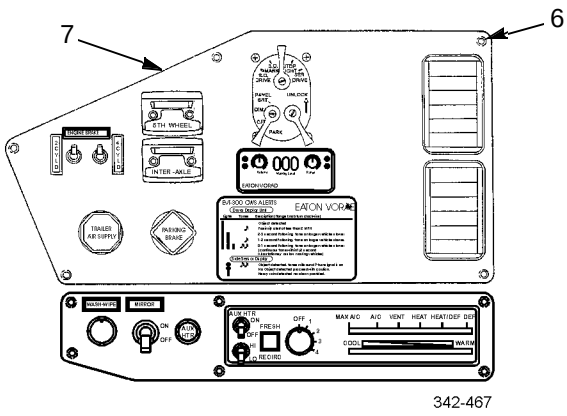
1. Coat threads with pipe sealing compound and install plug (15), tee (14), adapter (13), and five elbows (12) in valve (9).
2. Install valve (9) with four washers (11) and screws (10).
3. Connect six tubes (8) to valve (9).

PARKING BRAKE AND TRAILER AIR SUPPLY VALVE REPLACEMENT - CONTINUED 0160 00

INSTALLATION - CONTINUED

4. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.
5. Install panel (7) with five torx screws (6).
6. Install cover (5) with four torx screws (4).
7. Install defroster vent (3) with two washers (2) and torx screws (1).





END OF WORK PACKAGE

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FOOT BRAKE VALVE REPLACEMENT 0161 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Gasket (P/N 12-13041-000)

Compound, sealing, pipe (Item 10, WP 0235 00)

Grease, silicone (Item 16, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

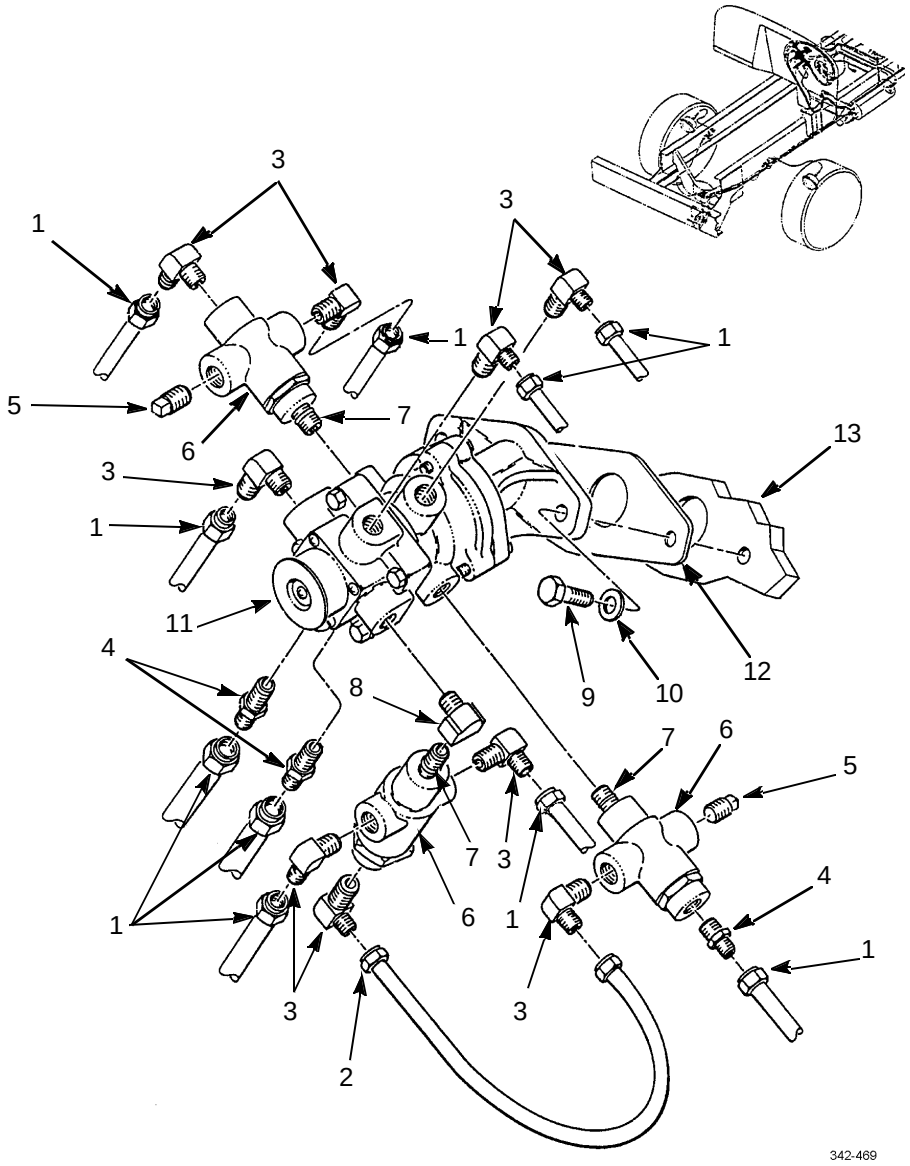
Foot brake valve plunger rod disconnected from brake pedal (WP 0134 00)

REMOVAL

NOTE

Tag tubes and connectors to aid in installation.

1. Disconnect 10 tubes (1) from elbows (3) and adapters (4). Remove tube (2).
2. Remove nine elbows (3), three adapters (4), two plugs (5), three check valves (6), three nipples (7), and elbow (8).
3. Remove two screws (9), washers (10), foot brake valve (11), and gasket (12) from firewall (13). Discard gasket.



INSTALLATION

1. Lightly coat sliding surface of foot brake valve (11) plunger and adapter bore with silicone grease.
2. Install foot brake valve (11) and new gasket (12) on firewall (13) with two washers (10) and screws (9).

WARNING

- Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.
- Ensure all air lines and fittings are clear of debris and excess pipe sealing compound does not enter air lines or fittings. Failure to follow this warning could result in injury to personnel or damage to equipment.

3. Lightly coat threads with pipe sealing compound and install elbow (8), three nipples (7), three check valves (6), two plugs (5), three adapters (4), and nine elbows (3).
4. Install tube (2). Connect 10 tubes (1) to elbows (3) and adapters (4).
5. Connect foot brake valve plunger rod to brake pedal (WP 0134 00).
6. Start vehicle and build air pressure (TM 9-2320-302-10). Check for leaks.

END OF WORK PACKAGE

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FRONT ANTI-LOCK BRAKE SYSTEM (ABS) SOLENOID VALVE REPLACEMENT 0162 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS 51922-11) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

NOTE

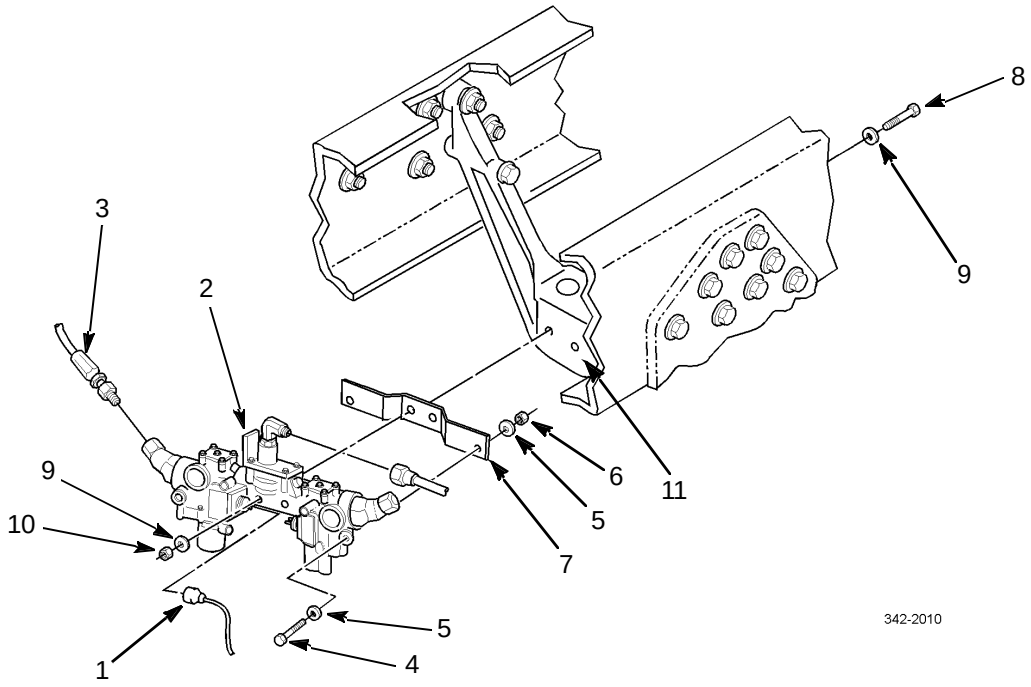
Right- and left-front ABS solenoid valves are replaced the same way. Right-front ABS solenoid valve is shown.

REMOVAL

NOTE

Tag air lines to aid in installation.

1. Disconnect two electrical cables (1) from ABS valve (2).



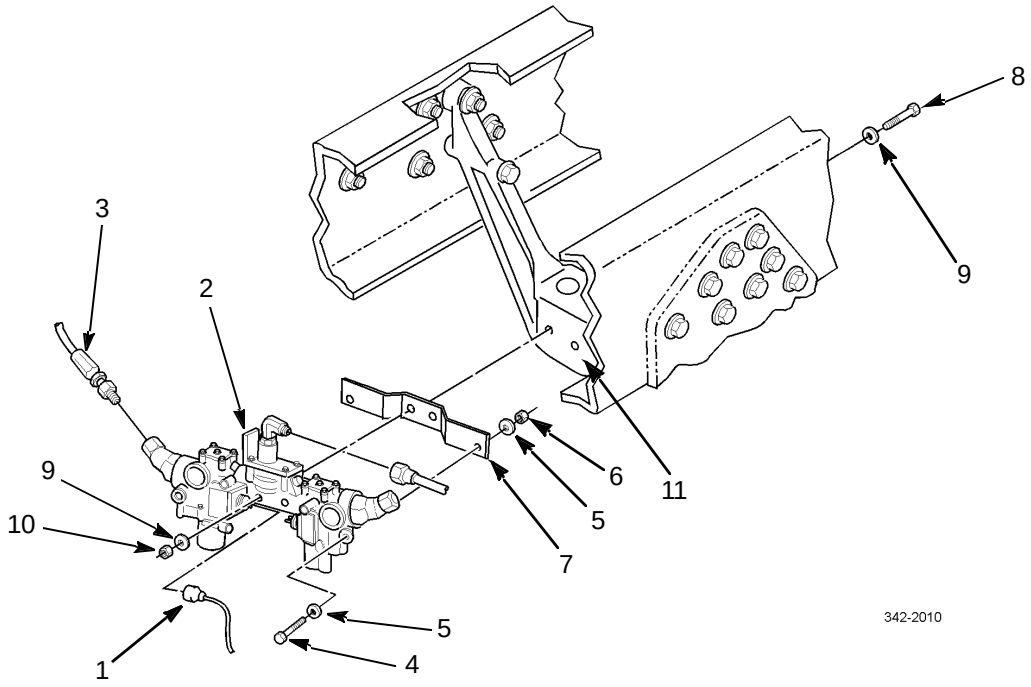
REMOVAL - CONTINUED

2. Disconnect three air lines (3) from ABS valve (2).
3. Remove two screws (4), four washers (5), two nuts (6), and ABS valve (2) from bracket (7).

NOTE

Do not perform next step unless bracket is damaged.

4. Remove two bolts (8), four washers (9), two nuts (10), and bracket (7) from frame (11).



INSTALLATION

NOTE

Do not perform next step unless bracket was removed.

1. Position bracket (7) on frame (11) and install two bolts (8), four washers (9), and two nuts (10).
2. Position ABS valve (2) on bracket (7) and install two screws (4), four washers (5), and two nuts (6).
3. Connect three air lines (3) to ABS valve (2).
4. Connect two electrical cables (1) to ABS valve (2).
5. Start vehicle (TM 9-2320-302-10) to build air pressure and check for leaks.

END OF WORK PACKAGE

REAR ANTI-LOCK BRAKE SYSTEM (ABS) SOLENOID VALVE REPLACEMENT 0163 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-11) (2)

Compound, sealing, pipe (Item 10, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

Rear platform removed (WP 0200 00)

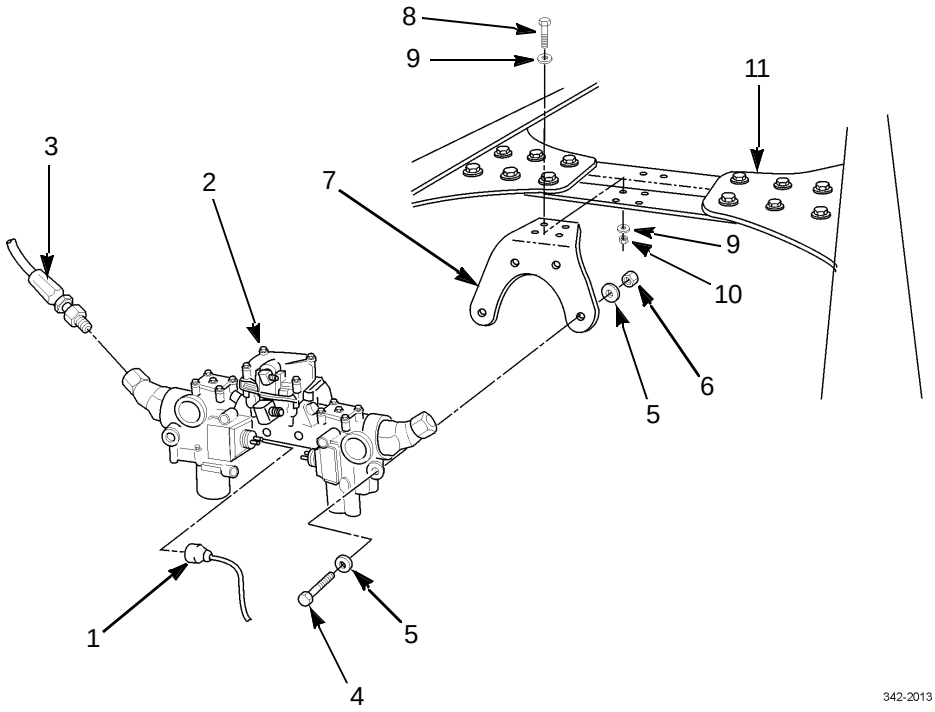
REMOVAL

1. Disconnect two electrical cables (1) from ABS valve (2).
2. Disconnect four air lines (3) from ABS valve (2).
3. Remove two screws (4), four washers (5), two nuts (6), and ABS valve (2) from bracket (7).

NOTE

Do not perform next step unless bracket is damaged.

4. Remove two bolts (8), four washers (9), two nuts (10), and bracket (7) from frame (11).

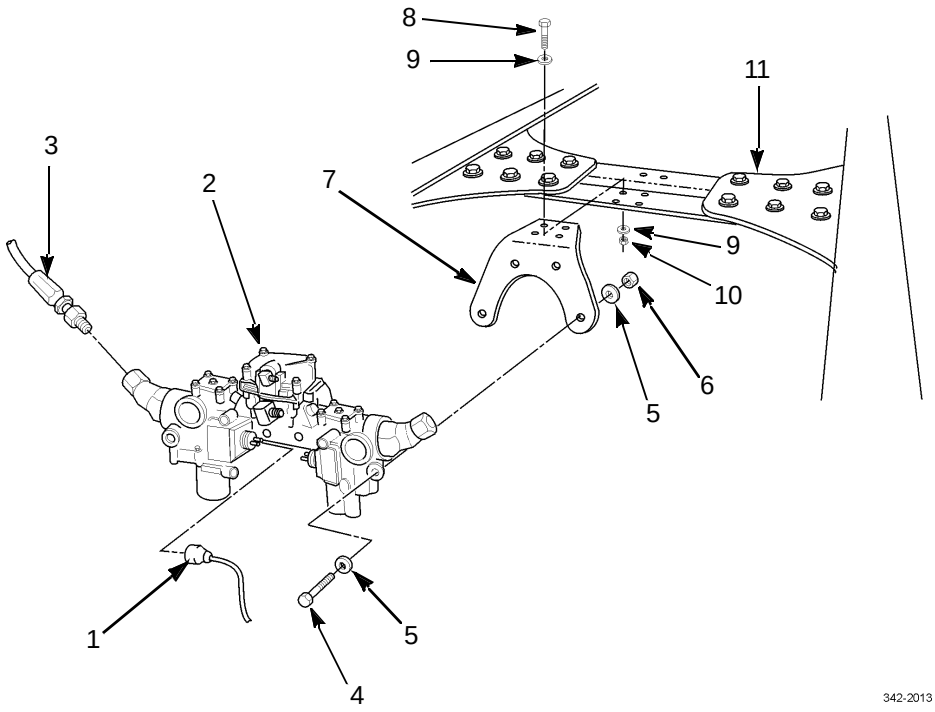


INSTALLATION

NOTE

Do not perform next step unless bracket was removed.

1. Position bracket (7) on frame (11) and install two bolts (8), four washers (9), and two nuts (10).
2. Position ABS valve (2) on bracket (7) and install two screws (4), four washers (5), and two nuts (6).
3. Connect four air lines (3) to ABS valve (2).
4. Connect two electrical cables (1) to ABS valve (2).
5. Start vehicle (TM 9-2320-302-10) to build air pressure and check for leaks.



6. Install rear platform (WP 0200 00).

END OF WORK PACKAGE

FRONT AND DUAL REAR WHEEL LUG NUT INSTALLATION 0164 00

THIS WORK PACKAGE COVERS

Front Wheel Lug Nuts Installation, Rear Wheel Lug Nuts Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-600 lb-ft (Item 47, WP 0236 00)

Wrench set, socket, 3/4 in drive (Item 48, WP 0236 00)

FRONT WHEEL LUG NUTS INSTALLATION

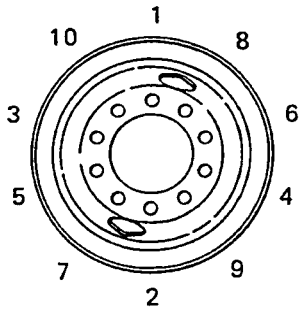
WARNING

Whenever any lug nuts require tightening or a wheel has been removed and replaced, all lug nuts must be tightened to the required torque. Failure to follow this warning may result in serious injury to personnel or damage to equipment.

NOTE

- Tightening pattern is the same for all wheel assemblies.
- After operating vehicle for 50-100 miles (80 to 160 km), tighten lug nuts again.

1. Install lug nut on each wheel stud and hand tighten until each lug nut is flush with face or chamfer of wheel.
2. Rotate wheel half a turn to seat parts and hand tighten each wheel lug nut again.
3. Tighten each lug nut to 50 lb-ft (68 Nm) in accordance with tightening pattern.



TIGHTENING PATTERN
342-489

FRONT WHEEL LUG NUTS INSTALLATION - CONTINUED

4. Using same tightening pattern, tighten each lug nut to 450-500 lb-ft (610-678 Nm).
5. Using same tightening pattern, again tighten each lug nut to 450-500 lb-ft (610-678 Nm).

REAR WHEEL LUG NUTS INSTALLATION

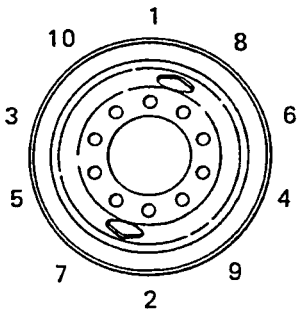
WARNING

Whenever any lug nuts require tightening or a wheel has been removed and replaced, all lug nuts must be tightened to required torque. Failure to follow this warning may result in serious injury to personnel or damage to equipment.

NOTE

- Tightening pattern is the same for all wheel assemblies.
- After operating vehicle for 50-100 miles (80 to 160 km), again tighten lug nuts.

1. Install a lug nut on each wheel stud and hand tighten until each nut is flush with face or chamfer of wheel.
2. Rotate wheel half a turn to seat parts and hand tighten each wheel lug nut again.
3. Tighten each wheel lug nut to 50 lb-ft (68 Nm) in accordance with tightening pattern.
4. Using same tightening pattern, tighten each wheel lug nut to 450-500 lb-ft (610-678 Nm).



TIGHTENING PATTERN
342-489

5. Using same tightening pattern, again tighten each wheel lug nut to 450-500 lb-ft (610-678 Nm).

END OF WORK PACKAGE

FRONT HUB, DRUM, WHEEL BEARINGS, AND SEAL REPLACEMENT 0165 00

THIS WORK PACKAGE COVERS

Removal, Installation, Adjustment (End Play)

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Handle, installer (Item 15, WP 0236 00)

Indicator, dial (Item 18, WP 0236 00)

Installation tool, ABS tone ring (Item 19, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Gasket (P/N 450755)

Seal, oil (P/N 35066)

Materials/Parts - Continued

Washer, lock (P/N 1229G475)

Washer, lock (P/N MS 35338-140) (6)

Oil, lubricating (Item 25, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Front wheel removed (TM 9-2320-302-10)

Front anti-lock brake system (ABS) sensor removed (WP 0106 00)

NOTE

Front axle ABS tone ring replacement is covered in this work package.

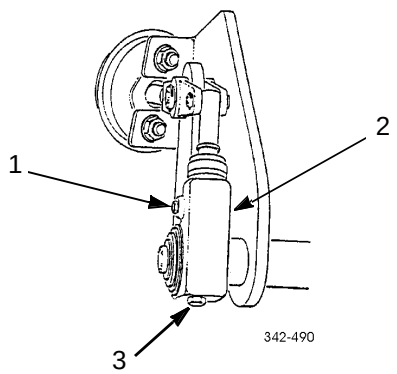
REMOVAL

1. Remove pressure relief screw, spring, and pawl assembly (1) from slack adjuster (2).

NOTE

Perform step 2 to obtain enough clearance between brake drum and brakeshoes to remove brake drum.

2. Turn adjusting nut (3) counterclockwise.



REMOVAL - CONTINUED

3. Remove brake drum (4) from hub (5).

NOTE

Place suitable container under hub opening to catch axle oil.

4. Remove six screws (6), lock washers (7), hub cap (8), and gasket (9) from hub (5). Discard gasket and lock washers.
5. Bend back tab on lock washer (10).
6. Remove jamnut (11), lock washer (10), lock ring (12), and adjusting nut (13) from axle spindle (14). Discard lock washer.
7. Remove outer wheel bearing (15) from axle spindle (14). Outer bearing race (16) will remain in bore of hub (5).
8. Remove hub (5) from axle spindle (14).
9. Remove oil seal (17) and inner wheel bearing (18) from hub (5). Discard oil seal.

NOTE

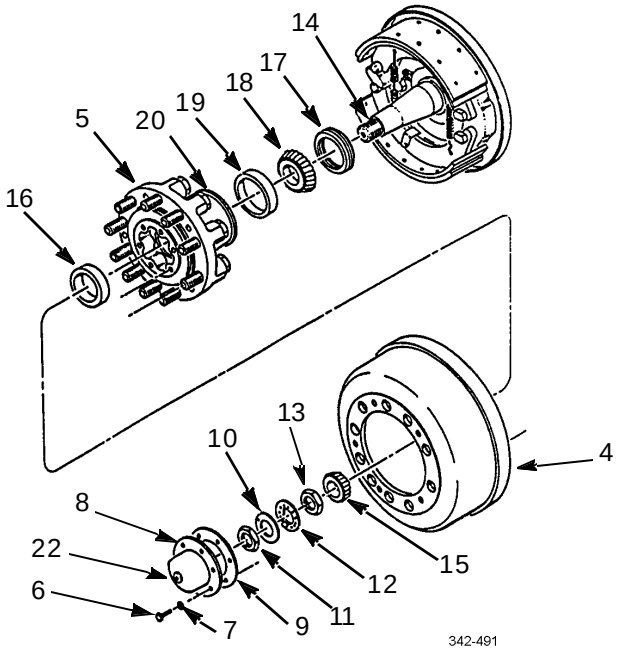
Perform step 10 if bearing races are damaged or if installing new bearings.

10. Remove inner bearing race (19) and outer bearing race (16) from bore of hub (5).

NOTE

ABS tone ring must be replaced if ring is damaged or if replacing hub.

11. To remove ABS tone ring (20) from hub (5), tap lightly beneath ring with a small hammer. Use a circular pattern with light tapping to prevent ring from cocking.



INSTALLATION

NOTE

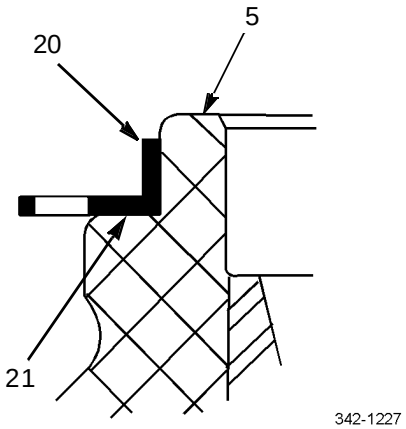
Perform step 1 if new bearing races or new bearings are being installed.

1. Install outer bearing race (16) and inner bearing race (19) in bore of hub (5).

NOTE

Ensure ABS tone ring seat on hub is clean and seat is not damaged. If seat is damaged, replace hub.

2. If removed, install ABS tone ring (20) on hub (5) as follows:
   a. Place ABS tone ring (20) on hub ring seat (21) with inside diameter flange of ring up.
   b. Center installation tool over ABS tone ring (20).
   c. Using installer handle and hammer or mallet, drive ABS tone ring (20) onto hub ring seat (21). Inspect ring to ensure complete seating on hub (5).



3. Coat two wheel bearings (15 and 18) with clean gear lubricating oil.
4. Install inner wheel bearing (18) and new oil seal (17) in hub (5).
5. Apply coat of gear lubricating oil to axle spindle (14).

CAUTION

To prevent damage to equipment, do not unseat oil seal or wheel bearing when mounting hub.

6. Mount hub (5) fully over axle spindle (14).
7. Fill cavity in hub (5) with gear lubricating oil.
8. Install outer wheel bearing (15) in hub (5).

NOTE

Install adjusting nut with dimple facing out.

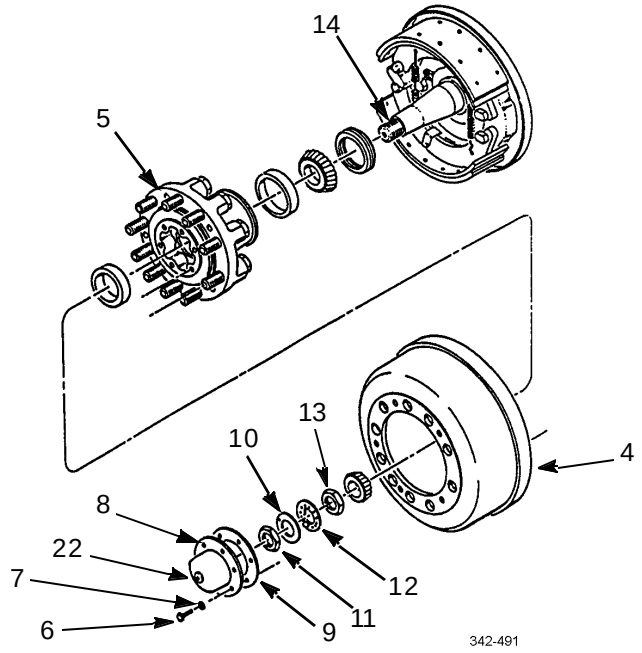
9. While turning hub (5), thread adjusting nut (13) on axle spindle (14) until against outer wheel bearing (15).
10. While turning hub (5) in both directions, tighten adjusting nut (13) to 100 lb-ft (136 Nm).
11. Loosen adjusting nut (13) completely to zero torque and spin wheel a few turns. Tighten adjusting nut to 50 lb-ft (68 Nm).
12. Back off adjusting nut (13) 1/6 to 1/4 turn.

INSTALLATION - CONTINUED

13. Install lock ring (12) and new lock washer (10) on axle spindle (14).
14. Install jamnut (11) on axle spindle (14). Tighten jamnut to 100-150 lb-ft (136-203 Nm).
15. Bend tab of lock washer (10) over a flat of jamnut (11).

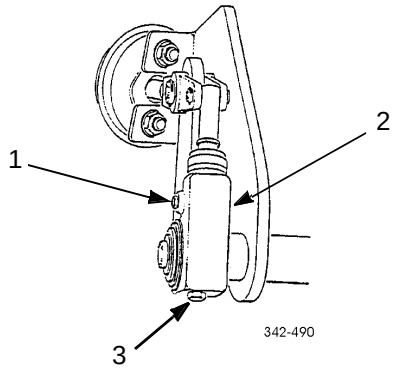
ADJUSTMENT (END PLAY)

1. Attach dial indicator magnetic base to hub (5).
2. Adjust dial indicator so plunger is against spindle (14) end.
3. Position dial indicator parallel to axis of spindle (14).
4. Grasp hub (5) at 3 and 9 o'clock positions.
5. Push and pull hub (5) in and out while rotating hub approximately 45 degrees.
6. Not end play while rotating hub (5) until dial indicator tip is in same position before rotation began.
7. Acceptable end play is .001-.005 inches.
8. If end play is not within tolerance, loosen jamnut (11) and either back off or tighten adjusting nut (13) as required.
9. Repeat steps 1 through 7 until acceptable end play is achieved.
10. Install hub cap (8) and new gasket (9) on hub (5) and with six screws (6) and new lock washers (7). Tighten screws to 180 lb-in (20 Nm).
11. Remove hub filler cap (22) and add gear lubricating oil to level of filler hole. Wait 5 minutes and add more oil, as needed.
12. Install hub filler cap (22).
13. Install brake drum (4) over hub (5).



ADJUSTMENT (END PLAY) - CONTINUED

14. Install pressure relief screw, spring, and pawl assembly (1) in slack adjuster (2). Tighten to 180-240 lb-in (20-27 Nm).



15. Install front wheel (TM 9-2320-302-10).
16. Adjust slack adjuster (WP 0139 00).
17. Install front anti-lock brake system (ABS) sensor (WP 0106 00).

END OF WORK PACKAGE

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REAR HUB, DRUM, WHEEL BEARINGS, AND SEAL REPLACEMENT 0166 00

THIS WORK PACKAGE COVERS

Removal, Installation, Adjustment (End Play)

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Handle, installer (Item 15, WP 0236 00)

Indicator, dial (Item 18, WP 0236 00)

Installation tool, ABS tone ring (Item 19, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Socket, socket wrench (Item 29, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Wrench, torque, 0-600 lb-ft (Item 47, WP 0236 00)

Materials/Parts

Gasket (P/N 2208x440)

Seal, oil (P/N 1277701)

Oil, lubricating (Item 25, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

Rear brakes caged (TM 9-2320-302-10)

Rear wheel removed (TM 9-2320-302-10)

Rear anti-lock brake system (ABS) sensor removed (rear-rear axle only) (WP 0107 00)

NOTE

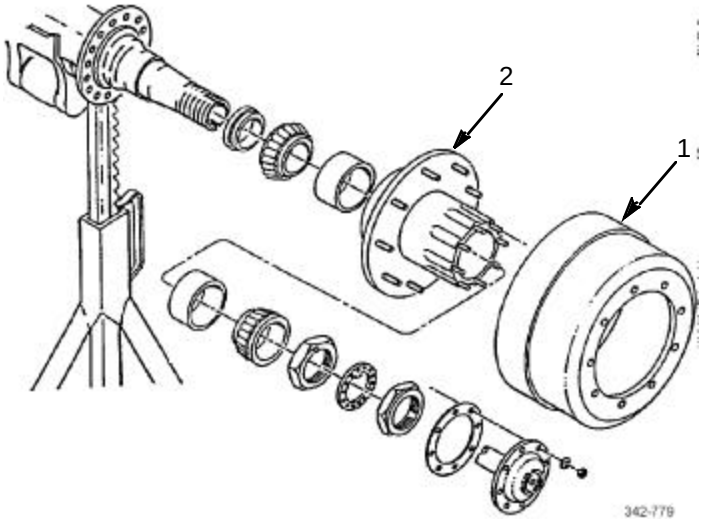
Rear-rear axle ABS tone ring replacement is covered in this work package.

REMOVAL

NOTE

- Procedure is the same for both sides.
- Procedure is the same for both rear axles except as noted.

1. Remove brake drum (1) from hub (2).



REMOVAL - CONTINUED

CAUTION

Ensure axle hub studs are not damaged during axle shaft removal. If damage occurs, replace stud to allow proper installation of tapered dowels and nuts.

NOTE

Have suitable container available to catch oil that will spill when axle shaft is removed.

2. Remove eight nuts (3), washers (4), axle shaft (5), and gasket (6). Discard gasket.
3. Remove jamnut (7), lock ring (8), and adjusting nut (9) from axle spindle (10).
4. Remove outer wheel bearing (11) from axle spindle (10).
5. Remove hub (2) from axle spindle (10).
6. Remove and discard seal (12) from hub (2).
7. Remove inner wheel bearing (13) from hub (2).
8. If damaged, remove eight studs (14) from hub (2).

NOTE

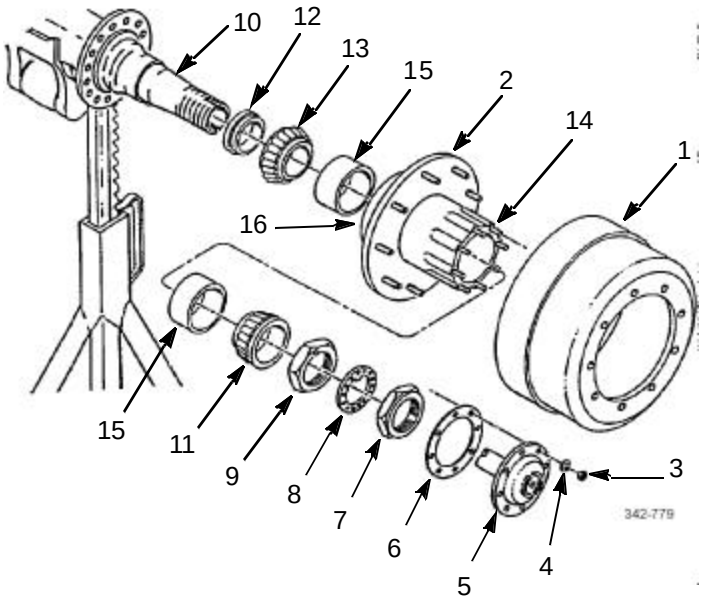
Perform step 9 if bearing cups are damaged or if installing new wheel bearings.

9. Using brass drift pin, carefully remove and discard two bearing cups (15) from hub (2).

NOTE

- The following step applies only to rear-rear axle hub.
- ABS tone ring must be replaced if ring is damaged or if replacing hub.

10. To remove ABS tone ring (16) from hub (2), use a small pry bar or hammer to gently pry off ring. Use a circular pattern around ring to prevent cocking.



INSTALLATION

NOTE

- Procedure is the same for both sides.
- Procedure is the same for both rear axles except as noted.

CAUTION

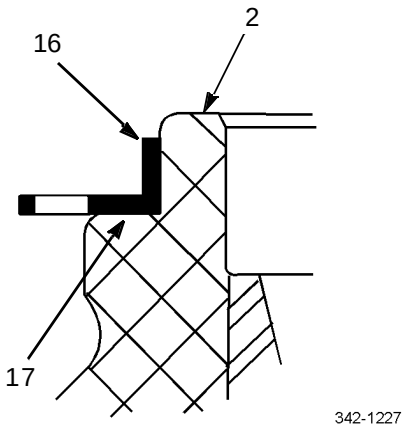
Bearings and bearing cups must be replaced as a set. Failure to do so could result in premature damage to either bearings or bearing cups.

1. If removed, use a brass draft pin to carefully install two bearing cups (15) in hub (2).
2. If removed, install eight studs (14) in hub (2).

NOTE

- The following step applies only to rear-rear axle hub.
- Ensure ABS tone ring seat on hub is clean and seat is not damaged. If seat is damaged, replace hub.

3. If removed, install ABS tone ring (16) on hub (2) as follows:
   a. Place ABS tone ring (16) on hub ring seat (17) with inside diameter flange of ring up.
   b. Center installation tool over ABS tone ring (16).
   c. Using installer handle and hammer or mallet, drive ABS tone ring (16) onto hub ring seat (17). Inspect ring to ensure complete seating on hub (2).



4. Coat inner wheel bearing (13) with gear lubricating oil.
5. Install inner wheel bearing (13) in hub (2).
6. Install new oil seal (12) in hub (2).
7. Install hub (2) on axle spindle (10) and fill cavity with gear lubricating oil.
8. Coat outer wheel bearing (11) with gear lubricating oil.
9. Install outer wheel bearing (11) in hub (2).

INSTALLATION - CONTINUED

NOTE

Adjusting nut can be identified by protrusion on one side.

10. With protrusion facing out, install adjusting nut (9) until adjusting nut contacts outer wheel bearing (11).

CAUTION

Hub must be rotated in both directions while tightening adjusting nut. Failure to do so will result in premature bearing failure.

11. Tighten adjusting nut (9) to 100 lb-ft (136 Nm).
12. Loosen adjusting nut (9) completely, then tighten to 50 lb-ft (68 Nm).
13. Loosen adjusting nut (9) 1/4 turn.

NOTE

During step 13, it may be necessary to tighten adjusting nut to align protrusion with alignment hole in lock ring.

14. Install lock ring (8) on axle spindle (10).
15. Install jamnut (7) on axle spindle (10). Tighten jamnut to 250-400 lb-ft (339-542 Nm).

ADJUSTMENT (END PLAY)

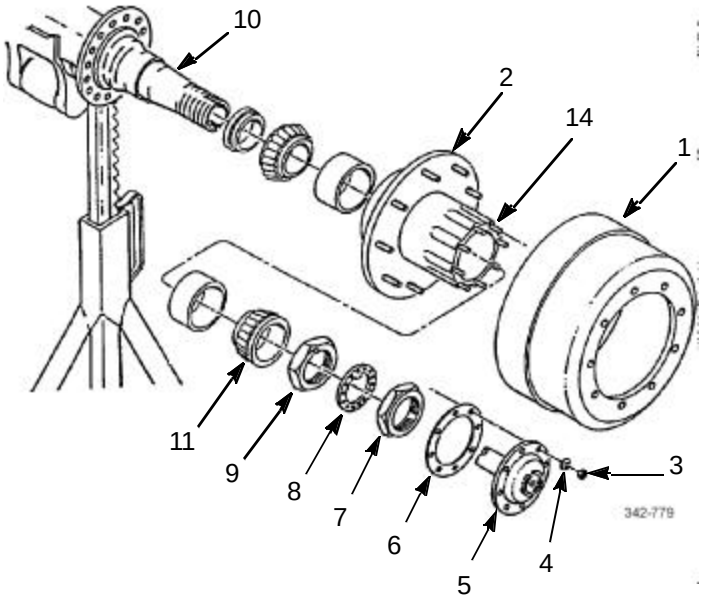
1. Attach dial indicator magnetic base to hub (2).
2. Adjust dial indicator so plunger is against spindle (10) end.
3. Position dial indicator parallel to axis of spindle (10).
4. Grasp hub (2) at 3 and 9 o'clock positions.
5. Push and pull hub (2) in and out while rotating hub approximately 45 degrees.
6. Note end play while rotating hub (2) until dial indicator tip is in same position before rotation began.
7. Acceptable end play is .001 - .005 inches.
8. If end play is not within tolerance, loosen jamnut (7) and either back off or tighten adjusting nut (9) as required.
9. Repeat steps 1 through 7 until acceptable end play is achieved.
10. Install new gasket (6) on studs (14).

NOTE

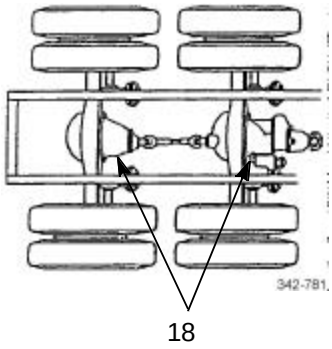
Splines on axle shaft must engage in differential before axle flange will seat against hub.

11. Install axle shaft (5) with eight washers (4) and nuts (3). Tighten nuts to 155 lb-ft (210 Nm).
12. Install brake drum (1) on hub (2).

ADJUSTMENT (END PLAY) - CONTINUED



13. Remove plug (18) and check oil level in accordance with Unit PMCS. Add oil as needed (WP 0021 00).
14. Install plug (18) and tighten to 35 lb-ft (47 Nm).



15. Install rear wheels (TM 9-2320-302-10).
16. Install rear anti-lock brake system (ABS) sensor (rear-rear axle only) (WP 0107 00).
17. Uncage rear brakes (TM 9-2320-302-10).

END OF WORK PACKAGE

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STEERING WHEEL REPLACEMENT 0167 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Puller kit, universal (Item 27, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-12077-000)

Equipment Condition

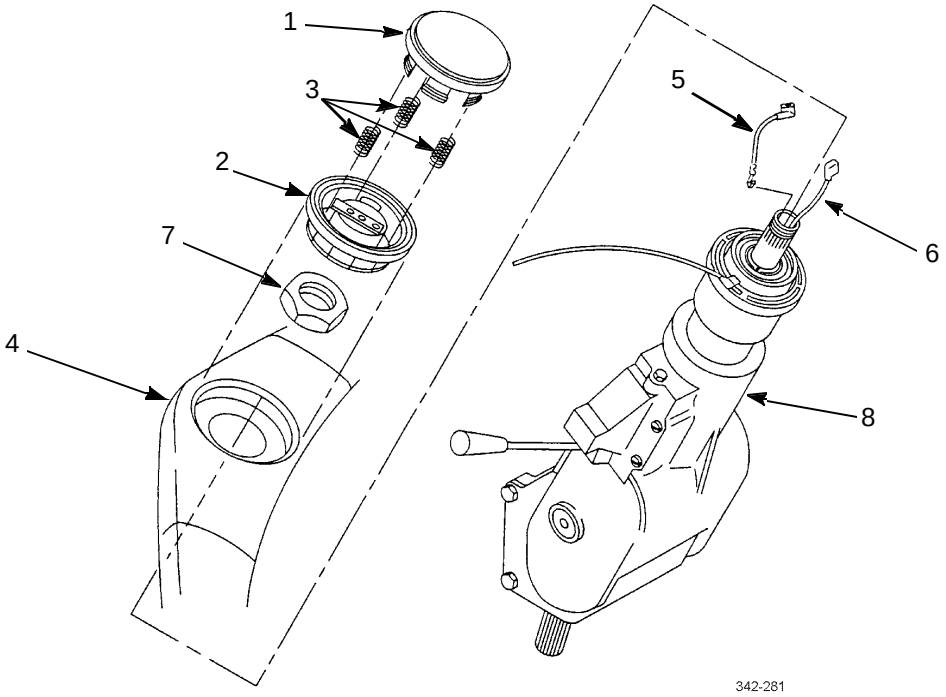
Front wheels turned straight ahead

REMOVAL

NOTE

Avoid rotating steering wheel during removal.

1. Pry cover (1) from horn button (2) and remove three springs (3).
2. Remove horn button (2) from steering wheel (4) and remove wires (5) and (6) from horn button.
3. Remove lock nut (7) from steering column (8). Discard lock nut.

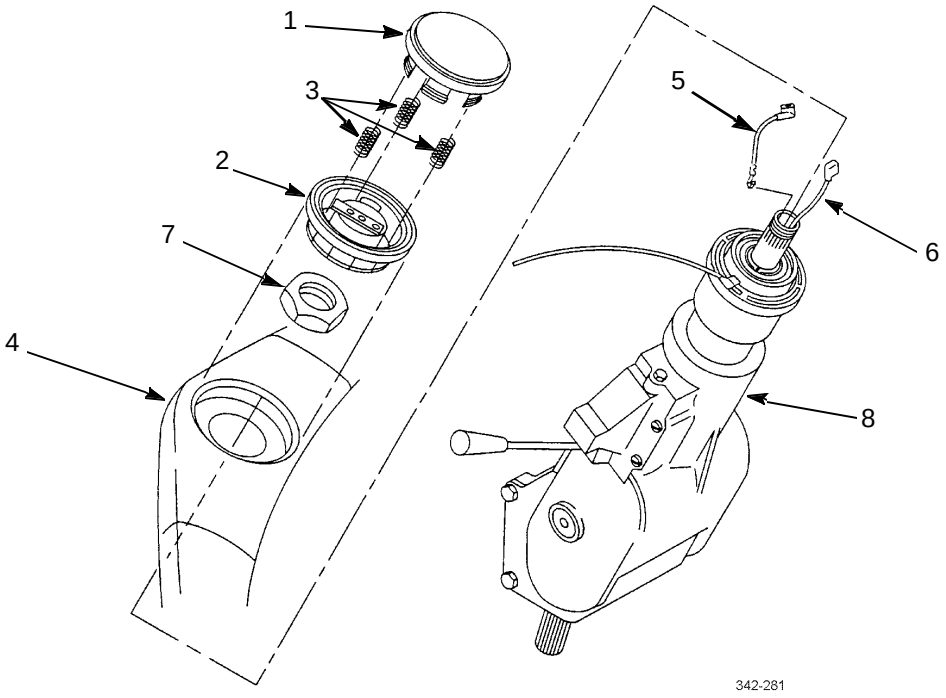


REMOVAL - CONTINUED

CAUTION

Use caution when removing steering wheel to prevent damage to wires.

4. Using universal puller kit, remove steering wheel (4) from steering column (8).



INSTALLATION

1. Align steering wheel (4) with steering column (8) and install new lock nut (7). Tighten lock nut to 60 lb-ft (81 Nm).
2. Install wires (5) and (6) on horn button (2). Press horn button on steering wheel (4).
3. Install three springs (3) and cover (1) on horn button (2).

END OF WORK PACKAGE

UNIVERSAL SHAFT REPLACEMENT AND REPAIR 0168 00

THIS WORK PACKAGE COVERS

Removal, Disassembly, Assembly, Installation

INITIAL SETUP

Tools and Special Tools

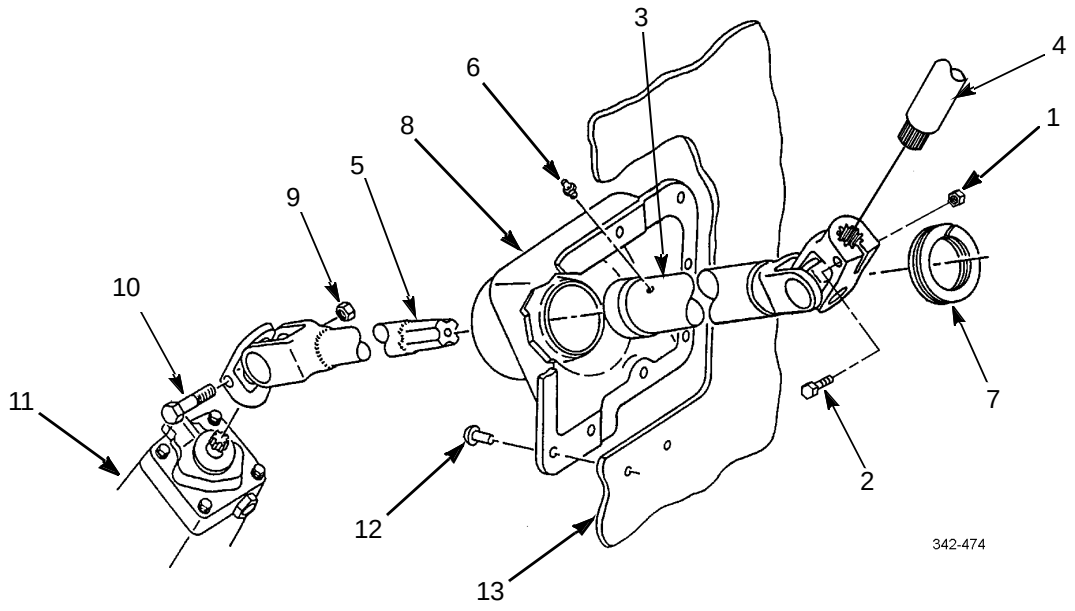
Tool kit, general mechanic's (Item 36, WP 0236 00)
Drill, electric, portable (Item 11, WP 0236 00)
Drill set, twist (Item 12, WP 0236 00)
Riveter, blind, hand (Item 28, WP 0236 00)

Materials/Parts

Nut, lock, (P/N 115307A)
Nut, lock (P/N 2C447622)
Kit (P/N 5-170X) (2)
Rivet, blind (P/N 1641-0631) (10)

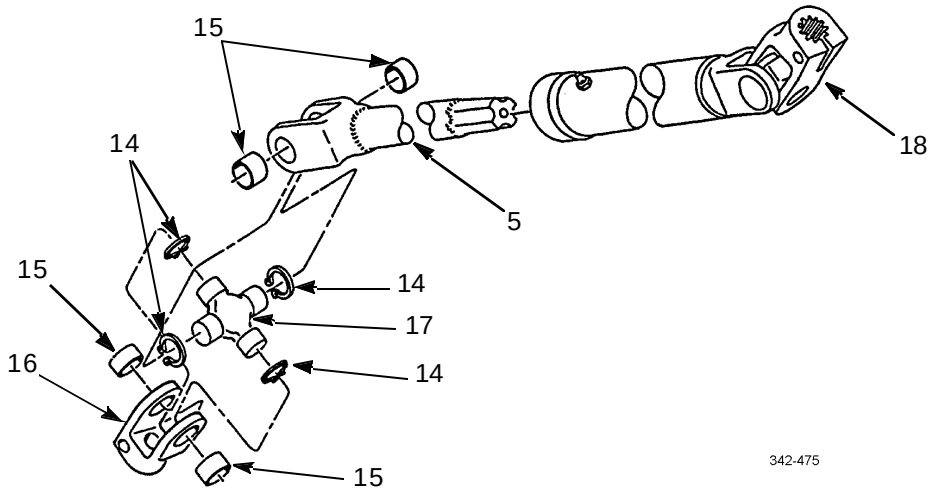
REMOVAL

1. Remove lock nut (1) and screw (2) from upper shaft (3). Discard lock nut.
2. Disconnect upper shaft (3) from steering column (4).
3. Support lower shaft (5) and remove grease fitting (6) from upper shaft (3).
4. Remove bushing (7) from boot (8).
5. Separate upper shaft (3) from lower shaft (5) and remove upper shaft from boot (8).
6. Remove lock nut (9), screw (10), and lower shaft (5) from steering gear (11). Discard lock nut.
7. If damaged, remove ten rivets (12) and boot (8) from firewall (13). Discard rivets.



DISASSEMBLY

1. Remove four snap rings (14), bearings (15), lower yoke (16), and cross (17) from lower shaft (5).
2. Repeat step 1 for upper yoke (18).



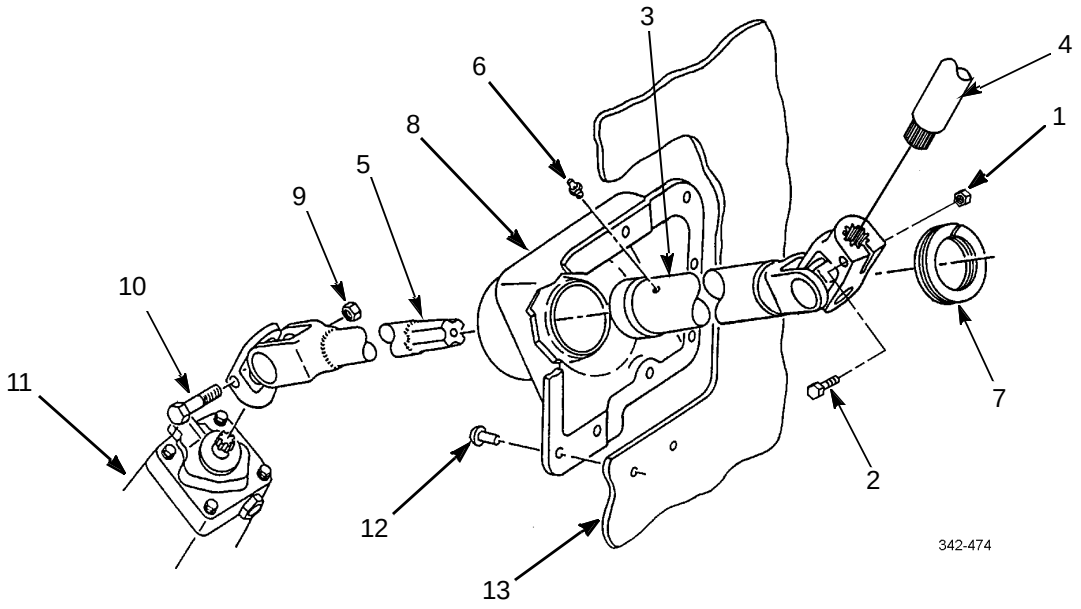
ASSEMBLY

1. Install cross (17), lower yoke (16), four bearings (15), and snap rings (14) on lower shaft (5).
2. Repeat step 1 for upper yoke (18).

INSTALLATION

1. If removed, install boot (8) on firewall (13) with ten new rivets (12).
2. Install splined end of lower shaft (5) through boot (8).
3. Install lower shaft (5) on steering gear (11).
4. Support lower shaft (5) on steering gear (11) and install screw (10) and new lock nut (9).
5. Install upper shaft (3) through boot (8) and onto lower shaft (5).
6. Install bushing (7) on boot (8).
7. Install grease fitting (6) in upper shaft (3).
8. Connect upper shaft (3) to steering column (4) and install screw (2) and new lock nut (1).

INSTALLATION - CONTINUED



END OF WORK PACKAGE

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PITMAN ARM AND DRAG LINK MAINTENANCE 0169 00

THIS WORK PACKAGE COVERS

Drag Link Removal, Pitman Arm Removal, Drag Link Installation, Pitman Arm Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)
Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-61)
Pin, cotter (P/N MS24665-379) (2)

References

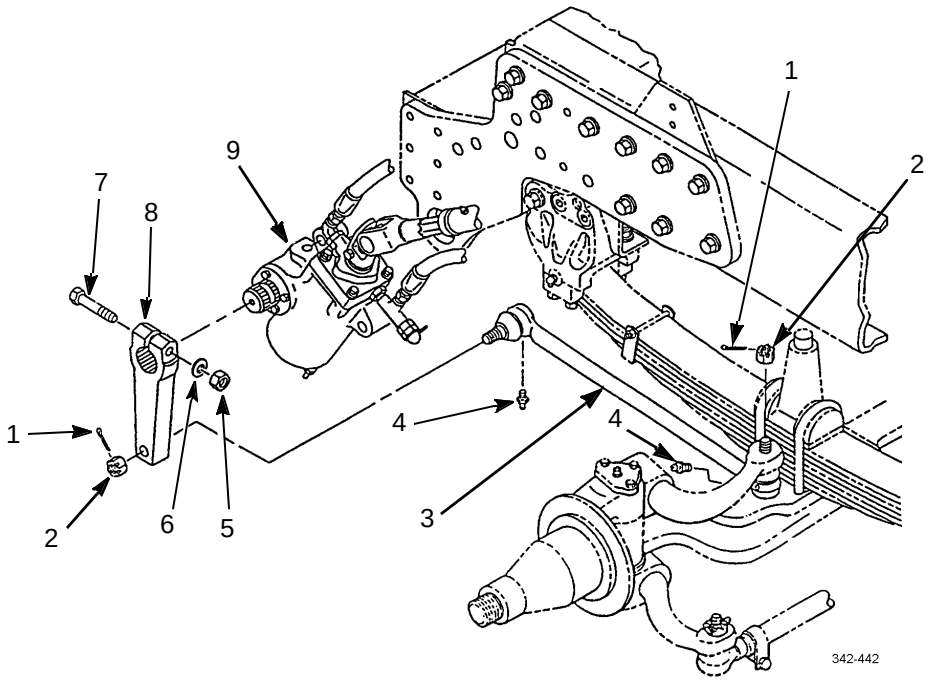
TM 9-2320-302-10

DRAG LINK REMOVAL

1. Remove two cotter pins (1) and castle nuts (2) from drag link (3). Remove drag link from vehicle. Discard cotter pins.
2. Remove two grease fittings (4) from drag link (3).

PITMAN ARM REMOVAL

Remove lock nut (5), washer (6), screw (7), and pitman arm (8) from steering gear (9). Discard lock nut.



DRAG LINK INSTALLATION

1. Install two grease fittings (4) in drag link (3).

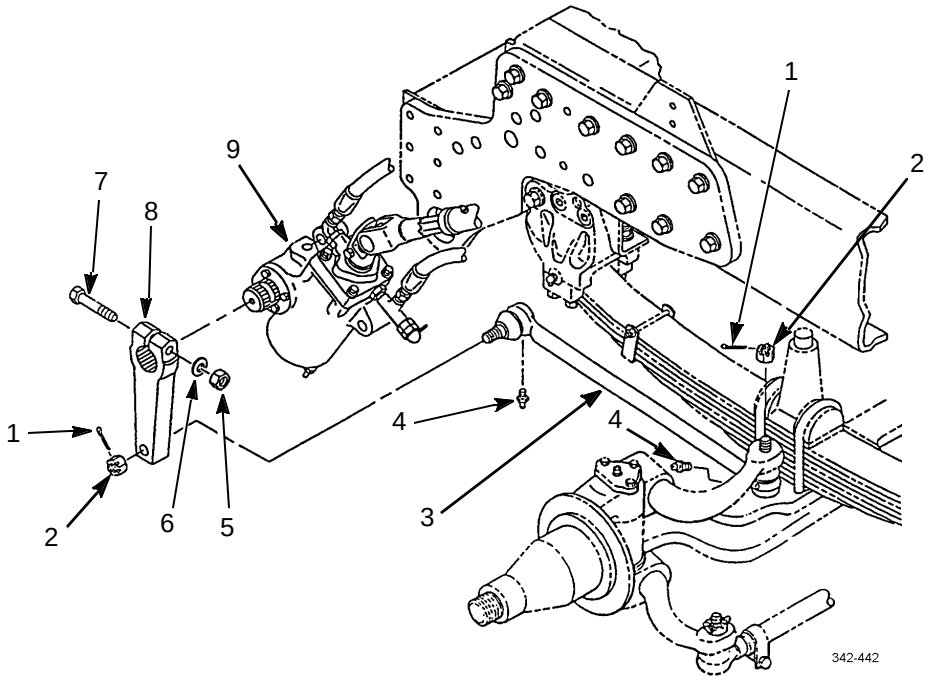
NOTE

Castle nuts are tightened to 160-215 lb-ft (217-292 Nm). Castle nuts may be tightened further to allow for cotter pin insertion. DO NOT exceed 300 lb-ft (407 Nm).

2. Install drag link (3) on vehicle with one castle nut (2) and one new cotter pin (1).

PITMAN ARM INSTALLATION

1. Install pitman arm (8) on steering gear (9) with screw (7), washer (6), and new lock nut (5). Tighten lock nut to 150-220 lb-ft (203-298 Nm).
2. Connect pitman arm (8) to drag link (3) and secure with castle nut (2) and new cotter pin (1).



END OF WORK PACKAGE

POWER STEERING RESERVOIR AND HOSE MAINTENANCE 0170 00

THIS WORK PACKAGE COVERS

Removal, Disassembly, Assembly, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Filter element (P/N 83213D)

Gasket (P/N Q-59278)

Materials/Parts - Continued

Nut, lock (P/N MS51922-33) (2)

Oil, lubricating (Item 19, WP 0235 00)

Rags, wiping (Item 28, WP 0235 00)

References

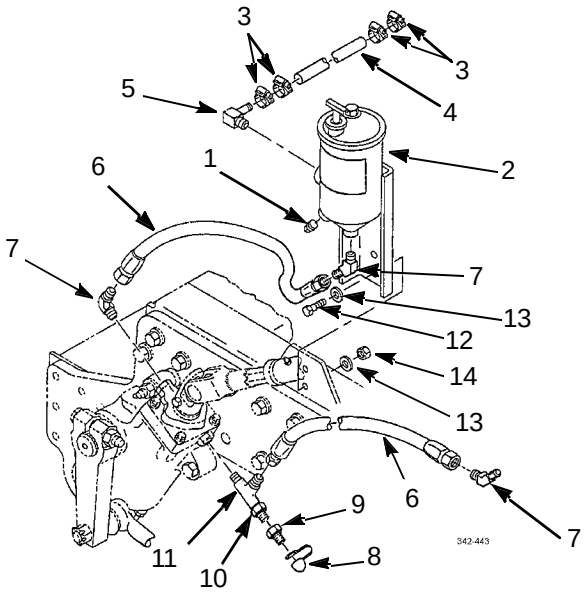
TM 9-2320-302-10

REMOVAL

WARNING

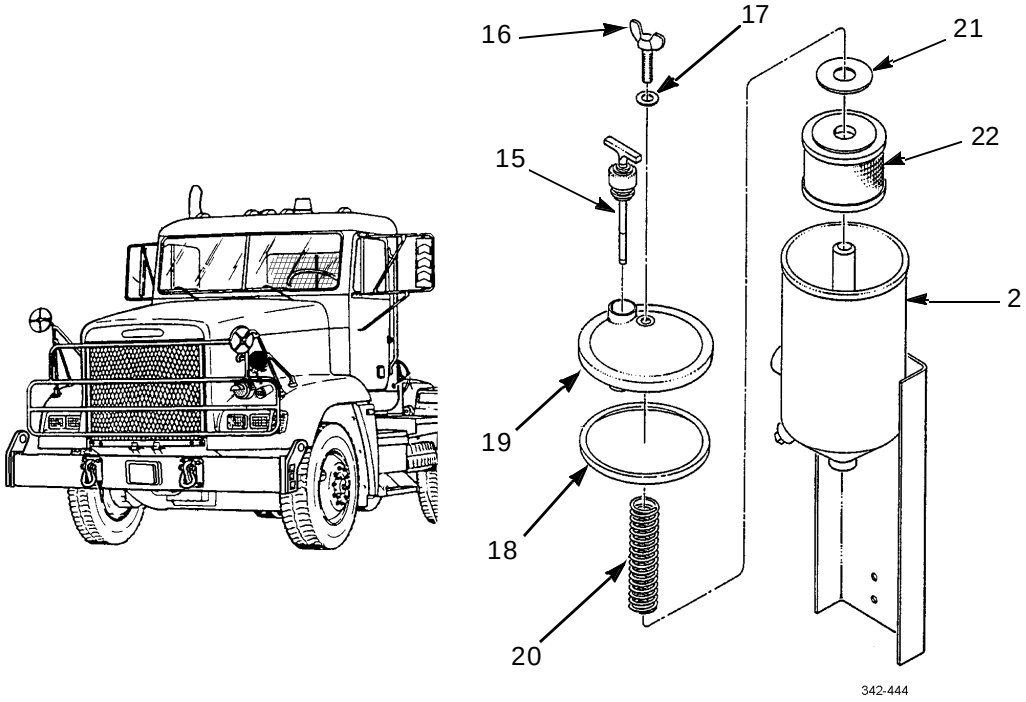
Spilled hydraulic fluid is very slippery. Wipe up any spilled fluid immediately. Failure to do so could result in serious injury to personnel.

1. Remove plug (1) and drain power steering reservoir (2).
2. Remove four clamps (3), hose (4), and elbow (5) from power steering reservoir (2).
3. Remove two hoses (6), three elbow fittings (7), protective cap (8), quick disconnect fitting (9), adapter fitting (10), and tee (11).
4. Remove two screws (12), four washers (13), two lock nuts (14), and power steering reservoir (2). Discard lock nuts.



DISASSEMBLY

1. Remove dipstick (15), wing screw (16), washer (17), gasket (18), and cover assembly (19). Discard gasket.
2. Remove spring (20), washer (21), and filter element (22) from power steering reservoir (2). Discard filter element.



