



200 ENGINE INSTALLATION & TESTING

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INSTALLATION

Description

Engine installation details vary from vehicle to vehicle. The following procedure provides general installation guidelines for MACK E7 engines.

It is good practice to steam-clean road grime, grease, and oil from the engine before service. Steam-cleaning the engine and engine compartment permits more detailed inspection and improved workmanship.

Before beginning, make sure all equipment has been inspected for safety and is available for use. Place vehicle on a flat, level surface. Make sure area has ample work space.

NOTE

Newly designed torsional idler-gear assemblies are now available for servicing both 1:1 and 0.7:1 ratio Flywheel Power Take-Off (FWPTO) units in E7 engines equipped with a T200 series transmission and FWPTO. New assemblies feature a two-piece idler gear and torsion spring.

The new torsional idler-gear assembly reduces spline wear on the FWPTO input (drive) gear. If the unit is removed for any reason:

- Inspect input gear splines for excessive wear.
- If splines show excessive wear, disassemble the FWPTO far enough to gain access to idler-gear assembly. Refer to MACK Service Manual 10-901, Flywheel Power Take-Off.

Removing Engine from Engine Stand

1. Attach a suitable lifting device to lifting points on engine.
2. Position and attach an engine hoist to lifting device; place tension on the device by operating hoist.
3. With lifting device supporting the engine weight, remove mounting capscrews from engine stand.

Engine Installation into Vehicle

NOTE

Obtain assistance when installing the engine. Be sure to watch for obstructions such as engine or chassis components, brackets, clamps or other components that may interfere with engine installation.

1. Align engine with torque converter or clutch (as applicable) and install transmission bell housing to the flywheel housing capscrews. Torque to specification.
2. Install engine mount capscrews to secure engine mounts to engine. Torque to specification.
3. Remove transmission jack from under transmission.
4. Install clutch linkage and bracket-retaining capscrews.
5. Install power-steering hoses and reservoir, if applicable.
6. Install hood rest crossmember(s), if applicable.
7. Install exhaust bracket to flywheel housing and exhaust clamp at turbocharger.
8. Install starter. Connect wiring and cables.
9. Install air cleaner housing, if required.
10. Install all coolant tubes, ground straps, air lines, fuel lines, hydraulic hoses or tubes, throttle linkage and electrical wiring harnesses that were removed from engine during removal.

NOTE

On some E7 models, the machined V-band was replaced with a 3.5-inch push-on turbocharger discharge connection that is angled forward. The remaining models use a 3-inch push-on connection directed 90 degrees outward from the center line of turbocharger.



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NOTE

A new S3B turbocharger with a 3.5-inch push-on compressor discharge has replaced the earlier S3B turbocharger with cast elbow required for V-band connection. You will need to know which type turbocharger is used on your engine when ordering replacement parts.

11. Connect tube to turbocharger and air cleaner assembly.
12. Connect heater hoses and A/C refrigerant lines, if applicable, where attached at lower dash panel behind engine.
13. Install fan and fan clutch assembly.

NOTE

Belts used on the same drive must be installed in matched sets. Refer to the Maintenance and Lubrication manual, TS494, for procedures and specifications.

14. Install and adjust belts per specifications.
15. Install radiator using a lifting device and an assistant, if required.
16. Install retaining capscrews to radiator support mounts.
17. Install retaining capscrews to radiator support rods at radiator support.
18. Install fastener to bracket that secures radiator fan air clutch solenoid valve to radiator support.
19. Locate engine coolant temperature sensor and connect electrical connector. Install sensor harness to radiator support.
20. Connect Chassis-Mounted Charge Air Cooler (CMCAC) outlet hose at cooler.
21. Connect CMCAC inlet hose at cooler.
22. Install clamps that retain coolant overflow tank and install tank.
23. Connect lower radiator hose to coolant inlet of oil cooler assembly.
24. Connect upper radiator hose to engine coolant outlet fitting.
25. If vehicle is equipped with air conditioning:

- a. Connect electrical connector to low-pressure cutout switch in A/C refrigerant line.
 - b. Connect electrical connector to binary (cycling clutch) pressure switch on receiver/dryer.
 - c. Connect A/C line at receiver/dryer.
 - d. Connect A/C compressor discharge hose at connection near radiator support.
 - e. Obtain A/C refrigerant recovery and recycling equipment (J 38750-A for R12 or J 39500-B for R134A), and recover A/C system refrigerant.
26. Tighten clamps securing air intake tube to turbocharger and air filter. Install intake tube.
 27. Install hood. Refer to Hood Installation procedures in the appropriate vehicle manual.

Filter Element Installation

CAUTION

All filters and coolant conditioners must meet MACK specifications. Prime oil filters before installation using the correct specification engine oil.

