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TM 5-4210-227-24&P-2 TECHNICAL MANUAL ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST) FOR 85' AERIAL LADDER FIRE FIGHTING TRUCK NSN 4210-00-965-1254 HEADQUARTERS, DEPARTMENT OF THE ARMY COMPLETE MANUAL
TABLE OF CONTENTS Publication Section Section Title TM 5-4210-227-24&P-1 1 Introduction/Tabulated Data 2 Chassis Assembly 3 Pump Assembly 4 Ladder Assembly 5 Hydraulic System 6 Electrical System 7 Pneumatic System 8 Ladder Calibration and Adjustments 9 Illustrations TM 5-4210-227-24&P-2 General Information 1 Engine (less major assemblies) 2 Fuel System and Governors 3 Air Intake Systems 4 Lubrication System 5 Cooling System 6 Exhaust System 7 Electrical Equipment, Instruments and Protective Systems (Sections 8 through 11 not included) 12 Special Equipment 13 Operation 14 Tune-up 15 Preventive Maintenance, Troubleshooting and Storage TM 5-4210-227-24&P-3 1 General Information 2 Description and Operation 3 Preventive Maintenance 4 General Overhaul Information 5 Disassembly of Transmission 6 Rebuild of Subassemblies 7 Assembly of Transmission 8 Wear Limits and Spring Data TM 5-4210-227-24&P-4 1 Allison Automatic Transmission HT 700 Series Parts Catalog 2 Supplemental Parts Information TM 5-4210-227-24&P-5 1 Drive Line 2 Front Axle 3 Rear Axle 4 Steering System 5 Fuel System 6 Brake System 7 Electrical System 8 Miscellaneous COMPLETE MANUAL TABLE OF CONTENTS Publication Section Section Title TM 5-4210-227-24&P-5 9 General Information (continued) 10 Installation Instructions 11 Troubleshooting and Service TM 5-4210-227-24&P-7 General Information 1 Engine (less major assemblies) 2 Fuel System and Governors 3 Air Intake System 4 Lubricator System 5 Cooling System 6 Exhaust System 7 Electrical Equipment, Instruments and Protective Systems 8 Power Take-off and Torque Converter 9 Transmissions (Sections 10 and 11 not included) 12 Special Equipment 13 Operation 14 Tune-up 15 Preventive Maintenance, Troubleshooting and Storage TM 5-4210-227-24&P-8 Parts List and Foldouts Tools and Equipment TM 5-4210-227-10 1 Introduction/Tabulated Data 2 Operator's Instructions 3 Operator Maintenance 4 Illustrations 5 Operator's Manual, Series 92 Engines 6 Operator's Manual, Series V-71 Engines 7 Built-in Parts Book for Detroit Diesel Engines 8 Operator's Manual, Fire Apparatus Chassis FOREWORD Descriptions, instructions and parts listing pertaining to the Model QWT 85 are discussed throughout this manual under the general headings Chassis, Pump and Ladder. Foldout illustrations and schematics are located at the rear of this volume. The foldout format is provided in order that illustrations and schematics may be referred to while the supporting text is being examined and studied. A detailed description is given in the Introduction of each volume to assist the user in finding the information required to maintain the equipment. -Operator's Manual (TM 5-4210-227-10)
This manual is designed to provide the information necessary for a fire fighter or mechanic to properly operate the truck, the pump and the ladder. -Maintenance Manual (TM 5-4210-227-24&P) This manual is divided into 8 volumes and contains the information necessary for an experienced mechanic to maintain and repair all facets of the apparatus. Each volume is individually indexed for ease of reference.
This manual contains all the information necessary to obtain assemblies and sub-assemblies or individual parts, required to repair and maintain the fire truck. TABULATED DATA a)Fire Truck Federal Stock Number: 4210-00-965-1254 Manufacturer 's Serial No.: Registration Nos.: CM3653 through CM3664 Manufacturer: Pierre Thibault Inc. Model: QWT 85 Contract Number: DAAJ10-84-A218 Truck Length: 459" Truck Width: 108" Truck Height: 138" Capacity or Payload: 51,000 GVWR Shipping Weight: 43,880 Ground Clearance: 10.25" Weight Loaded: 45,940 Front Axle 19,740 Rear Axle 26,200 b) Chassis Manufacturer: Duplex I.D. Number: I.C. ID91 D31 D6F 1008468 Model: D350 Wheel Base 230" c) Engine Manufacturer: Detroit Diesel Model: 8V-71 Turbo Serial Number: 8VA437868 Fuel: Diesel iii d) Transmission Manufacturer: Allison Model: HT-740 Serial No.: 2510087501 Capacity: 7 1/2 Gals e)Firefighting Water Pump Manufacturer: Hale Model: QSM FHD100 Capacity: 1000 GPM @ 150 psi f) Front Axle Manufacturer: Rockwell International Model: FL 941 QX-70 Capacity: 20,000 lbs. derivation of kinematic equations using calculus pdf Serial No.: N766718 f)1. Front Shock Absorbers Manufacturer: Duplex Model: 7605-1258 f)2. Front Springs Manufacturer Duplex Model: 7804-6731 g) Rear Axle Manufacturer: Rockwell International Model: U-170 PX-99 Capacity: 31,000 lbs. Serial No.: NW845892 g)1. Rear Suspension Manufacturer: Hendrickson Model: Single Axle RS-SA-340 h) Alternator Manufacturer: Delco Remy Model: Amp. 145 i) Batteries Manufacturer: Harris Model: 7605-0670 Voltage: 12 j)Battery Isolator Manufacturer: Sure Power Model: 1602 Rated Power: 3709 BHP @ 2,100 rpm k)Steering Gear Manufacturer: Sheppard Model: 7605-5478 l)Power Steering Pump Manufacturer: Vickers Model: 7605-5256 m)Windshield Wipers Manufacturer: American Bosch Model: WWC-12L Type: Electric n)Radiator Manufacturer: Blackstone Model: 7605-3750 o) Air Cleaner Manufacturer: FAAR Model: 62891-3 p)Driver's Seat Manufacturer: Bostrom Model: Four-way Adjustable Type: Standard q) Wheels Front: Manufacturer: Firestone Size: 22.5 x 16.5 Rear: Manufacturer: Firestone Size: 20 x 8.5 r) Tires Front: Manufacturer: Goodyear Size: 16.5 R 22.5 - 18 P.R. Capacity: 20,000 lbs Rear: Manufacturer: Michelin Size: 12.00 R 20X - 18 P.R. Capacity 31,000 lbs. s) Muffler Manufacturer: Nelson Model: 86130-21 t)AC Inverter Manufacturer: Dynamote Model: A40-120 u) Siren/PA Manufacturer: Code 3 Model: 3100 CAPABILITIES Fire Truck Turning Radius - Inside 31.5' - Outside 42.25' Rated Power: 370 BHP @ 2,100 rpm Engine Governor Setting: No Load - 2,100; Top Speed 58 mph Acceleration: 0 - 35 mph - 14 Seconds Braking: 20 to 0 mph - 15 feet Angle of Departure: Front - 15 degrees; Rear - 15 degrees Pump Single Stage Centrifugal Midship Mounted Driven by the truck engine from the output shaft of transmission Min discharge - 1000 gpm @ 150 psi Min discharge - 100 gpm @ 200 psi Min discharge - 500 gpm @ 250 psi From dry condition - take suction and discharge water in 30 sec.



