MAINTENANCE INSTRUCTION

M. I. 1746

Service Department
ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION
December, 1999

SCHEDULED MAINTENANCE PROGRAM

GT46MAC Locomotive

Equipped With 16-710G3B-Series Engine
and
AC Traction Components

SAFETY PRECAUTIONS

Please refer to the EMD Safety Precautions for GT46MAC Locomotives in appendix to the Locomotive Service Manual whenever routine service or maintenance work is to be performed on this locomotive.

The Maintenance Schedule as outlined in this instruction is specific to the GT46MAC locomotive and is offered for planning purposes only. As written, this document reflects current EMD product design and service experience for the 70-Series class of rail freight locomotives with AC traction components. The content of this M.I. reflects locomotive / engine overhaul cycles based on time, kilometers or megawatt-hours. This recommendation is consistent with present fleet performance and remains within the EMD experience envelope.

This Maintenance Instruction is intended to serve as a guide when establishing maintenance schedules to meet the particular requirements of individual operations and planned economic life of the locomotive. It provides average recommendations which should ensure satisfactory locomotive operation and economical maintenance costs where average load factors and climatic conditions are encountered.

The scheduled inspection and maintenance items defined herein are specific to the GT46MAC locomotives. Component renewal provisions are consistent with traditional "In-Carbody" engine overhaul procedures. Customers wishing to schedule more extensive overhaul procedures including a UTEX engine can extend the mega-watt interval to overhaul by 20%.

For planning purposes, EMD has established the following overhaul interval recommendations for the GT46MAC locomotive. These overhaul interval recommendations are based on whichever event occurs first: time, kilometers, or megawatt hours.

GT46MAC Locomotives:

* High Speed Service: 6 years / 1367905 kms / 23,000 MWHRS.
* Heavy Haul Service: 6 years / 1046045 kms / 23,000 MWHRS.

Note:

Kilometer and MWHR values referenced above are defined by Microprocessor Archive Data as accumulated by the locomotive control computer system.

As always, when specific operating conditions severely impact locomotive performance and or reliability, maintenance schedules must be adjusted accordingly.

INTRODUCTION

The recommendations contained in this Maintenance Instruction are based on the following:

1. Fuel oil shall meet the specifications of Maintenance Instruction 1750.

NOTE

Fuel filter integrity should be checked periodically by measuring pressure differential at the rack mounted filter gauge.

Wayside fuel filtration should be recognized as an important consideration in meeting the specification criteria of M.I. 1750. Locomotive re-fueling at remote-site locations by transient fuel vendors must also consider provisions for wayside or pre-delivery filtration.

2. Lubricants shall meet the specifications of Maintenance Instructions 1752, 1756, and 1764 with levels properly maintained for engine, journal boxes, traction motor support bearings, and gear cases.

NOTE

Periodic engine oil samples should be taken to monitor the suitability of the oil for continued use. Oil should be changed at the intervals specified in this M.I. or when laboratory analysis indicates fresh oil is required. Evaluation of engine and oil condition should dictate when more frequent oil changes are required. The type of service, type of oil, quality of filter elements, and condition of engine will influence the frequency of oil change.

3. Lubricating oil filters shall be of a quality equal to original equipment and shall be changed at the intervals specified in this Maintenance Instruction.

NOTE

Lube oil filter tank pressure should be checked periodically as a means to monitor filter condition.

4. Engine coolant shall meet the specifications in Maintenance Instruction 1748 and shall be maintained to proper levels.

NOTE

Periodic engine coolant samples should be taken to ensure that the quality of the solution is maintained. The specific concentrations of inhibitor in the coolant should be monitored and, as a general rule, coolant solution should be changed at least annually.

5. Government mandated inspections are specifically not included in this Maintenance Instruction.

NOTE

Development of a comprehensive inspection and maintenance plan, including unique owner/operator requirements, is deemed the responsibility of the customer.

6. Maintenance requirements and service procedures for Customer specified locomotive options and equipment shall be provided separate from this document.

NOTE

Service information on specialty items will generally be provided by the original manufacturer and reflect their recommendations. Distribution of such information will be through GMLG at time of locomotive delivery.

7. Publications, as referenced in abbreviation examples listed below, will be followed for inspection, tightening, and maintenance procedures.

