UNITED STATES MARINE CORPS
Logistics Operations School
Marine Corps Combat Service Support Schools
Training Command
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LVSM 7201

STUDENT OUTLINE

MAINTAIN THE DETROIT 8V92TA ENGINE

LEARNING OBJECTIVES

1. Terminal Learning Objective: Given an MK48/MK48A1, TM 2320-20/12A, LI 2320-12/9B, tools, and equipment, perform second echelon maintenance on the engine, per the reference. (3521.13.06)

2. Enabling Learning Objectives:

a. Given TM 2320-20/12A, LI 2320-12/9B, and partial statements pertaining to service procedures for the MK48 engine, complete the partial statements to describe the procedures used to service the engine, per the references. (3521.13.06a)

b. Given TM 2320-20/12A, LI 2320-12/9B, and partial statements pertaining to the MK48 engine, complete the partial statements to describe the procedures used to check the engine for serviceability, per the references. (3521.13.06b)

c. Given TM 2320-20/12A and partial statements pertaining to the MK48 engine rocker arm cover assembly, complete the partial statements to describe the procedures used to repair the rocker arm cover assembly, per the reference. (3521.13.06c)

d. Given TM 2320-20/12A and partial statements pertaining to the MK48 engine, complete the partial statements to describe the procedures used to diagnose a malfunctioning engine, per the reference. (3521.13.06d)

OUTLINE

1. DESCRIPTION AND PRINCIPLES OF OPERATION OF THE DETROIT 8V92TA ENGINE

a. The MK48 vehicle is powered by a two-cycle, liquid cooled Detroit diesel engine. The numbers and letters that make up the engine model identifier, 8V92TA, provide a further description of the engine.

(1) The first number, eight, identifies the number of cylinders the engine has.

(2) The V indicates that the cylinders are in a V configuration.

(3) The 92 is the number of cubic inches per cylinder. This is no small engine; the total cubic inch displacement is 736 cubic inches.

(4) The TA signifies that the engine is turbocharged and that it has an aftercooler to cool the inlet air.

b. You have been previously instructed on the principles of operation of a two-cycle diesel engine but a quick review will not hurt.

(1) The full name, two-stroke cycle diesel, gives us an idea of the principles of operation of this type engine. Instead of going through four strokes of the piston, two up and two down to complete a cycle, we have only two strokes to complete the cycle, one up and one down.

(2) The cylinder fires once for each revolution of the crankshaft. This type of engine has only a compression and a power stroke; in between or during these two strokes, intake and exhaust are taken care of.

(a) A four-cycle engine is really acting as an air pump during the intake and exhaust strokes. Since the intake and exhaust strokes are eliminated in the two-cycle engine, an air pump to supply air is mounted outside the engine. Other modifications include elimination of the intake valves and the addition of inlet air ports in the cylinder walls. The exhaust valves are retained; the Detroit 8V92TA diesel engine uses four exhaust valves per cylinder.

(b) Here is a description of a complete cycle in one cylinder.

1 Assume that the piston is at the bottom of its stroke, about to start its upward movement. The intake ports are open as are the exhaust valves. Air, driven by the air pump or blower, is being blown in the inlet ports and is pushing the exhaust gases from the previous cycle out of the cylinder through the exhaust valves.

2 As the piston travels upward, it closes the inlet air ports. All exhaust gases have been swept away so the valves close. The remainder of the stroke is an ordinary compression stroke, squeezing the fresh air into a small space at the top of the cylinder. Just before top

dead center, the injector shoots a spray of fuel into the chamber full of hot air. Ignition and expansion take place just as in a four-stroke cycle engine and the piston starts down on a power stroke.

3 When the piston has traveled a little more than halfway down, the exhaust valves open and the burned gases escape. As the piston goes farther down, the inlet ports are again uncovered and fresh air is blown into the cylinder. Just as before, this rids the cylinder of exhaust gases and also fills the cylinder with fresh air. The piston has reached bottom dead center and the cycle is complete, all in one turn of the crankshaft.

2. IDENTIFICATION, LOCATION, AND FUNCTION OF SPECIFIC COMPONENTS OF THE DETROIT 8V92TA ENGINE

a. Rocker Covers. The rocker covers employed on the Detroit 8V92TA engine are of a special design to accommodate the Jacobs engine brake that you will learn about later; one rocker cover is mounted on top of each cylinder head.

