ELECTRO-MOTIVE

M.I. 1805

MAINTENANCE INSTRUCTION

COLD WEATHER MAINTENANCE RECOMMENDATIONS

INTRODUCTION

The information presented in this publication is intended to provide the reader with recommended general locomotive cold weather maintenance procedures as well as to provide specific component winterization instructions.

The entire locomotive including components, systems, and the carbody has received coverage, and the entire locomotive product line is included in the scope of this document.

The contents have been sectionalized (as listed below), to aid the reader in locating information pertinent to individual equipment. Even so, because of the complexities in a publication of this type, the user is advised to exercise care when identifying and following a specific procedure.

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MAINTENANCE INSTRUCTION

ELECTRO-MOTIVE

SECTION I

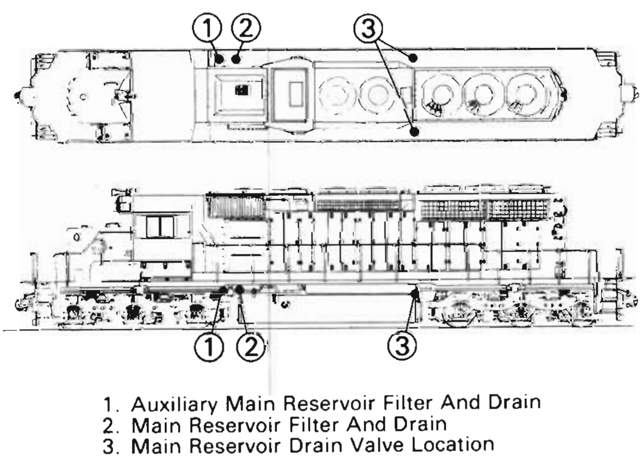
COLD WEATHER CHECK LIST FOR EMD LOCOMOTIVES

Electro-Motive has compiled the following check list to aid customers in their preparations for cold weather and winter operations. Most of these items are covered in Pointers or Maintenance Instructions issued by EMD, and excerpts of special winter interest are to be found in Sections II and III. These recommendations, now brought together, will help to identify and coordinate the special maintenance emphasis needed during inclement weather operation.

AIR SYSTEM

1. Drain Valves - Main Reservoirs and Compressed Air System Filters, Fig. 1.

   a. Clean, overhaul, and test. Seals and pistons should be lubricated at regular intervals with a good grade of air brake grease. Refer to manufacturer's maintenance instructions.



1. Auxiliary Main Reservoir Filter And Drain
2. Main Reservoir Filter And Drain
3. Main Reservoir Drain Valve Location

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Fig.1 – Typical Compressed Air System Drain Valve Locations

   b. If solenoid actuated, Fig. 2, check timer function and cycle duration (1 to 2 minutes). If faulty operation of the electro-thermo timer is suspected, first check to see that all electrical connections are tight at the timer and drain valves. If this does not produce satisfactory results, replace the thermo switch by removing the electro-thermo timer cover and pulling the tape tab on the switch. Plug in a new switch and replace cover, Fig. 3.

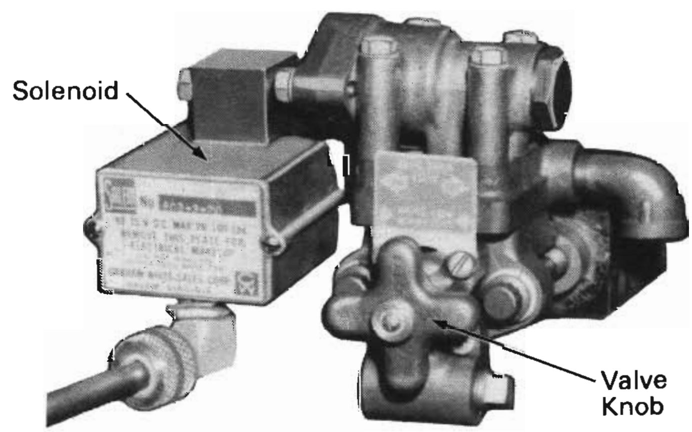

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Fig.2 – Solenoid Operated Automatic Drain Valve

   c. If pneumatically actuated, Fig. 4, blow out air line between drain valve and compressor control magnet valve, Fig. 5. Cycle compressor unloader to check drain valve function. Due to the internal drain valve spool mechanism, the compressor unloader line should cycle the auto/manual drain valve both on compressor engagement and disengagement.

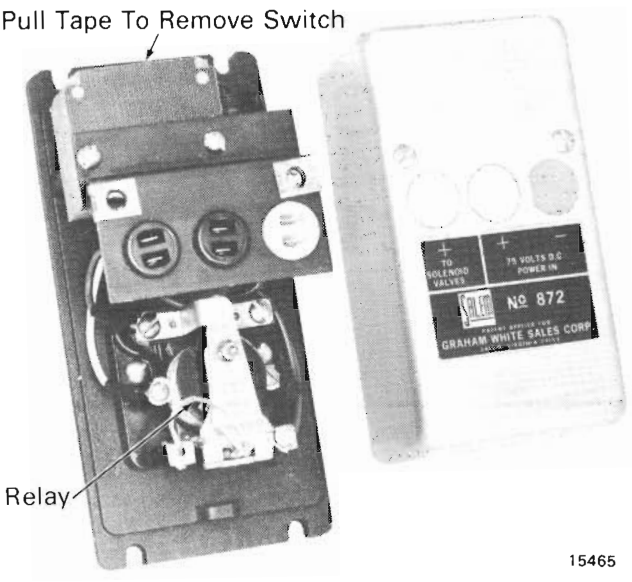

Fig.3 - Electro-Thermo Timer

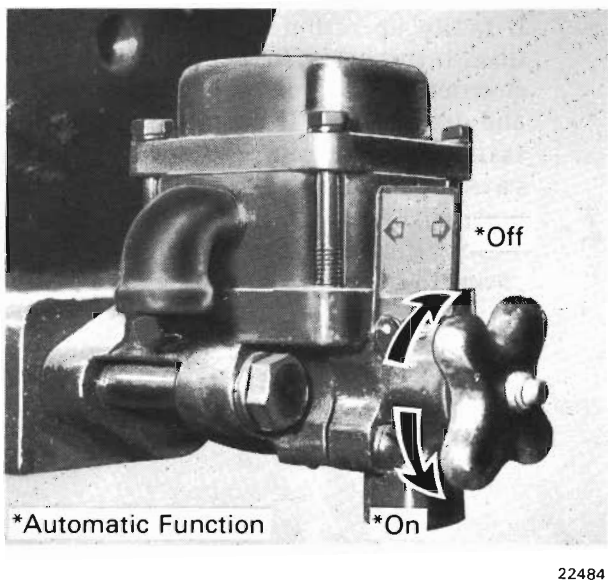

Fig.4 - Pneumatic Automatic/Manual Main Reservoir Drain Valve

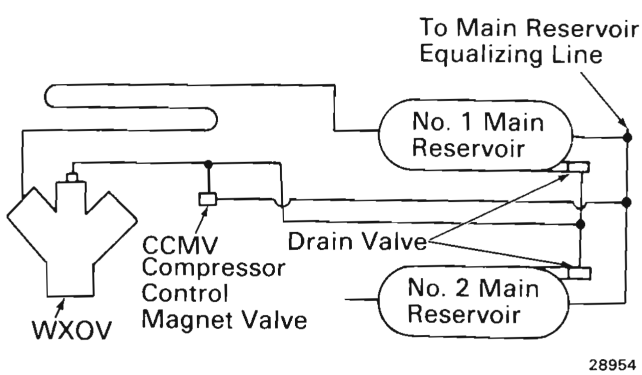

Fig.5 - Pneumatically Activated Drain Valve Schematic, Typical System

d. If electric drain valve heaters are installed, verify operation. Heaters will protect drain valves to 10° F. Below 10° F there is relatively little moisture in air and condensation is greatly reduced. Electric heaters are available for 880 and self-actuating valves. See Section III of this instruction.

2. Main Reservoirs

a. Drain all accumulated moisture from No. 1 and No. 2 main reservoirs. Turning the control knob on auto/manual drain valves, Fig. 4, clockwise as far as possible will turn the valve off. Manual draining will occur when the valve knob is midway between the ON and OFF positions. Automatic operation is restored by turning the valve fully counterclockwise.

b. When locomotive is operated in a warm environment during the winter season, drain all accumulated moisture from main reservoirs at least once a day.

3. Compressed Air System Filters - Main Reservoir, Auxiliary Main Reservoir, And Compressor Control Filter.

a. Clean, inspect, and replace filters where applicable, Fig. 6 typical. The main reservoir and auxiliary main reservoir centrifugal filter sump bowls should also be cleaned when new elements are installed. Before removing the bowl on the bottom of the filter, be sure the cutout located between the main reservoir and the filter is shut off.

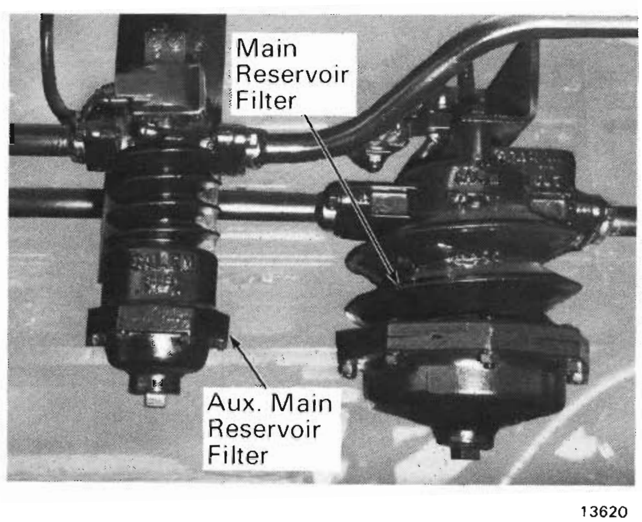

Fig.6 - Compressed Air Filters

Other filters to be remembered (where applicable) include independent equalizing/actuating line filters, the air compressor control line filter, and dryer system filters. Optional filters are described in Section III of this instruction.

b. Clean and test Air Dryer/Filter system where applied. Fig. 7 shows the installation of the Salem Twin Tower model dryer.

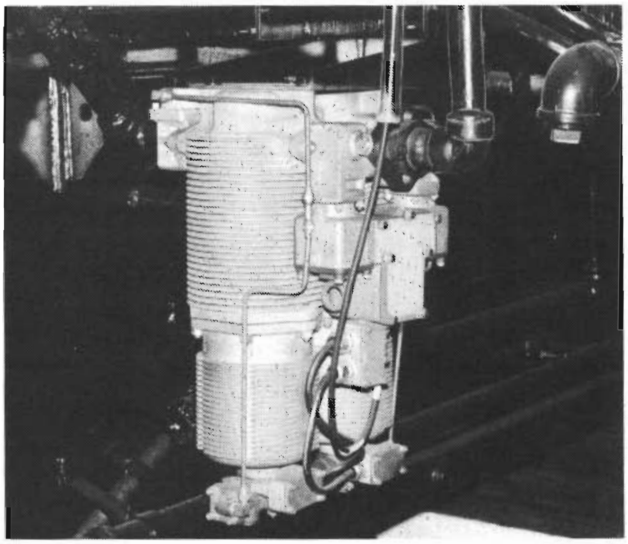

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Fig.7 - Twin Tower Air Dryer

Both dessicant dryer cannister assemblies and the final filter element should be replaced. The dryer is equipped with a timer that alternates air flow between the two dessicant beds on a two-minute cycle. The dryer may be functionally checked as follows.

With engine running, auto drain timer (ADT) circuit breaker on, No. 2 main reservoir cock open, and pressure above 690 kPa (100 psi); exhaust alternately comes from drain valve of each filter/dryer unit at 2 minute ±15 second intervals when in a regenerating cycle. Each exhaust is characterized by pronounced air discharge followed by continuous lesser flow until unit goes back into dehydrating cycle. There should be no air discharge from a dehydrating unit.

Humidity indicator (sight glass), located in pipe tee near final filter, should show at least partial blue. If indicator shows all white and filter/dryers are cycling normally as above, indicator should be replaced with a new one.

Air dryers are available for retrofit: see Section III of this instruction. Maintenance procedures for the air dryer system are found in M.I. 1096 - Locomotive Air Filter/Dryer System.

4. M.U. End Connections - All Lines and Hoses

   a. Blow out all moisture.

   b. When locomotive is operated in warm environment during winter season, blow out all M.U. end connection lines and hoses.

   c. Double ("Duplex") sets of hoses are available at each end of the locomotive. If installed, Fig. 8, connect all M.U. hoses to provide a parallel air path in the event of freezing and to prevent snow ingestion by open hoses.

   d. Dummy couplings and hose storage racks are available for M.U. connections. If installed, connect all loose hoses to dummy couplings or place in storage rack to reduce snow ingestion. Close air hose doors on snow plow of lead unit.

5. Safety Valve

If freezing of cooling coils is experienced between the air compressor discharge and system safety valve, the air compressor control switch (CCS) will not see the high pressure since the switch is downstream of the blockage; thus, the compressor will not be unloaded by the CCS switch. Install an additional safety valve of 180 psi at the air compressor discharge, Fig. 9. This will protect the air compressor and discharge piping upstream of the cooling coils from excessive pressure.

6. Bell

   a. Clean and check bell moisture separator, separator atmospheric vent, and ringer cartridge, Fig. 10. The cartridge will need replacement if sticking or leaking air, either condition possibly caused by freeze damage. The old cartridge can be removed by loosening the locknut on the side of the bell ringer assembly and backing out the setscrew three or four turns. The clevis is then unscrewed from the assembly by using the clapper as a lever and the cartridge can be pulled out with a pair of pliers.

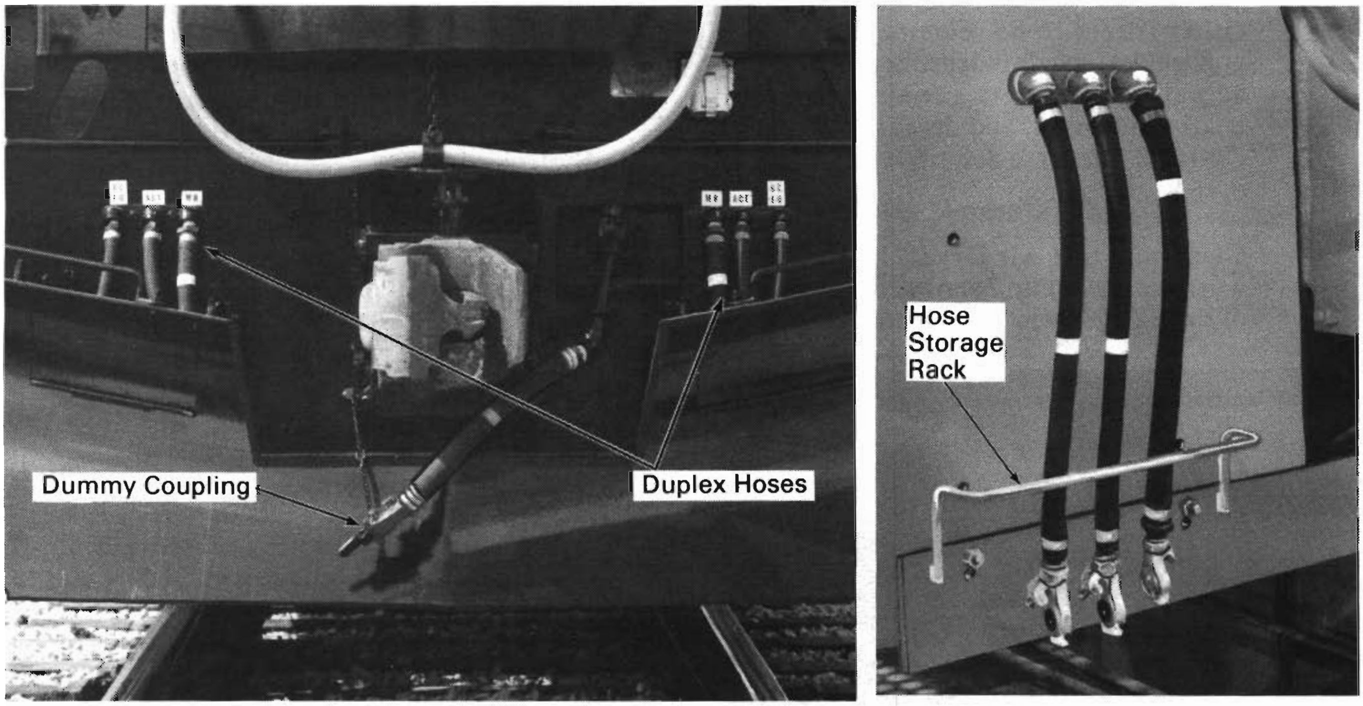

Fig.8 – Air Hose Dummy Coupling, "Duplex" Hoses, And Hose Storage Rack

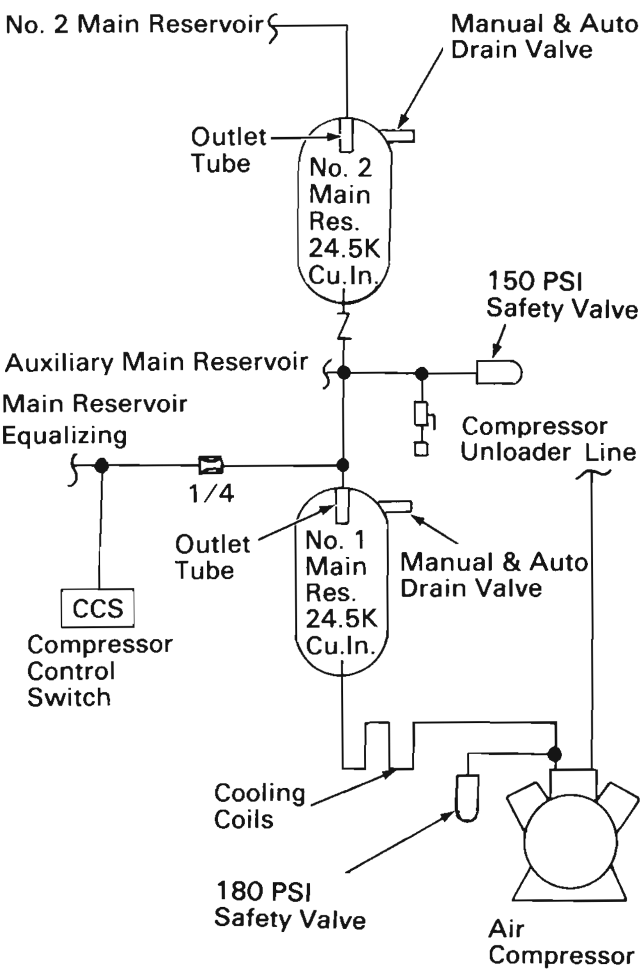

Fig.9 – Compressor/Cooling Coil Safety Valve Installation

b. Blow out the air line between the bell valve (at the control stand) and the moisture separator. While the ringer cartridge is removed, the bell should be blown out by actuating the bell ringer valve a few times before installing a new cartridge. Be sure the "O" rings are in place before reinstalling the clevis.

7. Brake Valves

a. If No. 53 port on 26C brake valve is not used, remove the pipe plug from the pipe bracket or sump, and drain moisture condensation, Fig. 11.

b. If freezing problems have been experienced with individual air brake components – P2A, etc., these should be cleaned, overhauled, and tested and their associated air lines blown out.

8. Sanders

a. Blow out the Sanding Control Valves. Two valves are located at each end of the locomotive. The control valve is equipped with automatic clean-out jets to clean out the orifice. To operate the clean-out jets, push in the plungers on each side of the valve, Fig. 12. The plunger will automatically reset at the beginning of the next sanding cycle from the high pressure clean-out blast of air.

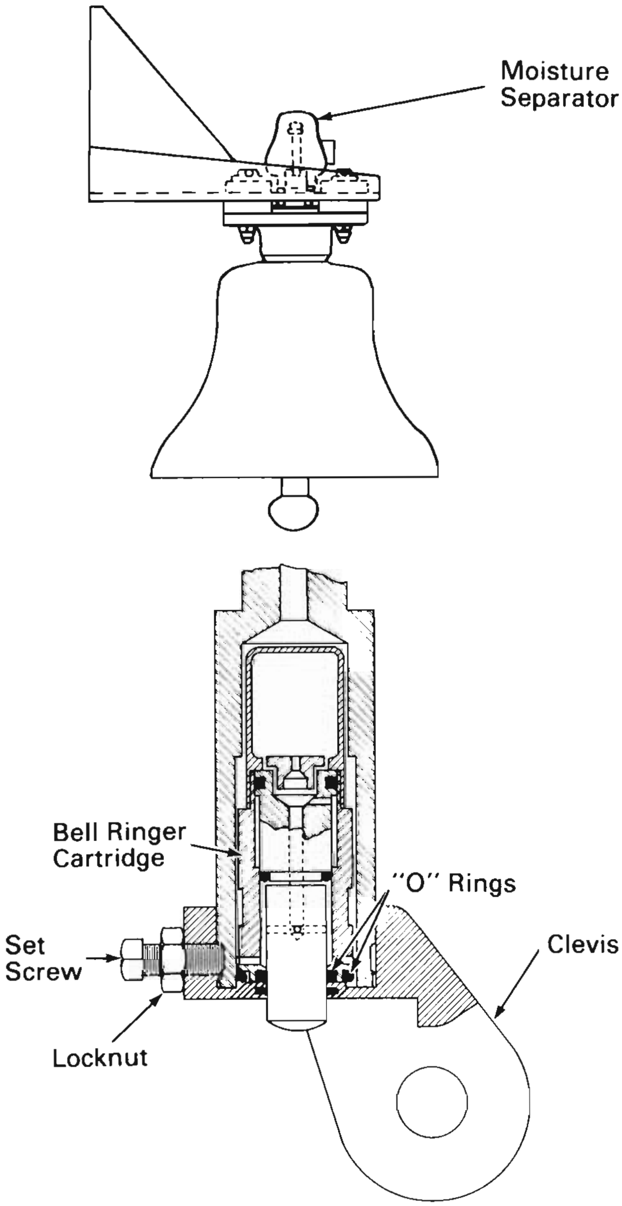

Fig.10 - Bell And Ringer Cross Section

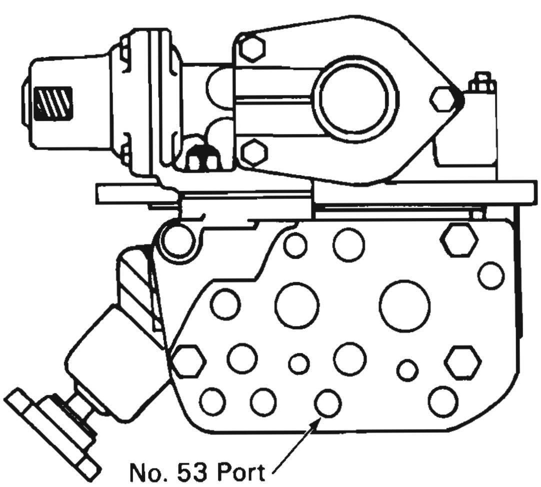

Fig.11 - 26C Brake Valve, Bottom View

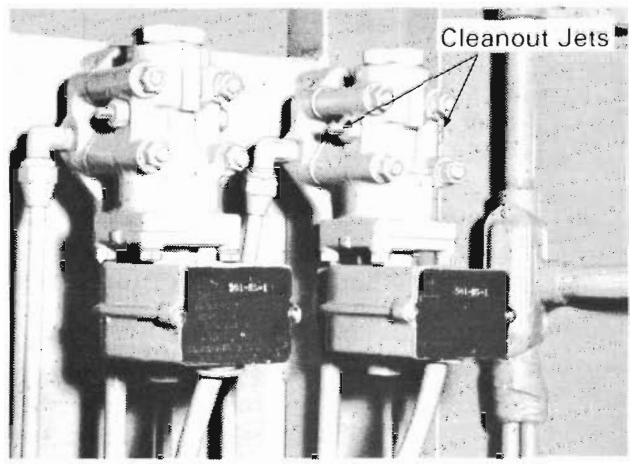

Fig.12 - Sanding Control Valves

b. Check sanding supply areas to be sure that sand is clean and moisture free. Damp or dirty sand is likely to clog the sand traps.

c. Clean out sand traps. A cleanout plug is located at the base of the sand trap. Before any work is performed, the shutoff valve mounted to the top of the trap should be closed by turning the shutoff valve handle to a horizontal position, Fig. 13.

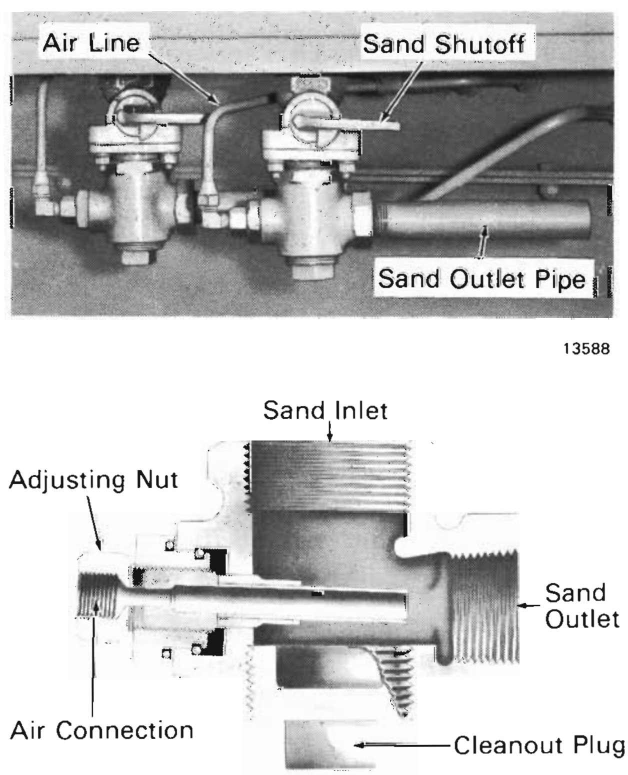

Fig.13 - Sand Trap Installation
And Cross Section

9. Windshield Wipers

   a. Check air operated windshield wipers for proper operation. Air connections should be tight and free from leaks.

   b. Remove exhaust fitting, Fig. 14, and check for dirty filter or plugged hole. Remove reverser bell housing and check for broken or jammed ball spring.

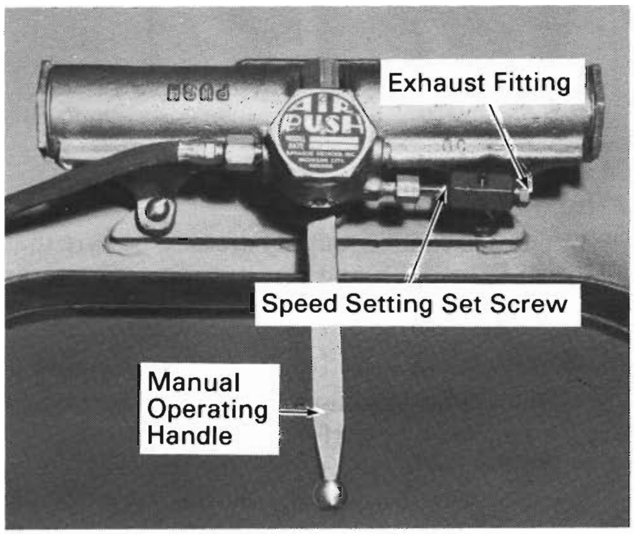

Fig.14 – Windshield Wiper Air Motor (Shown Without Protective Cover/Gasket)

   c. Check the internal air flow by removing the cylinder end caps and blowing out the holes in the valve chamber. Also blow into the exhaust outlet to make sure the hole is not plugged.

   d. If the speed of the wiper motor needs to be reset, it is adjusted by a set screw, Fig. 14, located in the exhaust restrictor. The following procedure should be used in making the adjustment.