with a lift of 10 deg through 20' of 6" suction hose 12 VDC Priming Pump Water Tank - 200 gals. Ladder Basic Weight - 11,560 lbs., Outtrigger Operation Speed Lower: Front - 9 sec. bedford_book_of_genres_fsu.pdf Rear - 18 sec. Raise: Front - 9 sec. Rear - 18 sec. Complete extension, elevation and 90 degrees rotation within 60 sec. Hydraulic Tank: 45 gals. (Imp.) MAINTENANCE MANUAL SECTION I 1. INTRODUCTION/TABULATED DATA 1.1. INTRODUCTION 1.1.1. TM 5-4210-227-24&P, Organizational, Direct Support, and General Support Maintenance Manual for the 85' Aerial Ladder Fire Fighting Truck is divided into eight volumes. These eight volumes are further subdivided into specific sections consisting of both Government and commercial literature. key elements of organizational behavior pdf TM 5-4210-227-10, Operator's Manual for the 85' Aerial Ladder Fire Fighting Truck is one separate manual consisting of four separate sections. 1.1.2. This volume consists of 12 sections and is arranged as follows: GENERAL INFORMATION 1. Engine (less major assemblies) 2. Fuel System and Governors 3. Air Intake Systems 4. Lubrication System 5. Cooling System 6. Exhaust System 7. Electrical Equipment, Instruments and Protective Systems 12. Special Equipment 13. Operation 14. Tune-Up 15. Preventive Maintenance, Troubleshooting and Storage NOTE For the Parts List for the 3V-71 Turbo Engine refer to duplex "Engine - Common-Parts" (on the following page) and "DETROIT DIESEL ENGINES - V71 OPERATORS' MANUAL," Section 8, "BUILT IN PARTS BOOK.1" IMPORTANT SAFETY NOTICE Proper service and repair is important to the safe, reliable operation of all motor vehicles. The service procedures recommended by Detroit Diesel Allison and described in this service manual are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when and as recommended. It is important to note that some warnings against the use of specific service methods that can damage the vehicle or render it unsafe are stated in this service manual. It is also important to understand these warnings are not exhaustive. Detroit Diesel Allison could not possibly know, evaluate and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. descriptive evaluative research design pdf Consequently, Detroit Diesel Allison has not undertaken any such broad evaluation. Accordingly, anyone who uses a service procedure or tool which is not recommended by Detroit Diesel Allison must first satisfy himself thoroughly that neither his safety nor vehicle safety will be jeopardized by the service method he selects. Printed in U.S.A. c 1982 General Motors Corp. FOREWORD This manual contains instructions on the overhaul, maintenance and operation of the basic V-71 Detroit Diesel Engines. Full benefit of the long life and dependability built into these engines can be realized through proper operation and maintenance. 89291129837.pdf Of equal importance is the use of proper procedures during engine overhaul. Personnel responsible for engine operation and maintenance should study the sections of the manual pertaining to their particular duties. Similarly, before beginning a repair or overhaul job, the serviceman should read the manual carefully to familiarize himself with the parts or sub-assemblies of the engine with which he will be concerned. business self evaluation examples The information, specifications and illustrations in this publication are based on the information in effect at the time of approval for printing. This publication is revised and reprinted periodically. It is recommended that users contact an authorized Detroit Diesel Service Outlet for information on the latest revisions. The right is reserved to make changes at any time without obligation. TABLE OF CONTENTS SUBJECT GENERAL INFORMATION 1 ENGINE (less major assemblies) 2 FUEL SYSTEM AND GOVERNORS 3 AIR INTAKE SYSTEM 4 LUBRICATION SYSTEM 5 COOLING SYSTEM 6 EXHAUST SYSTEM 7 ELECTRICAL EQUIPMENT, INSTRUMENTS AND PROTECTIVE SYSTEMS 12 SPECIAL EQUIPMENT 13 OPERATION 14 TUNE-UP 15 PREVENTIVE MAINTENANCE, TROUBLE SHOOTING AND STORAGE 1980 General Motors Corporation Sept., 1980 General Information DETROIT DIESEL V-71 (Vehicle) SCOPE AND USE OF THE MANUAL This manual covers the basic V-71 on-highway vehicle diesel engines built by the Detroit Diesel Allison Division of General Motors Corporation. Complete instructions on operation, adjustment (tune-up), preventive maintenance and lubrication, and repair (including complete overhaul) are covered. The manual was written primarily for persons servicing and overhauling the engine and, in addition, contains all of the instructions essential to the operators and users. engineering technology practical gui Basic maintenance and overhaul procedures are common to all V-71 