1. Install a new air filter in air filter housing.
2. Install Centri-Max™ assembly. Be sure to use a new element and O-rings.
3. Using an appropriate filter wrench such as J 29927, install oil filter elements and coolant conditioner element.

NOTE

Prime fuel filter elements before installation. Use only clean, MACK-specified, Grade 2D diesel fuel.

4. Prime the PRIMARY fuel filter element (red) by filling with clean No. 2 fuel oil. Do not fill filter through center hole; it must be filled using outer holes. Lubricate gasket with oil and install filter.



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5. Prime the SECONDARY fuel filter element (green) by filling with clean No. 2 fuel oil. Do not fill filter through center hole; it must be filled using outer holes. Lubricate gasket with oil and install filter.

FINAL PREPARATION

Lubrication

A lubricating oil film coats rotating parts and bearings of an overhauled engine, but this may not provide sufficient lubrication when engine is started for the first time. The following briefly describes the recommended procedure for ensuring proper lubrication.

CAUTION

Do not mix brands or types of lubricants. Chemical additives may be incompatible and may contribute to the formation of sludge, acid or hardening.

SERVICE HINT

Usually there are various points on the engine where a pressure line may be tapped into, but if no other is apparent, the oil gauge line may be disconnected and pressure tank applied at that point.

ENGINE LUBRICATION SYSTEM (PRIMING)

1. Fill engine crankcase with EO-L engine oil.

NOTE

MACK-specified EO-L engine lubricant is recommended. E7 series engine capacity is 33.5 quarts (32 liters).

2. Fill a pressure prelubricator (J 39258-A) with the recommended oil and connect pressure prelubricator to main oil gallery. Prime engine lubrication system with sufficient oil.
3. Remove oil level dipstick and check crankcase level. Add sufficient oil, if necessary, to bring it to the FULL mark on dipstick. Do not overfill.

TURBOCHARGER

1. Disconnect turbocharger oil inlet line and pour approximately one pint (473 ml) of clean engine oil into line. This ensures that bearings are properly lubricated for initial start-up.
2. Reconnect oil line.

AIR INLET SYSTEM

1. Check the integrity of air inlet system.
2. Inspect all piping, connections and the air cleaner element. Replace components as required.

COOLING SYSTEM

1. Check cooling system. Make sure all plugs are installed and tight. Make sure thermostat is installed.
2. Fill system with recommended coolant.

NOTE

To ensure that all air is purged from cooling system, remove a plug from top (or end) of coolant manifold during filling. This will eliminate any air that was trapped as a result of rapid filling.

3. Install a new coolant conditioner and fill with the recommended coolant mixture.
4. Check that all plugs and thermostat(s) are installed.

FUEL INJECTION PUMP (MECHANICALLY GOVERNED AND V-MAC ENGINES)

1. Remove the TEM sensor or the 12-mm plug in the governor housing.
2. Fill pump housing with 12 ounces (355 ml) of EO-L engine lubricant.
3. Reinstall TEM sensor or 12-mm plug.

NOTE

Prelubing should be performed after new and used injection pumps are installed on the engine.



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FUEL SYSTEM

1. Check fuel system to ensure that all connections are tight.
2. Remove any trapped air by operating manual priming pump, if equipped, located on the side of injection pump (V-MAC only).

NOTE

Prime the fuel system with clean, Grade 2D diesel fuel (DF-A).

3. Check injection pump timing. Injection pump-to-engine timing must be set for the specific engine. See Engine Identification Plate or Tune-Up manual for specifications.

Engine Operational Check

1. Remove all tools from the engine compartment.
2. Connect battery cables (negative cable last).
3. Clear work area of debris and personnel.
4. Start the engine. Check for leaks and monitor gauges for satisfactory oil pressure, etc.
5. After several minutes, shut the engine down. Check fluid levels and fill to capacity before restarting engine.
6. Refer to the following Rebuilt Engine Run-In Procedures for testing procedures.

REBUILT ENGINE RUN-IN PROCEDURES

Description

The durability and service life of a rebuilt engine is directly related to its initial run-in following overhaul. After a complete overhaul or any major repair job involving installation of piston rings, pistons, cylinder sleeves or bearings, the engine must be run-in prior to release for service.

Run-in procedures vary depending on method used (i.e., engine dynamometer, chassis dynamometer or highway run-in). Regardless of method, however, always properly prepare engine before starting it for the first time.

Run-In Check

NOTE

Install any additional instrumentation needed for run-in method selected.

The operator should be familiar with correct, established procedure for checking chassis power *before* using chassis dynamometer method for run-in (refer to applicable chassis dynamometer operation procedures).

The operator must be observant throughout the entire run-in procedure, in order to detect any problems that develop. Constantly monitor the instrumentation displaying functions of the engine and support systems, and record all readings.