   Place a piece of paper between the wiper blade and the glass to simulate a wet glass condition which reduces frictional drag on the blades.

   Make sure main reservoir air pressure is 896 to 965 kPa (130 to 140 psi). Turn operating valve in cab to the fully open position.

   Turn the adjusting screw in the exhaust restrictor until the wiper motor is running at 60 - 65 cycles (120 - 130 strokes) per minute.

   e. Replace wiper blades.

10. Air Compressor

   a. Check for proper Compressor Control Switch (CCS) operation. The air compressor should begin pumping when pressure falls to 896 kPa (130 psi) and stop on pressure rise at 965 kPa (140 psi). An air pressure gauge is provided at the Compressor Control Panel to check the pressure settings. If settings are off, check all other sources of trouble before attempting to reset the CCS. A test connection is provided, Fig. 15, that can be used to check the pressure gauge if inaccuracy is suspected.

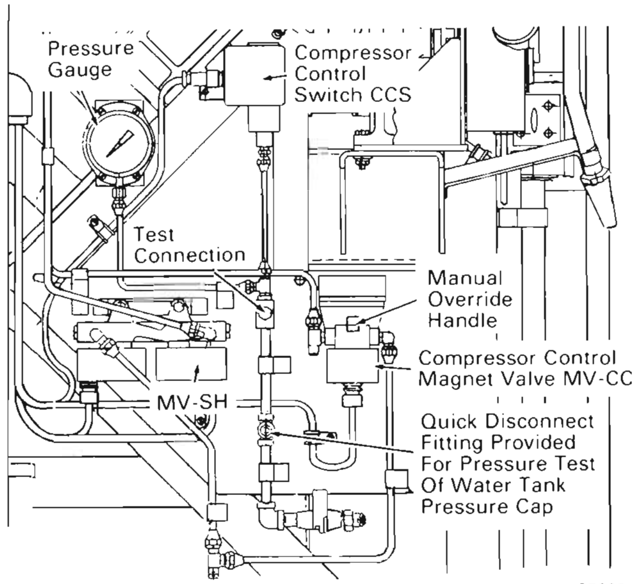

Fig.15 – Typical Compressor Control Panel

   b. Clean sediment from cylinder liner water passages of WBO and WBG air compressors not equipped with basic low sludge cylinders, Fig. 16, or not fitted with water deflectors. Water should be directed into the lower liner area through the water inlet passages and inspection ports to flush the accumulations.

Water deflection kits are available for WBO and WBG air compressors not already equipped for sediment removal or low sludge cylinders. Refer to Section III of this instruction.

NOTE

Effective January 1, 1985, new WBO air compressors are redesignated as WLN compressors; WBG air compressors are redesignated as WLG compressors. Both WLN and WLG compressors are equipped with low sludge cylinders and gear oil pumps

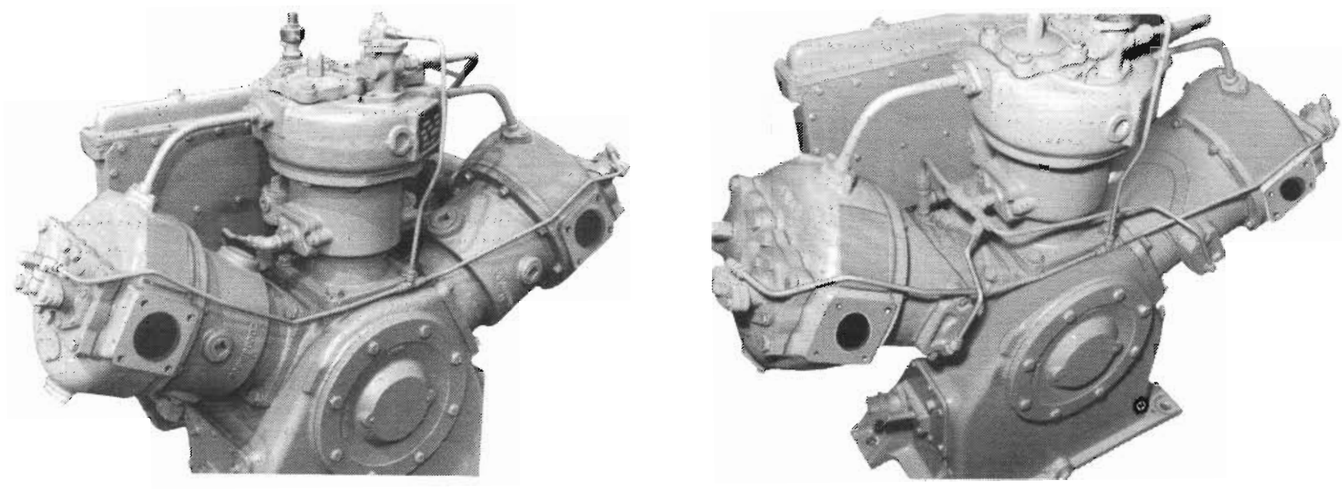

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Fig.16 – Typical Water Piping Applications

and thus are not subject to the modifications in Section III.

CARBODY AND CAB

1. Inspect cab and carbody for condition of weather stripping. In particular, check the sealing application on cab windows and doors, carbody doors, central air compartment access door and panel, and engineroom partition. Reference M.I. 1803 - Weatherproofing and Sealing for complete procedures.

   The carbody is slightly pressurized by generator cooling air which will help prevent snow incursion. If this pressure is not noted, check for leaks.

2. Apply carbody blanking plates per individual railroad instructions.

3. Winterize toilet per manufacturer's instructions.

CENTRAL AIR COMPARTMENT

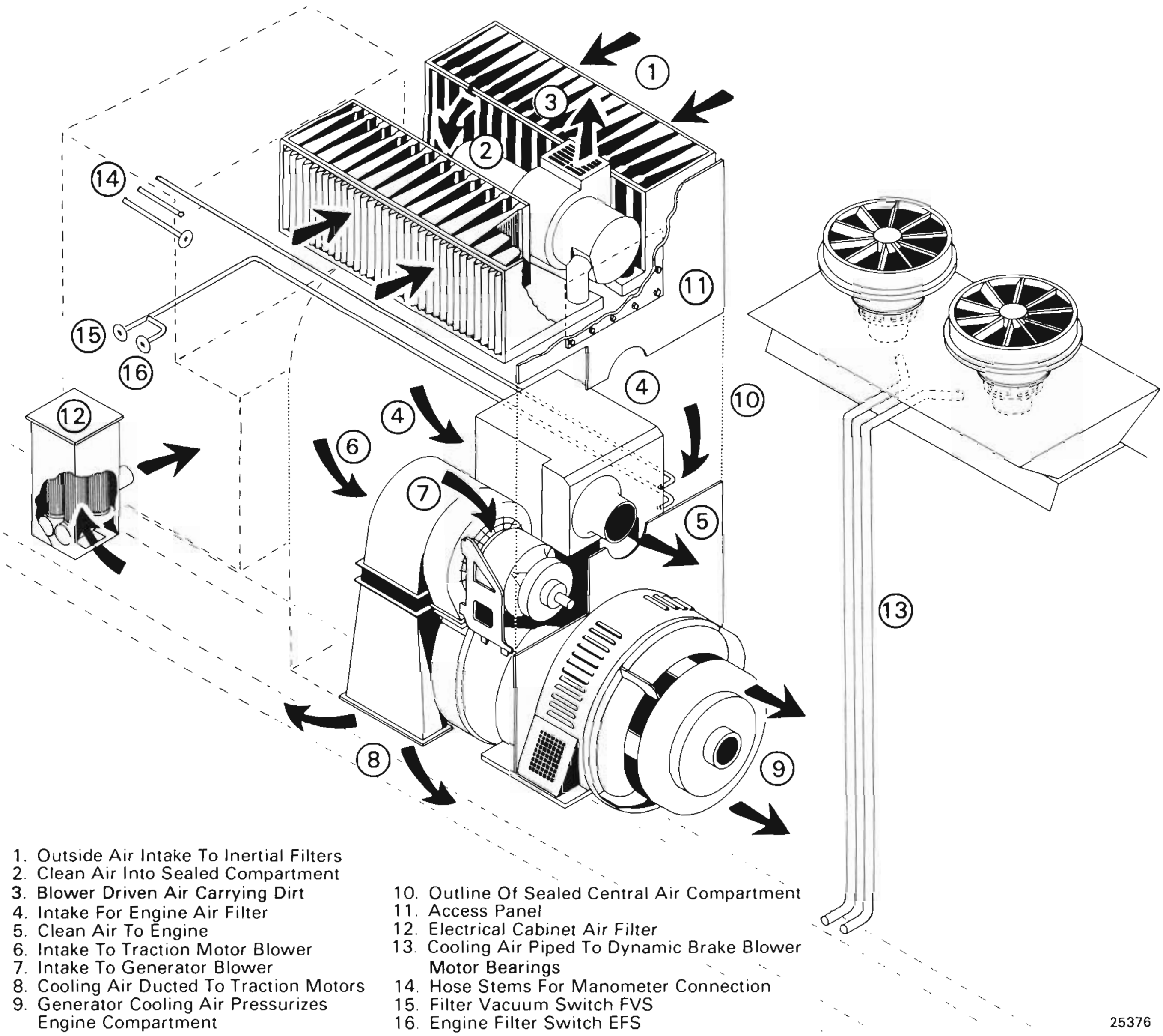
All Units:

1. Check for proper sealing of filter compartment doors and all panels including those on the rear of the high voltge cabinet. (See Section I - Cab & Carbody; also reference M.I. 1803 - Weatherproofing & Sealing).

2. Check inertial filter compartment and engine filter pressure drops and high voltage cabinet static pressure, Table 1. Clean inertials and change engine filters as necessary according to maximum limits. The only approved method of cleaning the inertial filters is immersion in a hot caustic or detergent bath followed by a cold wash.

NOTE

If depression readings are taken on an annual basis, a reading of more than 89 mm (3.5″) H_2O is indication that the inertial filters can be expected to plug within 12 months.



1. Outside Air Intake To Inertial Filters
2. Clean Air Into Sealed Compartment
3. Blower Driven Air Carrying Dirt
4. Intake For Engine Air Filter
5. Clean Air To Engine
6. Intake To Traction Motor Blower
7. Intake To Generator Blower
8. Cooling Air Ducted To Traction Motors
9. Generator Cooling Air Pressurizes Engine Compartment
10. Outline Of Sealed Central Air Compartment
11. Access Panel
12. Electrical Cabinet Air Filter
13. Cooling Air Piped To Dynamic Brake Blower Motor Bearings
14. Hose Stems For Manometer Connection
15. Filter Vacuum Switch FVS
16. Engine Filter Switch EFS

Fig.17 – Typical Central Carbody Air System – Turbocharged Engine

Hose stems located on the front of the electrical cabinet, Fig. 18, provide a convenient place to take manometer readings of the pressure drops.

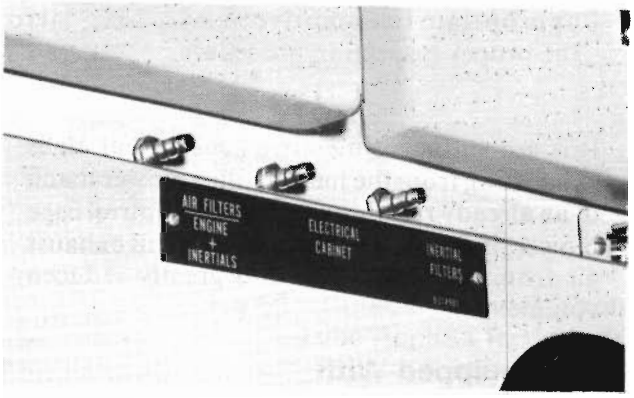


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Fig.18 – Hose Stems For Manometer Connections

Inertial Filters (Central Air Compartment)	
Minimum Depression	51 mm (2") H_2O
Maximum Depression	140 mm (5.5") H_2O
Combination Engine Plus Inertial Filters	
Minimum Depression	102 mm (4") H_2O
Maximum Depression With Pleated Paper Or Fiberglass Elements	
Turbocharged	356 mm (14") H_2O*
Roots Blown	458 mm (18") H_2O**
High Voltage Electrical Cabinet Filter	
Minimum Static Pressure	38 mm (1.5") H_2O

*Measured between filter top front (toward electrical cabinet) bolt hole and outside of filter compartment with door closed. Refer to applicable Locomotive Service Manual.

** Same as above but at lower back corner of filter.

Above filter specifications are typical of the 40-2 locomotive. Reference the applicable Locomotive Service Manual for oil bath filters and other locomotives

TABLE 1 – Typical Filter Specification

3. Check FVS (Filter Vacuum Switch) and EFS (Engine Filter Switch – generally only applied to turbocharged locomotives) for proper operation. When FVS closes, a signal will be sent to the annunciator (on units so equipped) to indicate excessive restriction of air to the engine. When EFS closes, it energizes the filter latching relay EFL. This operates to limit engine speed and power; the GOVERNOR SHUTDOWN/6th THROTTLE light on the engine control panel will come on and remain lit until the latching relay is reset. (Snow plugging on the road will be indicated by pick-up of one or both of these relays.)

   FVS and EFS should pick-up at the levels indicated in Table 2. If these switches need to be recalibrated, procedures are contained within the Central Air chapter of the locomotive service manuals and M.I. 5525.

SWITCH	PART NUMBER	PRESSURE DIFFERENTIAL AT TRIP
FVS/TURBO	8465021	356 ± 51 mm (14" ± 2") H_2O
FVS/ROOTS	8465511	458 ± 51 mm (18" ± 2") H_2O
EFS/TURBO	8466230	610 ± 51 mm (24" ± 2") H_2O

TABLE 2 – Switch Trip Values

5. Check for proper application of slip ring cover where equipped, Fig. 19. The cover lip should sit flat and tight against the generator face. Check that brush-holder and brush operation are not impaired; replace brushes if necessary.

6. Check to see that the aspirator drain in the filter compartment, Fig. 20, is clean and functioning properly. Ice blockage from underneath the frame (or above) should be cleared. Traction motor cooling air should be exhausting from the aspirator tube causing a venturi action at the aspirator drain hole.

7. Check for proper operation and rotation of inertial filter blower. Blower rotation is most easily verified on most units by climbing to the top of the locomotive before the engine is started and observing the squirrel cage blower

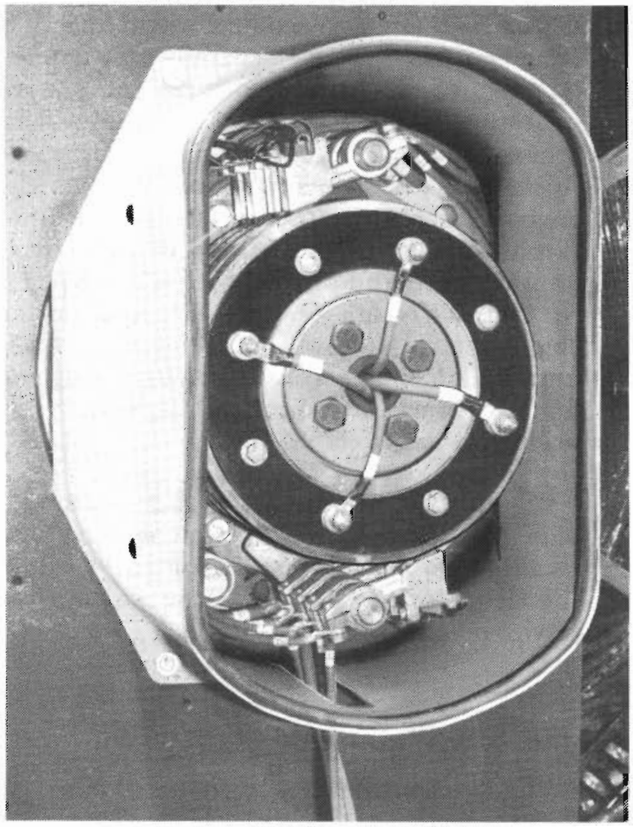


Fig.19 - Generator Slip Ring Cover

through the exhaust filter compartment. When the engine is started the blower will turn so that the vanes move up toward the observer. For older units otherwise equipped, reference the appropriate Locomotive Service Manual for the proper inspection procedure.

NOTE

It is not sufficient merely to check that air is exhausting from the inertial filter blower hatch of an already running engine. The squirrel cage blower, if running backward, will still exhaust air from the hatch, but at a greatly reduced volume.

Units Equipped With EMD Winterization:

1. Place "summer/winter" damper on side of winterization duct (located over the No. 1 fan) in the "winter" (open) position, Fig. 21.

2. Check the temperature switch calibrations, Table 3. On the basic winterization system there is one switch, the ATS-Ambient Temperature Switch. This is located either in the inertial air filter on the locomotive left side (short hood forward) or beneath the walkway and ahead of the No. 1 Air Reservoir. On the improved

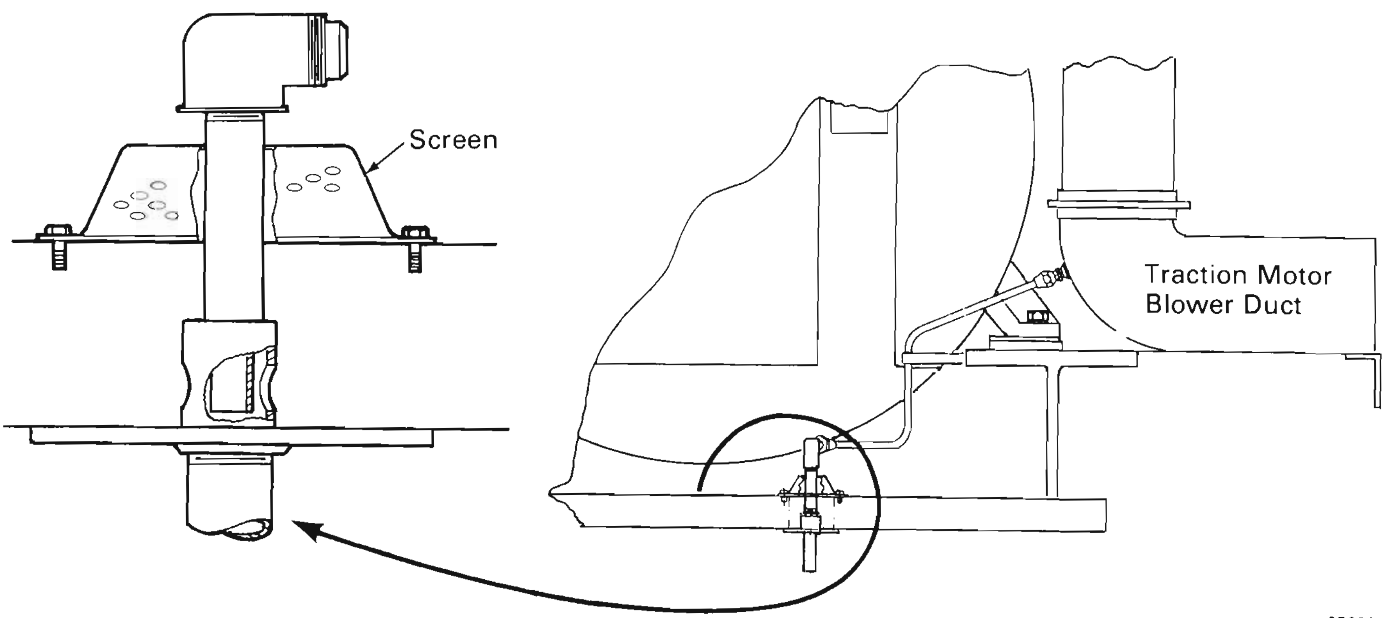
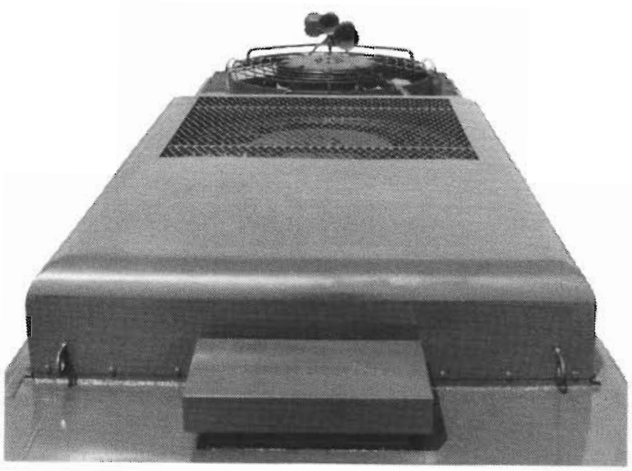
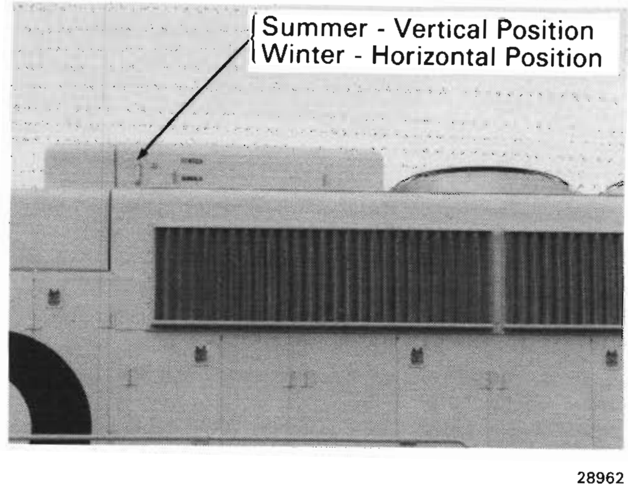


Fig.20 - Typical Generator Pit Aspirator



Hatch Over No. 1 Fan



Damper Handle

Fig. 21 - Winterization Hatch

winterization system (when equipped) there are shutters over the inertial filters controlled by two temperature switches, Fig. 22. These are labeled HTS, Hi Temperature Switch and LTS, Low Temperature Switch.

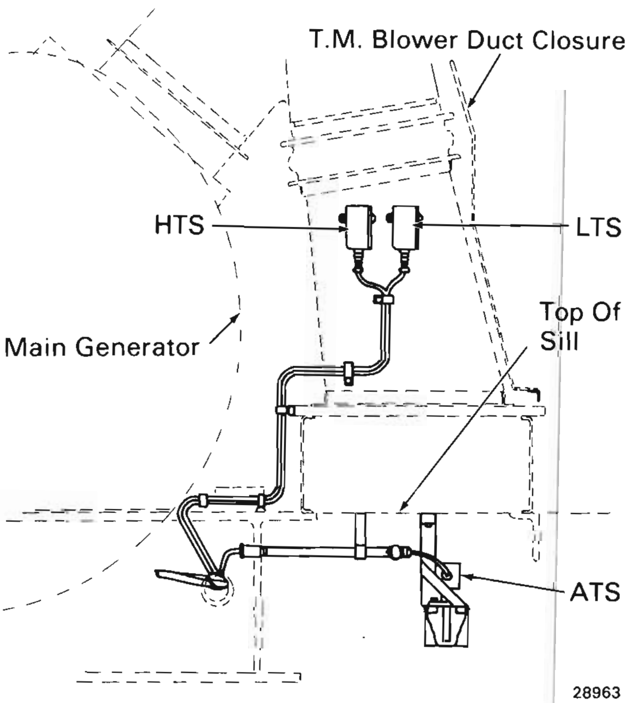


Fig.22 – Winterization Temperature Switch Locations

Switches should be tested by immersion in water up to the mounting flange. At immersion the water should be hotter than the "break" (opening) temperature. Ice should then be added to cool the fluid to below the "make" (contact closing) point.

3. Check for operation of winterization shutters in engineroom partition and, when equipped, inertial filter shutters, Fig. 23. Operation may be checked by test buttons on the temperature switches, when equipped. Otherwise pick up the air solenoid valves by electrically jumpering the associated relay contacts. (Refer to Specific Locomotive Physical Schematic Diagram.)

4. Check shutter linkage adjustment to ensure full opening of shutter blades.

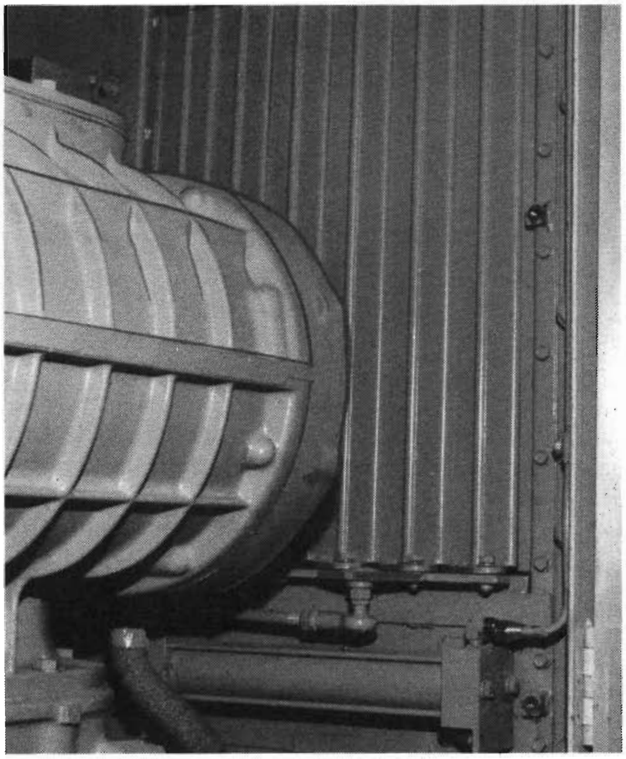
   Winterization packages are available for locomotives not so equipped. Details will be found in Section III of this instruction.

COOLING SYSTEM, Fig. 24

1. Manual drain valves for cab heaters and engine/air compressor – check for proper operation, that valves are free of sediment, sludge, and ice blockage. No leaks should be present when valves are closed.