engines and therefore apply to all engine models. The manual is divided into numbered sections. vemeni.pdf The first section covers the engine (less major assemblies). The following sections cover a complete system such as the fuel system, lubrication system or air system. Each section is divided into subsections which contain complete maintenance and operating instructions for a specific subassembly on the engine. For example, Section 1, which covers the basic engine, contains subsection 1.1 pertaining to the cylinder block, subsection 1.2 covering the cylinder head, etc. The subjects and sections are listed in the Table of Contents on the preceding page. Pages are numbered consecutively, starting with a new Page 1 at the beginning of each subsection. The illustrations are also numbered consecutively, beginning with a new Figure 1 at the start of each subsection. Information regarding a general subject, such as the lubrication system, can best be located by using the Table of Contents. Opposite each subject in the Table of Contents is a section number which registers with a tab printed on the first page of each section throughout the manual. Information on a specific subassembly or accessory can then be found by consulting the list of contents on the first page of the section. For example, the cylinder liner is part of the basic engine, therefore, it will be found in Section 1. 33979921260.pdf



Looking down the list of contents on the first page of Section 1, the cylinder liner is found to be in subsection 1.6.3. An Alphabetical Index at the back of the manual has been provided as an additional aid for locating information. SERVICE PARTS AVAILABILITY Genuine Detroit Diesel Allison service parts are available in the United States from authorized distributors and service dealers throughout the world. A complete list of all distributors and dealers is available in the World Wide Parts and Service Directory, 6SE280. This publication can be ordered from any authorized distributor. CLEARANCES AND TORQUE SPECIFICATIONS Clearances of new parts and wear limits on used parts are listed in tabular form at the end of each section throughout the manual. simpson 3100 power washer manual It should be specifically noted that the "New Parts" clearances apply only when all new parts are used at the point where the various specifications apply. This also applies to references within the text of the manual. The column entitled "Limits" lists the amount of wear or increase in clearance which can be tolerated in used engine parts and still assure satisfactory performance. It should be emphasized that the figures given as "Limits" must be qualified by the judgment of personnel responsible for installing new parts. These wear limits are, in general, listed only for the parts more frequently replaced in engine overhaul work. For additional information, refer to the paragraph entitled Inspection under General Procedures in this section. vuguvopivudap.pdf Bolt, nut and stud torque specifications are also listed in tabular form at the end of each section. Page 4 © 1980 General Motors Corp. General Information DETROIT DIESEL V-71 (Vehicle) PRINCIPLES OF OPERATION The diesel engine is an internal combustion power unit, in which the heat of fuel is converted into work in the cylinder of the engine. In the diesel engine, air alone is compressed in the cylinder; then, after the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition is accomplished by the heat of compression. The Two-Cycle Principle In the two-cycle engine, intake and exhaust take place during part of the compression and power strokes respectively as shown in Fig. 1. In contrast, a four cycle engine requires four piston strokes to complete an operating cycle; thus, during one half of its operation, the four-cycle engine functions merely as an air pump. A blower is provided to force air into the cylinders for expelling the exhaust gases and to supply the cylinders with fresh air for combustion. The cylinder wall contains a row of ports which are above the piston when it is at the bottom of its stroke. These ports admit the air from the blower into the cylinder as soon as the rim of the piston uncovers the ports as shown in Fig. 1 (scavenging). The unidirectional flow of air toward the exhaust valves produces a scavenging effect, leaving the cylinders full of clean air when the piston again covers the inlet ports. 44824784205.pdf As the piston continues on the upward stroke, the exhaust valves close and the charge of fresh air is subjected to compression as shown in Fig. 1 (compression). 14506023054.pdf Shortly before the piston reaches its highest position, the required amount of fuel is sprayed into the combustion chamber by the unit fuel injector as shown in Fig. 1 (power). 2010 rav 4 manual The intense heat generated during the high compression of the air ignites the fine fuel spray immediately. The combustion continues until the fuel injected has been burned. The resulting pressure forces the piston downward on its power stroke. The exhaust valves are again opened when the piston is about half way down, allowing the burned gases to escape into the exhaust manifold as shown in Fig. 1 (exhaust). Shortly thereafter, the downward moving piston uncovers the inlet ports and the cylinder is again swept with clean scavenging air. 68879523026.pdf This entire combustion cycle is completed in each cylinder for each revolution of the crankshaft, or, in other words, in two strokes; hence, it is a "two-stroke cycle". FIG.