LOM means Locomotive Operator's Manual
LSM means Locomotive Service Manual
EMM means Engine Maintenance Manual
M.I. means Maintenance Instruction
PC means Parts Catalog

DAILY

LOCOMOTIVE CAB

Using the display screen, note any defect recorded in the EM2000 locomotive control computer. If all reported defects are corrected, clear the annunciator.	LOM, LSM
Inspect and test all interior and exterior lights.	LOM, LSM
Check operation of electronic air brake system.	LOM, LSM and Knorr Publication.
Test operation of horn and sanders.	LOM, LSM
Check operation of indicating lights panels.	LOM, LSM

ABOVE DECK INSPECTION

With engine idling: Check engine room for fuel, oil, or water leaks, unusual noises, or smoke.	LOM, LSM, and EMM.
Check other locomotive systems (auxiliary generator, main alternator, traction motor blower, air compressor, and cooling fans) for unusual noises.	
Check engine oil level.	LOM, LSM and EMM.
Check cooling system water level.	LOM, LSM and EMM.
Check compressor oil level.	LOM, LSM and EMM.

BELOW DECK INSPECTION

With engine running, walk around the unit and check for:	LOM, LSM and EMM.
- Fuel, water, oil, or air leakage	
- Loose or dragging equipment	
- Couplers and draft gear for defects	
- MU hoses and cables for defects	
- Brake rigging for damage	
- HTSC truck for damage	
- Traction motor leads for damage	
- T. motors for cooling air flow and air ducts damage.	
- Wheel defects	
- Gearcase damage or leakage	
- Radar unit damage,	Confirm operation of radar blower and clean faceplate if required.
- Check adjustment of brake travel	
- Drain condensate from main reservoirs and verify proper operation of automatic drain valves	
- Check air dryer operation	Blue sight glasses indicates that dessicant is dry
- Check traction motors temperature and speed probes mounting and cables for defects.	

CAB AND CONTROL SYSTEMS

Test functional operation of electronic air brake system. Perform system diagnostics through EM2000 display screen. Correct any system failures.	LOM, LSM and Knorr Publication.
Check locomotive computer. - Verify correct Date, Time, and Unit Number from EM 2000 display. - Monitor computer display panel messages - Perform all locomotive self-tests functions.	LOM, LSM. See LSM for method. Perform checks or maintenance indicated by messages. Qualify fault indicating devices and systems.
Check for stored annunciator messages. - Acknowledge faults - Download archive and running totals as required.	

ENGINE (Running)

With engine idling and at operating temperature:

Inspect lines, connections, and equipment for leaks; fuel, oil, water, air, exhaust gas.	LSM, EMM.
Inspect cylinder head mechanisms for proper rocker arm and valve bridge operation.	EMM.
Check air compressor assembly for proper operation and note unusual operating noise(s).	LSM.

ENGINE (Stopped)

Renew all lube oil filter elements: - Primary filter elements. - Turbocharger element. - Soakback element	PC, EMM, LSM. Use elements equal to original equipment
Renew primary fuel filter element and engine mounted spin-on fuel filter elements.	PC, EMM, LSM. Use elements equal to original equipment.
Renew fiberglass element engine air filters.	PC, LSM. Use elements equal to original equipment.
Visually inspect crankcase and airbox for leaks. Check condition of power assemblies.	EMM. Clean airbox drains if necessary.
Inspect eductor tube for carbon deposits.	EMM. Clean if necessary.
Check cooling system inhibitor concentration.	M.I. 1748
Check operation of engine protector.	EMM, LSM, or M.I. 260.

ELECTRICAL EQUIPMENT AND SYSTEMS

Inspect , check, and test all alarms, automatic controls, and protective devices.	LSM and EMM.
Check operation of soak back pump and motor	With the engine shut down and soak back pump running, remove left rear handhole cover and check oil flow through gear train. Observe camshaft bearings. If lube oil flows from camshaft bearings with soak back pump running while the engine is shut down, inspect turbo filter outlet check valve for proper operation.
Renew traction inverter cabinets filter elements.	PC, LSM. Use elements equal to original equipment.
Check for low voltage DC grounds.	LSM
Check for low voltage AC grounds	LSM
Check ground relay action.	LSM.
Inspect cooling fan motors fuses	If pin protrudes on a single fuse only, always change both fuses in the motor circuit.
Check for blown fuses through TA 17 main generator inspection windows.	M.I. 3317
Check battery electrolyte level and specific gravity.	Wash cell tops and complete battery box. Apply petroleum jelly to terminals

