

UNITED STATES MARINE CORPS
Logistics Operations School
Marine Corps Combat Service Support Schools
Training Command
PSC Box 20041
Camp Lejeune, North Carolina 28542-0041

LVSM 7202

STUDENT OUTLINE

MAINTAIN THE AIR INDUCTION AND EXHAUST SYSTEM

LEARNING OBJECTIVES:

1. Terminal Learning Objectives:

a. Given an LVS, TM 2320-20/12A, tools, and equipment, perform second echelon maintenance on the engine air induction system, per the reference. (3521.13.07)

b. Given an MK48, TM 2320-20/12A, tools, and equipment, perform second echelon maintenance on the engine exhaust system, per the reference. (3521.13.08)

2. Enabling Learning Objectives:

a. Given an LVS, TM 2320-20/12A, tools, and equipment, inspect the air induction system for serviceability, per the reference. (3521.13.07a)

b. Given an LVS, TM 2320-20/12A, tools, and equipment, service the air induction system, per the reference. (3521.13.07b)

c. Given an LVS, TM 2320-20/12A, tools, and equipment, test the air induction system, per the reference. (3521.13.07c)

d. Given TM 2320-20/12A and partial statements pertaining to the MK48 air induction system, complete the partial statements to describe the procedures used to diagnose a malfunctioning air induction system. (3521.13.07d)

e. Given TM 2320-20/12A and partial statements pertaining to the MK48 air induction system, complete the partial

statements to describe the procedures used to repair components of the air induction system. (3521.13.07e)

f. Given TM 2320-20/12A and partial statements pertaining to the MK48 air induction system, complete the partial statements to describe the procedures used to replace components of the air induction system. (3521.13.07f)

g. Given an LVS, TM 2320-20/12A, tools, and equipment, inspect the exhaust system for serviceability, per the reference. (3521.13.08a)

h. Given an LVS, TM 2320-20/12A and partial statements pertaining to the MK48 engine exhaust system, complete the partial statements to describe the procedures used to diagnose a malfunctioning exhaust system, per the reference. (3521.13.08b)

i. Given an LVS, TM 2320-20/12A and partial statements pertaining to the MK48 engine exhaust system, complete the partial statements to describe the procedures used to repair components of the exhaust system, per the reference. (3521.13.08c)

j. Given an LVS, TM 2320-20/12A and partial statements pertaining to the MK48 engine exhaust system, complete the partial statements to describe the procedures used to replace unserviceable components of the engine exhaust system, per the reference. (3521.13.08d)

4. METHOD/MEDIA: A combination lecture and demonstration will explain the following:

a. The identification, location, and function of the components employed in the Detroit 8V92TA engine air induction and exhaust systems.

b. The principles of operation of the Detroit 8V92TA engine air induction and exhaust systems.

c. The organizational maintenance responsibilities relative to the Detroit 8V92TA engine air induction and exhaust systems.

d. The repair and diagnostic maintenance procedures that are required to be accomplished on the Detroit 8V92TA engine exhaust system at the organizational maintenance level.

INSTRUCTOR'S NOTE: Explain the instructional rating forms to students.

5. **EVALUATION:** *Following the lecture, a combined practical application exercise and performance test will give you the opportunity to practice and demonstrate your ability to perform the maintenance tasks that will be explained in the classroom.*

TRANSITION: *Are there any questions about what will be covered, how the lesson will be presented, or how you will be evaluated?*

BODY (HRS)

1. **IDENTIFICATION, LOCATION, AND FUNCTION OF THE COMPONENTS EMPLOYED IN THE DETROIT 8V92TA ENGINE AIR INDUCTION AND EXHAUST SYSTEMS** (10 MIN)

(SHOW CHART 1, MK48 AIR INDUCTION AND EXHAUST SYSTEMS)

a. We will begin with the air induction system. The air induction system employs an air cleaner assembly, turbocharger, blower, aftercooler, air restriction indicator, and the necessary hoses and ducts to route the inlet air to the appropriate places.