There must not be over .001" difference between any two adjacent cylinder counterbores when measured along the cylinder longitudinal centerline of the cylinder block. 7. Check the main bearing bores as follows: a. Check the bore diameters with the main bearing caps in their original positions. Bearing caps are numbered to correspond with their

One must not be over 100% difference between any two adjacent cylinder counterbores then measured along the cylinder longitudinal centerline or the cylinder block. 7) Check the main bearing bore as follows: check the bore diameter with the main bearing caps in their original positions. Bearing caps are numbered to correspond with their

the respective positions in the cylinder block. It is imperative that the bearing caps be reinstalled in their original positions to maintain the main bearing bore alignment. The number of the front main bearing cap is also stamped on the face of the oil pan mounting flange of the cylinder block adjacent to its permanent location in the engine as established at the time of manufacture. The No. 1 main bearing cap is always located at the end opposite the flywheel end of the cylinder block (Fig. 15). Lubricate the bolt threads and bolt head contact areas with a small quantity of International Compound No. 2, or equivalent. Then install and tighten the bolts to 165-175 lb-ft (224-238 Nm) torque. When making this check, do not install the main bearing cap stabilizers. The specified bore diameter is 4.812", to 4.813". If the bores do not fall within these limits, the cylinder block must be rejected. NOTE: Main bearing cap bolts are especially designed for this purpose and must not be replaced by ordinary bolts. b.Finished and unfinished main bearing caps are available for replacing broken or damaged caps. When fitting a finished replacement bearing cap, it may be necessary to try several caps before one will be found to provide the correct bore diameter and bore alignment. If a replacement bearing cap is installed, be sure to stamp the correct bearing position number on the cap. NOTE: Use the unfinished bearing caps for the front and intermediate bearing positions. The finished bearing caps, machined for the crankshaft thrust washers, are to be used in the rear bearing position. c.Main bearing bores are line-bored with the bearing caps in place and thus are in longitudinal alignment. If a main bearing bore is more than .001" maximum overall misalignment or .0005" maximum misalignment between adjacent bores the block must be line-bored (see Section 1.0) or scrapped. Misalignment may be caused by a broken crankshaft, excessive heat or other damage. d.If the main bearing bores are not in alignment © 1982 General Motors Corp. April, 1982 SEC. 1.1 Page 9 1.1 Cylinder Block DETROIT DIESEL V-71 (Vehicle) when a replacement bearing cap is used, the block must be line-bored (see Section 1.0). 8.Refer to the Cylinder Block Plugging Chart shown as a fold-out at the end of this manual and install the necessary plugs and dowels.

9.Replace loose or damaged dowel pins. The dowels at the ends of the cylinder block must extend .630". The dowels used to retain the crankshaft thrust washers on the rear main bearing cap must extend .110" to .120 " from the surface of the bearing cap. NOTE: A stepped dowel pin is available to replace loose pins in the rear main bearing cap. Before installing the stepped pins, rebore the dowel holes in the bearing cap with a No. 11 (.1910") or No. 12 (.1890") drill. After pressing the pins into the bearing cap, remove all burrs from the base of the dowel pins to ensure proper seating of the thrust washers. 10. If used, replace damaged or broken cylinder head studs. Drive new studs to a height of 4 3/8" ± 1/32" above the block at a minimum of 75 lb-ft (102 Nm) torque. Also examine the cylinder head retaining bolt holes. If the threads are damaged, use a tap to "cleanup" the threads or install a helical thread insert. 1 1. The tapped holes in the water-below-port cylinder blocks may be tapped with a 5/8"-1 1 UNC3B thread tap. The stud holes and unplugged bolt holes must have the thread extending 1.850" below the block surface. If the bolt hole in the block is plugged, the plug must be a minimum of 2.040" below the surface of the block and threaded the full distance (1.920" on blocks prior to January, 1975). When replacing a bolt hole plug in the current water-below-port block, refer to Shop Notes in Section 1.0. 12.Check the remaining cylinder block surfaces and threaded holes. Check all of the mating surfaces, or mounting pads, for flatness, nicks and burrs. Clean-up damaged threads in tapped holes with a tap or install helical thread inserts, if necessary. 13.After inspection, if the cylinder block is not to be used immediately, spray the machined surfaces with engine oil. If the block is to be stored for an extended period of time, spray or dip it in a polar type rust preventive such as Valvoline Oil Company's "Tectyl 502-C", or equivalent. Castings free of grease or oil will rust when exposed to the atmosphere. Assemble and Install Engine After the cylinder block has been cleaned and inspected, assemble the engine as follows: NOTE: Before a reconditioned or new service replacement cylinder block is used, steam clean it to remove the rust preventive and blow out the oil galleries with compressed air. 1.Mount the cylinder block on the overhaul stand. 2.If a new service replacement block is used, stamp the engine serial number and model number on the right-hand side of the cylinder block. Also stamp the position numbers on the main bearing caps (Fig. 15) and the position of the No. 1 bearing on the oil pan mounting flange of the block. 