Switch	Part Number	Contacts Close On Descending Temp. (° F)	Contacts Open On Rising Temp. (° F)
ATS	9551099	35 ± 2	45 ± 2
HTS	9551100	122 ± 2	132 ± 2
LTS	9551101	70 ± 2	80 ± 2

TABLE 3 – Winterization Temperature Switch Settings



Partition Shutters With
Roots Blown Engine

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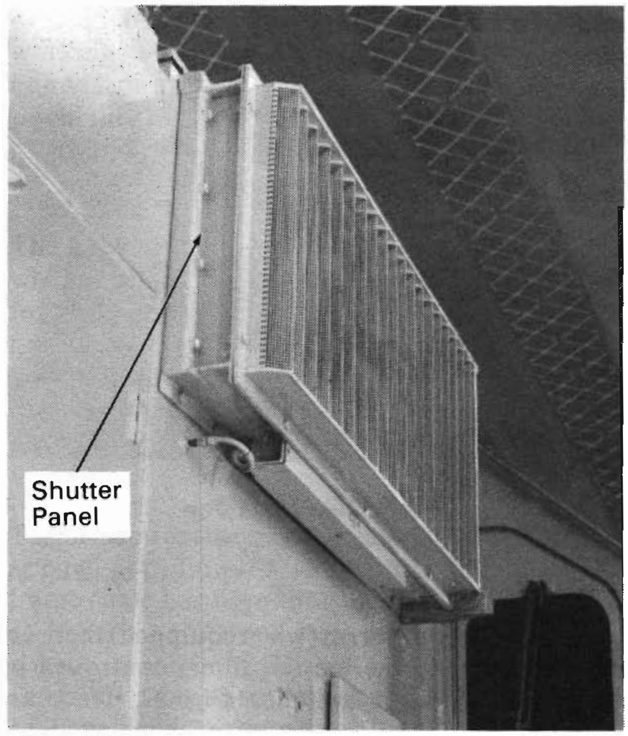

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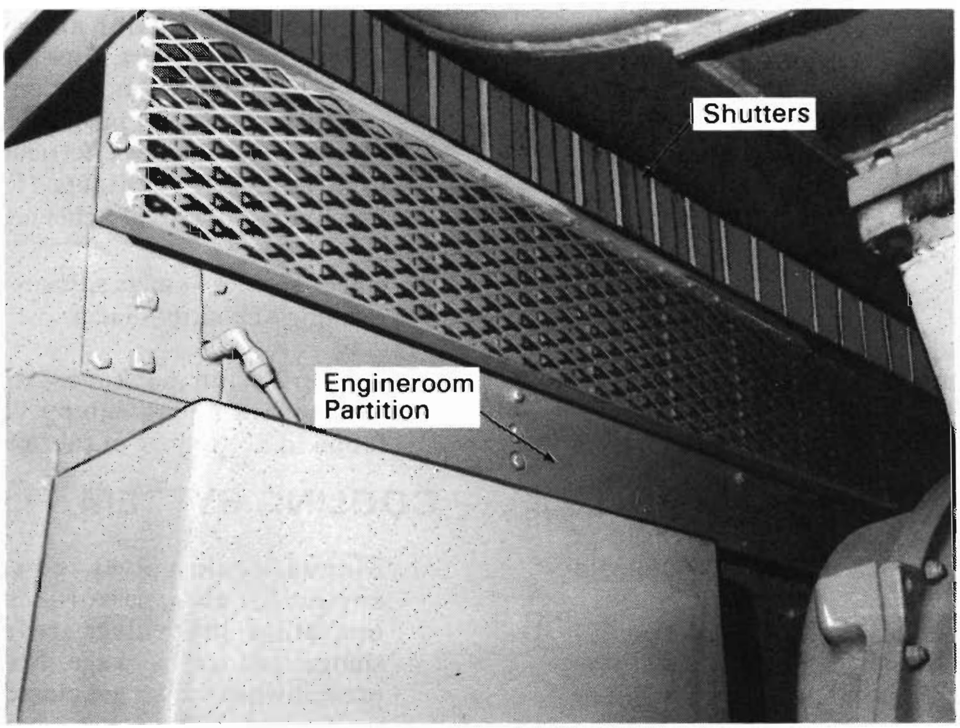
Inertial Shutters



Partition Shutters With
Turbocharged Engine

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Fig.23 – Winterization Shutters

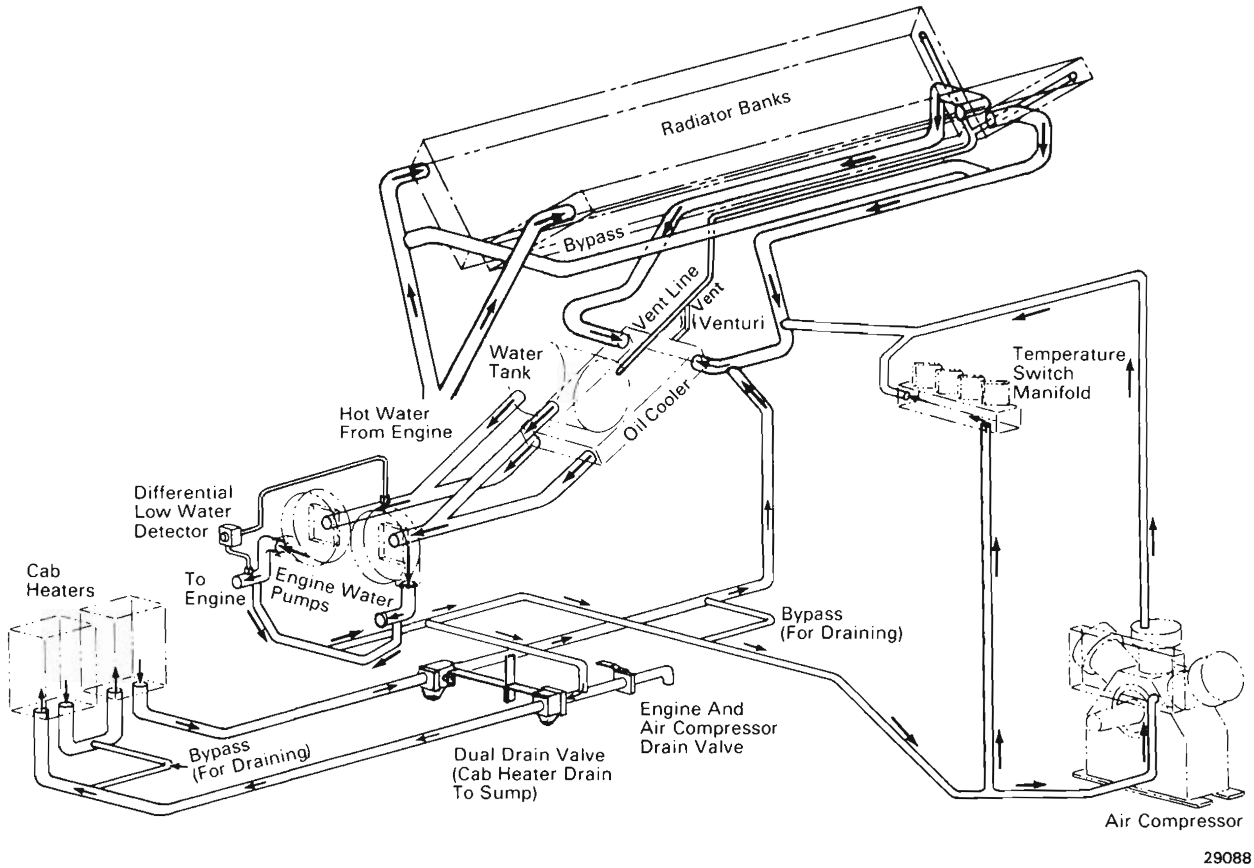


Fig.24 – Typical Cooling System Pictorial Diagram

2. Automatic drain valve operation – check circuitry on scheduled basis. Rebuild with kit if in excess of one year in service. The switch is supplied with a test switch on the side of the terminal box. The drain system is armed at engine shutdown through relay interlocks. The valve should drain at test with the engine shut down but not with the engine running. If the switch fails to drain, re-arm the system with the engine not running by turning the starting switch briefly to the start position. (The cold water fill switch disarms the automatic drain if pushed while the engine is running – it is clearly marked not to be activated except during engine shutdown.)

   The thermostat of the automatic drain valve, Fig. 25, may be tested separately by immersion in water and adding ice. The switch should trip between 40° F and 45° F on descending temperature and reset at about 55° F on rising temperature. Replace the thermostat if found defective.

   Automatic Drain Valves are available for winterizing older locomotives and are described in Section III of this instruction.

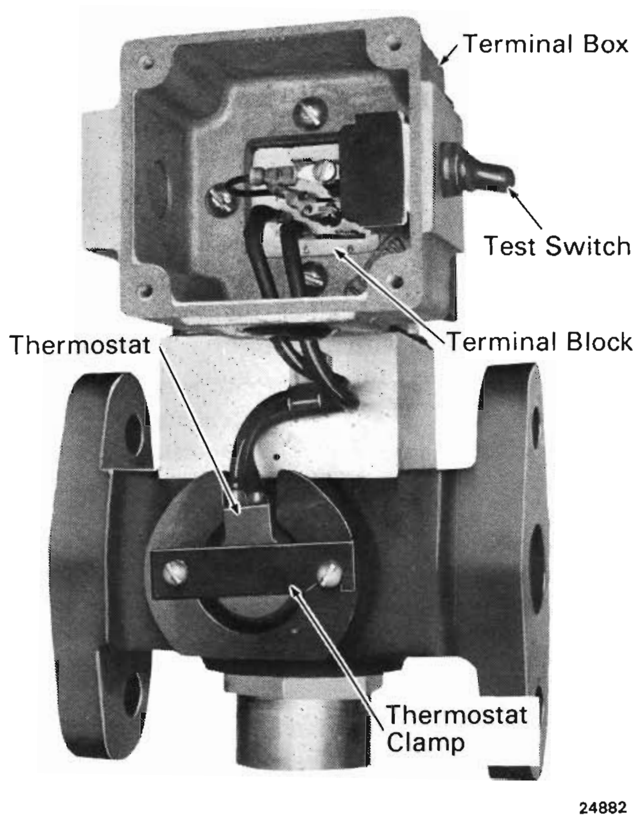


Fig.25 – Automatic Drain Valve

3. Pull and clean all cooling water radiator screens. Be sure that all radiator access covers are in place, in good condition and are properly sealing.

4. Flexible hoses should be replaced if stiff or split.

5. On units equipped with hot water cab heaters, check for leaks in the heater cores and all piping. Check that cores and pipelines drain properly and heaters are functioning. Flush lines to remove sediment.

   Electric Cab Heaters, as described in Section III of this instruction, are available for locomotives not so equipped.

6. Check external (to the engine) cooling system piping and radiator cores for water leaks under pressure. Loss of coolant can cause road shutdowns with attendant starting problems.

WARNING

Do not subject the water tank to pressure greater than 345 kPa (50 psi).

Cooling system pressure caps - inspect while pressurizing water system. Replace caps if seals have hardened or at specified interval in Scheduled Maintenance Program. Inspect filler necks and replace if damaged.

Male quick disconnet fittings are provided on the water tank and in the air system piping, Fig. 15, at the equipment panel located below the water tank. A locally fabricated testing apparatus, Fig. 26, can be used to pressurize the cooling system with main reservoir air while the diesel engine is running and coolant is at normal level.

a. Using the testing apparatus, operate the ball valve to gradually pressurize the cooling system. Tolerances for the pressure cap are as shown in Table 4.

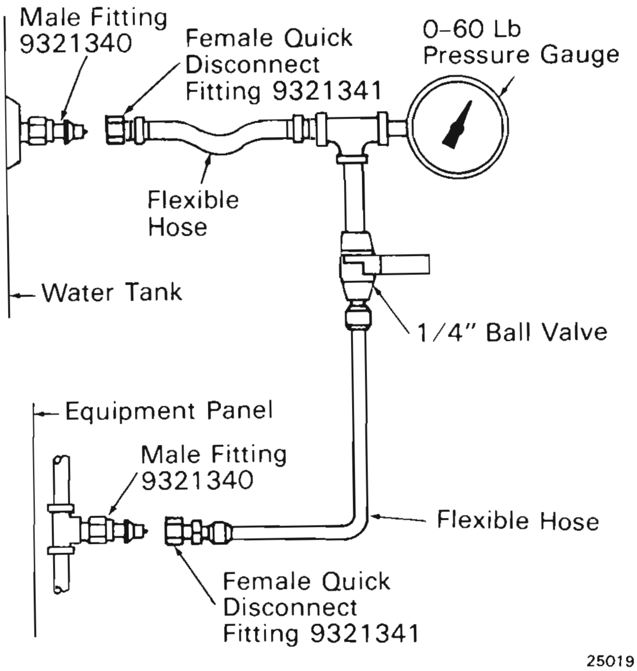


Fig.26 - Cooling System Pressure Test Apparatus

Cap	Min. Opening Pressure	Max. Opening Pressure
4 psi (obsolete)	21 kPa (3 psi)	35 kPa (5 psi)
7 psi (basic)	35 kPa (5 psi)	56 kPa (8 psi)
12 psi (tunnel-obsolete)	70 kPa (10 psi)	98 kPa (14 psi)
20 psi (tunnel-current)	126 kPa (18 psi)	154 kPa (22 psi)

TABLE 4 - Pressure Cap Tolerances

b. Close the ball valve and observe the pressure gauge. Pressure should drop slowly until the pressure cap closes. Pressure should then remain constant. Gauge pressure is the cap opening pressure.

7. On all engines check water manifold, jumper lines and top deck for water leaks while system is under pressure. On turbocharged engines inspect aftercoolers for water leaks.

8. Check the condition of each turbocharger aftercooler core by taking pressure differential readings across the aftercooler core. Use the following steps to check each aftercooler:

   a. With engine shut down or at idle remove two aftercooler cover mounting bolts as shown in Fig. 27. Install two drilled bolts fitted with hose stems into the bolt holes.

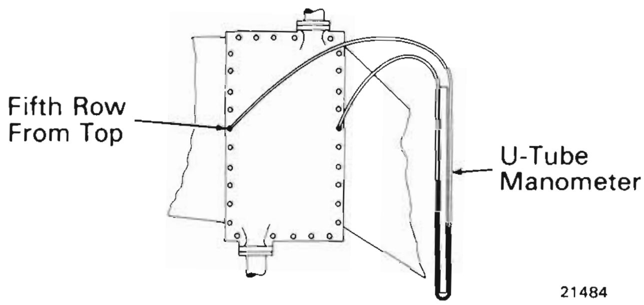


Fig.27 – Reading Differential Pressure On Aftercooler

WARNING

DO NOT remove hoses with engine at high speed. To prevent high pressure water discharge from manometer, DO NOT apply or remove hoses singly.

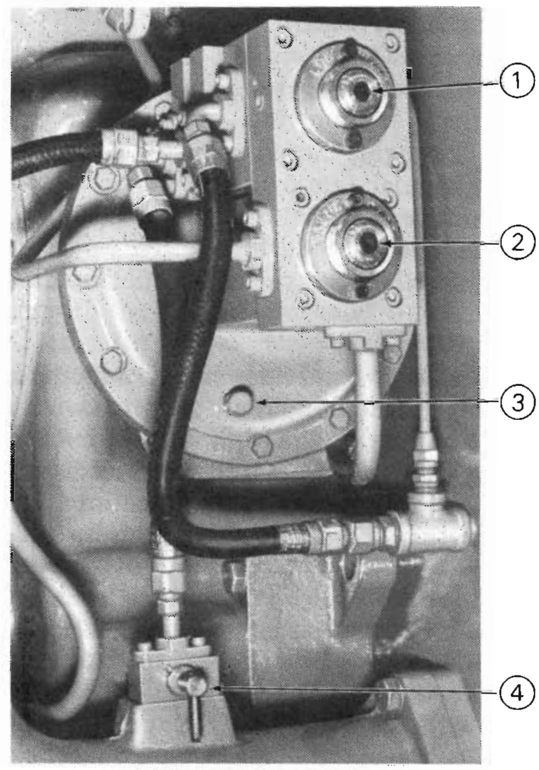
   b. Connect a U-tube manometer with a hose attached to each end to the two hose stems previously applied.

   c. Obtain a pressure differential reading with engine at full speed, with or without load. The maximum allowable pressure differential is listed below. If pressure differential is not within limits, refer to Engine Maintenance Manual for procedure to clean core.

   Maximum Aftercooler Pressure
   Differential . . . . 254 mm (10″) H_2O

9. Radiator shutters should operate free and smooth. In the closed position the shutters should seal tightly. Check air cylinder linkage to ensure maximum opening of the shutter blades. Rebuild or replace cylinders if excessive air leaks are noted.

10. Check engine protector operation. The water section of the protector is tested by moving the test cock, Fig. 28, to a horizontal position. This dumps the water pressure to the protector and the low water button will pop out exposing a red band. About 55 seconds later (engine at idle) the governor low oil button should pop out



1. Low Water Reset
2. Crankcase Pressure Reset
3. Vent And Test Fitting
4. Test Cock

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Fig.28 – Differential Low Water And Crankcase (Oil Pan) Pressure Detector

and shut down the engine. If the low water button does not pop out freely without assistance when the test cock is opened and the engine is at idle, the device should be removed and replaced.

Tripping of the device at engine shutdown or start-up is not a defective condition. The static pressure of water in the system may not be sufficient to keep the low water detector latched, or temporary cavitation may have the same result. The button should be reset after the engine is started and the system has vented.

The crankcase pressure detector may be tested in a similar mannner by applying a rubber tube over the test opening and applying a slight suction to trip the crankcase pressure button. The test opening is found either on top of the detector or on the diaphragm housing face.

CAUTION

Excess suction may damage the detector diaphragm.

11. On locomotives equipped with LITS switch (Low Idle Temperature Speed-up) check system operation by pressing test button (when equipped) or supplying voltage to the pick-up coil. The engine should leave low idle and speed up to regular idle or above (refer to specific locomotive Physical Schematic Diagram). In normal operation the locomotive will return to low idle when the switch reaches its dropout point.

    On late Dash-2 and early 50-Series locomotives an ambient sensing temperature switch was mounted inside the high voltage cabinet. A much improved switch system has been developed for these LITS applications. Details will be found in Section III of this instruction.

    For locomotives operating without an idle speed-up system the engine can be advanced to throttle-2 when idling occurs for periods of 30 minutes or longer at temperatures below 15° F. This will keep water jacket temperatures higher to help prevent coolant sludging and possible freezing (when not equipped with an automatic drain). This also helps to keep batteries protected by maintaining charging voltages.

12. Cooling system water supply points should be surveyed to ensure properly softened water is available. This is necessary to prevent sludge buildup which, in turn, can interfere with cooling system drainage. Maintaining proper coolant inhibitor concentrations will also prevent sludge formation. Refer to Section II of this instruction for regular coolant practices.

FUEL SYSTEM

1. Drain condensate from the locomotive fuel tank and, if equipped, the retention tank to prevent freezing. During draining the locomotive should be placed on an incline with the drain end of the tank facing downhill to facilitate condensate drainage. A ball drain valve, Fig. 29, is provided for this purpose.

   Ball drain valves are available for retrofit for locomotives not so equipped – refer to Section III of this instruction.

2. Isopropyl alcohol can be added to the fuel tank at the rate of 1-2 gallons per 1,000 gallons of fuel. This will minimize ice crystal formation which plugs filters.

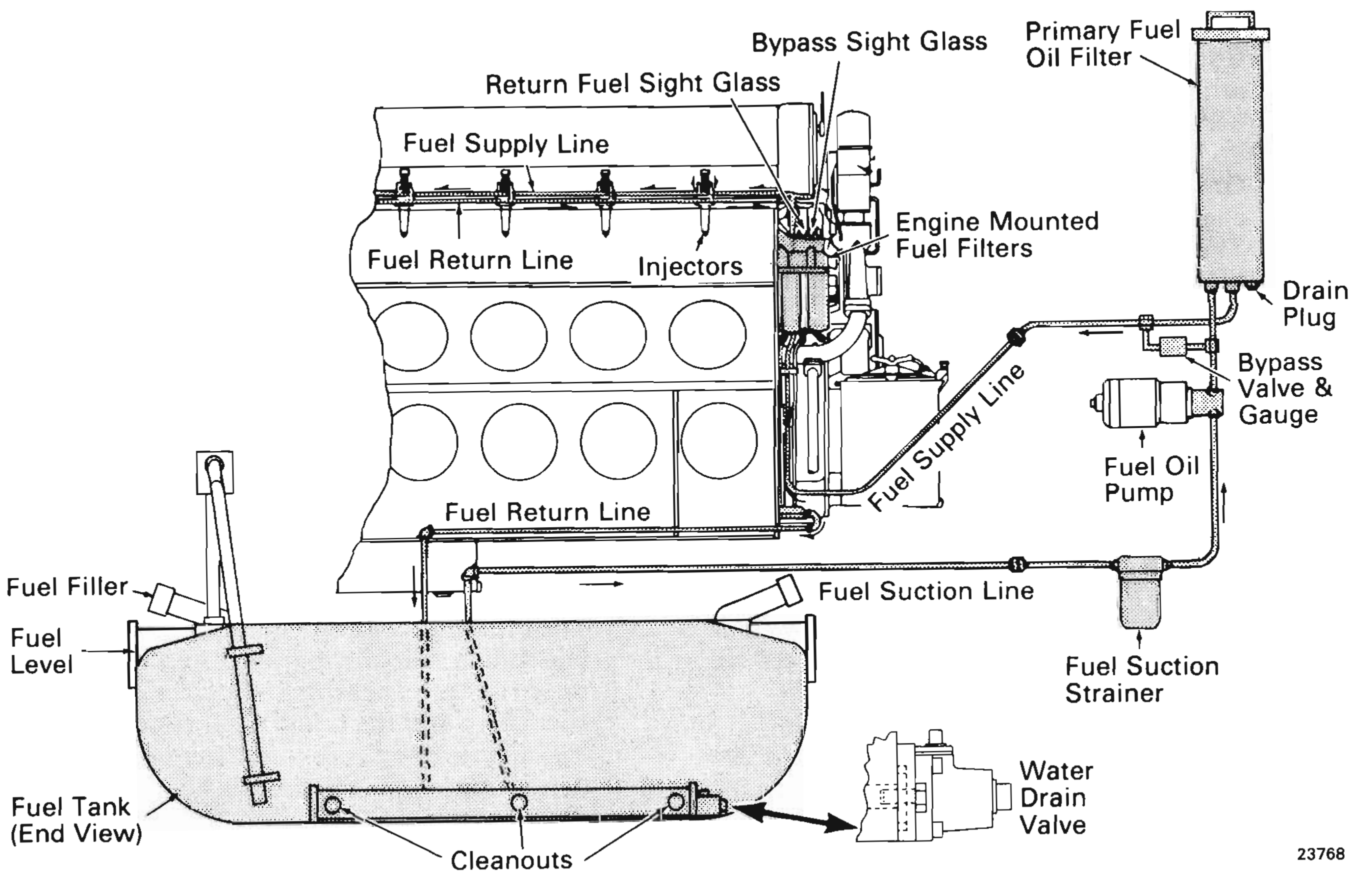

Fig.29 - Fuel Oil System, Pictorial Diagram

In extreme and prolonged winter conditions railroads should consider using a blend of No. 1 and No. 2 fuel oil.

3. Drain water from primary fuel filter when locomotive is so equipped. The primary filter is equipped with a bottom mounted drain plug, Fig. 30.

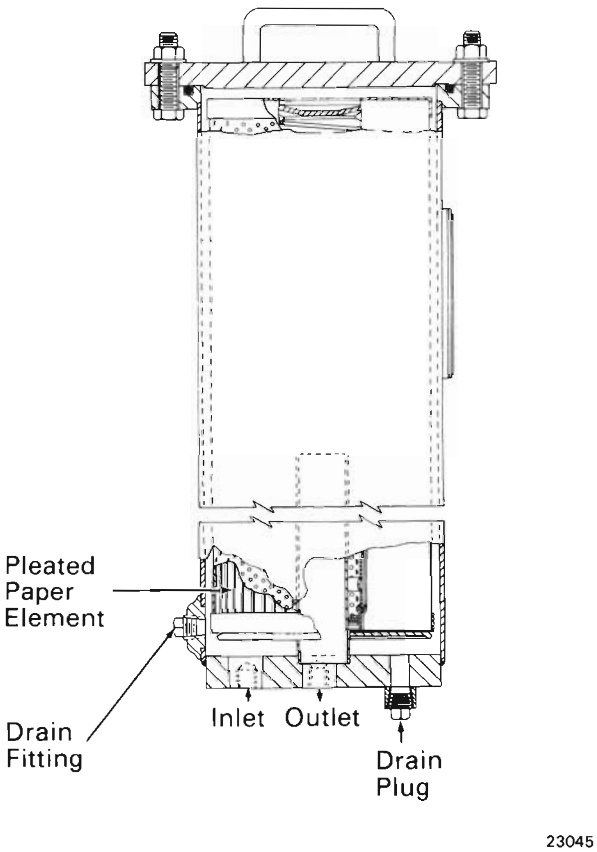

Fig.30 - Primary Fuel Filter Element And Housing

4. Check that primary fuel filter gauge and bypass valve, Fig. 31, are operational. This can be tested by inserting either a plugged filter or dummy filter into the primary filter housing and test running the engine. The gauge should bypass at approximately 30 psi differential pressure of the primary filter inlet and outlet.

   Bypass and gauge combinations are available for locomotive modernization - see Section III of this instruction.

5. Change out primary fuel filter element and engine mounted fuel filters. Maintain more frequent changeout schedule during winter for added tolerance to fuel waxing and water contamination.

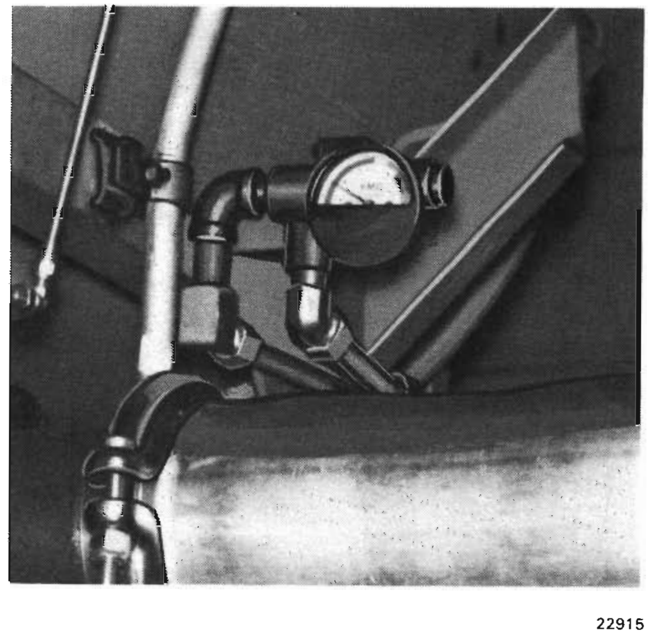

Fig.31 - Primary Fuel Filter Bypass Valve and Gauge

6. Fuel Preheaters

   a. Check water side of preheater for proper draining. If water is impeded through the lines, the pipes will be notably colder than surrounding water lines.

   b. Fuel piping on the outlet side of the preheater should be warmer than on the inlet side.

   c. On the small preheater installation activate the system by turning the fuel valve to the winter position, Fig. 32.

   d. Verify temperature valve operation on units equipped with the large EMD preheater and thermostatic valve, Fig. 33. Fuel supplied to the engine should stabilize at approximately 100° F when the locomotive is run in warm environments.

NOTE

The thermal element of the thermostatic valve must be changed every two years along with the "Viton" housing and element-to-housing seals for reliable valve operation. Part numbers will be found in the Service Data under the Routine Maintenance Parts And Equipment heading.

See Section III for available fuel preheater retrofits.