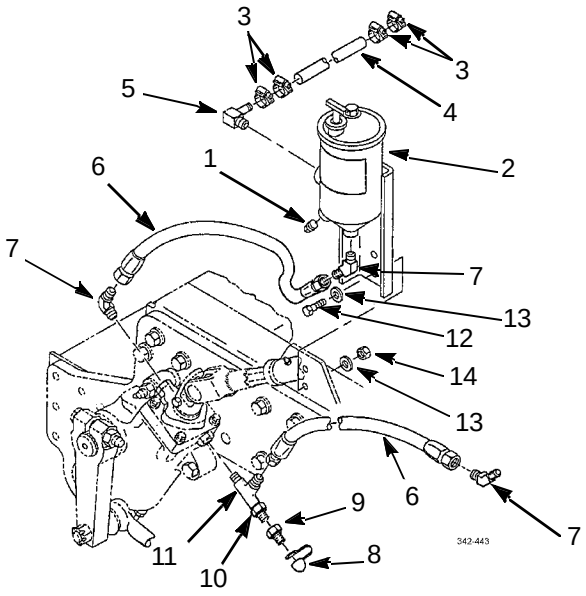
ASSEMBLY

1. Install new filter element (22), washer (21), and spring (20).
2. Install new gasket (18), cover assembly (19), washer (17), wing screw (16), and dipstick (15) in power steering reservoir (2).

INSTALLATION

1. Position power steering reservoir (2) and secure with two screws (12), four washers (13), and two new lock nuts (14).
2. Install three elbow fittings (7), tee (11), adapter fitting (10), quick disconnect fitting (9), protective cap (8), and two hoses (6).
3. Install elbow (5) and connect hose (4) using four clamps (3).
4. Install drain plug (1) in power steering reservoir (2).
5. Fill power steering reservoir (2) with lubricating oil in accordance with Unit PMCS (WP 0021 00). Check system for leaks and operation.

INSTALLATION - CONTINUED



END OF WORK PACKAGE

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RIGHT STEP REPLACEMENT 0171 00

THIS WORK PACKAGE COVERS

Step Assembly Removal, Front and Rear Mounting Bracket Removal, Step Disassembly, Step Assembly, Front and Rear Mounting Bracket Installation, Step Assembly Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

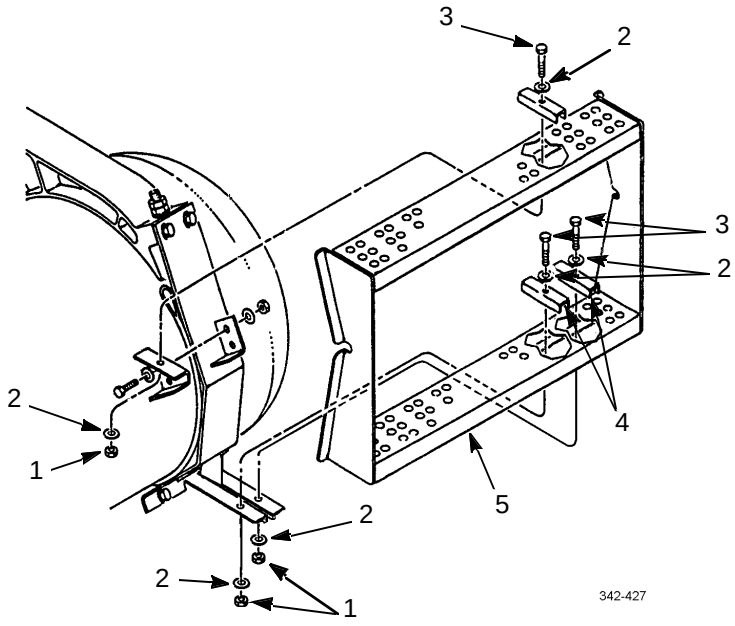
Nut, lock (P/N MS 51922-9) (8)

Nut, lock (P/N MS 51922-17) (8)

Rivet, blind (P/N 2771-0817) (8)

STEP ASSEMBLY REMOVAL

Remove six lock nuts (1), 12 washers (2), six screws (3), six retaining strap clamps (4), and step assembly (5) from vehicle. Discard lock nuts.

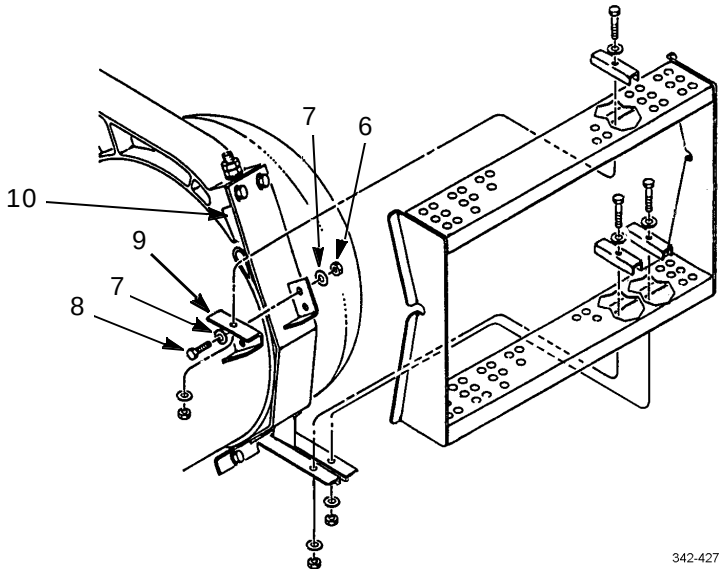


FRONT AND REAR MOUNTING BRACKET REMOVAL

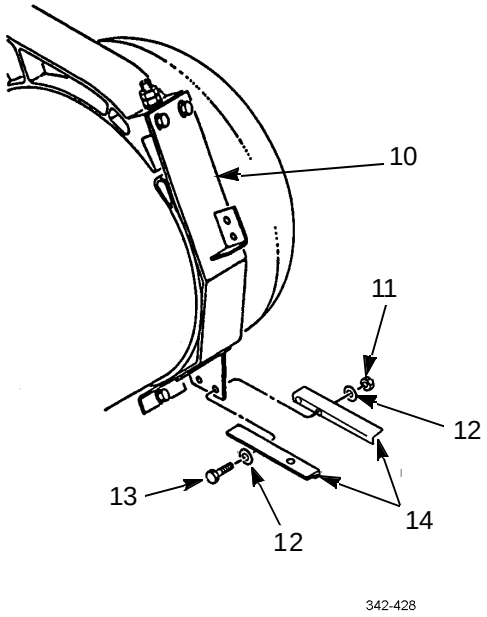
NOTE

Front and rear mounting brackets are removed in the same way. Front mounting bracket is shown.

1. Remove two lock nuts (6), four washers (7), two screws (8), and angle brackets (9) from front and rear mounting brackets (10). Discard lock nuts.



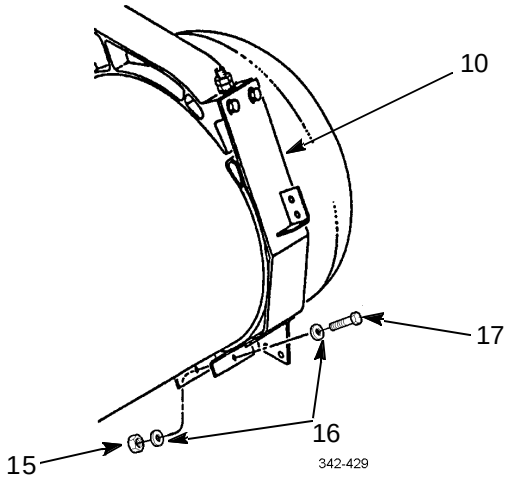
2. Remove two lock nuts (11), four washers (12), two screws (13), and four angle brackets (14) from front and rear mounting brackets (10). Discard lock nuts.



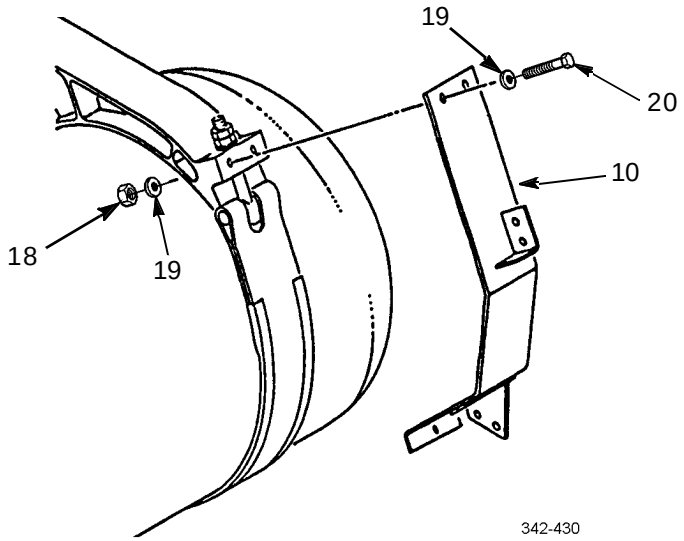
RIGHT STEP REPLACEMENT - CONTINUED 0171 00

FRONT AND REAR MOUNTING BRACKET REMOVAL - CONTINUED

3. Remove two lock nuts (15), four washers (16), and two bolts (17) from front and rear mounting brackets (10). Discard lock nuts.

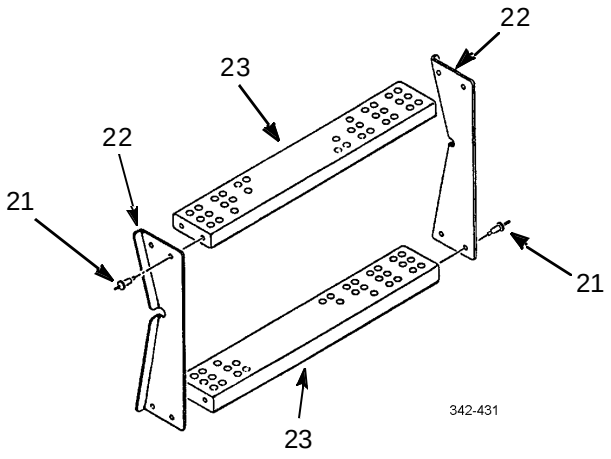


4. Remove four lock nuts (18), eight washers (19), four screws (20), and front and rear mounting brackets (10). Discard lock nuts.



STEP DISASSEMBLY

Remove eight rivets (21) and two support brackets (22) from two steps (23). Discard rivets.

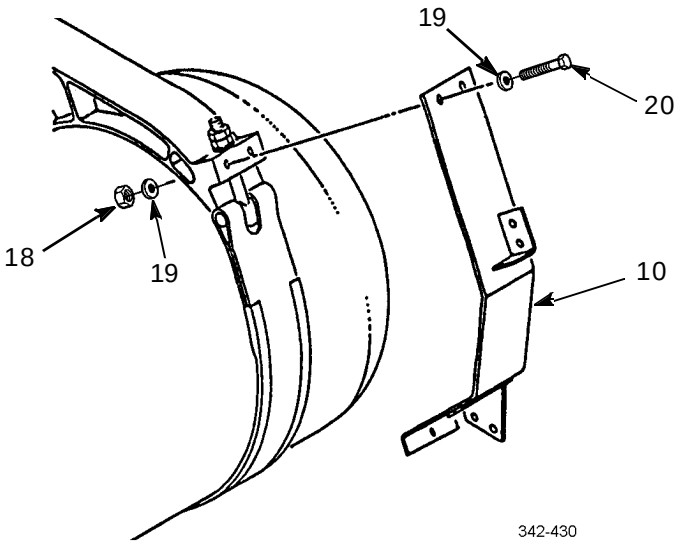


STEP ASSEMBLY

Install two support brackets (22) on two steps (23) with eight new rivets (21).

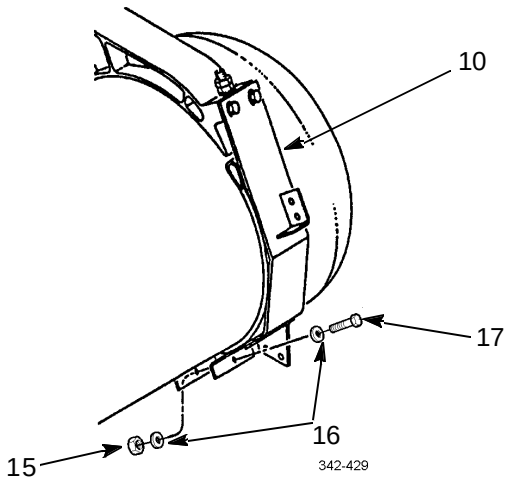
FRONT AND REAR MOUNTING BRACKET INSTALLATION

1. Install front and rear mounting bracket (10) with four screws (20), eight washers (19), and four new lock nuts (18).

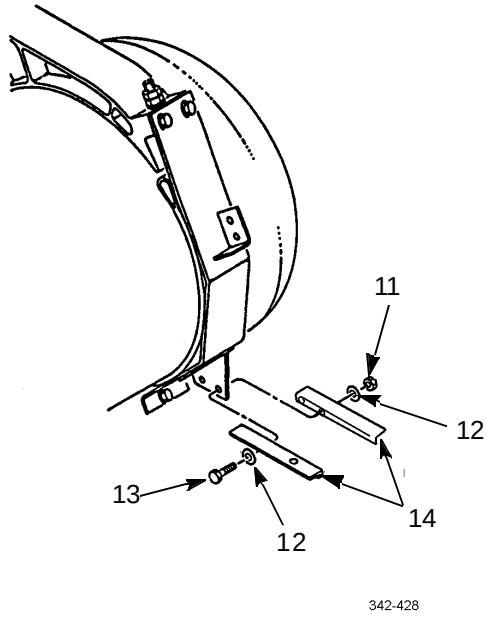


FRONT AND REAR MOUNTING BRACKET INSTALLATION - CONTINUED

2. Install two bolts (17), four washers (16), and two new lock nuts (15) on front and rear mounting brackets (10).



3. Install four angle brackets (14) on front and rear mounting brackets (10) with two screws (13), four washers (12), and two new lock nuts (11).

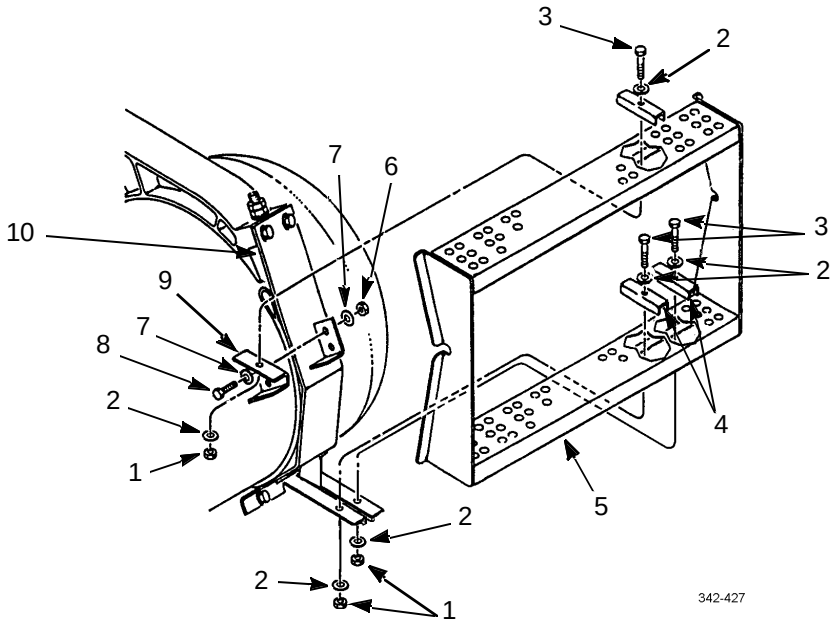


FRONT AND REAR MOUNTING BRACKET INSTALLATION - CONTINUED

4. Install two angle brackets (9) on front and rear mounting brackets (10) with two screws (8), four washers (7), and two new lock nuts (6).

STEP ASSEMBLY INSTALLATION

Install step assembly (5) on front and rear mounting brackets (10) with six screws (3), 12 washers (2), six retaining strap clamps (4), and new lock nuts (1).



END OF WORK PACKAGE

LEFT STEP REPLACEMENT 0172 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N MS51922-11) (2)

Equipment Condition

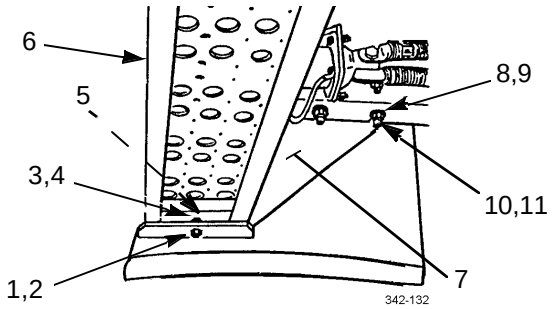
Battery box cover removed (TM 9-2320-302-10)

WARNING

DO NOT allow tools to come in contact with batteries. Electrical shock may occur.

REMOVAL

1. Remove two lock nuts (1), washers (2), screws (3), washer (4), two clamps (5), and step (6) from front and rear step brackets (7). Discard lock nuts.
2. Remove nuts (8), washers (9), screws (10), washers (11), and front step bracket (7).
3. Repeat step 2 for removal of rear step bracket (7).



INSTALLATION

1. Install front step bracket (7) with three washers (11), screws (10), washers (9), and nuts (8).
2. Repeat step 1 for installation of rear step bracket (7).
3. Install step (6) on front and rear step brackets (7) with two clamps (5), washer (4), two screws (3), washers (2), and new lock nuts (1).
4. Install battery box cover (TM 9-2320-302-10).

END OF WORK PACKAGE

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LEFT SIDE PLATFORM REPLACEMENT 0173 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

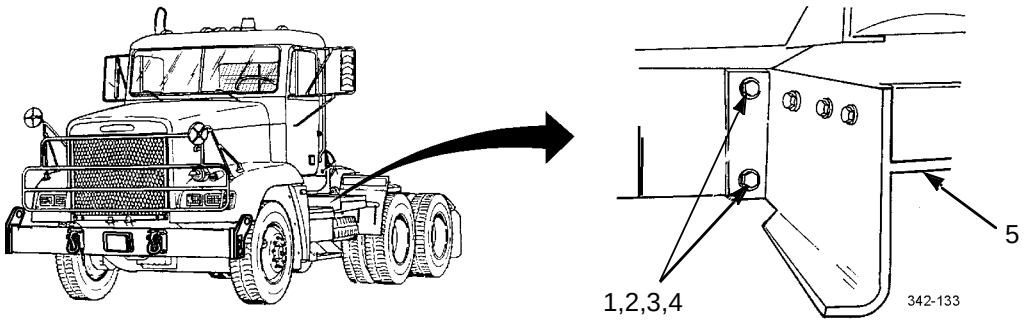
Primary II air tank removed (WP 0144 00)

Materials/Parts

Nut, lock (P/N MS51922-49) (4)

REMOVAL

Remove four lock nuts (1), washers (2), screws (3), washers (4), and left side platform (5) from vehicle. Discard lock nuts.



INSTALLATION

1. Install left side platform (5) on vehicle with four washers (4), screws (3), washers (2), and new lock nuts (1).
2. Install primary II air tank (WP 0144 00).

END OF WORK PACKAGE

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RIGHT REAR STEP REPLACEMENT 0174 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

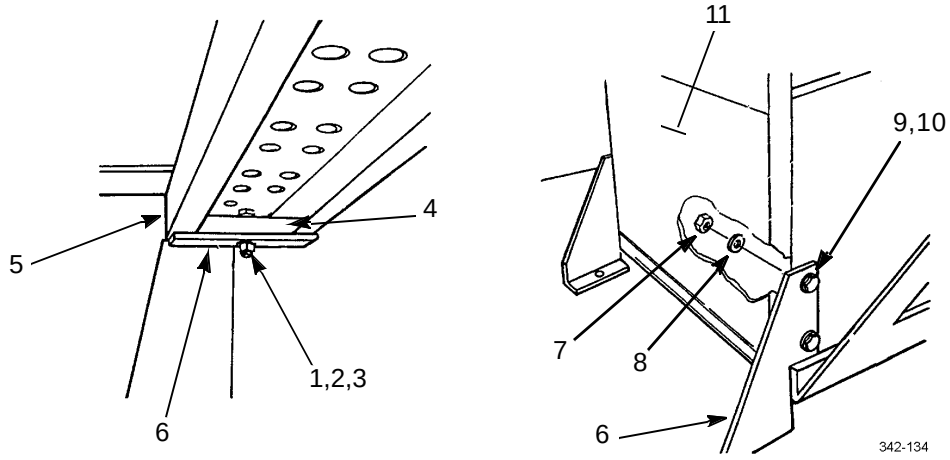
Materials/Parts

Nut, lock (P/N MS51922-11) (2)

Nut, lock (P/N MS51922-33) (4)

REMOVAL

1. Remove two lock nuts (1), washers (2), screws (3), clamp bars (4), and step (5) from two mounting brackets (6). Discard lock nuts.
2. Remove four lock nuts (7), washers (8), screws (9), washers (10), and two mounting brackets (6) from storage box (11). Discard lock nuts.



INSTALLATION

1. Install two mounting brackets (6) on storage box (11) with four washers (10), screws (9), washers (8), and new lock nuts (7).
2. Install step (5) on two mounting brackets (6) with two clamp bars (4), screws (3), washers (2), and new lock nuts (1).

END OF WORK PACKAGE

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FRONT BUMPER REPLACEMENT 0175 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-10340-125) (2)

Nut, lock (P/N MS51922-49) (12)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

Collision warning system (CWS) antenna assembly removed (WP 0111 00)

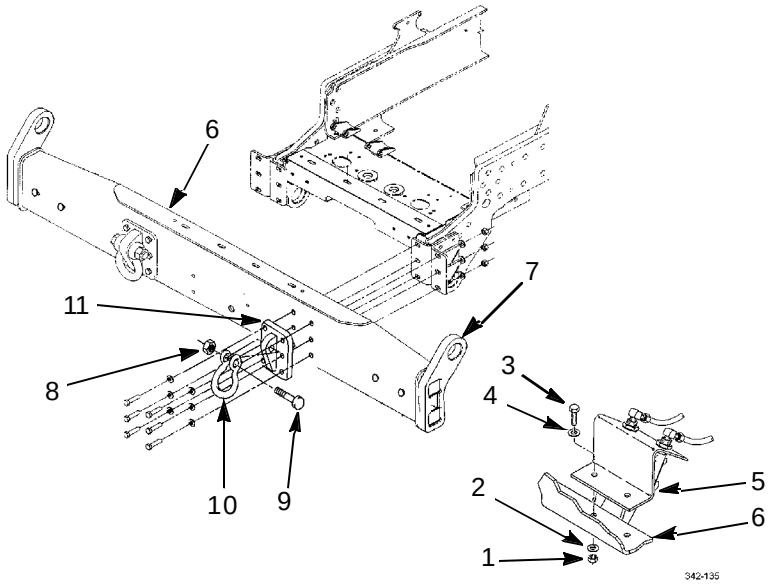
REMOVAL

1. Remove two lock nuts (1), washers (2), screws (3), washers (4), and bracket (5) from front bumper (6). Discard lock nuts.

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Ensure that any lifting device used is in good condition and of suitable load capacity. Keep clear of heavy parts supported only by lifting device. Failure to follow this warning may result in death or injury to personnel.

2. Attach suitable lifting device to front bumper (6) using bumper extensions (7) as attaching points.
3. Remove nut (8), bolt (9), and hook (10) from each tow bracket (11).

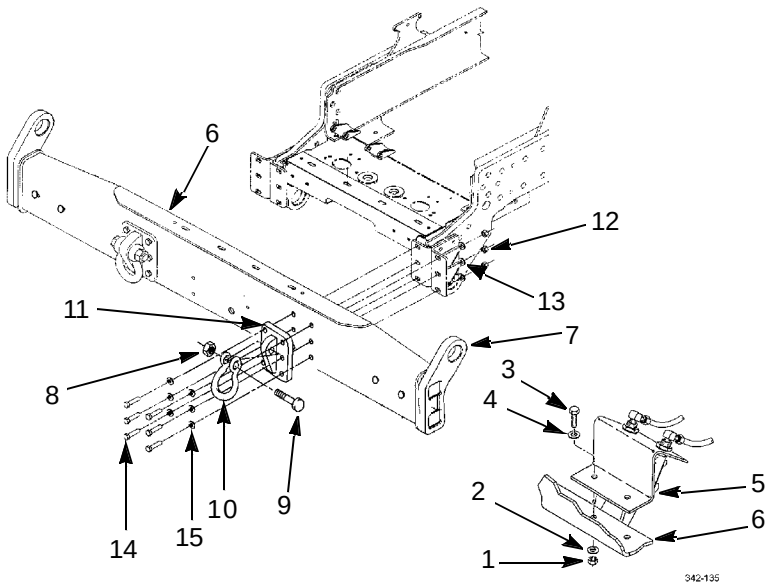


REMOVAL - CONTINUED

NOTE

Note bolt size and location to aid in installation.

4. Remove 12 lock nuts (12), washers (13), bolts (14), washers (15), two tow brackets (11), and front bumper (6) from vehicle. Discard lock nuts.
5. Lower bumper (6) to ground and disconnect lifting device.
6. Remove four spring pins (16), flat washers (17), straight pins (18), and two bumper extensions (7) from front bumper (6).



INSTALLATION

1. Install two bumper extensions (7) on front bumper (6) with four straight pins (18), flat washers (17), and spring pins (16).

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Ensure that any lifting device used is in good condition and of suitable load capacity. Keep clear of heavy parts supported only by lifting device. Failure to follow this warning may result in death or injury to personnel.

2. Attach suitable lifting device to front bumper (6) using bumper extensions (7) as attaching points.
3. Install front bumper (6) on vehicle with two tow brackets (11), 12 washers (15), bolts (14), washers (13), and new lock nuts (12). Tighten lock nuts to 180-200 lb-ft (244-271 Nm).
4. Install hook (10) on each tow bracket (11) with bolt (9) and nut (8).
5. Install bracket (5) on front bumper (6) with two washers (4), screws (3), washers (2), and new lock nuts (1).

INSTALLATION - CONTINUED

6. Install collision warning system (CWS) antenna assembly (WP 0111 00).

END OF WORK PACKAGE

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SPARE WHEEL HOIST REPLACEMENT 0176 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-49) (4)

Compound, sealing (Item 9, WP 0235 00)

References

TM 9-2320-302-10

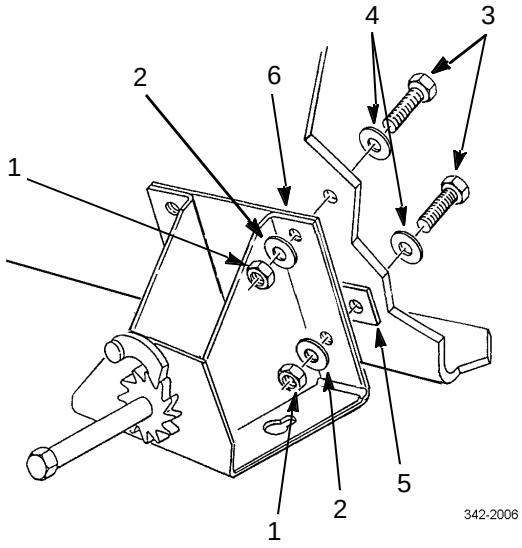
Equipment Condition

Spare tire removed (TM 9-2320-302-10)

Primary II air tank removed (WP 0144 00)

REMOVAL

Remove four lock nuts (1), washers (2), bolts (3), washers (4), two spacers (5), and spare wheel hoist (6). Discard lock nuts.



INSTALLATION

1. Install two washers (4) and two bolts (3).
2. Lightly coat both sides of two spacers (5) with sealing compound. Install spacers on two bolts (3).
3. Install spare wheel hoist (6) with four washers (4), bolts (3), washers (2), and new lock nuts (1).
4. Install primary II air tank (WP 0144 00).
5. Install spare tire (TM 9-2320-302-10).

END OF WORK PACKAGE

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REAR TIE DOWN REPLACEMENT 0177 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Mud flap assembly removed (WP 0196 00)

Materials/Parts

Nut, lock (P/N 23-0991-116) (6)

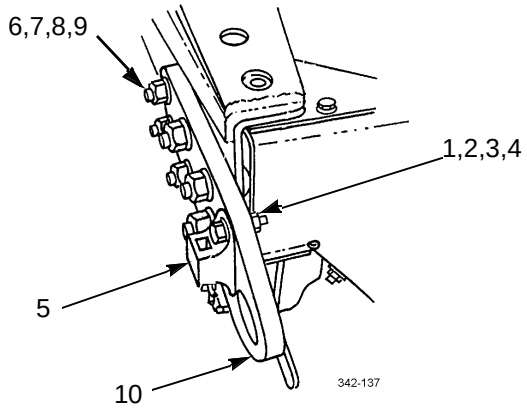
Nut, lock (P/N MS51922-33) (2)

NOTE

Right- and left-rear tie downs are replaced the same way.

REMOVAL

1. Remove two lock nuts (1), washers (2), screws (3), washers (4), and mud flap bracket (5). Discard lock nuts.
2. Remove six lock nuts (6), washers (7), bolts (8), washers (9), and tie down bracket (10). Discard lock nuts.



INSTALLATION

1. Install tie down bracket (10) with six washers (9), bolts (8), washers (7), and new lock nuts (6).
2. Install mud flap bracket (5) with two washers (4), screws (3), washers (2), and new lock nuts (1).
3. Install mud flap assembly (WP 0196 00).

END OF WORK PACKAGE

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FIFTH WHEEL ADJUSTMENT 0178 00

THIS WORK PACKAGE COVERS

Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

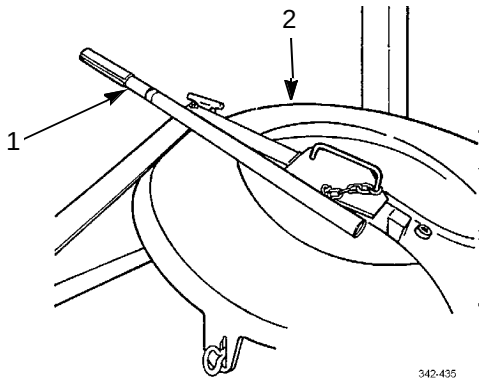
Tester, kingpin lock (Item 34, WP 0236 00)

References

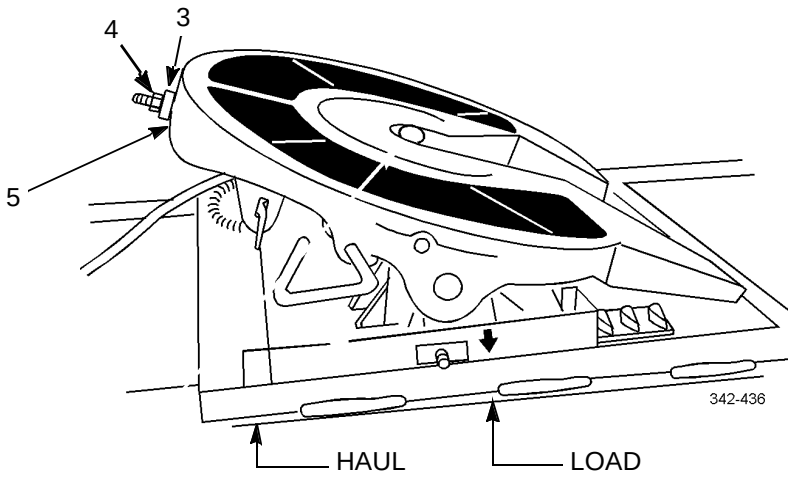
TM 9-2320-302-10

ADJUSTMENT

1. Install kingpin lock tester (1) on fifth wheel (2) and close locks.Visually check that locks are properly closed.



2. Rotate rubber bushing (3) between adjustment nut (4) and casting (5).



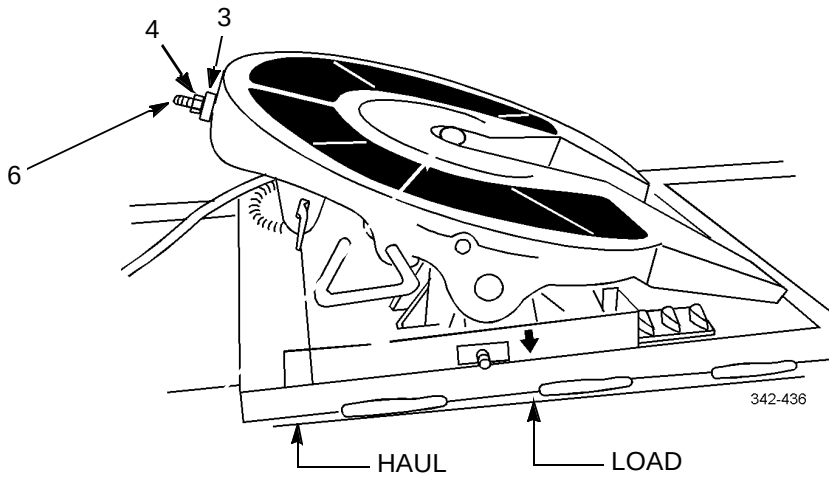
FIFTH WHEEL ADJUSTMENT - CONTINUED **0178 00**

ADJUSTMENT - CONTINUED

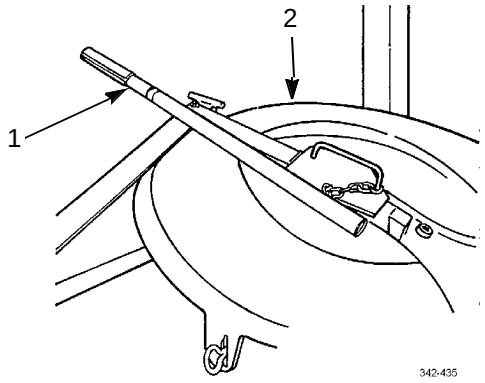
NOTE

Bushing should be snug, but able to rotate. If bushing does not rotate or rotates too freely, perform step 3.

3. If bushing (3) is too tight, rotate nut (4) on yoke shank (6) counterclockwise until bushing is snug. If bushing is loose, rotate nut clockwise until bushing is snug, but still rotates.



4. Verify proper adjustment by locking and unlocking fifth wheel (2) several times with lock tester (1).



END OF WORK PACKAGE

PINTLE HOOK REPLACEMENT AND REPAIR 0179 00

THIS WORK PACKAGE COVERS:

Removal, Disassembly, Assembly, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N XB-769) (2)

Pin, cotter (P/N 119-1)

Materials/Parts - Continued

Pin, cotter (P/N XB-773)

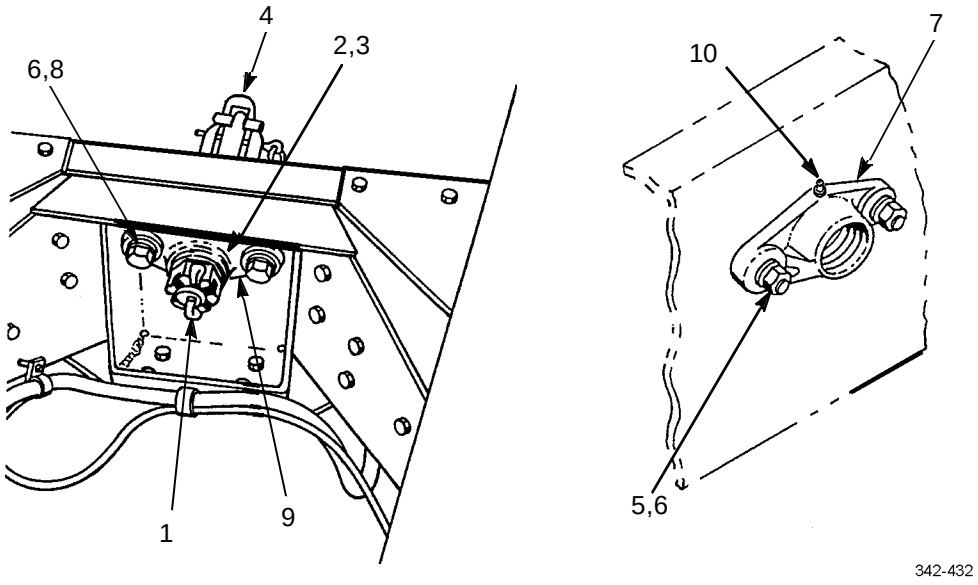
Grease, GAA (Item 15, WP 0235 00)

References

TM 9-2320-302-10

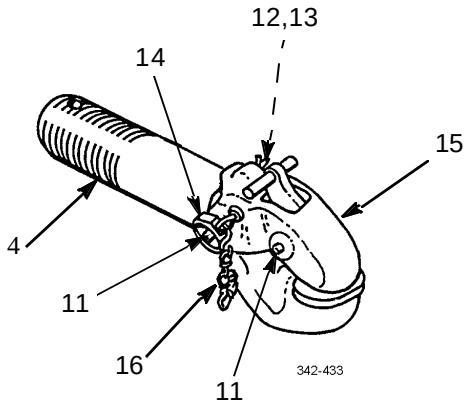
REMOVAL

1. Remove cotter pin (1), castle nut (2), washer (3), and pintle hook (4) from vehicle. Discard cotter pin.
2. Remove two lock nuts (5), washers (6), and outer bracket (7) from vehicle. Discard lock nuts.
3. Remove two screws (8), washers (6), and inner bracket (9) from vehicle.
4. Remove two lubrication fittings (10) from inner and outer brackets (7 and 9).



DISASSEMBLY

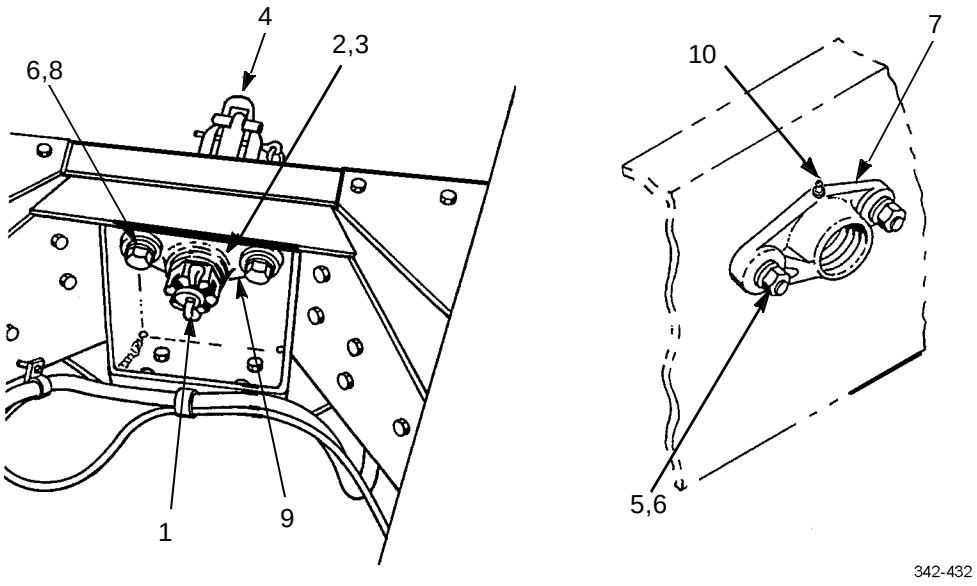
1. Remove cotter pin (12), castle nut (13), fluid passage bolt (14), and latch (15) from pintle hook (4). Discard cotter pin.
2. Remove two lubrication fittings (11) from latch (15).
3. Remove screw and chain assembly (16) from pintle hook (4).



ASSEMBLY

1. Install latch (15) on pintle hook (4) with fluid passage bolt (14), castle nut (13), and new cotter pin (12).
2. Install two lubrication fittings (11) on latch (15).
3. Install screw and chain assembly (16) on pintle hook (4).

INSTALLATION



1. Install two lubrication fittings (10) on inner and outer brackets (7 and 9).
2. Install inner bracket (9) on vehicle with two washers (6) and screws (8).

INSTALLATION - CONTINUED

3. Install outer bracket (7) on vehicle with two washers (6) and new lock nuts (5).
4. Install pintle hook (4) on vehicle with washer (3) and castle nut (2).
5. Adjust castle nut (2) to allow pintle hook (4) to rotate freely.
6. Install new cotter pin (1) through castle nut (2).
7. Lubricate pintle hook (4) with GAA grease in accordance with Unit PMCS (WP 0021 00).

END OF WORK PACKAGE

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TOWING BRACKET REPLACEMENT 0180 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

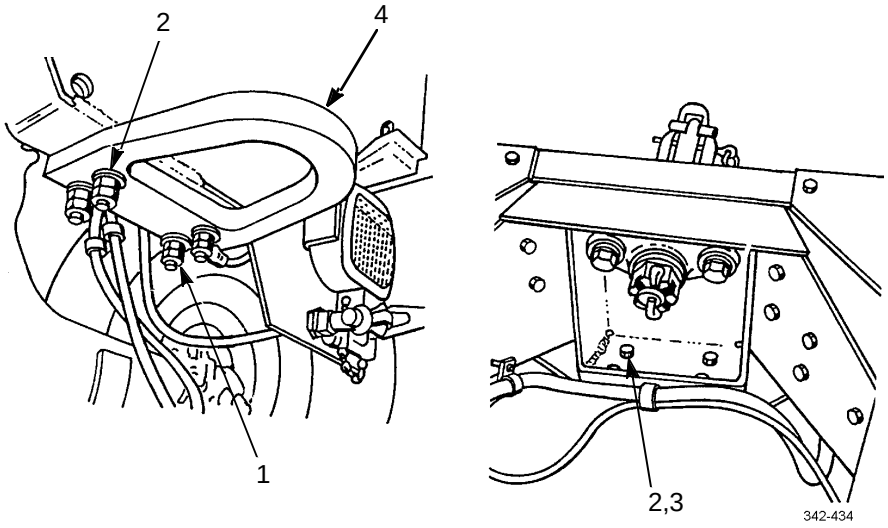
TM 9-2320-302-10

Material/Parts

Nut, lock (P/N MS 51922-33) (8)

REMOVAL

Remove eight lock nuts (1), washers (2), four bolts (3), and towing bracket (4) from vehicle frame. Discard lock nuts.



INSTALLATION

Install towing bracket (4) on vehicle frame with four bolts (3), eight washers (2), and new lock nuts (1).

END OF WORK PACKAGE

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TAILLIGHT BRACKET REPLACEMENT 0181 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-33) (2)

References

TM 9-2320-302-10

Equipment Condition

Rear blackout marker removed (WP 0086 00)

Taillight removed (WP 0087 00)

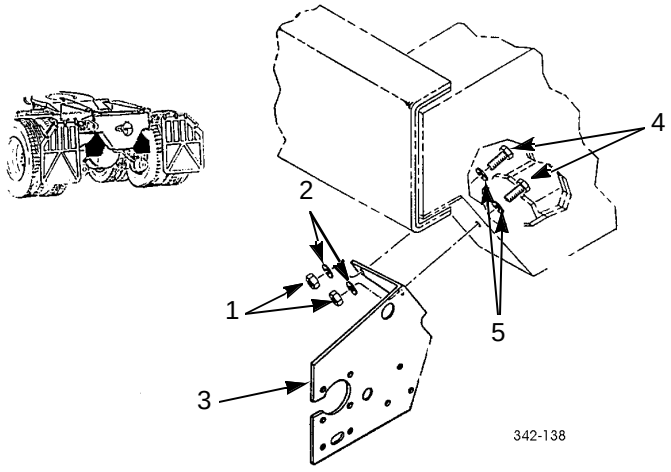
Rear gladhand removed (WP 0154 00)

NOTE

Right and left taillight brackets are replaced the same way. Left taillight bracket is shown.

REMOVAL

Remove two lock nuts (1), washers (2), bracket (3), two bolts (4), and washers (5) from vehicle. Discard lock nuts.



INSTALLATION

1. Install bracket (3) on vehicle with two washers (5), bolts (4), washers (2), and new lock nuts (1).
2. Install rear blackout marker (WP 0086 00).
3. Install taillight (WP 0087 00).
4. Install rear gladhand (WP 0154 00).

END OF WORK PACKAGE

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FRONT SHOCK ABSORBER REPLACEMENT 0182 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)
Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

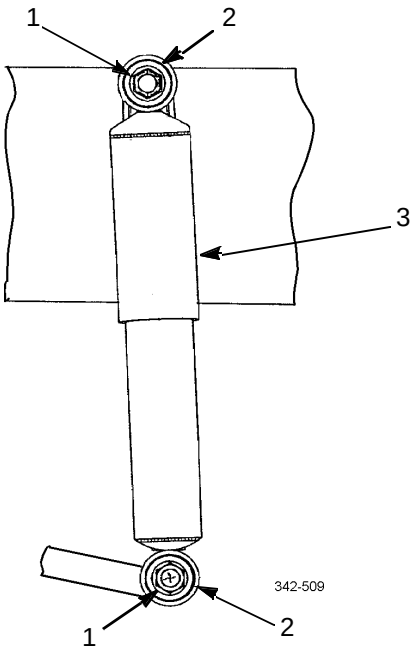
Nut, lock (P/N 23-09337-113) (2)

REMOVAL

NOTE

Note position of shock absorber and bolts to aid in installation.

Remove two lock nuts (1), washers (2), and shock absorber (3) from front of vehicle. Discard lock nuts.



INSTALLATION

Install shock absorber (3) on vehicle with two washers (2) and new lock nuts (1). Tighten lock nuts to 120-180 lb-ft (163-244 Nm).

END OF WORK PACKAGE

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REAR SHOCK ABSORBER REPLACEMENT 0183 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-600 lb-ft (Item 47, WP 0236 00)

Materials/Parts

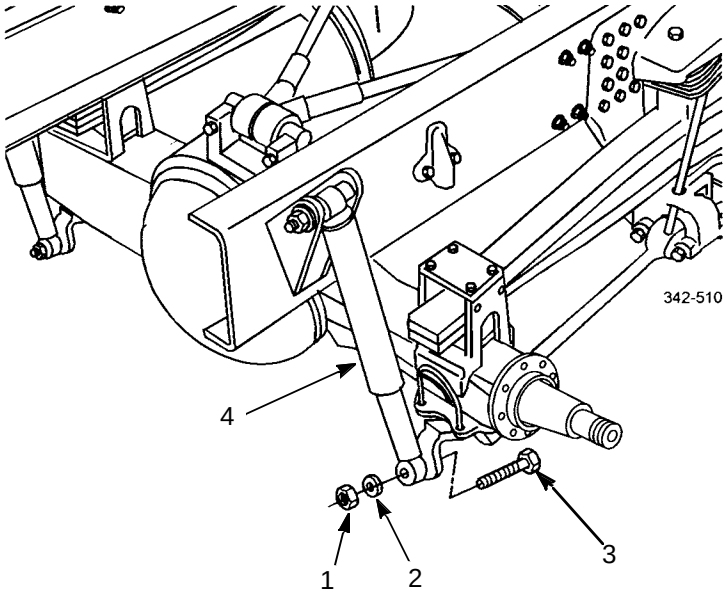
Nut, lock (P/N 23-09901-112) (2)

REMOVAL

NOTE

Note position of shock absorber and bolts for installation.

Remove two lock nuts (1), washers (2), bolts (3), and shock absorber (4) from rear of vehicle. Discard lock nuts.



INSTALLATION

Install shock absorber (4) on vehicle with two bolts (3), washers (2), and new lock nuts (1). Tighten lock nuts to 241 lb-ft (327 Nm).

END OF WORK PACKAGE

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BRUSH GUARD REPLACEMENT 0184 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-11) (6)

Nut, lock (P/N SR250000 SOH) (2)

Personnel Required

Two

References

TM 9-2320-302-10

REMOVAL

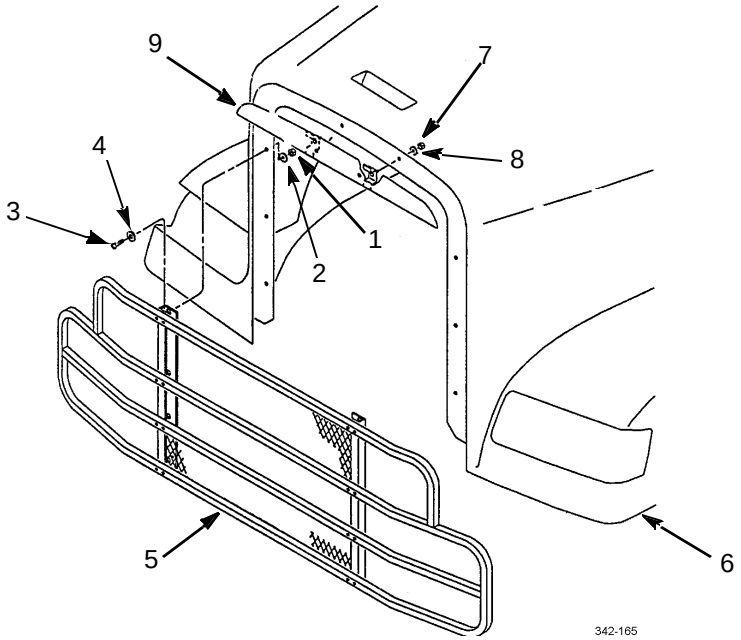
WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Failure to follow this warning may result in injury to personnel.

NOTE

Note location of mounting holes to aid in installation.

1. Remove six lock nuts (1), washers (2), screws (3), washers (4), and brush guard (5) from hood (6). Discard lock nuts.
2. Remove two lock nuts (7), washers (8), and top plate (9) from hood (6). Discard lock nuts.

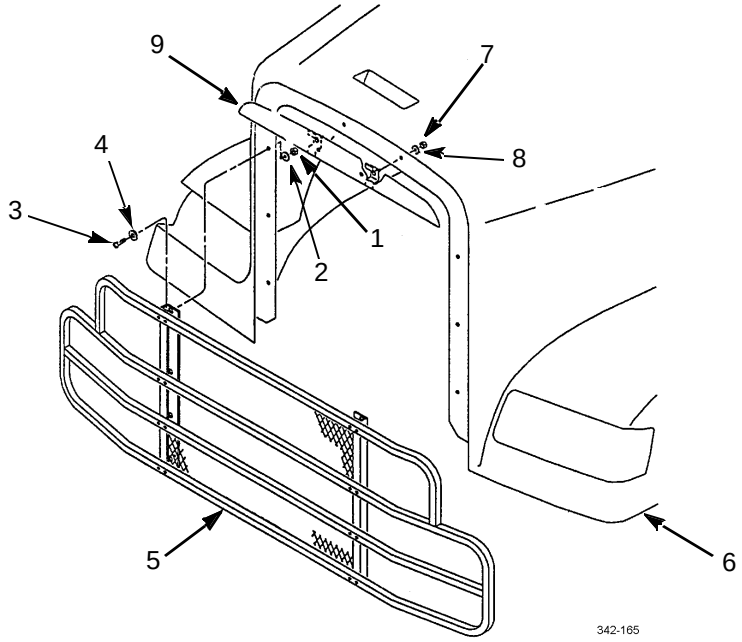


INSTALLATION

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Failure to follow this warning may result in injury to personnel.

1. Install top plate (9) on hood (6) with two washers (8) and new lock nuts (7).
2. Install brush guard (5) on hood (6) with six washers (4), screws (3), washers (2), and new lock nuts (1).



END OF WORK PACKAGE

ENGINE HOOD ASSEMBLY REPLACEMENT 0185 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-17) (2)

Straps, tiedown (Item 30, WP 0235 00)

Personnel Required

Four

References

TM 9-2320-302-10

REMOVAL

NOTE

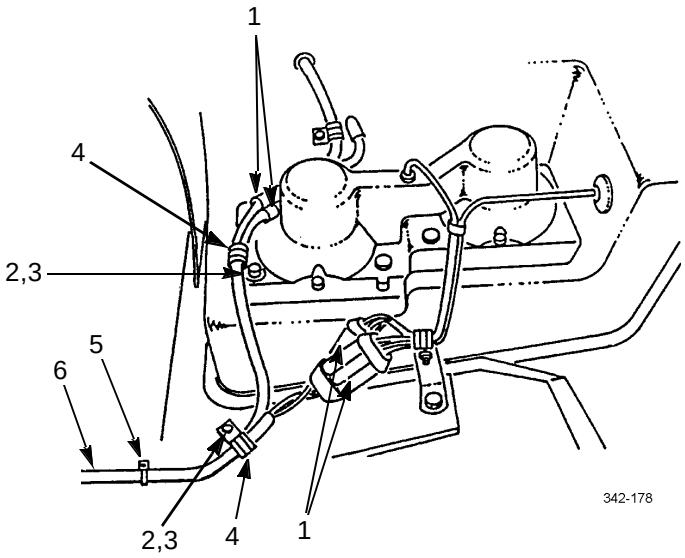
Right side of vehicle is shown.

1. Disconnect nine connectors (1).

NOTE

Quantity of tiedown straps may vary. Remove as necessary.

2. Remove four screws (2), two washers (3), four clamps (4), and tiedown straps (5). Set wiring harness (6) aside. Discard tiedown straps.

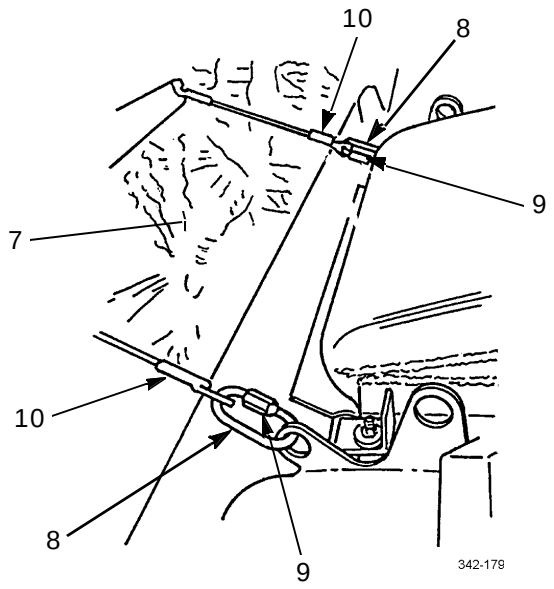


REMOVAL - CONTINUED

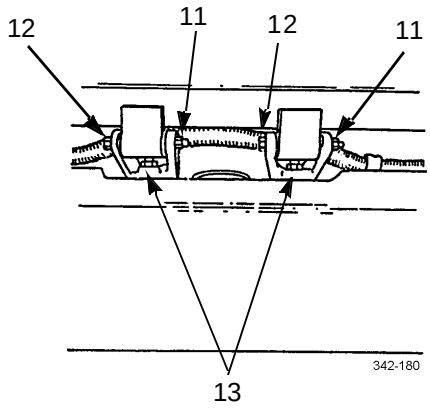
WARNING

When removing tilt assist cables, hood must be supported to prevent damage to hood or injury to personnel.

3. Support center of hood (7).
4. Open two chain links (8) by loosening two nuts (9) and remove two tilt assist cables (10) from chain links.



5. Close hood (7) (TM 9-2320-302-10).
6. Remove two lock nuts (11) and screws (12) from hinges (13). Discard lock nuts.

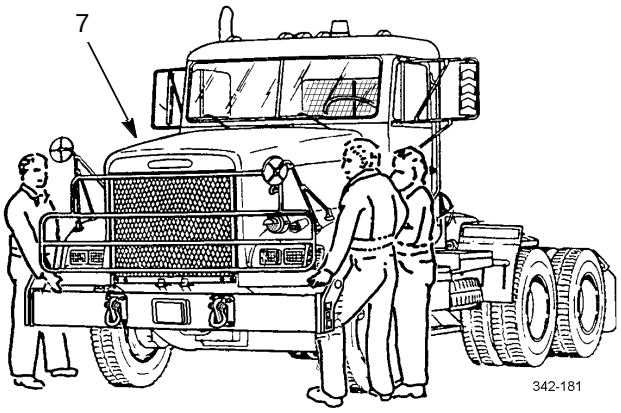


REMOVAL - CONTINUED

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Failure to follow this warning may result in injury to personnel.

7. Using four personnel, lift hood (7) approximately 4 in (10.2 cm) and walk toward front of vehicle until hood is clear of vehicle.



INSTALLATION

WARNING

Use extreme caution when handling heavy parts. Provide adequate support and use assistance during procedure. Failure to follow this warning may result in injury to personnel.

1. Using four personnel, install hood (7) to vehicle.
2. Install two screws (12) and new lock nuts (11) to hinges (13).

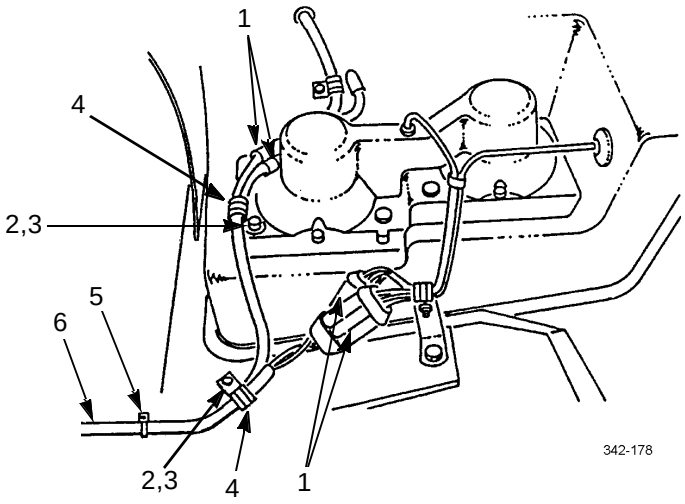
WARNING

When installing tilt assist cable, hood must be supported to prevent damage to hood or injury to personnel.

3. Open and support hood (7) (TM 9-2320-302-10).
4. Install two tilt assist cables (10) in two chain links (8) and close chain links by tightening two nuts (9).

INSTALLATION - CONTINUED

5. Position wiring harness (6) and install four clamps (4) with two washers (3) and four screws (2).
6. Connect nine connectors (1).
7. Install new tiedown straps (5) as necessary.



END OF WORK PACKAGE

HOOD ASSEMBLY REPAIR 0186 00

THIS WORK PACKAGE COVERS

Disassembly, Assembly

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N 23-09336-005) (4)

Nut, lock (P/N MS51922-9) (2)

Nut, lock (P/N MS51922-33) (7)

Nut, lock (P/N MS51988-7)

Equipment Condition

Headlights removed (WP 0083 00)

Blackout drive and marker lights removed (WP 0084 00)

Spotter mirrors removed (WP 0209 00)

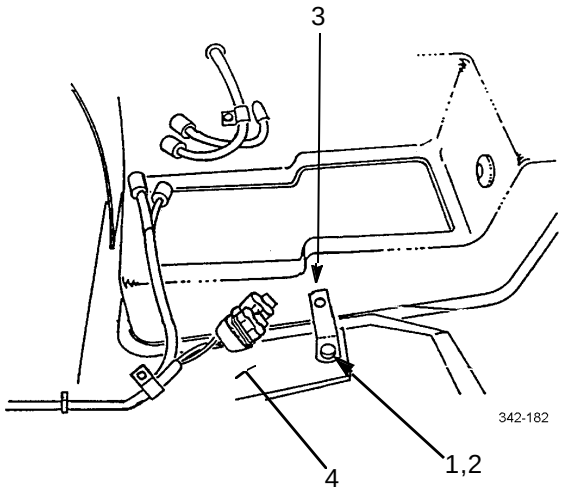
Brush guard removed (WP 0184 00)

Engine hood assembly removed (WP 0185 00)

Hood liners removed (WP 0189 00)

DISASSEMBLY

1. Remove two screws (1), washers (2), and brackets (3) from hood (4).

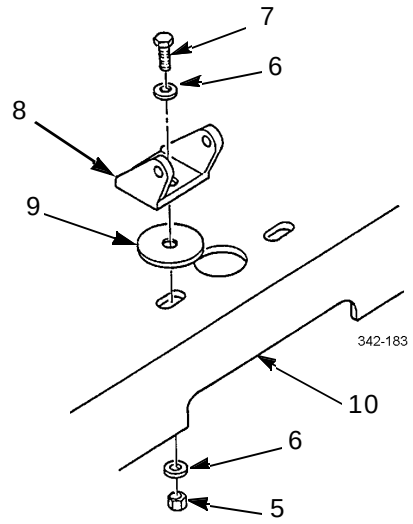


DISASSEMBLY - CONTINUED

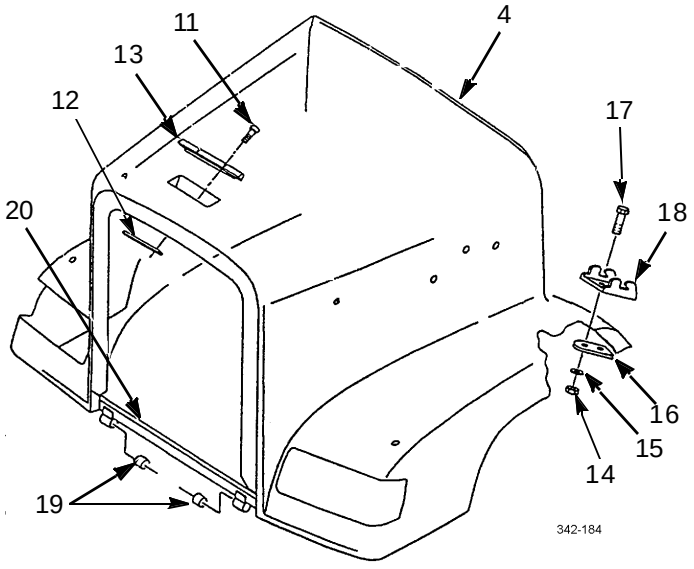
NOTE

Perform step 2 for each of two hinges. Hinges may be equipped with shims. Note quantity of shims at each hinge for installation.

2. Remove lock nut (5), two washers (6), screw (7), hinge (8), spacer (9), and shims, if equipped, from front crossmember (10). Discard lock nut

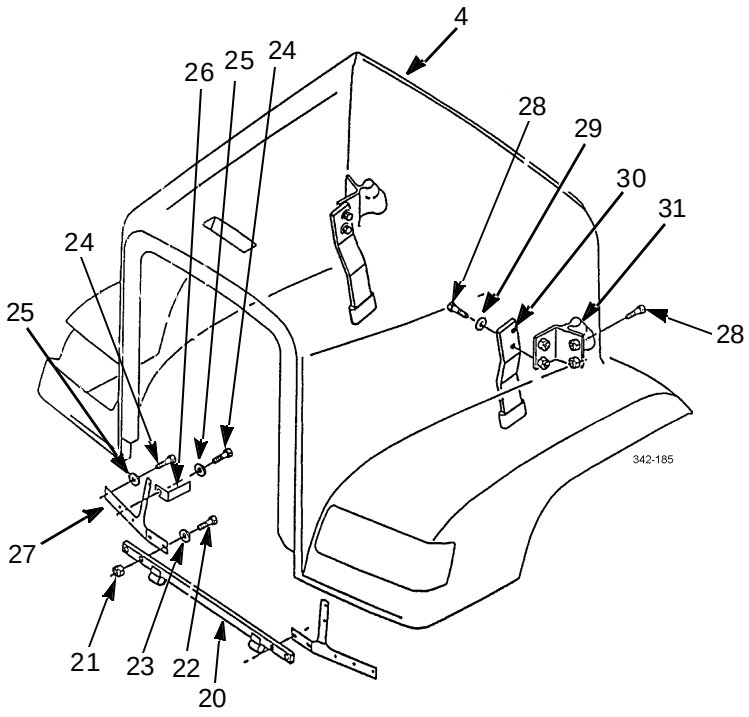


3. Remove two screws (11), backing plate (12), and handle (13) from hood (4).
4. Remove two lock nuts (14), washers (15), backing plate (16), two screws (17), and latch bracket (18) from each side of hood (4). Discard lock nuts.
5. Remove two bushings (19) from crosstie (20).



DISASSEMBLY - CONTINUED

6. Remove four lock nuts (21), screws (22), washers (23), and crosstie (20). Discard lock nuts.
7. Remove four screws (24), washers (25), bracket (26), and crosstie plate (27) from each side of hood (4).
8. Remove four screws (28), two washers (29), hood guide (30), and mount (31) from each side of hood (4).