3.Install all of the required cylinder block plugs and drain cocks. Use a good grade of non-hardening sealant on the threads of the plugs and drain cocks. Install the plugs flush with or below the surface of the block. NOTE: Make sure the cap plug, which blocks the oil cooler adaptor inlet from the adaptor outlet, is installed in the vertical passage. 4.Check the cam pocket drain hole spring pin (if used) in the front end of the block to be sure it is installed with the slot up. 5.Clean and inspect all engine parts and subassemblies and, using new parts as required, install them on the cylinder block by reversing the sequence of disassembly. The procedures for inspecting and installing the various parts and subassemblies are outlined in the following sections of this manual. 6.Use a chain hoist and suitable sling to transfer the engine to a dynamometer test stand. 7.Complete the engine build-up by installing all remaining accessories, fuel lines, electrical connections, controls etc. 8.Operate the engine on a dynamometer, following the run-in procedure outlined in Section 13.2.1. 9. Reinstall the engine in the vehicle. Page 10 ©1982 General Motors Corp. DETROIT DIESEL V-71 (Vehicle) 1.1.1 CYLINDER BLOCK END PLATES A flat steel plate, one bolted to each end of the cylinder block, provides a support for the flywheel housing at the rear and the balance weight cover at the front of the engine. Gaskets are used between the block and each end plate. Inspection When an end plate is removed, it is essential that all of the old gasket material be removed from both surfaces of the end plate and the cylinder block. Clean the end plate as outlined under Clean Cylinder Block in Section 1. 1. Inspect both surfaces of each end plate for nicks, dents, scratches or score marks and check the end plates for warpage. Check the plug nuts in the end plates for cracks or damaged threads. If nicks or scratches on the sealing surfaces of the end plates are too deep to be cleaned up, or the plug nuts are damaged, replace the end plates or plug nuts. When installing a plug nut, support the end plate on a solid flat surface to avoid distorting the plate. Then press the nut in the end plate until the head on the nut seats on the end plate. Install Cylinder Block Breather Pads A new breather pad designed to improve crankcase ventilation, was used beginning with engine 6VA16943, 8VA-7508 and 12VA-2332. The new pad differs from the two former pads in width only. To compensate for the decrease in width, two retainers have been provided to hold the new pads in the cavities behind the cylinder block rear end plate (Fig. 2). NOTE: Turbocharged engines do not require breather pads. After cleaning the breather pads and prior to installing the cylinder block rear end plate, reinstall the breather pads and retainers, if used, in the block as shown in Fig. 2. NOTE: Since the former breather pads were not the same size, be sure to reinstall them in their original locations. The end plates, when assembled to -the block, will apply pressure on the retainers and hold the pads in position. FIG. 1 - Cylinder Block End Plates and Relative Location of Parts ©1981 General Motors Corp. January , 1981 SEC. 1.1.1 Page 1 1.1.1 End Plates DETROIT DIESEL V-71 (Vehicle) FIG. 2 - Current Breather Pads and Retainers Installed in Cylinder Block Install End Plates 1.Affix new gaskets to the ends of the cylinder block, using a non-hardening gasket cement. Also apply an even coating of gasket cement to the outer surface of each gasket (the surface next to the end plate). Also attach the small round gasket to the corner at the front end of the cylinder block (Fig. 1). -NOTE: Do not use the V-92 gasket on engines built prior to January, 1977. Use the V-71 front end plate gasket that has been reinstated for service. 2.Attach the front end plate to the cylinder block with bolts and lock washers. Tighten the bolts finger tight. 3.Wipe the excess gasket cement from the bores in the end plate and the cylinder block. 4.Insert the right bank camshaft end bearing through the SMALL bearing bore in the end plate and into the bore of the block to accurately align the end plate with the cylinder block as shown in Fig. 3. FIG. 3 - Installing Front End Plate (8V Engine) NOTE: The holes in the front and rear end plates for the camshaft end bearings are not the same size. The smaller hole is accurately machined for alignment purposes and is always located on the right side of the engine as viewed from the rear. 5. With the bearing in place, tighten the 1/2"-13 end plate-to-cylinder block bolts to 71-75 lb-ft (96-102 Nm) torque. Tighten the 3/8"-16 bolts to 30-35 lb-ft (41-47 Nm) torque. Then remove the camshaft bearing which served as a pilot while attaching the front end plate. NOTE: On former blocks, tighten the 3/8"-16 bolts which thread into the special water jacket plugs in the cylinder block to 20-25 lb-ft (27-34 Nm) torque. On certain engines, a special washer is used with these bolts. 6. Install the rear end plate in the same manner as outlined above for the front end plate. NOTE: If used, attach the small cover to the cylinder block side of the rear end plate with two bolts and copper washers prior to installing the end plate. Use a new gasket between the cover and the end plate. 7. Trim off any excess gasket material. Page 2 ©1981 General Motors Corp. DETROIT DIESEL V-71 (Vehicle) 1.1.2 AIR BOX DRAINS During normal engine operation, water vapor from the air charge, as well as a slight amount of fuel and lubricating oil fumes, condenses and settles on the bottom of the air box. This condensation is removed by the air box pressure through air box drain tubes mounted on the sides of the cylinder block (Fig. 1, 2 or 3). Air box drains must be kept open at all times, otherwise water and oil that may accumulate will be drawn into the cylinders. Certain 6 and 8V upright engines have the air box drain tubes routed to the crankcase at the rear dipstick holes at each side of the engine, rather than to the atmosphere (Fig. 2).