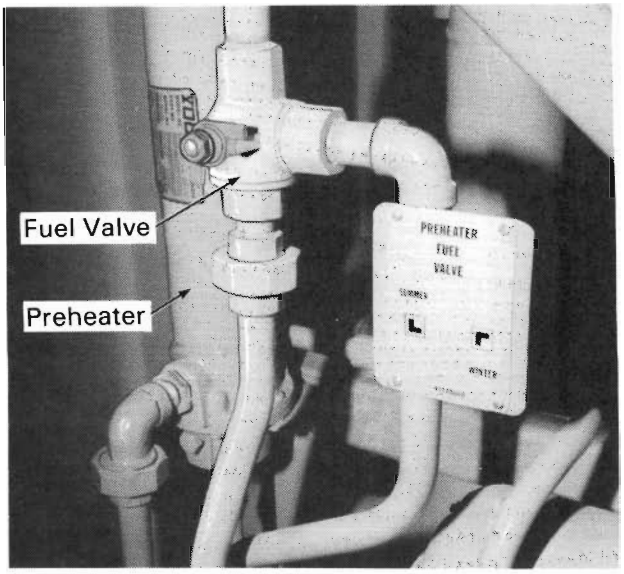

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Fig.32 - Winter Summer Valve In Use With Small EMD Fuel Preheater

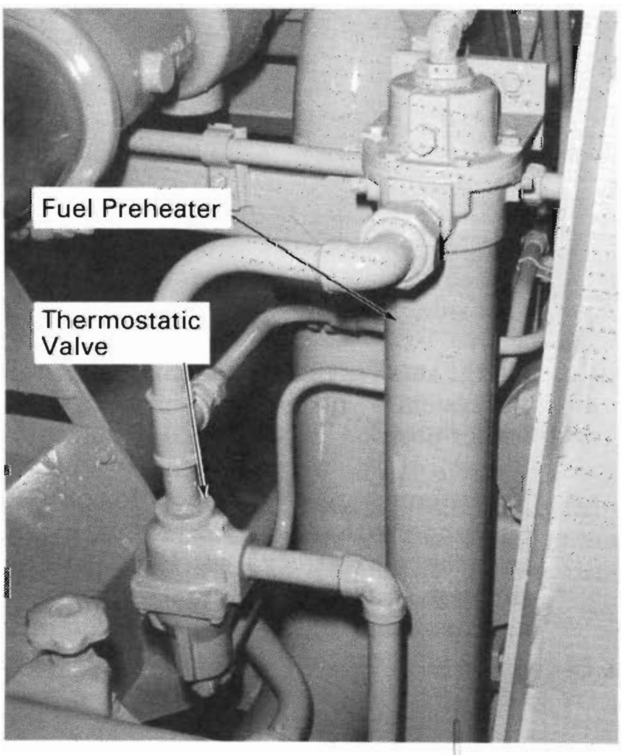

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Fig.33 - Thermostatic Valve In Use With Large EMD Fuel Preheater

7. Fuel pump operation and circuitry should be checked to avoid engine shutdown. Flow rates for the various pumps available are shown in M.I. 4110. Other Maintenance Instructions are listed under references in the Service Data.

8. Fuel suction strainer, Fig. 34, should be inspected and cleaned. During periods of extremely cold weather the element may be removed to help prevent waxing if the locomotive is at least six months beyond the last major overhaul, repair or new delivery.

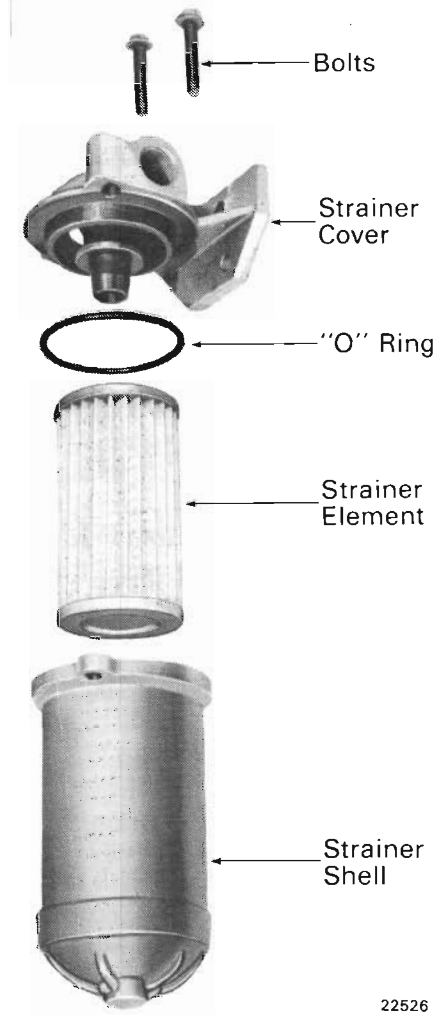

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Fig.34 - Fuel Suction Strainer, Exploded View

9. Fuel suppliers should be contacted for supply of minimum cloud point fuel to prevent fuel waxing. Pour point depressants may be needed for operation in extremely cold weather but are not recommended as a substitute for quality fuel; see Section II in this instruction.

10. Wayside fuel filtration should be maintained to prevent fuel sediment and water from causing unnecessary shutdowns. Water removal at wayside is extremely important as an additional control of moisture accumulation in the fuel system; See Section II of this instruction.

11. Fuel supply to the locomotive must be warm if possible. Cold fuel can overcome the preheater's ability to prevent waxing if large volumes of extremely cold fuel are added.

ELECTRICAL SYSTEM

1. Check batteries: State of charge (gravity), electrolyte level, and clean connections. Refer to battery manufacturer's recommendations for proper levels.

2. Check output of auxiliary generator; adjust voltage regulator if necessary. Refer to locomotive specifications or railroads's own recommendations for proper voltage setting.

3. Check starting contactor tips; replace if burnt. Replacement procedures will be found in the Locomotive Service Manual or applicable Maintenance Instruction.

4. Check starting motors and blow out brush dust. If severe brush wear is noted, replace brushes. Hard brushes 1852886 are recommended for replacement.

5. Check condition of ring gear; if rusted on engagement side, clean rust off and coat with rust inhibitor.

6. If unit is equipped with engine purge system, check operation of module and bypass switch. Retrofit of engine purge is available. Reference M.I. 9626 – Engine Purge Control or M.I. 9657 – Engine Purge Control with DC Main Generator.

7. If battery heaters are used, make sure they are functioning properly. External heating pads and internally heated unitized batteries are available – see Section III of this instruction.

8. Inspect cooling fan power circuit and main generator for blown fuses. Always replace the companion fuse along with the blown fuse found in the fan circuit.

   Locomotive modernization with a retrofit fan protection fuse kit is recommended for certain locomotives not so equipped. This will protect electrical system components in the event of a stalled fan due to snow blockage - see Section III of this instruction.

LUBRICATION SYSTEM, Fig. 35

1. Governor

   a. Check to ensure oil is at specified level. Maintain proper level during cold weather service. Do not over or under fill.

   b. Follow railroad's cold weather governor oil recommendations, if applicable, or refer to M.I. 1764 for EMD recommendations.

2. Lubrication Oil Filters

   a. Follow recommended turbocharger, soak-back and main lube filter changeout and monitoring procedures on a conscientious basis. Operation in bypass of main lube oil filter can result in turbo filter plugging and shutdown. Filter maintenance is thus of vital importance.

   To change the main lube oil filters, run the engine until the oil is sufficiently warm. The oil will then properly drain from the filter housing back to the engine sump when the filter drain valve is opened, Fig. 36.

   b. Replace the bypass valve, Fig. 37, with a qualified spare. The removed valve should be cleaned and bench tested by spring compression to standard height. Bypass valve specifications will be found in the Service Data of the applicable Locomotive Service Manual.

NOTE

On late model filters the oil bypass valve is located internally.

3. Check for dirty lube oil cooler core by inserting thermometers at the water pump discharge elbow and the lube oil strainer box, Fig. 38. Read temperature differential with engine on load test at full rated horsepower. Service limits for oil cooler cores are provided in M.I. 928.

4. Conscientious use of laboratory analysis to reflect lube oil condition relative to water leaks or contaminant level can be of significant value in the diagnosis and prevention of problems which may result in low oil or crankcase pressure shutdowns.

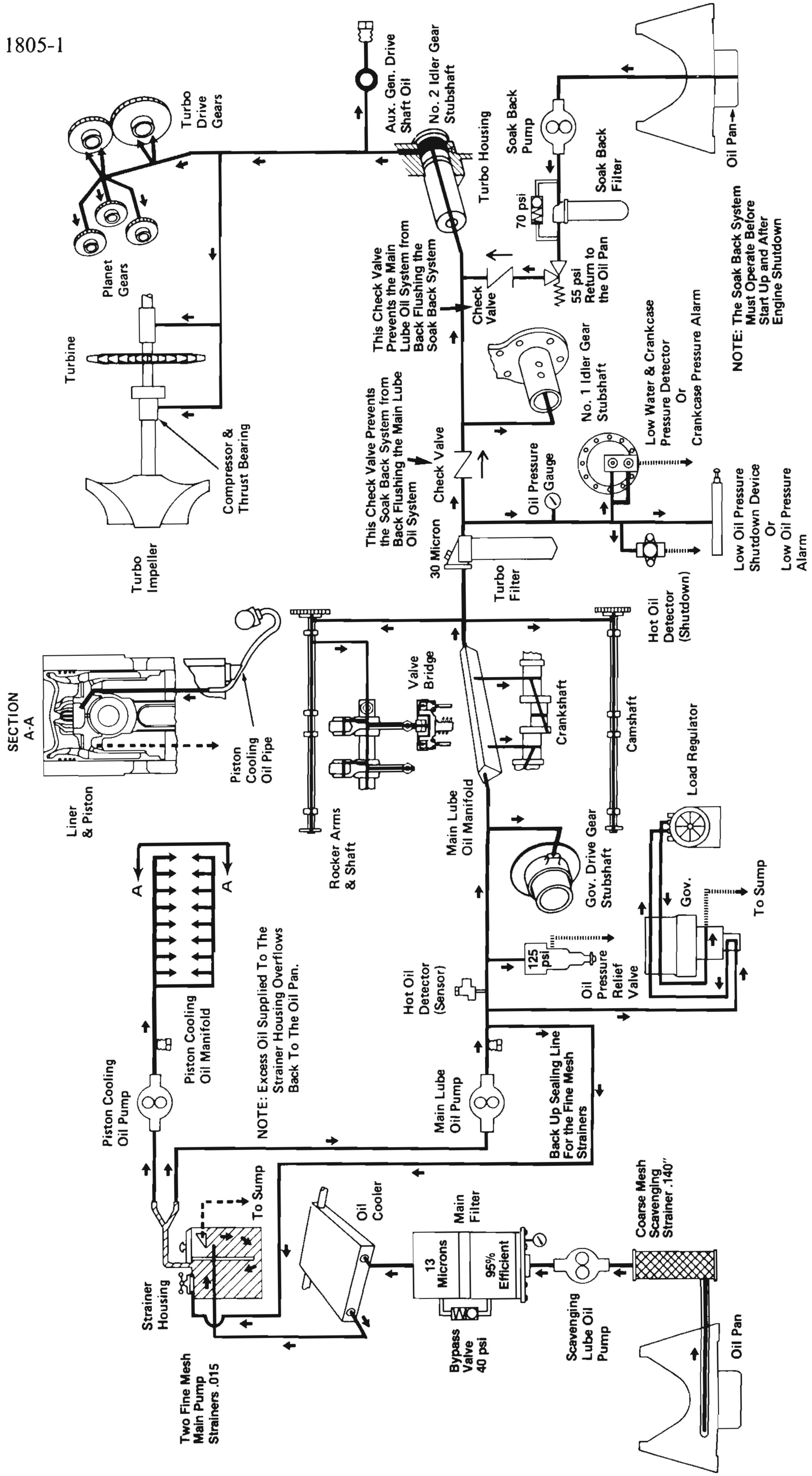


Fig.35 – Typical Lubricating Oil System

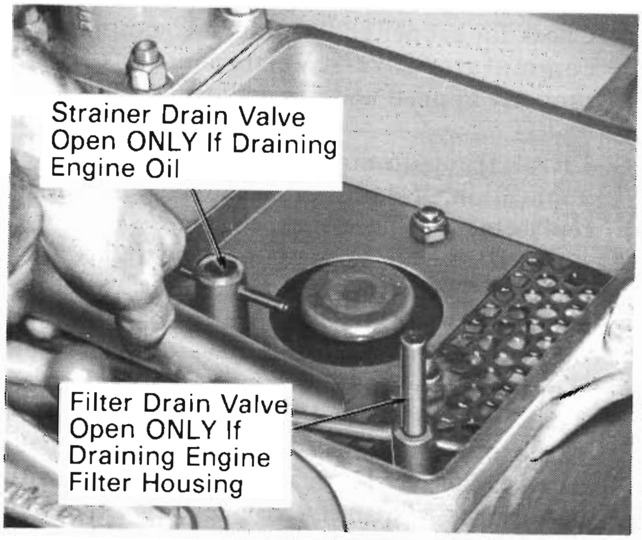


Fig.36 – Filling Or Adding Oil To System

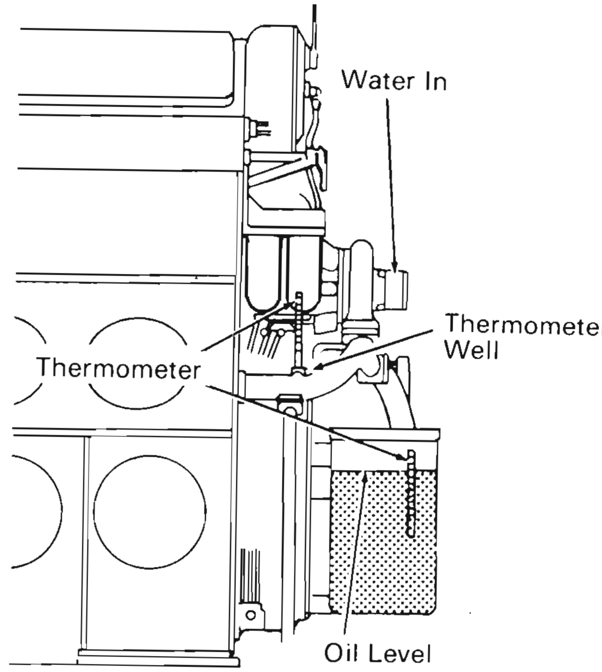


Fig.38 – Location Of Thermometers To Determine Oil And Water Temperature Differential

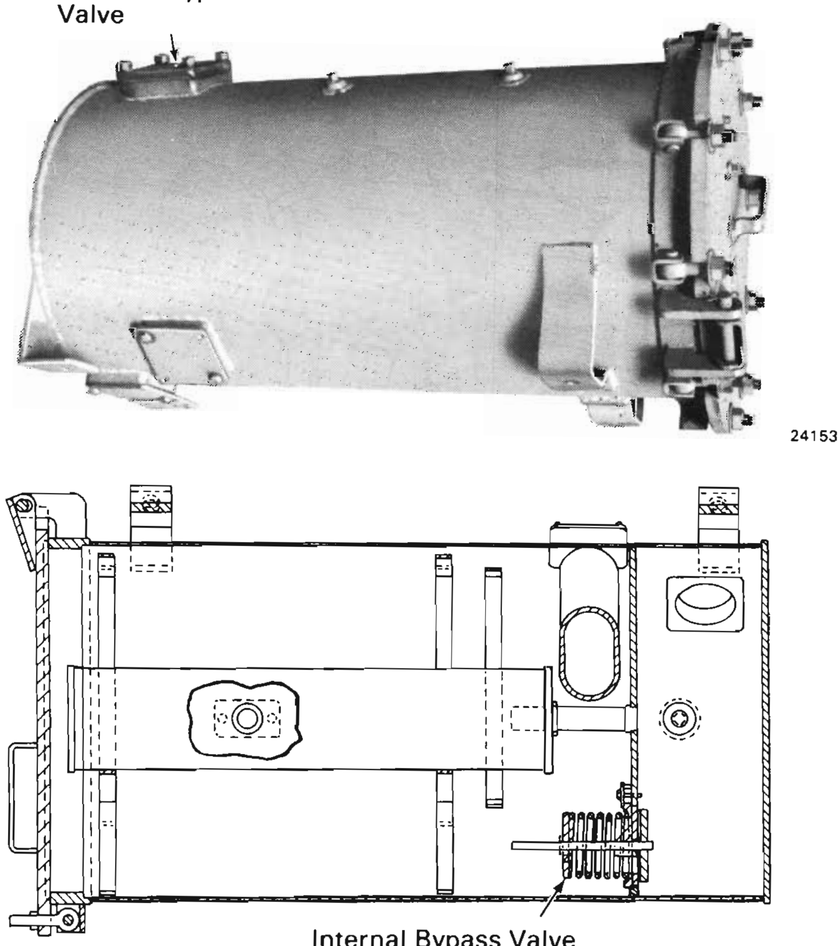


Fig.37 – Lube Oil Filter Bypass Valve Location

TRACTION MOTORS, Fig. 39

1. Apply RTV sealant to axle caps, axle shields, and behind support bearing flanges at time of motor mounting on axle in order to reduce water entry and accumulation in axle cap oil reservoirs.

2. Inspect support bearing oil filler caps for physical damage or "O" ring damage (on latest design). Replace damaged and old style "flip lid" caps with part 9333024. This cap is spring loaded to automatically return into position when released. See Section III and Fig. 64 for a description of this newer style cap.

3. Inspect wick lubricators for wear and damage at start of winter season. Wick face should release a small quantity of oil when squeezed.

4. Drain axle caps of any accumulated water and continue throughout winter season. Inspect and/or replace wick lubricator whenever significant water accumulation is noted. Wick cleaner 9502464 is available from EMD. See also Section II of this instruction regarding regular maintenance.

5. Check for proper application of traction motor commutator covers. Verify that gaskets are properly applied and are sealing correctly.

6. Check traction motor air ducts for proper application. If damaged, remove for repair or replacement as necessary.

7. Use a lubricant which meets EMD specifications (M.I. 1756). Since lithium soap thickend lubricant is more resistant to water wash-off, it is preferred to sodium soap thickend lubricant. Texaco "Code No. 1963 TMGL Premium" meets this requirement. During prolonged cold weather the gear lubricant may be thinned with car oil as required to prevent excessive channeling. See also Section II of this instruction for more information.

8. Inspect traction motor gear cases for sealing. Warped or damaged cases allow moisture ingestion at the axle and armature seals, and at the case split line.

9. The following are basic concerns in the weatherization of the traction motor that, although they are important the year round,

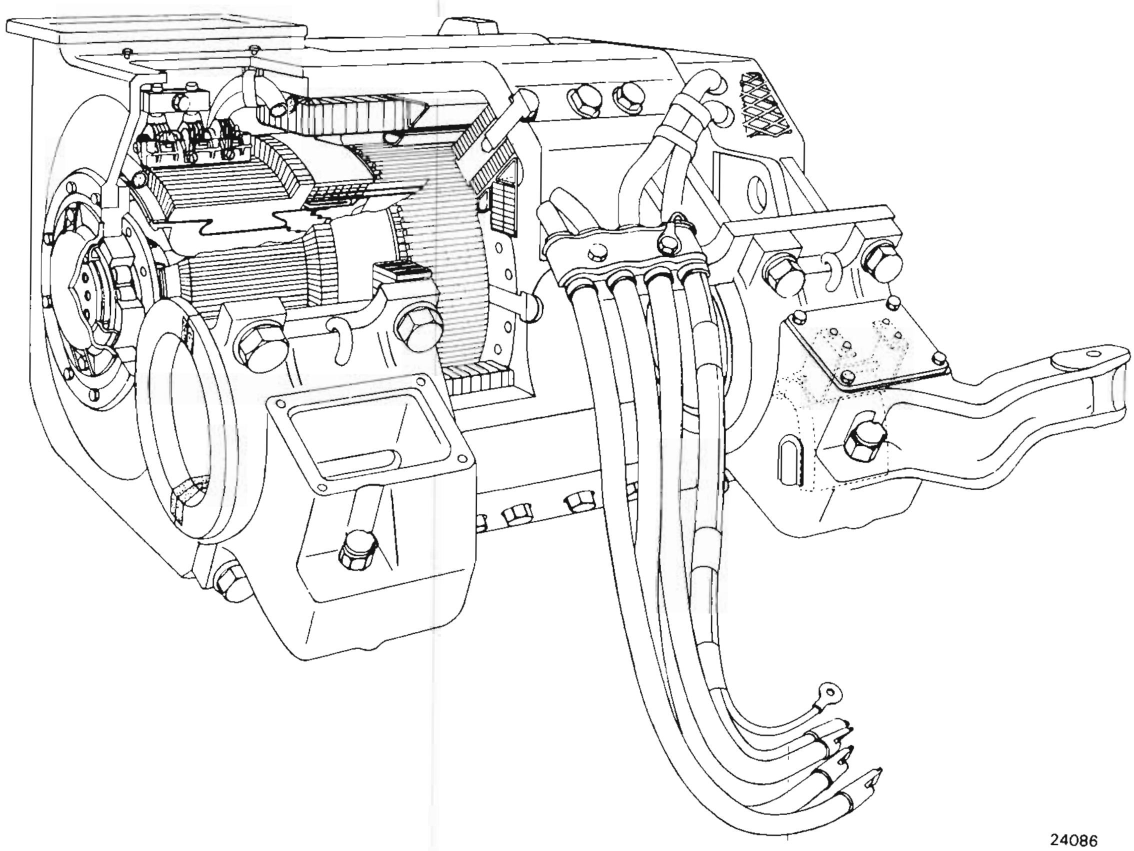


Fig.39 – Traction Motor

they are particularly important for winter operation.

a. The integrity of the molded rubber boot over the clasp connector should be checked to see that the clamping is satisfactory, the seal is good and that the boot is undamaged. For new style protective sleeve that helps the rubber boot seal out moisture see Section III of this instruction.

b. The teflon band on the armature should be wiped free of dirt at the onset of winter and later during winter operation if it should become dirty again.

c. The silicone rubber boots on the brush holders should be wiped free of dirt.

d. Check for proper seating of brushes and that brush-holders are not binding.

SECTION II

REGULAR WINTERIZATION MAINTENANCE

Establishing regular maintenance for the locomotive is of vital concern during the winter months. Many of the procedures in the foregoing checklist will prevent unnecessary shutdown when performed on a routine basis. Highlighted below are some of the more important areas.

FUEL AND LUBE OIL FILTRATION

All filters should be changed out at shorter scheduled intervals during winter. With the prevalent ambient temperatures causing water condensation the filters will have a shorter life. Fuel filters will also benefit from added tolerance to fuel waxing. M.I. 1750 – Fuel Recommendations reads in part —

The cloud and pour point of a fuel are measures of the formation of wax crystals and fluidity at low temperatures. To insure adequate flow through the fuel system filtration media during cold weather, the customer must specify the appropriate cloud and pour point requirements based on the lowest fuel system temperature expected. As a general rule, the cloud point should be 10° F (6° C) below the lowest expected fuel temperature to preclude the plugging of filtration media with wax precipitates.

This maintenance instruction also notes that in cold weather pipeline operations the use of halogenated dewaxing agents introduces organic chlorides into the fuel. This results in accelerated wear of chrome and iron surfaces. For reliable operation GOOD QUALITY FUEL IS A MUST.

Wayside fuel filteration, also very important, should include water removal capabilities. To equip a locomotive fleet with equipment capable of removing excessive amounts of water would be redundant and space consuming; the equipment is more easily and inexpensively employed at the wayside facility.

All other items in the checklist under "Fuel System" are equally important and should be maintained regularly.

COOLING SYSTEM

DRAINING THE COOLING SYSTEM

Due to a high incidence of frozen cooling system piping and air compressor low pressure heads in past winters, we would like to remind all customers that drain valves *must* be left open after draining the system.

Water remaining in pockets within the engine, radiator heads, and system piping can be displaced during locomotive movement. Such water can be retained in drain piping in sufficient quantity to reach air compressor low pressure heads if drain valves are closed or drain pipe is capped in any way.

In addition to leaving the cooling system drain valve open after draining, operating personnel should be reminded that the cab heater lines must also be drained after an engine shutdown in cold weather.

COOLANT SOLUTIONS

Coolant inhibitors must be specially balanced to protect the cooling system. While this is necessary year-round the conditions presented in winter sometimes add complications. A coolant suitable for use in EMD engine cooling systems must meet four basic requirements:

1. It must adequately transfer heat energy through the cooling system.
2. It must not form scale or sludge deposits in the cooling system.
3. It must not cause corrosion within the cooling system.
4. It must not deteriorate any of the cooling system seal materials.

These requirements are normally satisfied by combining a suitable water (i.e. mineral content) with a reliable corrosion inhibitor. To remain effective the inhibitor level must be carefully monitored during service. Coolant specifications are listed in M.I. 1748.

Antifreeze is not recommended for use in the locomotive cooling system. Antifreeze concentration levels are more critical than normal inhibitor concentration levels and thus require more frequent monitoring. Sludge may form in the cooling system when an inhibitor is combined with an incompatible antifreeze. Coolant leaks into the oil may also cause sludging in the lubrication system when antifreeze is present. More information is available on antifreeze solutions in M.I. 1748 but it should be noted that this information was originally included for application to early engine-generator sets.

Most manufacturers advise against mixing of different brands of corrosion inhibitors. This restriction recognizes the fact that some corrosion inhibitors may not be compatible with other brands. This incompatibility may lead to foaming, precipitation, or accelerated corrosion. EMD concurs with the manufacturer's advice in this respect.

TRACTION MOTOR AND GEAR CASE SEALING

Water and ice ingestion into the traction motor support bearings and gear case due to misapplication continues to trouble some locomotives during winter operation. Inspections should be increased as required to ensure that all component seals are properly maintained. If inspections show that water is present in the support bearing oil reservoir it should be drained before the unit is returned to service. The felt wick should also be removed and inspected when water is found in the support bearing. If there is evidence of water absorbtion to the wick the moisture must be removed.

Gear case distortion can also account for moisture ingestion. As gear cases are removed during axle and/or traction motor replacements they should be checked for dimensional accuracy. M.I. 1520 describes the procedure and necessary dimensions.

To help minimize water contamination all lubricant levels should be properly maintained on a regular basis. Accurate measurement of the support bearing cap oil level can be obtained only if the rule or rod is inserted parallel to the pipe, Fig. 40.

Procedures for inspection and reconditioning of these items are contained within M.I. 3900.

SEALING OF TRACTION MOTOR SUPPORT BEARINGS FROM MOISTURE

During severe weather, wind driven snow or rain may enter the traction motor at the axle cap split line, at the axle shield, or from behind the support bearing flange. Moisture can then migrate to the traction motor support bearing oil reservoirs.

Railroads experiencing accumulation of moisture in support bearing oil reservoirs can relieve the condition by applying RTV silicone compound. Applications should be made at the traction motor support bearing cap split line and at the edges of the axle shield, as indicated in Fig. 41, and between the support bearing flange back side and the traction frame and axle caps as indicated in Fig. 42. RTV silicone compound has excellent resistance to deterioration from exposure to weather, and can be peeled away readily when traction motor maintenance is required.

Oil residue must be removed from all sealing surfaces by wiping with a solvent before applying sealant. The sealant between the support bearing flange and motor frame must be applied at assembly of the bearing to the frame. A 1/4″ bead must complete a 360° arc on the bearing flange-to-barrel radius, Fig. 42.

CAUTION

Application of sealant directly to the flat of the flange can interfere with seating of the bearing in the frame and prevent an acceptable flange-to-frame gap (.005″ maximum).