(SHOW SLIDE 1, AIR CLEANER ASSEMBLY)

(1) The air cleaner assembly can be easily recognized by its unusually shaped grill. The air cleaner assembly is located on the left side of the vehicle, above the engine and behind the vehicle cab. As you know, the air cleaner assembly removes dust and other foreign matter from the inlet air. The air cleaner assembly consists of the following major components:

INSTRUCTOR'S NOTE: *Point to each component as it is discussed.*

- (a) SuperClone or pre-cleaner, as it is sometimes called,
- (b) Primary filter,
- (c) Secondary filter,
- (d) Dust bin, and
- (e) Plenum pan.

(2) The turbocharger is located on the right side of the engine, above the right bank of cylinders. The turbocharger compresses the inlet air and delivers it under high pressure to the blower.

(3) The blower is mounted on top of the engine in the valley between the cylinders. The blower is a conventional roots-type blower that forces

the inlet air through the aftercooler and into the air box from where it will be blown into the cylinders.

(4) The aftercooler is simply a radiator-like device that cools and condenses the air that was expanded by the action of the turbocharger so that more air can be forced into the cylinders. It is mounted in the engine block, under the blower.

(5) The air induction system includes the appropriate ducting to ensure that only filtered air enters the combustion chambers.

(6) The last component in the system that we will discuss is the air restriction indicator. This device is located in the vehicle cab. The air restriction indicator monitors the condition of the air cleaner and provides a visual signal to the operator or mechanic when the air cleaner assembly becomes restricted.

TRANSITION: Next, we will take a brief look at the exhaust system that is used on the MK48.

b. The exhaust system consists of the exhaust manifolds, exhaust pipes, crossover pipe, a muffler, and the appropriate clamps to seal connection points.

(1) The exhaust manifolds are of the conventional type. The exhaust manifolds collect the exhaust gases as they are expelled from the individual cylinders. There is one exhaust manifold bolted to each cylinder head.

(2) A crossover pipe and other sections of exhaust pipe carry the exhaust gases from the manifolds to the turbocharger and on to the muffler. The crossover pipe is connected to the left exhaust manifold and to the turbocharger adapter. Sections of exhaust pipe are connected from the right manifold to the turbocharger adapter and from the turbocharger to the muffler. The crossover pipe is wrapped with an insulating material to prevent burns if an operator or mechanic accidentally touches it while it is hot.

(3) The muffler serves the standard purpose; it muffles engine noise. It is located above the right fuel tank. The muffler is fitted with a rain cap that closes to prevent the entry of water when the engine is not running.

TRANSITION: Now that you are aware of the components that are employed in the air induction and exhaust system, let's see how they work together to ensure that the engine gets clean air and that the exhaust gases are carried away from the engine.

2. PRINCIPLES OF OPERATION OF THE DETROIT 8V92TA ENGINE AIR INDUCTION AND EXHAUST SYSTEMS

(SHOW SLIDE 2, AIR CLEANER OPERATION)

INSTRUCTOR'S NOTE: *use the transparency and trace the flow of inlet air through the inlet air tubes and the filters; also trace the exit path of the heavy particles of foreign matter.* (10 MIN)

a. Air to support the combustion process initially enters the air induction system through the SuperClone. The SuperClone is a series of specially designed air inlet tubes.

(1) As you can see on the transparency, the directional vanes in the air inlet tube start the inlet air rotating in a counterclockwise direction.

(2) The cyclonic action spins heavy contaminants into the dust bin, while the air that has been cleaned of heavy contaminants moves directly to the primary air filter. The SuperClone removes up to ninety-three percent of the dirt entering the air cleaner.

(a) The heavy particles that were extracted from the inlet air by the action of the air inlet tubes fell into a dust bin located below the SuperClone.

(b) Notice the two protrusions inside the dust bin. There is a plug with an orifice threaded into the outboard side of each of those protrusions. Those orifices expel inlet air that is piped to them from the inlet side of the blower.

(c) The stream of air coming out through the orifices blows out particles of foreign matter that have fallen into the dust bin outboard of their location. The particles that fall inboard of the orifices are drawn out of the dust bin as a result of the vacuum or low pressure created in that area by the stream of air exiting the orifices.

(d) The line that supplies air to the orifices is equipped with a check valve to prevent particles of foreign matter from being drawn out of the dust bin, through the orifices and on into the engine in the event that the air cleaner assembly becomes clogged.

(3) The primary filter is a dry-type element made of resin impregnated paper. The resin impregnated element is designed to catch finer dust particles than the SuperClone is capable of removing.