In conjunction with the new drain tubes, a check (control) valve has been installed in the air box drain fitting on each side of the engine to allow drainage only at low air box pressures. The check valve cutaway shows the valve operating at engine idle speed (Figs. 2 and 3). As the engine speed and air box pressure increase, the valve moves forward and seats, blocking air-flow. The check valve is only serviced as an assembly. Effective with engines built approximately June, 1981, the air box drains are being routed to the atmosphere (Fig. 3). Engines which have a closed air box drain system (Fig. 2) can be equipped with an open air box system (Fig. 3) - see Shop Notes in Section 1.0. Inspection A periodic check for air flow from the air box drain tubes should be made (refer to Section 15. 1). NOTE: Engines built prior to January 18, 1979 which use a 1/8"-18 pipe nipple in the sides of the air box drain system should be kept open. If plugged, this could cause a loss of engine lubricating oil. Inspect the check valve for proper operation as follows: 1.Disconnect the drain tube from the check valve. 2.Run the engine and note the airflow through the valve at idle speed. 3.If the check valve is operating properly, there will be no airflow at engine speeds above idle. To check the air box pressures on an engine with a closed air box drain system, use an air box cover with a tapped hole for a fitting. FIG. 1 - Air Box Drain Tube FIG. 2 - Closed Design Air Box Drain Tube and Check Valve System (6 and 8V Engines) © 1982 General Motors Corp. April, 1982 SEC. 1.1.2 Page 1 1.1.2 Air Box Drains DETROIT DIESEL V-71 (Vehicle) 1. Remove the plug in the cover. 2. Install a fitting and short drain tube. 3. Attach a manometer to the end of the drain tube and check the air box pressure as stated in Section 13.2. FIG. 3 - Open Design Air Box Drain Tube and Check Valve System Page 2 ©1982 General Motors Corp. DETROIT DIESEL V-71 (Vehicle) 1.2 CYLINDER HEAD The cylinder head (Figs. 1, 2 and 3), one on each cylinder bank, is a one-piece casting securely held to the cylinder block by special bolts. The exhaust valves, fuel injectors and the valve and injector operating mechanism are located in the cylinder head. Depending upon the engine application, either two or four exhaust valves are provided for each cylinder. Exhaust valve seat inserts, pressed into the cylinder head, permit accurate seating of valves under varying conditions of temperature and materially prolong the life of the cylinder head. To ensure efficient cooling, each fuel injector is inserted into a thin-walled tube (Fig. 4) which passes through the water space in the cylinder head. The lower end of the injector tube is pressed into the cylinder head and flared over; the upper end is flanged and sealed with a neoprene seal. The sealed FIG. 1 - Typical Cylinder Head Assembly (Two-Valve) (c) 1980 General Motors Corp. March, 1980 SEC. 1.2 Page 1 1.2 Cylinder Head DETROIT DIESEL V-71(Vehicle) FIG. 2 - Typical Cylinder Head Assembly (Four-Valve) upper end and flared lower end of the injector tube prevent water and compression leaks. The exhaust passages from the exhaust valves of each cylinder lead through a single port to the exhaust manifold. The exhaust passages and the injector tubes are surrounded by engine coolant. In addition, cooling of the above areas is further ensured by the use of water nozzles (Figs. 5 and 6) pressed into the water inlet ports in the cylinder head. The nozzles direct, the comparatively cool engine coolant at high velocity toward the sections of the cylinder head which are subjected to the greatest heat. The fuel inlet and outlet manifolds are cast as an integral part of the cylinder heads. Tapped holes are Page 2 provided for connection of the fuel lines at various points along each manifold. The water manifold is also cast as an integral part of the cylinder head for 6V and 8V engines and certain current 12V engines. To seal compression between the cylinder head and the cylinder liner, separate laminated metal gaskets are provided at each cylinder. Water and oil passages between the cylinder head and cylinder block are sealed with synthetic rubber seal rings which fit into counterbored holes in the block. A synthetic rubber seal fits into a milled groove near the perimeter of the block. When the cylinder head is drawn down, a positive leakproof metal-to-metal contact is assured between the head and the block. Page 2 (C) 1980 General Motors Corp. DETROIT DIESEL V-71 (Vehicle) Cylinder Head 1.2 FIG. 3 - Cylinder Head Mounting To make the cylinder heads more tolerant of abnormal coolant temperature, relief areas have been cast in the current four valve cylinder heads. These stress relief areas, which are shaped like a "dog bone", are cast in the fire deck of the cylinder head between the cylinders (Fig. 7). For visual identification of the current cylinder head on an engine, two bosses (at a later date a raised boss the shape of a "dog bone") are cast on the fuel manifold side of the three cylinder heads (6V engines) and a raised boss the shape of a "dog bone" is cast on the exhaust manifold side of the four (8V engines) and six (12V engines) cylinder heads FIG. 4 - Coolant Passages Around Exhaust Valves and Fuel Injectors (C 1980 General Motors Corp. FIG. 5 - Water Nozzles in Two-Valve Cylinder Head (Fig. 8). The current service cylinder heads which include the stress relief areas in the fire deck also include the nonmagnetic turbo exhaust valve inserts identified by the letter "T" stamped on the face of the cylinder head. NOTE: Production non-turbocharged cylinder heads include cast steel exhaust valve seat inerts which have magnetic qualities. An easy method for determining the type of exhaust valve seat insert in a cylinder head is with a magnet. The magnet will be attracted to the non-turbo insert (will stick). The magnet will not be attracted to the turbo insert, it will jump to the cylinder head. Cylinder Head Maintenance The engine operating temperature should be maintained between 160 -185 °F (71 °-85 °C) and the cooling system should be inspected daily and kept full at all times. The