If, during run-in, the engine develops any of the following abnormal running characteristics, shut it down immediately. Investigate and correct the problem before continuing run-in procedure.

Always investigate the following conditions:

- Unusual noises such as knocking, scraping, etc.
- A significant drop in engine oil pressure.
- A significant rise in coolant temperature, exceeding 240°F (116°C).
- A significant rise in oil temperature that exceeds 240°F (116°C).
- An exhaust temperature that exceeds maximum acceptable limit for the specific engine involved, as measured by a pyrometer (if applicable).
- Any oil, coolant or air inlet system leaks.



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[233 FA] CHASSIS-MOUNTED CHARGE AIR COOLING

Description

The Chassis-Mounted Charge Air Cooling (CMCAC) system cools hot turbocharged air before it enters the engine intake manifold. The CMCAC system uses ambient air as a cooling medium by allowing it to pass through a core equipped with heat-exchanging fins.

Hot turbocharged air, varying in pressure from 0.0–25 psi (0.0–172 kPa), passes through core tubes where heat is transferred to the ambient air by heat-exchanging fins.

Front-section core construction consists of a series of cold bars, cold fins and tube plates. Side-section core construction consists of a series of hot bars and hot fins.

Special Tool Required

- Charge Air Cooler Pressure Fixture J 41473

CMCAC Troubleshooting

Symptom	Probable Cause	Remedy
Normal Boost — High Pyrometer	1. Core fin obstructions.	1. Clean core fins.
Low Boost — High Pyrometer	1. Restriction in ducting between air cleaner and turbo. 2. Dirty turbocharger. 3. Leaks in the pressurized side of the induction system. 4. Inlet manifold leak. 5. Open petcock (if equipped). 6. Core leakage.	1. Check for blockage and clean. 2. Clean turbocharger. 3. Check for and repair leaks. 4. Check for loose or missing fittings, plugs, and/or damaged manifold-to-cylinder head gaskets. Replace missing parts, and repair loose connections. 5. Close petcock. 6. Pressure test core. Remove, repair or replace core if test results are not satisfactory.
Low Power	1. Restrictions in cooler. 2. Restrictions in cooler inlet and outlet tubes.	1. Perform restriction pressure test. Clean out restriction. 2. Disconnect and clean obstructions.

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CMCAC Pressure Test

1. Remove air ducting from core.
2. Plug core inlet opening.
3. Insert a plug with an air-line adapter in core outlet opening.
4. Connect a safety chain to both plugs. Use air charge cooler pressure fixture J 41473 on coolers with flange connections.
5. After repairing or replacing core, reconnect ducting. Torque clamp nuts until clamp spring is fully compressed.
6. Pressurize system to 30 psi (207 kPa).
7. Shut off air source. Pressure should not drop more than 5 psi (35 kPa) within 15 seconds. Repair or replace core if pressure drop exceeds specification.
8. Carefully release pressure in system.
9. After repairing or replacing core, reconnect ducting. Torque clamp nuts until clamp spring is fully compressed.

WARNING

Stand clear of plug area when system is pressurized.

5. When plugs are secured, attach an air line (fitted to a pressure regulator and gauge) to air-line adapter in core outlet opening.

NOTE

When the spring is fully compressed, torque on the nut is generally between 40–55 lb-in (4.5–6.2 N•m).

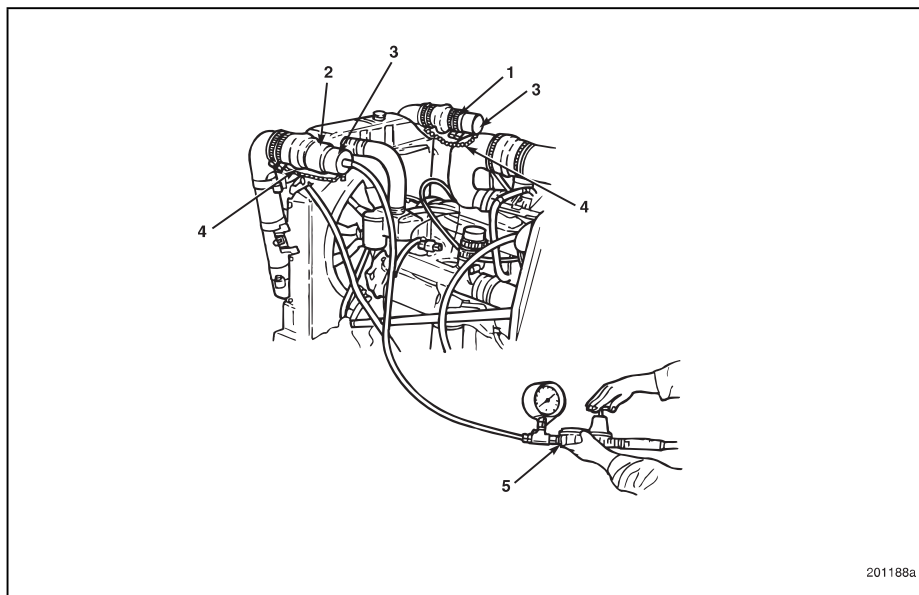


Figure 8-1 — CMCAC Pressure Test

1. Core inlet
2. Core outlet
3. Plug (part of J 41473)

4. Safety chain
5. Air pressure regulator and gauge (J 41473)



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Restriction Pressure Test

SERVICE HINT

Perform restriction pressure test at maximum, full-load condition.