MECHANICAL EQUIPMENT AND SYSTEMS

Inspect traction motor inlet guide vane assembly. - Check for worn bushings and rods, loose nuts, and cracking (fatigue) of actuating rod.	Replace excessively worn components as needed.
Check air compressor oil level.	LSM, add oil as required when compressor is stopped.
Check Governor oil level.	EMM, add oil as required.
Inspect main generator pit drain aspirator for plugging.	LSM, clean if necessary.
Check vertical and lateral shock absorbers for leaks and proper control. Replace if defects are evident.	LSM and M.I. 1515.
Check condition of wheels. Check for wear, sharp flanges, shelling, cracks, and flat spots. Check rim surface for pitting, crushing or build-up of cracks.	LSM
Check wheels for wheel size mismatch. True wheels or change wheel sets as required.	M.I. 1518
Check traction motors temperature and speed probes mounting and cables for damages. Ensure all plugs are secure.	LSM
Check traction motor gear case oil level.	LSM. Fill to overflow.

SIX MONTHS

CAB AND CONTROL SYSTEMS

Check functional operation of emergency fuel cut-off switches.	LOM and LSM
Lubricate throttle and reverser handle pivot points.	

ENGINE (Stopped)

Visually inspect crankcase and oil pan for external leaks. Check for indications of air leaks around aftercooler duct mounting flanges.	EMM.
Clean or renew fuel suction strainer element	LSM.

ELECTRICAL EQUIPMENT AND SYSTEMS

Check condition of traction alternator.	LSM and MI 3317. Clean rectifier banks and inspection windows.
Inspect diodes and fuses	Replace diodes and fuses as required and record failed diode locations.
Inspect commutation capacitors and resistors, and generator current transformers	
Inspect collector rings and brushes.	

MECHANICAL EQUIPMENT AND SYSTEMS

Take manometer reading to check proper ventilation at electrical control cabinet no.1	LSM
Renew main reservoir air filter elements.	LSM, PC. Use elements equal to original equipment.
Check operation of main reservoir automatic drain valves.	LSM.
Check yaw dampers for leakage and proper control. Inspect rod surface for scoring, pitting, or corrosion, and mounting bushings for deterioration.	LSM and M.I. 1515. Replace if defects are evident.

One Year / 227983 KM's/3833 MWHR's

ENGINE (Running)

Perform load test. - Check Horsepower. Correct as necessary.	LSM and EMM.
- Check engine speeds and governor balance point.	EMM and LSM. Apply governor on test stand if necessary.
- Check mechanical overspeed trip mechanism. Readjust if necessary.	EMM.
Check air pressure drop across aftercoolers.	EMM. Clean aftercooler cores if necessary.

ENGINE (Stopped)

Drain and renew governor oil.	EMM and M.I. 1764
Set MUI injector timing and rack length.	EMM.
Perform complete power assembly inspection, including liners, pistons, piston pins, p-pipes, connecting rods, and crankshaft.	EMM.
Visually inspect air box for oil/water leaks, and proper air box drainage. Clean airbox drains as required.	EMM.
Remove exhaust manifold inspection plate and inspect screen and trap.	EMM. If foreign objects are found in trap, remove screen to inspect turbine vanes. Also inspect power assemblies.
Check exhaust valves timing.	EMM.
Remove and clean oil separator element.	EMM.
Retorque main lube oil and piston cooling oil pump shaft nut.	EMM.