cylinder head fire deck will overheat and crack in a short time if the coolant does not cover the fire deck surface. When necessary, add coolant slowly to a hot engine to avoid rapid cooling which can result in distortion and cracking of the cylinder head (and cylinder block). (c) 1980 General Motor Corp. March, 1980 SEC. 1.2 Page 3 1.2 Cylinder Head DETROIT DIESEL V-71(Vehicle) FIG. 6 - Water Nozzles in Four-Valve Cylinder Head Abnormal operating conditions or neglect of certain maintenance items may cause cracks to develop in the cylinder head. If this type of failure occurs, a careful inspection should be made to find the cause and avoid a recurrence of the failure. Unsuitable water in the cooling system may result in lime and scale formation and prevent proper cooling. The cylinder head should be inspected around the exhaust valve water jackets. This can be done by removing an injector tube. Where inspection discloses such deposits, use a reliable non-corrosive scale remover to remove the deposits from the cooling system of the engine, since a similar condition will exist in the cylinder block and other components of the engine. Refer to Section 13.3 for engine coolant recommendations. Loose or improperly seated injector tubes may result in compression leaks into the cooling system and also result in loss of engine coolant. The tubes must be tight to be properly seated. Refer to Section 2.1.4. Overtightened injector clamp bolts may also cause head cracks. Always use a torque wrench to tighten the bolts to the specified torque. FIG. 7 - Current Four Valve Cylinder Head Other conditions which may eventually result in cylinder head cracks are: 1.Excess fuel in the cylinders caused by leaking injectors. 2.Sipping fan belts can cause overheating by reducing air flow through the radiator. 3.Accumulation of dirt on the radiator core which will reduce the flow of air and slow the transfer of heat from the coolant to the air. 4.Inoperative radiator cap which will result in loss of coolant. Remove Cylinder Head Certain service operations on the engine require removal of the cylinder head: 1.Remove and install pistons. 2.Remove and install cylinder liners. 3.Remove and install exhaust valves. FIG. 8 - Current Four Valve Cylinder Head Identification Page 4 (C) 1980 General Motors Corp. DETROIT DIESEL V-71 (Vehicle) Cylinder Head 1.2.4 Remove and install exhaust valve guides. 5.Recondition exhaust valves and valve seat inserts. 6.Replace fuel injector tubes. 7.Install new cylinder head gaskets and seals. 8.Remove and install camshaft. Due to the various optional and accessory equipment used, only the general steps for removal of the cylinder head are covered. If the engine is equipped with accessories that affect cylinder head removal, note the position of each before disconnecting or removing them to ensure correct reinstallation. Then remove the cylinder head as follows: 1.Drain the cooling system. 2.Disconnect the exhaust piping at the exhaust manifold. On turbocharged engines, remove the connections from the exhaust manifold to the turbocharger. Remove the turbocharger, if necessary. 3.Disconnect the fuel lines at the cylinder head. 4.Looseen the hose clamps and remove the hose attached to the thermostat housing cover. 5.Looseen the hose clamps at each end of the water bypass tube and remove the tube. 6.Remove the thermostat housing assembly. 7.Clean and remove the valve rocker cover and governor cover. 8.Disconnect the fuel rod from the injector control tube lever and the governor. Remove the fuel rod. 9.Looseen the fuel rod cover hose clamps. Then slide the hose up on the fuel rod cover toward the governor. 10.Remove the exhaust manifold. 11.Remove the water manifold, if used. 12.Remove the injector control tube and brackets as an assembly. 13.If the cylinder head is to be disassembled for reconditioning of the exhaust valves and valve seat inserts or for a complete overhaul, remove the fuel pipes and injectors at this time. Refer to Section 2.1 or 2.1.1 for removal of the injectors. 14.Check the torque on the cylinder head bolts and stud nuts (if used) before removing the head. Then remove the bolts and stud nuts (if used) and lift the cylinder head from the cylinder block with tool FIG. 9 Removing or Installing Cylinder Head with Tool J 22062-01 J 22062-01 (Fig. 9). If interference is encountered between the rear end of the right-bank cylinder head and any of the flywheel housing attaching bolts, loosen the bolts. Checking the torque before removing the head bolts and/ examining the condition of the compression gaskets and seals after the head is removed may reveal the causes of any cylinder head problems. NOTE: When placing the cylinder head assembly on a bench, protect the cam followers and injector spray tips, if the injectors were not FIG. 10 - Cylinder Head Mounted on Holding Plates (J 3087-01) (c) 1982 General Motor Corp. April, 1982 SEC. 1.2 Page 5 1.2 Cylinder Head DETROIT DIESEL V-71(Vehicle) FIG. 11 - Cylinder Head Prepared for Pressure Testing using Tool J 28454 removed, by resting the valve side of the head on 2 " wood blocks. 15.Place the cylinder head on its side and remove the engine lifter brackets and gaskets. Then attach the cylinder head holding plates J 3087-01 (Fig. 10) to raise the head above the work bench. 16.Remove and discard the cylinder head compression gaskets, oil seals and water seals. 17.After the cylinder head has been removed, drain the lubricating oil from the engine. Draining the oil at this time will remove any coolant that may have worked its way to the oil pan when the head was removed. Disassemble Cylinder Head If complete disassembly of the cylinder head is necessary, refer to Sections 1.2.1 and 1.2.2 for removal of the exhaust valve and injector operating mechanism. Clean Cylinder Head After the cylinder head has been disassembled and all of the plugs (except cup plugs) have been removed, thoroughly steam clean the head. If the water passages are heavily coated with scale, remove the injector tubes and water nozzles. Then clean the cylinder head in the same manner as outlined for cleaning the cylinder block (Section 1.1).