(1) The rocker covers enclose the engine's upper valve train mechanisms, Jacobs engine brake, and fuel injection assemblies. Both rocker covers contain breather housings. The right side rocker cover also has an attachment for the oil fill tube.

(2) The rocker covers prevent dirt, dust, and other foreign material from damaging the vital engine components they enclose. They also prevent the lubricating oil that is pumped to the upper cylinder head area from being lost through leakage.

b. Oil Filter and Adapter. The engine oil filter and adapter are located on the lower right side of the engine block.

(1) The oil filter is a disposable spin-on type filter that attaches to the filter adapter.

(2) The oil filter adapter contains a bypass valve that allows the oil to bypass the filter in the event that the filter becomes clogged.

c. Fuel Supply Pump. The fuel supply pump employed on the Detroit 8V92TA engine is a positive displacement, gear-type pump that transfers fuel from the fuel tanks to the fuel injectors, by way of the fuel/water separator, secondary fuel filter, fuel manifolds and fuel connector pipes.

(1) The fuel pump is attached to the governor housing, at the top of the engine, near the front.

(2) It is driven by the right-hand blower rotor by means of a drive coupling fork. The fuel pump does not need to be timed to the engine because all injection timing is accomplished through the injector rocker arms and injectors.

d. Shutdown Solenoid. This vehicle uses an electrically controlled solenoid to shut down or stop the engine. It is mounted at the top front of the engine and is attached to the stop lever on the governor.

(1) The shutdown solenoid is controlled by a switch in the vehicle cab. When the ENGINE STOP switch is pushed down, the solenoid pulls the stop lever on the governor inward. That action moves a series of rods in the engine and shuts off fuel flow to the injectors.

(2) In the event that an electrical failure renders the shutdown solenoid inoperative, the engine can be shut down by manually pushing the rod on the shutdown solenoid toward the solenoid.

e. Throttle Cylinder. The throttle cylinder is an air actuated cylinder that is attached to the top, right front side of the engine.

(1) The MK48 does not have straight mechanical linkage or a cable system between the throttle treadle valve and the speed control lever on the governor to allow the operator to control engine speed. A combination of air pressure and linkage is used.

(2) When the driver pushes down on the throttle treadle valve, air pressure, in direct relation to the movement of the treadle valve, is applied to the throttle cylinder. The air pressure extends a rod that is attached to the throttle cylinder, and the engine speed is increased to the desired revolutions per minute. When the operator releases the treadle valve, a spring inside the throttle cylinder, assisted by an external spring, retracts the linkage and returns the engine to idle speed.

f. Thermostats and Housings. Another unique feature of this engine is that it employs two thermostats in the cooling system to control engine temperature. One thermostat housing and its thermostat is attached to the front of each cylinder head.

g. Water Pump. The water pump employed in this engine is a typical centrifugal type pump. The pump is mounted on the engine front cover and it is driven by the right front camshaft gear.

h. Oil Cooler. The next component that you should be familiar with is the engine oil cooler. The engine oil cooler is mounted to the right side of the engine block.

(1) Engine oil under pressure flows from the oil pump to the oil cooler adapter plate. From the adapter plate, the oil is routed through the oil filter adapter and oil filter. When the oil leaves the filter and adapter, it flows back to the oil cooler adapter and then through the oil cooler core where it is cooled by the engine coolant.

(2) The oil cooler is fitted with a bypass valve to allow continued oil flow in the event the cooler becomes clogged.

i. Governor. This engine features a double-weight, variable-speed, and mechanical governor. The governor is mounted on and driven by the blower. The governor has two functions.

(1) It controls engine idle speed.

(2) It limits the maximum no-load engine speed.

j. Turbocharger and Blower. To ensure that the engine receives sufficient, fresh, clean air for efficient combustion, a turbocharger and blower are used. The turbocharger is mounted above the alternator at the rear of the engine and the blower is mounted in the valley between the cylinder heads.

(1) The turbocharger supplies fresh, pressurized air to the blower. The turbocharger is driven by exhaust gases produced by the engine.