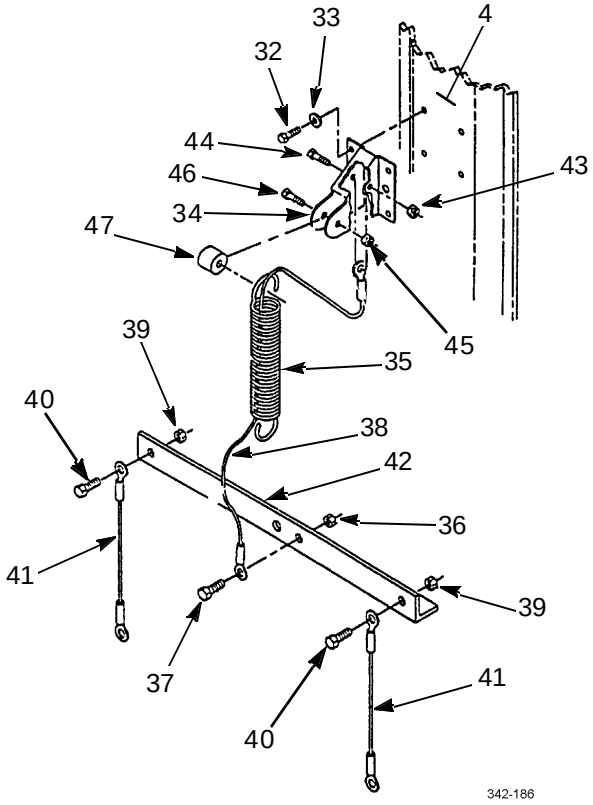
DISASSEMBLY - CONTINUED

9. Remove four screws (32), washers (33), and bracket (34) from hood (4).

10. Remove spring (35), lock nut (36), screw (37), cable (38), two lock nuts (39), screws (40), and two cables (41) from yoke (42). Discard lock nuts.

11. Remove lock nut (43), screw (44), and cable (38) from bracket (34). Discard lock nut.

12. Remove lock nut (45), screw (46), spring (35), and spacer (47) from bracket (34). Discard lock nut.



ASSEMBLY

1. Install spacer (47) and spring (35) on bracket (34) with screw (46) and new lock nut (45).

2. Feed cable (38) through spring (35) and install on bracket (34) with screw (44) and new lock nut (43).

3. Install cable (38) and two cables (41) on yoke (42) with screw (37) and new lock nut (36), two screws (40), and new lock nuts (39). Install spring (35) to yoke.

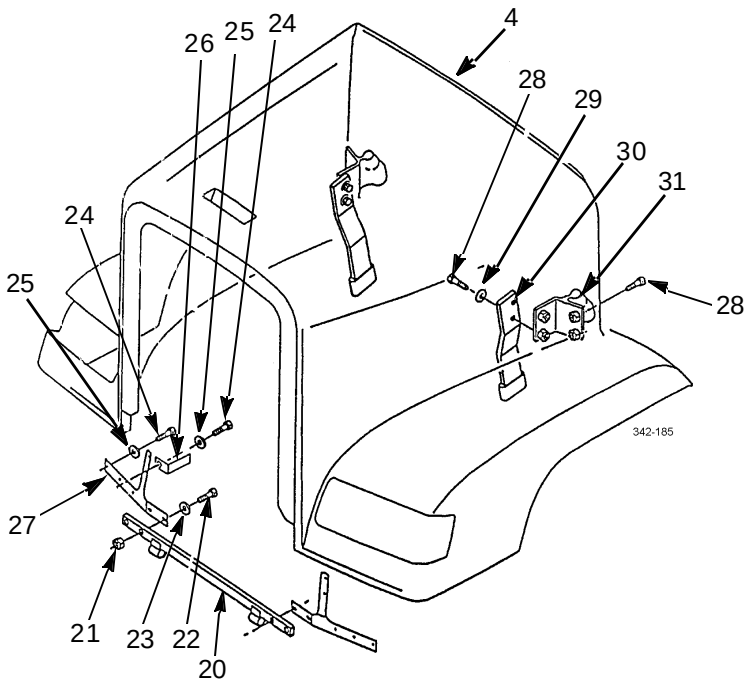
4. Install bracket (34) on hood (4) with four washers (33) and screws (32).

5. Install mount (31) on hood guide (30) on each side of hood (4) with two washers (29) and four screws (28).

6. Install crosstie plate (27) and bracket (26) on each side of hood (4) with four washers (25) and screws (24).

ASSEMBLY - CONTINUED

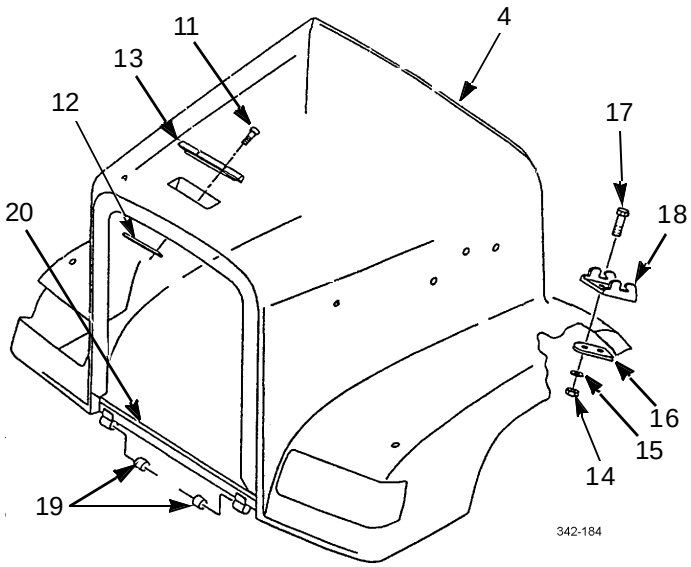
7. Install crosstie (20) on hood (4) with four washers (23), screws (22), and new lock nuts (21).



8. Install two bushings (19) in crosstie (20).

9. Install latch bracket (18) and backing plate (16) to each side of hood (4) with two screws (17), washers (15), and new lock nuts (14).

10. Install handle (13) and backing plate (12) on hood (4) with two screws (11).

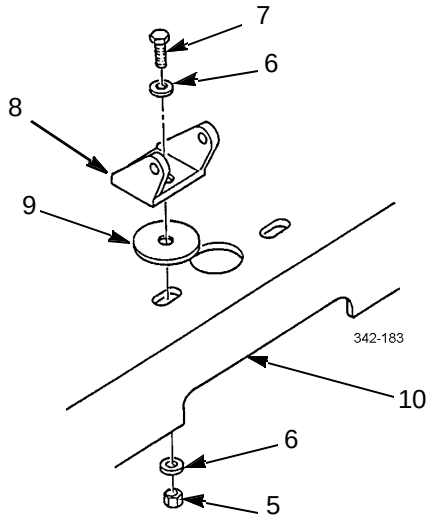


ASSEMBLY - CONTINUED

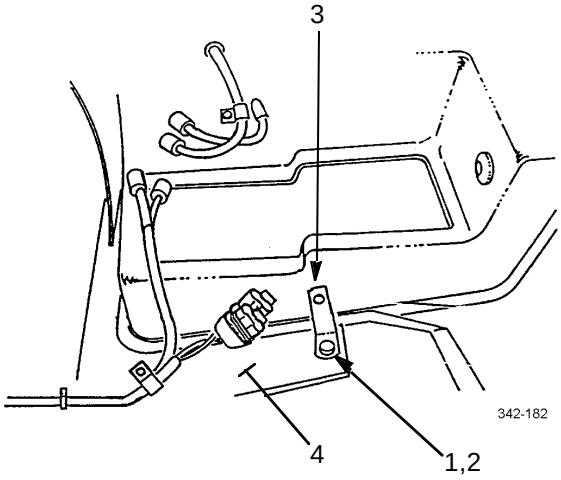
NOTE

Perform step 11 for each of two hinges.

11. Install spacer (9), shims, if equipped, and hinge (8) on front crossmember (10) with screw (7), two washers (6), and new lock nut (5).



12. Install two brackets (3) on hood (4) with two washers (2) and screws (1).



13. Install hood liners (WP 0189 00).
14. Install engine hood assembly (WP 0185 00).
15. Install brush guard (WP 0184 00).
16. Install spotter mirrors (WP 0209 00).
17. Install blackout drive and marker lights (WP 0084 00).
18. Install headlights (WP 0083 00).

END OF WORK PACKAGE

HOOD ADJUSTMENT 0187 00

THIS WORK PACKAGE COVERS

Adjustment Check, Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Bar, wrecking (Item 3, WP 0236 00)

Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS 51922-33) (2)

Nut, lock (P/N MS 51922-9) (8)

Shim(s) (P/N 17-10320-001)

Personnel Required

Two

References

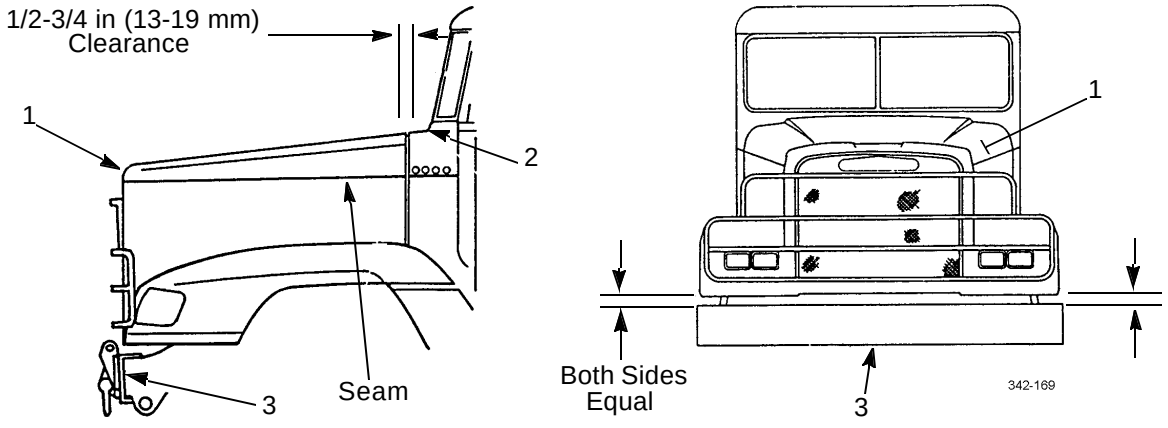
TM 9-2320-302-10

ADJUSTMENT CHECK

NOTE

Perform steps 1 through 3 to determine if hood adjustment is necessary.

1. Measure and note gap between rear edge of hood (1) and cowl (2) at seam and at 8 in (203 mm) below seam. Gap should be 1/2-3/4 in (13-19 mm).
2. Check that front of hood (1) is centered with bumper (3). Check that space between top edge of bumper (3) and lower edge of hood (1) is equal at both ends.
3. Ensure that hood (1) is not touching any components attached to frame. If any components are touching hood, identify and correct problem, and repeat steps 1 and 2.



ADJUSTMENT

1. Tilt hood (1) to fully open position (TM 9-2320-302-10).

NOTE

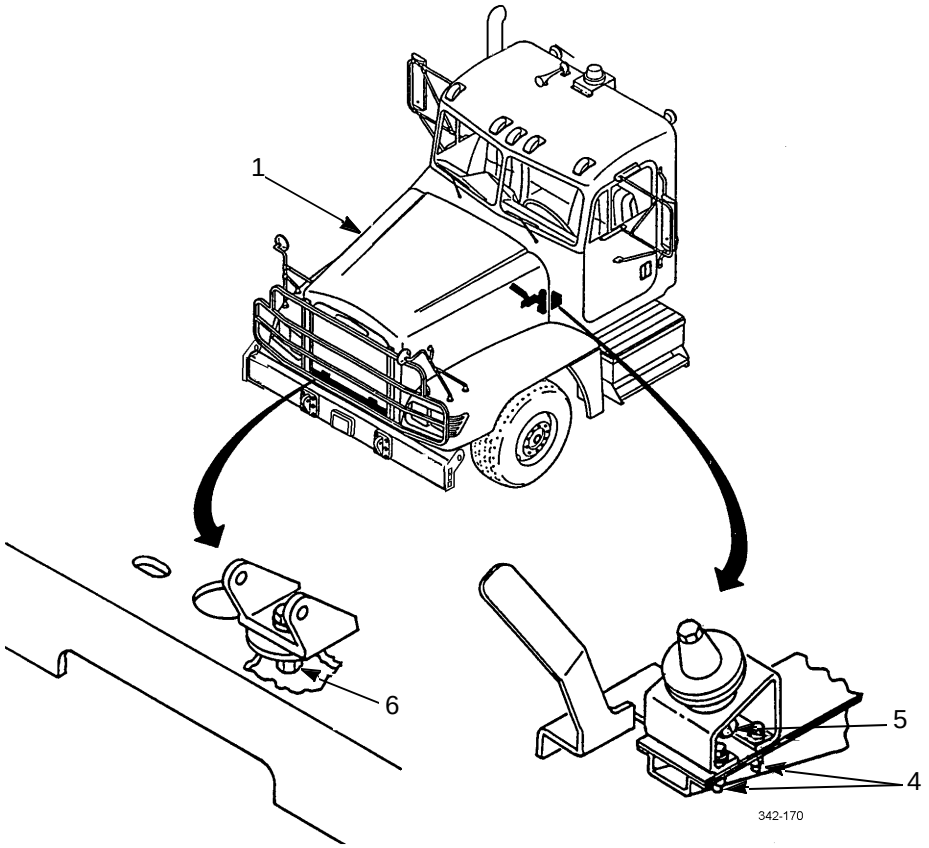
Repeat steps 2 and 3 for both sides of vehicle.

2. Loosen four lock nuts (4) just enough to allow hood (1) to slide forward and backward for adjustment.
3. Loosen lock nut (5) just enough to allow hood (1) to slide side-to-side for adjustment.

NOTE

- In step 4, lock nut must be kept tight enough for brackets to remain stationary despite pulling force of hood tilt assist springs.
- Repeat step 4 for both nuts.

4. Loosen lock nut (6) just enough to allow hood (1) to slide for adjustment.



NOTE

Prior to performing step 5, ensure that hood is centered and that components do not touch under hood when hood is lowered.

5. Close hood (1) and fasten two hood latches (7).

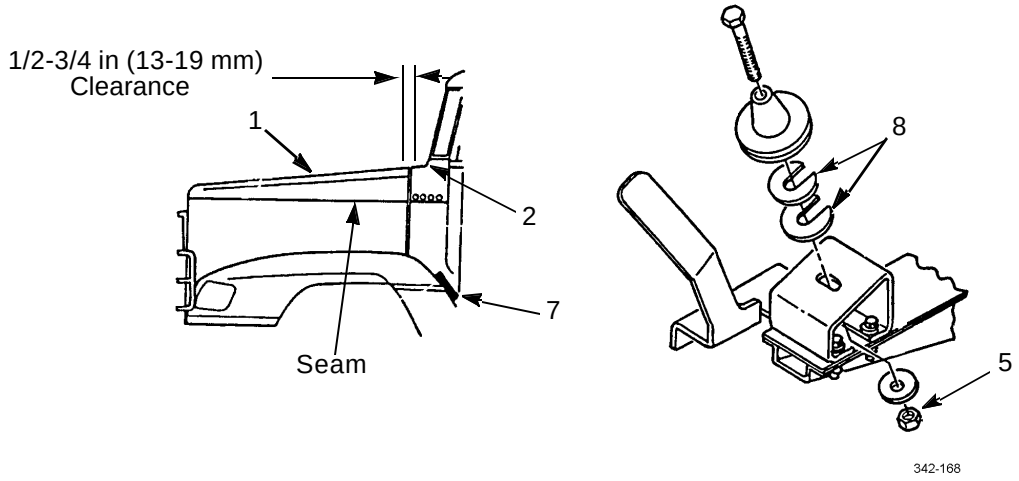
ADJUSTMENT- CONTINUED

6. Measure gap between hood (1) and cowl (2) 8 in (203 mm) below seam on both sides. Gap should be 1/2-3/4 in (13-19 mm). If gap is incorrect, move hood (1) forward or backward until gap is correct on both sides.
7. Check seams on both sides of hood (1) and cowl (2) for alignment. If seams are not aligned, note distance between seams.

NOTE

When performing step 8, use care not to disturb adjustment performed in step 6.

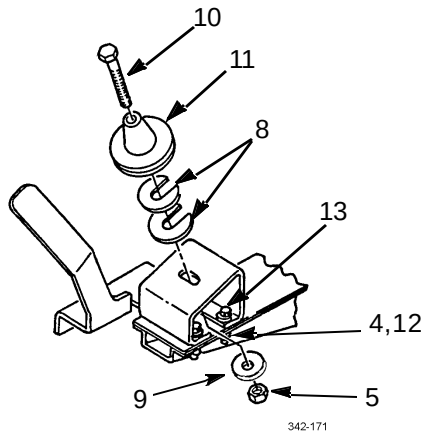
8. Tilt hood (1) to fully open position.
9. Loosen lock nut (5) just enough to allow installation or removal of spacers (8), as necessary.
10. Install or remove spacers (8) to raise or lower hood (1) to align seams.
11. Close hood (1) and repeat steps 7 through 10 until seam is aligned.



NOTE

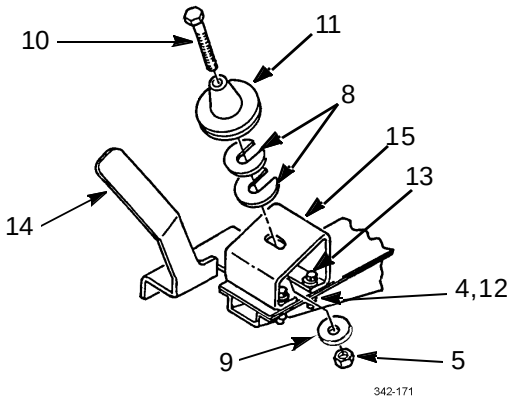
Perform steps 12 through 20 only if all spacers have been removed and seam is still not in alignment.

12. Remove lock nut (5), washer (9), bolt (10), and locator (11). Discard lock nut.
13. Remove four lock nuts (4), washers (12), and screws (13). Discard lock nuts.



ADJUSTMENT- CONTINUED

14. Remove hood guide (14) from under locator bracket (15). Install hood guide on top of locator bracket.
15. Install four screws (13), washers (12), and new lock nuts (4) just tight enough to allow forward or backward adjustment.
16. Install locator (11), bolt (10), washer (9), and new lock nut (5) just tight enough to allow for installation of spacers (8).
17. Repeat steps 8 through 11 until seam alignment is attained.
18. Tighten lock nut (5) just enough to allow side-to-side movement for adjustment.

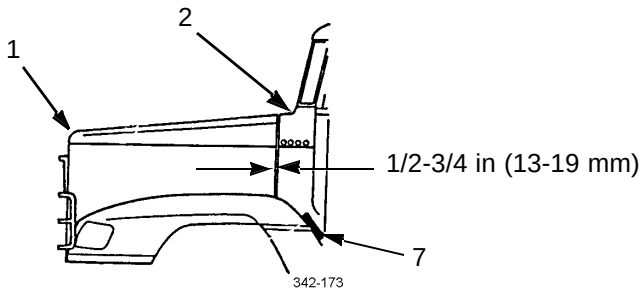


19. Repeat steps 9 through 18 for opposite side, if necessary.
20. Repeat steps 5 and 6.

NOTE

Perform step 21 only if required.

21. Close hood (1) and fasten two hood latches (7).
22. Measure and note gap between rear edge of hood (1) and cowl (2) at 1 in (25.4 mm) below seam and at 12 in (305 mm) below seam. Gap should be 1/2-3/4 in (13-19 mm).

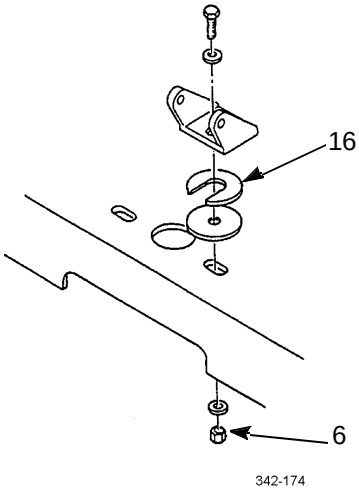


NOTE

- Perform steps 23 through 25 if gap is not correct.
- Repeat step 23 for both nuts.

23. Loosen lock nut (6) just enough to allow for installation or removal of spacers (16).

ADJUSTMENT- CONTINUED



NOTE

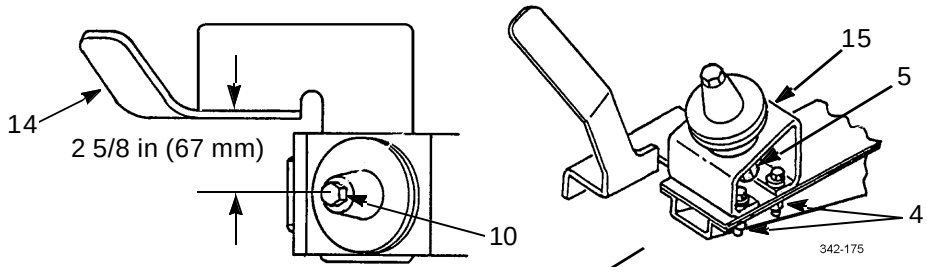
When performing step 24, amount of spacers must be equal under both hood mounting brackets. DO NOT use more than 3/4 in (19 mm) of spacers.

24. Using pry bar, raise front of hood (1) enough to insert or remove spacers (16) as needed to make gap between hood and cowl (2) equal, as measured in step 22.
25. Repeat step 22.
26. Tighten two lock nuts (6) to 85 lb-ft (115 Nm).

NOTE

When performing step 27, be extremely careful to prevent movement of locator brackets (15).

27. Carefully tilt hood (1) to fully open position.
28. Measure distance between centerline of bolt (10) and outboard face of hood guide (14). Distance must be 2-5/8 in (67 mm). If necessary, move hood guide (14) to obtain correct measurement.
29. Tighten four lock nuts (4) to 178 lb-in (20 Nm).
30. Tighten lock nut (5) to 70 lb-ft (95 Nm).



31. Repeat steps 29 and 30 for opposite side.

END OF WORK PACKAGE

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HOOD LATCH REPLACEMENT 0188 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N 23-09336-005) (4)

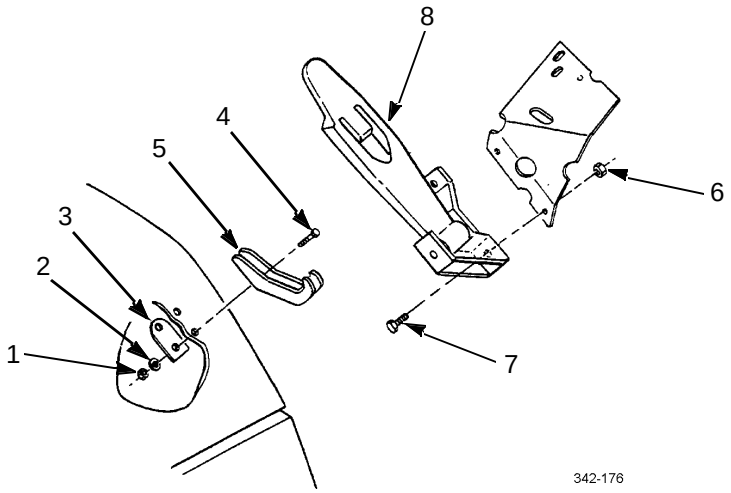
Nut, lock (P/N MS51922-1) (4)

REMOVAL

NOTE

Perform the following steps for each of two hood latches.

1. Remove two lock nuts (1), washers (2), backing plate (3), two screws (4), and hood catch (5). Discard lock nuts.
2. Remove two lock nuts (6), screws (7) and hood latch (8). Discard lock nuts.



INSTALLATION

1. Install hood latch (8) with two screws (7) and new lock nuts (6).
2. Install hood catch (5) and backing plate (3) with two screws (4), washers (2) and new lock nuts (1).

END OF WORK PACKAGE

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HOOD LINER REPLACEMENT 0189 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Drill, electric, portable (Item 11, WP 0236 00)

Drill set, twist (Item 12, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (26)

Screw, 1/4-20x1 in (10)

Materials/Parts - Continued

Screw, self-tapping, 1/4-20x3/4 in (6)

Washer, flat 1/4 in (10)

Tape, double-sided (Item 32, WP 0235 00)

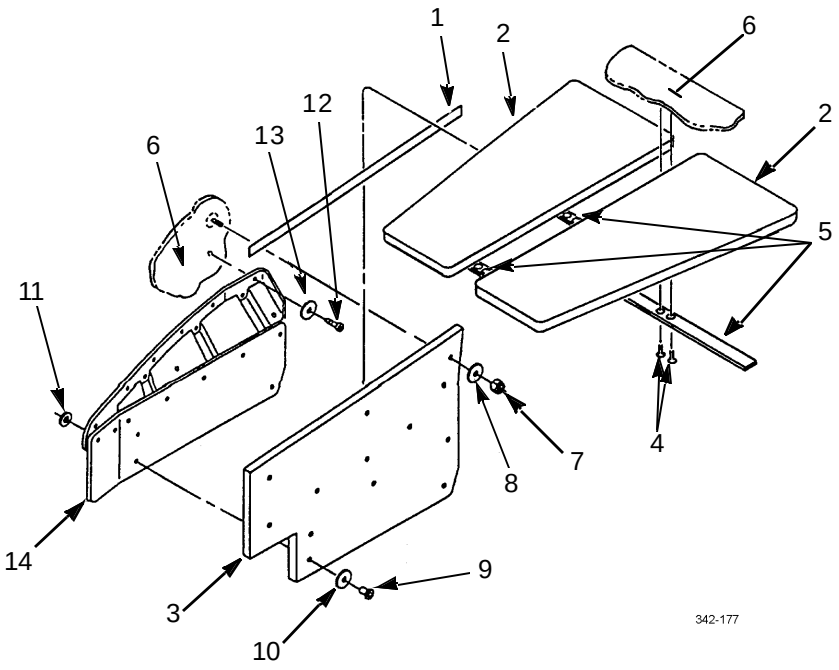
Tape, duct (Item 33, WP 0235 00)

Equipment Condition

Engine hood assembly removed (WP 0185 00)

REMOVAL

1. Cut or remove duct tape (1) between two top liners (2) and side liners (3).
2. Remove six rivets (4), three support straps (5), and two top liners (2) from hood (6). Discard rivets.
3. Remove eight lock nuts (7), washers (8), five rivets (9), washers (10 and 11), and side liners (3) from hood (6). Discard lock nuts, washers, and rivets.
4. Remove 10 screws (12), washers (13), and inner fender (14) from hood (6).
5. Repeat steps 3 and 4 for liner and inner fender on opposite side.



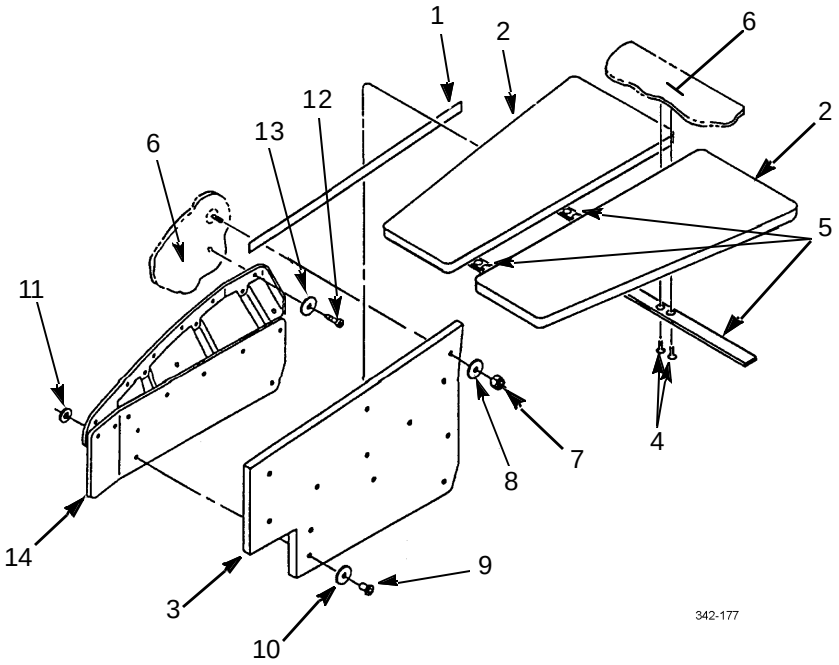
INSTALLATION

1. Install inner fender (14) to hood (6) with 10 washers (13) and screws (12).

NOTE

Use double-sided tape to hold liners in place. Rivets are replaced with self-tapping screws. Rivets with backing washers are replaced with screws and lock nuts.

2. Install side liners (3) on hood (6) with five new screws (9), washers (10 and 11), eight new washers (8), and new lock nuts (7).
3. Repeat steps 1 and 2 for liners and inner fenders on opposite side.
4. Install two top liners (2) on hood (6) with three support straps (5) and six new self-tapping screws (4).
5. Install duct tape (1) on each seam between two top liners (2) and side liners (3).



6. Install engine assembly hood assembly (WP 0185 00).

END OF WORK PACKAGE

HOOD PROP AND MOUNT REPLACEMENT 0190 00

THIS WORK PACKAGE COVERS

Hood Prop Removal, Hood Mount Removal, Hood Mount Installation, Hood Prop Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-9) (8)

Nut, lock (P/N MS51922-33) (2)

References

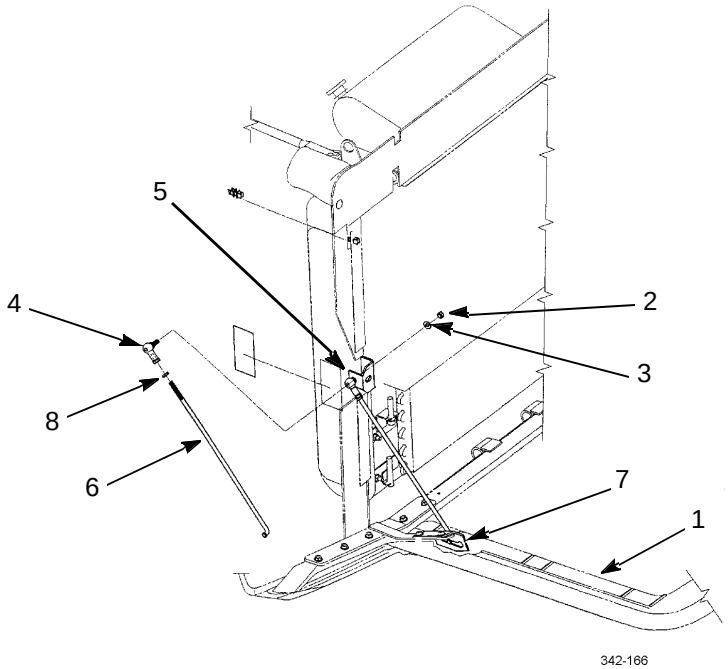
TM 9-2320-302-10

HOOD PROP REMOVAL

NOTE

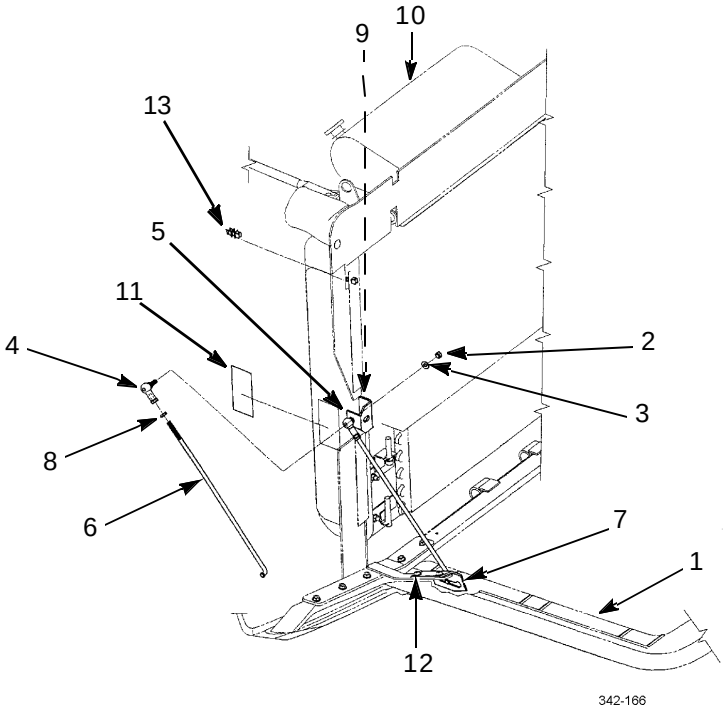
Left and right hood props are removed and installed the same way. Right hood prop is shown.

1. While supporting hood (1) in opened position, remove nut (2) and washer (3) from rod end (4).
2. Remove rod end (4) from radiator bracket (5) and remove prop (6) from hood bracket (7).
3. Loosen jamnut (8) and remove rod end (4) and jamnut from prop (6).



HOOD PROP REMOVAL - CONTINUED

4. Remove two screws (9) and radiator bracket (5) from radiator (10). Remove decal (11).
5. Remove two screws (12) and hood bracket (7) from hood (1).
6. Remove clip (13).



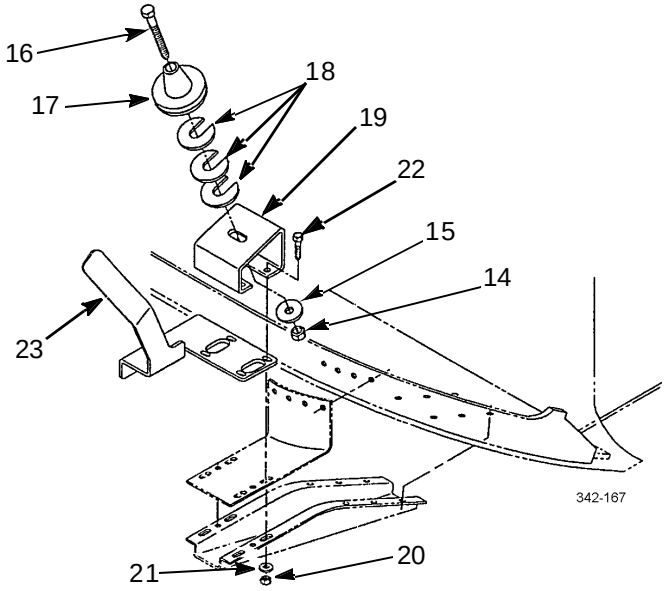
HOOD MOUNT REMOVAL

NOTE

Left and right hood mounts are removed and installed the same way. Left hood mount is shown.

1. Remove lock nut (14), washer (15), screw (16), locator (17), and three spacers (18) from mounting bracket (19). Discard lock nut.
2. Remove four lock nuts (20), washers (21), screws (22), mounting bracket (19), and hood guide (23). Discard lock nuts.

HOOD MOUNT REMOVAL - CONTINUED



HOOD MOUNT INSTALLATION

1. Install hood guide (23) and mounting bracket (19) with four screws (22), washers (21) and new lock nuts (20).
2. Install three spacers (18) and locator (17) to mounting bracket (19) with screw (16), washer (15) and new lock nut (14).

HOOD PROP INSTALLATION

1. Install clip (13).
2. Install hood bracket (7) to hood (1) with two screws (12). Tighten screws to 40 lb-ft (54 Nm).
3. Install radiator bracket (5) to radiator (10) with two screws (9). Tighten screws to 180 lb-in (20 Nm). Install decal (11).
4. Install jam nut (8) and rod end (4) on prop (6). Rotate prop into rod end as far as it will go, then back out two to four turns.
5. Install rod end (4) to radiator bracket (5) with washer (3) and nut (2).
6. Install prop (6) end into hood bracket (7). End of prop should be against slot end closest to vehicle when hood is fully open and tilt assist cables are tight.
7. If no adjustment is required, tighten jam nut (8) against rod end (4). If adjustment is required, proceed to next step.
8. Rotate prop (6) until prop is against hood bracket slot end closest to vehicle when hood is fully open and tilt assist cables are tight.
9. Tighten jam nut (8) against rod end (4).
10. Adjust hood (WP 0187 00).

END OF WORK PACKAGE

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SEAT REPLACEMENT 0191 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

Air system drained (TM 9-2320-302-10)

Seat belt removed (WP 0193 00)

NOTE

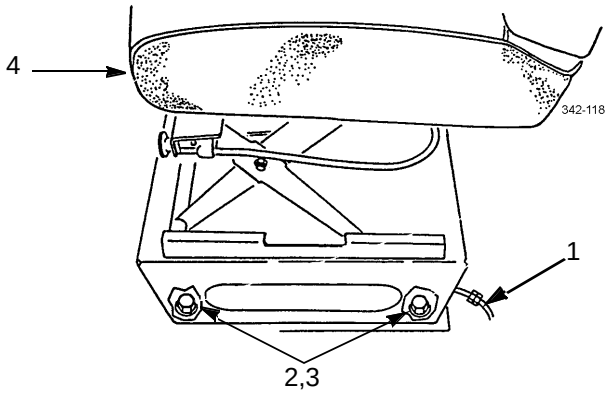
Driver seat and passenger seat are replaced the same way.

REMOVAL

WARNING

DO NOT disconnect any air system lines or fittings unless vehicle engine is shut down and air system pressure is relieved. Failure to follow this warning could result in serious injury to personnel.

1. Disconnect air line (1).
2. With assistance, remove four screws (2), washers (3), and seat (4) from vehicle.



INSTALLATION

1. With assistance, install seat (4) in vehicle with four washers (3) and screws (2).
2. Connect air line (1).
3. Install seat belt (WP 0193 00).

END OF WORK PACKAGE

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SEAT REPAIR 0192 00

THIS WORK PACKAGE COVERS

Disassembly, Assembly

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-300 lb-in (Item 44, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

Materials/Parts

Parts kit (P/N 622076-001)

Parts kit (P/N 622132-001)

Parts kit (P/N 622133-001)

Parts kit (P/N 622134-001)

Materials/Parts - Continued

Parts kit (P/N 622135-001)

Parts kit (P/N 622137-001)

Parts kit (P/N 622155-001)

Parts kit (P/N 1104385-002)

Parts kit (P/N 1349236-002) (3)

Equipment Condition

Seat removed (WP 0191 00)

DISASSEMBLY

NOTE

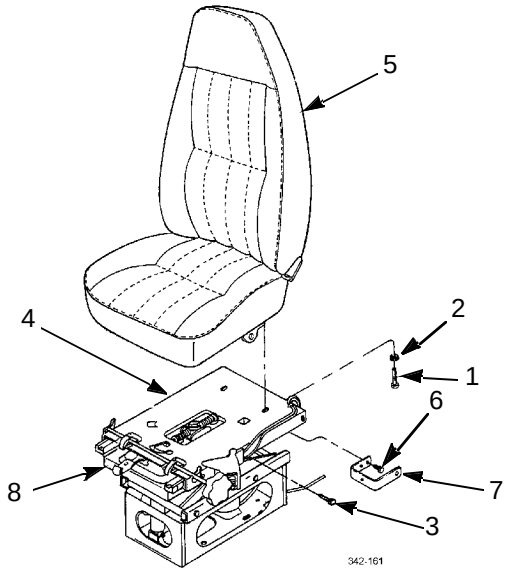
This task is the same for driver or passenger seat.

1. Adjust to rear position and remove two screws (1), washers (2), and shoulder bolts (3) from channel (4).
2. Remove seat (5) from channel (4).

NOTE

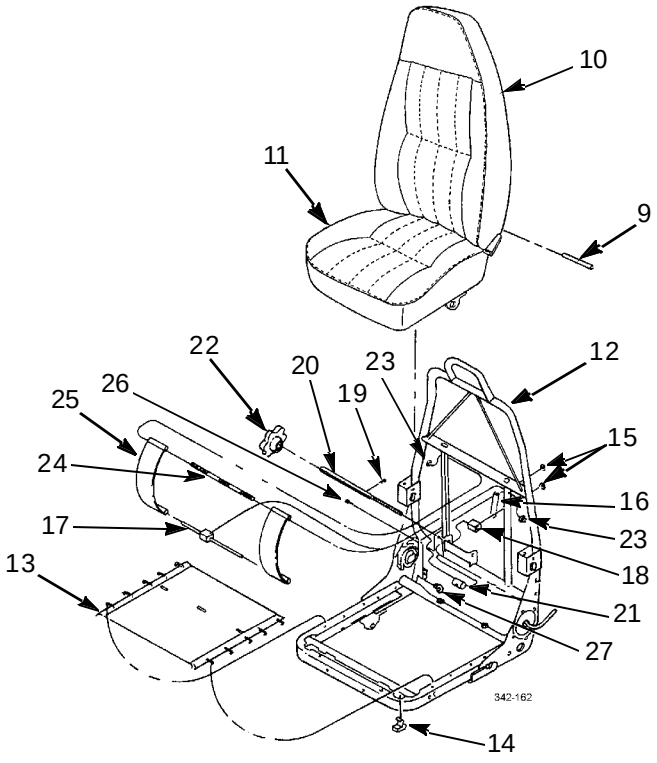
Perform steps 3 through 8 to disassemble seat frame.

3. Remove two screws (6) and bracket (7) from each side of upper plate (8).



DISASSEMBLY - CONTINUED

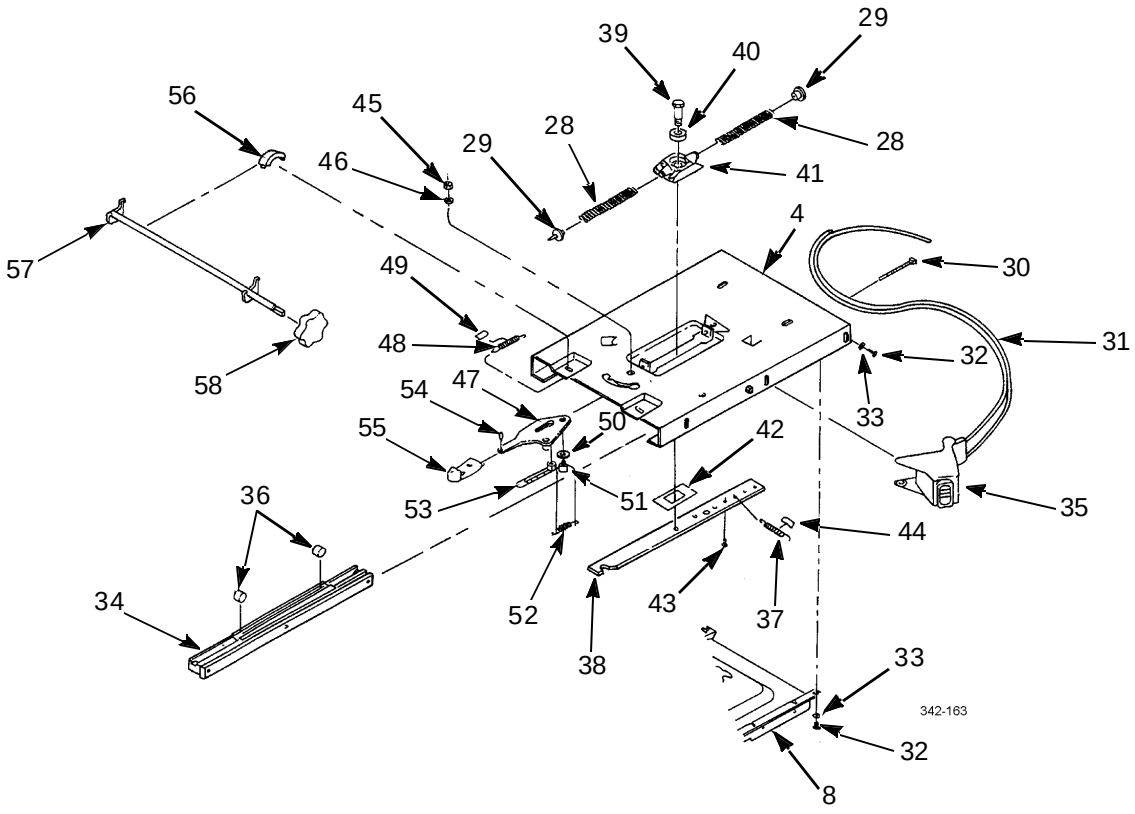
4. Remove two wires (9) and remove back cover (10) and pad (11) from frame (12).
5. Remove seat pad support (13) and two seat tilt blocks (14).
6. Remove two pushnuts (15) and remove linkage (16) from slide shaft (17) and adjustment block (18). Discard pushnuts.
7. Remove roll pin (19), adjustment shaft (20), spacer (21), and adjustment block (18) from frame (12). Remove knob (22) from adjustment shaft. Discard roll pin.
8. Remove two pushnuts (23), support shaft (24), two springs (25), and slide shaft (17). Discard pushnuts.
9. Remove screw (26) and stop block (27).



10. With channel (4) assembly still in rear position, remove isolator spring (28) and rubber bumper (29) at rear.
11. Adjust channel (4) assembly to forward position and remove isolator spring (28) and rubber bumper (29) at front.
12. Remove three wire ties (30) from air lines (31).
13. Remove six screws (32) and lock washers (33) from sides of channel (4) and six screws (32) and lock washers (33) from underneath channel to free two guide assemblies (34). Discard lock washers.
14. Remove two guide assemblies (34) and valve mount (35) from channel (4).
15. Remove two rollers (36) from each guide assembly (34).
16. Disconnect end of spring (37) from latch bar (38).
17. Remove bolt (39), washer (40), pivot block (41), latch bar (38), and spacer (42) from channel (4). Remove screw (43) from latch bar.

DISASSEMBLY - CONTINUED

18. Separate channel (4) from upper plate (8) and disconnect spring (37) and split poly loom (44) from channel.
19. Remove lock nut (45), washer (46), control handle (47), spring (48), split poly loom (49), washer (50), and shoulder bolt (51) from channel (4). Discard lock nut.
20. Remove spring (52), detent pin (53), pop rivet (54), and knob (55) from control handle (47). Discard pop rivet.
21. Remove two brackets (56) and tilt rod (57) from channel (4). Remove knob (58) from tilt rod.



DISASSEMBLY - CONTINUED

22. Using blocking between upper plate (8) and riser (59) to hold upper plate in fully raised position.

NOTE

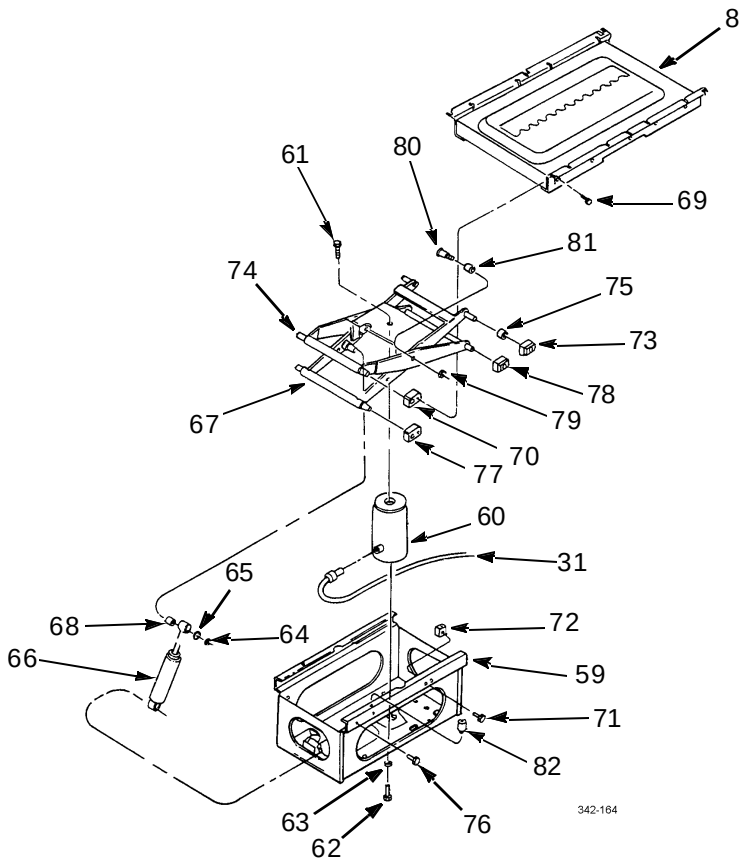
Perform steps 23 and 24 to remove air spring.

23. Disconnect air line (31) from air spring (60).
24. Remove screw (61), screw (62), washer (63), and air spring (60).

NOTE

Perform steps 25 and 26 to remove damper.

25. Remove two push-on fasteners (64), washers (65), and damper (66) from lever (67) and riser (59). Discard push-on fasteners.
26. Press two bearings (68) from damper (66).
27. At front of upper plate (8), remove two screws (69) from bearing blocks (70).
28. At rear of riser (59), remove two screws (71) and stop blocks (72).
29. Remove blocking supporting upper plate (8).



30. Slide upper plate (8) forward and rearward to remove upper plate from bearing blocks (70) and slide blocks (73).

DISASSEMBLY - CONTINUED

31. Remove bearing blocks (70) from ends of lever (74) and remove two slide blocks (73) and spacers (75) from ends of lever (67).
32. At front of riser (59), remove two screws (76) from bearing blocks (77).
33. Slide lever (67 and 74) assembly forward to remove two bearing blocks (77) and lever assembly from riser (59).
34. Remove bearing blocks (77) from ends of lever (67) and slide blocks (78) from ends of lever (74).
35. Remove two nuts (79) and shoulder bolts (80) to separate lever (67) and lever (74).
36. Press out two bearings (81) from lever (67).
37. Remove two rubber bumpers (82) from riser (59).

ASSEMBLY

1. Install two rubber bumpers (82) to riser (59).
2. Install two bearings (81) into lever (67) with flanges of bearings on outside of lever.
3. Install lever (74) to lever (67) with two shoulder bolts (80) and nuts (79). Tighten nuts to 192-240 lb-in (22-27 Nm).
4. Install two slide blocks (78) on rear of lever (74) and two bearing blocks (77) on front of lever (67).
5. Install lever (67 and 74) assembly into riser (59) and install two screws (76) into bearing blocks (77).
6. Install two spacers (75) and slide blocks (73) on ends of lever (67) and two bearing blocks (70) on ends of lever (74).
7. Install upper plate (8) over bearing blocks (70) and slide blocks (73).
8. Install two screws (69) to bearing blocks (70).
9. Using blocking between upper plate (8) and riser (59) to hold upper plate in fully raised position.
10. At rear of riser (59), install two stop blocks (72) with two screws (71).

NOTE

Perform steps 11 and 12 to install damper.

11. Press two bearings (68) into damper (66).
12. Install damper (66) to riser (59) and lever (67) with two washers (65) and new push-on fasteners (64).

NOTE

Perform steps 13 through 15 to install air spring.

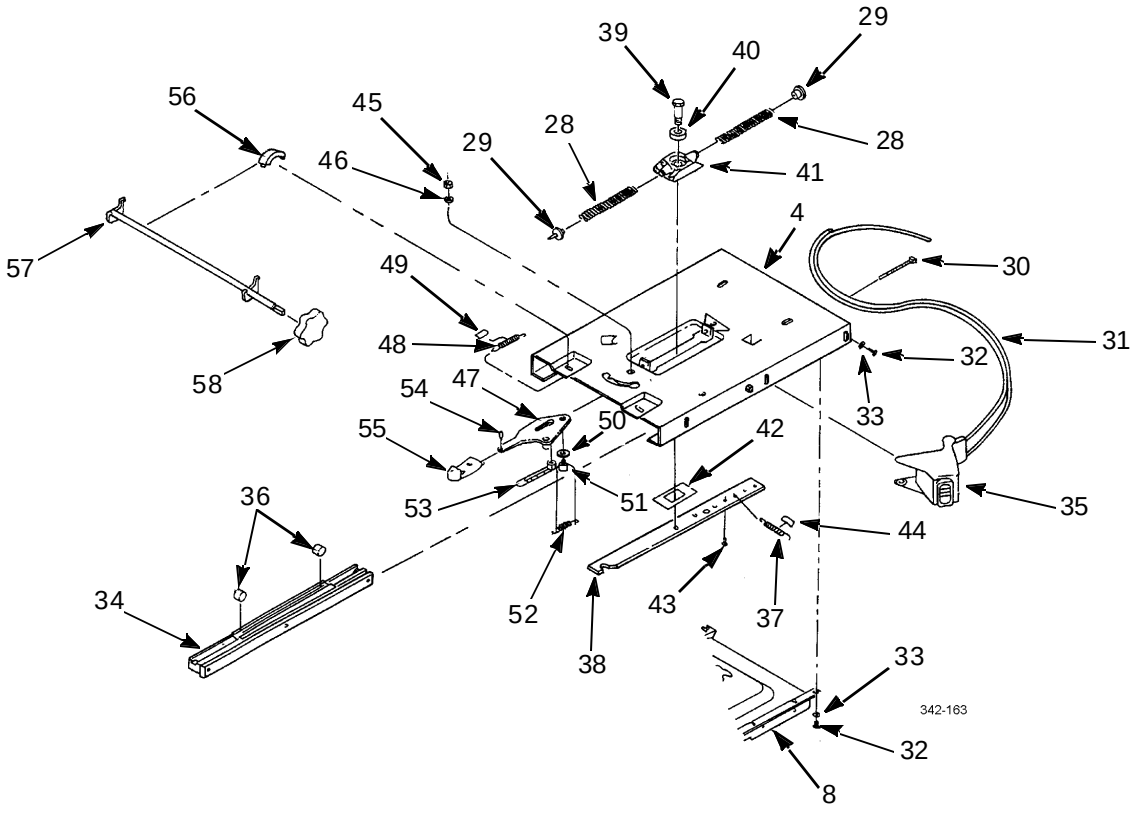
13. Position air spring (60) with fitting facing forward.
14. Install air spring (60) with washer (63), screw (62), and screw (61). Tighten screw (61) to 180-228 lb-in (20-26 Nm). Tighten screw (62) to 108-132 lb-in (12-15 Nm).
15. Connect air line (31) to air spring (60).
16. Remove blocking supporting upper plate (8).

ASSEMBLY - CONTINUED

17. Install knob (58) to tilt rod (57) and install two brackets (56) and tilt rod to channel (4).
18. Install knob (55), new pop rivet (54), detent pin (53), and spring (52) to control handle (47).
19. Connect spring (37) and split poly loom (44) to channel (4) and position channel to upper plate (8).
20. Install screw (43) to latch bar (38) and install spacer (42), latch bar, and pivot block (41) to channel (4) with washer (40) and bolt (39). Tighten bolt to 26-34 lb-ft (35-46 Nm).
21. Connect end of spring (37) to latch bar (38).
22. Install two rollers (36) to each of two guide assemblies (34).
23. Position valve mount (35) and two guide assemblies (34) to channel (4).
24. Install six new lockwashers (33) and screws (32) underneath channel (4) and six new lockwashers (33) and screws (32) to sides of channel.
25. Secure air lines (31) with three wire ties (30).
26. Adjust channel (4) assembly to forward position and install front isolator spring (28) and rubber bumper (29).
27. Adjust channel (4) assembly to rear position and install rear isolator spring (28) and rubber bumper (29).

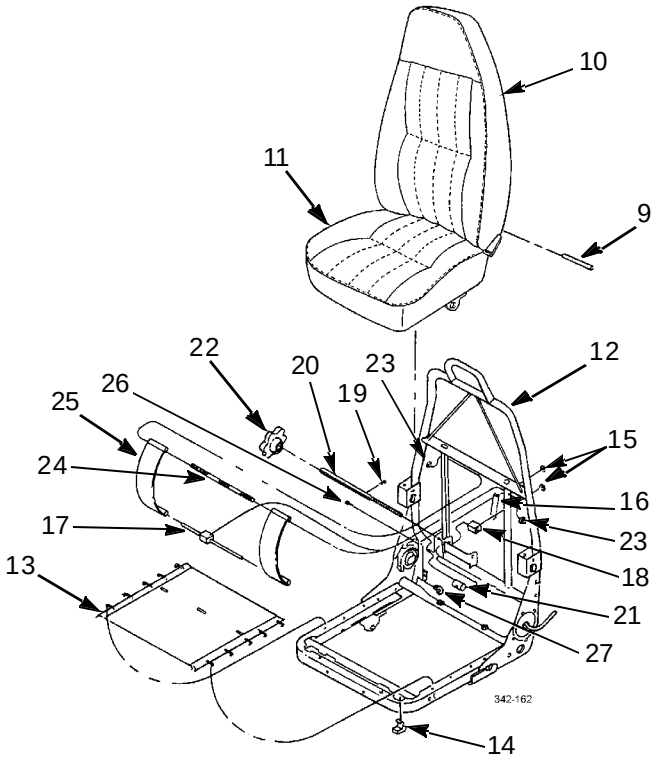
NOTE

Perform steps 28 through 33 to assemble seat frame.



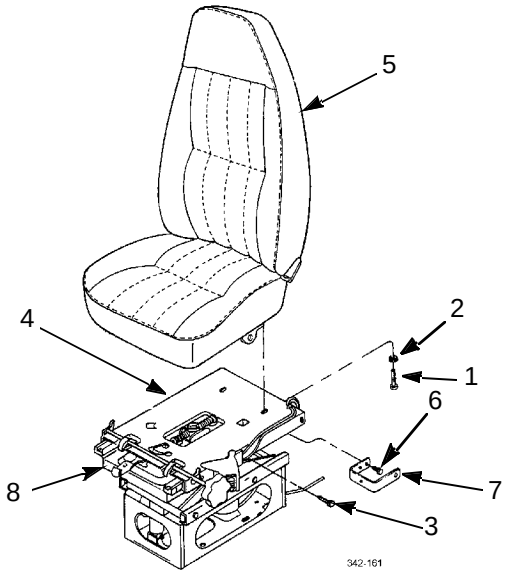
ASSEMBLY - CONTINUED

28. Install stop block (27) to seat frame (12) with screw (26).
29. Install slide shaft (17), two springs (25), support shaft (24) and two new pushnuts (23).
30. Install knob (22) to adjustment shaft (20) and install adjustment block (18), spacer (21), adjustment shaft, and new roll pin (19).
31. Install linkage (16) to adjustment block (18) and slide shaft (17) with two new pushnuts (15).
32. Install two seat tilt blocks (14) and seat pad support (13).
33. Install pad (11) and back cover (10) to frame (12) with two wires (9).



ASSEMBLY - CONTINUED

34. Install bracket (7) to each side of upper plate (8) with two screws (6). Tighten screws to 18-22 lb-ft (24-30 Nm). Position seat (5) to channel (4).
35. Install two shoulder bolts (3). Tighten bolts to 18-22 lb-ft (24-30 Nm).
36. Install two washers (2) and screws (1). Tighten screws to 18-22 lb-ft (24-30 Nm).



37. Install seat (WP 0191 00).

END OF WORK PACKAGE

SEAT BELT REPLACEMENT 0193 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

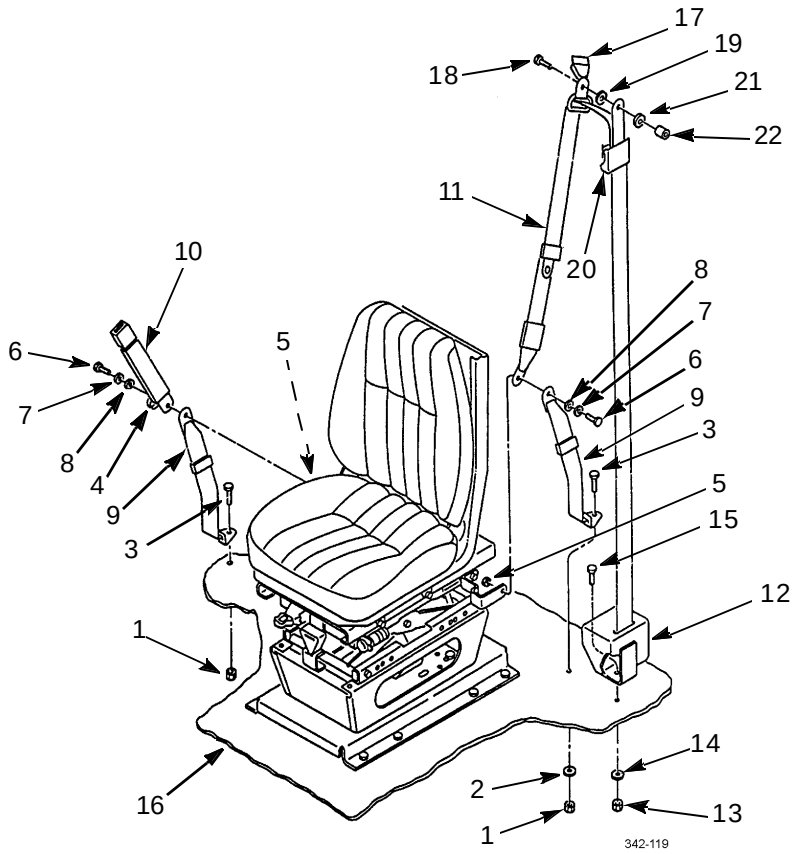
TM 9-2320-302-10

NOTE

Replacement mounting hardware for seat belt is supplied with new seat belt.

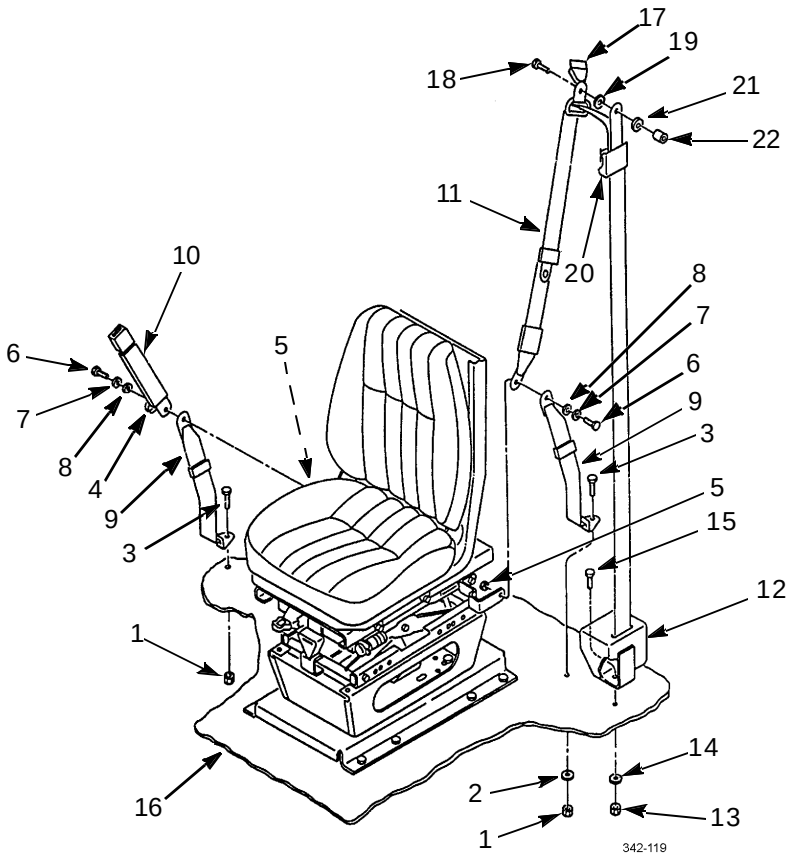
REMOVAL

1. Remove two lock nuts (1), washer (2), and two screws (3). Discard lock nuts.
2. Lift cover (4) and remove two lock nuts (5), screws (6), lock washers (7), washers (8), tether belts (9), and lock belt (10). Discard lock nuts and lock washers.
3. Disconnect seat belt (11).
4. Lift cover (12) and remove lock nut (13), washer (14), and screw (15). Discard lock nut.
5. Disconnect seat belt (11) from floor (16).
6. Lift cover (17) and remove screw (18), seat belt (11), washer (19), lock (20), washer (21), and bushing (22).



INSTALLATION

1. Install bushing (22), washer (21), lock (20), washer (19), seat belt (11), and screw (18). Close cover (17).
2. Connect seat belt (11) and install screw (15), washer (14), and new lock nut (13) in floor (16).
3. Close cover (12).
4. Connect seat belt (11) and install lock belt (10), tether belts (9), washers (8), new lock washers (7), screws (6), and new lock nuts (5).
5. Close cover (4). Install two screws (3), washer (2), and two new lock nuts (1).