ELECTRICAL EQUIPMENT AND SYSTEMS

Inspect all visible insulation and connections on traction motor leads and carbody boots.	LSM.
Inspect condition of traction alternator collector rings. Reverse polarity and replace brushes.	LSM and M.I. 3317-2.
Inspect DC motors: Dynamic brake blower motors. Fuel pump motor. Soak back motor	LSM, M.I. 4101 and M.I. 4104. Renew brushes as a complete set when required.
Visually inspect both dynamic braking grids and blower assemblies, clean with dry air.	LSM , M.I. 1601 and M.I. 4104.
Check operation of all contactors. Inspect arc chutes, tips, and interlock plunger bolts.	LSM.
Renew electrical cabinet air filters: Change high voltage cabinet filter elements. Change AC cabinet filter element.	PC, LSM. Use elements equal to original equipment.
Inspect traction inverter (TCC) cabinets. Clean cooling fins on phase modules. Check all cable and wiring connections.	LSM.
Remove starting motors from engine. Inspect starting motor. Lubricate bearings and renew brushes in sets, if required.	LSM, EMM
Inspect all electrical cabinets, check for loose plugs and connections. Check also for traces of overheating and water infiltration.	LSM

MECHANICAL EQUIPMENT AND SYSTEMS

Renew main reservoir air filter elements.	
Clean air compressor air filter housing and renew air filter elements.	PC, LSM. Use elements equal to original equipment. Do not attempt to clean elements.
Change air compressor oil and renew oil filter.	M.I. 1756 and M.I. 1144.
Replace DL filter elements in air brake system.	LSM. Use elements equal to original equipment
Inspect radiator air passages and clean if necessary.	LSM, and M.I. 549. Operation in areas and in periods of airborne seed and leaves can require more frequent cleaning.
Clean radiator header screens after first year of operation. Condition of screens at this time can provide a basis for future cleaning.	LSM. M.I. 549 and M.I. 550. The presence of metal chips at first cleaning or after engine parts have been renewed is not an abnormal condition.
Inspect and test cooling system pressure cap and filler neck. Replace cap as required.	PC, LSM. Use cap equivalent to original equipment.
Inspect cooling system pressure relief valve for leaks .	LSM.
Drain engine coolant and refill with new.	LSM and M.I. 1748
Measure pressure drop across inertial filters.	LSM. Remove and clean inertial filters, if necessary.
Remove and replace air dryer precoalescer element	LSM
Drain condensate from fuel tank.	LSM. drain more frequently during periods of high humidity or rapid temperature change.
Lubricate door hardware; hinges, latches, and linkages (including carbody doors).	M.I. 1756.
Lubricate handbrake chain and check operation. Inspect chain snubber.	LSM, and M.I. 1577.
Check functional operation of traction motor blower inlet vane system.	LSM. Add 1/4 oz. of lubricant (transmission fluid) to the cylinder and lubricate linkage.

TWO YEARS/ 455966 KM/ 7676 MWHRS

ENGINE

Renew or recondition engine protector and requalify.	M.I. 260. Qualify on test stand after renewing springs, “O” rings, and diaphragms. Replacement can be EMD Unit Exchange.
Remove hot oil detector and check for operation at proper temperature.	LSM.

MECHANICAL EQUIPMENT AND SYSTEMS

Check temperature differential between lube oil and cooling water into engine.	LSM. Perform during scheduled load test. Clean oil cooler if necessary. M.I. 927 and M.I. 928.
Renew thermostatic valve element of fuel oil preheater.	LSM.
Renew cooling system pressure cap.	LSM.
Inspect and requalify vertical and lateral truck shock absorbers.	LSM. Replace as required.

ELECTRICAL EQUIPMENT AND SYSTEMS

Check settings of EFS and FVS switches	LSM.

THREE YEARS/ 683950 KM/ 11499 MWHRS

ENGINE

Inspect and qualify lower connecting rod bearings for reuse.	EMM.
Install new upper connecting rod bearings.	EMM.
Install new lower main bearings.	EMM.
Inspect crankshaft gear damper.	EMM. Check for free movement.
Inspect and qualify piston cooling tubes.	EMM.
Check rocker arms, rocker arm bushings, and cam followers.	EMM.
Renew valve bridge and lash adjuster assemblies.	EMM.
Renew injectors.	EMM. Replace with EMD Unit Exchange.
Renew governor.	EMM. Replace with EMD Unit Exchange.
Renew top deck cover seals and check latches.	EMM.
Renew jacket water pump.	EMM. Rebuild or replace with EMD Unit Exchange.
Renew turbocharger aftercooler water pump.	EMM. Rebuild or replace with EMD Unit Exchange.
Perform self-load test after engine work. Confirm the following; - Proper loading at each throttle notch. - Engine function parameters are within specified range.	LSM, EMM.