(2) The blower pumps the fresh air received from the turbocharger into the cylinders. Because the action of the blower is constant, the blower also serves to scavenge exhaust gases. When the exhaust valves are open, the air being pumped into the cylinders by the action of the blower sweeps the exhaust gases out through the exhaust valve ports.

k. Aftercooler. An aftercooler is employed on the engine to cool inlet air. The action of the turbocharger heats and expands the engine's inlet air. Because the air is expanded, the amount of air that can be blown into the cylinders for the combustion process is lessened. By cooling and condensing the air, more can be forced into each cylinder for compression. As a result of having more air in the cylinders, more fuel can be injected. As you know, the more fuel that you can efficiently burn in an engine, the more power you can develop.

(1) The aftercooler is located under the blower.

(2) It is a small radiator-like device through which inlet air passes. Heat from the engine's inlet air is transferred to the cooling fins

of the aftercooler and is carried away by the engine coolant that is circulated through the device.

l. Alternator. The alternator that is used on the MK48 is a conventional alternator; its voltage output is adjustable. The alternator is flange mounted to the rear of the engine and it is driven by the blower drive gear. All other alternators that you have been exposed to were belt driven.

m. Starter. The starter that was selected for use on the MK48 is a standard overrunning clutch type starter. It is mounted to the left side of the bell housing.

n. Exhaust Manifolds and Pipes. There is nothing unique about the location or purpose of the exhaust manifolds and pipes that are used on this engine as they are configured for the MK48. However, as previously stated, the exhaust gases are routed to the turbocharger to drive the compressor wheel in the turbocharger before they are released to the atmosphere.

o. Jacobs Engine Brake. As you will recall, during your operator training you learned that the engine employed in the MK48 is equipped with a Jacobs engine brake. The Jacobs engine brake is a device that alters the operation of the MK48 engine to permit it to aid in slowing the vehicle down when it is activated. This unit consists of brake housing assemblies that are located under the rocker covers, a buffer switch in the governor housing, and two control switches in the vehicle cab.

(1) When the operator activates the Jacobs engine brake by turning the control switch in the cab to ON and selecting either HI or LOW braking action, the engine brake is ready for operation. Acceleration of the vehicle is not affected by the Jacobs engine brake; however, when the operator releases the throttle treadle, the engine becomes an air compressor. Instead of a power gain as the result of combustion and the resulting power stroke, there is a net power loss because the engine uses power to compress the air in the cylinders. The Jacobs engine brake accomplishes this by preventing fuel injection and controlling the action of the exhaust valves.

(2) Basically, this is how the Jacobs engine brake controls the exhaust valves and prevents fuel injection.

(a) When the operator activates the Jacobs engine brake, a solenoid opens an oil passage and allows engine oil to flow under pressure through a control valve and on to the top of the master and slave pistons that are contained in the brake housings. If HIGH was selected, all cylinders are effected; if LOW was selected, only the four left hand cylinders are effected. The master pistons are located above the injector push rods and the slave pistons are above the exhaust valves. Once the oil flows past the control valve, it is trapped by a ball check valve and it stays in this area as long as the Jacobs engine brake is applied.

(b) Each time an injection push rod starts up on its injection stroke, the master piston is forced upward. The movement of the piston pressurizes the engine oil that is on top of the piston and this pressure is transferred to the slave piston. Remember, this oil is trapped between the master and slave pistons by the check ball valve in the control valve. When the pressure is great enough, it overcomes a spring in the slave piston and the slave piston moves down. The downward movement of the slave piston forces the exhaust valves to open momentarily. At this time, the piston in the cylinder is near its top dead center position. With the exhaust valves open, the compressed air in the cylinder is released to the atmosphere through the exhaust system. At the same time that the exhaust valves are being opened to release the compressed air, the movement of additional linkage actuated by the slave piston prevents fuel injection.

(c) The sequence of events just described take place every time a cylinder is due to fire as long as the Jacobs engine brake is activated and the operator has the drive train in lockup and he or she does not have the throttle treadle valve pushed down.

(d) Maintenance of the Jacobs engine brake is not a responsibility of organizational maintenance; however, by knowing how it works you are in a good position to determine if it is functioning properly.

(e) ITV Film - "Operation of the Jake Brake".

1 Introduce ITV Film.

a There may still be some doubt in your mind as to how the Jacobs engine brake works. The short film that you are about to see should resolve the problem, if one exists.

b Pay particular attention to the manner in which engine oil is used to control the action of the exhaust valves.