END OF WORK PACKAGE

FRONT SPLASH GUARD AND FENDER EXTENSION MAINTENANCE 0194 00

THIS WORK PACKAGE COVERS

Removal, Disassembly, Assembly, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Personnel Required

Two

Materials/Parts

Nut, lock (P/N MS51922-9) (8)

Materials/Parts - Continued

Nut, lock (P/N MS51922-17) (9)

Nut, lock (P/N MS51922-33) (3)

References

TM 9-2320-302-10

Equipment Condition

Side marker/turn signal light removed (WP 0088 00)

REMOVAL

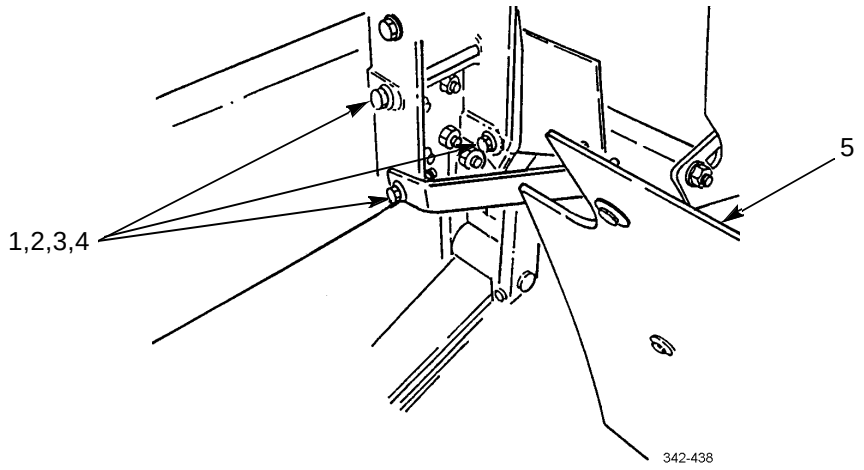
WARNING

Front fender extension and splash guard are heavy and awkward to handle. Use assistance when removing these items. Failure to follow this warning may result in injury to personnel.

NOTE

Procedures for right- and left-side fender extensions are the same.

Remove three lock nuts (1), six washers (2), three screws (3), and front fender extension (4) with splash guard (5) from vehicle. Discard lock nuts.

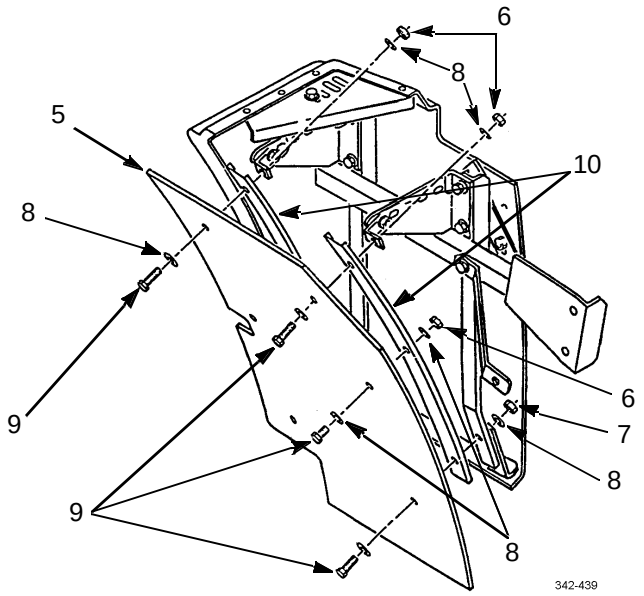


DISASSEMBLY

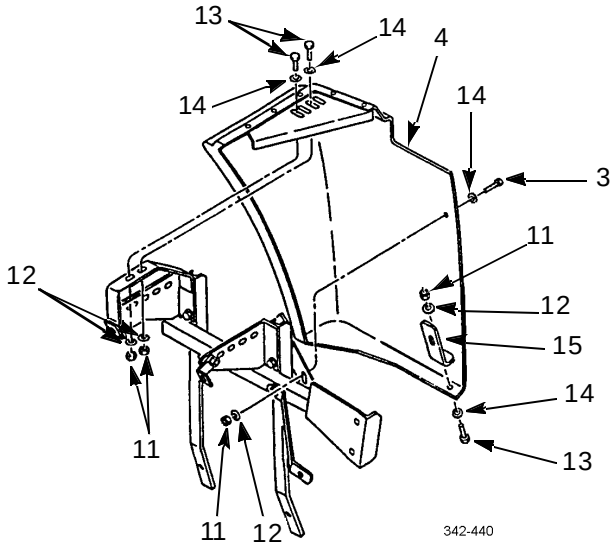
NOTE

Cap screws are different length as needed for use. Mark location of each during removal to aid during installation.

1. Remove four nuts (6), two lock nuts (7), 12 washers (8), six cap screws (9), two braces (10), and splash guard (5). Discard lock nuts.



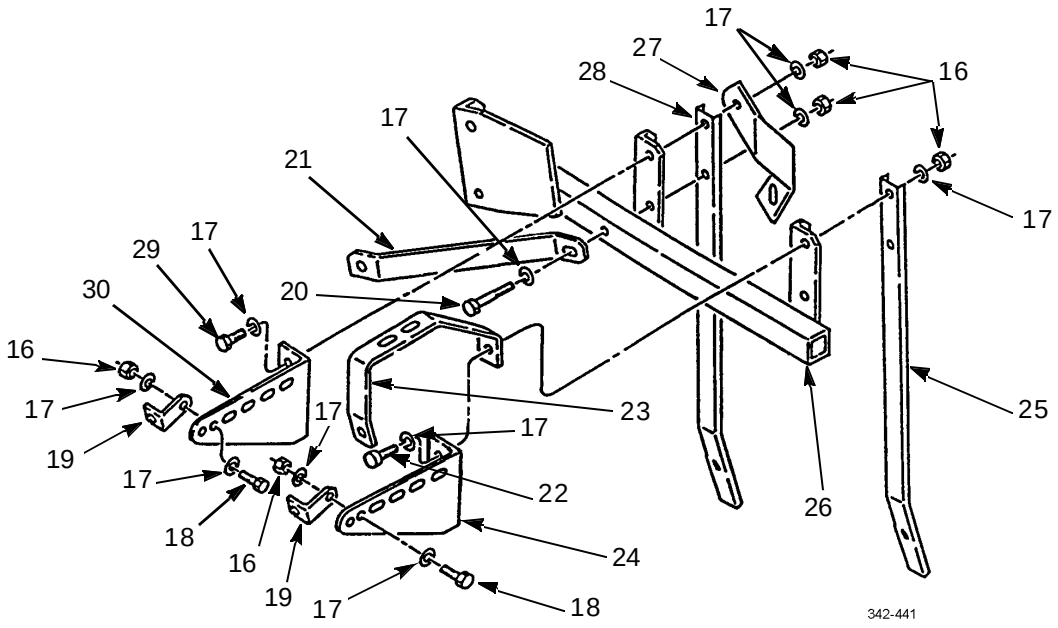
2. Remove four lock nuts (11), washers (12), screws (13), washers (14), bracket (15), and front fender extension (4). Discard lock nuts.



3. Remove two lock nuts (16), four washers (17), two cap screws (18), and two brackets (19). Discard lock nuts.

DISASSEMBLY - CONTINUED

4. Remove lock nut (16), two washers (17), cap screw (20), and bracket (21). Discard lock nut.
5. Remove lock nut (16), two washers (17), cap screws (22), two brackets (23 and 24), and brace (25) from bracket (26). Discard lock nuts.
6. Remove lock nut (16), two washers (17), cap screw (29), bracket (27), brace (28), and bracket (30) from bracket (26). Discard lock nuts.



ASSEMBLY

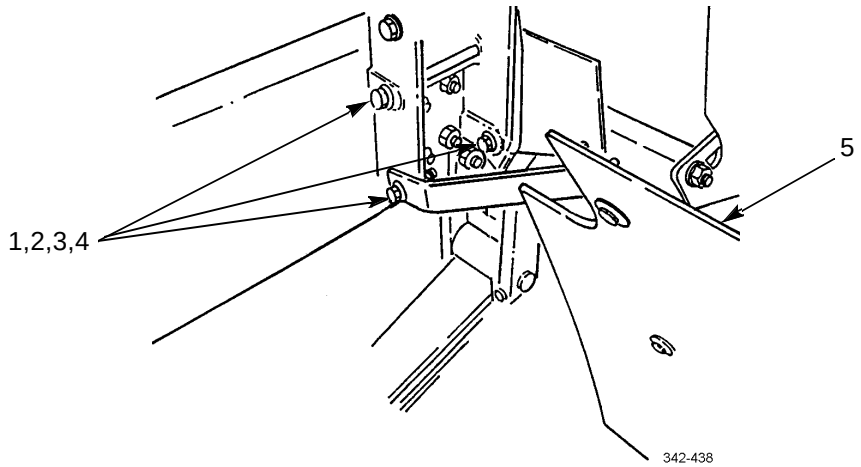
1. Install bracket (30), bracket (28), and bracket (27) on bracket (26). Secure in place with screw (29), two washers (17), and new lock nut (16).
2. Install brace (25) and brackets (24 and 23) on bracket (26). Secure in place with cap screw (22), two washers (17), and new lock nut (16).
3. Install bracket (21) on bracket (26) with screw (20), two washers (17), and new lock nut (16).
4. Install bracket (19) on each bracket (24 and 30). Secure with cap screw (18), two washers (17), and new lock nut (16).
5. Attach bracket (15) to front fender extension (4) and secure with screw (13), two washers (12 and 14), and new lock nut (11).
6. Attach front fender extension (4) to brackets (23 and 27) and secure in place with three screws (13), washers (14), washers (12), and new lock nuts (11).
7. Install splash guard (5) and two braces (10) to fender extension and bracket assembly with six cap screws (9), 12 washers (8), four nuts (6), and two new lock nuts (7).

INSTALLATION

WARNING

Front fender extension and splash guard are heavy and awkward to handle. Use assistance when installing these items. Failure to follow this warning may result in injury to personnel.

1. Position front fender splash guard (5) and fender extension (4) on vehicle and secure in place with three screws (3), six washers (2), and three new lock nuts (1).



2. Install side marker/turn signal light (WP 0088 00).

END OF WORK PACKAGE

REAR FENDER REPLACEMENT 0195 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 50-250 lb-ft (Item 46, WP 0236 00)

References

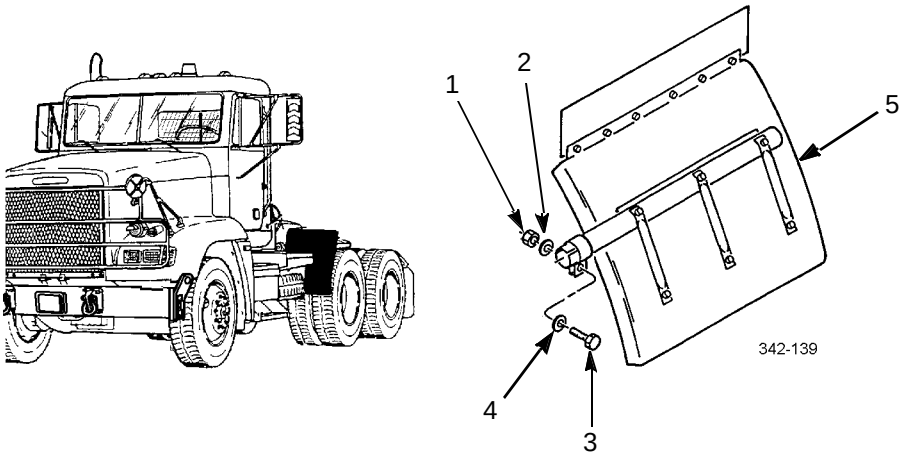
TM 9-2320-302-10

NOTE

Right and left fenders are replaced the same way. Right rear fender is illustrated.

REMOVAL

Remove nut (1), washer (2), screw (3), washer (4), and rear fender (5) from vehicle.



INSTALLATION

Install rear fender (5) on vehicle with washer (4), screw (3), washer (2), and nut (1). Tighten nut to 200 lb-ft (271 Nm).

END OF WORK PACKAGE

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MUD FLAP ASSEMBLY REPLACEMENT 0196 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

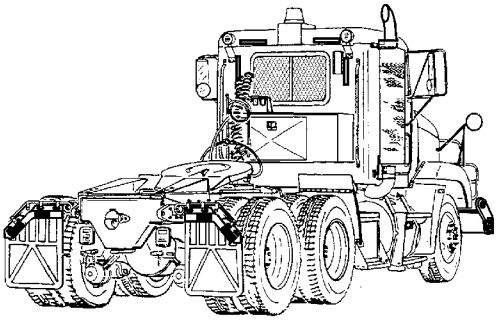
Materials/Parts

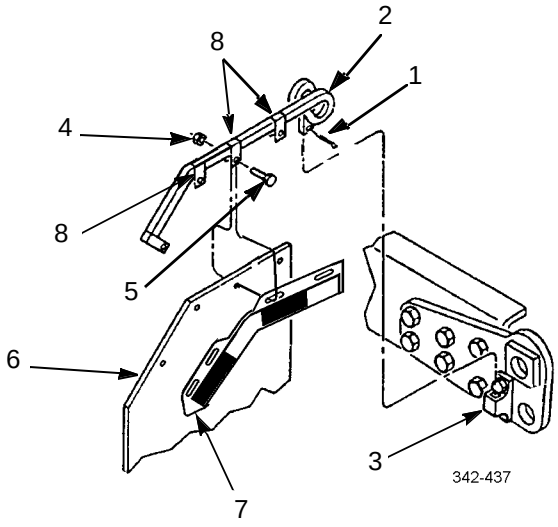
Nut, lock (P/N MS51922-17) (4)

Pin, cotter (P/N MS24665-623)

REMOVAL

1. Remove cotter pin (1) and mud flap hanger (2) from rear mounting bracket assembly (3). Discard cotter pin.
2. Remove four lock nuts (4), screws (5), mud flap (6), and reflective tape bracket (7) from mud flap hanger (2). Discard lock nuts.
3. Remove four clamps (8) from mud flap hanger (2).





INSTALLATION

1. Install four clamps (8) on mud flap hanger (2).
2. Position reflective tape bracket (7) on mud flap (6) and install mud flap on mud flap hanger (2) with four screws (5) and new lock nuts (4).
3. Install mud flap hanger (2) on rear mounting bracket assembly (3) with new cotter pin (1).

END OF WORK PACKAGE

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PERSONAL GEAR STORAGE BOX AND MOUNTING BRACKET REPLACEMENT 0197 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (3)

Nut, lock (P/N MS51922-17) (11)

Compound, caulking (Item 7, WP 0235 00)

Personnel Required

Two

References

TM 9-2320-302-10

Equipment Condition

Basic Issue Items (BII) storage box removed (WP 0198 00)

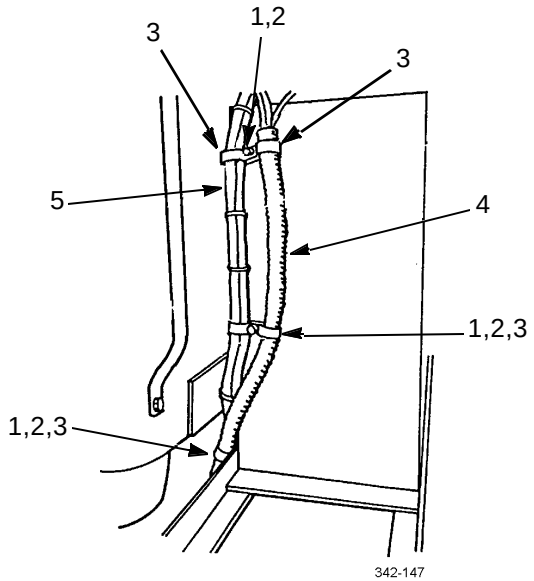
Spare wheel hoist removed (WP 0176 00)

Forward tractor protection valve removed (WP 0150 00)

Trailer electrical receptacles removed (WP 0078 00)

REMOVAL

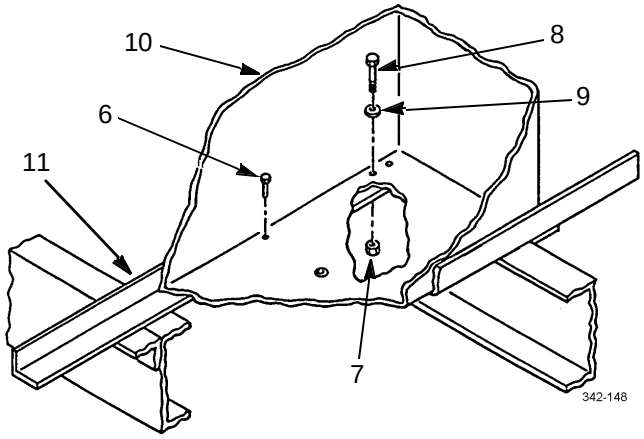
1. Remove three lock nuts (1), washers (2), and six clamps (3) and lay four air tubes (4) and two harnesses (5) aside. Discard lock nuts.



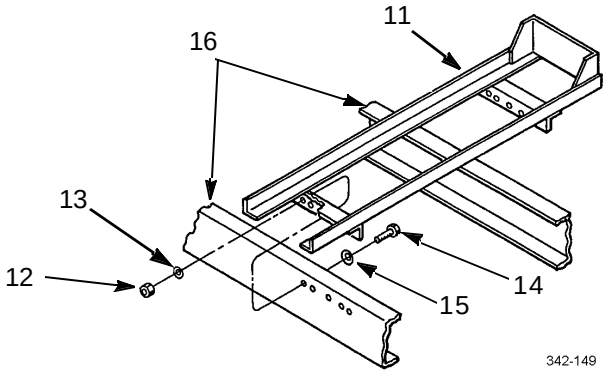
PERSONAL GEAR STORAGE BOX AND MOUNTING BRACKET REPLACEMENT - CONTINUED 0197 00

REMOVAL - CONTINUED

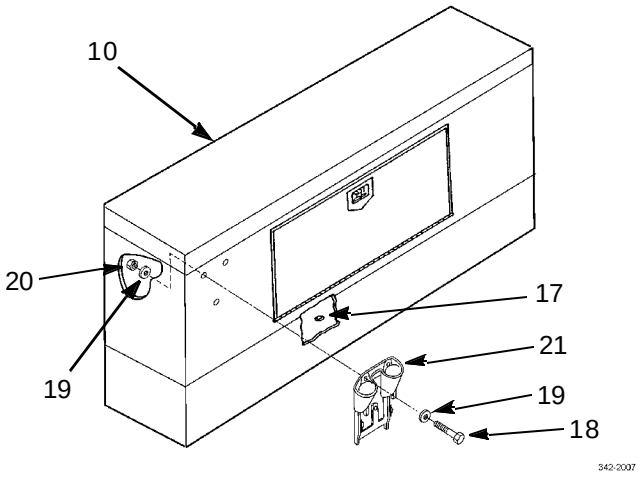
2. Remove two screws (6), four lock nuts (7), screws (8), washers (9), and personal gear storage box (10) from mounting bracket (11). Discard lock nuts.



3. Remove seven lock nuts (12), washers (13), screws (14), washers (15), and mounting bracket (11) from frame (16). Discard lock nuts.



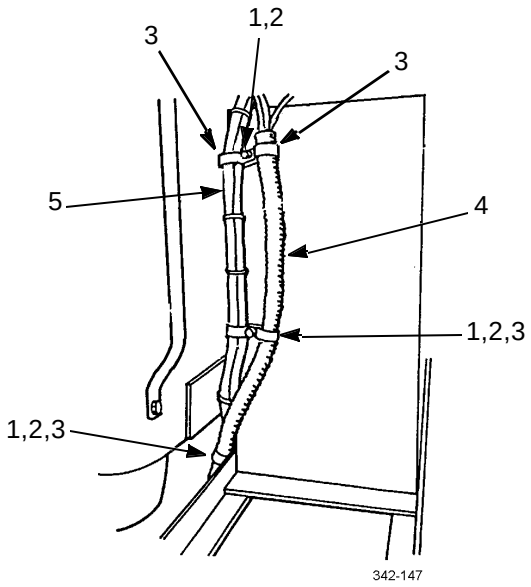
4. Remove drain (17) from personal gear storage box (10).



5. Remove three bolts (18), six washers (19), three nuts (20), and gladhand/electrical cable bracket (21) from personal gear storage box (10).

INSTALLATION

1. Install gladhand/electrical cable bracket (21) with three bolts (18), six washers (19), and three nuts (20).
2. Install mounting bracket (11) on frame (16) with seven washers (15), screws (14), washers (13), and new lock nuts (12).
3. Install drain (17) in personal gear storage box (10).
4. Apply caulking compound to bottom of four washers (9). Install personal gear storage box (10), four washers, screws (8), new lock nuts (7), and two screws (6) in mounting bracket (11).
5. Install four air tubes (4), two harnesses (5), six clamps (3), three washers (2), and new lock nuts (1) on personal gear storage box (10).



6. Install forward tractor protection valve (WP 0150 00).
7. Install spare wheel hoist (WP 0176 00).
8. Install Basic Issue Items (BII) storage box (WP 0198 00).
9. Install trailer electrical receptacles (WP 0078 00).

END OF WORK PACKAGE

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BASIC ISSUE ITEMS (BII) STORAGE BOX AND MOUNTING BRACKET REPLACEMENT 0198 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Compound, caulking (Item 7, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

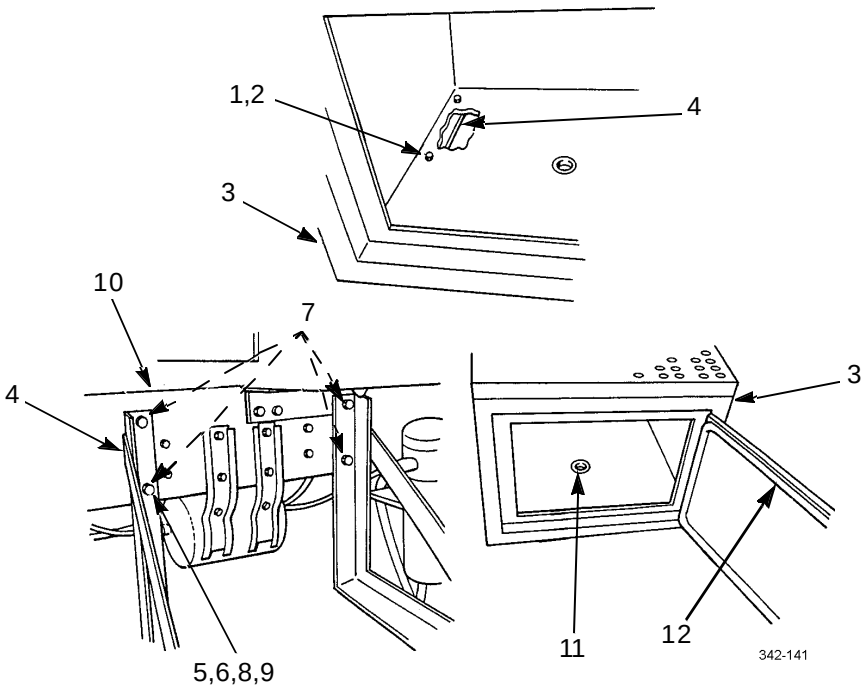
Primary I air tank removed (WP 0143 00)

Right rear step removed (WP 0174 00)

Vehicle jack mounting bracket removed (WP 0213 00)

REMOVAL

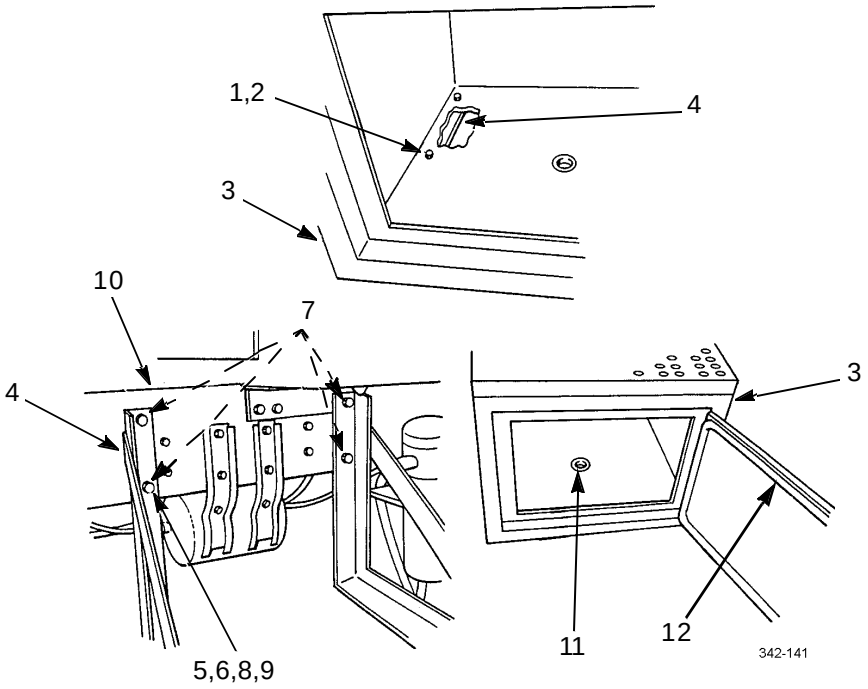
1. Remove six screws (1), washers (2), and storage box (3) from two mounting brackets (4).
2. Remove four nuts (5), washers (6), two mounting brackets (4), four spacers (7), screws (8), and washers (9) from frame rail (10).
3. Remove drain (11) and, if damaged, door seal (12) from storage box (3).



BASIC ISSUE ITEMS (BII) STORAGE BOX AND MOUNTING BRACKET REPLACEMENT- CONTINUED **0198 00**

INSTALLATION

1. Install drain (11) and, if removed, new door seal (12) in storage box (3).
2. Install four washers (9), screws (8), spacers (7), two mounting brackets (4), four washers (6), and nuts (5) on frame rail (10).
3. Apply caulking compound to bottom of six washers (2). Install storage box (3), six washers (2), and screws (1) in two mounting brackets (4).



4. Install vehicle jack mounting bracket (WP 0213 00).
5. Install right rear step (WP 0174 00).
6. Install primary I air tank (WP 0143 00).

END OF WORK PACKAGE

STORAGE BOX LATCH REPLACEMENT 0199 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

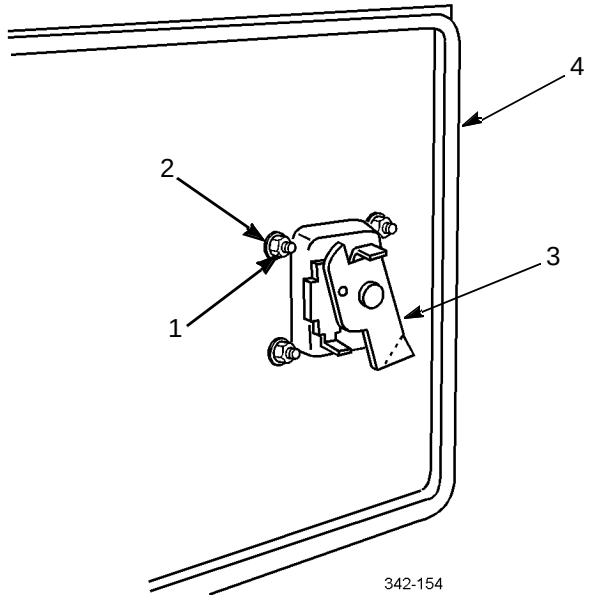
TM 9-2320-302-10

Materials/Parts

Nut, lock (P/N MS51922-1) (4)

REMOVAL

Remove four lock nuts (1), washers (2), and latch (3) from storage box (4).



INSTALLATION

Install latch (3) on storage box (4) with four washers (2), and new lock nuts (1).

END OF WORK PACKAGE

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REAR PLATFORM REPLACEMENT 0200 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

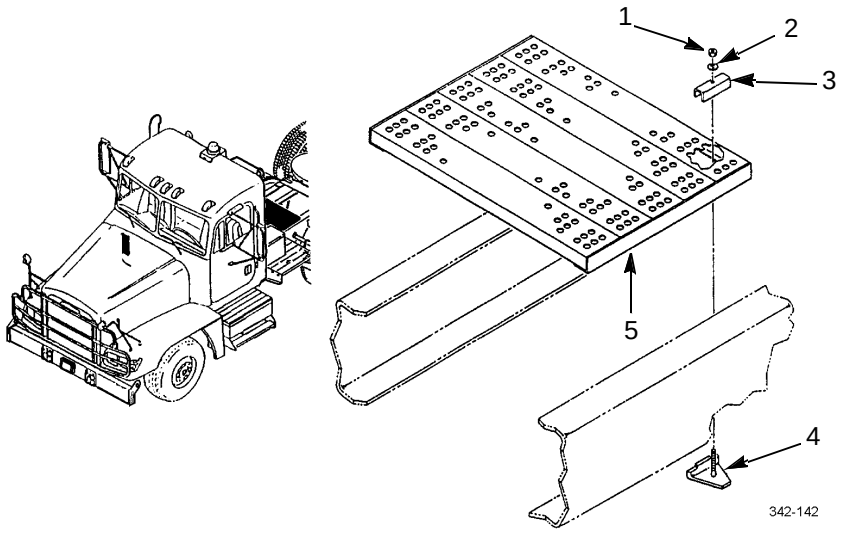
TM 9-2320-302-10

Materials/Parts

Nut, self-locking (P/N MS51922-1) (4)

REMOVAL

Remove four lock nuts (1), washers (2), clamps (3 and 4), and platform (5). Discard locknuts.



INSTALLATION

Install platform (5) with four clamps (3 and 4), washers (2), and new lock nuts (1).

END OF WORK PACKAGE

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FLOOR MATS REPLACEMENT 0201 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

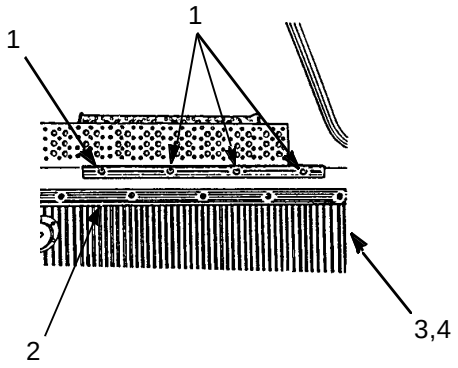
Wrench set, socket attachment (Item 49, WP 0236 00)

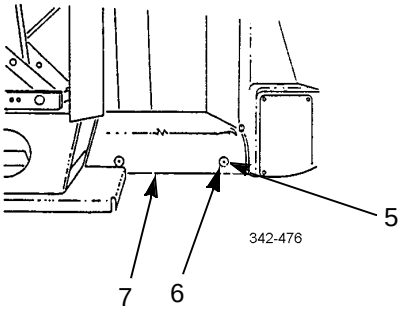
Equipment Condition

Seats removed (WP 0191 00)

REMOVAL

1. Remove 10 screws (1), two treadplates (2), floor mats (3), and insulation pads (4) from cab.
2. Remove 10 torx screws (5), washers (6), and floor mat (7) from cab.





INSTALLATION

1. Install floor mat (7) on cab with 10 washers (6) and torx screws (5).
2. Install two insulation pads (4), floor mats (3) and treadplates (2) on cab with 10 screws (1).
3. Install seats (WP 0191 00).

END OF WORK PACKAGE

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CAB LINERS REPLACEMENT 0202 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Equipment Condition

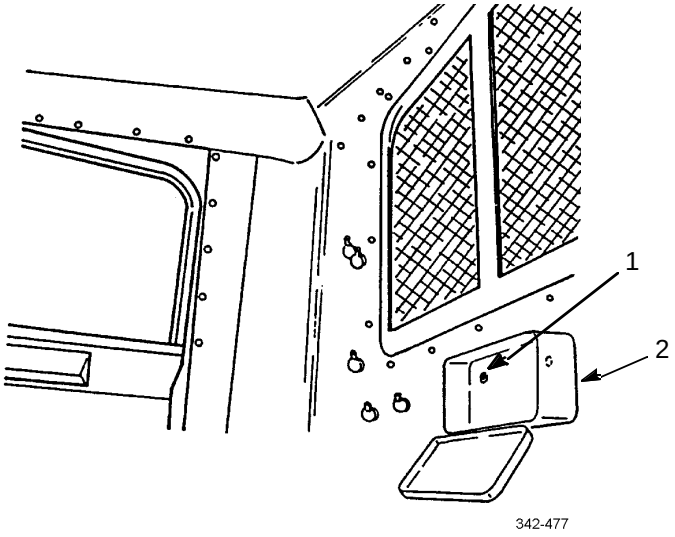
Seat belts removed (WP 0193 00)

Anti-lock brake system (ABS) electronic control unit removed (WP 0108 00)

Collision warning system (CWS) unit removed (WP 0111 00)

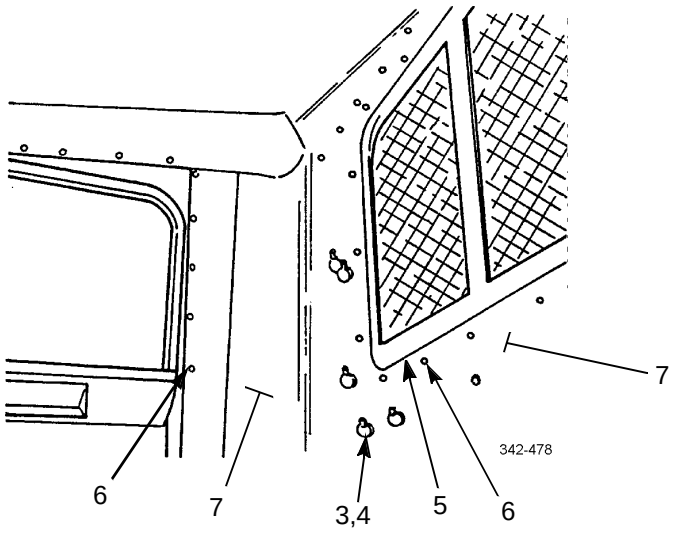
REMOVAL

1. Remove two screws (1) and first aid box (2) from cab.



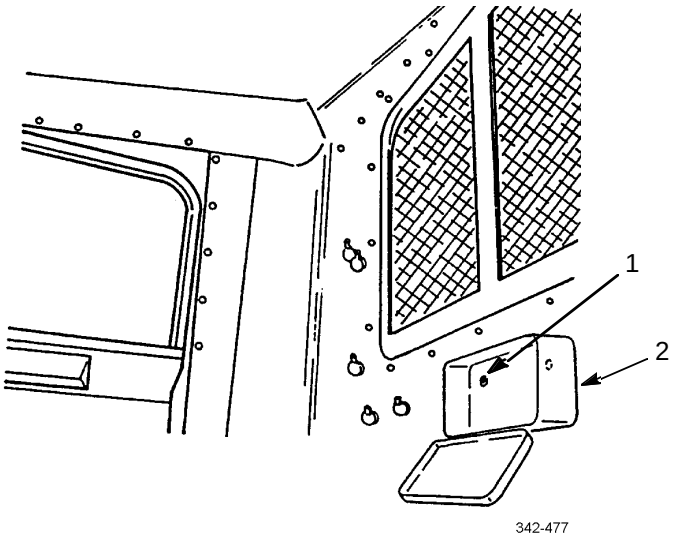
REMOVAL - CONTINUED

2. Remove five screws (3), clamps (4), and trim (5) from cab.
3. Remove 50 screws (6) and cab liners (7) from cab.



INSTALLATION

1. Install cab liners (7) on cab with 50 screws (6).
2. Install trim (5) on cab.
3. Install five clamps (4) on cab with five screws (3).
4. Install first aid box (2) on cab with two screws (1).



INSTALLATION - CONTINUED

5. Install collision warning system (CWS) unit (WP 0111 00).
6. Install anti-lock brake system (ABS) electronic control unit (WP 0108 00).
7. Install seat belts (WP 0193 00).

END OF WORK PACKAGE

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HEAD LINERS REPLACEMENT 0203 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

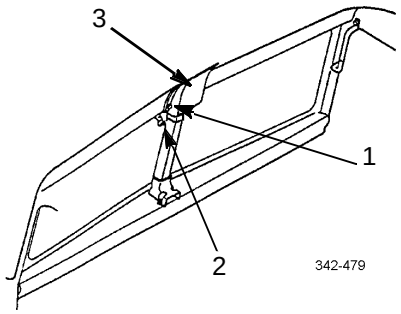
Wrench set, socket attachment (Item 49, WP 0236 00)

Equipment Condition

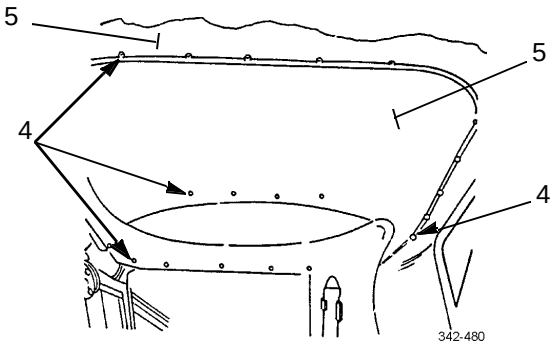
Interior light unit removed (WP 0091 00)

REMOVAL

1. Remove four torx screws (1), two brackets (2), and cover (3) from cab.



2. Remove 38 torx screws (4) and head liners (5) from cab.



INSTALLATION

1. Install head liners (5) on cab with 38 torx screws (4).
2. Install cover (3) and two brackets (2) on cab with four torx screws (1).
3. Install interior light unit (WP 0091 00).

END OF WORK PACKAGE

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CAB OVERHEAD STORAGE COMPARTMENT REPLACEMENT 0204 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

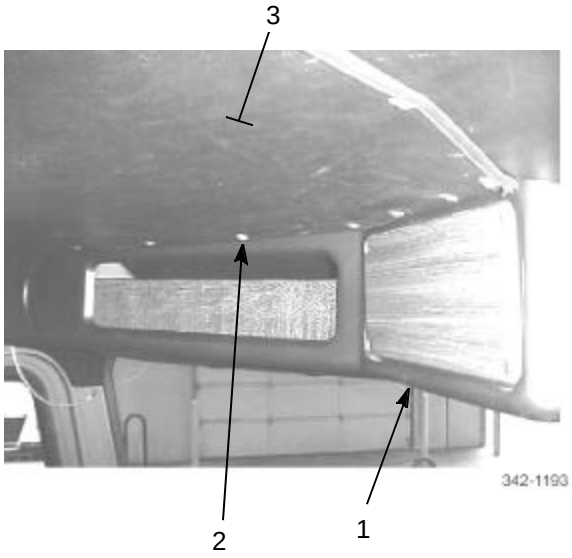
Tool kit, general mechanic's (Item 36, WP 0236 00)

Personnel Required

Two

REMOVAL

1. While supporting center of compartment (1), remove screws (2) securing compartment to cab ceiling (3).
2. Remove compartment (1) from cab.



INSTALLATION

1. Position and support center of compartment (1) against cab ceiling (3).
2. Install screws (2) securing compartment (1) to cab ceiling (3).

END OF WORK PACKAGE

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STEERING COLUMN COVER REPLACEMENT 0205 00

THIS WORK PACKAGE COVERS

Removal, Installation

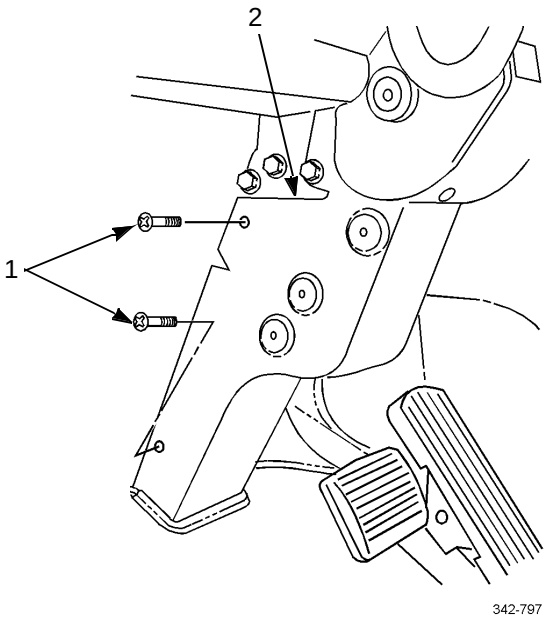
INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

REMOVAL

Remove four screws (1) and cover (2) from steering column.



INSTALLATION

Install cover (2) on steering column with four screws (1).

END OF WORK PACKAGE

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CAB DOOR ADJUSTMENT 0206 00

THIS WORK PACKAGE COVERS

Adjustment

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)
Wrench, torque, 0-200 lb-in (Item 43, WP 0236 00)
Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)
Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

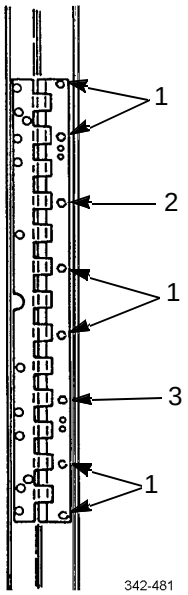
Screws, self-tapping (P/N 1901-0810) (6)

ADJUSTMENT

NOTE

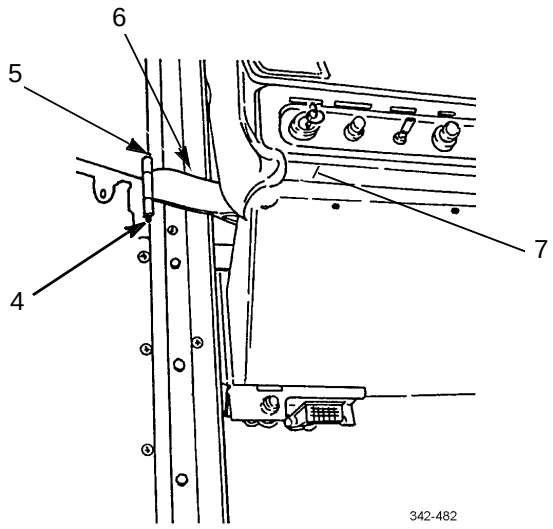
If performing cab door adjustment following repair or replacement, perform step 3 through 19.

1. Remove six self-tapping screws (1), leaving two adjusting screws (2 and 3) in place. Discard self-tapping screws.

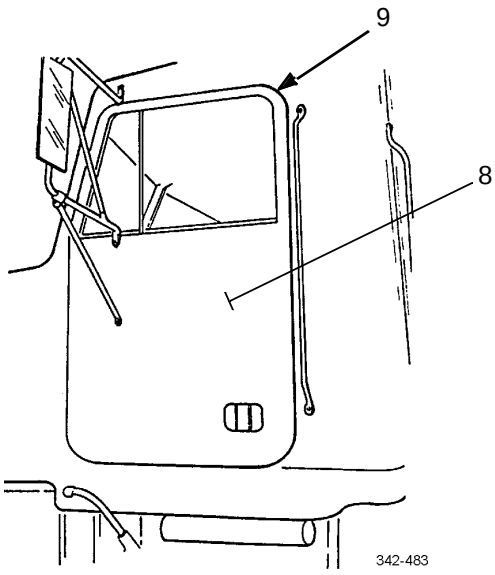


ADJUSTMENT - CONTINUED

2. Remove cap nut (4) and socket head screw (5) from door check arm (6).
3. Push door check arm (6) toward dashboard (7).



4. With cab door (8) closed, measure distance between top and bottom edges of cab door and door frame (9). Measurements must be equal within 3/32 in (2.38 mm).



NOTE

Perform steps 5 and 6 only if cab door requires adjustment.

5. To adjust cab door (8), loosen adjusting screws (2 and 3) just enough to allow movement of cab door (8) up and down to required measurement. Tighten adjusting screws.

ADJUSTMENT - CONTINUED

6. Repeat steps 4 and 5 until cab door (8) is properly adjusted.

NOTE

Cab door is fully closed when you hear two clicks of door latch. Door should not have to be slammed shut. If it is necessary to slam cab door shut, door must be adjusted.

7. With cab door (8) fully closed, check in-out position of top of cab door and flange (10) at hinge (11). Cab door must be flush +/- 1/16 in (1.58 mm).

NOTE

Perform steps 8 and 9 only if top of cab door in-out position requires adjustment.

8. To adjust top of cab door (8), loosen adjusting screw (2) and move cab door in or out to required measurement. Tighten adjusting screw.

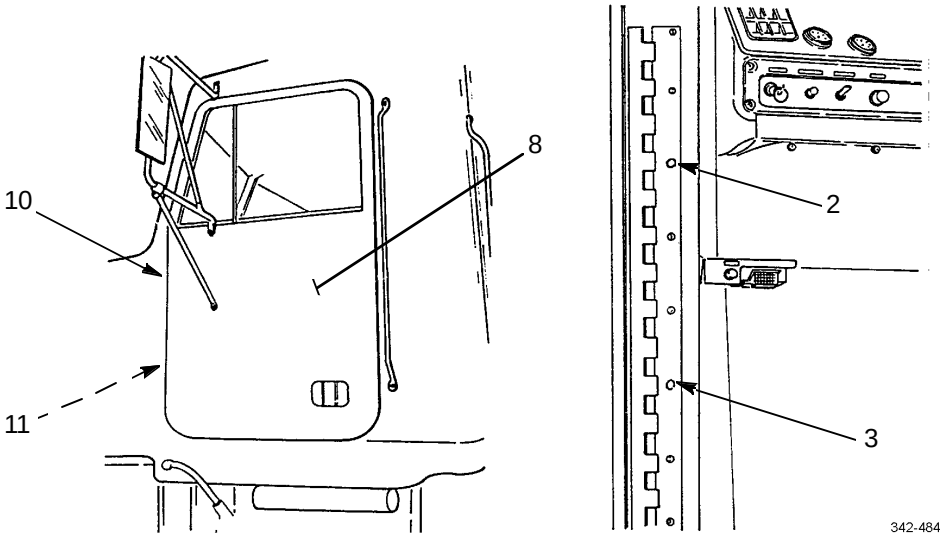
9. Repeat steps 7 and 8 until top of cab door (8) is properly adjusted.

10. With cab door (8) fully closed, check in-out position of bottom of cab door and flange (10) at hinge (11). Cab door must be flush +/- 1/16 in (1.58 mm)

NOTE

Perform steps 11 and 12 only if bottom of cab door in-out position requires adjustment.

11. To adjust bottom of cab door (8), loosen adjusting screw (3) and move cab door in or out to required measurement. Tighten adjusting screw.

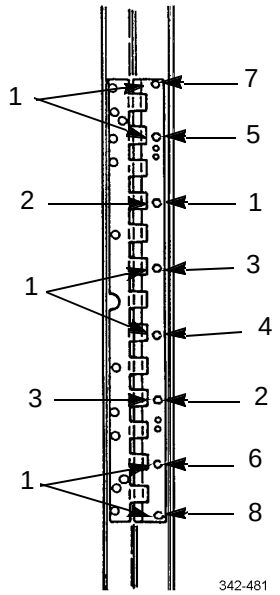


12. Repeat steps 10 and 11 until bottom of cab door (8) is properly adjusted.

CAB DOOR ADJUSTMENT - CONTINUED **0206 00**

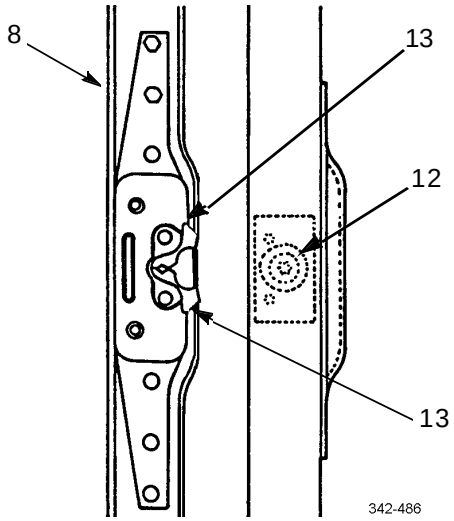
ADJUSTMENT - CONTINUED

13. Install six new self-tapping screws (1) and tighten self-tapping screws and adjusting screws (2 and 3) to 120 lb-in (14 Nm) in sequence shown.



TIGHTENING SEQUENCE

14. Close cab door (8) to within 2 in (5.08 cm) of striker pin (12) and see if door latch jaws (13) are centered on striker pin.



ADJUSTMENT - CONTINUED

15. Loosen torx screw (14) and add or remove shims (15) as necessary to center striker pin (12) and door latch jaws (13).

NOTE

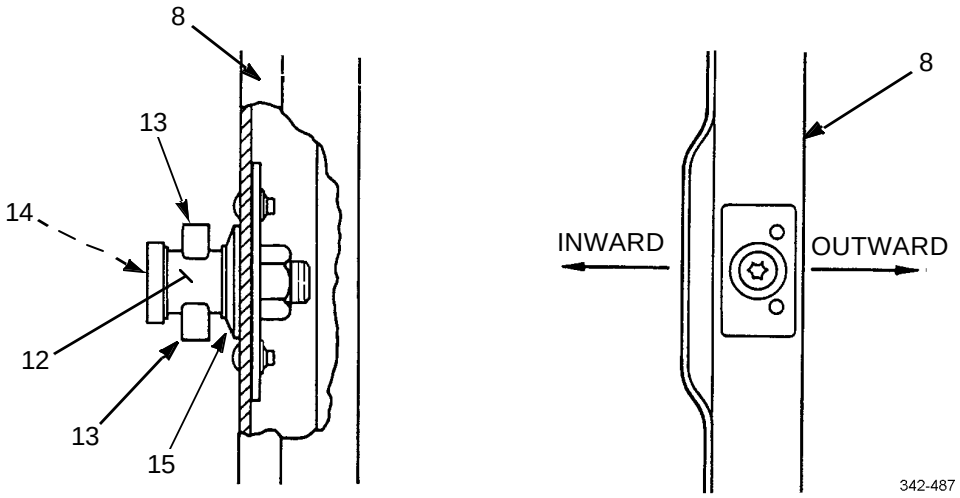
- Steps 16 through 19 must be performed from inside and outside of cab.
- Repeat steps 16 until door fully closes without difficulty.

16. Fully close cab door (8). If cab door was difficult to close or would not close, open cab door, loosen torx screw (14), and move striker pin (12) inward.
17. Tighten torx screw (14) to 37-42 lb-ft (50-57 Nm).

NOTE

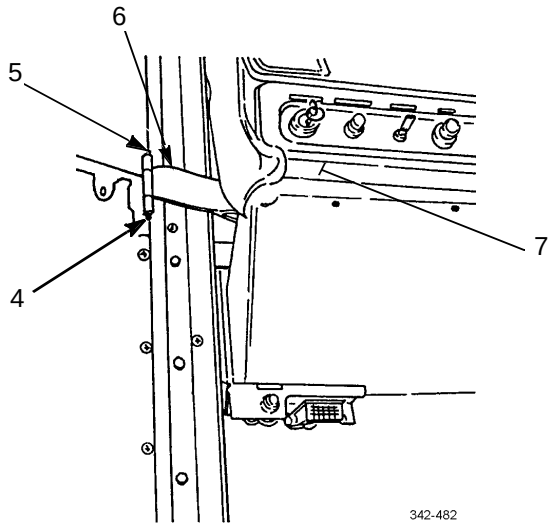
Repeat steps 18 until door opens without difficulty.

18. Open cab door (8). If cab door was difficult to open or would not open, loosen torx screw (14) and move striker pin (12) outward.
19. Tighten torx screw (14) to 37-42 lb-ft (50-57 Nm).



ADJUSTMENT - CONTINUED

20. Move door check arm (6) back into position.
21. Install socket head screw (5) and cap nut (4) on door check arm (6).



END OF WORK PACKAGE

TRANSMISSION TUNNEL ACCESS COVER REPLACEMENT 0207 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

Washer, lock (P/N MS35338-44) (12)

References

TM 9-2320-302-10

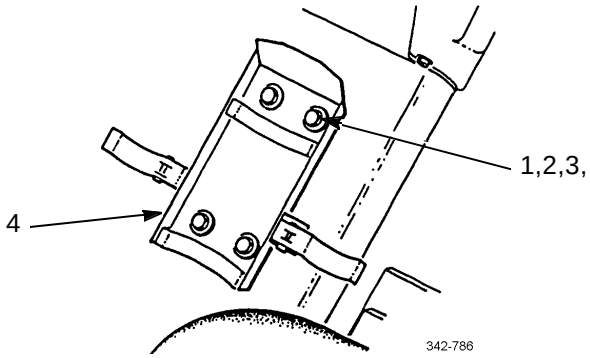
Equipment Condition

Fire extinguisher removed (TM 9-2320-302-10)

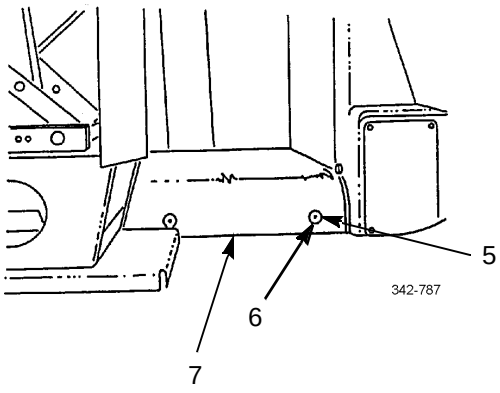
Transmission shift selector and shift tower removed (WP 0120 00)

REMOVAL

1. Remove four nuts (1), washers (2), screws (3), and fire extinguisher bracket (4) from vehicle.

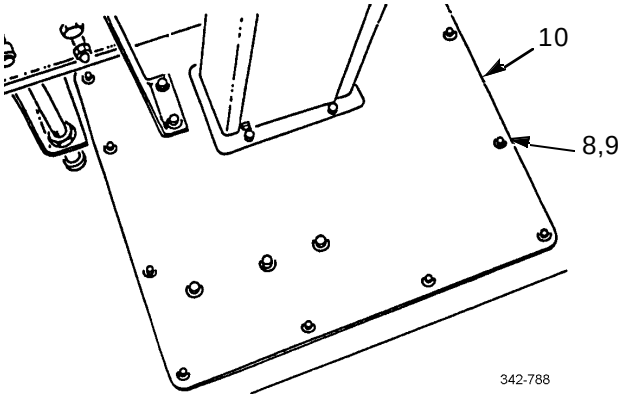


2. Remove ten torx screws (5), washers (6), and floor mat (7) from vehicle.



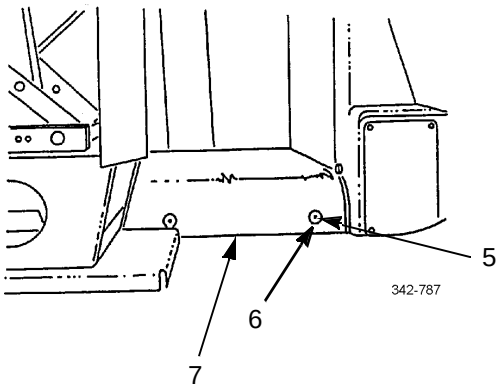
REMOVAL - CONTINUED

3. Remove 12 screws (8), lock washers (9), and transmission tunnel access cover (10) from vehicle. Discard lock washers.

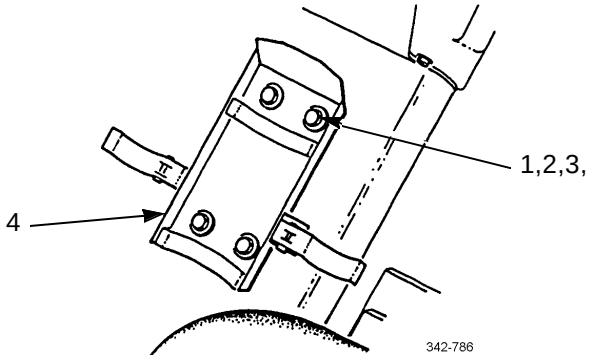


INSTALLATION

1. Install transmission tunnel access cover (10) on vehicle with 12 new lock washers (9) and screws (8).
2. Install floor mat (7) on vehicle with ten washers (6) and torx screws (5).



3. Install fire extinguisher bracket (4) on vehicle with four screws (3), washers (2), and nuts (1).



INSTALLATION - CONTINUED

4. Install transmission shift selector and shift tower (WP 0120 00).
5. Install fire extinguisher (TM 9-2320-302-10).

END OF WORK PACKAGE

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REAR VIEW MIRROR REPLACEMENT 0208 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

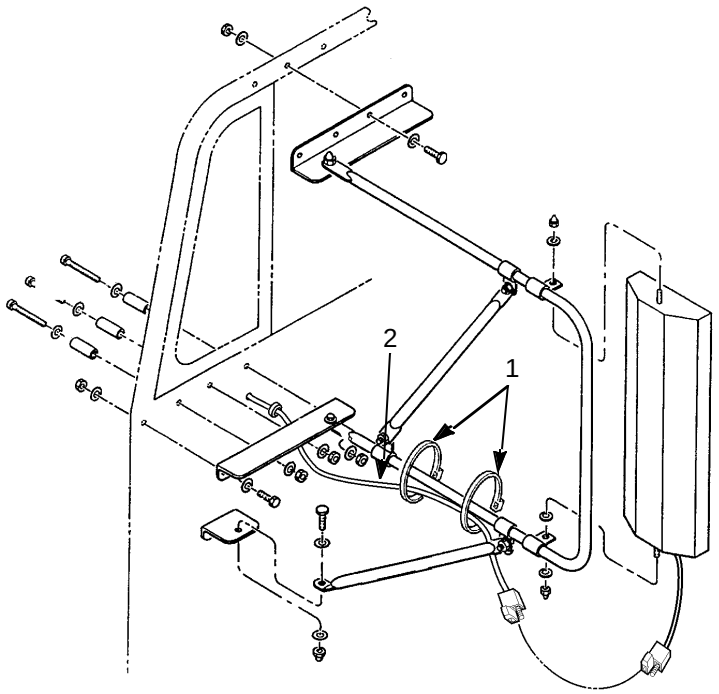
Strap, tiedown (Item 30, WP 0235 00)
Nut, lock (P/N MS51922-1) (8)
Washer, lock (P/N 23-09983-025) (3)

NOTE

Left and right rear view mirrors are replaced the same way. Left rear view mirror is shown.

REMOVAL

1. Remove tiedown straps (1) securing wiring harness (2).

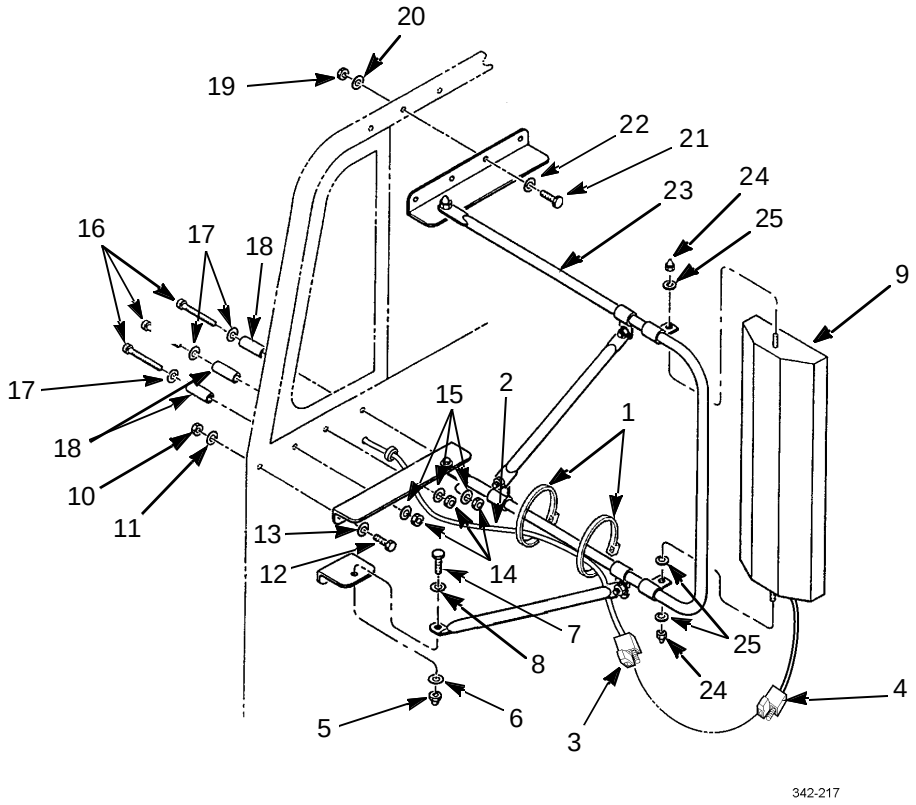


342-217

REAR VIEW MIRROR REPLACEMENT - CONTINUED 0208 00

REMOVAL - CONTINUED

2. Disconnect wiring harness connector (3) from mirror harness connector (4).
3. Remove cap nut (5), washer (6), screw (7), and washer (8) from mirror (9).
4. Remove lock nut (10), washer (11), screw (12), and washer (13) from mirror (9). Discard lock nut.
5. Remove three lock nuts (14), washers (15), socket head screws (16), washers (17), and spacers (18) from mirror (19). Discard lock nuts.
6. Remove four lock nuts (19), washers (20), screws (21), washers (22), and support (23) from door. Discard lock nuts.
7. Remove two cap nuts (24), three lock washers (25), and mirror (9) from support (23). Discard lock washers.



INSTALLATION

1. Install mirror (9) on support (23) with three new lock washers (25) and two cap nuts (24).
2. Install support (23) on door with four washers (22), screws (21), washers (20), and new lock nuts (19).
3. Install three spacers (18), washers (17), socket head screws (16), washers (15), and new lock nuts (14) on mirror (9).
4. Install washer (13), screw (12), washer (11), and new lock nut (10) on mirror (9).
5. Install washer (8), screw (7), washer (6), and cap nut (5) on mirror (9).

INSTALLATION - CONTINUED

6. Connect wiring harness connector (3) to mirror harness connector (4).
7. Secure wiring harness (2) using tiedown straps (1).

END OF WORK PACKAGE

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SPOTTER MIRROR REPLACEMENT 0209 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

Materials/Parts

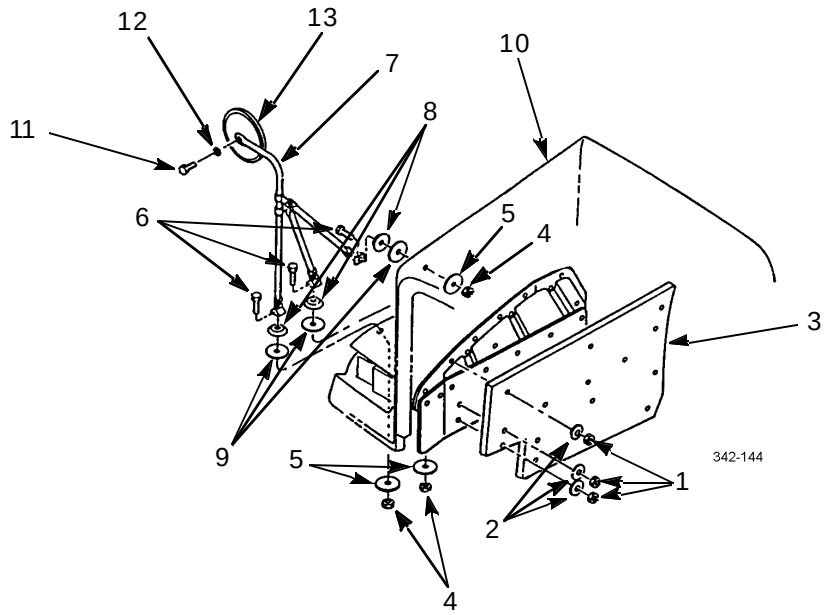
Nut, lock (P/N MS51922-1) (3)

Personnel Required

Two

REMOVAL

1. Remove three lock nuts (1) and washers (2) from hood liner (3). Discard lock nuts.
2. Remove three nuts (4), washers (5), screws (6), mirror assembly (7), three spacers (8), and washers (9) from hood (10).
3. Remove screw (11), washer (12), and spotter mirror (13) from mirror assembly (7).