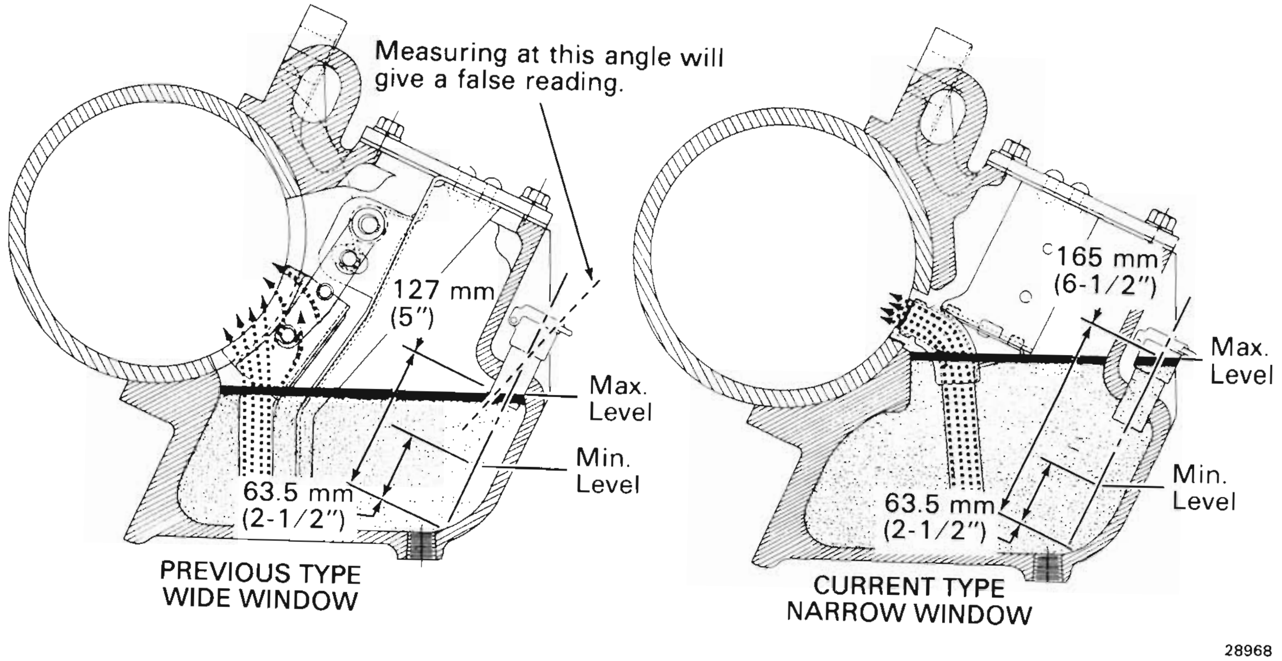


Fig.40 – Motor Support Bearing Oil Level

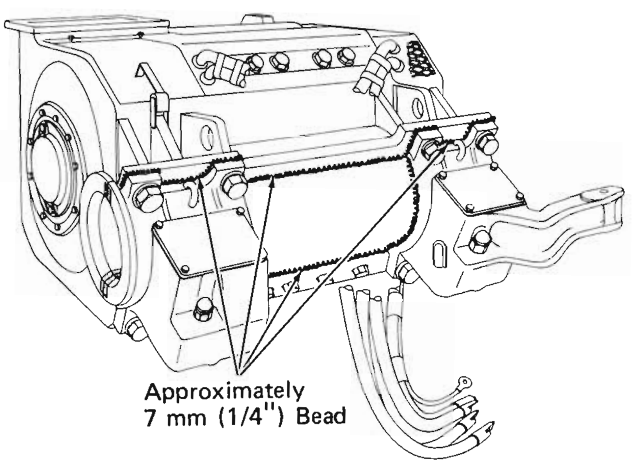


Fig.41 – Support Bearing And Axle Shield Moisture Seal

The other seams and split lines are sealed after the traction motor is mounted on its axle, and the axle shield and caps are secured. The bead of sealant must cover both metal surfaces and completely cover the parting lines of the axle shield. Particular attention must be given to the parting line above the top support bearing cap bolts where water is most likely to enter. If necessary, a pointed tool can be used to press sealant into the parting line area.

GENERAL COMMENTS

Electrical grounds and faults of the traction motor coils are often due to moisture seepage. Sometimes motors that electrically measure marginally can be helped back to within specifications. These motors will most likely fail again and have to be removed. To minimize moisture related failures the following steps, in addition to the checklist steps of Section I, will prove helpful.

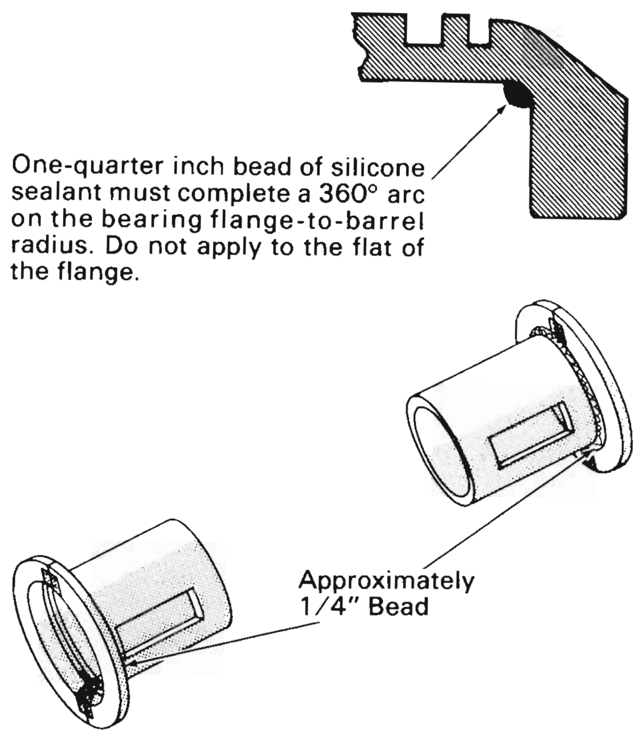


Fig.42 – Support Bearing Flange Moisture Seal

1. Remove all ice buildup on the motor and trucks when noticed.

2. Check that brush-holders are free of ice and that brushes are not binding. (This condition occasionally leads to false wheel slip indications.) If bound up brushes are found, these brushes and the brushes in the other holder of the same polarity should be replaced if evidence of differential wear or blackened shunts exists.

3. Use of dehumidified air blown through the motor will help dry out moisture. This will prove beneficial to wet motors *before* problems occur.

4. Motor vents should be free of ice internally and should pivot freely, thus allowing proper ventilation to the entire traction motor. Severe traction motor overheating in winter has been caused by fouled vents.

5. Cable insulation should not be damaged, frayed, or worn. Carefully check areas where cables are clamped or subjected to abrasion.

6. Contact area of connectors should be free of protruding nicks and burrs. The connectors should have a smooth, flat surface.

7. There should be no broken strands of cable at point of entry into connector. Crimped connectors, now basic, should have no indications of looseness. Inspect solder (on older style connections) at the top of the connector for cracks. The gap between the cable insulation and the connector should not be greater than 16 mm (5/8″).

8. Check grommets for deterioration, cracks, wear, and looseness to the frame.

9. The condemning limit of the external cable length without lugs is 1 168 mm (46″) minimum. The condemning length of the external cable length with lug is 1 253 mm (49-5/16″) minimum, measured from the outside edge of the cable clamp to the tip of the connector. Lead lengths are not to vary more than 38 mm (1-1/2″) between the longest lead and the shortest lead, but never shorter than the condemning limit.

Procedures for cable repair are included in M.I. 3900. Seal retrofit items are described in Section III for support bearing caps, gear cases and cable lead connectors.

TRACTION MOTOR GEAR LUBRICANT

Worn involute profiles of the traction motor gearing are the major source of damaging vibration. For this reason the use of a good quality lubricant maintained at proper levels is of utmost importance. During winter operation the incursion of water into the gearcase can strip sodium soap thickened lubricant from the gear teeth. Lithium soap thickened gear lubricants are more resistant to this effect. *The following lists key properties for a lithium soap gear lubricant (italics added for portions of direct reference to winter operation):*

Soap Thickener

A lubricant made with a lithium soap thickener will not strip from the gear teeth when water inadvertently enters the gear case and mixes with the lubricant.

Bulk Viscosity

The Brookfield Apparent Viscosity of 5000 - 10000 cp is the same as EMD has recommended for some time, and considerable experience has been obtained with lubricants in this viscosity range. This range is the best compromise for year-round use and is one which results in:

1. Nominal leakage at high ambients, provided gear cases are assembled with gutters or the newer plastic axle seals.

2. *Reasonably good slumping characteristic at low temperature to minimize channeling and temporary lubricant starvation.*

Occasional dilution with car oil may be necessary under prolonged extreme cold weather conditions.

Extreme Pressure

The extreme pressure properties are specified as minimum values. A lubricant having these properties will provide resistance to galling and scoring under high torque loading and will offer good resistance to wear under marginal lubricating conditions such as those existing when starting a heavy train at low ambient temperatures. The lubricant channels under these *conditions and, other than the lubricant adhering to the gear teeth, no additional lubricant is available until enough heat is generated to cause the lubricant to slump in the case. Under such conditions, dilution with car oil may be desirable.*

A closely controlled field test in locomotives with high HP/axle ratios has demonstrated the following lubricant provides superior lubrication for EMD traction gearing.

Brand	Lubricant	1 lb. Bag	2 lb. Bag
Texaco	Code No. 1963 TMGL Premium	9569938	9569939

Gear performance is not solely dependent on the type of gear lubricant that is used, but also on proper gear and gear case maintenance. Pinions and gears should be checked for involute profile wear (M.I. 1518) at wheel change time or when trucks are removed for reconditioning. The gear case should always be qualified whenever it is disassembled, as failure to do so may result in serous lubricant loss in operation and possible gear damage (M.I. 1520).

SECTION III

LOCOMOTIVE WINTER MODIFICATIONS

EMD offers several items for locomotive winterization to help railroads operate better during cold weather. This section describes those items as presently available. Each of the groups here describe the particular problems associated within their area and what is available to correct them. It is the intent of this section that by reviewing the various equipment areas customers can act upon their winterization requirements.

AIR (PNEUMATIC) SYSTEM

Frozen air brake equipment, auxiliary equipment (horns, sanding, etc.), and M.U. trainlines result from either entrained moisture or condensation caused by compressed air cooling to atmospheric temperature. The amount of entrained moisture and condensation due to cooling relate to the effectiveness of the main reservoir system which is the primary apparatus for pneumatic system moisture removal. EMD has run extensive tests on main reservoir piping configurations, dryers, filters, drain valves and heaters. From the results of these tests, the following main reservoir system configurations and equipment suggestions offer improved moisture removal and freeze resistance.

MAIN RESERVOIR SYSTEM CONFIGURATIONS

1. The most effective moisture removal configuration uses either a Salem 975 or WABCO D2B dessicant type air dryer. The dryer removes moisture from the air by absorption in the dessicant bed. Air leaving the dryer has a depressed dew point or, in other words, a lowered moisture saturation temperature. Under normal air demand conditions, the new saturation temperature is below ambient temperature. This prevents moisture condensation as the air cools to ambient temperature after leaving the dryer.

Each dryer has two dessicant beds. When one bed is absorbing moisture, the other is purging moisture during a regeneration cycle. Both dryers are equipped with thermostatically controlled drain valve heaters.

The air dryer is normally located in the underframe, on the left side between the fuel tank and the #2 truck. When the largest fuel tank is used, the dryer is located in the long hood between the air compressor and sand box. Fig. 43 and Fig. 44 illustrate the air dryer system in the underframe and long hood respectively.

The air dryer application provides the following features:

a. Air dryer located between the #1 and #2 main reservoir (M.R.). In this location, dried air is provided to the complete locomotive air system; air for the air brakes, all auxiliaries, and the equalizing M.R. train line (air supplied to and received from) is passed through the system air dryer.

b. Air dryer bypass (underframe mount only) for isolating and bypassing a damaged dryer.

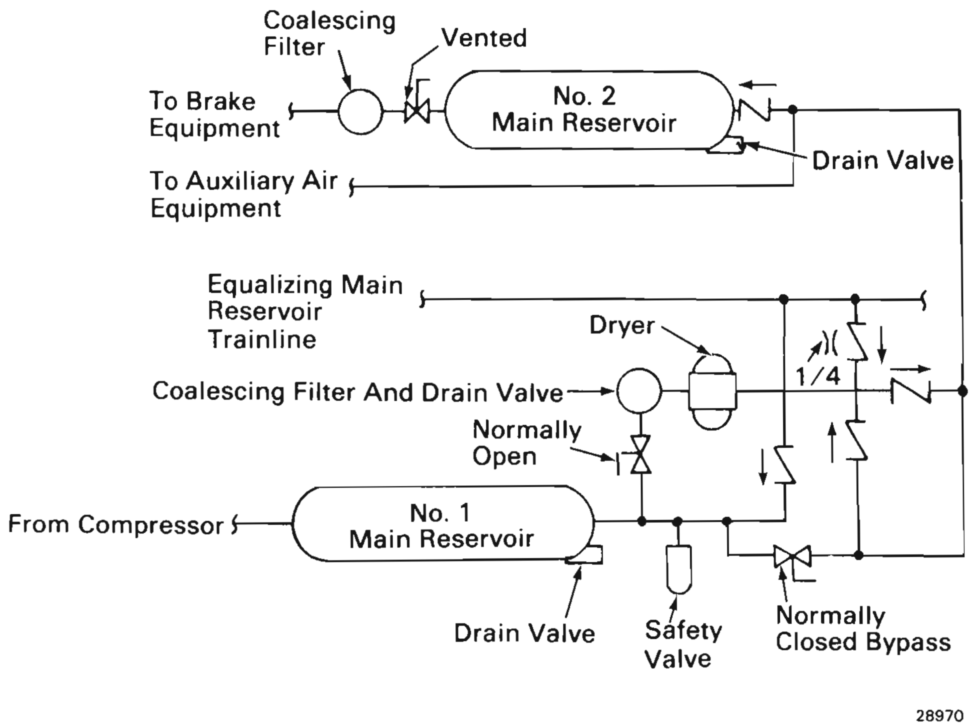


Fig.43 – Air Dryer - Underframe Mount

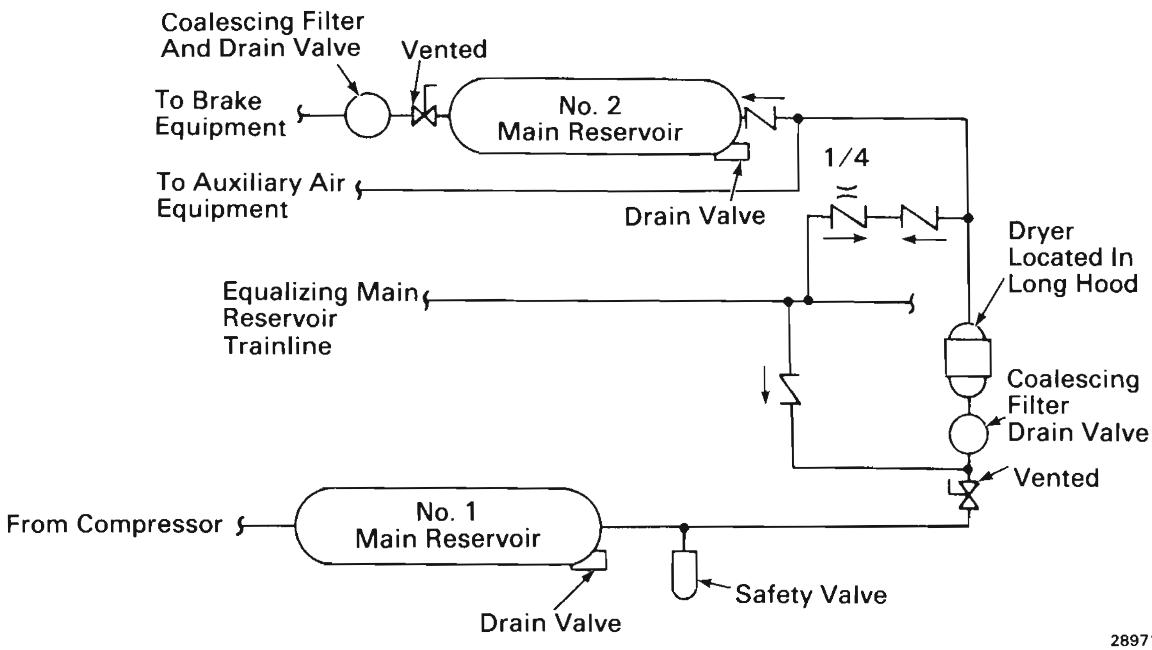


Fig.44 – Air Dryer - Long Hood Mount

c. Coalescing filter upstream of dryer to protect dryer from excess moisture and oil.

d. Self-actuating type drain valves at both reservoirs and the filter upstream of dryer.

e. Coalescing filter after No. 2 M. R.

2. The main reservoir configuration shown in Fig. 45 provides improved cooling and moisture removal over the standard configuration for auxiliary equipment (except water cooler)and equalizing main reservoir trainline air. This configuration is not as effective as the air dryer. Improved cooling and moisture removal is achieved by passing auxiliary air through rather than around the #2 M.R. In the event #2 M.R. pressure falls below 90 psi, the transfer valve switches auxiliary air from the #2 M.R. to the #1 M.R. This dedicates the #2 M.R. for the air brake equipment.

   A coalescing filter is recommended after the #2 M.R. and self-actuating type drain valves with heaters on both main reservoirs and the coalescing filter.

3. The standard main reservoir configuration, shown on Fig. 46, can have moisture removal enhanced by using coalescing filters after the #2 M.R. and in the auxiliary air equipment line. Self-actuating type drain valves with heaters are recommended at both main reservoirs and air filters.

DRAIN VALVES

Three types of drain valves are available: pneumatically actuated (Salem 580H or Prime 300-P); electrically actuated (Salem 880 or Prime 461), and self-actuating (Prime Thermionic or Sarco TDS52). Field and bench testing have shown the self-actuating drain valve to be more effective in removing moisture from main reservoirs and filters. The self-actuating type valves are self-regulating. This eliminates the need for external controls and allows simplified construction (e.g. no solenoids, springs, etc.). Continuous operation in the presence of moisture is another benefit due to the nature of the self-actuating valve. The pneumatically or electrically actuated valves either cycle at a fixed timed interval or when the air compressor cycles. Their cyclic rate allows moisture to accumulate that can be re-entrained and exhausted.

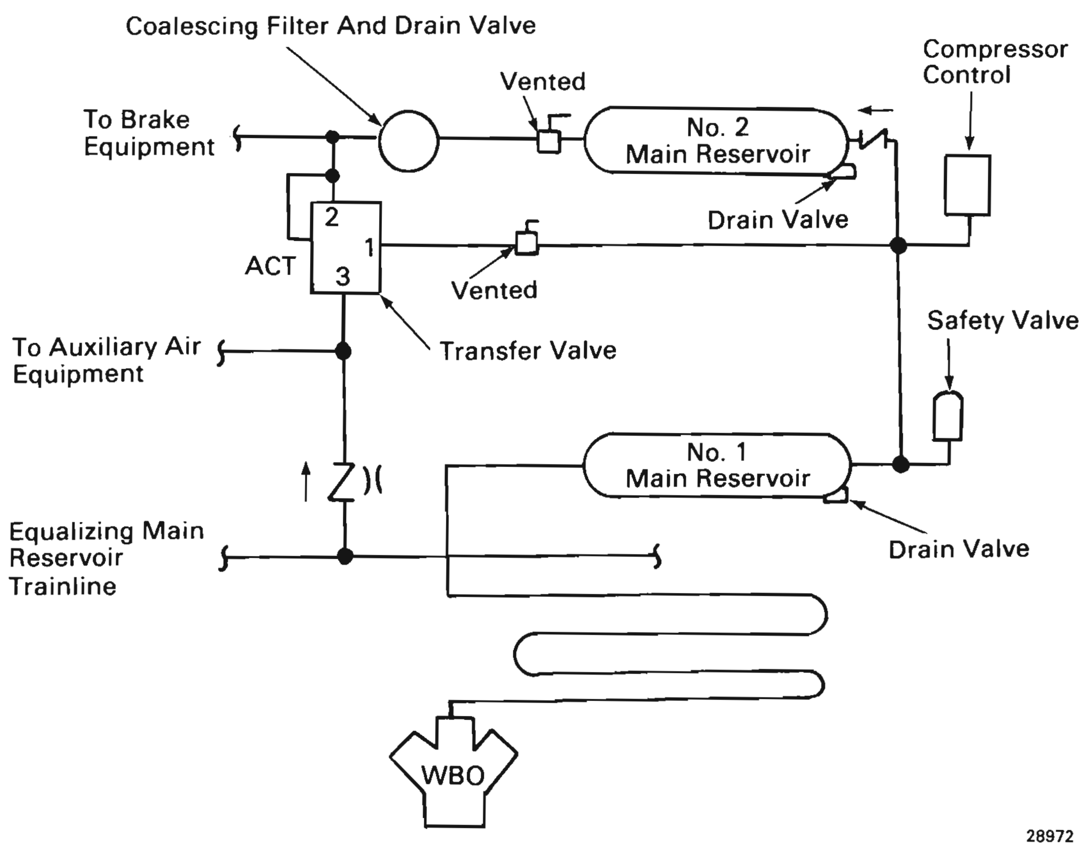


Fig.45 – Transfer Valve System

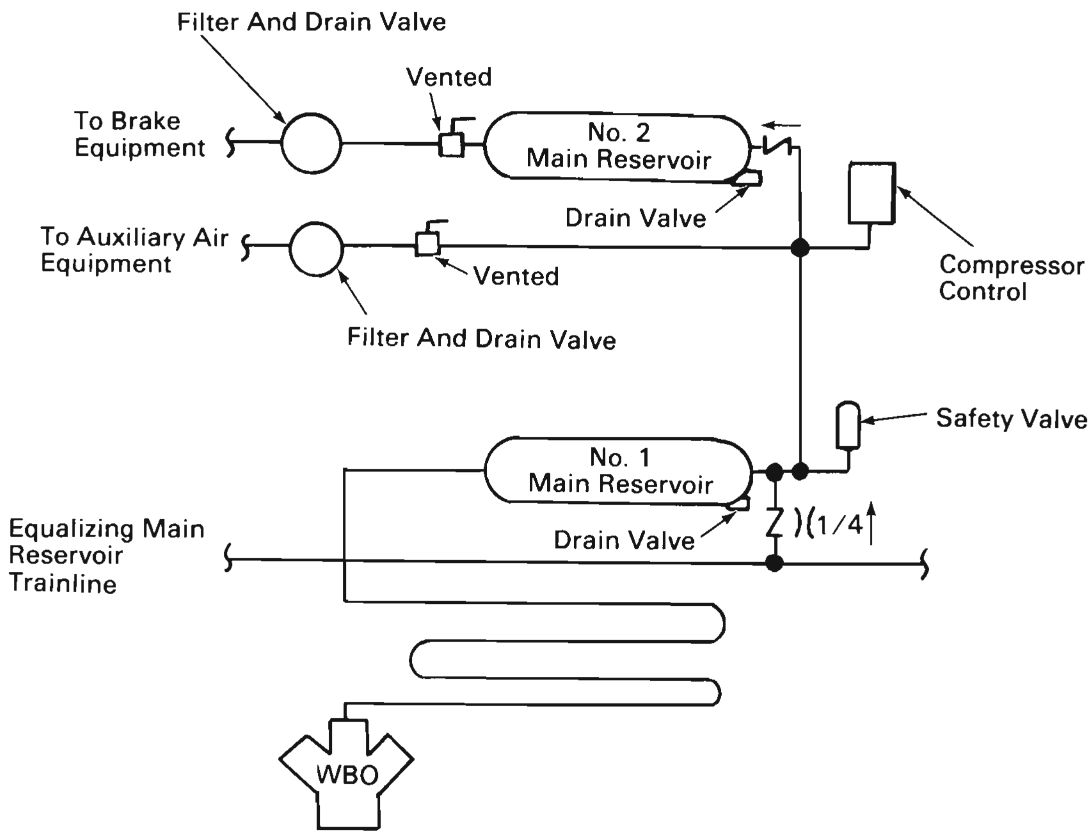


Fig.46 – Standard Pneumatic System

A cross-section of the Sarco self-actuating valve is shown in Fig. 47(a). Air under pressure at the inlet, Fig. 47(b), opens the valve when it overcomes trapped pressure above disc "A." It then flows radially outward underneath the disc until it reaches the exhaust cavity. As the air flows outward it creates a dynamic pressure towards the outer edge of the disc. This pressure leaks around the edge of the disc and into trap cavity above the disc. Since the radial air flow, Fig. 47(c), reduces the upward pressure against the disc, the air flow is eventually cut off as the trapped air pressure snaps the disc shut. (Since the trapped air is working over a greater area of the disc than the air at the inlet, the force generated on the disc by the trapped air becomes greater than the total force created on the disc at the inlet.)

Air carrying water will create less dynamic pressure outwards towards the disc edge than will dry air. This is because moist air will flow across the inlet-to-outlet pressure differential slower than dry air. The lower pressure at the disc's edge allows the valve to remain open until the water entrained in the air flow is exhausted. With the flow of dryer air, the air flow speed increases; the dynamic pressure towards the disc edge is greater, the pressure upwards is lessened and the valve closes. The cycle repeats as trapped air leaks around the disc to the exhaust cavity and the valve once again opens. The valve will snap shut in a fraction of a second if only dry air is present. The Prime Thermionic valve also operates on these same principles.

All pneumatic, electric, and self-actuating type drain valves are adaptable to the main reservoirs and all air system filters. A shutoff and manual drain are built into each valve.

Heaters are available for the Salem 880 and all self-actuating type drain valves. The heater prevents freezing to nominally 10° F. They are especially important when going from above to below freezing temperatures. Below 10° F, atmospheric moisture content is low and subsequently the amount of condensation is low. At above freezing temperatures, atmospheric moisture content is high and condensate formation is high. The heaters allow the M.R. system to effectively purge moisture and make the transition from above to below freezing temperatures. Heaters are generally thermostatically controlled.