(4) From the primary filter element, the inlet air passes down through a secondary filter element for final filtration and then on to the turbocharger.

(5) The turbocharger compresses the inlet air and then forces it through ducting to the engine blower. The blower further increases the pressure of the air and pushes it through an aftercooler and into an air box located between the cylinders.

(6) When the inlet ports in the cylinder are exposed by the downward motion of the piston, clean air to sweep out the exhaust gases and support the combustion process is forced into the cylinder by the combined action of the turbocharger and blower.

(SHOW SLIDE 3, AIR RESTRICTION INDICATOR)

(7) As was previously mentioned, there is an air restriction indicator located in the vehicle cab; it is typical of current military air restriction indicators.

(a) The air restriction indicator is connected by a hose to the air inlet duct. If the air cleaner becomes restricted, the action of the turbocharger and blower will create a vacuum in the air inlet duct. The vacuum will be imposed on the air restriction indicator through the hose that connects it to the air inlet duct.

(b) There are four windows in the air restriction indicator; two small windows and two that are larger. As the air cleaner becomes restricted, the vacuum created pulls down a red band inside the indicator. The larger windows are graduated in inches of vacuum and can be used to measure the relative amount of restriction in the air cleaner. When the red band has moved down to a point where the small window is completely covered by the red band, the air cleaner must be serviced.

(c) The indicator is reset by pushing down on its top.

TRANSITION: At this point you should have a good understanding of the principles of operation of the air induction system. Let's take a brief look at how the exhaust system works.

b. The exhaust system is not as unique as the air induction system.

(SHOW SLIDE 4, EXHAUST SYSTEM)

(1) When the exhaust gases are forced out of the engine's cylinders, they are first routed to the exhaust manifolds.

(2) From the exhaust manifolds, the exhaust gases must go to the turbocharger where they will be used to drive the turbine that is integral to the turbocharger. The exhaust gases from the left exhaust manifold are carried to the turbocharger by a crossover pipe. The gases from the right manifold are carried to the turbocharger by a short section of exhaust pipe.

(3) After the exhaust gases have done their job in the turbocharger, they again enter an exhaust pipe and are routed to the muffler. As previously stated, the muffler is of conventional design and purpose. The muffler expels the exhaust gases into the atmosphere.

TRANSITION: Now let's discuss those items you will be responsible for maintaining on the air induction and exhaust systems.

3. ORGANIZATIONAL MAINTENANCE RESPONSIBILITIES RELATIVE TO THE DETROIT 8V92TA ENGINE AIR INDUCTION AND EXHAUST SYSTEMS (5 MIN)

a. The organizational maintenance mechanic is responsible for inspecting and/or servicing the following:

- (1) air restriction indicator,
- (2) air cleaner assembly and induction tubing, and
- (3) the exhaust manifolds, piping, and muffler.

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

- (1) air restriction indicator,
- (2) air cleaner assembly and internal filters,
- (3) air induction tubing and related hoses,
- (4) exhaust manifolds and gaskets, and
- (5) the exhaust piping and muffler assembly.

TRANSITION: Next we will cover the repair procedures for the air induction system. The first procedure is to service the air cleaner assembly.

4. MAINTAIN THE ENGINE AIR INDUCTION SYSTEM (27 MIN)

a. Inspect the Air Induction System for Serviceability

(1) Visually inspect all castings and weldments for cracks.

(2) Check all hose and ducting surfaces for broken or frayed fabric. Check for breaks caused by sharp kinks or rubbing against other parts of the vehicle.

(3) Inspect all clamps and fittings for damaged threads or loose connections that may allow unfiltered air to enter.

(4) Inspect all sealing surfaces for nicks, burrs or anything that may prevent proper sealing.

(SHOW SLIDE 5, AIR CLEANER ASSEMBLY)

b. Service the Air Cleaner Assembly. When servicing the air cleaner, the following procedures must be followed:

INSTRUCTOR'S NOTE: Use an actual air cleaner to demonstrate servicing the air cleaner and replacement procedures for the air cleaner elements.

(1) First, inspect the inlet face of the SuperClone for the presence of leaves or other debris that would restrict the entry of air into the air cleaner assembly.

(2) Next, if there is a film of dust that exceeds 1/16 inch in thickness on the SuperClone's directional vanes, attempt to remove it with compressed air. If the compressed air fails to remove the dirt, wash the SuperClone in a solution of mild detergent.