INSTALLATION

NOTE

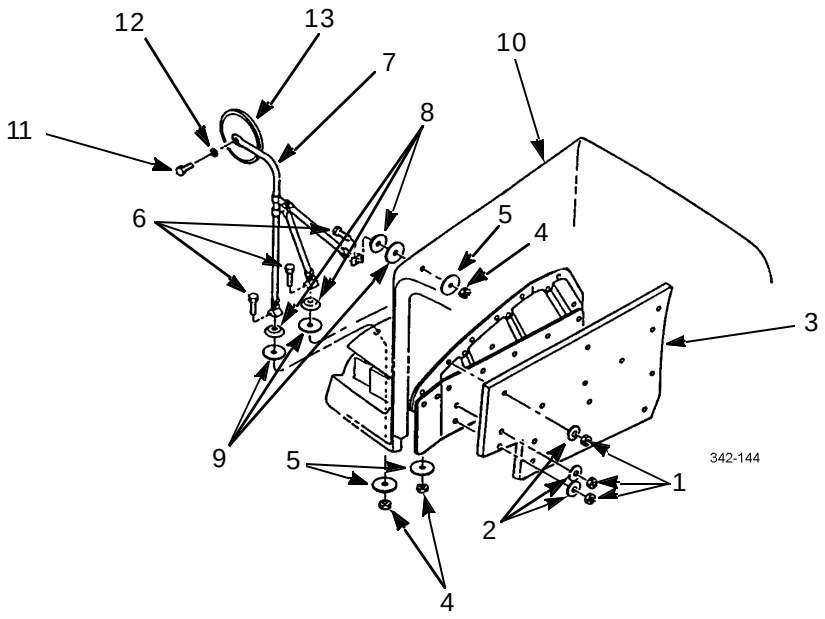
Some replacement mirrors may not have a drain hole. Drill a 1/16 inch hole at 6 o'clock position to allow any moisture to drain.

1. Install spotter mirror (13) on mirror assembly (17) with washer (12) and screw (11).

SPOTTER MIRROR REPLACEMENT - CONTINUED **0209 00**

INSTALLATION - CONTINUED

2. Install three washers (9), spacers (8) and mirror assembly (7) on hood (10) with three screws (6), washers (5), and nuts (4).
3. Install three washers (2) and new lock nuts (1) on hood liner (3).



END OF WORK PACKAGE

WINDSHIELD WIPER MOTOR AND LINKAGE REPLACEMENT 0210 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-200 lb-in (Item 43, WP 0236 00)

Materials/Parts

Seal, rubber (P/N 908028) (2)

References

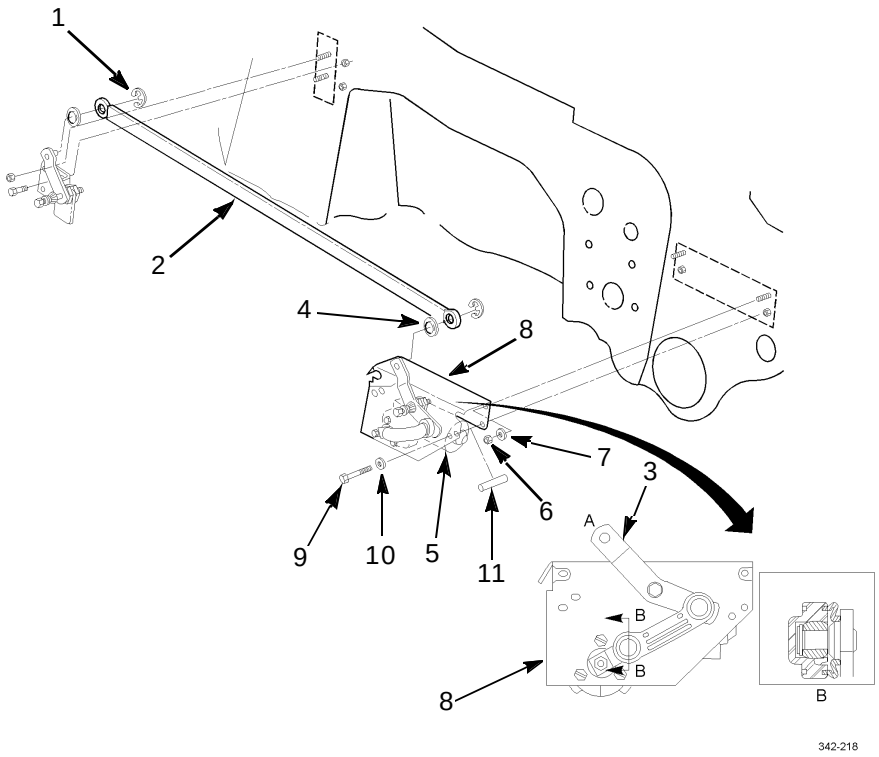
TM 9-2320-302-10

Equipment Condition

Windshield wipers and wiper arms removed (WP 0212 00)

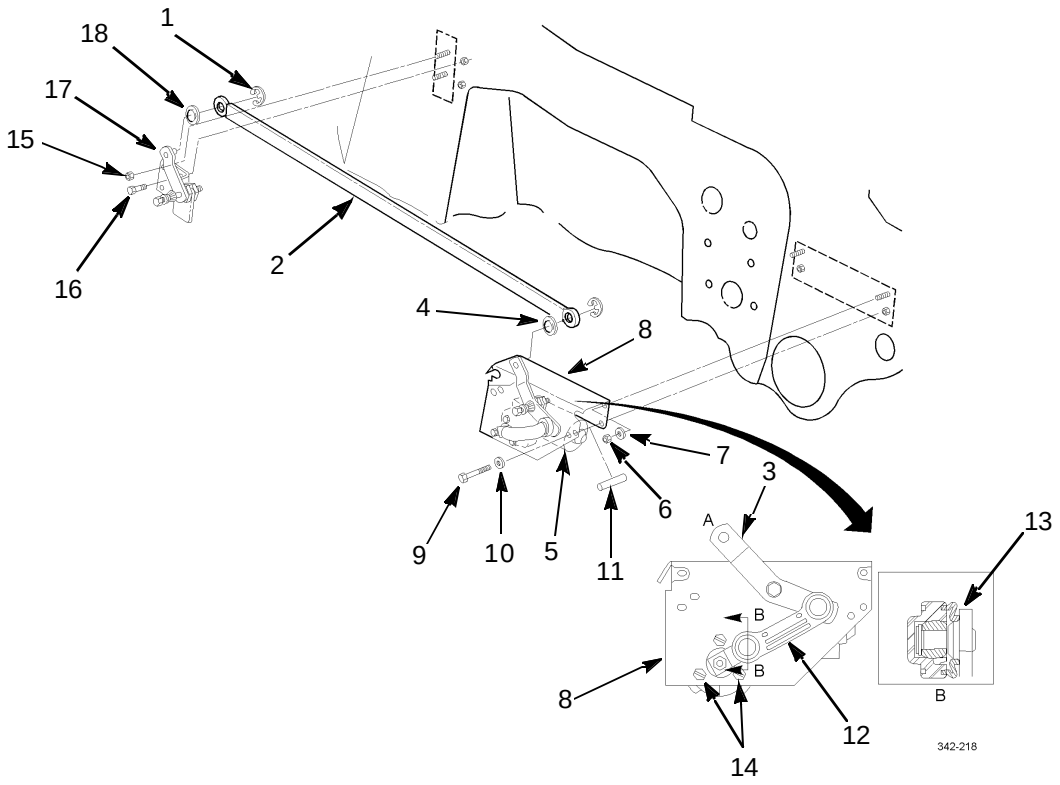
REMOVAL

1. Remove snapring (1) from linkage pivot bar (3).
2. Pry connecting link (2) from linkage pivot bar (3).
3. Remove rubber seal (4) from ball joint of linkage pivot bar (3). Discard rubber seal.
4. Disconnect wiper motor (5) wiring.
5. Remove two nuts (6) and washers (7) from brackets (8).
6. Remove two screws (9), washers (10), and spacers (11) securing bracket (8) and wiper motor (5) to firewall.
7. Remove bracket (8) and wiper motor (5).



REMOVAL - CONTINUED

8. Disconnect short link bar (12) from wiper motor crank (13).
9. Remove three screws (14) and wiper motor (5) from bracket (8).
10. Remove two nuts (15), screws (16), and pivot assembly (17) from firewall.
11. Pry connecting link (2) from pivot assembly (17).
12. Remove rubber seal (18) from ball joint of pivot assembly (17). Discard rubber seal.



INSTALLATION

1. Install new rubber seal (18) to ball joint of pivot assembly (17).
2. Install connecting link (2) to pivot assembly (17).
3. Install pivot assembly (17) to firewall with two screws (16) and nuts (15).
4. Install wiper motor (5) to bracket (8) with three screws (14). Tighten screws to 55 lb-in (621 Ncm).
5. Connect short link bar (12) to wiper motor crank (13).
6. Position bracket (8) and wiper motor (5) to firewall.
7. Install two spacers (11), washers (10), and screws (9). Tighten screws to 60-84 lb-in (678-949 Ncm).

INSTALLATION - CONTINUED

8. Install two washers (7) and nuts (6). Tighten nuts to 60-84 lb-in (678-949 Ncm).
9. Connect wiper motor (5) wiring.
10. Install new rubber seal (4) to ball joint of linkage pivot bar (3).
11. Install connecting link (2) to linkage pivot bar (2).
12. Install snapring (1) to linkage pivot bar (3).
13. Install windshield wipers and wiper arms (WP 0212 00).

END OF WORK PACKAGE

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WINDSHIELD WASHER RESERVOIR REPLACEMENT 0211 00

THIS WORK PACKAGE COVERS

Pump Removal, Reservoir Removal, Pump Installation, Reservoir Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

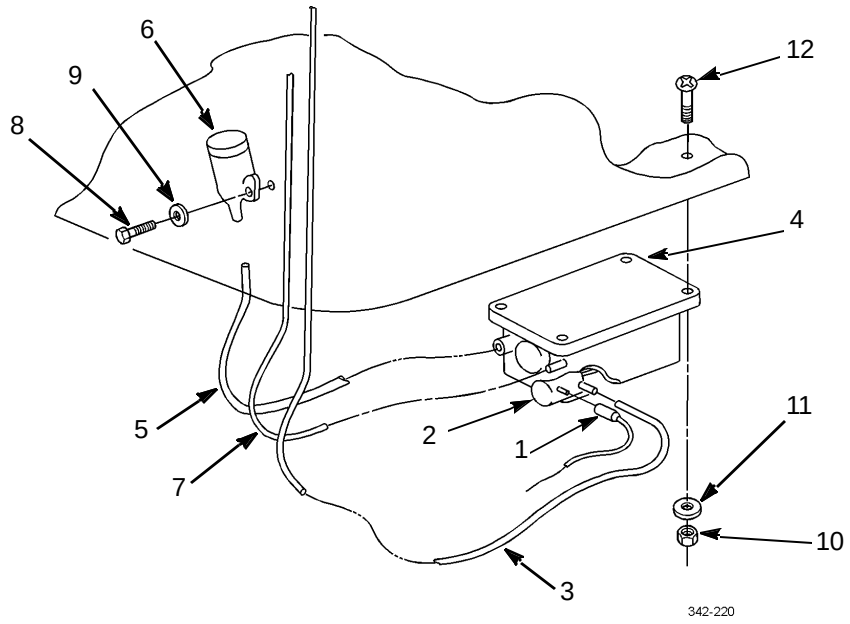
Compound, cleaning, windshield (Item 8, WP 0235 00)

References

TM 9-2320-302-10

PUMP REMOVAL

1. Remove wiring harness connector (1) from windshield washer reservoir pump (2).
2. Remove hose (3) from pump (2) and allow windshield washer solvent to drain into a suitable container.
3. Remove pump (2) from windshield washer reservoir (4).



RESERVOIR REMOVAL

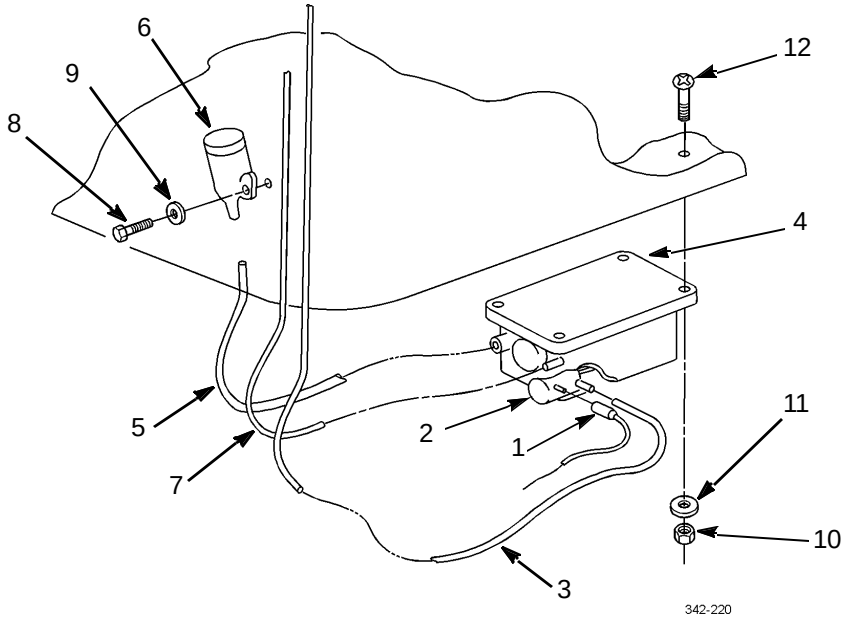
1. Remove filler tube (5) from filler spout (6) and windshield washer reservoir (4).
2. Remove vent hose (7) from windshield washer reservoir (4).
3. Remove two screws (8), washers (9), and filler spout (6) from vehicle.
4. Remove four nuts (10), washers (11), screws (12), and windshield washer reservoir (4) from vehicle.

PUMP INSTALLATION

1. Install pump (2) on windshield washer reservoir (4).
2. Install hose (3) on windshield washer reservoir pump (2).
3. Install wiring harness connector (1) on windshield washer reservoir pump (2).

RESERVOIR INSTALLATION

1. Install windshield washer reservoir (4) on vehicle with four screws (12), washers (11), and nuts (10).
2. Install filler spout (6) on vehicle with two washers (9) and screws (8).
3. Install vent hose (7) on windshield washer reservoir (4).
4. Install filler tube (5) on windshield washer reservoir (4) and filler spout (6).
5. Fill windshield washer reservoir (4) with windshield cleaning compound.



END OF WORK PACKAGE

WINDSHIELD WIPER AND WIPER ARM REPLACEMENT 0212 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

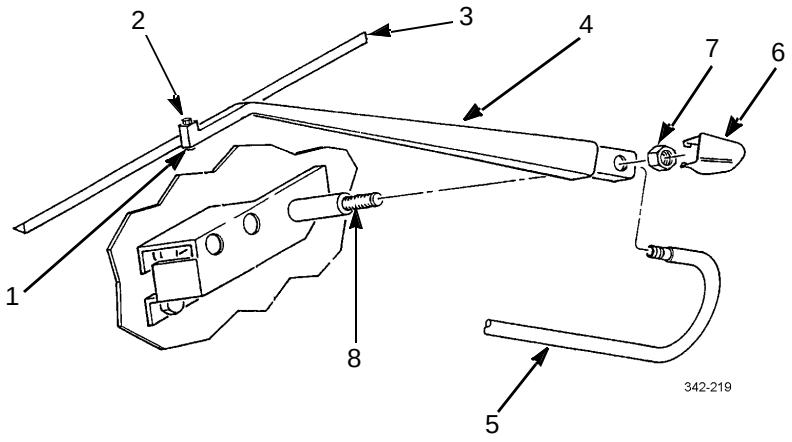
TM 9-2320-302-10

NOTE

Left and right windshield wipers and wiper arms are replaced the same way.

REMOVAL

1. Remove nut (1), screw (2), and windshield wiper (3) from wiper arm (4).
2. Disconnect hose (5) from wiper arm (4).
3. Remove cover (6), nut (7), and wiper arm (4) from shaft (8).



INSTALLATION

1. Install wiper arm (4) on shaft (8) with nut (7). Install cover (6) on wiper arm.
2. Install hose (5) on wiper arm (4).
3. Install windshield wiper (3) on wiper arm (4) with screw (2) and nut (1).

END OF WORK PACKAGE

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VEHICLE JACK MOUNTING BRACKET REPLACEMENT 0213 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

References

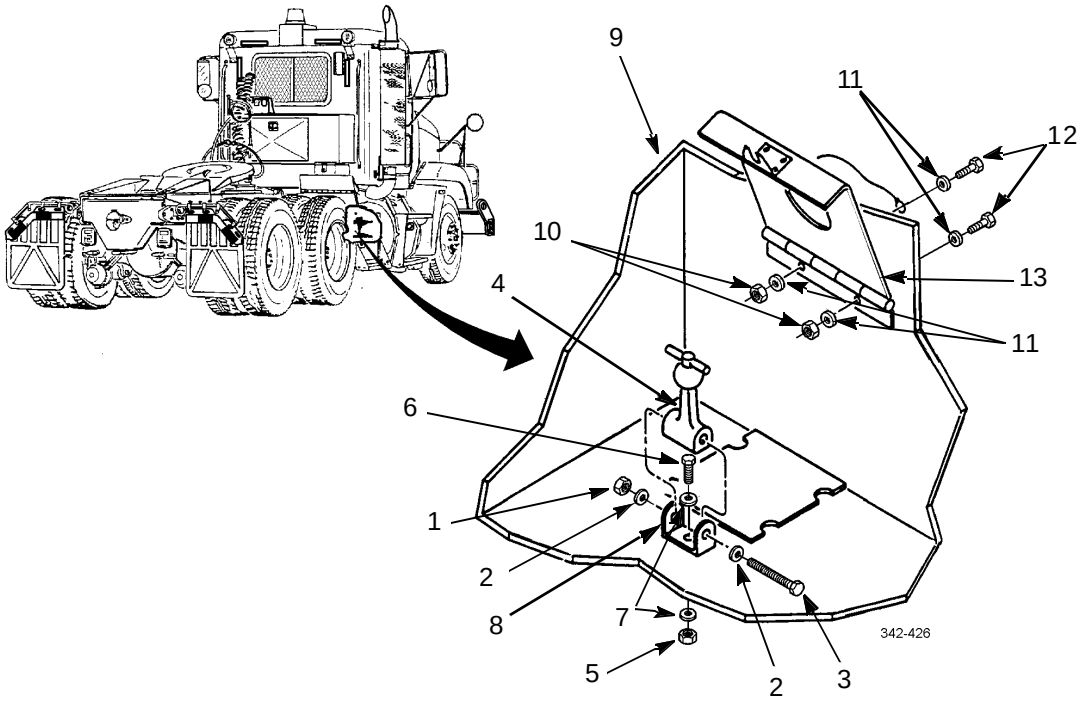
TM 9-2320-302-10

Materials/Parts

Compound, caulking (Item 7, WP 0235 00)

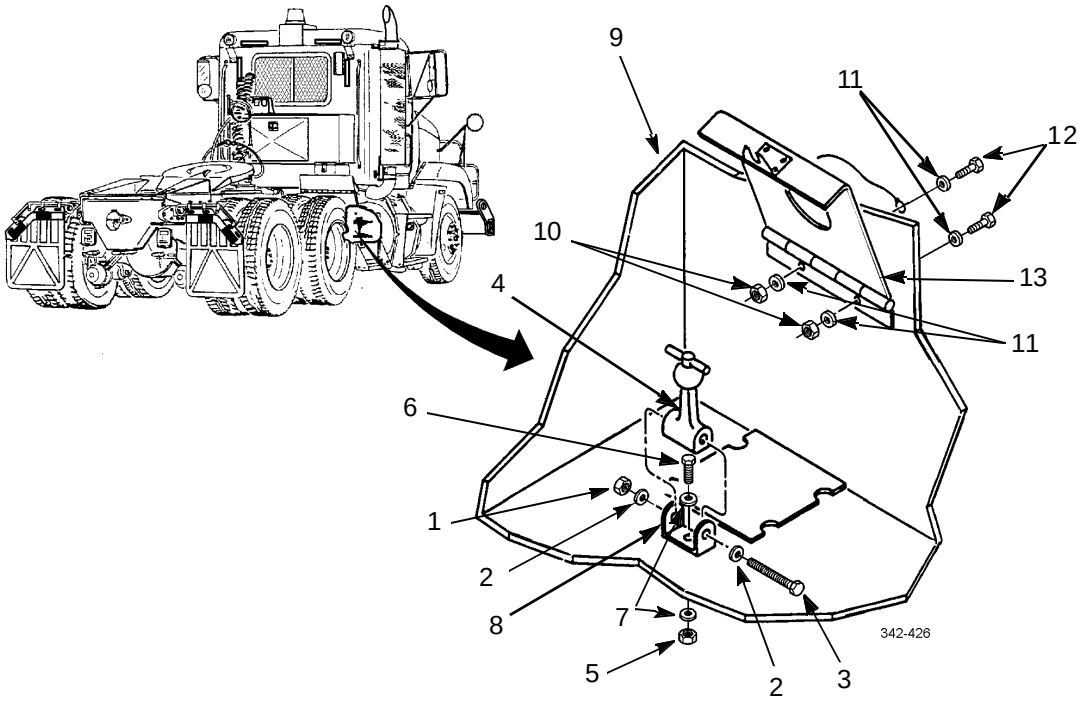
REMOVAL

1. Remove nut (1), two washers (2), screw (3), and latch (4) from jack storage location.
2. Remove nut (5), screw (6), two washers (7), and bracket (8) from storage box (9).
3. Remove two nuts (10), four washers (11), two screws (12), and vehicle jack mounting bracket (13) from storage box (9).



INSTALLATION

1. Install vehicle jack mounting bracket (13) on storage box (9) with two screws (12), four washers (11), and two nuts (10).
2. Install bracket (8) on storage box (9) with screw (6), two washers (7), and nut (5). Coat nut with caulking compound.
3. Insert latch (4) and secure on bracket (8) with screw (3), two washers (2), and nut (1). Coat nut with caulking compound.



END OF WORK PACKAGE

AIR HORN AND VALVE REPLACEMENT 0214 00

THIS WORK PACKAGE COVERS

Air Horn Removal, Air Horn Valve Removal, Air Horn Valve Installation, Air Horn Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Nut, lock (P/N MS51922-1) (3)

Compound, sealing, pipe (Item 10, WP 0235 00)

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

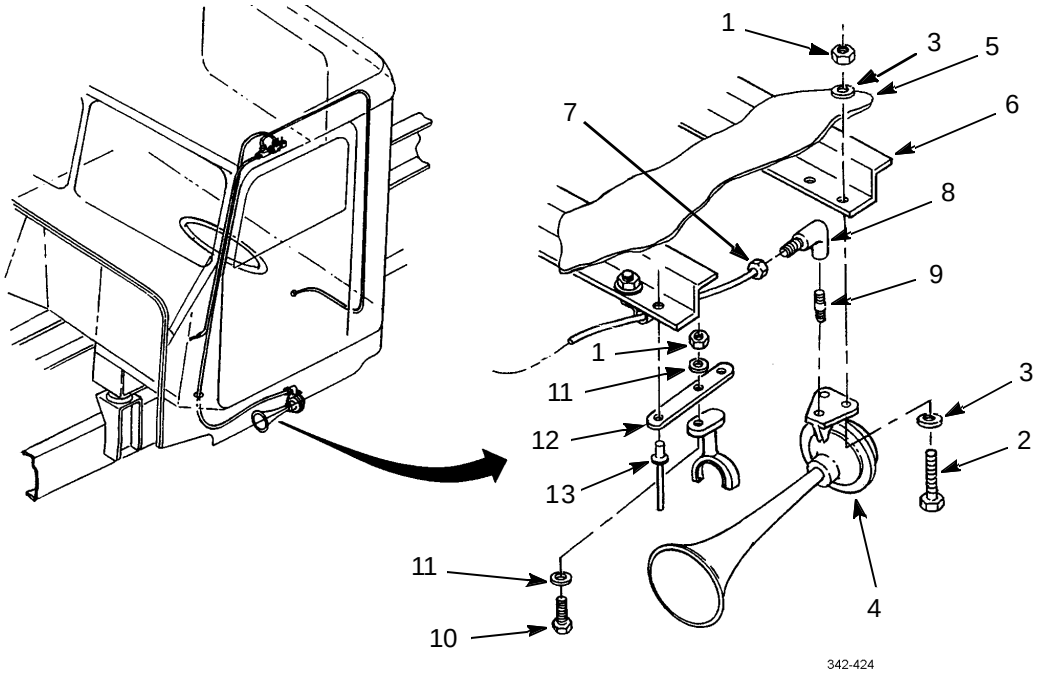
Air system drained (TM 9-2320-302-10)

Head liners removed from cab (WP 0203 00)

Cab overhead storage compartment removed (WP 0204 00)

AIR HORN REMOVAL

1. Remove two lock nuts (1), screws (2), and four washers (3) securing air horn (4) in place. Discard lock nuts.
2. Separate air horn (4) from cab floor (5) and bracket (6).
3. Remove air tube (7), elbow (8), and nipple (9) from air horn (4).
4. Remove lock nut (1), screw (10), two washers (11), and bracket (6) from plate (12). Discard lock nut.
5. If damaged, remove rivet (13) and plate (12) from cab floor (5).



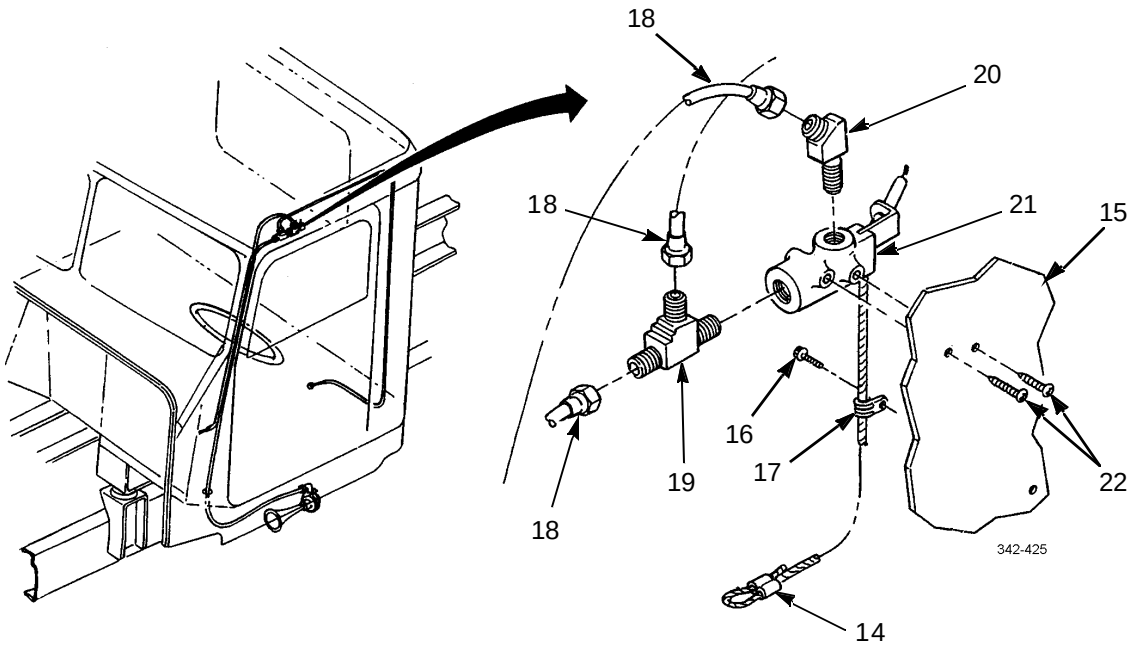
AIR HORN VALVE REMOVAL

1. Release end of pull cord (14) from cab (15).
2. Remove screw (16) and loop clamp (17) from cab (15). Remove loop clamp from pull cord (14).

NOTE

Tag tubes to aid in installation

3. Disconnect three tubes (18) and remove tee (19) and elbow (20) from valve (21).
4. Remove two screws (22) and valve (21) from cab (15).



AIR HORN VALVE INSTALLATION

WARNINGS

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. Apply a light coat of pipe sealing compound to threads of elbow (20) and tee (19).

NOTE

Ensure valve is properly positioned to allow for mounting on cab.

AIR HORN VALVE INSTALLATION - CONTINUED

2. Install tee (19) and elbow (20) on valve (21) and connect three tubes (18) to fittings.
3. Install valve (21) to cab (15) and secure with two screws (22).
4. Attach pull cord (14) with loop clamp (17) to valve (21) and secure loop clamp to cab (15) with screw (16).

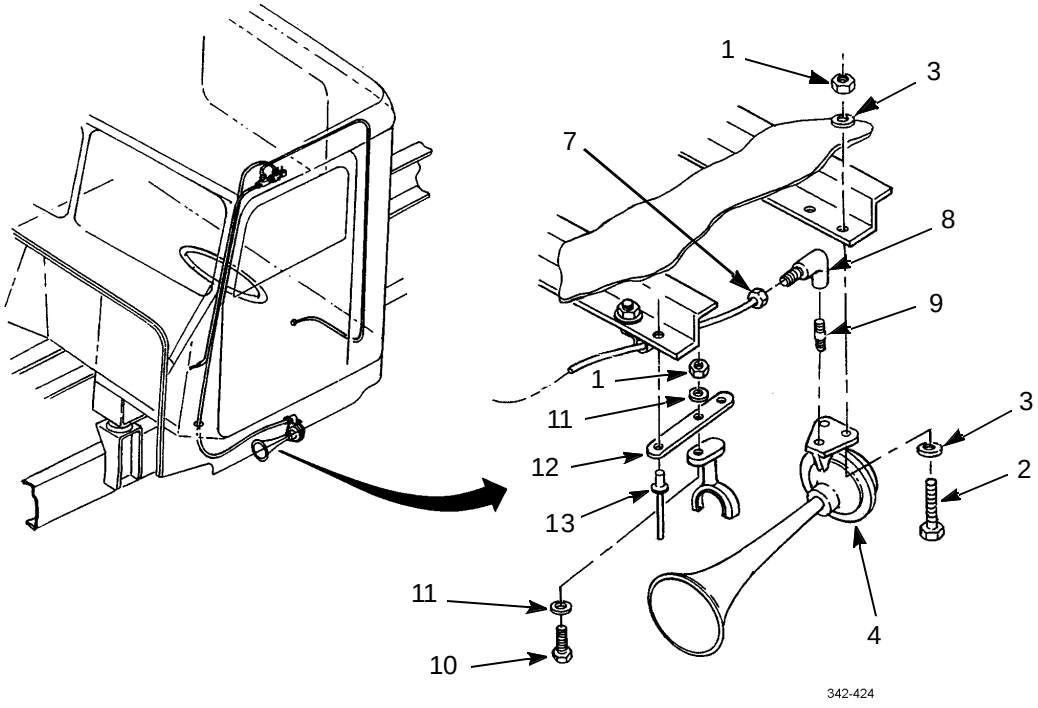
AIR HORN INSTALLATION

1. If removed, install plate (12) to cab floor (5) with new rivet (13).
2. Install bracket (6) to plate (12) with two washers (11), screw (10) and new lock nut (1).

WARNINGS

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesives or sealing compound contacts skin or clothing, wash immediately with soap and water.

3. Apply pipe sealing compound to nipple (9) and install elbow (8), nipple, and air tube (7) to air horn (4).
4. Position air horn (4) to bracket (6) and cab floor (5).
5. Secure air horn (4) in place with four washers (3), two screws (2) and new lock nuts (1).



6. Start vehicle and check for leaks in air system and operation of air horn.
7. Install cab head liners (WP 0203 00).

AIR HORN INSTALLATION - CONTINUED

8. Install cab overhead storage compartment (WP 0204 00).

END OF WORK PACKAGE

DATA AND INSTRUCTION PLATES REPLACEMENT 0215 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Drill, electric, portable (Item 11, WP 0236 00)

Drill set, twist (Item 12, WP 0236 00)

Riveter, blind, hand (Item 28, WP 0236 00)

Materials/Parts

Rivet (4)

References

TM 9-2320-302-10

NOTE

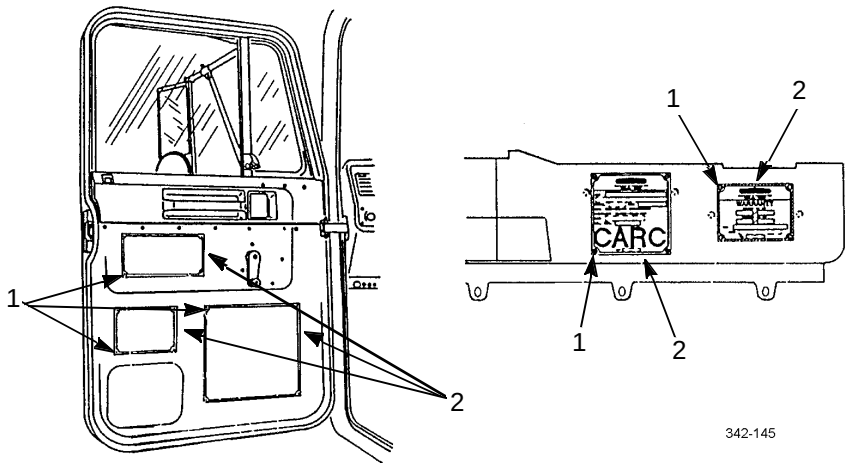
All data and instruction plates are replaced the same way.

REMOVAL

CAUTION

- If drilling in door panel, ensure that window is rolled up. Failure to do so could result in damage to window.
- If drilling in dashboard panel, ensure panel is removed from dashboard. Failure to do so could result in damage to heating ducts.

Remove four rivets (1) and plate (2). Discard rivets.



INSTALLATION

NOTE

If installing plate on new panel, use illustration for location of drill holes.

Install plate (2) with four new rivets (1).

END OF WORK PACKAGE

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M16 RIFLE MOUNTING BRACKET REPLACEMENT 0216 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

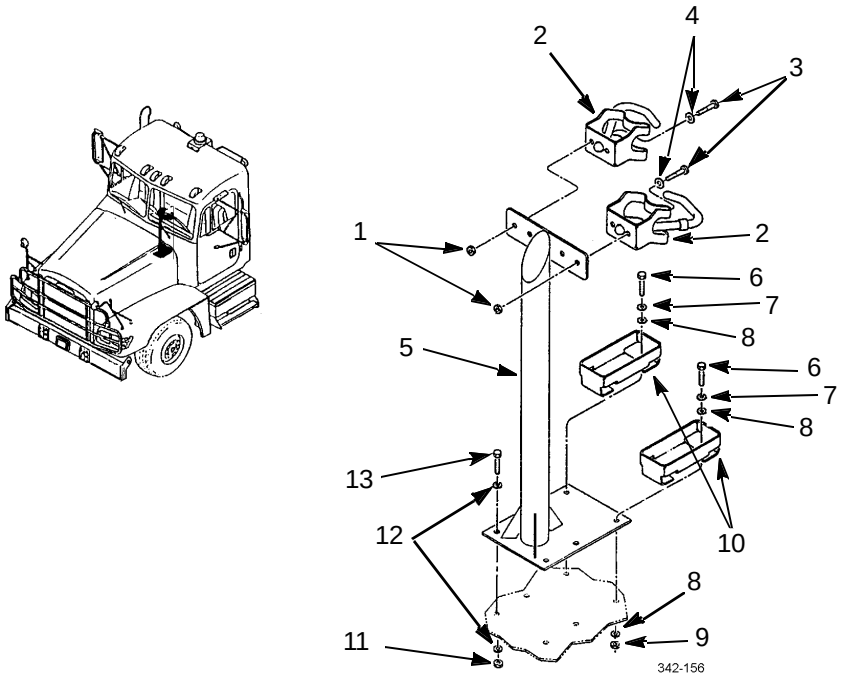
Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

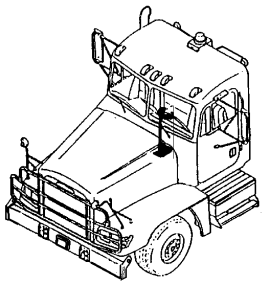
REMOVAL

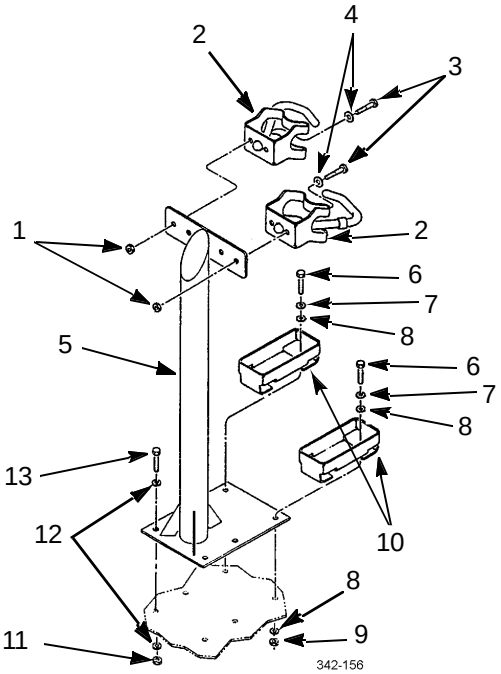
1. Remove four nuts (1), two catch bracket assemblies (2), four cap screws (3), and washers (4) from rifle mounting bracket (5).
2. Remove four caps crews (6), washers (7), eight washers (8), four nuts (9), and two rifle mounting supports (10) from rifle mounting bracket (5).
3. Remove two nuts (11), four washers (12), two cap screws (13), and rifle mounting bracket (5).



INSTALLATION

1. Install rifle mounting bracket (5) with four washers (12), two cap screws (13), and nuts (11).
2. Install two rifle mounting supports (10) on rifle mounting bracket (5) with eight washers (8), four washers (7), cap screws (6), and nuts (9).
3. Install two catch bracket assemblies (2) on rifle mounting bracket (5) with four washers (4), cap screws (3), and nuts (1).





END OF WORK PACKAGE

CUP HOLDER REPLACEMENT 0217 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

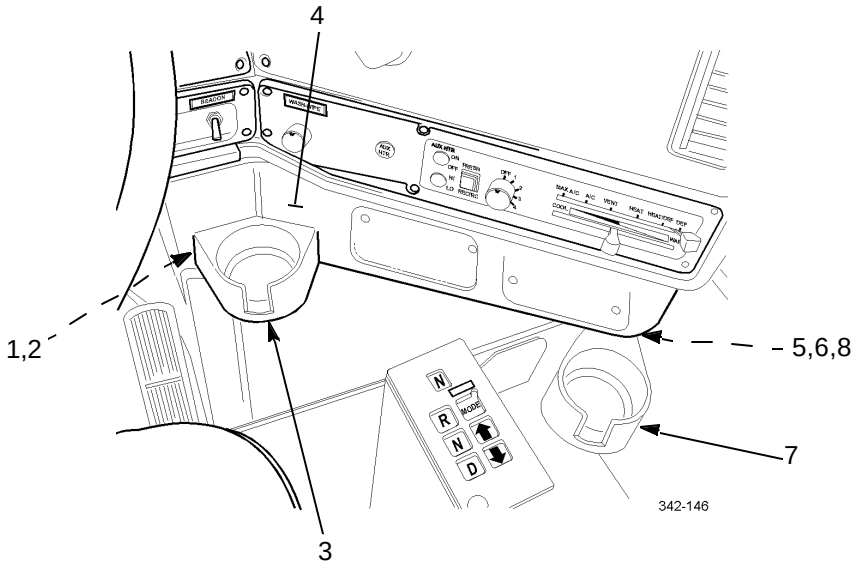
Tool kit, general mechanic's (Item 36, WP 0236 00)

References

TM 9-2320-302-10

REMOVAL

1. Remove two screws (1), flat washers (2), and L/H cup holder (3) from dash (4).
2. Remove two screws (5), flat washers (6), and R/H cup holder (7) from swivel (8).
3. Remove swivel (8) from dash (4).



INSTALLATION

1. Install L/H cup holder (3) on dash (4) with two flat washers (2) and screws (1).
2. Install swivel (8) on dash (4).
3. Install R/H cup holder (7) on swivel (8) with two flat washers (6) and screws (5). Ensure R/H cup holder rotates freely.

END OF WORK PACKAGE

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CAB ROOF AIR DEFLECTOR REPLACEMENT 0218 00

THIS WORK PACKAGE COVERS

Air Deflector Removal, Mounting Hardware Removal, Mounting Hardware Installation, Air Deflector Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench set, socket attachment (Item 49, WP 0236 00)

Materials/Parts

Nut, lock (P/N RUDAP691) (6)

Washer, lock (P/N RUDAP696) (8)

Personnel Required

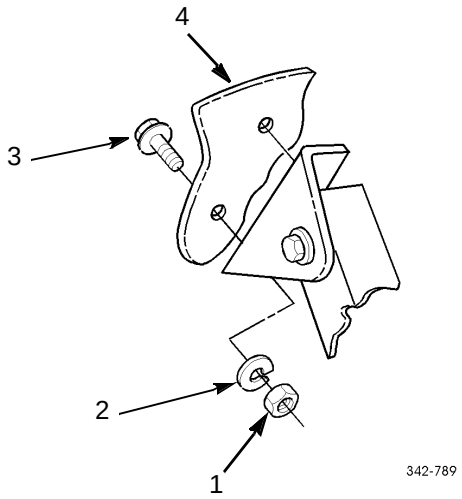
Two

Equipment Condition

Cab roof liner removed (WP 0202 00)

AIR DEFLECTOR REMOVAL

Remove eight nuts (1), lock washers (2), screws (3), and air deflector (4) from vehicle. Discard lock washers.

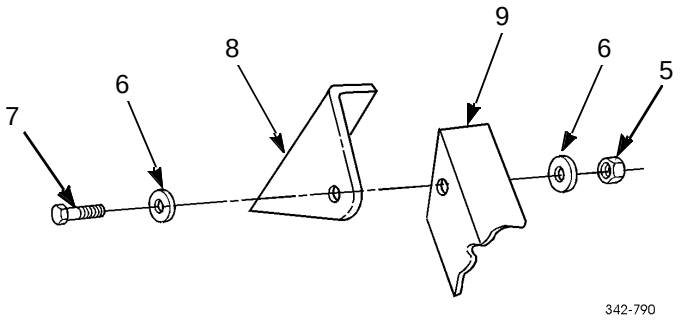


MOUNTING HARDWARE REMOVAL

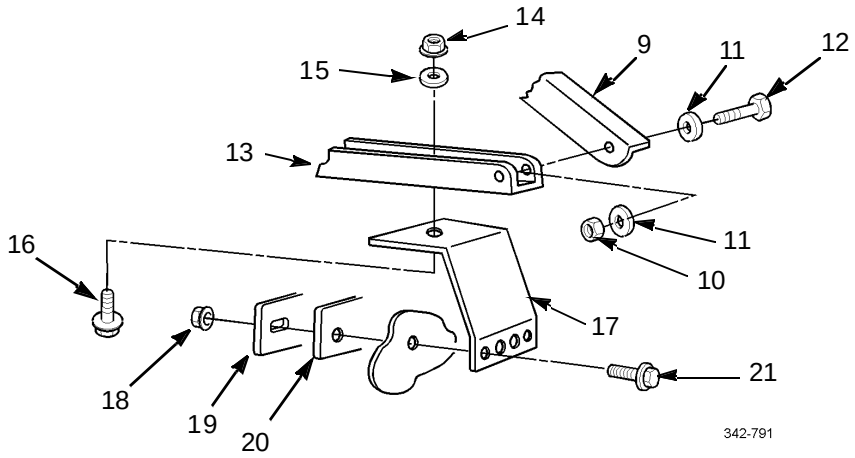
NOTE

Perform steps 1 through 6 at each side of cab roof.

1. Remove lock nut (5), two washers (6), screw (7), and top pivot bracket (8) from strut (9). Discard lock nut.

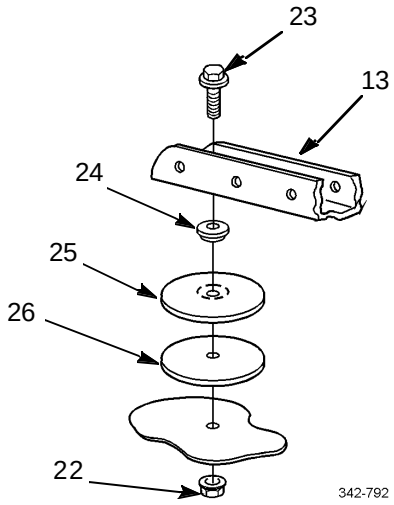


2. Remove lock nut (10), two washers (11), screw (12), and strut (9) from channel (13). Discard lock nut.
3. Remove nut (14), washer (15) and screw (16) and channel (13) from support bracket (17).
4. Remove two nuts (18), reinforcing plate (19), gasket (20), two screws (21), and support bracket (17) from rear of cab roof.

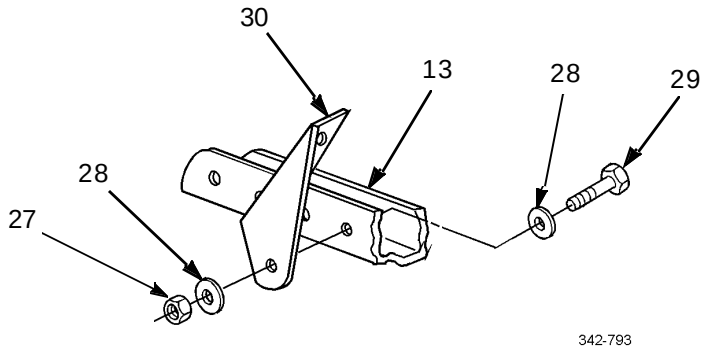


MOUNTING HARDWARE REMOVAL - CONTINUED

5. Remove two nuts (22), screws (23), channel (13), swivel spacers (24), swivel plates (25), and rubber seals (26) from cab roof.



6. Remove lock nut (27), two washers (28), screw (29), and bottom pivot bracket (30) from channel (13). Discard lock nut.



MOUNTING HARDWARE INSTALLATION

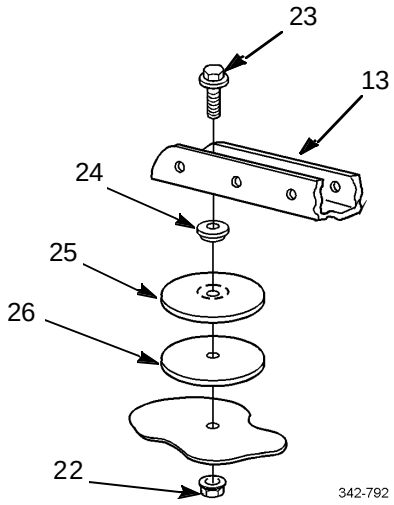
NOTE

Perform steps 1 through 6 at each side of cab roof.

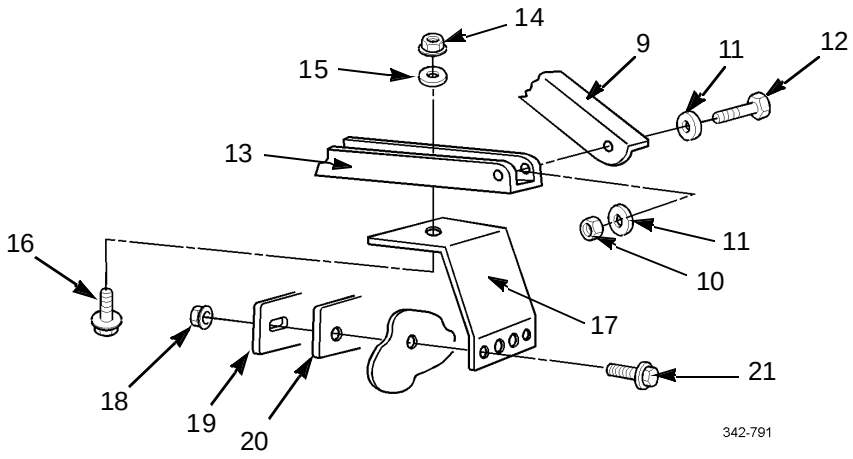
1. Install bottom pivot bracket (30) on third hole from front of channel (13) with screw (29), two washers (28), and new lock nut (27).

MOUNTING HARDWARE INSTALLATION

2. Install two rubber seals (26), swivel plates (25), swivel spacers (24), and channel (13) on cab roof with two screws (23) and nuts (22).

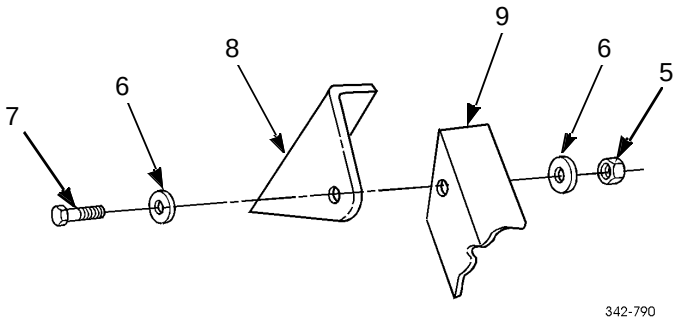


3. Install support bracket (17), gasket (20), and reinforcing plate (19) on rear of cab roof with two screws (21) and nuts (18).
4. Install channel (13) on support bracket (17) with screw (16), washer (15), and nut (14).



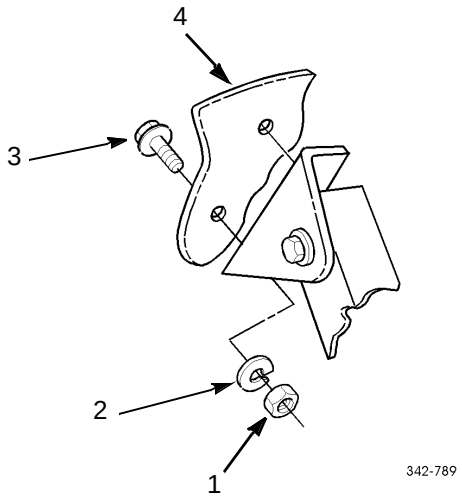
MOUNTING HARDWARE INSTALLATION - CONTINUED

5. Install strut (9) on rear hole of channel (13) with screw (12), two washers (11), and new lock nut (10).
6. Install top pivot bracket (8) on strut (9) with screw (7), two washers (6), and new lock nut (5).



AIR DEFLECTOR INSTALLATION

1. Install air deflector (4) on vehicle with eight screws (3), new lock washers (2) and nuts (1).



2. Install cab roof liner (WP 0202 00).

END OF WORK PACKAGE

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HVAC AIR CYLINDER REPLACEMENT 0219 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 00236 00)

References

TM 9-2320-302-10

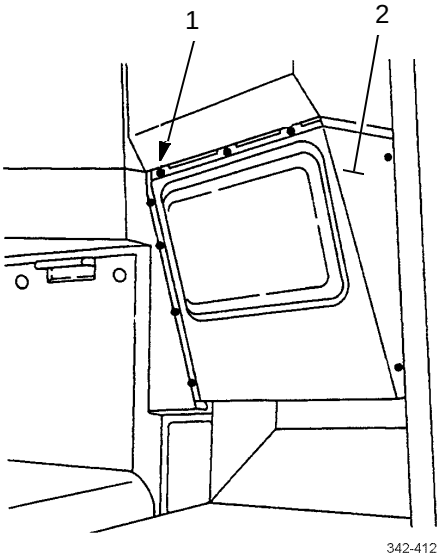
Materials/Parts

Nut, push (P/N BOA 702011 00)

Nut, push (P/N BOA 707014 00)

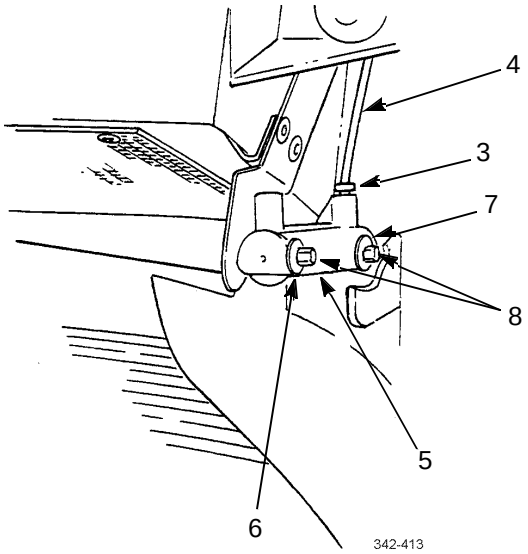
REMOVAL

1. Place heater/air conditioner slide lever in "DEF" position (TM 9-2320-302-10).
2. Remove screws (1) securing dash panel (2) in place.



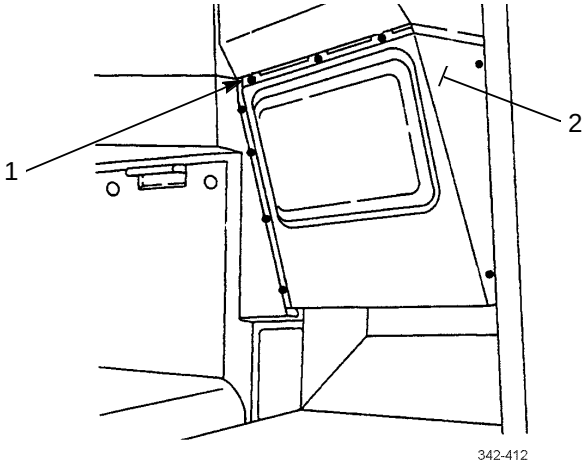
REMOVAL - CONTINUED

3. Push in on cover ring (3) and pull out on air line (4) to disconnect from air cylinder (5).
4. Remove push nuts (6 and 7) and air cylinder (5) from mounting rod (8) and flapper door rod (9). Discard push nuts.



INSTALLATION

1. Slide air cylinder (5) on mounting rod (8) and flapper door rod (9) and secure with new push nuts (6 and 7).
2. Install air line (4) by pushing air line into cover ring (3) as far as possible. Pull back carefully on air line to lock in place.
3. Operate vehicle and verify air cylinder (5) is functioning properly (TM 9-2320-302-10).
4. Install dash cover (2) with screws (1).



END OF WORK PACKAGE

HVAC BLOWER MOTOR REPLACEMENT 0220 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

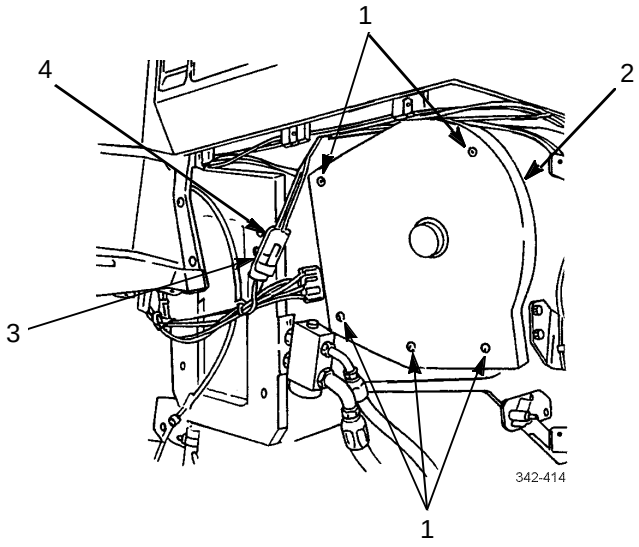
Dash panel removed for access (WP 0219 00)

References

TM 9-2320-302-10

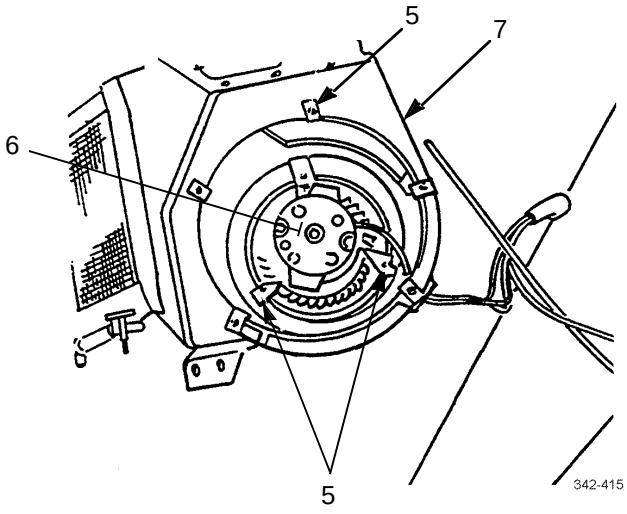
REMOVAL

1. Remove five screws (1) and blower motor cover (2).
2. Disconnect blower motor harness connector (3) from vehicle wiring harness receptacle (4).



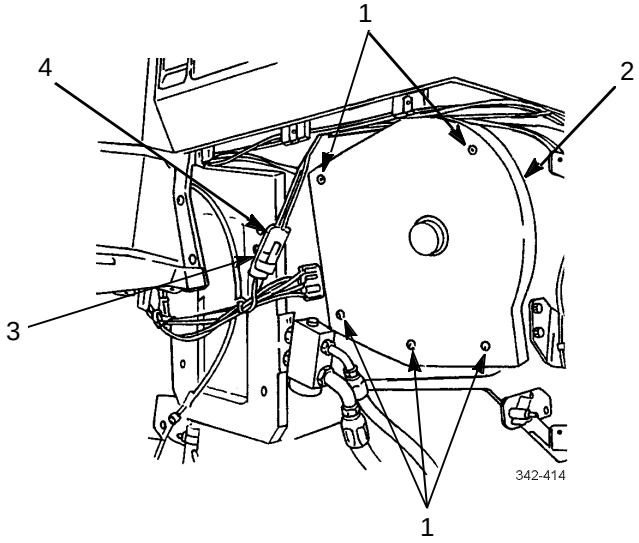
REMOVAL - CONTINUED

3. Remove three screws (5) and blower motor (6) from housing (7).



INSTALLATION

1. Install blower motor (6) on housing (7) with three screws (5).
2. Connect blower motor harness connector (3) to vehicle wiring harness receptacle (4).
3. Operate vehicle and check blower operation (TM 9-2320-302-10).
4. Install blower motor cover (2) with five screws (1).



5. Install dash panel (WP 0219 00).

END OF WORK PACKAGE

HVAC HEATER CORE REPLACEMENT 0221 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Gloves (Item 13, WP 0236 00)

Materials/Parts

Rags, wiping (Item 28, WP 0235 00)

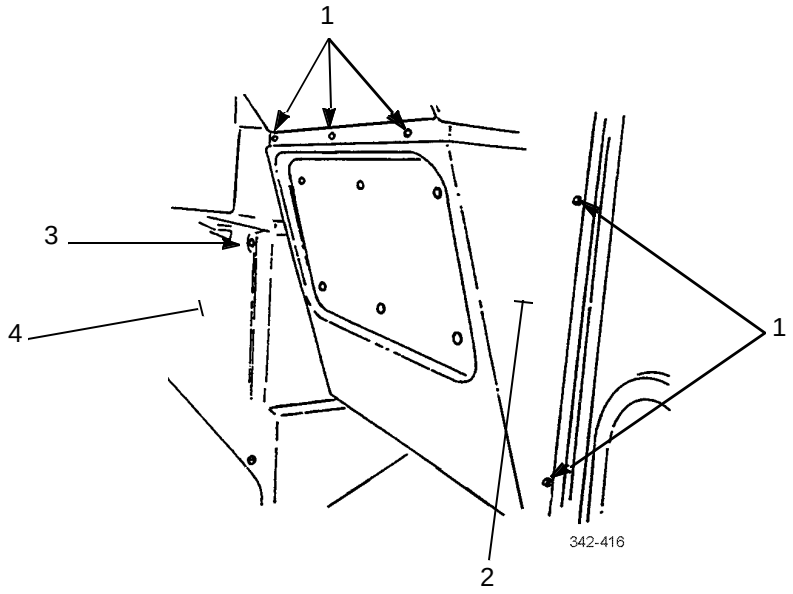
Tags, marker (Item 31, WP 0235 00)

Equipment Condition

Cooling system drained (WP 0041 00)

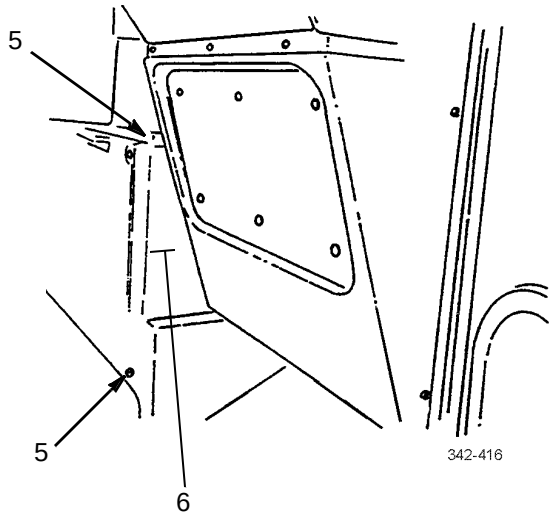
REMOVAL

1. Remove screws nine (1) and cover (2).
2. Remove three screws (3) and cover (4).

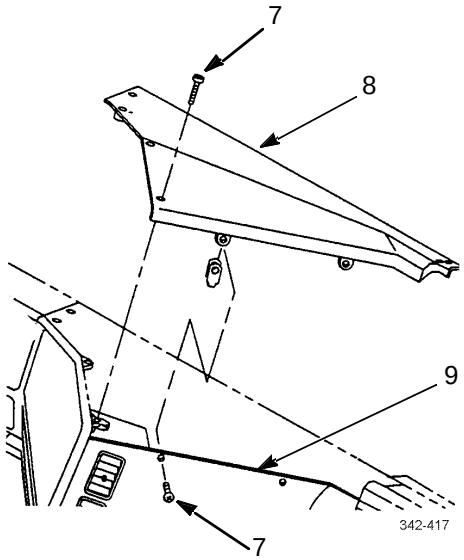


REMOVAL - CONTINUED

3. Remove two screws (5) and cover (6).

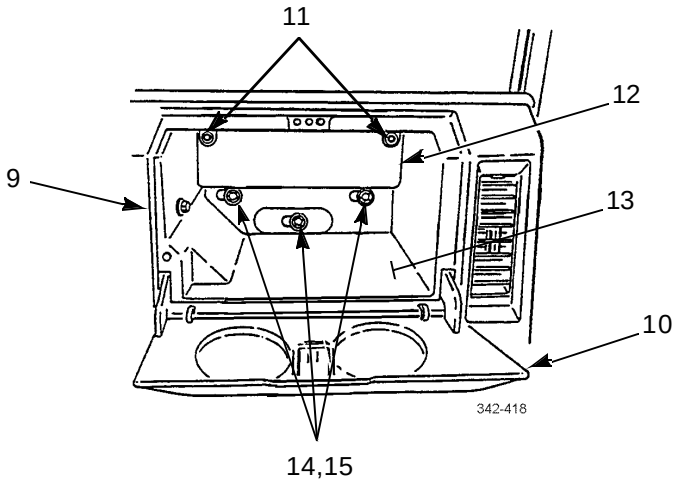


4. Remove seven screws (7) and cover (8) from dash panel (9).

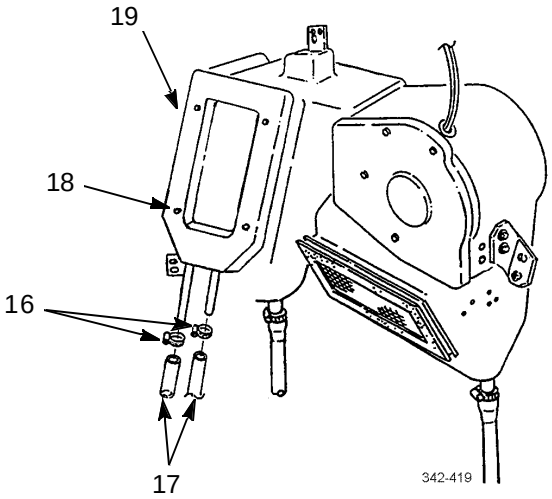


5. Open glove box door (10) and remove two screws (11) and top panel (12) from compartment (13).
6. Remove three nuts (14), spring washers (15) and compartment (13) from dash panel (9).
7. Disconnect and tag two flex hoses from ducts behind glove box.
8. Disconnect and tag air line from air cylinder behind glove box.

REMOVAL - CONTINUED



9. Place rags on cab floor, loosen two hose clamps (16), and tag and disconnect heater core hoses (17).
10. Remove four screws (18) and heater core cover (19).