FILTERS

Two types of air system filters are available: centrifugal type with and without paper elements (Salem 824 or 818 and Prime PM548 or PM597) or

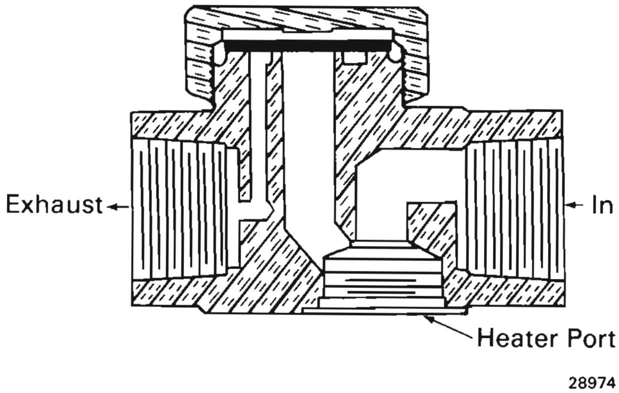


Fig.47(a) - SARCO Self-Actuating Drain Valve Schematic

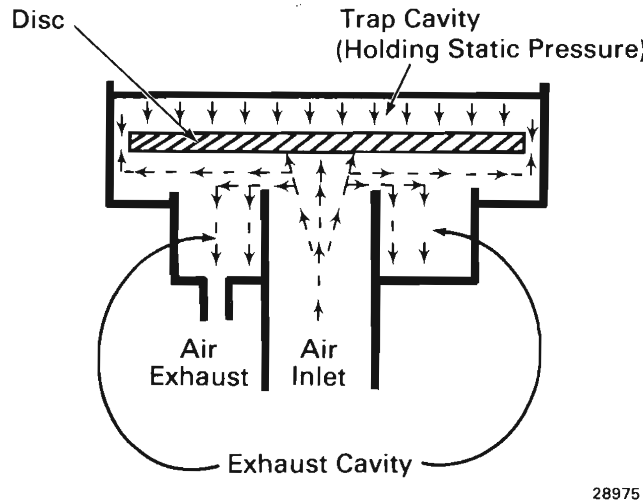


Fig.47(b) - Air Flow Within Valve

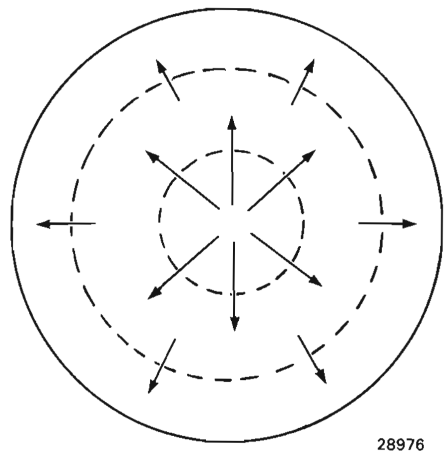


Fig.47(c) - Radial Air Flow On Inlet/Outlet Side Of Disc

coalescing type (Salem 824-170 or 818-170 and Prime PM5011 or PM5011-1). Bench and field testing have shown the coalescing type filter to be more effective in removing moisture. The coalescing filter is capable of removing aerosols (fine mist) as well as debris. The centrifugal paper type filter can remove droplets, but will not filter aerosols. With the ability to filter aerosols, the coalescing filter is more effective in overall moisture control.

AIR COMPRESSORS

Older style WBO and WBG air compressors operating in cold weather environments are susceptable to two system inadequacies. First, plunger oil pumps are able to supply only marginal amounts of lubrication with very cold oil because of the high viscosity rise. Second, sediment from the coolant solution accumulates in the water jacket passages due to pockets of low water velocity and, under certain conditions, sludging of the coolant. The effect of this is an obvious loss of cooling that increases lacquer and carbon formation in the cylinder.

Gear Pump Conversion

All WBO air compressors with plunger type lube oil pumps can be converted to gear type lube oil pumps. The conversion process is detailed in M.I. 9621 - Modernization Recommendation - Conversion of WBO Air Compressor From Plunger To Gear Type Oil Pump which is used in conjunction with M.I. 1144 - Air Compressor Models WBO and WBG. Some advantages of this conversion are:

1. The gear pump delivers a larger volume of oil than the plunger type pump, providing a greater margin of safety when clearances become greater.

2. Less sensitivity to oil viscosity.

3. Reduced wear on moving parts due to filtered oil.

4. Elimination of inlet and outlet check valves removes the possibility of lube oil pressure loss due to sticking check valves.

5. Elimination of severe pressure oscillations.

Two kits are available for conversion, one with a new crankshaft and one without. Kit part numbers are in the Service Data and instructions for rework are included with each kit.

Water Deflector Modification
For Sediment Removal

Effective in 1974 WBO and WBG air compressors were built with water deflectors designed for the prevention of sediment accumulation in the low and high pressure heads. The sediment is agitated by coolant flow from the water deflectors and is then removed by the normal coolant flow. This provides a more even flow of coolant throughout the compressor heads and increases cooling efficiency. Air compressors equipped with the reduced sludge low pressure cylinders, Fig. 16, do not need water deflector retrofits.

Separate water deflector kits are available for the WBO and WBG air compressors, Fig. 48. Assembly sketches are included with each kit as listed in the Service Data. Jacket and head water passages should be cleaned prior to applying any of the sediment removal equipment as this will increase sediment removal effectiveness.

CENTRAL AIR SYSTEM

Some of the most serious operating difficulties that a locomotive faces come from snow and ice in the central air compartment. Snow can plug the engine filters and thus reduce the engine's air intake. Moisture from the snow can also enter the traction motor and generator blowers resulting in grounds. Excessive moisture in extreme weather conditions has even formed enough ice on the traction motor brush-holders to hold the brushes off of the commutator.

Snow can enter the compartment in two main ways. All compartment access doors and panels must seal tightly to keep snow out. Worn or misapplied seals should be renewed. All main generator inspection doors and covers must also be tight to help prevent snow entry. The generator fiberglass slip ring cover must keep moisture out by sealing tightly against the outer cover.

More troublesome is snow penetration through the inertial filters. Separation of wet heavy snow from air is relatively easy due to the difference between the two in specific gravities. Fine powdery snow reacts quite differently: it is of about the same specific gravity as air and therefore passes through the inertial filter stage. As the accumulation of snow blocks the aspirator in the generator pit moisture further accumulates and creates added potential for system grounds. This is also aggravated sometimes by the build-up of ice on the underframe causing blockage of the pit drain. These effects are increased in snow plowing operation when snow is kicked up and to the sides of the locomotive.

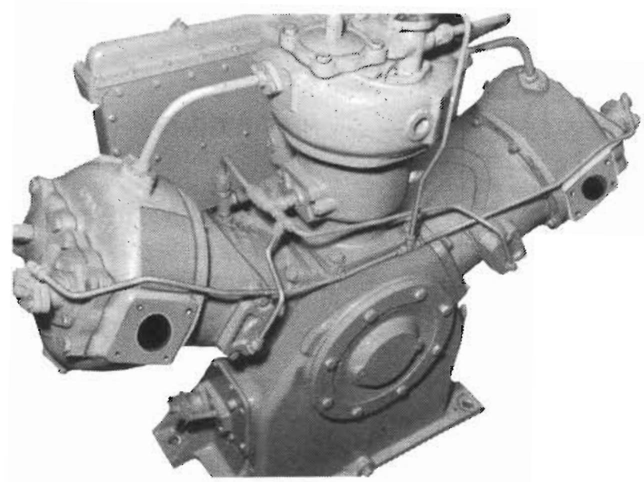
Electrical cabinet components on earlier locomotives not equipped with pressurized high voltage cabinets are also troubled by moisture grounds. Pressurization, air filtration, and better seals have nearly eliminated this trouble on later locomotives.

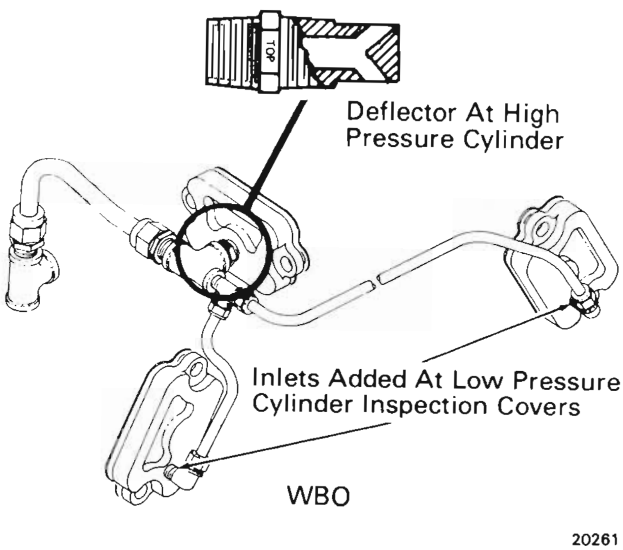
CENTRAL AIR COMPARTMENT WINTERIZATION

To provide warmer intake air to the central air compartment, a winterization hatch is fit over the number 1 cooling fan and temperature operated shutters are installed in the engineroom partition, Fig. 49.

The shutters, controlled by an automatic temperature switch, will open at 35° F falling temperature and close at 45° F rising ambient temperature. When the shutters open, air is drawn from the winterization hatch where it has already been partially warmed by passing through the radiators. As it passes over the engine exhaust manifolds it picks up more heat. The warmed air then enters the central air compartment through the partition shutters and mixes with cold air being drawn in through the inertial filters.

A GP38-2, as an example, at third throttle has an inlet temperature 21° F above the ambient temperature. At eighth throttle this temperature difference is 36° F. A GP38-2 can thus operate in third throttle down to 11° F or to -4° F in eighth throttle and maintain a central air compartment temperature of 32° F. This conversion is detailed in M.I. 9636 - Locomotive Winterization.





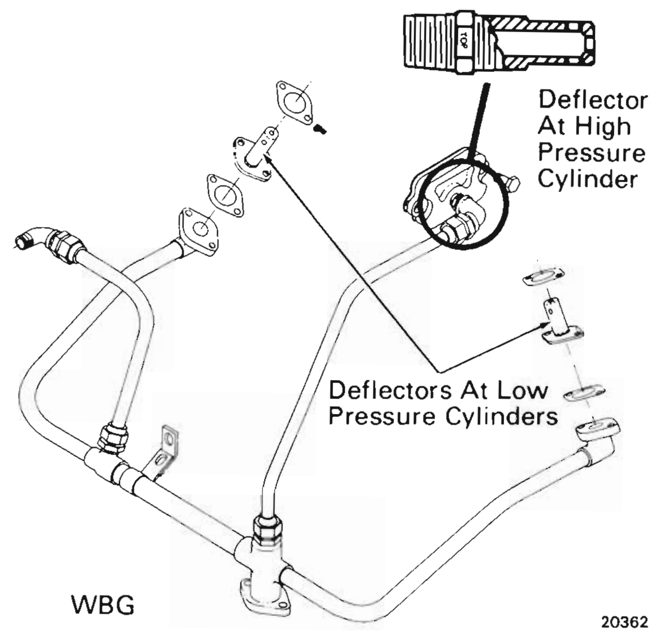


Fig.48 – Water Deflector System Applied To Earlier Units

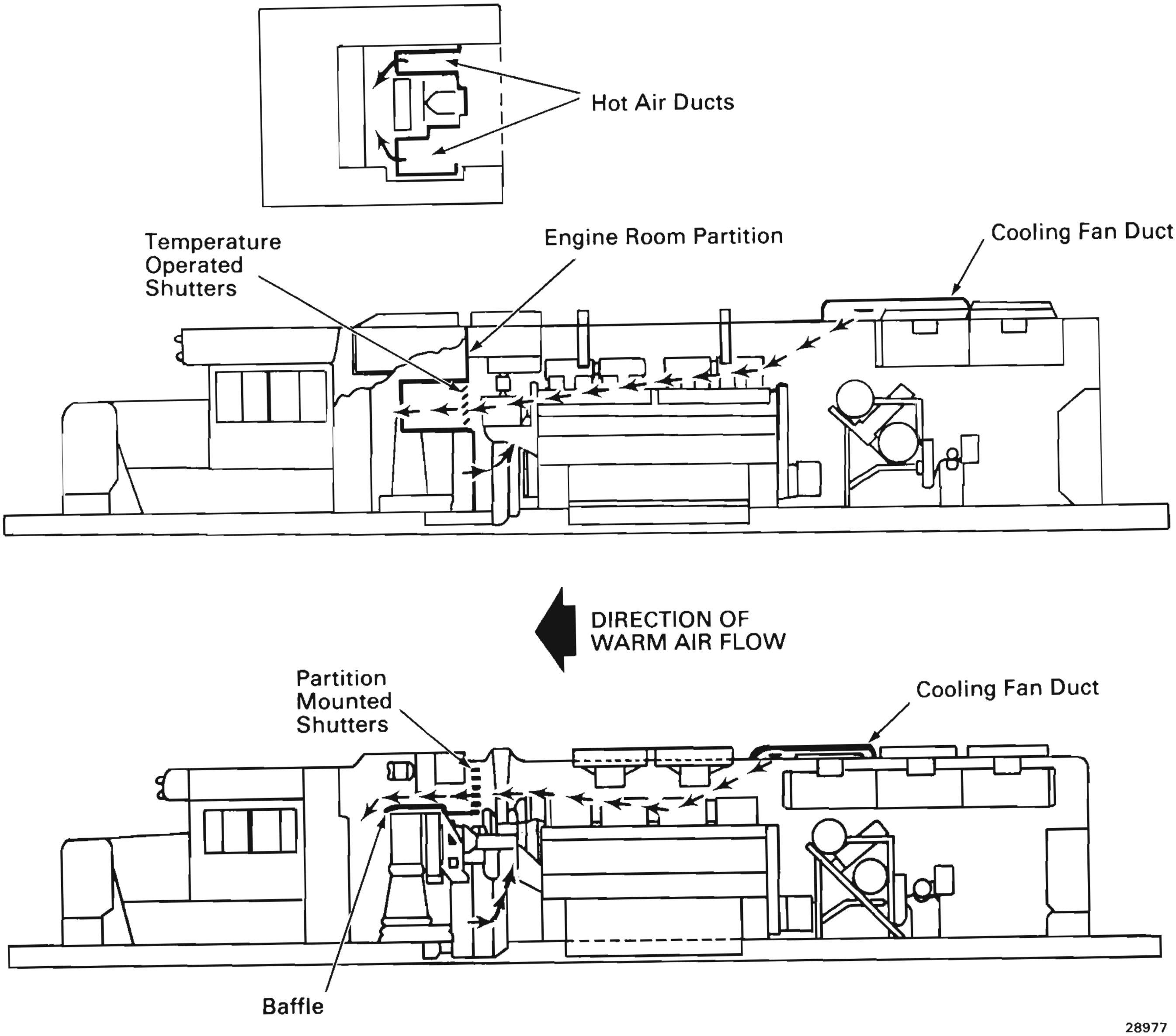


Fig.49 – Typical Winterization Systems

IMPROVED WINTERIZATION SYSTEM

For locomotives that have to operate within more severe winter conditions a system has been developed that provides larger temperature differentials above ambient than provided by the standard winterization package. This consists of the standard system described above and shutters designed to fit over the inertial filters, Fig. 50. These shutters are controlled by temperature switches mounted in the traction motor air duct. Temperature differentials measured on a GP38-2 were 58° F above ambient in third throttle and 97° F above ambient in eighth throttle, Fig. 51.

The improved winerization system has thus far been developed only for GP38(-2) and GP49 locomotives. Should you wish to apply this system to other locomotives, please contact your EMD representative. The shutters can be resized to fit other locomotive series as required.

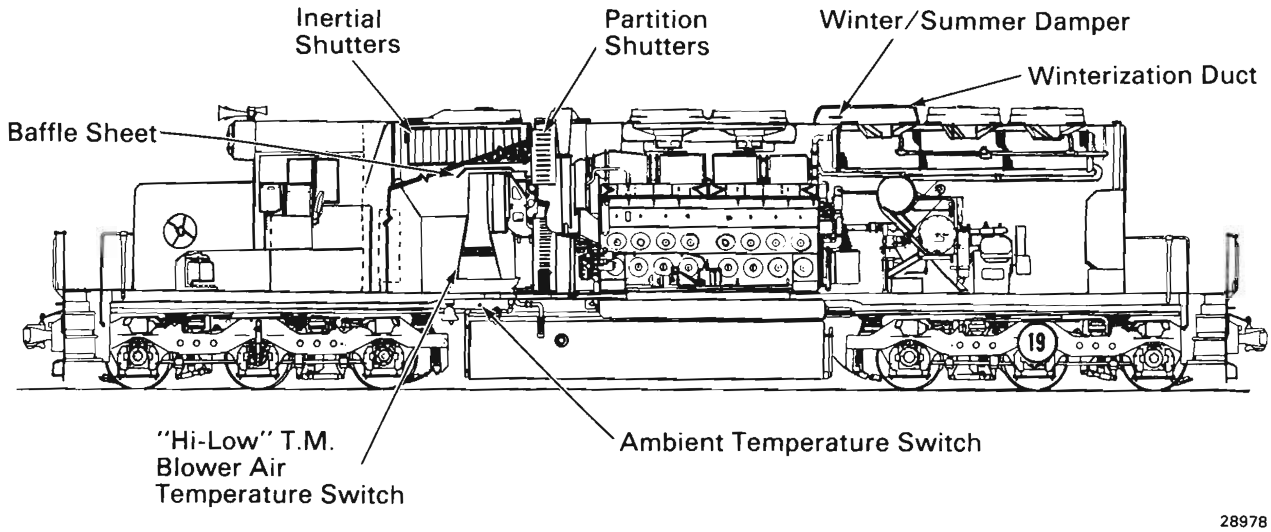


Fig.50 – Improved EMD Winterization System

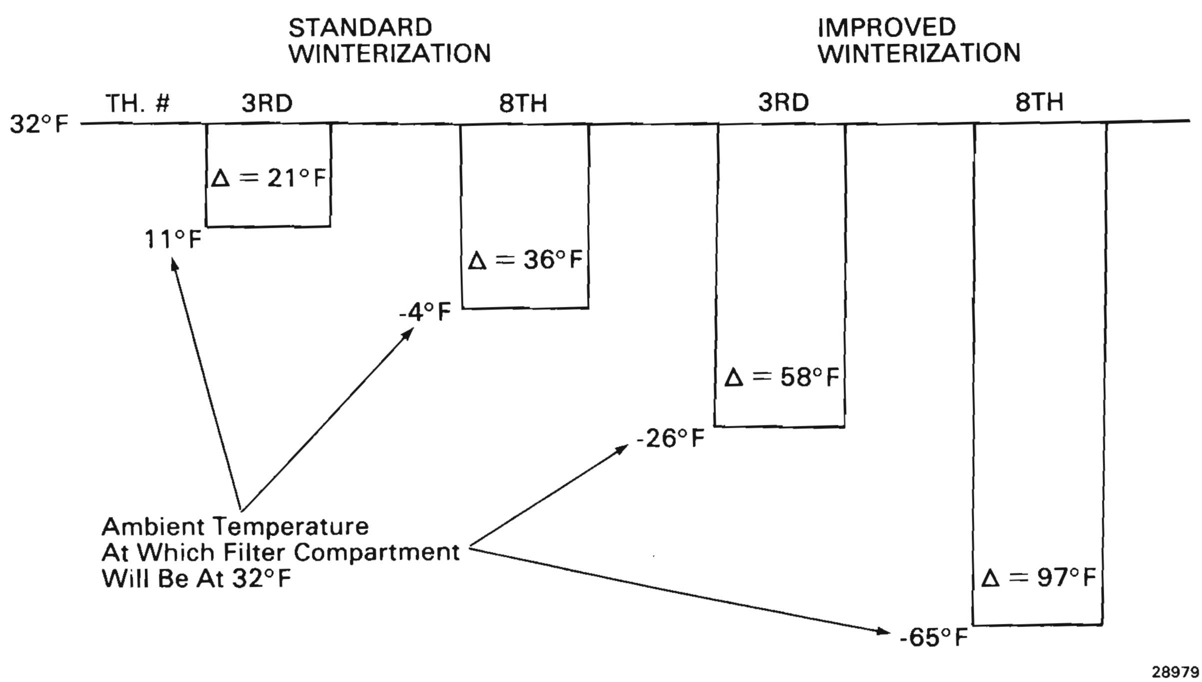


Fig.51 – Typical Central Air Compartment Performance On A Winterized GP38-2.

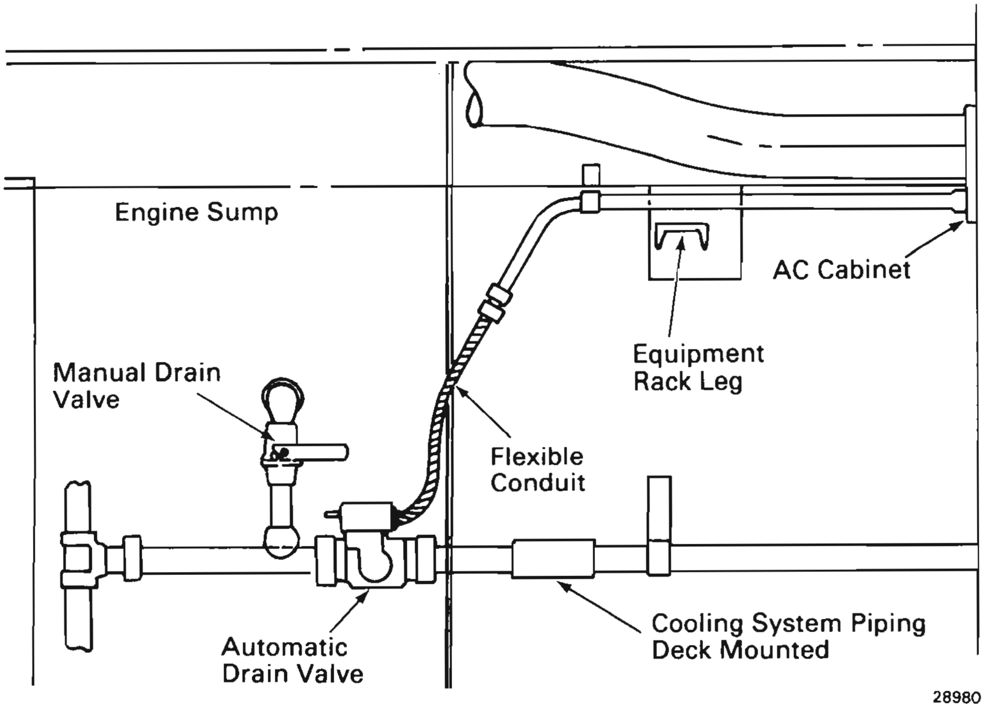


Fig.52 – Physical Application Of
Automatic Cooling System Drain Valve

HIGH VOLTAGE CABINET AIR FILTER APPLICATION

Locomotives delivered prior to September 1, 1967 were not equipped with pressure ventilated high voltage cabinets. A Modernization Recommendation, M.I. 9615 – High Voltage Cabinet Air Filter Application, describes a retrofit that is available for GP38/39/40, SD38/39/40/45, and SDP38/40/45 locomotives.

Pressurization of the cabinet will help prevent the entrance of moisture. More so, the filtration will remove dirt that, once settled on the electrical components, traps moisture, provides paths for electrical shorts, and further accelerates the decay of electrical insulation. Air flow through the cabinet is provided by special openings that are left unsealed. This helps dry out cabinet air moisture and cools the electrical devices thus prolonging insulation life.

Cabinet seal integrity should be maintained as indicated in M.I. 1803 – Weatherproofing And Sealing.

COOLING SYSTEM

AUTOMATIC DRAIN VALVE

The most common cause of extensive freeze damage to the cooling system, the engine, and the air compressor is engine shut-down for any cause during freezing weather followed by failure to completely drain the coolant from all parts of the system.

To prevent freezing of the cooling system an automatic drain valve kit is available for installation.

Engine shutdown energizes the automatic drain valve circuitry. When coolant temperature falls to 7° C (45° F), an internal thermostat trips, activating the automatic drain valve. The entire cooling system will then drain within 10-12 minutes. An AUTO DRAIN COLD WATER FILL SWITCH is provided to electrically override the automatic drain valve, closing the drain valve for re-filling a drained engine or to facilitate cold water filling. Restarting the engine re-activates the automatic cooling system drain circuitry to provide protection in the event of future shutdown. The system is interlocked through the engine fuel pump circuit so that the automatic drain valve cannot be activated when the engine is running.

The automatic drain valve is located in the engine coolant pipe next to the manual drain tee, Fig. 52. At this location the water temperature is the lowest available for sensing on the locomotive after shutdown. The graph in Fig. 53 shows the declining temperatures sensed on an SD40-2 after engine shutdown.

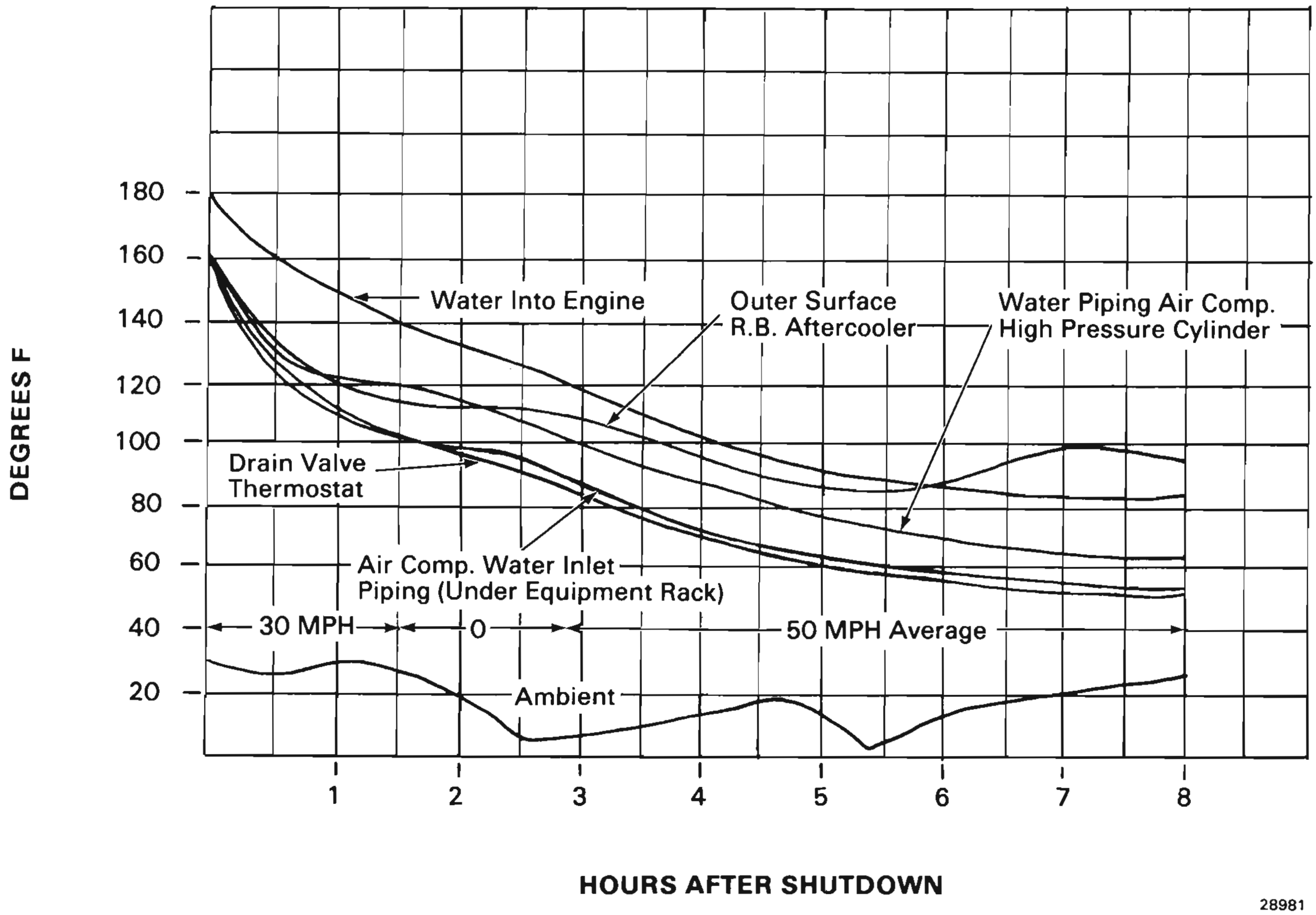


Fig.53 – Coolant Temperatures After Hot Engine Shutdown

Conversion details are covered in Modernization Recommendation M.I. 9637 – Cooling System Automatic Drain Modification.