MECHANICAL EQUIPMENT AND SYSTEMS

Recondition air compressor valves. - Inspect compressor and related piping for air, water, and / or oil leaks. - Verify functional operation of intercooler pressure relief valve.	M.I. 1144. Replace valve as required.
Renew or replace the air filter dryer assembly.	LSM, Vendor publication.
Renew flexible coupling seals in cooling and lube oil piping.	LSM.
Remove primary lube oil filter bypass valve. Clean, inspect, and test.	M.I. 926.
Recondition main reservoir drain valves .	LSM.
Renew traction motor blower inlet shutter magnet valve .	LSM and M.I. 4707
Renew sanding magnet valves and radar blower magnet valve.	LSM and M.I. 4707
Renew compressor control magnet valve.	LSM and M.I. 4707
Recondition or replace horn magnet valves and EBT magnet valve.	LSM and M.I. 4707
Renew traction motor blower inlet guide vane assembly.	LSM.
Recondition fuel pump and renew coupling spider.	M.I. 4110.

ELECTRICAL EQUIPMENT AND SYSTEMS

Renew the fuel pump motor	M.I. 4101
Recondition or replace electric starter motors.	EMM. Replacement should be EMD Unit Exchange.
Check electrical cabinets door seals for leakage due to damage or deterioration.	LSM. Replace seals if necessary. Adjust lock keeper, if required.

SIX YEARS/ 1367905 KM/ 23000 MWHRS

ENGINE

Drain lubricating oil. Replace with fresh charge of oil after overhaul work is complete.	LSM, EMM, and M.I. 1752.
Renew power pack assemblies. Apply new heads, liners, pistons, and rings. Apply new wrist pins and bearings. Apply new head seat rings. Apply new lower liner inserts. Apply new rocker arms and rocker arm bushings. Apply new valve bridges and lash adjusters.	EMM. Replacement components should be new or EMD unit exchange.
Install new upper and lower connecting rod bearings.	EMM.
Visually inspect and requalify crankshaft. Install new lower main bearings. Install new thrust collars.	EMM.
Visually inspect and requalify all components of the front and rear gear trains.	EMM.
Renew or recondition crankshaft damping device.	EMM. Replace with new or reconditioned gear-type damper.
Renew turbocharger.	EMM. Replace with EMD Unit Exchange.
Renew turbocharger external clutch assembly.	EMM.
Recondition auxiliary generator drive assembly.	EMM.
Clean or renew aftercooler cores.	EMM.
Inspect exhaust manifold sections. Renew manifold base gaskets. Renew expansion joints.	EMM.
Renew or recondition oil pumps.	EMM. Replacement should be EMD Unit Exchange.
Remove oil pressure relief valve; clean, inspect, and test.	EMM.

Remove lube oil soakback filter assembly. Disassemble, clean, inspect, and replace by-pass ball valves .	EMM.
Remove turbocharger lube oil filter assembly. Disassemble, clean, inspect, and replace check valves.	EMM.

ELECTRICAL EQUIPMENT AND SYSTEMS

Remove rectifier assemblies from generator air boxes. Remove fuses and thoroughly wash heat sink and diodes. Requalify all fuses for reuse. Check diodes.	M.I. 3317-2 or 3 **CAUTION: Never use a caustic cleaner solution.** Pointers article 2L97.
Remove main generator bearing cover. Inspect for grease contamination, excessive wear, and overheating. Apply new grease.	M.I. 3317-1.
Check operation of all fan / blower motors contactors. Inspect interlocks and cabling. - Renew cooling fans contactors tips. - Renew braking contactor tips. - renew TCC s blowers contactor tips.	LSM, and M.I. 5364-B.
Renew dynamic brake cooling fan assembly.	LSM., M.I. 4104. Replace with EMD Unit Exchange.
Renew radiator cooling fan assemblies.	LSM, M.I. 4105. Replace with EMD Unit Exchange.
Renew auxiliary generator .	LSM, M.I. 3707. Replace with EMD Unit Exchange.
Renew generator blower assembly.	LSM. Replace with EMD Unit Exchange.
Renew inertial filter blower motor assembly.	LSM, and M.I. 3614. Replace with EMD Unit Exchange.
Renew soak back pump motor.	LSM, and M.I. 4101. Replace with EMD Unit Exchange.