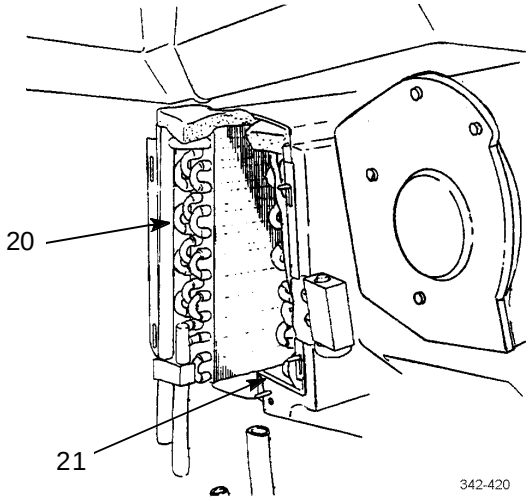


REMOVAL - CONTINUED

WARNING

Failure to wear protective gloves could result in serious skin cuts from sharp edges and fins.

11. Wearing protective gloves, slide heater core (20) with seal up and out of housing (21).

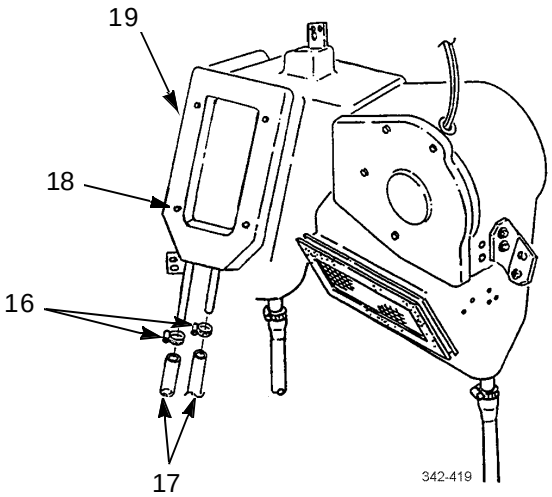


INSTALLATION

WARNING

Failure to wear protective gloves could result in serious skin cuts from sharp edges and fins.

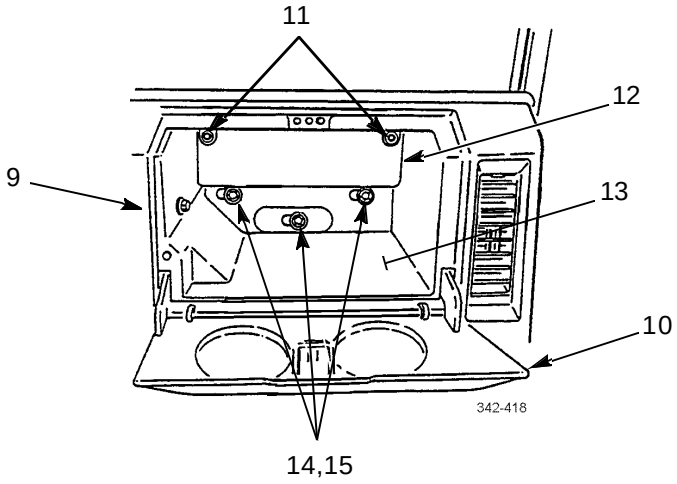
1. Wearing protective gloves, slide heater core (20) with seal into housing (21).



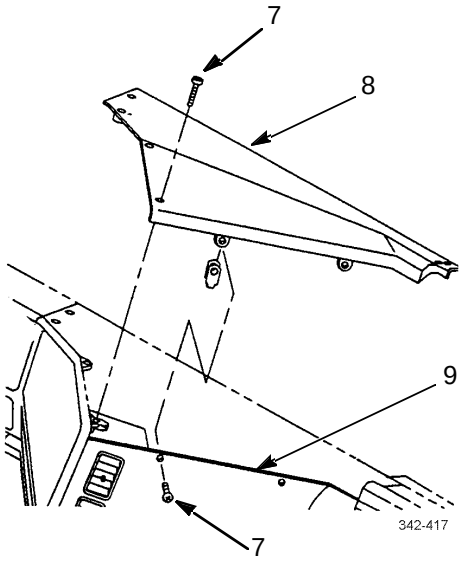
2. Install heater core cover (19) and secure with four screws (18).
3. Install heater core hoses (17) and tighten two clamps (16).

INSTALLATION - CONTINUED

4. Connect air line to cylinder behind glove box.
5. Connect two flex hoses to ducts behind glove box.
6. Insert compartment (13) into dash (9) and secure with three nuts (14) and spring washers (15).
7. Insert top panel (12) to compartment (13) and secure with two screws (11).

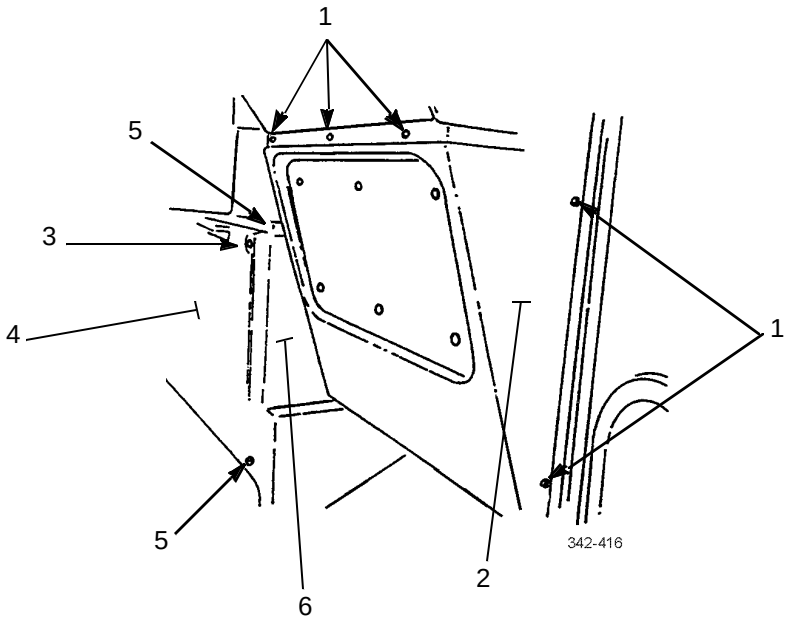


8. Position cover (8) on dash panel (9) and secure with seven screws (7).



INSTALLATION - CONTINUED

9. Position cover (6) on dash panel (9) and secure with two screws (5).
10. Position cover (4) on dash panel (9) and secure with three screws (3).
11. Position cover (2) on dash panel (9) and secure with nine screws (1).



12. Fill cooling system (WP 0041 00).

END OF WORK PACKAGE

AIR CONDITIONER RESISTER BLOCK REPLACEMENT 0222 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

References

TM 9-2320-302-10

Equipment Condition

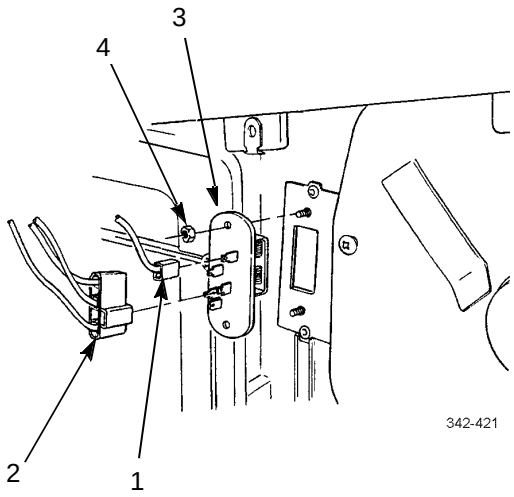
Dash panel access covers removed (WP 0219 00)

REMOVAL

NOTE

Tag wires to aid in installation.

1. Remove wiring harness connectors (1 and 2) from resistor block (3).
2. Remove two nuts (4) and resistor block (3).



INSTALLATION

1. Install resistor block (3) with two nuts (4).
2. Install wiring harness connectors (1 and 2) on resistor block (3).
3. Install dash panel access covers (WP 0219 00).

END OF WORK PACKAGE

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AIR CONDITIONER THERMOSTATIC SWITCH REPLACEMENT 0223 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Equipment Condition

Dash panel access covers removed (WP 0219 00)

References

TM 9-2320-302-10

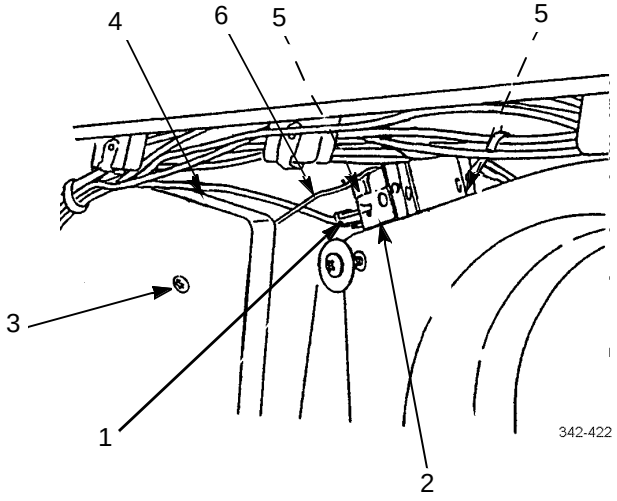
REMOVAL

1. Disconnect wiring harness connector (1) from thermostatic switch (2).
2. Remove four screws (3) and heater core cover (4).

NOTE

Mark thermostatic switch sensor tube at entry point in evaporator to aid in installation.

3. Remove two screws (5) and thermostatic switch (2) with sensor tube (6) attached.



INSTALLATION

1. Transfer measurement from old sensor tube (6) to new sensor tube, if installing a new thermostatic switch (2).

INSTALLATION - CONTINUED

CAUTION

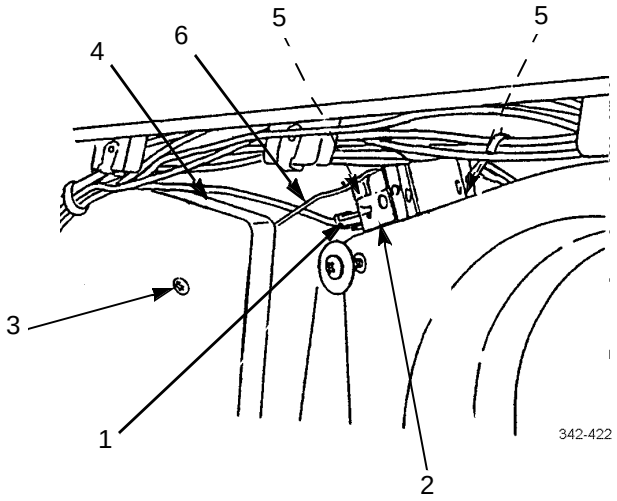
Use care when installing thermostatic switch sensor tube in evaporator. Using too much force will cause tube to bend or kink.

2. Carefully insert sensor tube (6) into evaporator to a depth equal to mark on sensor tube.

NOTE

Sensor tube must be in contact with evaporator coil fin and be at least 4 in (10 cm) in evaporator.

3. Install thermostatic switch (2) with two screws (5).
4. Install heater core cover (4) with four screws (3).
5. Connect wiring harness connector (1) to thermostatic switch (2).



6. Install dash panel access covers (WP 0219 00).

END OF WORK PACKAGE

AIR CONDITIONER BINARY SWITCH REPLACEMENT 0224 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 0-200 lb-in (Item 43, WP 0236 00)

Materials/Parts

Packing, preformed (P/N J200AR11)

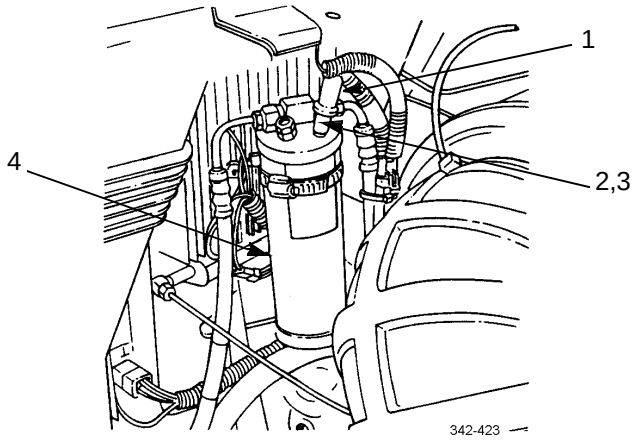
Oil, lubricating, refrigerant (Item 26, WP 0235 00)

References

TM 9-2320-302-10

REMOVAL

1. Disconnect harness connector (1) from binary switch (2).
2. Remove binary switch (2) and preformed packing (3) from receiver-drier (4). Discard preformed packing.



INSTALLATION

1. Lightly coat new preformed packing (3) with refrigerant lubricating oil. Install preformed packing on threads of receiver-drier (4) coupling.
2. Install binary switch (2) and tighten to 108 lb-in (1220 Ncm).
3. Connect harness connector (1) to binary switch (2).

END OF WORK PACKAGE

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AIR CONDITIONER LEAK TEST 0225 00

THIS WORK PACKAGE COVERS

Inspection, Test

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Leak detector, refrigerant (Item 22, WP 0236 00)

References

TM 9-2320-302-10

INSPECTION

WARNING

- Liquid refrigerant, when exposed to air, quickly evaporates and will freeze skin or eye tissue. Use care to prevent refrigerant from touching your skin or eyes. Serious injury or blindness may result if you come in contact with liquid refrigerant.
- Refrigerant R-134a air conditioning systems should not be pressure tested or leak tested with compressed air. Combustible mixtures of air and R-134a may form, resulting in fire or explosion, which could cause personal injury.

NOTE

- Refrigerant is odorless. As a result, all of it may leak away and not be noticed until system stops cooling. All vehicle refrigerant systems lose some refrigerant depending on the condition of system. Higher loss rates signal a need to locate and repair leaks.
- Leaks are most often found at the compressor hose connections and at various fittings and joints in system. If unapproved replacement hoses are installed, refrigerant can be lost through hose permeation.

1. Visually inspect refrigerant system for air conditioning lubricant leakage and corrosion and damage to lines, hoses, and other components.
2. Visually inspect lowest points of fittings, hoses, and lines for indication of lubricant leakage.

TEST

Use a leak detector in accordance with the manufacturer's instruction manual and check for refrigerant leakage at hose connections, fittings, and areas where leakage might occur. If leaks are indicated, notify Direct Support Maintenance of leak in air conditioning system.

END OF WORK PACKAGE

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AIR CONDITIONER COMPRESSOR MAGNETIC CLUTCH REPLACEMENT 0226 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Holder, clutch (Item 17, WP 0236 00)

Puller kit, universal (Item 27, WP 0236 00)

Wrench, torque, 0-200 lb-in (Item 43, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 45, WP 0236 00)

References

TM 9-2320-302-10

Equipment Condition

Alternator belt removed (WP 0054 00)

REMOVAL

1. Using clutch holding tool to keep pulley from rotating, remove retaining bolt (1) and washer (2) from center of pulley rotor assembly (3).

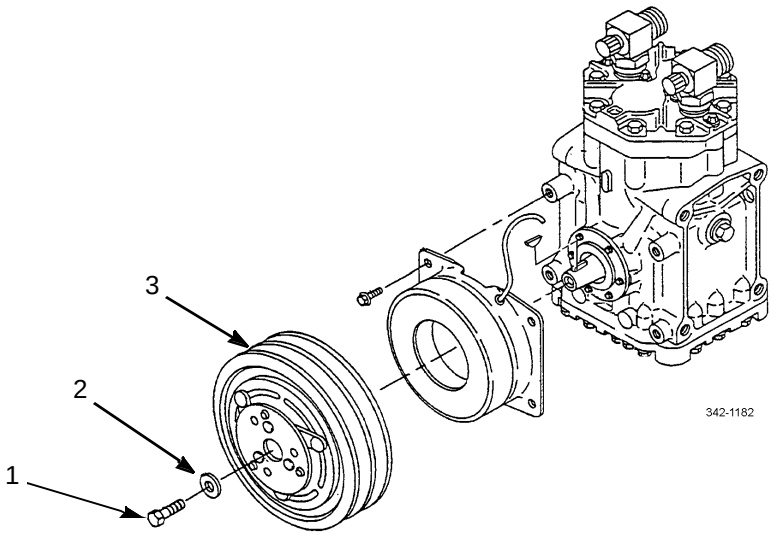
CAUTION

DO NOT try to remove pulley rotor assembly by prying or hammering. Failure to follow this caution could result in equipment damage.

NOTE

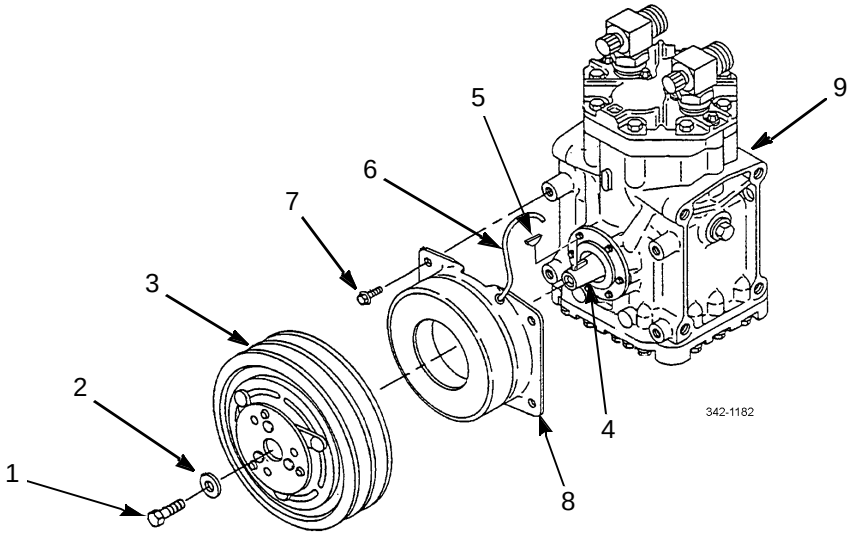
Use a 5/8-11 bolt that is long enough to serve as clutch remover.

2. Install puller kit bolt in hub of pulley rotor assembly (3).



REMOVAL - CONTINUED

3. Tighten puller kit bolt to remove pulley rotor assembly (3) from compressor shaft (4). Remove woodruff key (5) from compressor shaft. Retain woodruff key for later use.
4. Remove field coil electrical lead (6).
5. Remove four bolts (7) and field coil assembly (8) from compressor (9).



INSTALLATION

1. Install field coil assembly (8) on compressor (9) with four bolts (7). Tighten bolts to 96 lb-in (1084 Ncm).
2. Install woodruff key (5) and pulley rotor assembly (3) on compressor shaft (4) taking care to properly align and seat shaft and hub keyways.
3. Install washer (2) and retaining bolt (1) on pulley rotor assembly (3). Using clutch holding tool to keep pulley from rotating, tighten retaining bolt to 20 lb-ft (27 Nm).
4. Turn pulley rotor assembly (3) by hand to ensure that assembly moves freely without interference with field coil assembly (8).
5. Install field coil electrical lead (6).
6. Verify clutch engages when proper voltage is applied.
7. Install alternator belt (WP 0054 00).

END OF WORK PACKAGE

M13 DECONTAMINATION KIT MOUNTING BRACKET REPLACEMENT 0227 00

THIS WORK PACKAGE COVERS

Removal, Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Wrench, torque, 15-75 lb-ft (Item 46, WP 0236 00)

Materials/Parts

Nut, self-locking (P/N MS51922-11) (2)

References

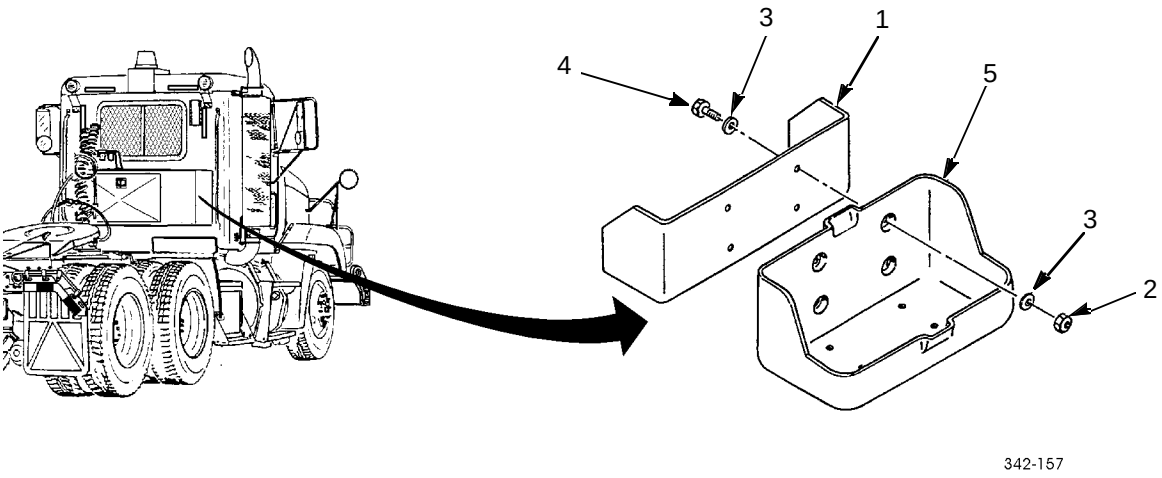
TM 9-2320-302-10

Equipment Condition

Decontamination tank removed

REMOVAL

1. Open door of personal gear storage box (1).
2. Remove four self-locking nuts (2), eight washers (3), four cap screws (4), and M13 decontamination kit mounting bracket (5) from side of personal gear storage box (1). Discard self-locking nuts.



INSTALLATION

1. Install M13 decontamination kit mounting bracket (5) on side of personal gear storage box (1) with four cap screws (4), eight washers (3), and four new self-locking nuts (2).
2. Tighten four self-locking nuts (2) to 22 lb-ft (30 Nm).
3. Close door of personal gear storage box (1).
4. Install decontamination tank.

END OF WORK PACKAGE

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GENERAL MAINTENANCE INSTRUCTIONS 0228 00

GENERAL

1. These general maintenance instructions contain general shop practices and specific methods you must be familiar with to properly maintain the M915A3 Tractor Truck. You should read and understand these practices and methods before performing any Unit Maintenance procedures.
2. Before beginning a task, find out how much repair, modification or replacement is needed to fix the equipment. Sometimes the reason for equipment failure can be seen right away and complete teardown is not necessary. Disassemble equipment only as far as necessary to repair or replace damaged parts.
3. In some cases, a part may be damaged during removal. If the part appears to be good, and other parts behind it are not defective, leave it in place and continue with the procedure. Here are a few simple rules:
   a. Do not remove dowel pins or studs unless loose, bent, broken or otherwise damaged.
   b. Do not remove bearings or bushings unless damaged. If you need to remove them to access parts behind, carefully pull out bearings and bushings.
   c. Replace all gaskets, lock washers, lock nuts, seals, cotter pins, and preformed packings.
4. All tags and forms attached to the equipment must be checked to learn the reason for removal of equipment from service. Modification Work Orders (MWOs) and Technical Bulletins (TBs) must also be checked for equipment changes and updates.

WORK SAFETY

1. Before beginning a procedure, think about the safety risks and hazards to yourself and to others. Wear protective gear such as safety goggles or lenses, safety shoes, rubber apron or gloves.
2. Before beginning a procedure, ensure that the following conditions have been observed, unless otherwise specified:
   a. Vehicle must be parked on level ground with parking brake applied and wheels blocked.
   b. Transmission must be in N (Neutral).
   c. Engine must be off.
   d. Master battery switch must be in OFF position.
   e. Components must be at operating temperature to be tested.
3. Immediately clean up spilled fluids to avoid slipping.
4. When lifting heavy parts, have someone help you. Ensure that lifting equipment or jack is working properly, that it meets weight requirement of part being lifted, and that it is securely fastened to part.
5. Always use power tools carefully.
6. Observe all WARNINGs and CAUTIONS.

CLEANING INSTRUCTIONS

WARNING

Improper cleaning methods and use of unauthorized cleaning liquids or solvents can injure personnel and damage equipment. To prevent this, refer to TM 9-247 for further instructions.

1. **General.** Cleaning instructions will be the same for the majority of parts and components which make up the truck. The following applies to all cleaning operations:
   a. Clean all parts before inspection, after repair, and before assembly.
   b. Keep hands free of grease which can collect dust, dirt, and grit.
   c. After cleaning, all parts should be covered or wrapped to protect them from dust and dirt. Parts that are subject to rust should be lightly oiled after cleaning.

CLEANING INSTRUCTIONS - CONTINUED

2. **Castings, Forgings, and Machined Metal Parts.**
   a. Clean inner and outer surfaces with detergent (Item 11, WP 0235 00) and dry with clean rags (Item 28, WP 0235 00).
   b. Remove grease and accumulated deposits with a scrub brush.

WARNING

Compressed air used for cleaning or drying purposes, or for clearing restrictions, should never exceed 30 psi (207 kPa). Wear protective clothing (goggles/shield, gloves, etc.) and use caution to avoid injury to personnel.

   c. Clear all threaded holes with compressed air to remove dirt and cleaning fluids.

CAUTION

DO NOT wash oil seals, electrical cables, and flexible hoses with dry cleaning solvent or mineral spirits. Serious damage or destruction of material will result.

3. **Oil Seals, Electrical Cables, and Flexible Hoses.** Wash oil seals, electrical cables, and flexible hoses with a solution of detergent (Item 11, WP 0235 00) and water, and wipe dry with a clean rag (Item 28, WP 0235 00).
4. **Bearings.** Clean bearings in accordance with TM 9-214.

PRESERVATION OF PARTS

Unpainted metal parts that will not be installed immediately after cleaning may be covered with a thin coat of lubricating oil (Item 19, WP 0235 00).

PAINTING

1. On painted areas where paint has been removed, paint in accordance with procedures outlined in TM 43-0139 and TB 43-0209.
2. For camouflage painting instructions, refer to FM 5-20.

INSPECTION INSTRUCTIONS

NOTE

All damaged areas should be marked for repair or replacement.

1. All components and parts must be carefully checked to determine if they are serviceable for use, can be repaired or must be scrapped.
2. Inspect drilled and tapped (threaded) holes for the following:
   a. Wear, distortion, cracks, and any other damage in or around holes.
   b. Threaded areas for wear distortion (stretching) and evidence of cross-threading.
3. Inspect metal lines, flexible lines or hoses, and metal fittings and connectors for the following:
   a. Metal lines for sharp kinks, cracks, bad bends, and dents.
   b. Flexible lines or hoses for fraying, evidence of leakage, and loose metal fittings or connectors.
   c. Metal fittings and connectors for thread damage and worn or rounded hex heads.

INSPECTION INSTRUCTIONS - CONTINUED

4. Inspect castings, forgings, and machined metal parts for the following:
   a. Machined surfaces for nicks, burrs, raised metal wear, and other damage.
   b. Inner and outer surfaces for breaks and cracks.
5. Inspect bearings in accordance with TM 9-214.

DISASSEMBLY AND ASSEMBLY INSTRUCTIONS

1. Keep major components together whenever possible and practical.
2. Tag hoses, electrical wires, cables, and harnesses to identify them and aid during installation.
3. Keep related parts together for identification purposes.
4. Temporarily install attaching hardware such as screws, bolts, washers, and nuts to prevent loss.
5. Only disassemble to the point of the problem.
6. Ensure that parts are clean and lubricated before assembly.

REPAIR INSTRUCTIONS

CAUTION

Before welding, the following components must be disconnected: DDEC ECU, Transmission ECU, ABS ECU, CWS ECU, and batteries. If welding on a trailer, it must be uncoupled from tractor truck. Failure to follow this caution may damage electronic components.

1. Repair castings, forgings, and machined parts using the following instructions:
   a. Repair minor cracked castings or forgings in accordance with TM 9-237.
   b. Repair minor damage to machined surfaces with an abrasive cloth dipped in detergent (Item 11, WP 0235 00).
   c. Replace any deeply nicked machined surface that could affect the assembly operation.
   d. Repair minor damage to threaded cap screw holes with thread tap of same size to prevent cutting oversize.
2. After repair, thoroughly clean all parts to prevent dirt, metal chips or other foreign material from entering any working parts.

LUBRICATION INSTRUCTIONS

NOTE

Refer to TM 9-2320-302-10 and to Unit PMCS (WP 0021 00) for detailed, illustrated instructions on proper lubrication. Some general practices to remember:

a. Use the correct lubricant.
b. Keep lubricants clean.
c. Clean all fittings prior to lubrication.
d. Lubricate clean disassembled and new parts to prevent rust.

APPLICATION OF ADHESIVES AND SEALING COMPOUNDS

WARNING

Adhesives and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive or sealing compound contacts skin or clothing, wash immediately with soap and water.

1. **General.** Adhesives are recommended in some tasks to ensure and strengthen seals. Sealing compounds are used to seal parts against moisture. The following information describes their correct use and application.
2. **Adhesive.** Adhesive provides a seal against leakage and a resistance to loosening when used in the assembly of threaded, slip-fitted or press-fitting parts. Always use grade of adhesive specified and never use when other retaining means are provided, such as lockwires, lock washers, lockplates, and fasteners.
3. **Sealing Compound.**
   a. Anytime a seal is broken, the part must be thoroughly cleaned to remove any remaining sealing compound and dirt.
   b. Thoroughly clean surface before applying sealing compound.
   c. When applying sealing compound, ensure that the area is completely covered. Press sealing compound into and around parts as necessary.
   d. Sealing compound will set in 15-30 minutes depending on temperature and humidity.

STANDARD TOOL REQUIREMENTS

1. The following are general practices regarding the use of tools:
   a. Always use the proper tool kit and tools for the procedure being performed.
   b. Ensure that tools are clean and lubricated to reduce wear and to prevent rust.
   c. Keep track of tools. Do not be careless with them.
   d. Return tools to toolbox when finished with repair or maintenance.
   e. Return toolboxes and tools to tool storage when not in use.
   f. Inventory tools before and after each use.
2. Some maintenance tasks may require special or fabricated tools. The “Initial Setup” of the procedure will specify any special or fabricated tools needed to perform that procedure. Use these special tools only for the maintenance procedures for which they are designed or called out. If you are unfamiliar with a required tool, see your supervisor.

TAGGING WIRES AND HOSES

1. Use marker tags (Item 31, WP 0235 00) to identify all electrical wires, fuel, oil, and coolant lines, and any other parts which may be hard to identify or replace later. Fasten tags to parts during removal by wrapping wire fasteners around or through parts and twisting ends together. Position tags to be out of the way during cleaning, inspection, and repair. Mark tags with a pencil, pen or marker.
2. Whenever possible, identify electrical wires with the number of the terminal or wire to which it connects. If no markings can be found, tag both wires or wire and terminal, and use the same identifying mark for both. If you cannot tag a wire because it must fit through a small hole or you cannot reach it, write down the description of the wire and the point to which it connects or draw a simple diagram on paper. Be sure to write down enough information so you will be able to properly connect the wires during assembly. If you need to identify a loose wire, look for identifying number near end of the wire, stamped on a permanent metal tag. Compare the number to wire numbers on the appropriate electrical schematic.

TAGGING WIRES AND HOSES - CONTINUED

3. Identify fuel, oil, and coolant lines when you are taking off more than one line at the same time. Mark tags with points to which lines and hoses must be connected. If it is not obvious which end of a line goes where, tag each end of the line.

4. Identify and tag other parts as required by name and installed location.

SOLDERING

CAUTION

Use low wattage soldering gun when soldering electrical wires, connectors, terminal lugs, and receptacles. High wattage soldering guns may damage parts by overheating.

1. Solder connection must be bright and clean before soldering. Remove dirt and grease with detergent (Item 11, WP 0235 00). Solder used must be of lead-tin alloy, rosin core (Item 29, WP 0235 00) with soldering flux (Item 12, WP 0235 00). All wires, parts, and soldering gun (Item 30, WP 0236 00) must be tinned for good connection and maximum transfer of heat.

2. To prevent overheating damage to electrical parts when soldering and unsoldering connections, hold bare wire, lead or terminal lug close to soldering point with long roundnose pliers. Pliers act as heat sink and absorb excess heat.

3. Clean all solder joints with a scrub brush and electrical parts with detergent (Item 11, WP 0235 00) after soldering to get a bright, clean surface.

HEAT SHRINKABLE TUBING

NOTE

Further information on shrink wrap usage and sources of supply can be found in WP 0119 00.

Use heat shrinkable tubing to insulate soldered and crimped electrical connections as follows:

a. Cut desired length of new heat shrinkable tubing twice the diameter of the connection to be covered.

b. Slide the heat shrinkable tubing onto the wire and out of the way before making electrical connection.

c. After making electrical connection, slide heat shrinkable tubing into place over electrical connection.

WARNING

DO NOT touch heat shrinkable tubing for at least 30 seconds after heating. Heat shrinkable tubing is hot and will burn you.

d. Hold heat gun (Item 16, WP 0236 00) 4-5 in (10.2-12.7 cm) away from heat shrinkable tubing and apply heat for approximately 30 seconds. Stop applying heat as soon as heat shrinkable tubing forms to the shape of the electrical connection.

ELECTRICAL GROUND POINTS

Many electrical problems are the result of poor ground connections. You can ensure that ground connections are good by performing the following steps:

ELECTRICAL GROUND POINTS - CONTINUED

WARNING

Although master battery switch must be on and battery ground cable connected in order to test electrical circuit voltage, turn off master battery switch or disconnect battery ground cable before performing resistance tests or replacing parts. This will prevent shock to personnel, and damage to parts and equipment.

a. Remove hardware connecting ground cable terminal lug to ground point.

b. Clean mounting hardware, ground cable terminal lugs, and ground point with detergent (Item 11, WP 0235 00) and scrub brush.

c. Remove any rust with wire brush and crocus cloth.

d. Look for cracks, loose terminal lugs, and stripped threads. Replace any defective parts.

e. Install hardware connecting ground cable terminal lug to ground point. Ensure that all hardware is tight.

LINES AND PORTS

To keep dirt from contaminating fluid systems when removing and installing fuel, oil, and coolant lines, perform the following steps:

a. Clean fittings and surrounding area before disconnecting lines.

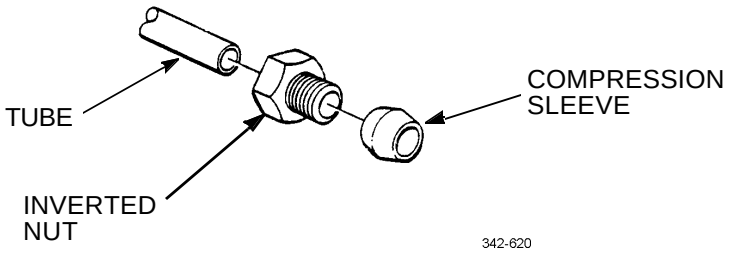
b. Cover, cap, plug or tape lines and ports after disconnecting lines. When these are not available, use hand-carved wooden plugs, clean rags (Item 28, WP 0235 00), duct tape (Item 33, WP 0235 00) or other similar materials to prevent dirt from entering system.

c. Ensure that new and used parts are clean before installing.

d. Wait to remove cover, cap, plug or tape from lines and ports until just before installing lines.

TUBES AND COMPRESSION FITTINGS

1. Tubes with inverted nuts and compression fittings are designed for one time assembly. Once assembled, they must be replaced as a unit if any parts are found defective. Used parts may not seal properly when used with new ones.
2. Used tube assemblies in good condition can be installed to their original location without leaking.
3. Assemble new tubes, compression sleeves, and inverted nuts as follows:
   a. Slide inverted nut onto end of tube.
   b. Slide compression sleeve onto end of tube.
   c. Repeat previous two steps for other end of tube as required.

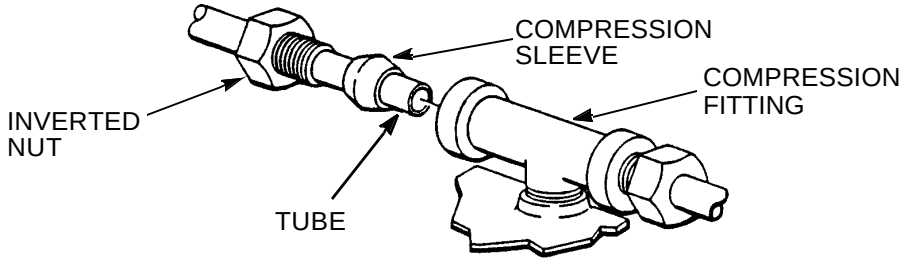


4. Install new tube assemblies as follows:
   a. Insert end of tube as far as it will go into compression fitting to which tube is being installed.

TUBES AND COMPRESSION FITTINGS - CONTINUED

b. Twist inverted nut into compression fitting and tighten inverted nut against compression sleeve with open-end wrench. Compression sleeve will clamp down around tube and conform to internal surface of compression fitting and inverted nut.

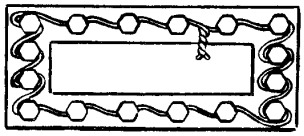
c. Repeat previous two steps for other end of tube as required.



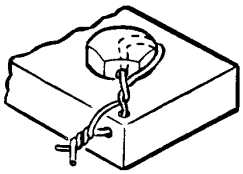
LOCKWIRE

1. Always use nonelectrical wire (Item 34, WP 0235 00).
2. Drilled head screws and bolts usually do not require lockwiring if they are installed with self-locking nuts or lock washers.
3. Three screws or bolts are the maximum number that may be lockwired in a series when they are spaced 4-6 in (10.2-15.2 cm) apart. The maximum number of closely spaced multiple groups of screws or bolts to be lockwired is limited to the number of units that can be lockwired with a 24 in (61 cm) length of wire.
4. Do not secure screws, bolts or fittings which are spaced more than 6 in (15.2 cm) apart. Lockwire these fasteners to tie points 6 in (15.2 cm) or less away.
5. Lockwire parts so that tension will be on lockwire when parts tend to loosen. Lockwire should be installed and twisted tight so that loop around head stays down and does not come up over head of screw or bolt. This does not apply to castellated nuts when slot is close to top of nuts; wire is more secure when made to pass along the side of stud. Ensure that lockwire is tight but not overstressed.
6. Make pigtail of 1/4-1/2 in (6.4-12.7 mm) at end of lockwire. Bend pigtail down so it will not become a snag.
7. When lockwiring castellated nuts, tighten castellated nut to low side of torque range, then continue tightening until slot lines up with hole.
8. In blind, tapped hole application of bolts, castellated nuts or studs, lockwire as illustrated.

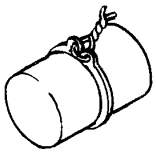
LOCKWIRE - CONTINUED



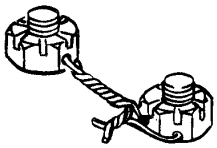
SMALL SCREWS IN CLOSELY SPACED, CLOSED GEOMETRICAL PATTERN: SINGLE WIRE METHOD



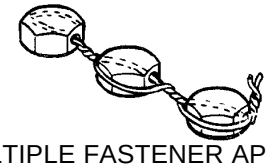
SINGLE FASTENER APPLICATION: DOUBLE TWIST METHOD



EXTERNAL RETAINER RING: SINGLE WIRE METHOD



CASTELLATED NUTS ON UNDRILLED STUDS: DOUBLE TWIST METHOD



MULTIPLE FASTENER APPLICATION: DOUBLE TWIST METHOD

342-622

FLUID DISPOSAL

Dispose of contaminated drained fluids in accordance with the Standard Operating Procedures (SOP) of your unit.

MULTIMETER

1. **General.** The digital multimeter (Item 24, WP 0236 00) is used to troubleshoot the electrical system of the vehicle. The multimeter's ohms scale is used to test for continuity, shorts, and resistance and the voltmeter scale is used to test voltage levels at any point in the electrical system.

2. **Continuity Tests.** Continuity tests are performed to check for breaks in a circuit (such as a fuse, switch, light bulb or electrical cable).

NOTE

If digital readout will not zero properly, replace batteries and repeat zeroing procedure. If digital readout will not zero after batteries have been replaced, notify your supervisor.

a. **Zero the Multimeter.**

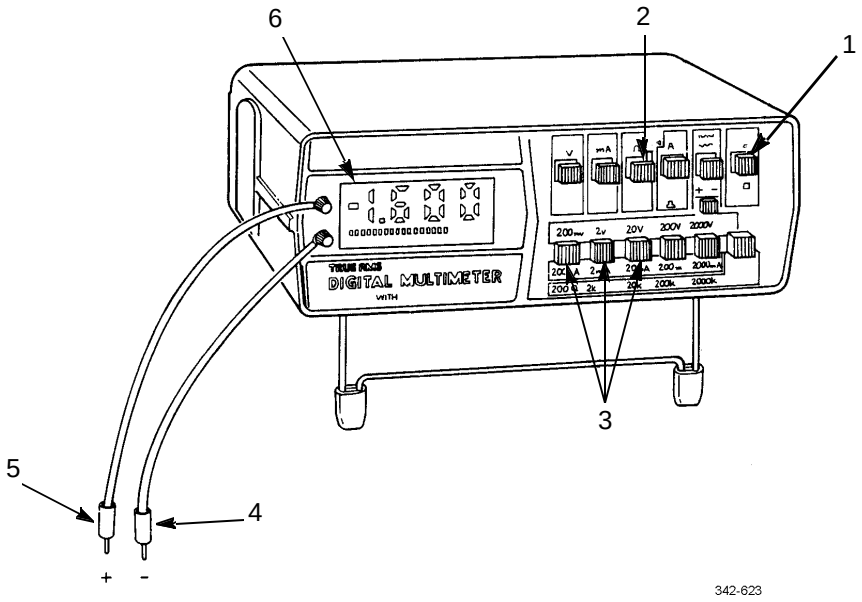
(1) Set multimeter ON/OFF switch (1) to ON position.

(2) Press OHMS FUNCTION switch (2).

(3) Press LOWEST VOLTAGE/OHMS selector switch (3).

(4) Touch black and red probes (4 and 5) together and check for a zero reading on digital readout (6).

MULTIMETER - CONTINUED



CAUTION

Before performing a continuity test, always turn master battery switch to OFF position and disconnect circuit to be tested. Failure to follow this caution may damage multimeter.

b. **Testing for Continuity.**

(1) Zero multimeter.

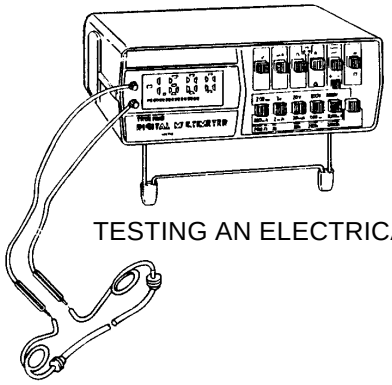
(2) Connect black and red probes (4 and 5) to both terminals of circuit being tested.

(3) Read digital readout (6) and interpret results as follows:

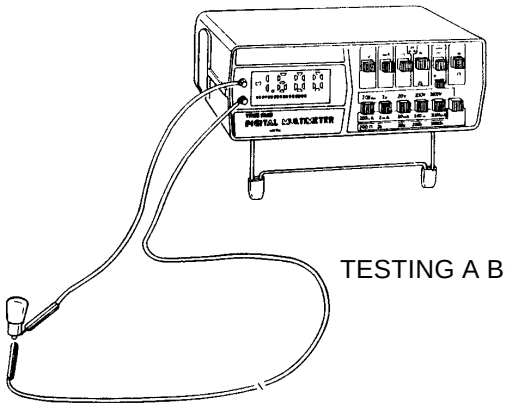
(a) If digital readout (6) indicates 0 (zero), circuit has continuity.

(b) If digital readout (6) indicates resistance, circuit is open.

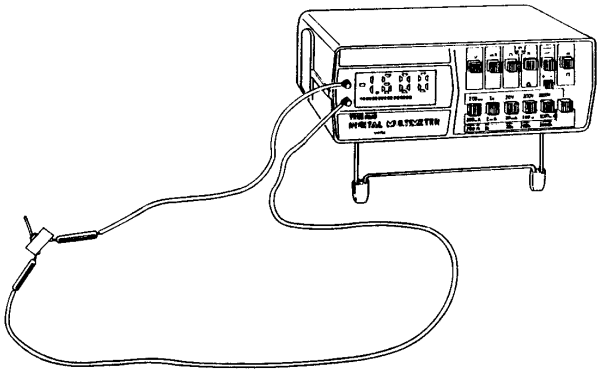
MULTIMETER - CONTINUED



TESTING AN ELECTRICAL CABLE



TESTING A BULB



342-624

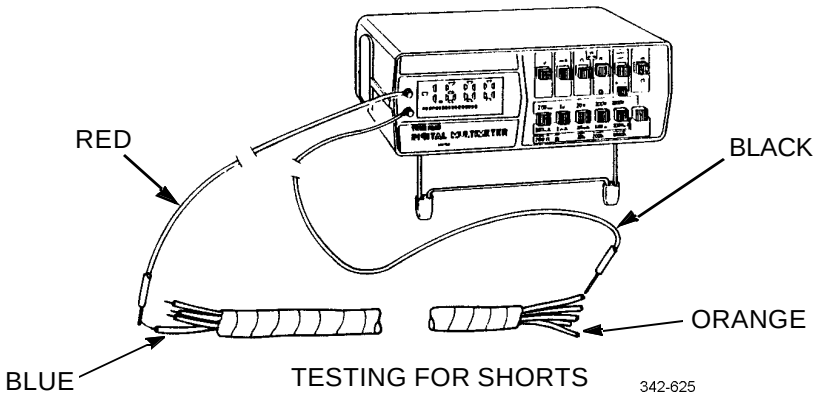
TESTING A SWITCH

MULTIMETER - CONTINUED

CAUTION

Before performing a continuity test, always turn master battery switch to OFF position and disconnect circuit to be tested. Failure to follow this caution may damage multimeter.

c. **Testing for Shorts.** A short (or short circuit) occurs when two circuits that should not be connected have metal-to-metal contact with each other. A short also occurs when a circuit that should not touch ground has metal-to-metal contact with ground.



(1) Zero multimeter.

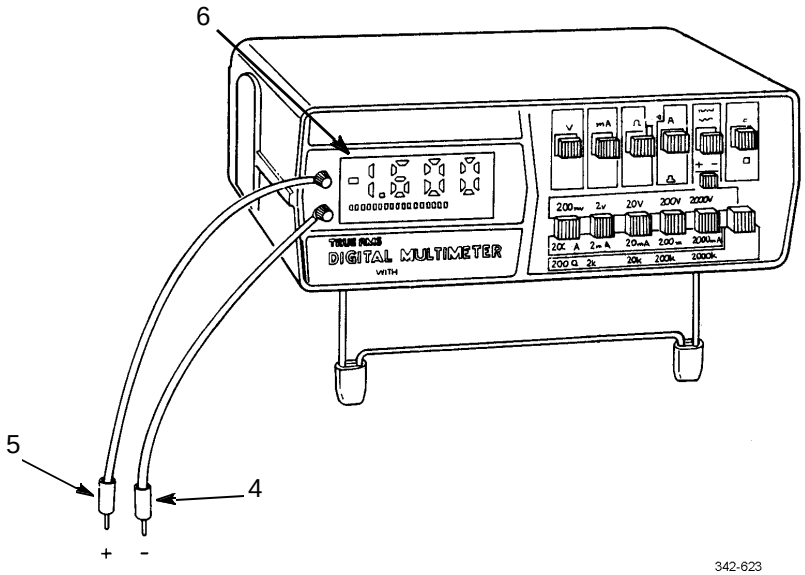
(2) Connect black probe (4) to one circuit and red probe (5) to either a ground or another circuit.

(3) Read digital readout (6) and interpret results as follows:

(a) If digital readout (6) indicates 0 (zero), circuits are shorted or circuit is grounded if testing to ground.

(b) If digital readout (6) does not indicate 0 (zero), circuits are not shorted.

(c) If digital readout (6) jumps or flickers, circuits are shorted or grounded intermittently.



MULTIMETER - CONTINUED

CAUTION

Before performing a continuity test, always turn master battery switch to OFF position and disconnect circuit to be tested. Failure to follow this caution may damage multimeter.

d. **Testing for Resistance.** Allowable resistance readings depend on circuit being tested. Refer to the particular section dealing with that circuit or component for allowable readings.

(1) Zero multimeter.

(2) Press OHMS FUNCTION switch (2).

(3) Press LOWEST VOLTAGE/OHMS selector switch (3). If test calls for ohms range other than RX1, set RANGE SELECTOR switch (7) to required range.

(4) Connect black and red probes (4 and 5) across circuit to be tested.

(5) Read digital readout (6) and interpret results as circuit resistance.

3. **Measuring DC Voltage.**

a. Set multimeter ON/OFF switch (1) to ON position.

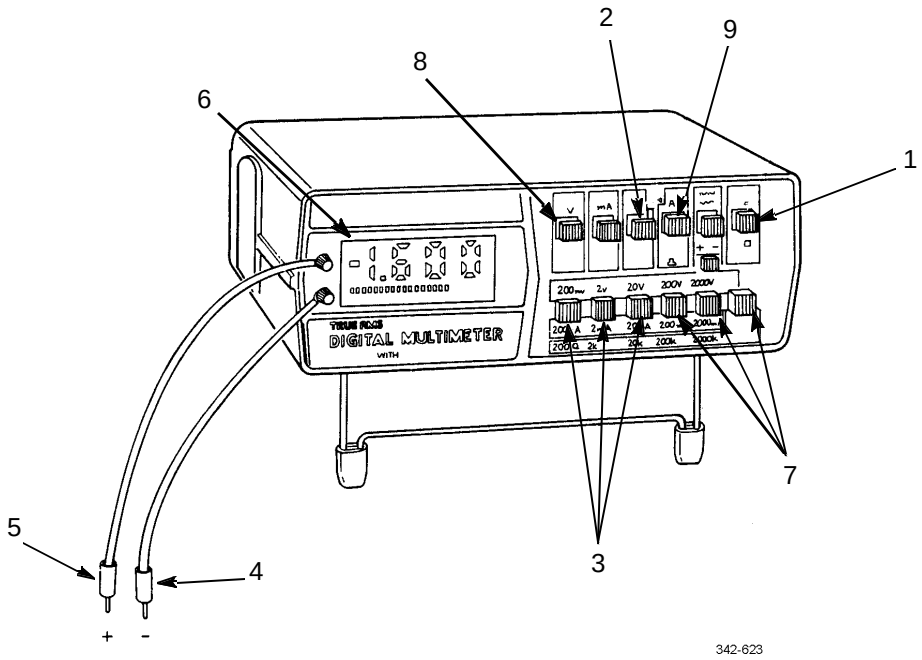
b. Press VOLTS FUNCTION switch (8).

c. Set AC/DC selector switch (9) to DC.

d. Select and press LOWEST VOLTAGE/OHMS selector switch (3) for voltage range higher than volts to be measured.

e. Connect red probe (5) to positive (+) side of circuit and black probe (4) to negative (-) side of circuit.

f. Read digital readout (6) and interpret results as DC voltage in circuit being tested.



ELECTRICAL REPAIR

For complete instructions on the repair of standard military and commercial connectors and general information on splicing, refer to WP 0119 00.

END OF WORK PACKAGE

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ARCTIC HEATER REPLACEMENT (WEBASTO) 0229 00

THIS WORK PACKAGE COVERS

Arctic Heater Removal, Arctic Heater Fuel Pump Removal, Arctic Heater Installation, Arctic Heater Fuel Pump Installation

INITIAL SETUP

Tools and Special Tools

Tool kit, general mechanic's (Item 36, WP 0236 00)

Pan, drain (Item 25, WP 0236 00)

Materials/Parts

Tags, marker (Item 31, WP 0235 00)

Personnel Required

Two

Equipment Condition

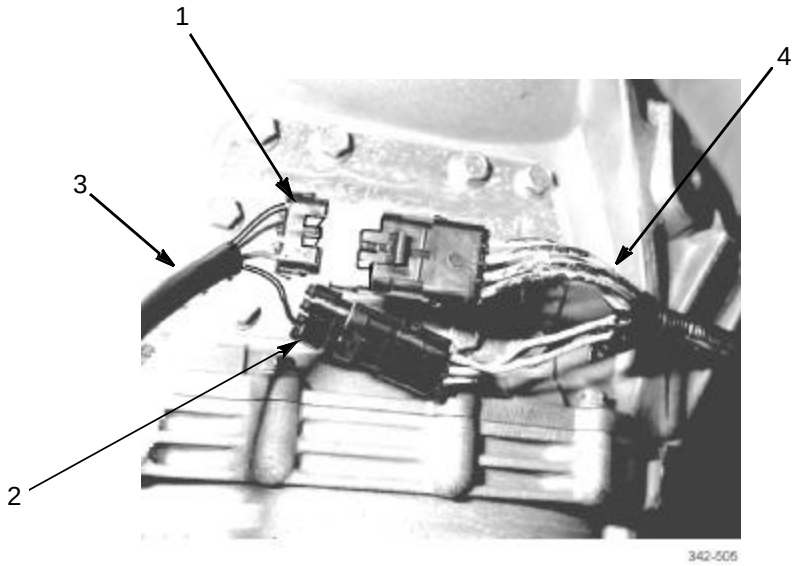
Cooling system drained (WP 0041 00)

ARCTIC HEATER REMOVAL

WARNING

DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. At top of transmission, tag and disconnect two connectors (1 and 2) of arctic heater harness (3) from connectors of wiring harness (4).



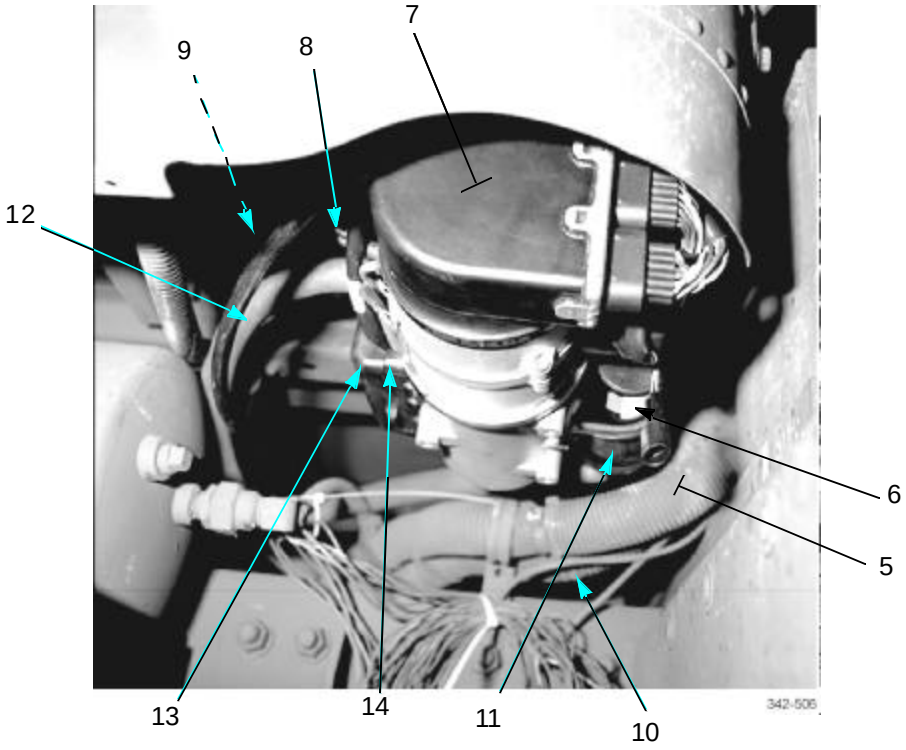
ARCTIC HEATER REMOVAL - CONTINUED

2. At left-rear of cab, loosen clamp and disconnect exhaust tube (5) from exhaust port (6) of arctic heater (7).
3. While supporting arctic heater (7), remove four nuts and screws holding arctic heater mounting bracket to cab floor.
4. Disconnect connector (8) of arctic heater (7) from connector of wiring harness (9).

NOTE

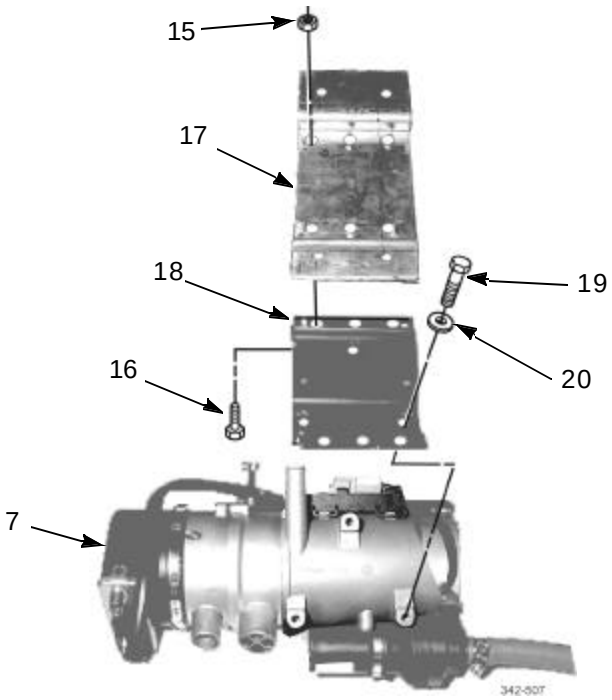
Have suitable container available to catch coolant draining from hoses.

5. Loosen clamp and disconnect coolant hose (10) from coolant pump (11) of arctic heater (7).
6. Loosen clamp and disconnect coolant hose (12) from coolant outlet port (13).
7. Loosen clamp and disconnect fuel supply hose from fuel inlet (14).
8. Remove arctic heater (7) assembly from vehicle.



ARCTIC HEATER REMOVAL - CONTINUED

9. Remove six nuts (15), screws (16) and mounting bracket (17) from adapter bracket (18).
10. Remove three screws (19), washers (20), and adapter bracket (18) from arctic heater (7).



ARCTIC HEATER FUEL PUMP REMOVAL

WARNING

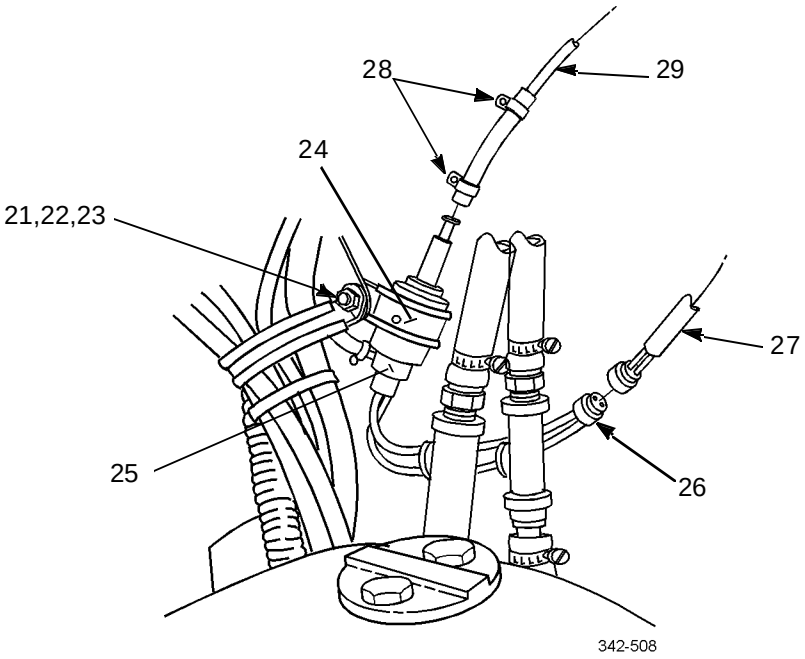
DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. Remove nut (21), washer (22), screw (23), and clamp (24) from arctic heater fuel pump (25).
2. Disconnect connector (26) of arctic heater fuel pump (25) from wiring harness (27).

NOTE

- Have a suitable container available to catch fuel draining from hoses.
- Note position of pump for installation.
- Perform step 3 at each end of arctic heater fuel pump.

3. Loosen clamp (28) and disconnect fuel hose (29) from arctic heater fuel pump (25).
4. Remove arctic heater fuel pump (25) from vehicle.

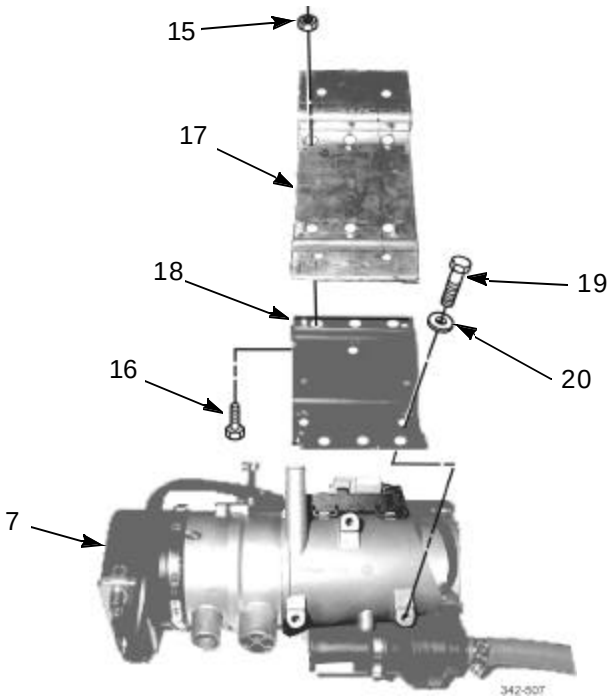


ARCTIC HEATER INSTALLATION

WARNING

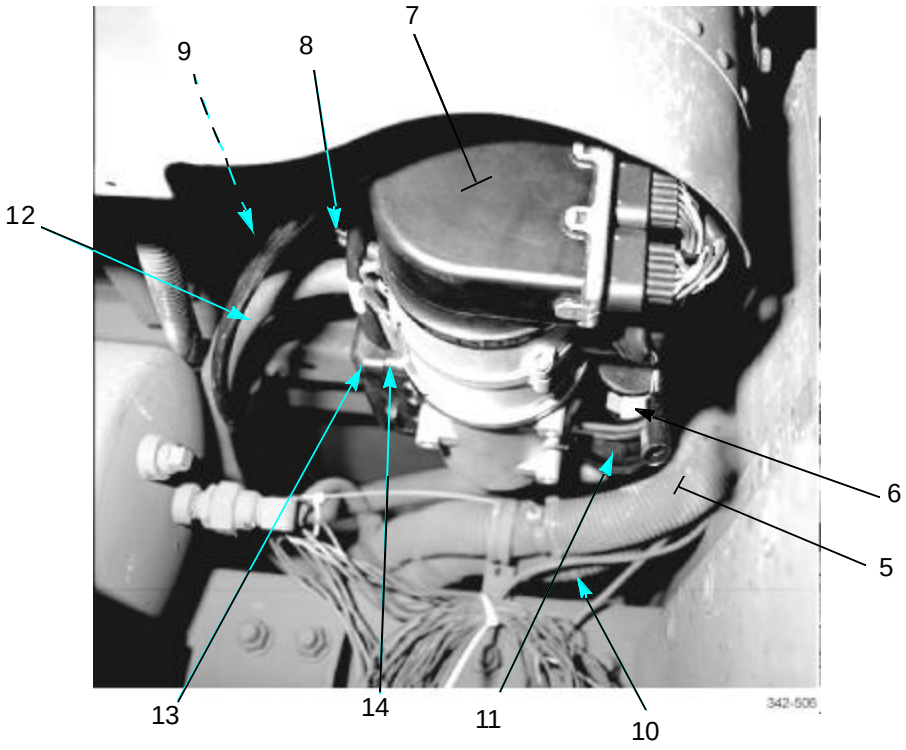
DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. Install adapter bracket (18) to arctic heater (7) with three washers (20) and screws (19).
2. Install mounting bracket (17) to adapter bracket (18) with six screws (16) and nuts (15).