Clean all of the cylinder head components with fuel oil and dry them with compressed air. Inspect Cylinder Head 1. Before a cylinder head can be reused, it must be inspected for cracks. Five prescribed methods for checking a cylinder head for cracks are as follows: NOTE: If any method reveals cracks, the cylinder head should be considered unacceptable for reuse. Magnetic Particle Method: The cylinder head is magnetized and then covered with a fine magnetic powder or solution. Flaws, such as cracks, form a small local magnet which cause the magnetic particles in the powder or solution to gather there, effectively marking the crack. The cylinder head must be demagnetized after the test. FIG. 12 - Checking Bottom Face of Cylinder Head Page 6 (C) 1982 General Motors Corp. DETROIT DIESEL V-71 (Vehicle) Cylinder Head 1.2 Fluorescent Magnetic Particle Method: This method is similar to the magnetic particle method, but is more sensitive since it uses fluorescent magnetic particles which glow under a "Black Light". Very fine cracks, especially on discolored or dark surfaces, that may be missed using the Magnetic Particle Method will be disclosed under the "Black Light". Fluorescent Penetrant Method: A highly fluorescent liquid penetrant is applied to the area in question. Then the excess penetrant is wiped off the surface and the part is dried. A developing powder is then applied which helps to draw the penetrant out of the flaws by capillary action. Inspection to find the crack is carried out using a "Black Light". Non-Fluorescent Penetrant Method: The test area being inspected is sprayed with "Spotcheck" or Dye Check. Allow one to thirty minutes to dry. Remove the excess surface penetrant with clean cloths premoisened with cleaner / remover. DO NOT flush surface with cleaner / remover because this will impair -sensitivity. Repeat this procedure with additional wipings until residual surface penetrant has been removed. Shake developer thoroughly until agitator rattles. Invert spray can and spray short bursts to clear valve. Then spray this developer film evenly over the test area being inspected. Allow developer film to dry completely before inspecting. Recommended developing time is 5 to 15 minutes. The above four methods provide basic instructions. Specific details should be obtained from the supplier of the equipment or material. Pressure Check Method: Pressure check the cylinder head as follows: a.To seal off the water holes in the cylinder head, assemble tool set J 28454 as follows (Fig. 11): FIG. 13 - Minimum Distance Between Top and Bottom Faces of Cylinder Head 1.Install the rubber stoppers on the bridges. a.Large stoppers are installed on the long center bridge feet opposite the notch and on the long end bridge feet closest together. b.Small stoppers are installed opposite the large stoppers on center bridge and end bridge feet and on all short bridges. 2.Install the necessary parts, loosely, on the cylinder head. 3.Tighten the hold down bolts until the stoppers start to distort. A 5 lb-ft (7 Nm) torque is usually sufficient. NOTE: Do not overtighten the hold down bolts. The rubber stopper could distort enough to seal both the inner and outer diameter of the water nozzles. If the outer diameter is sealed, a leak from the outer diameter would not be detected. 4. Install the air supply plate. NOTE: Do not hook onto the pressure checking tool, or any part of it, to move the cylinder head from one location to another. If this is done it could result in permanent damage to the tool. b.Install scrap or dummy injectors to ensure proper seating of the injector tubes. Dummy injectors may be made from old injector nuts and bodies -the injector spray tips are not necessary. Tighten the injector clamp bolts to 20-25 lb-ft (27-34 Nm) torque. c.Apply 40 psi (276 kPa) air pressure to the water jacket. Then immerse the cylinder head in a tank of water, previously heated to 180°-200 F (82° -93°C), for about twenty minutes to thoroughly heat the head. Observe the water in the tank for bubbles which indicate a leak or crack. Check for leaks at the top and bottom of the injector tubes, oil gallery, exhaust ports, fuel manifolds and at the top and bottom of the cylinder head. d.Relieve the air pressure and remove the cylinder head from the water tank. Then remove the palates, gaskets and injectors and dry the head with compressed air. 2.Check the bottom (fire deck) of the cylinder head for flatness: (c) 1982 General Motor Corp. April, 1982 SEC. 1.2 Page 7 1.2 Cylinder Head DETROIT DIESEL V-71(Vehicle) Maximum Maximum Engine Longitudinal Transverse Warpage Warpage 6V .0055" .004" 8V .008" .00411 12V .010" .004" TABLE 1 FIG. 14 - Correct Installation of Water Nozzles in Two-Valve Cylinder Head a.Use a hedvy, accurate straight-edge and feeler gages, tool J 3172, to check for transverse warpage at each end and between all cylinders. Also check for longitudinal warpage in six places as shown in Fig. 12. Refer to Table I for maximum allowable warpage. b.Use the measurements obtained and the limits given in Table I as a guide to determine the FIG. 15 - Correct Installation of Water Nozzles in Four-Valve Cylinder Head advisability of reinstalling the head on the engine or of refacing it. The number of times a cylinder head may be refaced will depend upon the amount of stock previously removed. c.If the cylinder head is to be refaced, remove the injector tubes prior to machining. Do not remove more metal from the fire deck of any cylinder head below the minimum distance of 3.536" (Fig. 13). NOTE: When a cylinder head has been refaced, critical dimensions such as the protrusion of valve seat inserts, exhaust valves, injector tubes and injector spray tips must be checked and corrected. The push rods must also be adjusted to prevent the exhaust valves from striking the pistons after the cylinder head is reinstalled in the engine. Also, deburr the water nozzles. 3.Install new injector tubes (Section 2.1.4) if the old tubes leaked or the cylinder head was refaced. 4.Inspect the exhaust valve seat inserts and valve guides (refer to Section 1.2.2). 5.Inspect the cam follower bores in the cylinder head for scoring or wear. Light score marks may be cleaned up with crocus cloth wet with fuel oil. Measure the bore diameters with a telescope gage and micrometer and record the readings. Measure the diameter of the cam followers with a micrometer. Record and compare the readings of the followers and bores to determine the cam follower-to-bore clearances. The clearance must not exceed .006" with used parts (refer to Section 1.4) for specifications). If the bores are excessively scored or worn, replace the cylinder head. 6.Check the water hole nozzles to be sure they are not loose. If necessary, replace the nozzles as follows: a.Remove the old nozzles. b.Make sure the water inlet ports in the cylinder head are clean and free of scale. The water holes at each end of the head may be cleaned up with a 1/2" drill and the intermediate holes may be cleaned up with a 13/16" drill. Break the edges of the holes slightly. c.Press the nozzles in place with the nozzle openings Page 8 (C) 1982 General Motors Corp.