LOW IDLE TEMPERATURE SPEED-UP SWITCH

A new ambient sensing temperature switch modification is available to replace former high voltage cabinet mounted switches. This Low-Idle Temperature Speed-up (LITS) switch is mounted beneath the locomotive skirt where it senses true ambient temperature.

The older style LITS switches were applied with fuel preheater options and/or low idle operation. Due to electrical cabinet heat retention on some locomotives, the HVC mounted LITS switches would not activate the idle speed-up function until the ambient temperature was several degrees lower than intended. This caused lower engine temperatures than intended which resulted in fuel pre-heater inefficiency, engine combustion inefficiency, and souping. Application of the new LITS switch will restore proper system operation.

The LITS system is also used to protect against battery discharging when applied to locomotives not equipped with auxiliary generator 2803063 (UTEX 9551383). A more complete description of this function will be found under LITS Battery Protection of *Electrical System* in this section. The LITS kit part number will be found in the Service Data.

Immersion Heater Layover Protection

Immersion heater systems are available for freeze protection of the locomotive cooling system. These standby protection systems were originally designed for commuter rail operations where locomotives are subject to overnight and weekend layover. During cold weather operation, locomotives often have to be kept running to prevent freezing. Applying an immersion heater system produces three immediate benefits in addition to freeze protection. Fuel consumption is reduced since the locomotive no longer runs continuously during layover. Engine wear is also reduced due to less engine operation time. Lastly, engine performance will not suffer from the souping or liner varnishing that can occur due to long periods of no-load operation.

The standard layover protection system includes a water pump which circulates heated coolant throughout the cooling system. For layover periods longer than overnight (e.g. weekends or holidays) or for very cold weather, the extended layover protection system also provides for oil heating. During these types of layover periods, the engine oil will lose its heat and become viscous (thicken). Engine starting becomes very difficult and the engine may even have insufficient lubrication after startup. Oil heating is accomplished by installing an oil pump and modified lube oil cooler in addition to the standard layover system. With this, oil enters from the cooler's top side and picks up heat from the circulating coolant as it (the oil) gravitates through the cooler.

The typical immersion heater system operates on three-phase 480 volt AC lineside power. Other systems are available for three-phase 240 volts AC, two-phase 220 volts AC, and single-phase 220 and 115 volts AC power availability.

COMPREHENSIVE LAYOVER PROTECTION

For comprehensive protection of the locomotive, three options are available for addition to the immersion heater systems discussed above. Battery heating systems, as discussed in this publication in Section III – Electrical System, can also be line powered during locomotive layover. To keep the batteries charged and help protect against battery freezing, a battery charger is also available that works from the wayside line voltage. Layover cab heat, the third option, warms the cab and protects against moisture condensation. This is especially beneficial in protecting electrical components and preventing cab window frosting.

CAB ENVIRONMENT

Proper train handling is aided when the cab environment does not hinder or distract the crew. During winter operation this means that the cab interior should be kept adequately warm and the windows frost free for best possible visibility. To these ends, cab sealing has been improved over the years and cab heaters have been effectively employed. Seals should be maintained in accordance with M.I. 1803 – Weatherproofing And Sealing.

On older locomotives, cab heaters sometimes develop leaks; occasional engine shutdowns have also led to heater pipeline freezes. This has caused excessive downtime for maintenance on some railroads. Since the hot water heater system depends on the flow of engine coolant it is also susceptible to line blockage caused by sediment and sludging. This effectively decreases heating capacity.

Window defrosters used with the hot water heaters have been equally ineffective at times since they rely directly on the cab heaters. Conditions from glass fogging to sheets of ice have been noted when the defrosters are not operating efficiently.

ELECTRIC CAB HEATER MODIFICATION

Electric cab heaters are available for retrofit to GP9, SD9, and all newer locomotives. The hot water heaters are replaced by forced air electric units which are dimensionally identical. Two side wall (strip) heaters are also mounted in the cab. This system provides quicker and more reliable heat generation. Defrosting is also much improved from the better heating ability and the moisture drying effect created from the heaters. A fresh air ventilator is included with the system that will prevent the air from becoming excessively dry.

NOTE

On all locomotives modified for low idle (255 RPM) the Low Idle Temperature Switch modification should also be made to protect battery charging at low ambient temperatures; refer to LITS Battery Protection under Electrical System of this section.

ELECTRICAL SYSTEM

BATTERIES AND STARTING SYSTEM

Battery capacity and (as a result) starting system reliability deteriorate at low temperatures. For the majority of today's railroad batteries, the lead acid type, freezing is a constant threat when operating under extreme environmental conditions. A typical battery will freeze at -20° F with a relatively full charge (1.235 specific gravity level typical). If allowed to discharge to a 1100 specific gravity level, freezing can occur as high as +20° F. Maintaining the charge level at low temperatures also becomes more difficult since the electrolyte resistance rises slightly as the temperature drops. The low temperature increases electrolyte viscosity which limits its circulation about the plates within the battery. As electrolyte temperatures decrease below 0° F, charging rapidly becomes impossible.

Battery Heating

To counter battery freezing, EMD offers two systems for battery heating. An external (to the battery) system consists of one laminated heating pad per battery compartment. These heating pads sit on the battery compartment floor with the batteries directly on top. For the unitized battery a heating pad is built internal to the battery housing. The external pad system is not used with the unitized battery due to the large standoffs of this battery; the space created beneath the unitized battery limits thermal transfer efficiency. Both systems are thermostatically activated as ambient temperature falls below +35° F.

Temperatures		Percentage Of Capacity* At 80° F	
°C	°F	20-Hr Rate	20-Min Rate
27	80	100	100
15	60	90	84
4	40	77	67
-7	20	63	52
-18	0	49	34
-29	-20	35	19
-40	-40	21	2
-51	-60	9	-

* Capacities at temperatures lower than +80° F are expressed as a percentage of the respective +80° F rating (e.g. 20-Hr Rate @ +40° F/20-Hr Rate @ +80° F; 20-Min Rate @ +40° F/20-Min Rate @ +80° F).

TABLE 5 – Relative Temperature Capacity Of Lead-Acid Storage Batteries

As can be seen in Table 5, the battery capacity drops off steeply at low temperatures. The 20-Minute rate falls even faster than the 20-Hour rate. Starting ability, which is dependent on short-term ratings, is thus even more dependent on temperature than low current draws such as cab lighting and control circuitry. (The low current draws are more affected by the 20-Hour long-term ratings.

The external battery heaters will keep electrolyte temperature at 30° F above ambient. The internally heated batteries will remain 40° F to 45° F above ambient. Battery heater performance is shown in Table 6. With these systems the batteries will be more resistant to freezing and provide increased starting reliability.

Both systems are available for active or standby service. In active service the system operates only while the engine is running. Power is 74 Volts DC taken from the auxiliary generator. The standby system was designed specifically for commuter locomotives. The batteries are heated during overnight layover periods when the engine is shut down. This is a plug-in type system that draws 480 Volt AC three-phase power from the local utility.

Parts information will be found in the Service Data.

Battery Protection – Improved LITS Switch

An improved ambient sensing temperature switch is available for locomotives equipped with high voltage cabinet mounted LITS (Low Idle Temperature Speedup) switches. HVC mounted switches have sometimes been subject to electrical cabinet heat retention. This effectively has lowered the temperature at which idle speedup occurs.

HVC mounted switches were originally mounted as a part of fuel preheater options in 1979. Their purpose was to raise the engine speed back to normal idle from low idle at times of low-ambient temperatures. This higher speed would keep the engine water warmer and enable the fuel preheaters to function better in cold weather. In 1981 the HVC mounted LITS switch was made basic to increase

	Original*	New 20-Min Ratings*		Effective Temperature	
Temp (° F)	20-Min Rating	External	Internal	External	Internal
40	67%	**	**	40° F	40° F
30	59	84%	92%	60	70
20	52	75	84	50	60
10	43	67	75	40	50
0	34	59	67	30	40
-10	26	52	59	20	30
-20	19	43	52	10	20
-30	10	34	43	0	10
-40	2	26	34	-10	0

*As a percentage of 20-Min Rating at 80° F
**Unchanged – System activates at 35° F descending temperature.

TABLE 6 – Battery Heater Performance

idle speeds in low ambients. This change raised the speed-up temperature to +10° F and functioned to aid in battery charging; locomotives ordered without the new style AC auxiliary generator 2803063 (UTEX 9551383) did not have sufficient capacity at low idle to simultaneously charge the batteries and run electric cab heaters.

The improved ambient temperature sensing LITS switch is available as part of the LITS ambient temperature sensing kit. The LITS switch is relocated to beneath the walkway skirt and ahead of the No. 1 main air reservoir, Fig. 54. From here it senses true ambient temperature and is not subject to the temperature variations of the high voltage cabinet. Neither will the switch be fooled by the warmed air of the central air compartment on locomotives equipped with EMD's winterization system.

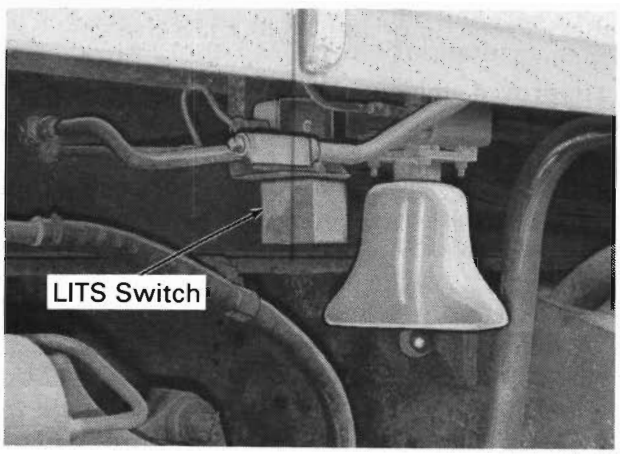


Fig.54 - Improved LITS Switch Mounting

The new LITS switch activates the idle speed-up function at +15° F ambient on descending temperature and returns the locomotive to low idle at +25° F ambient on rising temperatures.

Switches replaced by the LITS kit 9566543 are shown in Table 7.

Old Switch Part No.	Idle Speed-Up Activation (° F)*	Return to Low Idle (° F)*
9518967	5 ± 5	20 ± 5
9528924	10 ± 5	25 ± 5
9536503	20 ± 5	35 ± 7

*Activation and drop-out temperatures within the high voltage cabinet based on a 10° to 15° Farenheit temperature rise over ambient. Ambient temperatures are considered to be 15° F lower than the temperatures listed above.

TABLE 7 - Replaced HVC Mounted Temperature Switches

Any unit modified for low idle as indicated in M.I. 9619 should also be modified with the new LITS switch if equipped with electric cab heaters but without auxiliary generator 2803063. If interested in this application, contact your EMD Service Representative for wiring instructions when ordering the kit.

Starting Motor Thermal Overload Protection

To protect starting motors from burn-up due to prolonged and/or repeated engine cranking, the Starting Motor Protection Kit is offered for locomotive modernization. A thermal bar-switch assembly is inserted in the starting motor cable circuit. Within the thermal bar housing is a calibrated stainless steel bar that is subject to the same current as the starting motors and is designed to heat at a rate analogous to that of the starting motors. Mounted on top of the bar is a bi-metallic thermostat which is pre-set for 250° F pick-up and 150° F drop-out. Tripping of the switch due to heat buildup from prolonged and/or repeated cranking will cause immediate termination of engine cranking. Normal engine starting is not compromised by the system, but it will provide protection for the starting motors against burn-up due to operator abuse and undercharged or cold battery cranking.

Application of the kit is described in Maintenance Instruction M.I. 9631 - Starting Motor Thermal Overload Protection.

AR6, AR10, AND AR12 MAIN GENERATOR GROUND FAULT DETECTION SYSTEM

When phase-to-phase shorts occur within one-half of the generator, the ground fault detection system previously applied would sometimes not detect the single-phase condition. M.I. 9647 - Improved Ground Fault Detection System, which was published in August 1980 details the conversion process to modernize this circuit. The modified circuit protects against generator damage by removing generator excitation.

As M.I. 9647 points out there is a previous Modernization Recommendation M.I. 9557 - Ground Relay Sensitivity for this same circuit. M.I. 9557 covers GP40, SD40, and SD45 locomotives delivered prior to July 1, 1967. The neutral ground relay circuit had a sensitivity of 400 milliamperes which is raised to 875 milliamperes. This change reduces unnecessary ground relay trips due to harmless leakage from cables, traction motors, and the generator in the presence of high humidity or moisture.

COOLING SYSTEM PROTECTION FUSES

Ice and snow drag or blockage of the locomotive cooling fans causes high currents in the fan motors. Without electrical supply line fuses to check these current overloads, the fan motor insulation can be damaged. These high currents may also be reflected in damage to the fan contactors, associated wiring, and the companion alternator.

Modernization Recommendation M.I. 9627 - Addition Of Cooling System Protection Fuses details how to protect pre-1972 model 38, 39, 40, and 45 locomotives which were delivered without fan fuses. Fig. 55 shows a typical installation for a three-fan locomotive.

Keeping the fans clear of snow and ice, for instance at all fueling stops, should eliminate most problems. This is not always possible while in operation though, especially when in snow plowing or blizzard conditions. The fan fuse system will protect the fans and locomotive until a stalled fan can be cleared. The system will also provide year round protection from electrical shorts.

FUEL SYSTEM

Fuel waxing and water condensation as a result of cold weather conditions will shorten filter life due to plugging. (A discussion of fuel cloud point and waxing is found in Section 11 of this instruction.) The obvious result is engine shutdown from fuel starvation. The following systems are offered to overcome this problem.

FUEL PREHEATER

Two standardized fuel preheaters are available for retrofit from EMD. Both heaters are of the same design with the "large" preheater simply having a longer core for higher heating capacity than the "small" preheater. Some locomotives which already have a small preheater but still experience waxing problems should consider upgrading to the "large" system capacity.

EMD preheaters are of mechanically bonded construction for improved reliability. Installation is made at the equipment rack in the vertical position. This provides positive draining that prevents freezing. Shorter runs that reduce exposure to cold are also realized for both water and fuel lines.

The larger preheater is mounted on the pressure side of the pump, Fig. 56, and is the preferred application. The fuel is sufficiently heated to warm the fuel in the tank at low ambient temperatures. Operation is automatic with the use of a thermostatic valve that will limit upper temperatures to the engine at the 90° F to 105° F range. This will prevent the adverse engine effects of high fuel inlet temperatures.

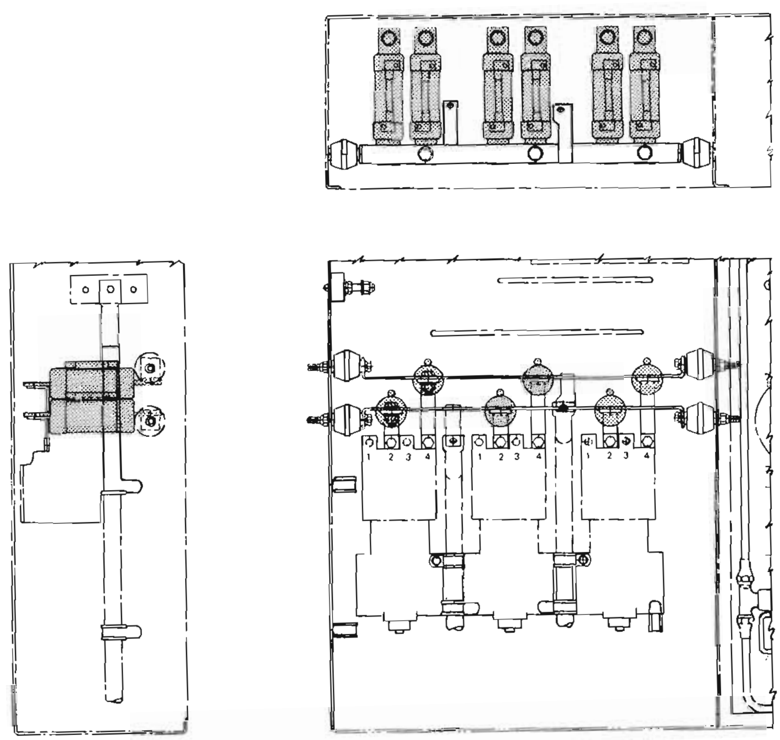


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Fig.55 – Fan Fuse Mounting, Three-Fan Locomotives

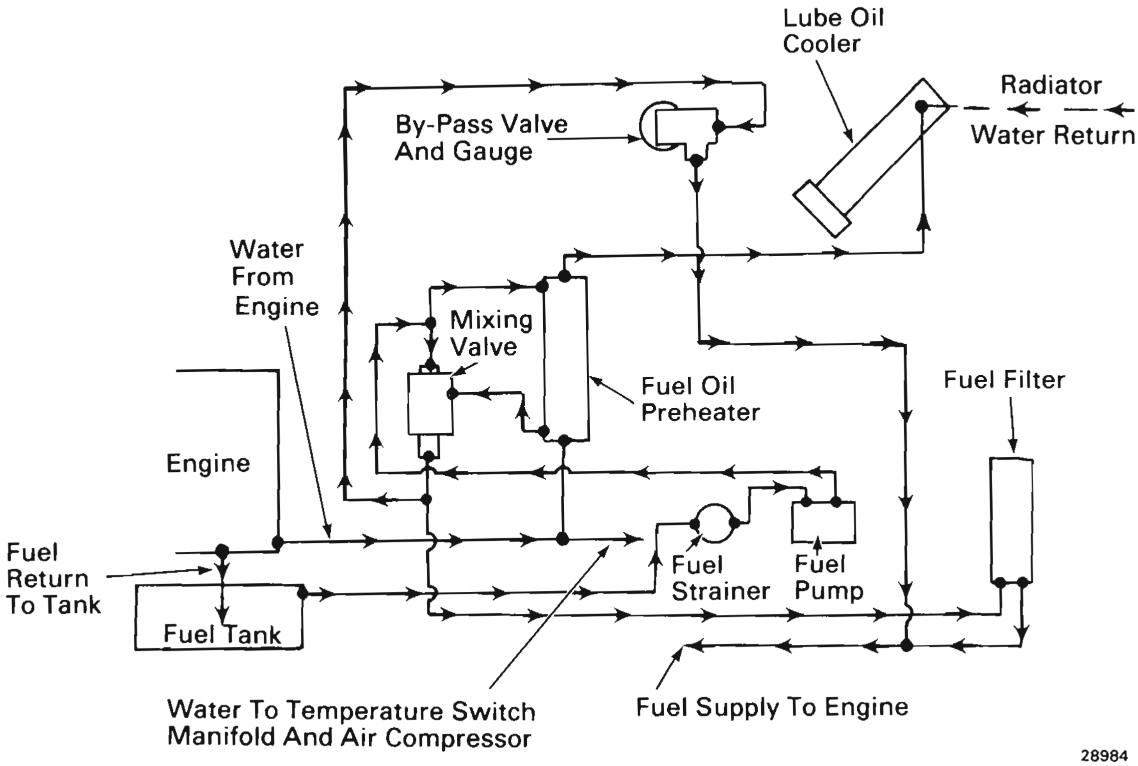

Fig.56 - Large Preheater System Piping Schematic

NOTE

The thermal element of the valve must be changed every two years along with the "Viton" housing and element-to-housing seals for reliable valve operation. Part numbers will be found in the Service Data under the Routine Maintenance Parts heading.

The small preheater is applied before the fuel strainer and pump, Fig. 57. This avoids waxing problems since the fuel is heated before it enters the strainer. The small preheater system operates with a manual valve for summer/winter operation. Since the temperature rise across the small preheater is less than across the large preheater, the outlet temperature of the small preheater will be within safe limits for the engine during normal winter conditions without the use of a temperature valve.

Temperature rise through the small preheater is 31° F and for the large preheater is 59° F, both for a 100° F inlet temperature differential (ITD) of fuel to water at standard idle. The small preheater may be used where a temperature difference of 30° F or less will occur between the lowest expected ambient temperature and the fuel cloud point. Performance data for both systems is shown below in Table 8 and Figs. 58 and 59. Between these two preheaters an application can be selected that will fill the needs for specific operating conditions.

Preheater P/N	Ambient Temp. (°F)	Fuel Oil Temp. Out of Preheater with 4 GPM Pump @Idle (°F) with Ambient Temp. Fuel in Tank	Fuel ΔT for 100°F ITD @Idle (°F)	Stabilized Fuel Tank Temp. @Idle and Amb. Temp.	Fuel Temp. Out of Preheater with Stabilized Fuel Tank Temp.
9325052	-40	-3	31	-10 ± 5	21
(Small)	-20	17		10 ± 5	41
9517269	-40	42	59	25 ± 15	63
(Large)	-20	62		45 ± 15	83

TABLE 8 - EMD Fuel Preheater Performance

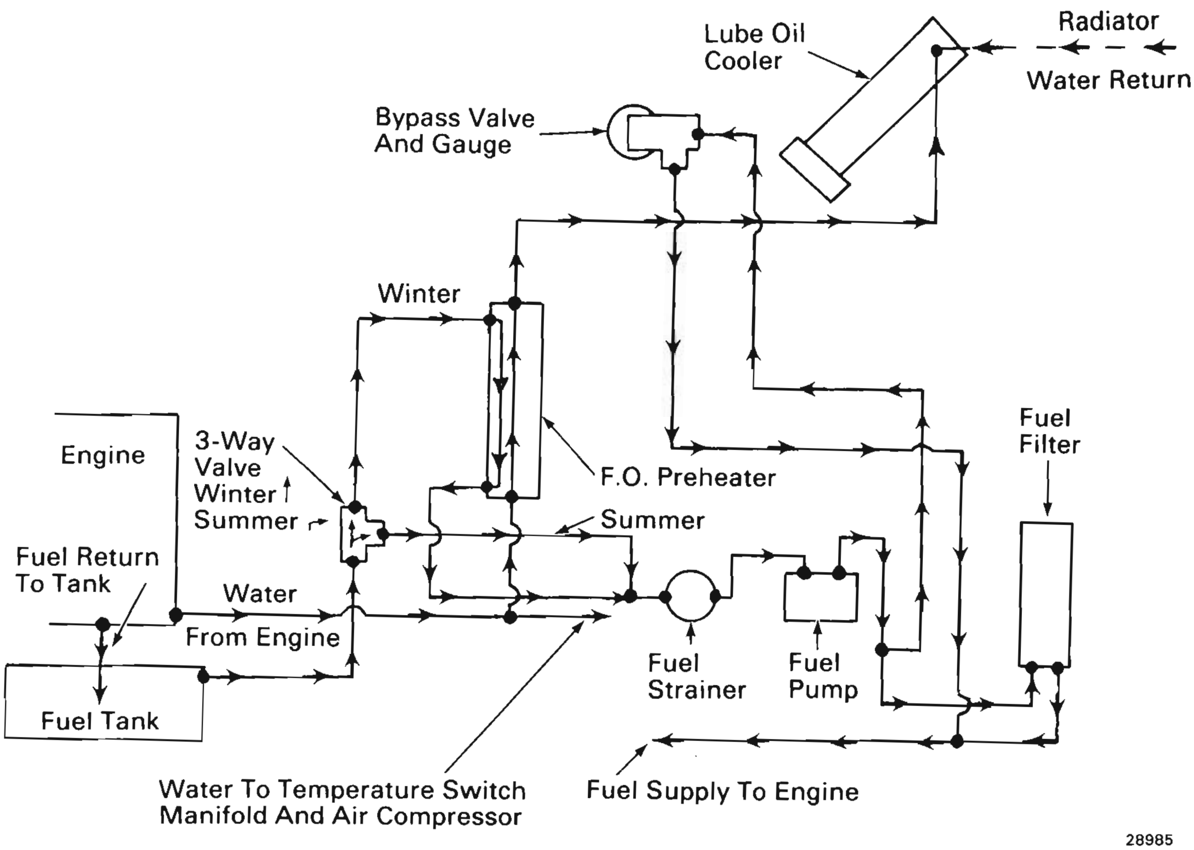

Fig.57 – Small Preheater System Piping Schematic

FUEL TANK CONDENSATE DRAIN

A ball cock condensate drain, Fig. 60, is available for fuel tank modification to those units not so equipped originally. The ball cock allows faster and more complete drainage along with ease of access.

Any EMD fuel tank equipped with a clean out sump or manifold can be modified externally to the tank thus simplifying installation. A manifold application is also available for 1971-vintage 4000 gallon tanks which were originally equipped with a manifold on only one end. With some modification to the tank this manifold can also be applied to older fuel tanks (without manifolds) which have drain plugs located in the end sheet of the tank.

Modernization Recommendation M.I. 9580 - Ball Cock Fuel Tank Condensate Drain describes the conversion.

DUAL PRIMARY FUEL FILTERS AND BYPASS VALVE

High back pressure due to plugged fuel filters will cause the fuel pump to prematurely wear out and fail. Adding a second primary fuel filter piped in parallel, Fig. 61, is recommended as this will offer more basic area of filtration and added tolerance to waxing. (The piping should not be in series which will increase back pressure as the filters plug.) Dual filters will allow longer filter life and more reliable operation between scheduled maintenance changes. The second filter assembly should be located as close as possible to the first to facilitate filter changing.

The fuel pump motor can be protected from overload by installing a fuel filter gauge and bypass valve, Fig. 31 and Fig. 61. The relief valve bypasses fuel around the primary fuel filter when the pressure drop across the filter is approximately 30 psi. Pressure drop across the primary fuel filter can be read at a glance and should be checked regularly to assure adequate primary fuel filter operation. Part numbers for the indicator/ bypass valve and the application drawing will be found in the Service Data. Models prior to the GP35 can use the same bypass valve and indicator but slight changes in piping will be required.

WINTERIZING PIPE LINES

Fuel lines can be lagged to retain heat where runs are exposed below the underframe. Woven glass tape fixed with adhesive is wrapped in one layer, half-width overlapped. Tape ends should be secured with friction tape and open end clamps. Part numbers for tape and adhesive will be found in Service Data.