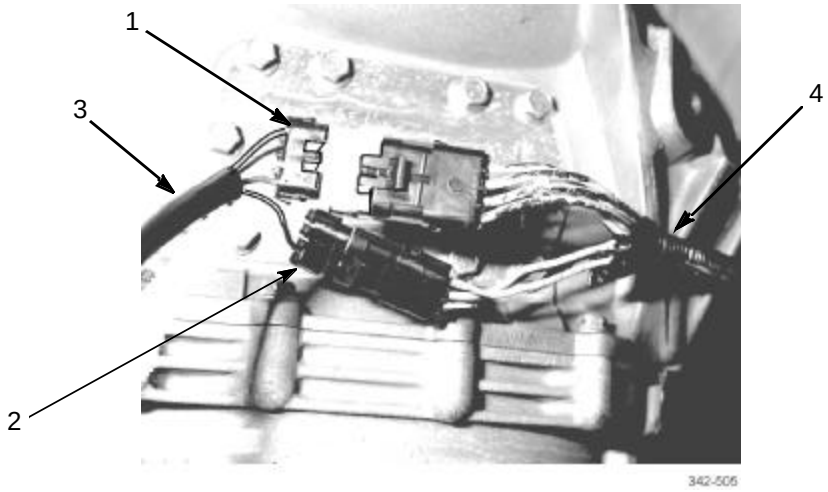
ARCTIC HEATER INSTALLATION - CONTINUED

1. Position arctic heater (7) assembly to vehicle.
2. While supporting arctic heater (7), connect fuel supply hose to fuel inlet (14) and tighten clamp.
3. Connect coolant hose (12) to coolant outlet port (13) and tighten clamp.
4. Connect coolant hose (10) to coolant pump (11) of arctic heater (7) and tighten clamp.
5. Connect connector (8) of arctic heater (7) to connector of wiring harness (9).
6. Install mounting bracket of arctic heater to cab floor with four screws and nuts.
7. Install exhaust tube (5) to exhaust port (6) of arctic heater (7) and tighten clamp.



ARCTIC HEATER INSTALLATION - CONTINUED

8. At top of transmission, connect two connectors (1 and 2) of arctic heater harness (3) to connectors of wiring harness (4).



ARCTIC HEATER FUEL PUMP INSTALLATION

WARNING

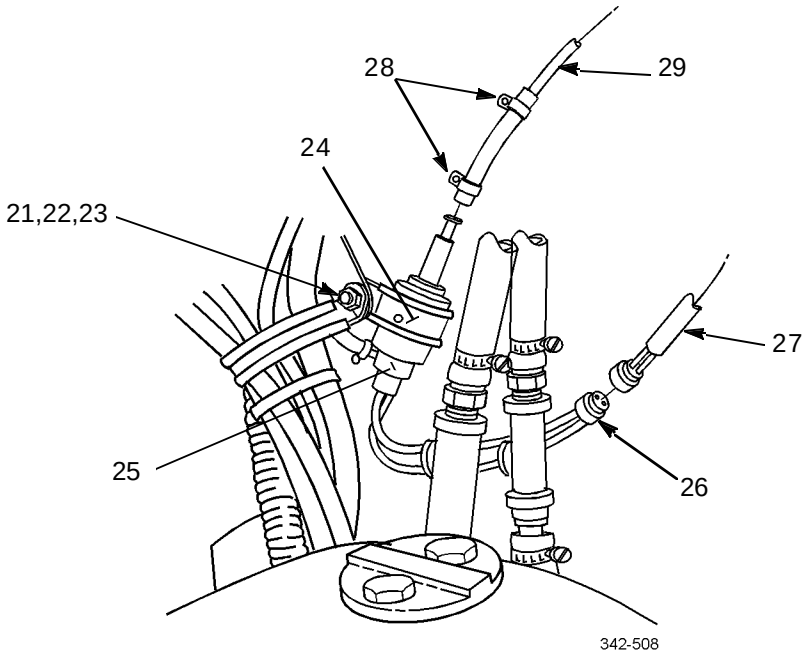
DO NOT perform fuel system checks, inspections or maintenance while smoking or near fire, flames or sparks. Fuel may ignite, causing injury or death to personnel or damage to equipment.

1. Position arctic heater fuel pump (25) to vehicle.

NOTE

Perform step 2 at each end of arctic heater fuel pump.

2. Connect fuel hose (29) to arctic heater fuel pump (25). Tighten clamp (28).
3. Connect connector (26) of arctic heater fuel pump (25) to wiring harness (27).
4. Install arctic heater fuel pump (25) with clamp (24), screw (23), washer (22), and nut (21).



ARCTIC HEATER FUEL PUMP INSTALLATION - CONTINUED

5. Fill cooling system (WP 0041 00).

END OF WORK PACKAGE

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ILLUSTRATED LIST OF MANUFACTURED ITEMS 0230 00

SCOPE

1. This work package includes complete instructions for making items authorized to be manufactured or fabricated at Unit Maintenance.
2. A Part Number Index in alphanumeric order is provided in Table 1 for cross-referencing the part number of the item to be manufactured to Table 2, which covers fabrication criteria.
3. All bulk materials needed for manufacture of an item are listed by part number or specification number.

PART NUMBER INDEX

Table 1. Part Number Index.

PART NUMBER	NAME	TABLE NUMBER
FITC-02	Cable, Special Purpose	2
NT10010-BKX13	Tube, Nylon	2
NT10010-BKX16	Tube, Nylon	2
NT10010-BKX40	Tube, Nylon	2
NT10010-BKX175	Tube, Nylon	2
PFT-4A	Tubing, Nonmetellic	2
PFT-4A-BLK-100X13	Tube, Nylon	2
PFT-4A-BLK-100X46	Tube, Nylon	2
PFT-4A-BLK-100X48	Tube, Nylon	2
PFT-4A-BLK-100X54	Tube, Nylon	2
PFT-4A-BLK-100X70	Tube, Nylon	2
PFT-4A-BLK-100X78	Tube, Nylon	2
PFT-4A-BLK-100X85	Tube, Nylon	2
PFT-4A-BLK-100X93	Tube, Nylon	2
PFT-4A-BLK-100X159	Tube, Nylon	2
PFT-4A-BLK-100X225	Tube, Nylon	2
PFT-6B-BLK-100X6	Tube, Nylon	2
PFT-6B-BLK-100X15	Tube, Nylon	2
PFT-6B-BLK-100X18	Tube, Nylon	2
PFT-6B-BLK-100X25	Tube, Nylon	2
PFT-6B-BLK-100X34	Tube, Nylon	2
PFT-6B-BLK-100X36	Tube, Nylon	2
PFT-6B-BLK-100X40	Tube, Nylon	2
PFT-6B-BLK-100X42	Tube, Nylon	2
PFT-6B-BLK-100X52	Tube, Nylon	2
PFT-6B-BLK-100X53	Tube, Nylon	2
PFT-6B-BLK-100X70	Tube, Nylon	2

Table 1. Part Number Index - Continued.

PART NUMBER	NAME	TABLE NUMBER
PFT-6B-BLK-100X75	Tube, Nylon	2
PFT-6B-BLK-100X79	Tube, Nylon	2
PFT-6B-BLK-100X100	Tube, Nylon	2
PFT-6B-BLK-100X113	Tube, Nylon	2
PFT-6B-BLK-100X115	Tube, Nylon	2
PFT-6B-BLK-100X119	Tube, Nylon	2
PFT-6B-BLK-100X120	Tube, Nylon	2
PFT-6B-BLK-100X130	Tube, Nylon	2
PFT-6B-BLK-100X149	Tube, Nylon	2
PFT-6B-BLK-100X150	Tube, Nylon	2
PFT-6B-BLK-100X159	Tube, Nylon	2
PFT-8B-BLK-100X1	Tube, Nylon	2
PFT-8B-BLK-100X7	Tube, Nylon	2
PFT-8B-BLK-100X36	Tube, Nylon	2
PFT-8B-BLK-100X50	Tube, Nylon	2
PFT-8B-BLK-100X60	Tube, Nylon	2
PFT-8B-BLK-100X78	Tube, Nylon	2
PFT-8B-BLK-100X100	Tube, Nylon	2
PFT-8B-BLK-100X115	Tube, Nylon	2
PFT-8B-BLK-100X121	Tube, Nylon	2
PFT-8B-BLK-100X130	Tube, Nylon	2
PFT-8B-BLK-100X140	Tube, Nylon	2
P52-6738	Coupling, Assembly	2
04-9323-013	Pipe, Flex	2
05-09562-005	Hose, Neoprene	2
05-09562-006	Hose, Straight	2
05-09564-008	Hose, Neoprene	2
05-12538-036	Hose	2
05-12539-043	Hose, Straight	2
05-15224-004	Hose, Rubber	2
06-18131-000	Liner, Plywood	2
12-13366-040	Tube, Nylon	2
12-13367-045	Tube, Nylon	2
12-13367-060	Tube, Nylon	2
12-13367-105	Tube, Nylon	2
12-13367-142	Tube, Nylon	2
12-13367-200	Tube, Nylon	2

Table 1. Part Number Index - Continued.

PART NUMBER	NAME	TABLE NUMBER
12-13370-037	Tube, Nylon	2
12-13371-037	Tube, Nylon	2
12-13374-006	Tube, Nylon	2
12-13472-019	Tube, Nylon	2
12-13473-040	Tube, Nylon	2
18-11197-001X10	Trim, Edging	2
22-21952-004	Hose	2
22-21952-018	Hose	2
22-21952-020	Hose	2
22-21952-048	Hose	2
22-21952-052	Hose	2
22-21952-063	Hose, Heater	2
22-28607-018	Hose, Heater	2
22-28607-061	Hose, Rubber	2
22-30167-030	Hose, Heater	2
22-30168-003	Hose, Heater	2
22-30168-034	Hose, Heater	2
22-35191-010	Seal	2
22-35281-016	Hose, Rubber	2
22-35281-030	Hose, Rubber	2
22-35282-025	Hose, Rubber	2
22-35282-090	Hose, Rubber	2
22-35282-135	Hose, Rubber	2
23323FX-48	Hose, Nonmetallic	2
350359X0.3	Hose, Coolant	2
350359X1.8	Hose, Coolant	2
350359X3.5	Hose, Coolant	2
350359X3.8	Hose, Coolant	2
4246-0410X5	Tubing, Nylon	2
47336AX	Hose, Nonmetallic	2
47338AX	Hose, Nonmetallic	2
48-00050-206X6	Tape, Foam	2
48-00081-038X24	Hose	2
48-00099-150X3	Hose	2
48-00100-010X5	Tubing, Nylon	2
48-00100-010X10	Tubing, Nylon	2
48-00100-010X15	Tubing, Nylon	2

Table 1. Part Number Index - Continued.

PART NUMBER	NAME	TABLE NUMBER
48-00100-812X15	Tubing, Nylon	2
48-00100-812X18	Tubing, Nylon	2
48-00100-814X16	Tubing, Nylon	2
48-00100-815X15	Tubing, Nylon	2
48-00100-816X6	Tubing, Nylon	2
48-00100-816X18	Tubing, Nylon	2
48-00100-816X48	Tubing, Nylon	2
48-00100-829X12	Tubing, Nylon	2
48-00100-829X36	Tubing, Nylon	2
48-00100-829X56	Tubing, Nylon	2
48-00101-010X7	Tube, Nylon	2
48-00101-010X48	Hose	2
48-00101-010X72	Hose	2
48-00101-010X96	Hose	2
48-00101-010X144	Hose	2
48-00101-010X180	Hose	2
48-00101-010X264	Hose	2
48-00101-020X24	Hose, Nonmetallic	2
48-00101-020X48	Hose, Nonmetallic	2
48-00101-020X96	Hose, Nonmetallic	2
48-00101-020X120	Hose, Nonmetallic	2
48-00101-022X1	Tube, Nylon	2
48-00101-030X10	Tube, Nylon	2
48-00101-030X108	Hose, Nonmetallic	2
48-00121-016X30	Hose	2
48-00121-016X53	Hose	2
48-02014-008X48	Hose	2
48-02015-012X24	Hose, Rubber	2
48-02217-025X5	Conduit, Nonmetallic	2
48-02217-025X36	Tubing, Nonmetallic	2
48-02217-050X3	Conduit	2
48-02217-050X8	Conduit	2
48-02217-062X3	Conduit	2
48-02217-062X105	Conduit	2
48-02217-075X57.08	Conduit	2
48-02218-050X105	Conduit	2
48-02218-075X12	Conduit	2

Table 1. Part Number Index - Continued.

PART NUMBER	NAME	TABLE NUMBER
48-02454-106X27	Tape, Foam	2
48-02454-206X12	Tape, Ureth Foam	2
48-02471-001X8	Seal, Door	2
48-02471-001X55	Seal	2
5156170	Hose	2
68240R-276	Conduit	2
77620-7.5	Hose	2

Table 2. Manufactured Items.

PART NUMBER	NAME	MANUFACTURED FROM	DESCRIPTION
FITC-02	CABLE, SPECIAL PURPOSE	M83420/1-005	144 IN LONG
NT10010-BKX13	TUBE, NYLON	3250-1010	40 IN LONG
NT10010-BKX16	TUBE, NYLON	3250-1010	13 IN LONG
NT10010-BKX40	TUBE, NYLON	3250-1010	40 IN LONG
NT10010-BKX175	TUBE, NYLON	3250-1010	175 IN LONG
PFT-4A	TUBING, NONMETALLIC	PFT-4A BLACKX1300	CUT TO FIT
PFT-4A-BLK-100X13	TUBE, NYLON	PFT-4A BLACKX1300	13 IN LONG
PFT-4A-BLK-100X46	TUBE, NYLON	PFT-4A BLACKX1300	46 IN LONG
PFT-4A-BLK-100X48	TUBE, NYLON	PFT-4A BLACKX1300	48 IN LONG
PFT-4A-BLK-100X54	TUBE, NYLON	PFT-4A BLACKX1300	54 IN LONG
PFT-4A-BLK-100X70	TUBE, NYLON	PFT-4A BLACKX1300	70 IN LONG
PFT-4A-BLK-100X78	TUBE, NYLON	PFT-4A BLACKX1300	78 IN LONG
PFT-4A-BLK-100X85	TUBE, NYLON	PFT-4A BLACKX1300	85 IN LONG
PFT-4A-BLK-100X93	TUBE, NYLON	PFT-4A BLACKX1300	93 IN LONG
PFT-4A-BLK-100X159	TUBE, NYLON	PFT-4A BLACKX1300	159 IN LONG
PFT-4A-BLK-100X225	TUBE, NYLON	PFT-4A BLACKX1300	225 IN LONG
PFT-6B-BLK-100X6	TUBE, NYLON	3250-061	6 IN LONG
PVT-6B-BLK-100X15	TUBE, NYLON	3250-061	15 IN LONG
PFT-6B-BLK-100X18	TUBE, NYLON	3250-061	18 IN LONG
PFT-6B-BLK-100X25	TUBE, NYLON	3250-061	25 IN LONG
PFT-6B-BLK-100X34	TUBE, NYLON	3250-061	34 IN LONG

Table 2. Manufactured Items - Continued.

PART NUMBER	NAME	MANUFACTURED FROM	DESCRIPTION
PFT-6B-BLK-100X36	TUBE, NYLON	3250-061	36 IN LONG
PFT-6B-BLK-100X40	TUBE, NYLON	3250-061	40 IN LONG
PFT-6B-BLK-100X42	TUBE, NYLON	3250-061	42 IN LONG
PFT-6B-BLK-100X52	TUBE, NYLON	3250-061	52 IN LONG
PFT-6B-BLK-100X53	TUBE, NYLON	3250-061	53 IN LONG
PFT-6B-BLK-100X70	TUBE, NYLON	3250-061	70 IN LONG
PFT-6B-BLK-100X75	TUBE, NYLON	3250-061	75 IN LONG
PFT-6B-BLK-100X79	TUBE, NYLON	3250-061	79 IN LONG
PFT-6B-BLK-100X100	TUBE, NYLON	3250-061	100 IN LONG
PFT-6B-BLK-100X113	TUBE, NYLON	3250-061	113 IN LONG
PFT-6B-BLK-100X115	TUBE, NYLON	3250-061	115 IN LONG
PFT-6B-BLK-100X119	TUBE, NYLON	3250-061	119 IN LONG
PFT-6B-BLK-100X120	TUBE, NYLON	3250-061	120 IN LONG
PFT-6B-BLK-100X130	TUBE, NYLON	3250-061	130 IN LONG
PFT-6B-BLK-100X149	TUBE, NYLON	3250-061	149 IN LONG
PFT-6B-BLK-100X150	TUBE, NYLON	3250-061	150 IN LONG
PFT-6B-BLK-100X159	TUBE, NYLON	3250-061	159 IN LONG
PFT-8B-BLK-100X1	TUBE, NYLON	C608-100BLK	15 IN LONG
PFT-8B-BLK-100X7	TUBE, NYLON	C608-100BLK	7 IN LONG
PFT-8B-BLK-100X36	HOSE, NONME.	C608-100BLK	36 IN LONG
PFT-8B-BLK-100X50	TUBE, NYLON	C608-100BLK	50 IN LONG
PFT-8B-BLK-100X60	TUBE, NYLON	C608-100BLK	60 IN LONG
PFT-8B-BLK-100X78	TUBE, NYLON	C608-100BLK	78 IN LONG
PFT-8B-BLK-100X100	TUBE, NYLON	C608-100BLK	100 IN LONG
PFT-8B-BLK-100X115	TUBE, NYLON	C608-100BLK	115 IN LONG
PFT-8B-BLK-100X121	TUBE, NYLON	C608-100BLK	121 IN LONG
PFT-8B-BLK-100X130	TUBE, NYLON	C608-100BLK	130 IN LONG
PFT-8B-BLK-100X140	TUBE, NYLON	C608-100BLK	140 IN LONG
P52-6738	COUPLING ASSEMBLY	24032	CUT TO FIT
04-9323-013	PIPE, FLEX	R342S5 25	13 IN LONG
05-09562-005	HOSE, NEOPRENE	24244	5 IN LONG
05-09562-006	HOSE, STRAIGHT	24240	6 IN LONG

Table 2. Manufactured Items - Continued.

PART NUMBER	NAME	MANUFACTURED FROM	DESCRIPTION
05-09564-008	HOSE, NEOPRENE	24248	8 IN LONG
05-12538-036	HOSE, STRAIGHT	4230-0174	36 IN LONG
05-12539-043	HOSE, RUBBER	28430	43 IN LONG
05-15224-004	LINER, PLYWOOD	24228	4 IN LONG
06-18131-000	TUBE, NYLON	CS122-56 GRADE CD INTERIOR TYPE	7X7.5 IN
12-13366-040	TUBE, NYLON	PFT-4A BLACKX1300	40 IN LONG
12-13367-045	TUBE, NYLON	3250-061	45 IN LONG
12-13367-060	TUBE, NYLON	PFT-4A BLACKX1300	60 IN LONG
12-13367-105	TUBE, NYLON	3250-061	105 IN LONG
12-13367-142	TUBE, NYLON	PFT-4A BLACKX1300	142 IN LONG
12-13367-200	TUBE, NYLON	PFT-4A BLACKX1300	200 IN LONG
12-13370-037	TUBE, NYLON	PFT-4A BLACKX1300	37 IN LONG
12-13371-037	TUBE, NYLON	PFT-4A BLACKX1300	37 IN LONG
12-13374-006	TUBE, NYLON	3250-061	6 IN LONG
12-13472-019	TUBE, NYLON	PFT-4A BLACKX1300	19 IN LONG
12-13473-040	TUBE, NYLON	PFT-4A BLACKX1300	40 IN LONG
18-11197-001X10	TRIM, EDGING	48-02188-001	10 FT LONG
22-21952-004	HOSE	4230-0002	4 IN LONG
22-21952-018	HOSE	4230-0002	18 IN LONG
22-21952-020	HOSE	4230-0002	20 IN LONG
22-21952-048	HOSE	4230-0002	48 IN LONG
22-21952-052	HOSE	4230-0002	52 IN LONG
22-21952-063	HOSE, HEATER	4230-0002	63 IN LONG
22-28607-018	HOSE, HEATER	350357	18 IN LONG
22-28607-061	HOSE, RUBBER	MS521301A203R	6 IN LONG
22-30167-030	HOSE, HEATER	4230NX-5/8	30 IN LONG
22-30168-003	HOSE, HEATER	4230NX-3/4	3 FT LONG
22-30168-034	HOSE, HEATER	4230NX-3/4	34 IN LONG
22-35191-010	SEAL	48-02412-525	CUT TO FIT
22-35281-016	HOSE, RUBBER	35055	16 IN LONG
22-35281-030	HOSE, RUBBER	35055	30 IN LONG
22-35282-025	HOSE, RUBBER	35056	25 IN LONG

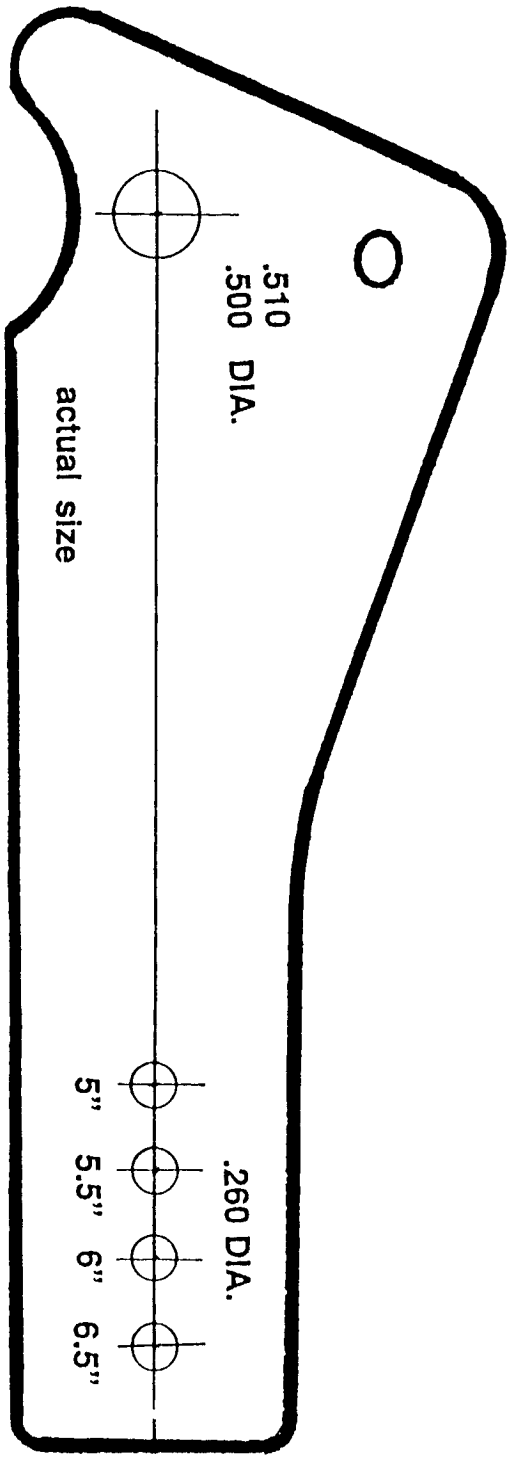
Table 2. Manufactured Items - Continued.

PART NUMBER	NAME	MANUFACTURED FROM	DESCRIPTION
22-35282-090	HOSE, RUBBER	35056	90 IN LONG
22-35282-135	HOSE, RUBBER	35056	135 IN LONG
23323FX-48	HOSE, NONMETALLIC	3250-061	48 IN LONG
350359X0.3	HOSE, COOLANT	4230-0174	0.3 FT LONG
350359X1.8	HOSE, COOLANT	4230-0174	1.8 FT LONG
350359X3.5	HOSE, COOLANT	4230-0174	3.5 FT LONG
350359X3.8	HOSE, COOLANT	4230-0174	3.8 FT LONG
4246-0410X5	TUBING, NYLON	PFT-4A BLACKX1300	5 FT LONG
47336AX	HOSE, NONMETALLIC	FC350-06	12 IN LONG
47338AX	HOSE, NONMETALLIC	FC350-10	19 IN LONG
48-00050-206X6	TAPE, FOAM	V532X 3/4 INX200FT	6 FT LONG
48-00081-038X24	HOSE	28430	24 IN LONG
48-00099-150X3	HOSE	24224	3 IN LONG
48-00100-010X5	TUBING, NYLON	PFT-4A BLACKX1300	5 FT LONG
48-00100-010X10	TUBING, NYLON	PFT-4A BLACKX1300	10 FT LONG
48-00100-010X15	TUBING, NYLON	PFT-4A BLACKX1300	15 FT LONG
48-00100-812X15	TUBING, NYLON	C602	15 IN LONG
48-00100-812X18	TUBING, NYLON	C602	18 IN LONG
48-00100-814X16	TUBING, NYLON	C602	16 IN LONG
48-00100-815X15	TUBING, NYLON	C602	15 IN LONG
48-00100-816X6	TUBING, NYLON	C602	6 IN LONG
48-00100-816X18	TUBING, NYLON	C602	18 IN LONG
48-00100-816X48	TUBING, NYLON	C602	48 IN LONG
48-00100-829X12	TUBING, NYLON	C602	12 IN LONG
48-00100-829X36	TUBING, NONMETALLIC	4246-02277	36 IN LONG
48-00100-829X56	TUBING, NYLON	C602	56 IN LONG
48-00101-010X7	TUBE, NYLON	3250-061	7 FT LONG
48-00101-010X48	HOSE	PFT-6B-BLK-100	48 IN LONG
48-00101-010X72	HOSE	PFT-6B-BLK-100	72 IN LONG
48-00101-010X96	HOSE	PFT-6B-BLK-100	96 IN LONG
48-00101-010X144	HOSE	PFT-6B-BLK-100	144 IN LONG
48-00101-010X180	HOSE	PFT-6B-BLK-100	180 IN LONG

Table 2. Manufactured Items - Continued.

PART NUMBER	NAME	MANUFACTURED FROM	DESCRIPTION
48-00101-010X264	HOSE	PFT-6B-BLK-100	264 IN LONG
48-00101-020X24	HOSE, NONMETALLIC	C608-100BLK	24 IN LONG
48-00101-020X48	HOSE, NONMETALLIC	C608-100BLK	48 IN LONG
48-00101-020X96	NOSE, NONMETALLIC	C608-100BLK	96 IN LONG
48-00101-020X120	HOSE, NONMETALLIC	C608-100BLK	120 IN LONG
48-00101-022X1	TUBE, NYLON	48-00101-022	1 FT LONG
48-00101-030X10	TUBE, NYLON	3250-1010	10 FT LONG
48-00101-030X108	HOSE, NONMETALLIC	3250-1010	108 IN LONG
48-00121-016X30	HOSE	48-00121-016	30 IN LONG
48-00121-016X53	HOSE	48-00121-016	53. IN LONG
48-02014-008X48	HOSE	4251-0125	48 FT LONG
48-02015-012X24	HOSE, RUBBER	881-12	24 IN LONG
48-02217-025X5	CONDUIT, NONMETALLIC	64498R	5 FT LONG
48-02217-025X36	TUBING, NONMETALLIC	64498R	36 IN LONG
48-02217-050X3	CONDUIT	68237R	3 FT LONG
48-02217-050X8	CONDUIT	68237R	8 IN LONG
48-02217-062X3	CONDUIT	68237R	3 FT LONG
48-02217-062X105	CONDUIT	48-02218-050	105 IN LONG
48-02217-075X57.08	CONDUIT	68240R	57.08 IN LONG
48-02218-050X105	CONDUIT	48-02218-050	105 IN LONG
48-02218-075X12	CONDUIT	48-02218-075	12 IN LONG
48-02454-106X27	TAPE, FOAM	4516 5/8 in	27 IN LONG
48-02454-206X12	TAPE, URETH FOAM	V4062	12 FT LONG
48-02471-001X8	SEAL, DOOR	48-02471-001	8 FT LONG
48-02471-001X55	SEAL	48-02471-001	5.5 FT LONG
5156170	HOSE	MS521301A206R	2.5 IN LONG
68240R-276	CONDUIT	68240R	276 IN LONG
77620-7.5	HOSE	77551	7.5 IN LONG

Table 2. Manufactured Items - Continued.

PART NUMBER	NAME	MANUFACTURED FROM	DESCRIPTION
	AUTOMATIC SLACK ADJUSTER INSTALLATION TEMPLATE		

TORQUE LIMITS **0231 00**

SCOPE

This work package lists standard torque values and provides general information for applying torque. Special torque values and tightening sequences are indicated in the maintenance procedures for applicable components.

GENERAL

1. Always use torque values listed in Table 1 when a maintenance procedure does not give a specific torque value.

2. Unless otherwise indicated, standard torque tolerance shall be ±10%.

3. Torque values listed are based on clean, dry threads. Reduce torque by 10% when engine oil is used as a lubricant. Reduce torque by 20% if new plated cap screws are used.

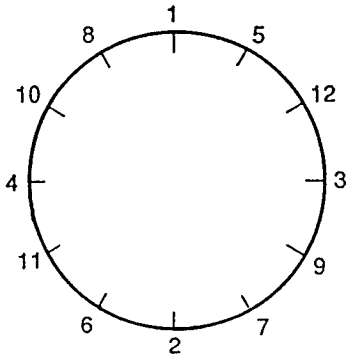
4. Cap screws threaded into aluminum may require reductions in torque of 30% or more of Grade 5 cap screw torque. Cap crew threaded into aluminum must also attain two cap screw diameters of thread engagement.

5. If the maintenance procedures do not specify a tightening order, use the following guides:

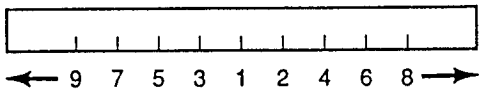
   a. Unless otherwise specified, lubricate threads of fasteners with oil (OE/HDO-10 or OEA).

   b. When tightening fasteners above 30 lb-ft (41 Nm), use the torque pattern but only tighten to 70 percent of final value (multiply final value by 0.7). Repeat pattern until final value is reached.

   c. Tighten circular patterns using circular torque pattern. Tighten straight patterns using straight torque pattern.



CIRCULAR TORQUE PATTERN

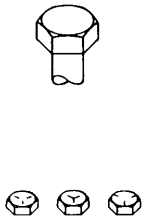
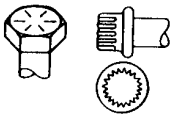


STRAIGHT TORQUE PATTERN

CAUTION

If replacement cap screws are of higher grade than originally supplied, use torque specifications for the original. This will prevent equipment damage due to overtorquing.

Table 1. Torque Limits.

CURRENT USAGE	MUCH USED	MUCH USED	USED AT TIMES	USED AT TIMES
QUALITY OF MATERIAL	INDETERMINATE	MINIMUM COMMERCIAL	MEDIUM COMMERCIAL	BEST COMMERCIAL
SAE Grade Number	1 or 2	5	6 or 7	8
Cap Screw Head Markings Manufacturer's marks may vary These are all SAE Grade 5 (3 line)				
CAP SCREW BODY SIZE INCHES - THREAD	TORQUE LB-FT (NM)	TORQUE LB-FT (NM)	TORQUE LB-FT (NM)	TORQUE LB-FT (NM)
1/4 20 28	5 (7) 6 (8)	8 (11) 10 (14)	10 (14)	12 (16) 14 (19)
5/16 18 24	11 (15) 13 (18)	17 (23) 19 (26)	19 (26)	24 (33) 27 (37)
3/8 16 24	18 (24) 20 (27)	31 (42) 35 (47)	34 (46)	44 (60) 49 (66)
7/16 14 20	28 (38) 30 (41)	49 (66) 55 (75)	55 (75)	70 (95) 78 (106)
1/2 13 20	39 (53) 41 (56)	75 (102) 85 (115)	85 (115)	105 (142) 120 (163)
9/16 12 18	51 (69) 55 (75)	110 (149) 120 (163)	120 (163)	155 (210) 170 (231)
5/8 11 18	83 (113) 95 (129)	150 (203) 170 (231)	167 (226)	210 (285) 240 (325)
3/4 10 16	105 (142) 115 (156)	270 (366) 295 (400)	280 (380)	375 (508) 420 (569)
7/8 9 14	160 (217) 175 (237)	395 (536) 435 (590)	440 (597)	605 (820) 675 (915)
1 8 14	235 (319) 250 (339)	590 (800) 660 (895)	660 (895)	910 (1234) 990 (1342)

CHAPTER 4
SUPPORTING INFORMATION

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REFERENCES 0232 00

SCOPE

This work package lists all forms, field manuals, technical bulletins, technical manuals, and other publications referenced in this manual and which apply to Unit Maintenance of the M915A3 Line Haul Tractor Truck.

PUBLICATIONS INDEXES

The following indexes should be consulted frequently for latest changes or revisions and for new publications relating to material covered in this technical manual.

Consolidated Index of Army Publications and Blank Forms . . . . . DA Pam 25-30

Functional User's Manual for the Army Maintenance Management System . . . . . DA Pam 738-750

U.S. Army Equipment Index of Modification Work Orders. . . . . DA Pam 750-10

FORMS

Refer to DA Pam 738-750, *The Army Maintenance Management System (TAMMS)*, for instructions on the use of maintenance forms.

Equipment Inspection and Maintenance Worksheet . . . . . DA Form 2404

Equipment Log Assembly (Records) . . . . . DA Form 2408

Maintenance Request Form. . . . . DA Form 2407

Preventive Maintenance Schedule and Record . . . . . DD Form 314

Processing and Deprocessing Record for Shipment, Storage and Issue of Vehicles and Spare Engines . . . . . DD Form 1397

Product Quality Deficiency Report . . . . . SF Form 368

Recommended Changes to Equipment Technical Publications . . . . . DA Form 2028-2

Recommended Changes to Publications and Blank Forms. . . . . DA Form 2028

Report of Discrepancy (ROD). . . . . SF Form 364

FIELD MANUALS

Camouflage . . . . . FM 5-20

Operation and Maintenance of Ordnance Material in Extreme Cold Weather (0°F to -65°F) . . . . . FM 9-207

TECHNICAL BULLETINS AND SUPPLY BULLETINS

Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment, and Materials Handling Equipment . . . . . TB 43-0209

Corrosion Prevention and Control Including Rustproofing Procedures for Tactical Vehicles and Trailers . . . . . TB 43-0213

Solder and Soldering . . . . . TB SIG 222

Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems. . . . . TB 750-651

Warranty Bulletin for M915A3 Truck Tractor . . . . . TB 9-2320-302-15

REFERENCES - CONTINUED **0232 00**

TECHNICAL MANUALS

Administrative Storage of Equipment . . . . . TM 740-90-1
Cooling Systems: Tactical Vehicles . . . . . TM 750-254
Inspection, Care, and Maintenance of Antifriction Bearings . . . . . TM 9-214
Materials Used for Cleaning, Preserving, Abrading and Cementing Ordnance Materiel and Related Materials, Including Chemicals . . . . . TM 9-247
Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tool List for Decontaminating Apparatus, Portable . . . . . TM 3-4230-214-12&P
Operator's, Unit, Direct Support and General Maintenance Manual for Care, Maintenance, Repair and Inspection of Pneumatic Tires and Inner Tubes . . . . . TM 9-2610-200-14
Operator's, Organizational, Direct Support, and General Support Maintenance Manual for Lead-acid Storage Batteries . . . . . TM 9-6140-200-14
Operator's Manual for M915A3 Tractor Truck . . . . . TM 9-2320-302-10
Operator's Manual for Welding Theory and Application . . . . . TM 9-237
Painting Instruction for Field Use . . . . . TM 43-0139
Preservation, Packaging, and Packing of Military Supplies and Equipment . . . . . TM 38-230-1 & TM 38-230-2
Procedures for Destruction of Tank-automotive Equipment to Prevent Enemy Use . . . . . TM 750-244-6
Repair Parts and Special Tools Lists for M915A3 Tractor Truck . . . . . TM 9-2320-302-24P
Use of Antifreeze Solutions, Antifreeze Extender, Cleaning Compounds, and Test Kit in Engine Cooling Systems . . . . . TM 750-651

OTHER PUBLICATIONS

Abbreviations for Use on Drawings and in Specifications, Standards, and Technical Documents MIL-STD-12D
Army Medical Department Expendable/Durable Items . . . . . CTA 8-100
Expendable/Durable Items (Except Medical, Class V Repair Parts, and Heraldic Items . . . . . CTA 50-970
Fuels and Lubricants Standardization Policy for Equipment Design, Operation, and Logistic Support . . . . . AR 70-12
Vehicle, Wheeled, Preparation for Shipment and Limited Storage of MIL-V-62038D

MAINTENANCE ALLOCATION CHART (MAC) INTRODUCTION 0233 00

THE ARMY MAINTENANCE SYSTEM MAC

1. This introduction provides a general explanation of all maintenance and repair functions authorized at the various maintenance levels under the standard Army Maintenance System concept.

2. The MAC immediately following the introduction designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component shall be consistent with the capacities and capabilities of the designated maintenance levels, which are shown in the MAC (WP 0234 00) in column (4) as:

   Unit - includes two subcolumns, C (Operator/Crew) and O (Unit) Maintenance

   Direct Support - includes an F subcolumn

   General Support - includes an H subcolumn

   Depot - includes a D subcolumn

3. The tools and test equipment requirements (immediately following the MAC) list the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from the MAC.

4. The remarks (immediately following the tools and test equipment requirements) contain supplemental instructions and explanatory notes for a particular maintenance function.

MAINTENANCE FUNCTIONS

Maintenance functions are limited to and defined as follows:

1. **Inspect.** To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

2. **Test.** To verify serviceability by measuring the mechanical, pneumatic, hydraulic or electrical characteristics of an item and comparing those characteristics with prescribed standards on a scheduled basis, i.e., load testing of lift devices and hydrostatic testing of pressure hoses.

3. **Service.** Operations required periodically to keep an item in proper operating condition; e.g., to clean (includes decontaminate, when required), to preserve, to drain, to paint or to replenish fuel, lubricants, chemical fluids or gases.

4. **Adjust.** To maintain or regulate, within prescribed limits, by bringing into proper position, or by setting the operating characteristics to specified parameters.

5. **Align.** To adjust specified variable elements of an item to bring about optimum or desired performance.

6. **Calibrate.** To determine and cause corrections to be made or to be adjusted on instruments of test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

7. **Remove/Install.** To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating or fixing into position a spare, repair part or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

8. **Replace.** To remove an unserviceable item and install a serviceable counterpart in its place. “Replace” is authorized by the MAC and its assigned maintenance level is shown as the third position code of the Source, Maintenance and Recoverability (SMR) code.

9. **Repair.** The application of maintenance services, including fault location/troubleshooting, removal/installation, disassembly/assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction or failure in a part, subassembly, module (component or assembly), end item or system.

MAINTENANCE FUNCTIONS - CONTINUED

NOTE

The following definitions are applicable to the "repair" maintenance function:

- Services - Inspect, test, service, adjust, align, calibrate, and/or replace.
- Fault location/troubleshooting - The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or Unit Under Test (UUT).
- Disassembly/assembly - The step-by-step breakdown (taking apart) of a spare/functional group coded item to the level of its least component, that is assigned an SMR code for the level of maintenance under consideration (i.e., identified as maintenance significant).
- Actions - Welding, grinding, riveting, straightening, facing, machining, and/or resurfacing.

10. **Overhaul.** That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

11. **Rebuild.** Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

EXPLANATION OF COLUMNS IN THE MAC, TABLE 1

1. **Column (1) - Group Number.** Column (1) lists FGC numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the Next Higher Assembly (NHA).

2. **Column (2) - Component/Assembly.** Column (2) contains the item names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

3. **Column (3) - Maintenance Function.** Column (3) lists the functions to be performed on the item listed in Column (2). (For a detailed explanation of these functions refer to "Maintenance Functions" outlined above).

4. **Column (4) - Maintenance Level.** Column (4) specifies each level of maintenance authorized to perform each function listed in column (3), by indicating work time required (expressed as manhours in whole hours or decimals) in the appropriate subcolumn. This work time figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number or complexity of the tasks within the listed maintenance function varies at different maintenance levels, appropriate work time figures are to be shown for each level. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the MAC. The symbol designations for the various maintenance levels are as follows:

C . . . . . Operator or Crew Maintenance
O . . . . . Unit Maintenance
F . . . . . Direct Support Maintenance
L . . . . . Specialized Repair Activity (SRA)
H . . . . . General Support Maintenance
D . . . . . Depot Maintenance

EXPLANATION OF COLUMNS IN THE MAC, TABLE 1 - CONTINUED

NOTE

The "L" maintenance level is not included in column (4) of the MAC. Functions to this level of maintenance are identified by a work time figure in the "H" column of column (4), and an associated reference code is used in the REMARKS CODE column (6). This code is keyed to the remarks and the SRA complete repair application is explained there.

5. **Column (5) - Tools and Equipment Reference Code.** Column (5) specifies, by code, those common tool sets (not individual tools), common Test, Measurement and Diagnostic Equipment (TMDE), and special tools, special TMDE, and special support equipment required to perform the designated function. Codes are keyed to the entries in the tools and test equipment table.
6. **Column (6) - Remarks Code.** When applicable, this column contains a letter code, in alphabetical order, which is keyed to the remarks table entries (Table 3).

EXPLANATION OF COLUMNS IN THE TOOLS AND TEST EQUIPMENT REQUIREMENTS, TABLE 2

1. **Column (1) - Tool or Test Equipment Reference Code.** The tool and test equipment reference code correlates with a code used in column (5) of the MAC.
2. **Column (2) - Maintenance Level.** The lowest level of maintenance authorized to use the tool or test equipment.
3. **Column (3) - Nomenclature.** Name or identification of the tool or test equipment.
4. **Column (4) - National Stock Number (NSN).** The NSN of the tool or test equipment.
5. **Column (5) - Tool Number.** The manufacturer's part number, model number or type number.

EXPLANATION OF COLUMNS IN THE REMARKS, TABLE 3

1. **Column (1) - Remarks Code.** The code recorded in column (6) of the MAC.
2. **Column (2) - Remarks.** This column lists information pertinent to the maintenance function being performed as indicated in the MAC.

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Table 1. MAC for the M915A3 Tractor Truck.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
01	**ENGINE**								
0100	Engine Assembly	Inspect	0.3						
		Test		0.5	0.5			6,17,21,114	
		Service		2.0				102,120	
		Replace			17.0			100,100,120	
		Repair			18.0			100,120	
		Overhaul					30.0	100,101,120	
	Engine Mounts	Replace			0.8			100,120	
0101	Cylinder Head Assembly	Replace			4.0			23,48,50,100, 120	
		Repair				10.4		3,13,23,26,27, 28,50,67,69,87, 89,90,91,94,95, 101,120	
	Cylinder Block	Inspect				1.0		100	
		Test				1.0		1,100,111,112, 120	
		Replace				6.0		100,120	
		Repair				12.0		1,3,11,12,13,39, 50,69,80,83,100, 101,111,112,120	
0102	Vibration Damper	Replace			1.0			100,120	
	Crankshaft Assembly	Inspect				0.5		101	
		Replace				17.3		47,85,101,120	
	Main Seals	Replace			1.0			45,88,100,120	
0103	Flywheel Housing	Replace				1.0		9,100,120	
0104	Rod, Piston and Pin	Inspect				0.5		101	
		Replace				18.0		25,31,34,35, 78,82,101,120	
0105	Rocker Arm Assemblies	Inspect			0.4			100,120	
		Replace			2.8			32,54,72,75,79, 100,107,120	
	Rocker Arm Cover Housing	Replace			0.5			100,120	
	Camshaft Assembly	Inspect			0.4			100	
		Replace			3.0			74,77,100,107, 120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
	Camshaft Drive Gear	Inspect			0.2				
		Replace			1.0			44,100,120	
0106	Oil Pan	Replace			0.8			100,120	
		Repair			1.0			100,120	
	Oil Filter	Replace		0.8				102	
	Oil Filter Adapter	Replace		1.5				102,120	
	Oil Cooler Core	Replace		3.0				102,120	
	Oil Pump Assembly	Replace			1.0			100,120	
		Repair				3.0		100,120	
	Regulator Valve Assembly	Replace			0.5			100,120	
0108	Exhaust Manifold	Replace			1.4			36,100,120	
	Intake Manifold	Replace			1.0			36,100,120	
0109	Bull/Idler Gears	Replace				1.5		7,9,10,76,81, 100,120	
	Accessory Drive	Replace			1.0			22,97,100,120	
0112	Engine Retarder Assembly	Test			0.8			21,114	
		Adjust			0.5			100,120	
		Replace			0.5			100,120	
		Repair			4.3			100,120	
0125	Gear Case and Front Cover	Replace			1.8			36,81,100, 120	
03	**FUEL SYSTEM**								
0301	Fuel Injector Assembly	Replace			2.0			100,120	
		Repair			1.8			100,120	
0302	Fuel Pump	Replace			0.5			120	
	Hose Assembly	Replace		1.0				120	
0304	Air Cleaner Assembly	Replace		0.3				120	
	Air Intake Assembly	Replace		0.2				120	
0305	Turbocharger	Replace			0.8			5,99,100,120	
		Repair				3.0		100,120	
0306	Fuel Tank	Inspect		0.1					
		Replace		2.0				102,120	
0309	Fuel Filter Elements	Service	0.1						
		Replace		0.3				102	
0311	Ether Starting Aid	Replace		1.0				120	
		Repair		0.5				120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
0312	Electronic Throttle Assembly	Replace		0.3				120	
04	**EXHAUST SYSTEM**								
0401	Muffler	Inspect		0.1					
		Replace		0.5				120	
	Exhaust Pipe	Inspect		0.1					
		Replace		1.3				120	
05	**COOLING SYSTEM**								
0501	Radiator Assembly	Service		0.3				102	A
		Replace		0.7				102,120	
		Repair			0.5			101	
0502	Fan Shroud	Replace		1.0				120	
0503	Thermostat Housing	Replace		0.5				120	
		Repair		0.5				39,61,120	
0504	Water Pump	Replace		3.0				42,102,120	
		Repair			1.5			98,113,120	
0505	Fan Drive Support	Replace			0.6			100,120	
	Fan Clutch and Drive	Replace		2.0				120	
		Repair			1.5			100,120	
	Fan Clutch Solenoid	Replace		0.5				120	
	Fan Belt	Adjust		0.5				102,120	
		Replace		0.5				120	
	Spindle and Housing	Replace		1.5				100,120	
		Repair			3.0			120	
0508	Water Filter	Replace		0.3				102	
06	**ELECTRICAL SYSTEM**								
0601	Alternator	Test		0.3	0.5			21,101,103,114	
		Replace		0.3				120	
		Repair			2.0			101,119	
	Drive Belt	Adjust		0.5				102,120	
		Replace		0.5				120	
0602	Regulator	Replace		0.5				120	
	Dual Voltage Control Unit	Test		0.3				102	
		Replace		0.3				120	
0603	Starter	Replace		1.5				120	
		Repair			2.0			101,119	
0605	Engine Electronic Control Unit (ECU)	Test		0.3				21,114	
		Replace		0.3				120	B

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
	Engine Wiring Harness	Test		0.2				103	
		Replace			1.0			120	
		Repair		0.3				103,120	
0607	Instrument Panel Switches	Replace		0.3				120	
0608	Fuse, Relay and Circuit Breaker	Replace		0.1				120	
0609	Headlight	Adjust		0.3				120	
		Repair		0.2				120	
	Taillight	Replace		0.2				120	
		Repair		0.2				120	
	Blackout Lights	Replace		0.3				120	
		Repair		0.2				120	
	Side Marker Lights	Replace		0.3				120	
		Repair		0.2				120	
0610	Air Pressure Warning Sensors	Replace		0.5				120	
	ABS, Electronic Control Unit (ECU)	Test		0.3				4,18,114	
		Replace		0.3				120	B
	ABS Sensors	Replace		0.5				120	
	Engine Sensors	Replace		0.2				120	
0611	Electric Horn	Replace		0.2				120	
0612	Batteries	Test		0.2				103	C
		Replace		0.5				120	
0613	Chassis Harness	Test		0.2				103	
		Replace			2.0			120	
		Repair		0.3				103,120	
	Cab Harness	Test		0.2				103	
		Replace			2.0			120	
		Repair		0.3				103,120	
	ABS, Electrical Harnesses	Replace			1.0			120	
		Repair		0.3				103,120	
	Turn Signal Switch Assembly	Replace		0.3				120	
07	**TRANSMISSION**								
	Shift Selector	Replace		0.3				120	
	Electronic Control Unit	Replace		0.5				120	B
	Wiring Harness	Replace		0.5				120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
	Sensors	Replace		0.3				120	
	Control Module	Replace				1.0		120	
		Repair				1.0		100,120	
0708	Torque Converter	Replace				0.5		73,120	
		Repair				1.0		33,65,100,117, 120	
0710	Fill/Check Tube	Replace		0.3				120	
	Yoke	Replace			0.3			120	
	Transmission	Service		1.0				102,120	
	Assembly	Test		0.3	0.5			20,114	
		Replace			8.0			10,14,15,100, 120	
		Repair				10.0		14,15,63,84,100, 120	
	Torque Converter Housing	Replace				0.5		100,120	
	Flex Plate and Ring Gear	Replace			8.0			75,100,120	
	Front Support and Oil Pump Module	Replace				0.5		24,53,55,56, 57,59,62,100, 120	
		Repair				0.5		24,53,55,56, 57,59,62,100, 120	
	Rear Cover Module	Replace				0.5		57,66,84,92,100, 118,120,122	
		Repair				0.5		57,66,84,92,100, 118,120,122	
	Main Shaft Module	Replace				0.5		100,120	
0713	Rotating Clutch Module	Replace				0.5		29,30,49,60,66, 100,118,120	
		Repair				0.5		29,30,49,60,66, 100,118,120	
	C3/C4 and Main Bearing Module	Replace				0.5		68,100,120	
		Repair				0.5		68,100,120	
	P1/P2 Planetary Module	Replace				0.5		59,66,100,120	
		Repair				0.5		59,66,100,120	
	Control Valve	Replace				0.5		93,100,103,120, 123	
		Repair				0.5		93,100,103,120, 123	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
0721	Oil Cooler and Hoses	Replace		0.5				103,120	
09	**DRIVELINES**								
0900	Propeller Shafts	Inspect		0.2					
		Service		0.2				102	
		Replace		1.9				103,120	
		Repair		1.0				103,120	
10	**FRONT AXLE**								
1000	Axle Assembly	Inspect	0.3						
		Service		0.1				102,120	
		Aline		1.0				102,120	
		Replace			4.5			100,120	
		Repair			4.0			100,120	
1004	Tie Rod Knuckle	Replace			0.8			120	
		Repair			1.0			102,120	
11	**REAR AXLE**								
1100	Forward-rear Axle	Inspect	0.1						
		Service		0.2				102,106,120	
		Replace			4.5			100,120	
		Repair			8.0			102,120	
	Rear-rear Axle	Inspect	0.1						
		Service		0.2				102,106,120	
		Replace			3.0			100,120	
		Repair			8.0			101,120	
1102	Differential	Replace			1.0			101,120	
		Repair				10.5		41,96,101,120	
	Output Shaft Assembly	Replace			0.1			101,120	
12	**BRAKES**								
1202	Hanging Brake Assembly	Replace		1.0				120	
		Repair		0.3				120	
	Front Brakes	Inspect		0.7					
		Service		0.1				120	
		Adjust		0.5				120	
		Replace		2.0				102,120	
	Rear Brakes	Inspect		0.7					
		Service		0.1				120	
		Adjust		0.5				120	
		Replace		2.0				102,120	
	Brake, Slack Adjusters	Adjust		0.3				120	
		Replace		0.3				120	
1208	Front Chamber Assembly	Inspect		0.2					
		Replace		1.3				120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
	Rear Chamber	Inspect		0.2					
	Assembly	Replace		1.3				120	
	Air Dryer	Service		0.5				120	
		Replace		0.5				120	
		Repair		0.8				100,120	
	Foot Valve	Replace		0.2				120	
		Repair			1.0			100,120	
	Air Valves	Replace		0.3				120	
	Air Reservoir	Replace		0.3				120	
	ABS Solenoid Valve	Replace		0.8				120	
1209	Air Compressor	Replace		1.0				103,120	
		Repair			4.0			46,101,120	
13	**WHEELS**								
1311	Front Hub and Drum	Replace		0.5				102,120	
	Assemblies	Repair		0.1				42,101,120	
	Wheel Assembly	Inspect	0.1	0.5					
		Replace		0.4				102,120	
	Rear Hub and Drum	Replace		0.5				102,120	
		Repair			1.0			42,101,120	
	ABS Tone Ring	Replace		0.5				51,120	
1313	Tires	Replace		0.1				102,120	
		Repair			0.5			102	D
14	**STEERING**								
1401	Steering Wheel	Replace		1.0				102,120	
	Tilt Steering Column	Replace			1.0			120	
	Steering Universal Joint	Replace		3.0				120	
	and Shaft	Repair		1.0				120	
1407	Steering Gear	Replace			0.5			100,120	
		Repair			2.5			8,38,43,52,58, 101,108,120	
1410	Power Steering Pump	Test			0.3			116,120	
		Replace			0.7			100,120	
		Repair			1.5			100,120	
1411	Power Steering Hoses	Inspect		0.1					
		Replace		0.5				120	
1413	Reservoir Assembly and	Replace		1.0				120	
	Bracket	Repair		1.0				103,120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REF CODE	(6) REMARKS CODE
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
15	**FRAME ASSEMBLY**								
1501	Frame Components	Inspect	0.5	0.5					
		Replace			2.1			101,120	
	Ramp Assembly	Inspect	0.1						
		Replace			0.3			101,120	
1503	Pintle Hook	Inspect	0.1	0.2					
		Service		0.1				102	
		Replace		0.5				120	
		Repair		0.5				120	
1504	Spare Tire Carrier	Replace		1.0				120	
		Repair		0.5				120	
1506	Fifth Wheel Assembly	Inspect	0.3						
		Service		0.3				102	
		Adjust		1.0				115,120	
		Replace			2.0			100,120	
		Repair			1.0			100,120	
	Wear Plate	Replace			1.0			100,120	
		Repair			0.8			100,120	
	Slider Bracket	Replace			0.5			100,120	
		Repair			1.3			100,104,120	
16	**SUSPENSION**								
1601	Front Suspension	Inspect		0.1					
		Service		0.1				102	
		Replace			1.5			100,120	
		Repair			1.0			100,120	
	Shackle/Bracket Assembly	Replace			0.5			100,120	
	Front Spring Assembly	Replace			2.0			100,120	
	Shock Absorbers	Replace		0.5				120	
	Rear Suspension	Inspect		0.1					
		Replace			6.0			100,120	
		Repair			12.0			100,120	
	Spring Pack	Replace			1.0			100,120	
	Shock Absorbers	Replace		0.5				120	
1605	Torque Rods	Replace			1.0			100,120	
18	**CAB**								
1801	Cab Assembly	Inspect	0.1						
		Replace				4.0		105,120	
		Repair				3.0		101,120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
	Doors	Replace			0.4			120	
		Repair			0.7			120	
	Hood	Adjust		0.3				120	
		Replace		0.5				103,120	
		Repair			2.0			100,120	
1802	Windshield and Windows	Replace			1.5			100,120	
	Quarter Fender Assembly	Replace		0.4				120	
1805	Floor Covers	Replace		1.0				120	
1806	Seat Belt Assembly	Inspect	0.2						
		Replace		0.5				120	
	Seat Assembly	Inspect	0.1	0.2					
		Replace		0.5				120	
		Repair		2.0				100,120	
1808	Storage Boxes	Replace		0.5				120	
		Repair		0.5				120	
22	**ACCESSORY ITEMS**								
2202	Heater Hoses	Replace		1.5				120	
	Mirrors	Replace		0.3				120	
	Windshield Washer and Motor	Replace		1.2				120	
	Vehicle Heater/Air Conditioner	Test		0.3				70	
		Replace			2.0			86,120	
		Repair			1.0			100,120	
	Heater/Air Conditioner Controls	Replace		0.2				120	
2210	Data Plates	Replace		0.2				120	
33	**SPECIAL PURPOSE KITS**								
3303	Arctic Personnel and Engine Heater Kit	Install		2.0				103,120	
		Replace		1.0				103,120	
		Repair		2.0				103,120	
34	**ARMAMENT MATERIAL**								
3401	Rifle Mounting Kit	Replace		0.5				120	

Table 1. MAC for the M915A3 Tractor Truck - Continued.

(1)	(2)	(3)	(4) MAINTENANCE LEVEL					(5)	(6)
			UNIT		DS	GS	DEPOT	TOOLS AND EQUIPMENT	
GROUP NUMBER	COMPONENT/ ASSEMBLY	MAINTENANCE FUNCTION	C	O	F	H	D	REF CODE	REMARKS CODE
42	**ELECTRICAL EQUIPMENT**								
4209	Beacon Warning Light Kit	Install	0.1						
		Replace		0.2				120	
52	**REFRIGERATION, AIR CONDITIONER/ HEATER, AND AIR CONDITIONING COMPONENTS**								
5200	Air Conditioning System	Inspect	0.1	0.3				70	
		Service			1.5			86	
	Compressor	Replace			1.0			86,120	
5201	Compressor Clutch	Replace		0.8				40,120	
	Belt	Adjust		0.2				103,120	
		Replace		1.0				120	
5217	Valves and Lines	Replace		0.5				86,120	
5230	Condenser	Replace		1.0				86,120	
	Receiver-drier	Replace		1.0				86,120	
68	**WARNING, SCANNING, AND SIGNAL DEVICES, AND NAVIGATIONAL INSTRUMENTS**								
6809	Collision Warning System (CWS)	Inspect	0.1						
		Test		0.3				19,114	
		Replace		0.3				120	B
		Repair		0.3				120	
	Harness, Collision Warning System	Replace			1.0			120	
		Repair		0.3				103,120	
91	**CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) EQUIPMENT**								
9120	M13 Decontamination Mounting Kit	Replace		0.5				120	

Table 2. Tools and Test Equipment Requirements for the M915A3 Tractor Truck.

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER	(5) TOOL NUMBER
1	H	Adapter, Cylinder	4910-01-319-6971	J38768-A
2	O	Adapter, Electrical (part of tool number J38500-H)	5935-01-353-2532	J34812-1
3	H	Adapter, Motor, Hoist	3950-01-319-6973	J35635-A
4	O	Adapter, Test, ABS	4910-01-372-3128	446 300 3140
5	F	Adapter, Torque Wrench	5120-00-215-8200	11663358-2
6	F	Adapter Kit, Mechanical	4940-01-353-7038	J28593
7	F	Adjuster, Lash, Cam-I	5120-01-322-8885	J35596
8	F	Adjusting Tool, Worm	5120-01-371-7369	J37070
9	H	Alignment Stud Set		J43431
10	F	Barring Tool, Engine	5120-01-322-3498	J36237
11	H	Bolt, Eye	5306-01-294-3028	993-042
12	H	Bolt, Eye, Cylinder Block Lift Tool	5306-01-319-1987	J35595
13	H	Bracket, Engine Mounting	2510-01-320-8905	J35636
14	F	Bracket, Transmission Holding		J35926
15	F	Bracket, Transmission Holding		J41445
16	O	Cable Assembly, Special (part of tool number J38500-H)	6150-01-353-9708	J38500-2
17	O	Card, Software		J38500-2300D
18	O	Cartridge, ABS	4910-01-354-2767	J38500-404A
19	O	Cartridge, CWS	TBD	TBD
20	O	Cartridge, Test, Transmission	4940-01-367-6194	J38500-303
21	O	Cartridge, Test Set, DDEC III/ IV (part of tool number J38500-H)	4940-01-367-4657	J38500-1500C
22	F	Checker, Gear Lash	5120-01-353-2520	J38662
23	F	Clamp, Material Lift	3940-01-324-4713	J35641-A
24	H	Compressor, Main-Pressure Relief Spring		J41462
25	H	Compressor, Piston Ring	5120-01-353-8567	J35598-A
26	H	Compressor, Spring		J8062-3
27	H	Compressor, Spring	5120-01-353-2522	J24203-3
28	H	Compressor, Spring		J8062-1

Table 2. Tools and Test Equipment Requirements for the M915A3 Tractor Truck - Continued.

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER	(5) TOOL NUMBER
29	H	Compressor, Spring, C2 (use with J37030-3)		J37030-1
30	H	Compressor, Spring, C5 (use with J37030-3)		J37030-2
31	F	Driver, Bushing	5120-01-353-2521	PT 4365-1
32	F	Gage, Profile		J42749
33	H	Gage, Profile	5220-01-388-1460	J38548
34	H	Gage, Profile		J35884-A
35	H	Gage, Profile		J38689-A
36	F	Guide Stud Set	5120-01-322-3505	J36107
37	H	Guides, Connecting Rod		J43661
38	H	Handle, Drive	5120-00-677-2259	J8092
39	O	Handle, Installer	5120-00-977-5578	J7079-2
40	O	Holder, Clutch	5120-01-439-0305	99-499
41	F	Holding Bar, Pinion	5120-01-455-0436	J3453-1
42	O	Indicator, Dial	5210-00-402-9619	J7872
43	F	Inserter, Bearing	5120-01-354-2943	J37071-A
44	H	Inserter, Gear	5120-01-322-1132	J35949
45	F	Inserter, Seal	5120-01-322-1129	J35686-B
46	F	Inserter and Remover	5120-01-338-7182	J25447-B
47	H	Inserter and Remover	5120-01-322-2360	J35642
48	F	Inserter and Remover	5120-01-322-6222	J36310-A
49	H	Inserter and Remover, Spring	5120-01-388-5623	J35923-2
50	H	Inserter Set, Dowel	5120-01-322-3500	J36224
51	O	Installation Tool, ABS Tone Ring		107119
52	F	Installation Tool, Seal	5120-01-354-0468	J37073
53	H	Installer, Charging Pump Bushing		J39954
54	F	Installer, Cup Plug	5120-01-333-4744	J36326
55	H	Installer, Front Support Sleeve and PTO Bearing		J37041
56	H	Installer, Output Bearing		J37034
57	H	Installer, Output Bearing Cup (use with J37034)		J37033
58	F	Installer, Output Shaft	5120-01-054-4042	J-24202-1A

Table 2. Tools and Test Equipment Requirements for the M915A3 Tractor Truck - Continued.

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER	(5) TOOL NUMBER
59	H	Installer, P1 Carrier Bushing and Ground Sleeve Bearing, Pump Body Bushing, and Bearing Retainer Bushing		J37038
60	H	Installer, Rotating Clutch Bushing		J37040
61	O	Installer, Seal	5120-00-977-5579	J8550
62	F	Installer, Seal, Input		J37032
63	F	Installer, Seal, Output		J37031
64	H	Installer, Valve Stem Seal		J39109
65	H	Installer, Torque Converter Cover Bushing		J39949
66	H	Installer, Turbine Shaft Bushing/Output Bushing/P2 Carrier Bushing		J37036
67	H	Installer, Valve Guide	5120-01-322-3501	J33191-A
68	H	Installer, Wear Plate		J39534
69	H	Installer Set, Cup Plug	5120-01-322-2359	J35653
70	O	Leak Detector, Refrigerant	4940-01-387-0948	16500
71	O	Level, Digital		J38460-A
72	F	Lifter, Rocker Arm	5120-01-322-6116	J35996-A
73	F	Lifting, Bracket, Flywheel	5120-01-116-6049	J-24365
74	F	Pilot, Cam Gear	5120-01-322-3508	J35906
75	F	Pin, Shoulder, Headless	5315-01-333-2771	J36235
76	H	Plate, Indexing	3460-01-319-5533	J35651
77	F	Plate, Retaining	3040-01-319-0848	J35652-B
78	H	Pliers, Piston Ring	5120-01-142-2459	J22405-02
79	F	Pliers, Retaining Ring	5120-01-322-6888	J36347
80	H	Press, Cylinder Line	3449-01-319-5599	J35597-A
81	H	Protector, Crankshaft	2815-01-321-9248	J35994
82	H	Protector, Piston	5120-01-048-2156	J24210
83	H	Puller, Mechanical	5120-01-322-1128	J35791
84	F	Puller Kit, Universal	5180-01-048-2153	J24171-A
85	H	Pump, Hydraulic Ram	4320-01-320-4618	J35951-175
86	F	Reclaimer, Refrigerant, R134A	4250-01-396-8928	EEEAC304A

Table 2. Tools and Test Equipment Requirements for the M915A3 Tractor Truck - Continued.