2 Show ITV Film.

3 Critique ITV Film.

a The film that you have just seen clearly explains how the operation of the exhaust valves is hydraulically controlled through the use of engine oil.

b The film also explained that, as a result of the use of the Jacobs engine brake, the engine becomes a power absorbing, retarding mechanism.

c Are there any questions about the information that was presented in the film? (Answer students' questions.)

p. Fuel Injectors. The fuel injectors used in the Detroit 8V92TA engine that powers the MK48 are needle valve type injectors. There is, of course, one injector for each cylinder and they are mounted in the cylinder heads.

(1) The injectors pressurize, meter, atomize, and inject the fuel required for engine operation.

(2) The timing of injection is controlled by a camshaft that activates the injector push rods and rocker arms in the conventional manner. Movement of the rocker arms forces the injector plungers down, which forces fuel to be injected.

(3) The amount of fuel that is injected is determined by the opening and closing of ports in the injector body. The same plungers that are actuated by the rocker arms are also rotated by a rack gear. This rotation varies the alignment of the ports previously mentioned to determine the amount of fuel delivery. Bear in mind that all injector rack gears are connected by way of injector control tube assemblies; therefore, the effect of the governor and the position of the throttle treadle valve affects fuel delivery to all cylinders equally.

q. Throttle Delay Mechanism. A throttle delay mechanism is employed in turbocharged engines such as the 8V92TA to retard full-fuel injection when the engine is accelerated. This reduces exhaust smoke during acceleration and helps improve fuel economy.

(1) When the vehicle operator pushes the throttle treadle valve down to increase engine speed, the turbocharger tends to lag momentarily. At this time, the fuel injectors are capable of delivering more fuel than the engine can use in relation to the amount of air that is available for the combustion process. If the engine was not equipped with a throttle delay mechanism, an overfueling condition would exist during initial acceleration and the result would be offensive black smoke and less than desirable fuel economy. This is how the throttle delay mechanism works.

(2) When the operator releases pressure on the treadle valve, a piston in the throttle delay mechanism is pulled down in its cylinder by a linkage that is connected to the injector control tube. During this movement to a no-fuel condition, the piston passes a hole in the delay mechanism's

special rocker arm bracket. Above the hole is a reservoir that is supplied with engine oil by a drilled passage in the rocker arm shaft bracket. When the hole below the reservoir is uncovered, the oil in the reservoir runs into the space above the piston head in the throttle delay mechanism's cylinder. At this time, the delay mechanism is ready to function.

(3) When the operator attempts to accelerate, the movement of the injector control tubes and injector racks to the full-fuel position is momentarily retarded while the oil is being expelled from the cylinder through a small orifice by the upward movement of the time delay mechanism piston.

(4) The throttle delay mechanism is installed between the No. 1 and No. 2 cylinders on the right cylinder bank. The complete mechanism also includes a yield link in place of the standard operating lever connecting link in the governor. This yield link, as the name implies, yields when the treadle valve is pushed and prevents damage to the various throttle linkages while the throttle treadle valve is depressed but the movement of the injector racks is being prevented by the throttle delay mechanism.

r. Cylinder Heads

(1) The cylinder heads, one on each cylinder bank, are one-piece castings held securely to the cylinder block by special capscrews. The exhaust valves, four per cylinder, fuel injectors, one per cylinder, Jacobs engine brake, and the valve operating mechanisms are located in the cylinder head.

(2) Exhaust valve seat inserts pressed into the cylinder head permit accurate seating of the valves under varying conditions of temperature. This significantly prolongs the life of the cylinder head.

(3) The exhaust gases pass from the exhaust valves of each cylinder head through a single port to the exhaust manifold.

(4) The exhaust passages and the injector tubes are surrounded by engine coolant. In addition, cooling is further ensured by the use of water nozzles pressed into the water inlet ports of the cylinder head. The nozzles direct the engine coolant at high velocity toward the sections of the cylinder head that are subjected to the greatest heat.

(5) The fuel inlet and outlet manifolds are integral parts of the cylinder heads. Tapped holes are provided for connection of the fuel lines at various points along each manifold.

s. Valve Operating Mechanism

(1) Three rocker arms are provided for each cylinder. The two outer arms operate the exhaust valves, and the center arm operates the fuel injector.