A restriction in the internal portion of cooler may interfere with proper airflow, and can result in excessively high pyrometer readings. To perform a restriction pressure test, use the following procedure:

1. Units are equipped with connections on the inward sides of inlet and outlet charge cooler tubes. Remove plugs and install pressure gauge lines to begin test.
2. Install the appropriate pressure gauge to inlet and outlet charge air cooler tubes. The maximum allowable pressure drop across cooler is 2 psi (13.79 kPa) at full-load condition.

NOTE

If using manometers for this test, the difference between readings should not exceed 4 in-Hg (13.5 kPa).

3. If pressure drop is higher than specified amount, remove CMCAC. Flush the inside to remove any deposits that may be present. Do not use caustic cleaners. Be extremely careful when handling cooler so as not to damage core.

CAUTION

The clamp springs must always be located on underside of tube to avoid damaging hood when closed.

4. Reinstall cooler if removed to flush and then pressure-test CMCAC system.
5. If cooler passes restriction and pressure tests, remove test equipment, reinstall inlet and outlet tubes, hoses and clamps or reinstall plugs, if equipped. Tighten clamps to 38 lb-in (4.3 N·m).

Core Repair

Certain types of CMCAC core foreign object impact damage can be field-repaired (depending on extent of damage). Other types, or more extensive damage, cannot be field-repaired and require core replacement.

Determining whether or not core damage is repairable is a critical first step. Proper diagnosis can eliminate costly man hours and keep vehicle downtime to a minimum.

REPAIR PROCEDURES

The following guidelines will help you determine which areas are repairable or nonrepairable.

To ensure the CMCAC system will function properly after repair or replacement, a pressure/leak test is recommended.



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Damage	Core Failures	Recommended Repair Procedure	System Check
Repairable	All header tank-to-core separations	Tungsten-Inert (TIG) weld method	Perform pressure/leak test
	All header tank cracks	Tungsten-Inert (TIG) weld method	Perform pressure/leak test
	Bent cold fins	Straighten with small screwdriver or pair of small needlenose pliers	Perform pressure/leak test
	Tube plate cracks or welds not exceeding 0.25 inch (6.35 mm) in length	RTV method or Tungsten-Inert (TIG) weld method	Perform pressure/leak test
	Tube cracks or weld separations exceeding 0.25 inch (6.35 mm) in length	Tungsten-Inert (TIG) weld method	Perform pressure/leak test
Nonrepairable	Internal fins damaged and separated from tube plate	No repair procedure is recommended — replace unit	Perform pressure/leak test
	Tube blockage	No repair procedure is recommended — replace unit	Perform pressure/leak test
	Cold bar separations or openings exceeding 0.25 inch (6.35 mm) in length	No repair procedure is recommended — replace unit	Perform pressure/leak test
	Excessive cold fin damage (original shape of fins distorted beyond repair)	No repair procedure is recommended — replace unit	Perform pressure/leak test

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INSPECTION

1. Carefully inspect entire system to determine exact location and extent of damage.
2. Inspect cold fins and cold bars that run horizontally in cooler.
3. Inspect all brazed or welded joints in header tank.
4. Make sure area to be repaired is free of surface oxide and foreign materials such as oil, grease, dirt, etc. Prior to repair, prepare surface with a clean stainless-steel brush.

TUNGSTEN-INERT (TIG) WELD METHOD

TIG-weld using 1/16–5/32 inch diameter AWS ER 4043 filler rod. Welds should exhibit complete fusion without excessive overlap or undercut.

NOTE

MACK recommends pressure-testing the CMCAC system after repairs are complete.

CMCAC Preventive Maintenance

In case of engine and/or turbocharger failure, perform the following steps to make sure CMCAC system is free from debris:

1. Remove chassis-mounted cooler and flush inside with a safety solvent to remove oil and other foreign debris.
2. Shake cooler to remove large pieces.
3. Wash with hot soapy water. Rinse with clean water and blow dry with compressed air in reverse direction of flow.
4. Carefully inspect cooler to ensure cleanliness. Do not use caustic cleaners.



NOTES