(1) TOOL OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER	(5) TOOL NUMBER
87	H	Reconditioning Set	5120-01-322-3507	J33880
88	F	Remover, Seal	5120-01-322-1131	J35993
89	H	Remover, Valve Guide	5120-01-322-3506	J34696-B
90	H	Remover, Valve Seat	5120-00-494-1836	J23479-271
91	H	Remover, Valve Seat	5120-01-322-8883	J23479-460-A
92	H	Remover, Wheel Bearing Cup	5120-00-784-6482	J3940
93	H	Remover/Installer, Main Pressure Spring		J35924
94	H	Replacing Tool, Engine	5120-01-322-1133	J33190
95	H	Replacing Tool, Engine	5120-01-322-2955	J34983
96	H	Scale	4910-00-707-9178	J544-01
97	F	Service Kit, Accessory Drive	5120-01-322-3499	J36024
98	F	Service Kit, Water Pump	5120-01-322-6115	J35988-C
99	F	Shield, Turbo Protect	4910-01-127-7959	J26554-A
100	F	Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Basic, Less Power	4910-00-754-0707	SC 4910-95-A31
101	F	Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Wheeled Vehicles	4910-00-348-7696	SC 4910-95-A02
102	O	Shop Equipment, Automotive Maintenance and Repair: Organizational Maintenance, Common No. 1	4910-00-754-0654	SC 4910-95-A74
103	O	Shop Equipment, Automotive Maintenance and Repair: Organizational Maintenance, Common No. 2	4910-00-754-0650	SC 4910-95-A72
104	F	Slider, Spring Compression	4910-01-165-6015	TFTLN-2500
105	F	Sling, Beam Type	3940-01-353-8561	J-39520
106	O	Socket, Socket Wrench	5130-01-389-8450	BWD482
107	F	Socket, Socket Wrench	5120-01-322-1123	J36003-A
108	F	Spanner Attachment	5120-01-353-8490	J 37464
109	F	Spreader, Sling	3940-01-354-9446	38841

Table 2. Tools and Test Equipment Requirements for the M915A3 Tractor Truck - Continued.

(1) TOOLS OR TEST EQUIPMENT REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
110	H	Test Block, Pressure Switch		J33884
111	H	Tester, Cylinder	4910-01-320-4638	J29006-5
112	H	Tester, Cylinder	4910-01-319-6990	J36223-D
113	F	Tester, Impeller	5120-01-322-2358	J35687
114	O	Tester, Internal Combustion, DDEC Diagnostic Reader		J38500-H
115	O	Tester, Kingpin Lock	4910-01-157-3571	TFTLN-1000
116	F	Tester, Power Steering	4910-01-160-3618	J-26487-B
117	H	Tool, Torque Converter Bolt		J38564
118	H	Tool Base, Spring Compressor, C1, C2, and C5		J37030-3
119	F	Tool Kit, Automotive Fuel and Electrical System Repair	5180-00-754-0655	SC 5180-95-B08
120	O	Tool Kit, General Mechanic's: Automotive	5180-00-177-7033	SC 5180-95-N26
121	O	Tool Kit, Internal Combustion	5180-01-358-5231	J35888-60
122	H	Tool Set, Spanner Nut Torque		J37035
123	H	Tray Set, Valve Body Parts		J33163
124	O	Wiring Harness	6150-01-354-2604	J35751
125	O	Wrench, Box	5120-01-322-1124	J35948

Table 3. Remarks for the M915A3 Tractor Truck.

(1) REMARKS CODE	(2) REMARKS
A	Refer to TM 750-254 (cooling systems) for additional information.
B	Do not discard failed ECU. Contact Contractor Logistic Support (CLS) for disposition instructions.
C	Refer to TM 9-6140-200-14 (batteries) for additional information.
D	Refer to TM 9-2610-200-14 (tires) for additional information.

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EXPENDABLE AND DURABLE ITEMS LIST 0235 00

SCOPE

This work package lists expendable and durable items you will need to maintain the M915A3 Tractor Truck. This listing is for information only and is not authority to requisition the listed items. These items are authorized to you by CTA 50-970, *Expendable/Durable Items (Except Medical, Class V Repair Parts, and Heraldic Items)*, or CTA 8-100, *Army Medical Department Expendable/Durable Items.*

EXPLANATION OF COLUMNS

1. **Column (1) - Item Number.** This number is assigned to the entry in the list and is referenced in the narrative instructions to identify the item [e.g., Use antifreeze (Item 4, WP 0235 00)].
2. **Column (2) - Level.** This column identifies the lowest level of maintenance that requires the listed item.

   C - Operator/Crew

   O - Unit Maintenance
3. **Column (3) - National Stock Number (NSN).** This is the NSN assigned to the item which you can use to requisition it.
4. **Column (4) - Item Name, Description, Commercial and Government Entity Code (CAGEC), and Part Number (P/N).** This provides the other information you need to identify the item.
5. **Column (5) - Unit of Measure (U/M).** This code shows the physical measurement or count of an item, such as gallon, dozen, gross, etc.

Table 1. Expendable and Durable Items List.

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) ITEM NAME, DESCRIPTION, CAGEC, AND PART NUMBER	(5) U/M
1	O		ADHESIVE (71984) RTV732-3OZTUBE	
		8040-00-877-9872	3 Ounce Tube	OZ
2	O		ADHESIVE: General Purpose, Type II (18876) 9995460	
		8040-00-664-4318	1 Pint Can	PT
3	O	8040-00-142-9823	ADHESIVE: Silicone Rubber (81349) MIL-A-46106	KIT
4	C		ANTIFREEZE: Permanent, Ethylene Glycol, Inhibited (81349) MILA46153	
		6850-00-181-7929	1 Gallon Bottle	GAL
		6850-00-181-7933	5 Gallon Can	GAL
		6850-00-181-7940	55 Gallon Drum	GAL
5	C		ANTIFREEZE: Permanent, Type: Arctic Grade (81349) MIL-A-11755	
		6850-00-174-1806	55 Gallon Drum	GAL
6	O		COMPOUND: Antiseize, High Temperature (73165) 51008	
		8030-00-597-5367	25 pound can	LB
7	O		COMPOUND: Caulking (21106) MORTITE B-2	
		8030-01-241-9727	90 Foot Roll	FT
8	C		COMPOUND: Cleaning, Windshield (81348) O-C-1901	
		6850-00-926-2275	16 Ounce Can	OZ
9	O		COMPOUND: Sealing: Dissimilar Metal Protection (71961) 6099	
		8030-01-392-3276	1 Gallon Can	GAL
10	O		COMPOUND: Sealing, Pipe (05972) 079-21	
		8030-00-081-2286	50 CC Bottle	CC
		8030-00-081-2327	Box of 10 Bottles, 10 CC Each Bottle	CC
11	C		DETERGENT: General Purpose, Liquid (81348) P-D-220	
		7930-00-282-9699	1 Gallon Can	GAL

Table 1. Expendable and Durable Items List - Continued.

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) ITEM NAME, DESCRIPTION, CAGEC, AND PART NUMBER	(5) U/M
12	O		FLUX: Soldering (58536) A-A-51145 TY1 FORM A	
		3439-00-255-9935	1 Pound Can	LB
13	C		FUEL: Diesel, DF-1 Grade, Winter (81346) ASTM D 975	
		9140-00-286-5286	Bulk	GAL
		9140-00-286-5287	5 Gallon Can	GAL
		9140-00-286-5288	55 Gallon Drum, 16 Gage	GAL
		9140-00-286-5289	55 Gallon Drum, 18 Gage	GAL
14	C		FUEL: Diesel, DF-2 Grade (81346) ASTM D 975	
		9140-00-286-5294	Bulk	GAL
		9140-00-286-5295	5 Gallon Can	GAL
		9140-00-286-5296	55 Gallon Drum, 16 Gage	GAL
		9140-00-286-5297	55 Gallon Drum, 18 Gage	GAL
15	C		GREASE: Automotive and Artillery, GAA (81349) M-10924	
		9150-01-197-7693	14 Ounce Cartridge (M-10924-B)	OZ
		9150-01-197-7688	1-1/4 Ounce Tube (M-10924-A)	OZ
		9150-01-197-7690	2-1/4 Pound Can (M-10924-C)	LB
		9150-01-197-7692	35 Pound Can (M-10924-E)	LB
		9150-01-197-7691	120 Pound Drum (M10924-F)	LB
16	O		GREASE: Silicone (53711) 5205453	
		9150-01-066-1823	Box of 12 tubes, 5.3 ounces each	OZ
17	O		GREASE: Molybdenum Disulfide (39428) 1062K97	
		9150-01-326-5424	14 Ounce Cartridge	OZ
18	C		OIL: Lubricating, OEA, Arctic (81349) MIL-L-46167	
		9150-00-402-4478	1 Quart Can	QT
		9150-00-402-2372	5 Gallon Can	GAL
		9150-00-491-7197	55 Gallon Drum	GAL
19	C		OIL: Lubricating, OE/HDO 10 (81349) MIL-L-2104	
		9150-00-189-6727	1 Quart Can	QT
		9150-00-186-6668	5 Gallon Can	GAL
		9150-00-191-2772	55 Gallon Drum, 18 Gage (MILL2104)	GAL

Table 1. Expendable and Durable Items List - Continued.

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) ITEM NAME, DESCRIPTION, CAGEC, AND PART NUMBER	(5) U/M
20	C		OIL: Lubricating, OE/HDO 15/40 (81349) MIL-L-2104	
		9150-01-152-4117	1 Quart Can	QT
		9150-01-152-4118	5 Gallon Can	GAL
		9150-01-152-4119	55 Gallon Drum	GAL
21	C		OIL: Lubricating, OE/HDO 30 (81349) MIL-L-2104	
		9150-00-186-6681	1 Quart Can	QT
		9150-00-188-9858	5 Gallon Can	GAL
		9150-00-189-6729	55 Gallon Drum	GAL
22	C		OIL: Lubricating, OE/HDO 40 (81349) MILL2104	
		9150-00-189-6730	1 Quart Can	QT
		9150-00-188-9862	55 Gallon Drum	GAL
23	C		OIL: Lubricating, GO 75 (81349) MIL-PRF-2105	
		9150-01-035-5390	1 Quart Can	QT
		9150-01-035-5391	5 Gallon Can	GAL
24	C		OIL: Lubricating, GO 80/90 (81349) MIL-PRF-2105	
		9150-01-035-5392	1 Quart Can	QT
		9150-01-313-2191	1 Gallon Can	GAL
		9150-01-035-5395	5 Gallon Can	GAL
		9150-01-035-5394	55 Gallon Drum	GAL
25	C		OIL: Lubricating, GO 85/140 (81349) MIL-PRF-2105	
		9150-01-048-4591	1 Quart Can	QT
		9150-01-035-5395	5 Gallon Can	GAL
		9150-01-035-5396	55 Gallon Drum	GAL
26	C		OIL: Lubricating, Refrigerant Compressor, Synthetic Ester (59595) CAPELLA HFG-68NA	
		9150-01-410-8972	1 Quart Can	QT
27	O		PAINT: Heat Resisting, White (87187) 1505	
		8010-01-141-3949	13 Ounce Can, Pressurized Spray	OZ
28	C		RAG: Wiping (64067) 7920-00-205-1711	
		7920-00-205-1711	50 Pound Bale	LB

Table 1. Expendable and Durable Items List - Continued.

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) ITEM NAME, DESCRIPTION, CAGEC, AND PART NUMBER	(5) U/M
29	O		SOLDER: Lead-tin Alloy, Rosin Core (81348) QQ-S-571	
		3439-00-555-4629	1 Pound Spool	LB
30	O		STRAP: Tiedown, Electrical Components Box of 100	EA
		5975-00-984-6582	(96906) MS3367-1-0 6 Inch Length, 1.75 Inch Maximum Bundle, Black	
		5975-00-935-5946	(96906) MS3367-2-1 13.35 Inch Length, 4 Inch Maximum Bundle, Brown	
		5975-00-903-2284	(96906) MS3367-4-0 4 Inch Length, Black	
31	O		TAG: Marker (64067) 9905-00-537-8954	
		9905-00-537-8954	Bundle of 50	EA
32	O		TAPE: Double-sided (7X678) 4970	YD
33	O		TAPE: Duct, 2 Inches Wide (39428) 1791K70	
		5640-00-103-2254	60 Yard Roll	YD
34	O		WIRE: Nonelectrical (81346) ASTM A641	
		9505-00-596-0191	5 Pound Coil	LB

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TOOL IDENTIFICATION LIST 0236 00

SCOPE

This work package lists all common tools and supplements and special tools/fixtures needed to maintain the M915A3 Tractor Truck.

EXPLANATION OF COLUMNS IN THE TOOL IDENTIFICATION LIST

1. **Column (1) - Item Number (No.).** This number is assigned to the entry in the list and is referenced in the initial setup to identify the item (e.g., Tool kit, general mechanic's, Item 36, WP 0236 00).
2. **Column (2) - Item Name.** This column lists the item by noun nomenclature and other descriptive features (e.g., Cartridge, ABS).
3. **Column (3) - National Stock Number.** This is the National Stock Number (NSN) assigned to the item; use it to requisition the item.
4. **Column (4) - Part Number/CAGEC.** Indicates the primary number used by the manufacturer (individual, company, firm, corporation or Government activity) which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items. The manufacturer's Commercial and Government Entity Code (CAGEC) is also included.
5. **Column (5) - Reference.** This column identifies the authorizing supply catalog or RPSTL for items listed in this work package.

TOOL IDENTIFICATION LIST

Table 1. Tool Identification List.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER/ CAGEC	(5) REFERENCE
1	Adapter, Electrical	5935-01-353-2532	J 34812-1 (33287)	TM 9-2320-302-24P
2	Adapter, Test, ABS	4910-01-372-3128	446 300 3140 (78500)	TM 9-2320-302-24P
3	Bar, Wrecking: 30 in length	5120-00-293-0665	55-130 (57068)	SC 4910-95-A72
4	Cable Assembly, Special	6150-01-353-9708	J 38500-2 (33287)	TM 9-2320-302-24P
5	Card, Software		J38500-2300D (33287)	TM 9-2320-302-24P
6	Cartridge, ABS	4910-01-354-2767	J38500-404A (33287)	TM 9-2320-302-24P
7	Cartridge, CWS	TBD	TBD	TBD
8	Cartridge, Test, Transmission	4940-01-367-6194	J38500-303 (33287)	TM 9-2320-302-24P
9	Cartridge, Test Set, DDEC III/IV	4940-01-367-4657	J38500-1500C (33287)	TM 9-2320-302-24P
10	Compressor Unit, Reciprocating	4310-00-752-9633	MIL-C-52980 (81349)	SC 4910-95-A74
11	Drill, Electric, Portable: 3/8 in size	5130-00-935-7354	6635 (55111)	SC 4910-95-A74
12	Drill Set, Twist	5133-00-293-0983	800434 (19203)	SC 4910-95-A74
13	Gloves, Chemical and Oil Protective: rubber	8415-00-641-4601	ZZ-G-381 (81348)	SC 4910-95-A74
14	Goggles, Industrial	4240-00-052-3776	A-A-1110 (58536)	SC 4910-95-A74
15	Handle, Installer	5120-00-977-5578	J7079-2 (33287)	TM 9-2320-302-24P
16	Heat Gun	4940-00-561-1002	**6966C (78976)	GSA Catalog
17	Holder, Clutch	5120-01-439-0305	99-499 (07BE6)	TM 9-2320-302-24P
18	Indicator, Dial	5210-00-402-9619	J7872 (33287)	TM 9-2320-302-24P
19	Installation Tool, ABS Tone Ring		107119 (4N501)	TM 9-2320-302-24P
20	Installer, Seal	5120-00-977-5579	J8550 (33287)	TM 9-2320-302-24P
21	Jack, Hydraulic, Hand: 12 ton capacity	5120-00-224-7330	67224 (07505)	SC 4910-95-A74
22	Leak Detector, Refrigerant	4940-01-387-0948	16500 (07295)	TM 9-2320-302-24P
23	Level, Digital		J-44675 (33287)	
24	Multimeter, Digital	6625-01-139-2512	T00377 (55026)	SC 4910-95-A72
25	Pan, Drain: 4 gallon capacity	4910-00-387-9592	450 (05463)	SC 4910-95-A74
26	Pliers, Retaining Ring: internal, 0.120 in diameter, 3.15-6.5 in ring diameter	5120-00-293-0186	4200-3174865PC4 (80064)	SC 4910-95-A72
27	Puller Kit, Universal	5180-00-313-9496	1178 (45225)	SC 4910-95-A72
28	Riveter, Blind, Hand: 3/32 in, 1/8 in, 5/32 in, and 3/16 in diameters	5120-00-017-2849	250K (10054)	SC 4910-95-A74
29	Socket, Socket Wrench	5130-01-389-8450	BWD482 (55719)	TM 9-2320-302-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER/ CAGEC	(5) REFERENCE
30	Soldering Gun	3439-00-618-6623	D550-3 (97049)	SC 4910-95-A74
31	Tape, Measuring: 50 feet long	5210-00-554-7085	403 (37163)	SC 4910-95-A72
32	Tensiometer, Dial Indicating	6635-01-093-3710	BT-33-73F (33287)	SC 4910-95-A74
33	Tester, Internal Combustion, DDEC Diagnostic Reader	4910-01-343-3508	J 38500-H (33287)	TM 9-2320-302-24P
34	Tester, Kingpin Lock	4910-01-157-3571	TFTLN-1000 (74410)	TM 9-2320-302-24P
35	Tool Kit, Electrical Connector Repair	5180-00-876-9336	7550526 (19204)	SC 4910-95-A72
36	Tool Kit, General Mechanic's: Automotive	5180-00-177-7033	SC5180-90-N26 (50980)	SC 5180-95-N26
37	Tool Kit, Internal Combustion	5180-01-358-5231	J 35888-60 (33287)	TM 9-2320-302-24P
38	Trestle, Hoist, Portable: 7 ton capacity	3950-00-251-8013	306 (79805)	SC 4910-95-A72
39	Vise, Machinist's	5120-00-293-1439	504M2 (79416)	SC 4910-95-A74
40	Wiring Harness	6150-01-354-2604	J 35751 (33287)	TM 9-2320-302-24P
41	Wrench, Box	5120-01-322-1124	J35948 (33287)	GSA Catalog
42	Wrench, Strap, Oil Filter	5120-00-020-2947	2432097 (10001)	SC 4910-95-A74
43	Wrench, Torque: 3/8 in drive, 0-200 lb-in capacity	5120-00-853-4538	F200I (90947)	SC 4910-95-A72
44	Wrench, Torque: 3/8 in drive, 0-300 lb-in capacity	5120-00-776-1841	2163993 (10001)	SC 4910-95-A74
45	Wrench, Torque: 3/8 in drive, 15-75 lb-ft capacity	5120-01-355-1734	QC2FR75 (55719)	SC 4910-95-A74
46	Wrench, Torque: 50-250 lb-ft capacity	5120-01-042-0982	VB-2503MFR (27464)	SC 4910-95-A74
47	Wrench, Torque: 3/4 in drive, 100-600 lb-ft capacity	5120-01-113-9564	7379 (45225)	SC 4910-95-A72
48	Wrench Set, Socket: 3/4 in drive	5120-00-204-1999	FEDSTD353 (06542)	SC 4910-95-A72
49	Wrench Set, Socket Attachment: screwdriver, torx, 1/4 and 3/8 in drive	5120-01-178-6342	J-29843 (33287)	GSA Catalog
50	Pliers, Slip Joint	5120-00-537-3375	HCP48A	

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INDEX

Subject	*Work Package*	*Page*
Numerics		
12V Power Receptacle Replacement	0068 00	0068 00-1
A		
Access Cover Replacement, Transmission Tunnel	0207 00	0207 00-1
Adjustment		
Air Compressor Governor	0028 00	0028 00-1
Alternator Belt	0054 00	0054 00-1
Cab Door	0206 00	0206 00-1
Fifth Wheel	0178 00	0178 00-1
Headlamp	0082 00	0082 00-1
Hood	0187 00	0187 00-1
Slack Adjuster	0139 00	0139 00-1
Air		
Brake Chamber Replacement, Front	0141 00	0141 00-1
Brake Chamber Replacement, Rear	0142 00	0142 00-1
Cleaner Element Replacement	0036 00	0036 00-1
Cleaner Maintenance	0036 00	0036 00-1
Cylinder Replacement, HVAC	0219 00	0219 00-1
Deflector Replacement, Cab Roof	0218 00	0218 00-1
Dryer Canister Replacement	0158 00	0158 00-1
Dryer Replacement	0157 00	0157 00-1
Horn and Valve Replacement	0214 00	0214 00-1
Intake Duct Maintenance	0036 00	0036 00-1
Intake Tubes and Hoses Replacement	0037 00	0037 00-1
Pressure Sending Units (Primary/Secondary) Replacement	0105 00	0105 00-1
Recirculation Shield Replacement	0038 00	0038 00-1
Solenoid Replacement		
Front ABS	0162 00	0162 00-1
Rear ABS	0163 00	0163 00-1
Supply Tank and Fittings Replacement	0146 00	0146 00-1
Tank and Fittings Replacement, Primary I	0143 00	0143 00-1
Tank and Fittings Replacement, Primary II	0144 00	0144 00-1
Tank and Fittings Replacement, Secondary	0145 00	0145 00-1
Temperature Sensor Replacement	0101 00	0101 00-1
Tube Replacement	0147 00	0147 00-1
Air Compressor		
Discharge Hose Replacement	0027 00	0027 00-1
Governor Replacement and Adjustment	0028 00	0028 00-1
Replacement	0029 00	0029 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
A - Continued		
Air Conditioner		
Binary Switch Replacement	0224 00	0224 00-1
Compressor Magnetic Clutch Replacement	0226 00	0226 00-1
Leak Test	0225 00	0225 00-1
Resister Block Replacement	0222 00	0222 00-1
Thermostatic Switch Replacement	0223 00	0223 00-1
Air Conditioning Control Panel Replacement	0067 00	0067 00-1
Air Conditioning System		
Theory of Operation	0003 00	0003 00-9
Troubleshooting and Testing	0017 00	0017 00-1
Air System		
Theory of Operation	0003 00	0003 00-5
Troubleshooting	0014 00	0014 00-1
Alignment		
Collision Warning System (CWS) Antenna	0110 00	0110 00-1
Front Axle Toe-in	0131 00	0131 00-1
Alternator		
Belt Replacement and Adjustment	0054 00	0054 00-1
Replacement	0055 00	0055 00-1
Antenna Alignment, Collision Warning System (CWS)	0110 00	0110 00-1
Antenna Assembly Replacement, Collision Warning System (CWS)	0111 00	0111 00-1
Anti-lock Brake System (ABS)		
Air Solenoid Replacement		
Front	0162 00	0162 00-1
Rear	0163 00	0163 00-1
Electronic Control Unit Replacement	0108 00	0108 00-1
Sensor Replacement, Front	0106 00	0106 00-1
Sensor Replacement, Rear	0107 00	0107 00-1
Tone Ring Replacement, Front Axle	0165 00	0165 00-1
Tone Ring Replacement, Rear-rear Axle	0166 00	0166 00-1
Troubleshooting and Testing	0013 00	0013 00-1
Arctic Heater Replacement (WABASTO)	0229 00	0229 00-1
Automatic Ether Starting Aid		
Maintenance	0035 00	0035 00-1
Wiring Harnesses Replacement	0117 00	0117 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
B		
Basic Issue Items (BII) Storage Box and Mounting Bracket Replacement	0198 00	0198 00-1
Battery		
Box Replacement	0114 00	0114 00-1
Cables Replacement	0115 00	0115 00-1
Replacement	0113 00	0113 00-1
Belt		
Alternator, Replacement and Adjustment	0054 00	0054 00-1
Fan, Replacement and Adjustment	0046 00	0046 00-1
Seat, Replacement	0193 00	0193 00-1
Blackout		
Drive Light Replacement	0084 00	0084 00-1
Marker Light Replacement	0084 00	0084 00-1
Marker Replacement, Rear	0086 00	0086 00-1
Marker Replacement, Right Front	0085 00	0085 00-1
Blower Motor Replacement, HVAC	0220 00	0220 00-1
Box Replacement, Battery	0114 00	0114 00-1
Bracket Replacement		
Taillight	0181 00	0181 00-1
Towing	0180 00	0180 00-1
Brake Chamber Replacement		
Air, Front	0141 00	0141 00-1
Air, Rear	0142 00	0142 00-1
Brake Light/Trailer Brake Light Sending Unit Replacement	0109 00	0109 00-1
Brake Pedal Replacement	0134 00	0134 00-1
Brake Spider and Brake Chamber Bracket Replacement		
Front	0136 00	0136 00-1
Rear	0138 00	0138 00-1
Brake System		
Theory of Operation	0003 00	0003 00-5
Troubleshooting	0012 00	0012 00-1
Brakeshoe Replacement		
Front	0135 00	0135 00-1
Rear	0137 00	0137 00-1
Breather Replacement		
Rear Axle	0133 00	0133 00-1
Transmission	0128 00	0128 00-1
Brush Guard Replacement	0184 00	0184 00-1
Bumper Replacement, Front	0175 00	0175 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
C		
Cab		
Air Junction Block Replacement	0149 00	0149 00-1
Door Adjustment	0206 00	0206 00-1
Liners Replacement	0202 00	0202 00-1
Overhead Storage Compartment Replacement	0204 00	0204 00-1
Roof Air Deflector Replacement	0218 00	0218 00-1
Cables Replacement, Battery	0115 00	0115 00-1
Cab-to-Frame Ground Wire Replacement	0118 00	0118 00-1
Canister Replacement, Air Dryer	0158 00	0158 00-1
Center Gage Panel Maintenance	0061 00	0061 00-1
Central Processing Unit (CPU) Replacement, Collision Warning System (CWS)	0111 00	0111 00-1
Characteristics, Capabilities, and Features, Equipment	0002 00	0002 00-1
Charge Air Cooler and Air Recirculation Shield Replacement	0038 00	0038 00-1
Chassis and Fifth Wheel Troubleshooting	0016 00	0016 00-1
Check Engine Switch and Jumper Harness Replacement	0070 00	0070 00-1
Circuit Breaker Replacement	0071 00	0071 00-1
Clearance Light Replacement	0089 00	0089 00-1
Clutch and Drive Pulley Replacement, Fan	0049 00	0049 00-1
Clutch Solenoid Replacement, Fan	0048 00	0048 00-1
Collision Warning System (CWS)		
Antenna Alignment	0110 00	0110 00-1
Maintenance	0111 00	0111 00-1
Theory of Operation	0003 00	0003 00-10
Troubleshooting	0018 00	0018 00-1
Column Cover Replacement, Steering	0205 00	0205 00-1
Compressor Replacement, Air	0029 00	0029 00-1
Connectors Maintenance, Electrical	0119 00	0119 00-1
Constant Air Junction Block Replacement	0148 00	0148 00-1
Control Module Replacement	0066 00	0066 00-1
Control Module Replacement, Electronic	0075 00	0075 00-1
Control Panel Replacement, Heater and Air Conditioning	0067 00	0067 00-1
Coolant Hoses, Pipes, and Clamps Replacement	0042 00	0042 00-1
Cooler and Oil Filter Adapter Maintenance, Oil	0025 00	0025 00-1
Cooling System		
Drain and Fill	0041 00	0041 00-1
Theory of Operation	0003 00	0003 00-3
Troubleshooting	0009 00	0009 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
C - Continued		
Corrosion Prevention and Control (CPC)	0001 00	0001 00-1
Cup Holder Replacement	0217 00	0217 00-1
D		
Dash Panel Replacement, Upper Right	0063 00	0063 00-1
Data and Instruction Plates Replacement	0215 00	0215 00-1
Data, Equipment	0002 00	0002 00-6
DDEC Engine Troubleshooting	0007 00	0007 00-1
Destruction of Army Materiel to Prevent Enemy Use	0001 00	0001 00-1
Dipstick, Tube, and Adapter Replacement, Oil Level	0023 00	0023 00-1
Discharge Hose Replacement, Air Compressor	0027 00	0027 00-1
Drag Link Replacement	0169 00	0169 00-1
Drain and Fill Cooling System	0041 00	0041 00-1
Drive Train, Theory of Operation	0003 00	0003 00-1
Driveline		
Replacement	0129 00	0129 00-1
U-joints and Bearings Replacement	0130 00	0130 00-1
Driver Display Unit (DDU) Replacement, Collision Warning System (CWS)	0111 00	0111 00-1
Dryer Replacement, Air	0157 00	0157 00-1
Dual Voltage Control Replacement	0058 00	0058 00-1
E		
Electric Horn Replacement	0112 00	0112 00-1
Electrical Connectors Maintenance	0119 00	0119 00-1
Electrical System		
Theory of Operation	0003 00	0003 00-3
Troubleshooting	0010 00	0010 00-1
Electronic		
Control Module Replacement	0075 00	0075 00-1
Control Unit (ECU) Replacement, Anti-lock Brake System (ABS)	0108 00	0108 00-1
Control Unit (ECU) Replacement, Transmission	0124 00	0124 00-1
Throttle Replacement	0074 00	0074 00-1
Engine Hood Assembly Replacement	0185 00	0185 00-1
Engine Troubleshooting	0006 00	0006 00-1
Equipment		
Characteristics, Capabilities, and Features	0002 00	0002 00-1
Data	0002 00	0002 00-6

INDEX - Continued

Subject	*Work Package*	*Page*
E - Continued		
Ether Starting Aid Maintenance, Automatic	0035 00	0035 00-1
Exhaust System		
Flex Pipe, Clamps, and Heat Shield Replacement	0040 00	0040 00-1
Muffler, Stack, and Heat Shield Replacement	0039 00	0039 00-1
Theory of Operation	0003 00	0003 00-2
Troubleshooting	0008 00	0008 00-1
F		
Fan		
Belt Replacement and Adjustment	0046 00	0046 00-1
Clutch and Drive Pulley Replacement	0049 00	0049 00-1
Clutch Solenoid Replacement	0048 00	0048 00-1
Impeller and Shroud Replacement	0047 00	0047 00-1
Temperature Sensor Replacement	0100 00	0100 00-1
Fender Extension Maintenance, Front	0194 00	0194 00-1
Fender Replacement, Rear	0195 00	0195 00-1
Fiber Optic Light Source Replacement	0069 00	0069 00-1
Fifth Wheel Adjustment	0178 00	0178 00-1
Fill Tube Maintenance, Oil	0022 00	0022 00-1
Filter Adapter and Bracket Replacement, Water	0051 00	0051 00-1
Filter Adapters Replacement, Fuel	0032 00	0032 00-1
Filter Element		
Fuel Filter, Replacement	0031 00	0031 00-1
Fuel Strainer, Replacement	0031 00	0031 00-1
Oil, Replacement	0024 00	0024 00-1
Water, Replacement	0050 00	0050 00-1
Flex Pipe, Clamps, and Heat Shield Replacement, Exhaust System	0040 00	0040 00-1
Floor Mats Replacement	0201 00	0201 00-1
Foot Brake Valve Replacement	0161 00	0161 00-1
Front		
Air Brake Chamber Replacement	0141 00	0141 00-1
Brake Spider and Brake Chamber Bracket Replacement	0136 00	0136 00-1
Brakeshoe Replacement	0135 00	0135 00-1
Bumper Replacement	0175 00	0175 00-1
Gladhands Replacement	0153 00	0153 00-1
Quick-release Valve Replacement	0155 00	0155 00-1
Service Brake Relay Valve Replacement	0152 00	0152 00-1
Shock Absorber Replacement	0182 00	0182 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
F - Continued		
Front - Continued		
Splash Guard and Fender Extension Maintenance	0194 00	0194 00-1
Front Axle		
Stop Cushion Replacement	0132 00	0132 00-1
Toe-in Alignment	0131 00	0131 00-1
Fuel		
Filter Adapters Replacement	0032 00	0032 00-1
Hoses and Fittings Replacement	0030 00	0030 00-1
Pressure Sensor Replacement	0092 00	0092 00-1
Pump Replacement	0034 00	0034 00-1
Strainer and Filter Element Replacement	0031 00	0031 00-1
Tank and Mounting Brackets Replacement	0033 00	0033 00-1
Temperature Sensor Replacement	0093 00	0093 00-1
Fuel Level Sending Unit Replacement	0094 00	0094 00-1
Fuel System, Theory of Operation	0003 00	0003 00-1
Fuse Replacement	0071 00	0071 00-1
G		
Gages and Lamps Replacement, Left Panel	0060 00	0060 00-1
General Lubrication Procedures	0020 00	0020 00-1
General Maintenance Instructions	0228 00	0228 00-1
Gladhand(s) Replacement		
Front	0153 00	0153 00-1
Rear	0154 00	0154 00-1
Governor Replacement and Adjustment, Air Compressor	0028 00	0028 00-1
Ground Wire Replacement, Cab-to-Frame	0118 00	0118 00-1
Guard Replacement, Brush	0184 00	0184 00-1
H		
Hand Brake Replacement, Trailer	0159 00	0159 00-1
Head Liners Replacement	0203 00	0203 00-1
Headlamp		
Adjustment	0082 00	0082 00-1
Replacement	0083 00	0083 00-1
Headlight Replacement	0083 00	0083 00-1
Heater Control Panel Replacement	0067 00	0067 00-1
Heater Core Replacement, HVAC	0221 00	0221 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
H - Continued		
Heater Replacement, Arctic (WABASTO)	0229 00	0229 00-1
Hoist Replacement, Spare Wheel	0176 00	0176 00-1
Hold-down Pin Replacement, Battery	0113 00	0113 00-1
Hood		
Adjustment	0187 00	0187 00-1
Latch replacement	0188 00	0188 00-1
Liner Replacement	0189 00	0189 00-1
Prop and Mount Replacement	0190 00	0190 00-1
Hood Assembly		
Replacement, Engine	0185 00	0185 00-1
Hook, Pintle, Replacement and Repair	0179 00	0179 00-1
Horn Replacement, Electric	0112 00	0112 00-1
Hoses and Fittings Replacement, Fuel	0030 00	0030 00-1
Hoses, Pipes, and Clamps Replacement, Coolant	0042 00	0042 00-1
Housing Cover Replacement, Thermostat	0043 00	0043 00-1
Hub, Drum, Wheel Bearings, and Seal Replacement		
Front	0165 00	0165 00-1
Rear	0166 00	0166 00-1
HVAC		
Air Cylinder Replacement	0219 00	0219 00-1
Blower Motor Replacement	0220 00	0220 00-1
Heater Core Replacement	0221 00	0221 00-1
I		
Illustrated List of Manufactured Items	0230 00	0230 00-1
Impeller and Shroud Replacement, Fan	0047 00	0047 00-1
Intake Tubes and Hoses Replacement, Air	0037 00	0037 00-1
Interior Light Unit and Bulb Replacement	0091 00	0091 00-1
Introduction		
Troubleshooting	0004 00	0004 00-1
Unit Preventive Maintenance Checks and Services (PMCS)	0020 00	0020 00-1
J		
Junction Block Replacement		
Cab Air	0149 00	0149 00-1
Constant Air	0148 00	0148 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
L		
Lamps Replacement		
Left Panel	0060 00	0060 00-1
Right Gage Panel	0062 00	0062 00-1
Latch Replacement		
Hood	0188 00	0188 00-1
Storage Box	0199 00	0199 00-1
Leak Test, Air Conditioner	0225 00	0225 00-1
Left Hand Switch Panel Maintenance	0064 00	0064 00-1
Left Panel Gages and Lamps Replacement	0060 00	0060 00-1
Left Side Platform Replacement	0173 00	0173 00-1
Left Step Replacement	0172 00	0172 00-1
Light Maintenance, Utility	0090 00	0090 00-1
Light Replacement		
Blackout Drive	0084 00	0084 00-1
Clearance	0089 00	0089 00-1
Marker Light, Blackout	0084 00	0084 00-1
Side Marker/Turn Signal	0088 00	0088 00-1
Light Source Replacement, Fiber Optic	0069 00	0069 00-1
Light Unit and Bulb Replacement, Interior	0091 00	0091 00-1
Liner(s) Replacement		
Cab	0202 00	0202 00-1
Head	0203 00	0203 00-1
Hood	0189 00	0189 00-1
List		
Abbreviations	0001 00	0001 00-2
Nomenclature Cross-reference	0001 00	0001 00-2
Location and Description of Major Components	0002 00	0002 00-2
Lubrication		
Data	Table 1.	0020 00-4
Procedures, General	0020 00	0020 00-1
Lug Nut Installation, Front and Dual Rear Wheel	0164 00	0164 00-1
M		
M13 Decontamination Kit Mounting Bracket Replacement	0227 00	0227 00-1
M16 Rifle Mounting Bracket Replacement	0216 00	0216 00-1
Magnetic Clutch Replacement, Air Conditioner Compressor	0226 00	0226 00-1
Maintenance Forms, Records, and Reports	0001 00	0001 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
M - Continued		
Maintenance Instructions, General	0228 00	0228 00-1
Major Components, Location and Description	0002 00	0002 00-2
Manufactured Items, Illustrated List	0230 00	0230 00-1
Master Battery Switch Replacement	0072 00	0072 00-1
Mats Replacement, Floor	0201 00	0201 00-1
Mirror Replacement		
Rear View	0208 00	0208 00-1
Spotter	0209 00	0209 00-1
Module Replacement		
Control	0066 00	0066 00-1
Water Level	0080 00	0080 00-1
Motor and Linkage Replacement, Windshield Wiper	0210 00	0210 00-1
Mounting Bracket Replacement		
M13 Decontamination Kit	0227 00	0227 00-1
M16 Rifle	0216 00	0216 00-1
Vehicle Jack	0213 00	0213 00-1
Mud Flap Assembly Replacement	0196 00	0196 00-1
Muffler, Stack, and Heat Shield Replacement, Exhaust System	0039 00	0039 00-1
N		
Nomenclature Cross-reference List	0001 00	0001 00-2
O		
Oil		
Cooler and Oil Filter Adapter Maintenance	0025 00	0025 00-1
Cooler Lines and Fittings Replacement, Transmission	0122 00	0122 00-1
Cooler Replacement, Transmission	0127 00	0127 00-1
Fill Tube Maintenance	0022 00	0022 00-1
Fill/Level Check Tube Replacement, Transmission	0121 00	0121 00-1
Filter Element Replacement	0024 00	0024 00-1
Filter Elements Replacement, Transmission	0123 00	0123 00-1
Level Dipstick, Tube, and Adapter Replacement	0023 00	0023 00-1
Pressure Sending Unit Replacement	0097 00	0097 00-1
Pressure Sensor Replacement	0095 00	0095 00-1
Sample Valves Replacement	0026 00	0026 00-1
Temperature Sensor Replacement	0096 00	0096 00-1
Overhead Storage Compartment Replacement, Cab	0204 00	0204 00-1
Ozone Depleting Substances (ODS)	0001 00	0001 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
P		
Parking Brake and Trailer Air Supply Valve Replacement	0160 00	0160 00-1
Parking Brake Pressure Switch Replacement	0079 00	0079 00-1
Pedal Replacement, Brake	0134 00	0134 00-1
Personal Gear Storage Box and Mounting Bracket Replacement	0197 00	0197 00-1
Pintle Hook Replacement and Repair	0179 00	0179 00-1
Pitman Arm Replacement	0169 00	0169 00-1
Plates Replacement, Data and Instruction	0215 00	0215 00-1
Platform Replacement		
Left Side	0173 00	0173 00-1
Rear	0200 00	0200 00-1
PMCS Initial Setup	0020 00	0020 00-3
Power Steering Reservoir and Hose Maintenance	0170 00	0170 00-1
Preparation for Storage or Shipment	0001 00	0001 00-1
Preventive Maintenance Checks and Services (PMCS) Introduction	0020 00	0020 00-1
Preventive Maintenance Checks and Services (PMCS), Unit	0021 00	0021 00-1
Primary I Air Tank and Fittings Replacement	0143 00	0143 00-1
Primary II Air Tank and Fittings Replacement	0144 00	0144 00-1
Probe Replacement, Water Level	0081 00	0081 00-1
Prop and Mount Replacement, Hood	0190 00	0190 00-1
Pump Maintenance, Water	0052 00	0052 00-1
Pump Replacement, Fuel	0034 00	0034 00-1
R		
Radiator		
Replacement	0045 00	0045 00-1
Support Rod Replacement	0044 00	0044 00-1
Rear		
Air Brake Chamber Replacement	0142 00	0142 00-1
Axle Breather Replacement	0133 00	0133 00-1
Brake Spider and Brake Chamber Bracket Replacement	0138 00	0138 00-1
Brakeshoe Replacement	0137 00	0137 00-1
Fender Replacement	0195 00	0195 00-1
Gladhand Replacement	0154 00	0154 00-1
Platform Replacement	0200 00	0200 00-1
Quick-release Valve Replacement	0156 00	0156 00-1
Relay Valve Replacement	0151 00	0151 00-1
Shock Absorber Replacement	0183 00	0183 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
R - Continued		
Rear - Continued		
Suspension System, Theory of Operation	0003 00	0003 00-8
Tie Down Replacement	0177 00	0177 00-1
View Mirror Replacement	0208 00	0208 00-1
Receptacle Replacement		
12V Power	0068 00	0068 00-1
NATO Slave	0076 00	0076 00-1
Trailer Electrical	0078 00	0078 00-1
Utility Power	0077 00	0077 00-1
Regulator Replacement, Voltage	0057 00	0057 00-1
Relay Replacement	0071 00	0071 00-1
Relay Replacement, Starter	0059 00	0059 00-1
Reporting Equipment Improvement Recommendations (EIRs)	0001 00	0001 00-1
Reservoir and Hose Maintenance, Power Steering	0170 00	0170 00-1
Reservoir, Windshield Washer, Replacement	0211 00	0211 00-1
Resister Block Replacement, Air Conditioner	0222 00	0222 00-1
Right Gage Panel and Lamps Replacement	0062 00	0062 00-1
Right Hand Switch Panel Replacement	0065 00	0065 00-1
Right Rear Step Replacement	0174 00	0174 00-1
Right Step Replacement	0171 00	0171 00-1
S		
Sample Valves Replacement, Oil	0026 00	0026 00-1
Seat		
Belt Replacement	0193 00	0193 00-1
Repair	0192 00	0192 00-1
Replacement	0191 00	0191 00-1
Secondary Air Tank and Fittings Replacement	0145 00	0145 00-1
Selector Replacement, Shift	0120 00	0120 00-1
Sending Unit Replacement		
Brake Light/Trailer Brake Light	0109 00	0109 00-1
Fuel Level	0094 00	0094 00-1
Oil Pressure	0097 00	0097 00-1
Sensor Replacement	0099 00	0099 00-1
Air Temperature	0101 00	0101 00-1
Anti-lock Brake System (ABS), Front	0106 00	0106 00-1
Anti-lock Brake System (ABS), Rear	0107 00	0107 00-1
Fan Temperature	0100 00	0100 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
S - Continued		
Sensor Replacement - Continued		
Fuel Pressure	0092 00	0092 00-1
Fuel Temperature	0093 00	0093 00-1
Oil Pressure	0095 00	0095 00-1
Oil Temperature	0096 00	0096 00-1
Side, Collision Waring System (CWS)	0111 00	0111 00-1
Synchronous Reference	0104 00	0104 00-1
Timing Reference	0103 00	0103 00-1
Transmission Speed	0126 00	0126 00-1
Turbo Boost Sensor (TBS)	0102 00	0102 00-1
Water Level	0099 00	0099 00-1
Water Temperature	0098 00	0098 00-1
Service Upon Receipt	0019 00	0019 00-1
Shaft Replacement and Repair, Universal	0168 00	0168 00-1
Shift		
Selector Replacement	0120 00	0120 00-1
Tower Replacement	0120 00	0120 00-1
Shock Absorber Replacement		
Front	0182 00	0182 00-1
Rear	0183 00	0183 00-1
Side Sensor Display Replacement, Collision Warning System (CWS)	0111 00	0111 00-1
Slack Adjuster Adjustment	0139 00	0139 00-1
Slack Adjuster and S-cam Replacement	0140 00	0140 00-1
Slave Receptacle Replacement, NATO	0076 00	0076 00-1
Solenoid Replacement, Fan Clutch	0048 00	0048 00-1
Spare Wheel Hoist Replacement	0176 00	0176 00-1
Spindle and Housing Replacement	0053 00	0053 00-1
Splash Guard Maintenance, Front	0194 00	0194 00-1
Spotter Mirror Replacement	0209 00	0209 00-1
Starter		
Relay Replacement	0059 00	0059 00-1
Replacement	0056 00	0056 00-1
Steering		
Column Cover Replacement	0205 00	0205 00-1
Wheel Replacement	0167 00	0167 00-1
Steering System		
Theory of Operation	0003 00	0003 00-7
Troubleshooting	0015 00	0015 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
S - Continued		
Step Replacement		
Left	0172 00	0172 00-1
Right	0171 00	0171 00-1
Right Rear	0174 00	0174 00-1
Stop Cushion Replacement, Front Axle	0132 00	0132 00-1
Stop/Tail/Backup Lights Wiring Harness Replacement	0116 00	0116 00-1
Storage Box		
Basic Issue Items (BII) and Mounting Bracket, Replacement	0198 00	0198 00-1
Latch Replacement	0199 00	0199 00-1
Personal Gear and Mounting Bracket, Replacement	0197 00	0197 00-1
Storage or Shipment, Preparation for	0001 00	0001 00-1
Strainer and Filter Element Replacement, Fuel	0031 00	0031 00-1
Support Rod Replacement, Radiator	0044 00	0044 00-1
Switch		
Binary, Air Conditioner, Replacement	0224 00	0224 00-1
Check Engine, Replacement	0070 00	0070 00-1
Master Battery, Replacement	0072 00	0072 00-1
Parking Brake Pressure, Replacement	0079 00	0079 00-1
Thermostatic, Air Conditioner, Replacement	0223 00	0223 00-1
Turn Signal, Replacement	0073 00	0073 00-1
Switch Panel		
Maintenance, Left Hand	0064 00	0064 00-1
Replacement, Right Hand	0065 00	0065 00-1
Symptom Index, Troubleshooting	0005 00	0005 00-1
Synchronous Reference Sensor Replacement	0104 00	0104 00-1
T		
Taillight		
Bracket Replacement	0181 00	0181 00-1
Maintenance	0087 00	0087 00-1
Tank and Fittings Replacement		
Air Supply	0146 00	0146 00-1
Primary I Air	0143 00	0143 00-1
Primary II Air	0144 00	0144 00-1
Tank and Mounting Brackets Replacement, Fuel	0033 00	0033 00-1
Theory of Operation		
Air Conditioning System	0003 00	0003 00-9
Air System	0003 00	0003 00-5

INDEX - Continued

T - Continued

Subject	*Work Package*	*Page*
Theory of Operation - Continued		
Brake System	0003 00	0003 00-5
Collision Warning System (CWS)	0003 00	0003 00-10
Cooling System	0003 00	0003 00-3
Drive Train	0003 00	0003 00-1
Electrical System	0003 00	0003 00-3
Exhaust System	0003 00	0003 00-2
Fuel System	0003 00	0003 00-1
Rear Suspension System	0003 00	0003 00-8
Steering System	0003 00	0003 00-7
Traction Control System	0003 00	0003 00-7
Thermostat and Thermostat Housing Cover Replacement	0043 00	0043 00-1
Throttle Replacement, Electronic	0074 00	0074 00-1
Tie Down Replacement, Rear	0177 00	0177 00-1
Timing Reference Sensor Replacement	0103 00	0103 00-1
Toe-in Alignment, Front Axle	0131 00	0131 00-1
Tone Ring, ABS, Replacement		
Front Axle	0165 00	0165 00-1
Rear-rear Axle	0166 00	0166 00-1
Torque Limits	0231 00	0231 00-1
Tower Replacement, Shift	0120 00	0120 00-1
Towing Bracket Replacement	0180 00	0180 00-1
Traction Control System, Theory of Operation	0003 00	0003 00-7
Tractor Protective Valves Replacement	0150 00	0150 00-1
Trailer Electrical Receptacles Replacement	0078 00	0078 00-1
Trailer Hand Brake Replacement	0159 00	0159 00-1
Transmission		
Breather Replacement	0128 00	0128 00-1
Electronic Control Unit (ECU) Replacement	0124 00	0124 00-1
Electronic Control Unit (ECU) Wiring Harness Replacement	0125 00	0125 00-1
Oil Cooler Lines and Fittings Replacement	0122 00	0122 00-1
Oil Cooler Replacement	0127 00	0127 00-1
Oil Fill/Level Check Tube Replacement	0121 00	0121 00-1
Oil Filter Elements Replacement	0123 00	0123 00-1
Speed Sensor Replacement	0126 00	0126 00-1
Tunnel Access Cover Replacement	0207 00	0207 00-1
Transmission and Driveline Systems Troubleshooting	0011 00	0011 00-1
Troubleshooting		
Air System	0014 00	0014 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
T - Continued		
Troubleshooting - Continued		
Brake System	0012 00	0012 00-1
Chassis and Fifth Wheel	0016 00	0016 00-1
Collision Warning System (CWS)	0018 00	0018 00-1
Cooling System	0009 00	0009 00-1
DDEC Engine	0007 00	0007 00-1
Driveline Systems	0011 00	0011 00-1
Electrical System	0010 00	0010 00-1
Engine	0006 00	0006 00-1
Exhaust System	0008 00	0008 00-1
Introduction	0004 00	0004 00-1
Steering System	0015 00	0015 00-1
Symptom Index	0005 00	0005 00-1
Transmission	0011 00	0011 00-1
Troubleshooting and Testing		
Air Conditioning System	0017 00	0017 00-1
Anti-lock Brake System (ABS)	0013 00	0013 00-1
Tube Replacement, Air	0147 00	0147 00-1
Turbo Boost Sensor (TBS) Replacement	0102 00	0102 00-1
Turn Signal		
Light Replacement	0088 00	0088 00-1
Switch Replacement	0073 00	0073 00-1
U		
U-joints and Bearings Replacement, Driveline	0130 00	0130 00-1
Unit		
Preventive Maintenance Checks and Services (PMCS)	0021 00	0021 00-1
Preventive Maintenance Checks and Services (PMCS) Introduction	0020 00	0020 00-1
Universal Shaft Replacement and Repair	0168 00	0168 00-1
Upper Right Dash Panel Replacement	0063 00	0063 00-1
Utility Light Maintenance	0090 00	0090 00-1
Utility Power Receptacle Replacement	0077 00	0077 00-1
V		
Valve(s) Replacement		
Air Horn	0214 00	0214 00-1
Foot Brake	0161 00	0161 00-1
Front Service Brake Relay	0152 00	0152 00-1

INDEX - Continued

Subject	*Work Package*	*Page*
V - Continued		
Valve(s) Replacement - Continued		
Parking Brake and Trailer Air Supply	0160 00	0160 00-1
Quick-release, Front	0155 00	0155 00-1
Quick-release, Rear	0156 00	0156 00-1
Rear Relay	0151 00	0151 00-1
Tractor Protection	0150 00	0150 00-1
Vehicle Jack Mounting Bracket Replacement	0213 00	0213 00-1
Voltage Control Replacement, Dual	0058 00	0058 00-1
Voltage Regulator Replacement	0057 00	0057 00-1
W		
Warranty Information	0001 00	0001 00-1
Water		
Filter Adapter and Bracket Replacement	0051 00	0051 00-1
Filter Element Replacement	0050 00	0050 00-1
Pump Maintenance	0052 00	0052 00-1
Temperature Sensor Replacement	0098 00	0098 00-1
Water Level		
Module Replacement	0080 00	0080 00-1
Probe Replacement	0081 00	0081 00-1
Sensor Replacement	0099 00	0099 00-1
Wheel		
Bearings and Seal Replacement, Front Hub, Drum	0165 00	0165 00-1
Bearings and Seal Replacement, Rear Hub, Drum	0166 00	0166 00-1
Lug Nut Installation, Front and Dual Rear	0164 00	0164 00-1
Replacement, Steering	0167 00	0167 00-1
Windshield		
Washer Reservoir Replacement	0211 00	0211 00-1
Wiper and Wiper Arm Replacement	0212 00	0212 00-1
Wiper Motor and Linkage Replacement	0210 00	0210 00-1
Wiper and Wiper Arm Replacement, Windshield	0212 00	0212 00-1
Wiring Harness(es) Replacement		
Automatic Ether Starting Aid	0117 00	0117 00-1
Stop/Tail/Backup Lights	0116 00	0116 00-1
Transmission Electronic Control Unit (ECU)	0125 00	0125 00-1

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By Order of the Secretary of the Army:

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Chief of Staff

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JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
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ITEM	PAGE	PARA-	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON
	0035 00-1	Initial Setup				Item number for Oil, Lubricating is not correct.

SAMPLE

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE
Johnny Wilson, E-5, MOTOR SGT	DSN 867-7967	

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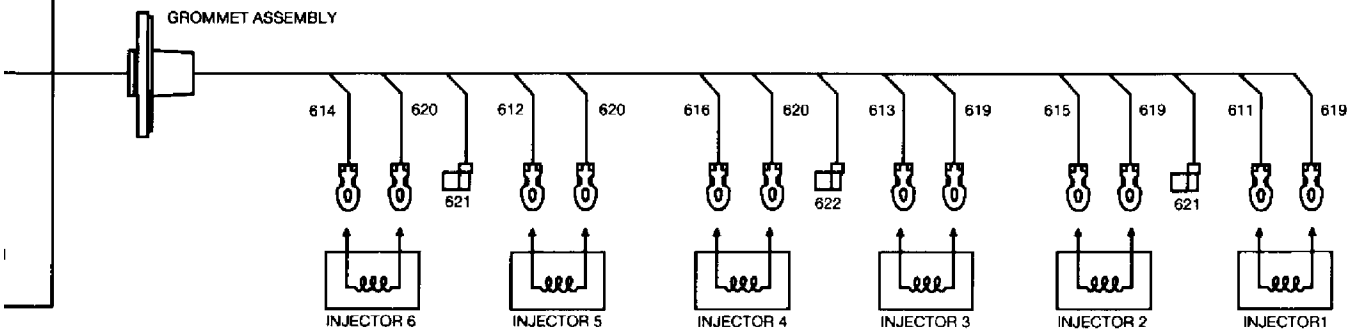
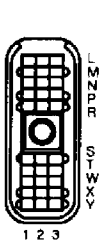
DDEC III/IV WIRING DIAGRAM

DDC RESPONS



INJECTOR HARNESS SCHEMATIC (SERIES 60 WITH JAKE BRAKES SHOWN)



30 WAY CONNECTOR
DDC P/N 12034400
TERMINAL
DDC P/N 12103861

WIRE NO.	COLOR	
925	DK BLU	CAN_H / J1939 (+)
926	DK BLU/WHT	CAN_H / J1939 ( )
927	WHT/BLU	CAN_H / J1939 SHIELD

PROPRIETARY COMMUNICATION LINK THAT IS USED FOR MULTI-BLOCK ECM COMMUNICATIONS

CRANKCASE PRESSURE MONITOR (149 ENGINES ONLY)

452	BLK	A
ANALOG INPUT		B
416	GRA	C

SOLID STATE

OIL AND COOLANT SENSORS

WIRE NO.	COLOR		
452	BLK	A	OIL PRESSURE SENSOR
530	BRN	B	
416	GRA	C	
452	BLK	A	COOLANT PRESSURE SENSOR (92 INDUSTRIAL ENGINES ONLY)
976	DK GRN	B	
416	GRA	C	
452	BLK	A	OIL TEMPERATURE SENSOR
120	TAN	B	
452	BLK	A	COOLANT TEMPERATURE SENSOR
133	YEL	B	

FUEL SENSORS

WIRE NO.	COLOR		
452	BLK	A	FUEL PRESSURE SENSOR
905	YEL	B	
416	GRA	C	
452	BLK	A	FUEL TEMPERATURE SENSOR
472	ORN	B	

WIRE NO.	CC
452	B
432	L
416	G
452	B
904	P
416	G
452	B
132	Y

D.	CAVITY	COLOR
	T-1	PPL
	T-2	DK GRN
	S-2	LT BLU
	S-1	WHT
	R-2	TAN
	N-2	WHT
	P-3	YEL
	W-1	GRA
	P-1	DK GRN
	Y-2	BLACK
	R-3	ORN
	P-2	BRN
	S-3	RED
	T-3	ORN
	W-3	YEL
	X-3	TAN/BLK
	Y-3	RED
	X-1	BRN
	L-1	PPL/WHT
	M-1	YEL
	N-1	ORN
	R-1	DK GRN
	Y-1	LT GRN/YEL
	W-2	ORN
	X-2	PNK
	L-3	DK BLU
	M-3	DK BLU/WHT
	N-3	WHT/BLU
	M-2	BLU
	L-2	DK GRN

CRANK POSITION SENSORS

WIRE NO.	COLOR		
109	PPL	A	TIMING REFERENCE SENSOR
110	DK GRN	B	
112	WHT	A	SYNCHRONOUS REFERENCE SENSOR
111	LT BLU	B	

WIRE NO.	COLOR	
909	LT GRN/YEL	PWM OUT #2
910	ORN	PWM OUT #3
911	PNK	PWM OUT #4
561	LT BLU	ENGINE BRAKE MED - CONNECTS
562	LT GRN	ENGINE BRAKE LOW - CONNECTS
573	BRN	TIMED INPUT
565	RED	TO VEHICLE INTERFACE HARNESS
564	TAN/BLK	
563	YEL	

IO.	CAVITY	COLOR
	H-3	ORN
	D-2	DK BLUE
	B-1	PPL/WHT
	B-3	PNK
	E-1	LT GRN
	F-3	LT BLU
	K-1	GRA
	B-2	PPL
	D-1	BRN
	H-1	GRA/RED
	H-2	GRA
	G-1	BRN/RED
	J-2	ORN
	J-1	YEL/RED
	F-1	YEL
	G-2	ORN/BLK
	F-2	BRN/WHT
	G-3	LT BLUE/YEL
	A-2	TAN
	E-2	LT BLUE/BLK
	E-3	LT BLUE/ORN
	K-2	LT BLUE/BLK
	D-3	YEL
	C-2	DK GREEN/YEL
	C-1	DK GREEN
	J-3	WHT
	A-3	RED/BLK
	C-3	BLK
	K-3	WHT
	A-1	GRA

ONNECTOR		
	A	ORN
	B	BLK/WHT

OEM RESPONSIBILITY

VEHICLE INTERFACE HARNESS

IGNITION

953 BLK/WHT A69

DEDICATED 12/24 VDC BATTERY POWER MUST BE SOURCED DIRECTLY FROM BATTERY POST OR BUS BAR

440 ORN A69

SWITCHED IGNITION

WIRE NO.	COLOR
439	PNK

OFF / ON

MUST PROVIDE IGNITION POWER IN RUN AND CRANK MODES. DO NOT SOURCE ANY ACCESSORY FROM CIRCUIT 439

30 WAY CONNECTOR
DDC P/N 12034398
TERMINAL
DDC P/N 12103881

ALL UNUSED CAVITIES REQUIRE PLUGS (DDC P/N 12034413)

CONNECTOR
DDC P/N 12015378
TERMINAL
DDC P/N 12089188

NOTE:
FUSE MUST BE PLACED BETWEEN MATING CONNECTOR AND BATTERY

TO ENGINE SENSOR HARNESS PIGTAIL

565	RED	E9
564	TAN/BLK	E9
563	YEL	E9

CONNECTOR DDC P/N 12129615
TERMINAL DDC P/N 12045773
CABLE SEAL DDC P/N 12052924
SECONDARY LOCK DDC P/N 1252845

GOVERNOR

WIRE NO.	COLOR	
916	RED/BLK	C
417	DK BLUE	B
952	BLK	A

LIMITING SPEED GOVERNOR (THROTTLE POSITION SENSOR)

WIRE NO.	COLOR	
916	RED/BLK	C
510	BRN	B
952	BLK	A

VARIABLE SPEED GOVERNOR (POWER TAKE-OFF CONTROL)

WIRE NO.	COLOR	
439	PNK	DAS
		DIGITAL OUTPUT
		DIGITAL INPUT
		DIGITAL INPUT
		DIGITAL INPUT
		DIGITAL INPUT
		BRAKE SWITC
		DIGITAL INPUT
953	BLK/WHT	CLUTC SWITC
		VEHICLE SPEED SE
556	LT BLU/BLK	SIGNAL
557	LT BLU/ORN	RETURN
		DIGITAL INPUT
		DIGITAL INPUT
		DIGITAL INPUT
		DIGITAL INPUT
		DIGITAL OUTPUT
		DIGITAL OUTPUT

ENSOR

HT

VEL

12881

12880

INSTRUMENT PANEL

WIRE NO.	COLOR	
509	PPL	RD — STOP ENGINE LIGHT RED
419	PPL/WHT	YEL — CHECK ENGINE LIGHT YELLOW
439	PNK	

POWER HARNESS- SINGLE ECM SINGLE FUSE

12 OR 24 VDC SUPPLY

(+) BATTERY POSITIVE

(-) BATTERY NEGATIVE

CRIMP WIRES INTO SINGLE CONNECTOR AT BATTERY ONLY

COLOR-RED. SEE POWER HARNESS ASSEMBLY SECTION FOR APPROPRIATE CABLE SIZE (2) CABLES REQ'D.

COLOR-BLACK. SEE POWER HARNESS ASSEMBLY SECTION FOR APPROPRIATE CABLE SIZE (4) CABLES REQ'D.

FUSE

5 AMP IGNITION FUSE

CONNECTOR
P/N 12124634
TERMINAL
P/N 12077413
CABLE SEAL / 5 NEEDED
P/N 12015193
SECONDARY LOCK
P/N 12052816

ECM POWER CONNECTOR

CAVITY	WIRE NO.	
C	241	
E	150	
B	151	
D	150	
A	240	
A	440	
B	953	

* USE 12 AWG WIRE NOT TO EXCEED 14 FEET IN LENGTH. REFER TO POWER HARNESS SECTION FOR CABLE REQUIREMENTS. (5 PLACES)

NOTE:
TO VEHICLE INTERFACE HARNESS

DIAGNOSTIC CONNECTOR

WIRE NO.	CAVITY	COLOR	LABEL
900	A	DK GRN/YEL	DATA LINK (+)
901	B	DK GRN	DATA LINK (–)
—	C	RED	+ 12/24 VDC
—	D	CAVITY PLUG P/N 23507136	
953	E	BLK/WHT	BATTERY GROUND
—	F	CAVITY PLUG P/N 23507136	

CONNECTOR & SEAL ASSEMBLY DDC P/N 23513052

PROTECTIVE CAP DDC P/N 23513054

TERMINAL DDC P/N 23513053

WIRE NO.	COLOR	
	DIGITAL INPUT	
953	BLK/WHT	N.O. — DIAGNOSTIC REQUEST AND STOP ENGINE OVERRIDE SWITCH

NOTE: SEE DOCUMENTATION ON OPERATION

MISCELLANEOUS

WIRE NO.	COLOR	
908	WHT	PWM #1
505	GRA	TACHOMETER DRIVE
563	YEL	DIGITAL OUTPUT W-3
564	TAN/BLK	DIGITAL OUTPUT X-3
565	RED	DIGITAL OUTPUT Y-3

DIGITAL INPUT - LOW

DIGITAL INPUT - MEDIUM

BACK SIDE OF SWITCH GROUP

COMMUNICATIONS HARNESS FOR DDEC III/IV

CAVITY	WIRE NO.	COLOR	FUNCTION
F	925	DK BLU	CAN_H / J1939 (+) CONTROL DATA LINK
E	926	DK BLU/WHT	CAN_L / J1939 (–) CONTROL DATA LINK
D	927	WHT/BLU	CAN_H / J1939 SHIELD
C	439	PNK	IGNITION
B	801	TAN	J1922 (–) CONTROL DATA LINK
A	800	TAN/WHT	J1922 (+) CONTROL DATA LINK

CONNECTS DIRECTLY INTO ECM'S COMMUNICATION

CONNECTOR
P/N 12066317

THE METRIC SYSTEM AND EQUIVALENTS

Linear Measure

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

Weights

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Pounds
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

Liquid Measure

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

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 = 0.0386 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

Temperature

5/9 (°F - 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5 C° +32 = F°

APPROXIMATE CONVERSION FACTORS

To Change	To	Multiply By
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Sq Inches	Sq Centimeters	6.451
Sq Feet	Sq Meters	0.093
Sq Yards	Sq Meters	0.836
Sq Miles	Sq Kilometers	2.590
Acres	Sq 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	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Sq 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
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Sq Centimeters	Sq Inches	0.155
Sq Meters	Sq Feet	10.764
Sq Meters	Sq Yards	1.196
Sq Kilometers	Sq Miles	0.386
Sq 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	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Sq Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621

PIN: 078099-000