(2) Each set of three rocker arms pivots on a shaft supported by two brackets. A single bolt secures each bracket to the top of the cylinder head. Removal of the two bracket bolts permits the rocker arm assembly for one cylinder to be raised, providing easy access to the fuel injector and the exhaust valve springs.

(3) The rocker arms are operated by a camshaft through cam followers and short push rods that extend through the cylinder head. Each cam follower operates in a bore in the cylinder head. A guide for each set of three cam followers is attached to the bottom of the cylinder head to retain the cam followers in place and to aline the cam follower rollers with the camshaft lobes.

(4) A coil spring inside each cam follower maintains a predetermined load on the cam follower to ensure contact of the cam roller on the camshaft lobe at all times

3. ORGANIZATIONAL MAINTENANCE RESPONSIBILITIES FOR THE DETROIT 8V92TA ENGINE

a. The organizational maintenance mechanic is responsible for changing the engine oil.

b. The organizational maintenance mechanic is also responsible for inspecting and replacing the following components:

(1) rocker covers,

(2) oil filter,

(3) oil filter adapter, and

(4) oil pan.

4. SERVICING THE DETROIT 8V92TA DIESEL ENGINE

a. Changing The Engine Oil

(1) During the period that the vehicle is under warranty, engine oil must be changed every 3000 miles or semiannually, whichever comes first.

(2) The vehicle's lubrication instruction indicates that, after the warranty expires, oil will be changed when directed by an oil analysis laboratory.

(3) Under the oil analysis program, the vehicle LI directs us to sample the engine oil every 25 hours of operation or every 30 days, whichever comes first. However, TI 4731-14/1B Change 1, dated Sept. 94, directs us to sample the oil every 90 days.

(4) Prior to draining the engine oil, operate the engine to bring the oil temperature up to the normal operating range. Because of the location of the drain plug, extreme care must be taken to keep from getting burned. You will need a funnel with a long extension tube to direct the draining oil into a container. The container you select should be capable of holding 24 quarts of oil.

(5) With the container and funnel in place, remove the drain plug and allow all the oil to drain.

(6) After all the oil has drained, remove the magnetic plug and inspect it for metal shavings or fine metal particles. If there are large metal particles, your supervisor must be notified.

(7) Next, move your container under the oil filter. You will not need a funnel to divert the oil. Now, using a filter wrench, turn the spin-on oil filter counterclockwise to remove it. The filter must be discarded in accordance with local environmental regulations after it has been removed.

(8) To install a new oil filter, first coat the seal of the filter with clean engine oil.

(a) Next, wipe off the mating surface of the oil filter adapter with a clean rag.

(b) Now, install the oil filter onto the adapter and hand tighten it until the seal touches the oil filter adapter mating surface.

(c) After the seal makes contact with the mating surface, tighten the filter an additional 2/3 of a turn.

(9) Now that the oil filter is installed, the next step is to install the drain plug and magnetic plug.

(a) First, you must coat the threads of each plug with pipe sealant.

(b) Next, install the magnetic plug and drain plug; then torque each one to 33-37 foot-pounds.

(10) To fill the engine with new oil, remove the filler cap from the filler tube. Before filling the engine with oil, always check LI 2320-12/9 for the proper type and viscosity of oil.

(a) Fill the engine until the oil level is between the L band and F band on the engine dipstick. Make sure the vehicle is on level ground.

(b) Install the engine dipstick and the filler cap.

(c) Start and run the engine for about 10 minutes. While the engine is running, check for leaks around the drain plug and oil filter. Stop the engine and wait 5 minutes before rechecking the oil level on the dipstick. The oil should still be between the L and F band on the dipstick. If the oil is not within the marks, add or remove oil until it is.

5. CHECKING THE DETROIT 8V92TA ENGINE FOR SERVICEABILITY

a. The organizational maintenance mechanic is responsible for checking the engine for serviceability. However, the extent to which some components are inspected will depend on whether the component is removed or still attached to the engine. For example, if the oil filter adapter gasket was being replaced, you would inspect the mating surfaces and relief valve components at that time.

(1) First, inspect the engine and engine compartment for indications of fuel, water, or oil leaks. It is not unusual for the engine to consume about one cup of oil per operating hour under normal operating conditions.

(2) Start the engine and listen for any unusual noises such as grinding metal, squeaks or knocking. If these noises or any other unusual sounds are detected, notify your supervisor.