(3) Now, check the orifices, also called positive pressure nozzles, in the dust bin to make sure they are not restricted. To do so, you will have to remove them.

(a) After the SuperClone is removed, an 11/16 inch socket on an extension with the proper drive handle can be used to remove the orifices from the dust bin.

(b) To clean the orifices, use a toothpick or pipe cleaner and cleaning solvent. Remove any particles of foreign matter that have accumulated in the orifices and be sure to clean out any sludge that has been deposited in the orifices.

(4) Complete the servicing of the air induction system by inspecting the primary and secondary filters. The individual elements cannot be serviced and should be replaced if they are found to be contaminated.

TRANSITION: *Since I have just told you there is a requirement to inspect the SuperClone and the filters I should tell you how to remove them.*

c. Replacement of the Air Cleaner Elements

(1) The first element to remove is the SuperClone. This can be done by removing the capscrews and nuts from the sides of the SuperClone. Then pull the SuperClone out.

(2) The next element to remove is the primary filter element.

(a) To remove this element, first remove the clamping straps.

(b) Next, remove the sealing frame.

(c) Then lift the primary filter element out of the plenum pan.

(3) To remove the secondary filter element, all that is required is to loosen the capscrews and swing the holding tabs away from the element, and then lift the element out.

(4) To install the filter elements, the secondary element is installed first, making sure that the tabs are locked in place. Next, the primary filter is installed and then the SuperClone. The installation procedures are accomplished in the reverse order of removal. However, all of the attaching nuts and capscrews must be torqued to a specific torque value.

You should consult your technical manual to obtain the correct specifications.

(SHOW SLIDE 6, AIR CLEANER ASSEMBLY REPLACEMENT)

TRANSITION: *Next we will cover the replacement of the air cleaner assembly.*

INSTRUCTOR'S NOTE: *Instructor will use slide to point out location of components and replacement procedures.*

d. Replacement of the Air Cleaner Assembly

(1) When removing the air cleaner assembly. The following steps must be performed:

(a) First, loosen the clamp that holds the air inlet ducting to the air cleaner assembly. Then slide the clamp back and remove the ducting from the air cleaner.

(b) Next, loosen the clamp and remove the hose to the dust bin.

(c) Remove the worklamp from the bracket on the side of the air cleaner. Lay the worklamp to the side so it is not in your way.

(d) Now, move to the back side of the air cleaner assembly and remove the capscrew and locknut that hold the inlet ducting hanger to the air cleaner. Also, remove the capscrew and nut from the bracket that holds the engine coolant tube.

(e) While an assistant holds the air cleaner assembly, finish removing the capscrews that hold the air cleaner to the support bracket. Once all capscrews have been removed, lift out the air cleaner assembly.

(2) With the air cleaner assembly removed from the vehicle, inspect the dust bin hoses and elbows. If they are damaged or deteriorated, they must be replaced. To facilitate reinstallation, note the position of the elbows before you remove them.

(3) To reinstall the air cleaner assembly, the following procedures must be followed:

(a) If the dust bin hoses and elbows were replaced, the new elbows must be installed in the same position the old ones were in before removal.

(b) Now, position the air cleaner assembly between the support brackets and have your assistant start two of the capscrews. The air cleaner should be able to support itself. Finish putting in the remaining capscrews and tighten them securely.

(c) On the back side of the air cleaner, position the bracket for the engine coolant tube and install the retaining nut and capscrew.

(d) Next, position the other hanger for the inlet ducting to the air cleaner assembly and install that capscrew and retaining nut.

(e) Now, go to the side of the air cleaner and install the worklamp back on its bracket.

(f) Last, install the hose back onto the dust bin and install the air inlet ducting back onto the bottom of the air cleaner. Slide each clamp onto the fittings and tighten them securely.

(SHOW SLIDE 7, AIR INLET DUCTING)

TRANSITION: The organizational mechanic is responsible for replacing the ducting if it is determined to be unserviceable.

e. Replacement of the Air Inlet Ducting. This task is accomplished using the following procedures:

(1) Loosen the clamp on the air compressor inlet hose located in the center of the intake ducting. Slide the clamp back and remove the air inlet hose from the ducting.

(2) Now, remove the air restriction indicator line and its fitting from the intake ducting.