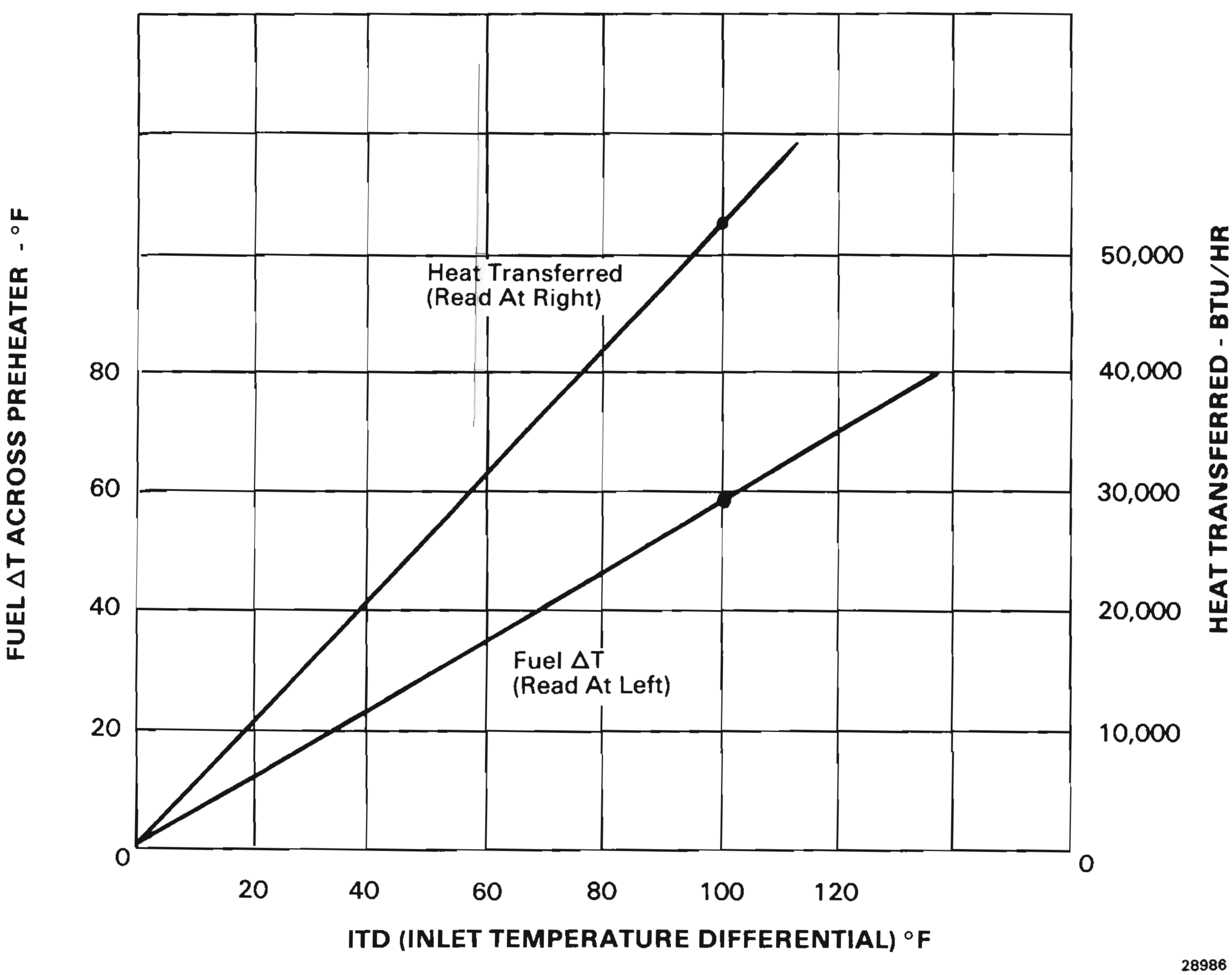

Fig.58 – EMD Large Preheater Performance At Idle

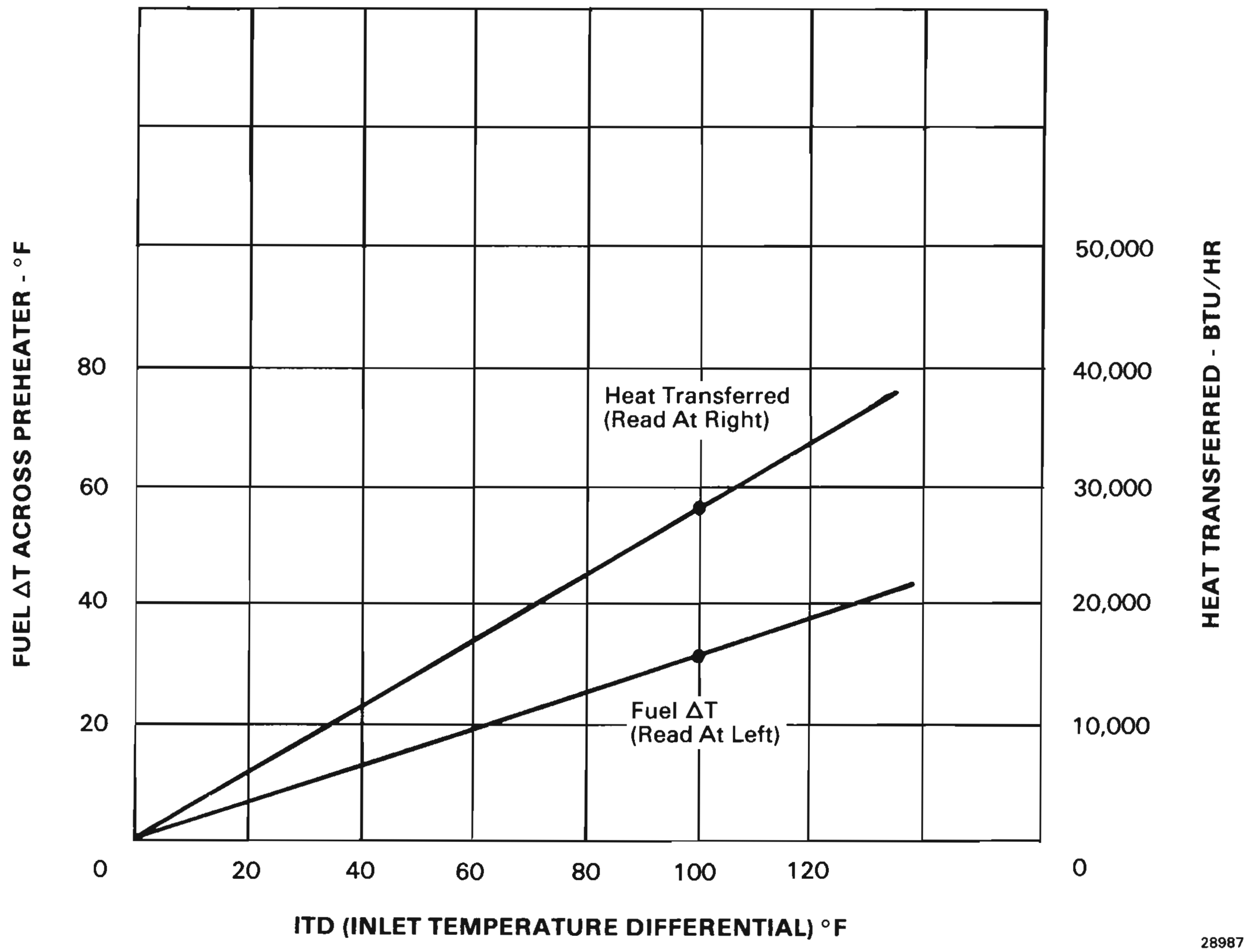

Fig.59 – EMD Small Preheater Performance At Idle

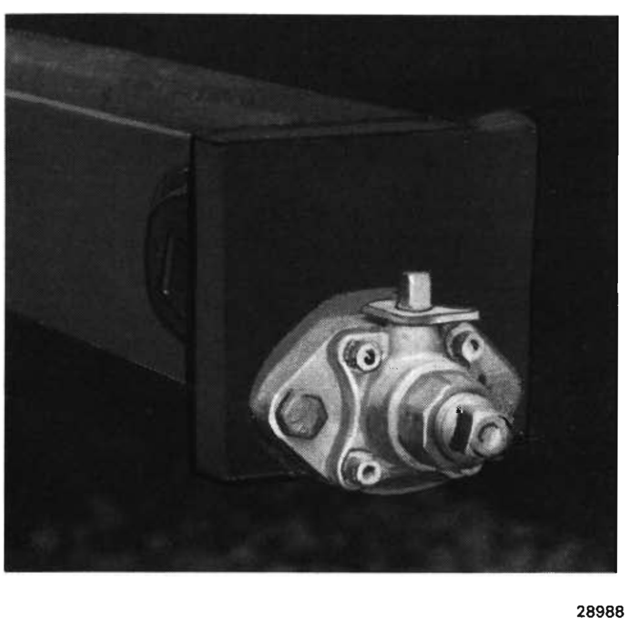

Fig.60 – Fuel Tank Ball Drain Valve

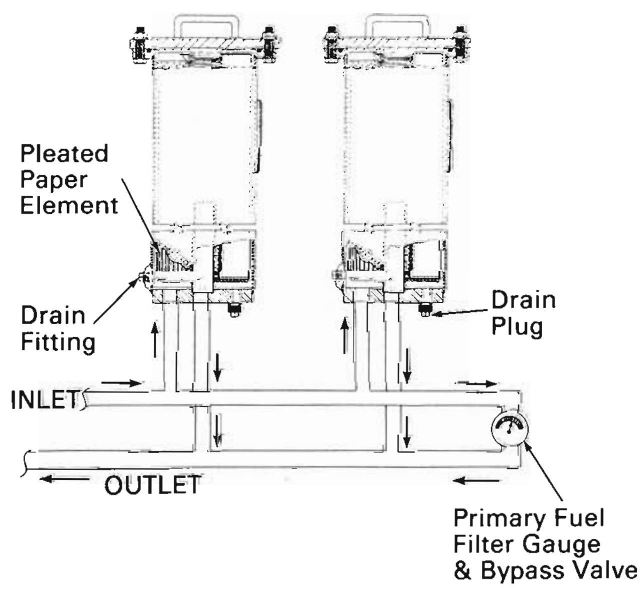

Fig.61 – Dual Primary Fuel Filter And Bypass Valve Schematic

TRACTION MOTORS

Snow and slush buildup on the motor exterior works its way into the gear case, support bearing reservoir, and the motor itself causing lubrication and electrical failures. Much can be done on a scheduled basis to seal the motor as was discussed in Section II. Items as follow are available for retrofit to provide even better sealing effectiveness.

PLASTIC GEAR CASE SEAL

Electro-Motive recommends that a gear case manufactured prior to mid-1982 be modified to use the current plastic seal at the axle bore. These seals greatly decrease lubricant loss and prevent moisture intrusion from slush riding about the area of the motor axle. Refer to M.I. 9656 for modification procedures.

PROTECTIVE SLEEVE FOR TRACTION MOTOR CLASP CONNECTOR

Locomotives shipped from EMD after July 1975 are equipped with a new protective rubber sleeve, Fig. 62, on traction motor clasp connectors. The protective sleeve is designed to prevent water from working its way downward under the standard clasp connector insulating sleeve, thus eliminating the possibility of an electrical current path that results in ground relay action.

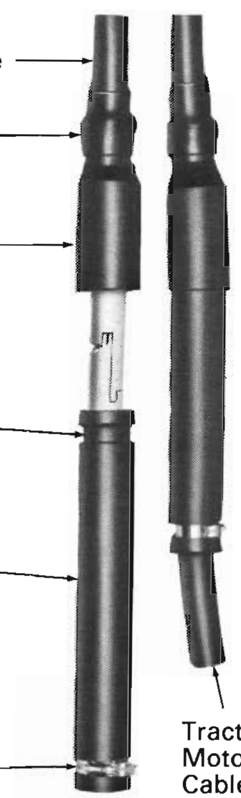

Fig.62 – Protective Sleeve Applied To Traction Motor Clasp Connector

The protective sleeve is available in Kit 9096902, which contains four protective sleeves 8491261 and four heat-shrinkable tubes 8491336 to equip the four underfame cables for one traction motor. When the kit is appplied to locomotives in service, the existing standard insulating sleeves and one sleeve clamp (lower) per cable remain in use.

The protective sleeves and heat-shrinkable tubes are applied as follows. Make certain that the underframe cable has been thoroughly cleaned.

1. Slide heat-shrinkable tube 8491336 over the small end of new protective sleeve 8491261.

2. Slide the tube and sleeve assembly (small end first) over the underframe cable until the wide end of the sleeve is approximately 4-1/4" past the end of the clasp connector, Fig. 63.

3. Using an industrial heat gun (300° -500° F air supply), shrink the tube onto the new protective sleeve by applying heat evenly around the circumference at the area of the protective sleeve.

NOTE
Use of a blowtorch is not recommended.

4. Allow the tube to cool for a few moments.

5. After the heat-shrinkable tube is cool on the protective sleeve, shrink the remainder of the tube onto the underframe cable.

6. Connect clasp connector in the normal manner and slide the standard insulating sleeve under the new protective sleeve on the underframe cable.

7. Tighten the lower sleeve clamp securely.

NOTE
The upper sleeve clamp is not required.

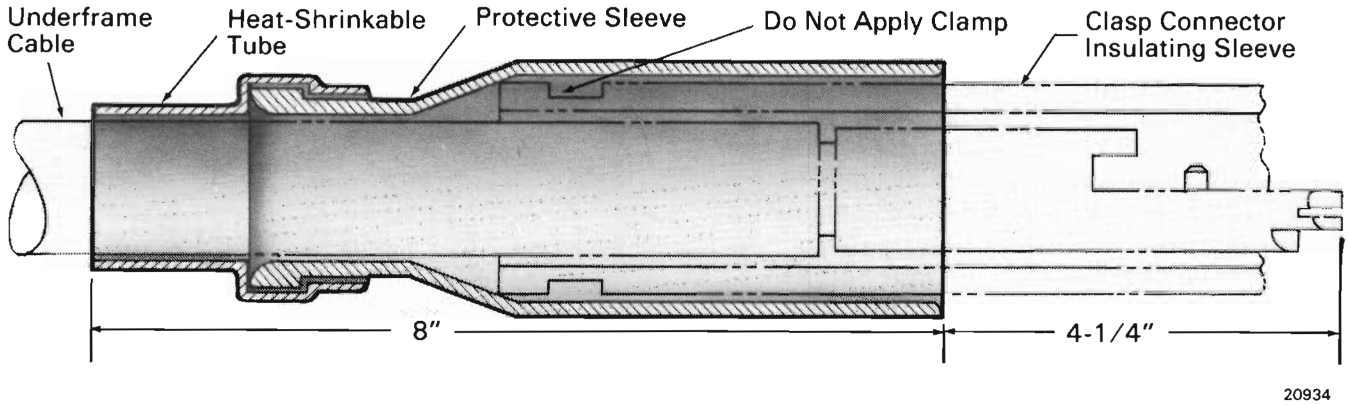

Fig.63 – Cutaway View Of Protective Sleeve And Heat-Shrinkable Tube Applied To Underframe Cable Clasp Connector

NEW SUPPORT BEARING OIL FILLER CAP AND WICK LUBRICATOR COVER GASKET

Filler Cap

A new traction motor support bearing oil filler cap 9333024 has been developed to eliminate oil leakage and improve durability.

The new filler cap, Fig. 64, is held firmly against a metal base by spring action. A length of cable attached to the center of the cap runs through a coil spring positioned below the base. The spring is held captive around the cable by the base of the filler cap and a stop at the end of the cable. As the cap is pulled away from the base, the cable is drawn up, compressing the spring. When the cap is released, the spring returns to its normal length and pulls the cable with the cap back onto the base.

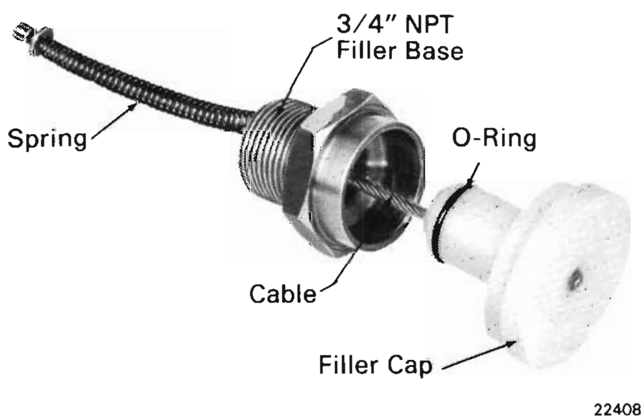

Fig.64 – Oil Filler Cap

The base for the new filler cap has the same 3/4" NPT thread as the old filler cap but, unlike the 8319096 cap, requires little maintenance other than periodic cleaning.

Cover Gasket

Another improvement to the support bearing system is the adoption of a new gasket material for the 8140322 (D37 thru D77), 8183201 (D19, D29, and D36), and 8370434 (D29CC) wick lubricator cover gaskets.

The new gasket consists of a cork, nitrile rubber, and cellulose material that retains its properties after use and has greater tensile strength than the previous cork gasket. The new material maintains excellent conformability and sealability and is not prone to misalignment. It also resists taking a permanent set, thereby permitting cover bolts to retain proper torque.

SERVICE DATA

REFERENCES

CENTRAL AIR SYSTEM

COMPRESSED AIR SYSTEM

COOLING SYSTEM

ELECTRICAL SYSTEM AND ENGINE STARTING

FUEL SYSTEM

LUBRICATING OIL SYSTEM

TRACTION MOTOR

ROUTINE MAINTENANCE PARTS AND EQUIPMENT

NOTE

Since several part types (e.g. filters, gaskets, temperature switches) differ extensively between applications, refer to the Service Data Sections of the applicable Locomotive Service Manual for routine maintenance items not listed below.

COMPRESSED AIR SYSTEM

See applicable Locomotive Service Manual.

CENTRAL AIR SYSTEM

Pressure Sensitive Backed Tape-Type Gasket
- 1.6 mm x 19 mm (1/16″ x 3/4″) Rubber Cork 8135382
  - 31 m (100 Ft) Length 8133198
- 1.6 mm x 47.6 mm (1/16″ x 1-7/8″) Rubber Cork 8135383
  - 31 m (100 Ft) Length 8133199
- Rubber Weather Seal 8324100

Electrical Cabinet Air Filter
- Pleated Cotton – Paper Elements 8345482
- (These elements also used as engine lube oil filters.)

Engine Air Filters – See applicable Locomotive Service Manual.

COOLING SYSTEM

Low Water Detector Qualification And Testing Apparatus 9339066
Temperature Switch-To-Manifold Gasket 8314926
Drain Cock 1/4″ NPT 8386667
Thermometer Well 1/4″ NPT 8268162
Water Tank Pressure Cap Assembly
- 28 kPa (4 psi) (Obsolete) – (2-Prong) 8292303
- 48 kPa (7 psi) (Basic) – (2-Prong) 9087321
  - – (3-Prong) 9323490
- 84 kPa (12 psi) (Tunnel-Obsolete) – (2-Prong) 9082206
- 138 kPa (20 psi) (Tunnel-Current) – (3-Prong) 9338780

Quick Disconnect Female Fitting 9321341
Quick Disconnect Male Fitting 9321340
Automatic Drain Valve Repair Kit 9523106

See applicable Locomotive Service Manual for Filler Neck Assemblies. Refer to applicable Maintenance Instruction for Fan Contactor maintenance.

FUEL SYSTEM AND ENGINE STARTING

Hard Brush, Starter Motor	1852886
Primary Fuel Filter Element, Pleated Paper	8345482
Engine Mounted Spin-On Fuel Filter Element	8423132
Suction Strainer	8341983
Mesh Element	9324489
"O" Ring, Housing-To-Cover	8343161
Pressure Differential Gauge With Bypass Valve	9323489
Valve - 90° AMOT (For Large Fuel Preheater System)	9509003
Element Assembly - 90°	9518200
Seal, Housing	9518201
"O"-Ring, Element To Housing	8175435

See applicable Locomotive Service Manual for filters not listed above. Refer to applicable Maintenance Instruction for Power and Starting Contactor maintenance.

LUBRICATING OIL SYSTEM

Pleated Cotton-Paper Elements	8345482

NOTE
Filter changeout recommendation will be found in the applicable Scheduled Maintenance Program.

Quick Disconnect Male Fitting	9321340
Quick Disconnect Female Fitting	9321341
Kit; Lube Oil Tank Pressure Test (0-100 psi gauge, hose, and female quick disconnect fitting)	9325061

See applicable Locomotive Service Manual for proper Filter Housing Gaskets and Bypass Valve Assemblies.

TRACTION MOTOR AND GEAR CASE

RTV, Silicone Compound 340 g. (12 oz.) Cartridge	8366747
Gear Lubricant, Texaco "Code No. 1963 TMGL Premium" 1 lb. Bag	9569938
2 lb. Bag	9569939
Wick Lubricator Cleaning Machine	9502464

SPECIFICATIONS

AIR COMPRESSOR LUBE OIL

Compressor lube oil must be SAE 10 weight turbine type oil containing anti-rust, anti-oxidation, and anti-foam inhibitors and should contain the following properties:

Viscosity-Saybolt Universal (ASTM D88 or D2161)	
@ 38° C (100° F) seconds	130 to 180
@ 99° C (210° F) seconds	42 to 45
Pour Point (ASTM D97 Degrees - Minimum)	-18° C (0° F)
Rust-Distilled Water (ASTM D665)	No Rust

Inertial Filters (Central Air Compartment)	
Minimum Depression	51 mm (2″) H_2O
Maximum Depression	140 mm (5.5″) H_2O

SPECIFICATIONS (CONT'D)

AIR COMPRESSOR LUBE OIL (CONT'D)

Combination Engine Plus Inertial Filters

Minimum Depression	102 mm (4″) H_2O
Maximum Depression – Turbocharged	356 mm (14″) H_2O
– Roots Blown	458 mm (18″) H_2O

High Voltage Electrical Cabinet Filter

Minimum Static Pressure	38 mm (1.5″) H_2O

After Cooler Core

Maximum Pressure Differential	254 mm (10″) H_2O

NOTE

Above filter specifications are typical of 40-2 series locomotives. Reference applicable Locomotive Service Manual for other locomotive series.

Filter Switches

Filter Vacuum Switch-FVS – Turbocharged Engines 356 ± 51 mm (14″ ± 2″) H_2O	8465021
Engine Filter Switch-EFS – Turbocharged Engines 610 ± 51 mm (24″ ± 2″) H_2)	8466230
Filter Vacuum Switch-FVS – Roots Blown Engines (18″ ± 2″) H_2O	8431248

	Close On Descending Temp.		Open On Rising Temp.		
	°C	(°F)	°C	(°F)	Part No.
Ambient Temp. Switch-ATS	2±1	(35±2)	7±1	(45±2)	9551099
Low Temp. Switch-LTS	21±1	(70±2)	26±1	(80±2)	9551101
High Temp. Switch-HTS	50±1	(122±2)	56±1	(132±2)	9551100

Low Idle Temperature Switch 9566542

	°C	(°F)
Close On Descending Temp.	-9±1	(15±2)
Open On Rising Temp.	-4±1	(25±2)

Refer to the applicable Locomotive Service Manual for specifications on items that differ between applications (temperature switches, lube oil bypass gauge, air filters, etc.)

LOCOMOTIVE MODERNIZATION PARTS

The following parts and kits are available for locomotive modernization as referenced in the Retrofit area of this publication. If assistance is required with a retrofit application, contact your service representative.

COMPRESSED AIR SYSTEM

Air Dryer	
Salem 975-000 Dessicant	6994425
975-004 Applied To GP39-2, F40PH	9507385
975-200 Twin-Tower Dessicant	9559771
WABCO D2B (Will apply upon request.)	N.P.N.
Transfer Valve - Salem	9096768
Drain Valves	
Pneumatically Actuated	
Salem 580-H-6	8451213
Prime 300-P	8268430
Electrically Actuated	
*Salem 880-6-20	8465745
Prime 461	8468570
Self-Actuating	
*Prime Thermionic	9565091
*Sarco TDS 52	9534772
Heaters (Available for "*" designated drain valves)	9534498
Blowdown Timers	
Salem Electro-thermal	8365499
Prime Recycling	8468552
Filters (Including Electrically Actuated Drain Valve)	
Centrifical	
Salem 818-1-20	8465754
Salem 824-1-20	8465755
Prime PM 548	8468560
Prime PM 597	8468561
Coalescing	
Salem 818-170	9565501
Salem 824-170	9565502
Prime PM 5011 (Cannot be manually cycled.)	9510355
Prime PM 5011-1 (Can be manually cycled.)	9549590
DL Filter	8426391
Heaters	
for Salem 818	9318967
for Salem 824	9318968
Safety Valve - 180 psi	8389945

AIR COMPRESSOR

Gear Pump Conversion Kit - WBO Compressors
- With Crankshaft 9331736
- Without Crankshaft 9339049

Installation References . . . . M.I. 9621, M.I. 1144
Drawing Furnished With Conversion Kit.

Water Deflection Kit
- For WB0 Compressor 8498379
- For WBG Compressor 9083385

CENTRAL AIR COMPARTMENT WINTERIZATION

Refer to M.I. 9636 – Locomotive Winterization for parts and conversion details.

If interested in the improved winterization system, contact your EMD Sales Representative.

AIR FILTER APPLICATION FOR THE HIGH VOLTAGE CABINET

Refer to M.I. 9615 - High Voltage Cabinet Air Filter Application for parts and conversion details.

COOLING SYSTEM AUTOMATIC DRAIN VALVE

Automatic Drain Valve Kit 9516379
- Includes: Automatic Drain Valve 9523127

Installation Reference . . . . M.I. 9637

IMMERSION HEATER SYSTEM

If interested in wayside powered Layover Protection Systems contact your EMD Sales or Service Representative for parts and installation details.

ELECTRIC CAB HEAT

Refer to M.I. 9625 - Electric Cab Heater Installation for parts and conversion details.

BATTERY PROTECTION

Battery Heating - External System
- Drawing, Typical Battery Heater Asm. Application 9506753
  - Includes: Battery Heater Asm. (2) 9090480
  - Thermostat (2) 8495269
- Physical Schematic – Typical WD00337

Battery Heating - Internal System
- Drawing, Typical Battery Application (heated) 9522553
  - Includes: Unitized Heated Battery – (2) 9522552
  - Thermostat - (2) 8495269
- Physical Schematic – Typical WD00373

LITS Ambient Temperature Sensing Kit 9566543
- Includes: Temperature Switch 9566542

STARTING MOTOR THERMAL OVERLOAD PROTECTION

Kit, Starting Motor Protection 9513351

Installation Reference . . . . M.I. 9631

GENERATOR GROUND FAULT DETECTION

Refer to M.I. 9647 – Improved Ground Fault Detection System for parts and conversion details.

COOLING SYSTEM PROTECTION FUSES

Refer to M.I. 9627 – Addition Of Cooling System Protection Fuses for parts and conversion details.

FUEL PREHEATERS

Large EMD Preheater	9517269
90° AMOT Thermostatic Mixing Valve	9509003
Typical Installation Drawing	L16232
(AMOT Thermal Elements are listed under Routine Maintenance Parts.)	

Small EMD Preheater	9325052
Manual 3-Way Valve	9332972
Typical Installation Drawing	L16252

FUEL TANK DRAIN

Refer to M.I. 9580 – Ball Cock Fuel Tank Condensate Drain for parts, conversion details, and reference drawings.

FUEL SYSTEM

Primary Fuel Filter Assembly	8379120
Bypass Valve And Indicator	9323489
Reference Drawing	WS41307

Woven Glass Tape – .060/.065 x 3″ 50 ft/roll, Order by roll	8105872
Adhesive – 1 Qt. Can	8255268
– 5 Oz. Tube	8392241

PLASTIC GEAR CASE SEAL

Modification Kit – Plastic Gear Case Seal	9547749
Installation Reference	M.I. 9656

TRACTION MOTOR

Protective Sleeve Kit – (1 per Motor)	9096902
Includes: Protective Sleeves – (4)	8491261
Heat-Shrinkable Tubes - (4)	8491336

Filler Cap Asm.	9333024