(3) Now, inspect for any loose mounts, bolts, or capscrews.

(4) Finally, inspect all hoses, wires, and clamps for looseness or wear.

(5) Oil Filter Adapter. Inspect the oil filter adapter as follows:

(a) Inspect for a leaking gasket between the cylinder block and the adapter. You must do this before the adapter is removed from the engine.

(b) Next, inspect the adapter for cracks and the mating surfaces for nicks and burrs.

(c) Finally, check for a broken relief spring and inspect the relief piston for nicks or burrs. Replace any of the components that fail inspection.

(6) Oil Pan. Inspect the oil pan for the following defects:

(a) First, inspect the oil pan for leaks, cracks, warpage, or excessive dents.

(b) Next, inspect for damaged threads in the pipe plug holes.

(c) Check for broken or damaged brackets.

(d) The last items to check are the dipstick and filler tubes. Inspect these components for cracks, dents, or signs of leaks. Replace any components that fail inspection.

(7) Rocker Covers. There are several items that must be inspected on the rocker covers. If any of the items fail inspection, replace them.

(a) First, inspect the rocker covers for cracks and dents.

(b) Now, inspect the rubber isolators for cracks or tears.

(c) Next, inspect the oil filler cap for wear or a damaged seal. Also check for a broken filler cap chain.

(d) One of the most important items to check is the steel mesh element. Check to see if it is plugged or stretched out of shape.

(e) Finally, inspect the rocker cover gaskets for oil leaks. This inspection should always be performed before and after removing the rocker covers.

6. DIAGNOSE DETROIT 8V92TA ENGINE MALFUNCTIONS

a. General

(1) The transparency that you see on the screen lists some of the engine malfunctions that are covered in the troubleshooting section of the TM.

(2) To quickly find the troubleshooting procedure you need, use the Symptom Index. Symptoms are listed by components or systems.

(3) Each malfunction symptom given for an individual component or system is followed by steps leading to the cause of the malfunction and the actions required to correct it.

(4) Locate the malfunction symptom then thoroughly read and carefully follow each step of the troubleshooting procedures.

(5) Here are a few simple rules to follow when troubleshooting:

(a) Obtain as much information from the operator as possible about the malfunction.

(b) Never overlook the possibility that the problem may be a simple one and may be repairable with a simple adjustment.

(c) Use as many of your senses as you can to locate and isolate problems. Look at it, listen to it, smell it, and feel it.

(d) Use all available test equipment to help find and isolate problems.

(e) Whenever possible, isolate the system first and then the component causing the malfunction.

(f) Remember, there is a cause for every failed part. Whenever possible, determine the cause of the failure before assuming the malfunction is completely repaired.

(g) Use proven automotive theories and principles when troubleshooting the vehicle.

b. Malfunction: Low Engine Oil Pressure

(1) Test 1 is to check the engine oil level on the dipstick.

(a) If the level is correct, go to Test 3.

(b) If the level is not correct, drain or add oil as needed to bring it to the correct level and then go to Test 2.

(2) Test 2. Check the oil filter, oil lines, and engine for leaks.

(a) If no leaks are found, go to Test 3.

(b) If leaks are found, make repairs or replace parts as needed.

(c) If the required repairs are beyond your level of maintenance, notify your supervisor.

(3) Test 3. Check the oil pressure gauge and warning light circuits.

(a) Refer to ELECTRICAL SYSTEM troubleshooting in this manual.

(b) If the malfunction still exists, notify your supervisor.

(4) This is a good example of the corrective action required. The manual often instructs you to skip a test, as it did here, and many times it directs us to another troubleshooting section of the manual, such as directing us to ELECTRICAL SYSTEM troubleshooting.

c. Malfunction: Blue Exhaust Smoke (Engine Temperature 160 Degrees Fahrenheit or Above)

(1) Here we have a malfunction listed that has no tests to be performed at the organizational maintenance level.

(2) The only thing you can do is notify your supervisor, who will authorize you to evacuate the vehicle to a shop having third echelon maintenance capabilities, if your shop doesn't.

(3) Do you have any questions about malfunction diagnosis? If there are no questions, we'll not cover any more malfunctions, as the procedures are basically the same. Just be sure to follow the steps as they are listed in the manual.

REFERENCES:

LI 2320-12/9B
TM 2320-20/12A