(3) Next, remove the support bracket from the back side of the air cleaner. This procedure was previously covered.

(4) Once the support bracket has been removed, loosen the clamps at the turbocharger and at the air cleaner assembly. Separate the ducting from the turbocharger and air cleaner and remove the complete assembly from the vehicle.

(5) Note and mark the exact position of the duct hoses and how they are put together. This will save time and problems when you have to install the ducting back into the vehicle. Once the ducting is marked, loosen the remaining clamps and remove the individual ducting tubes and support bracket.

TRANSITION: *After you have carefully inspected the components of the air inlet ducting for cracks or deterioration, you must reassemble and install them back into the vehicle.*

(6) Assemble and install the inlet ducting by reversing the order used during removal.

(a) Before you slide the clamps onto the ducting, lay out the individual ducting tubes in their correct order. Now, place the clamps onto the individual ducting tubes and slide the tubes together. Tighten the clamps just enough to hold the complete ducting assembly together, but not too tight that it cannot be adjusted.

(b) Next, position the ducting into the vehicle and connect the ends of the ducting to the turbocharger and the air cleaner assembly. You may have to twist the individual ducting tubes in order to get a proper alignment. Slide the clamps to the ends and tighten them just enough to hold the ducting in place.

(c) Now, line up the support bracket with the back of the air cleaner assembly and install it.

(d) Make any further adjustments to the ducting to ensure it is properly lined up. Now you can complete the tightening of all the clamps.

(e) To complete this task, you must reinstall the air restriction indicator line and the air compressor's air inlet hose to the ducting.

TRANSITION: That covers the air induction system. Now we will discuss the exhaust system. During this portion of the lecture, we will only cover how to inspect the components. The replacement can be accomplished by following the procedures outlined in the technical manual. We will begin by inspecting the engine exhaust manifold.

5. INSPECTING THE ENGINE EXHAUST SYSTEM

(SHOW SLIDE 8, EXHAUST SYSTEM)

(5 MIN)

a. Engine Exhaust Manifolds. Begin by examining around the exhaust manifolds for leaks which are indicated by black soot marks. This would indicate that the manifold is loose or the gasket is blown. Also check the exhaust manifold retaining nuts, exhaust mounting flanges, and clamps for looseness or damage.

b. Engine Exhaust and Crossover Pipes. To examine the exhaust pipe and crossover pipe, look for leaks which are indicated by black soot marks around the connections. Also, check that the exhaust pipe retaining clamps are tight and that the pipe is in good condition.

c. Muffler. Complete the inspection of the exhaust system by inspecting the muffler.

(1) The muffler should be securely mounted in place and there should not be any holes in it.

(2) The muffler's heat shield should be securely attached to the muffler.

(3) While inspecting the muffler, check to make sure that the rain cap is in position and that it moves freely from open to closed.

6. DIAGNOSIS OF MALFUNCTIONS IN THE DETROIT 8V92TA ENGINE AIR INDUCTION AND EXHAUST SYSTEMS

(5 MIN)

a. The vehicle technical manual addresses only one complaint for the exhaust system and that complaint is "Determine the Cause of a Noisy Exhaust System." To isolate that complaint you would proceed as follows:

(1) Check the muffler and exhaust pipes for damage or loose connections.

(a) If they are damaged or loose, repair or replace them as needed.

(b) If there is no damage or no loose connections, the exhaust manifolds must be checked.

(2) Check the exhaust manifolds for damage or looseness. If they are damaged or loose, tighten or replace them.

b. There are no diagnostic procedures in the manual that pertain to isolating faults in the air induction system. However, as a result of the information that you have been provided, you know that problems can arise in that system. The major cause of malfunctions within the air intake system is a restriction within the system.

(1) A restricted air filter will be indicated by the appearance of a red band in the windows of the air restriction indicator. If the red band appears, the SuperClone must be inspected to see if its air inlet tubes are blocked and the primary and secondary air filters must be checked and replaced if they are dirty.

(2) If large particles of foreign matter accumulate in the SuperClone's dust bin, that would be an indication that there is a restriction in the air line, check valve, or orifices that are components of the positive pressure system that is designed to clean the dust bin. To isolate that malfunction, each of the components must be inspected.

REFERENCE:

TM 2320-20/12A