MECHANICAL EQUIPMENT AND SYSTEMS

Recondition air compressor	Refer to vendor publication.
Renew turbocharger-to-filter air duct .	
Recondition soak back pump and renew coupling spider.	M.I. 4110
Recondition air compressor drive shaft coupling.	LSM, and M.I. 1753.
Recondition auxiliary generator drive coupling.	M.I. 1753.
Pressure test cooling system pressure relief valve.	LSM.
Pressure test cooling reservoir fill valve.	LSM.

TWELVE YEARS/ 2735810 KM/ 46000 MWHRS

ELECTRICAL EQUIPMENT AND SYSTEMS

Renew main generator bearing.	M.I. 3317-1.
Renew traction motors.	Replacement should be EMD Unit Exchange. Refer to Non-scheduled Maintenance portion of this M.I.

EIGHTEEN YEARS/ 4103715 KM/ 69000 MWHRS

ENGINE

Renew engine.	Replacement should be EMD Unit Exchange.

ELECTRICAL EQUIPMENT AND SYSTEMS

Renew main traction alternator and companion alternator.	Replacement should be EMD Unit Exchange.

NON-SCHEDULED MAINTENANCE

A definite time schedule for items listed below cannot be established due to variations in wear and component life related to operating conditions.

ELECTRICAL COMPONENTS

HIGH VOLTAGE CABLING

Renew.

LOW VOLTAGE WIRING

Renew.

ELECTRONIC AIR BRAKE — LSM and Vendor publication.

Replace battery in Knorr memory module at ten years.

HIGH VOLTAGE CABINET — LSM

Replace control system computer modules as required.

Inspect connectors and cables for signs of fatigue at time of component replacement.

Replace DC Link contactors, braking contactors, and motors modules as required.

Clean inside of TCC Cabinets/Low Voltage Cabinets as required--remove dust.

MECHANICAL COMPONENTS

TRUCK ASSEMBLIES

The HTSC truck has been designed to achieve a one-million mile service life. Actual overhaul frequency of the truck assembly needs to be consistent with service life and the scheduled maintenance of other locomotive components as reflected in this M.I.

At overhaul, inspect, test, and repair or replace the following items as necessary; frame, steering mechanism, wear plates, springs, spring seats, snubbers, brake rigging, rubber secondary springs, and sander guides. — LSM and M.I. 1515.

*The following work is to be performed at each **wheel truing,** or when one or more truck assemblies are removed for reconditioning.*

SHOCK ABSORBERS

Inspect and qualify vertical truck shock absorbers.	LSM. Replace as necessary.

*The following work is to be performed at **wheel change** time or when one or more truck assemblies are removed for reconditioning.*

YAW DAMPERS

Inspect and qualify primary and secondary yaw dampers.	LSM, M.I. 1515. Replace as necessary.

LATERAL WEAR PADS — LSM and M.I. 1515.

Replace at wheel change.

PINION

Check for involute profile wear.

Magnaflux. — M.I. 1518.

Replace at 4^{th} wheel change

AXLE GEAR

Check for involute profile wear.

Magnaflux. — M.I. 1518.

AXLE

Magnaflux with wheels and inner races removed.	M.I. 1518.

TRACTION MOTOR

Disassemble motor:

Clean rotor, stator, and frame.

Check for grounds, open or shorted Windings.

Process the stator and frame assembly through a VPI varnish dip and bake operation.

Inspect and re-grease TM non-drive end bearing.

Re-assemble motor:	Whenever truck assembly is removed from locomotive, check traction motors for unusual bearing noise or heat at maximum 1500 RPM.
Check bearings using heat and noise test.	

TRACTION MOTOR SUPPORT BEARINGS

Renew roller bearing assemblies at second wheel change.	Replacements should be EMD Unit Exchange or equivalent.

JOURNAL BOXES/JOURNAL BEARINGS

Remove and re-qualify tapered rollers.	M.I. 1553. Replacements should be EMD Unit Exchange or equivalent.

BRAKE RIGGING

Check condition of brake rigging. Remove, disassemble, and replace hardware with new parts as required.	LSM and M.I. 1515.