ELECTRO-MOTIVE

M.I. 1750

Rev. I

MAINTENANCE INSTRUCTION

DIESEL FUEL RECOMMENDATIONS ALL EMD AND FORMER CDED ENGINES

SAFETY PRECAUTIONS

Please refer to the EMD Safety Precautions section in the applicable Locomotive Running Maintenance Manual or Locomotive Service Manual whenever routine service or maintenance work is to be preformed.

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1.0 Introduction

Maintenance Instruction (M. I.) 1750, Rev I is issued to add information about low-sulfur fuel, biodiesel fuel, and fuel additives. It is also issued for general editorial updates and to bring it into the latest editorial format.

2.0 Fuel Additives

It is the policy of Electromotive Diesel (EMD) to manufacture engines that operate satisfactorily on good quality commercial fuels that are regularly provided by the petroleum industry and meet the requirements of this maintenance instruction. As a result, EMD does not recommend the use of supplementary fuel additives marketed under such designations as conditioners, combustion enhancers, smoke suppressants, or graphitizers.

EMD warranty does not cover the effects of the use of specific fuel or fuel additives. EMD warranty covers only EMD materials and workmanship. If a failure arises as a result of using a specific fuel or fuel additive, it is the responsibility of the fuel or additive supplier and/or the customer to accept the costs incurred.

There is a variety of fuel additives offered on the market today covering a wide range of claims including fuel consumption improvements and/or emission benefits. In some instances such additives may prove beneficial, while in other cases they may promote specific problems. The evaluation of such additives to establish their actual performance characteristics requires extensive laboratory screening, short-term performance tests, and long-term durability evaluation. Such a multitude of potential additive tests cannot be realistically justified by EMD since they would impose extensive costs as well as deter from priority test programs critical to its product line.

In 1980, the Association of American Railroads adopted Recommended Practice (RP) 503 specifically for the controlled evaluation of such products by an independent testing laboratory at the expense of the additive supplier. While the procedure addresses the first two issues noted previously, it does not address long-term durability issues. Following successful completion of the RP 503 testing, it is recommended that a one to two year test be conducted on at least three engines to document durability performance and establish cost /benefit ratio for the customer.

Because there are a large number of companies that market fuel additive products, as well as the high internal costs to fully evaluate performance characteristics, EMD is not able to endorse any of these products for use by customers. If a customers intend to use any additive product, it is their responsibility to fully evaluate the product.

From an emissions point of view, the EPA does recognize aftertreatment technologies, including the use of catalysts, as viable emission control measures. Aftertreatment technologies are used to alter or modify exhaust gas substituents after the engine combustion chamber in such a manner as to help meet regulatory limits. A fuel additive is not an aftertreatment technology as defined by the EPA. The additive's proper use is difficult to control in the field and is therefore not regarded as tamper proof. The EPA does recognize fuel additives, primarily to assure that they do no harm to regulated engines.

3.0 Recommended Limits for Fuels

The recommendations in this section are based on many years of operating experience and provide test limits for qualifying fuels being supplied to the engine. The inherently low level of maintenance required by EMD engines is best be realized if the engine fuel systems are supplied with fuel that meets these recommendations.

The cleanliness, quality, and uniformity of the fuels supplied to the engine fuel tanks are the responsibilities of all who are involved in the manufacture, transportation, and handling of the fuels. The fuel should be free from acid, which, when in contact with any metal, forms enough soap to plug the fuel filters. EMD will consult, upon request, with any user, supplier, or petroleum refiner on any question pertaining to fuels to be used in EMD engines.

The recommended limits for fuels are listed in Table 1. This table contains references to five notes (Note 1 through Note 5). These notes provide supplementary information that is useful in interpreting the information contained in the table.

Table 1

Method Of Test	ASTM Designation	Limits #2D – S5000	Limits #2D – S500
Cetane Number	D-613	40 (Min.)	43 (Min.)
Cetane Index	D-4737	40 (Min.)	43 (Min.)
Density @ 15° C	D-4052	820 – 860 kg/cubic meter	820 – 850 kg/cubic meter
90% Boiling Point	D-86	343 °C (650 °F) (Max.)	343 °C (650 °F) (Max.)
Final Boiling Point	D-86	371 °C (700 °F) (Max.)	371°C (700 °F) (Max.)
Distillation Recovery	D-86	99.0% (Min.)	99.0% (Min.)
Total Sulfur	D-2622	0.50% (Max.) - Note 1	0.05% (Max.)
Copper Strip Corrosion (3 hr. @ 100° C)	D-130	No. 2 Strip Or Better	No. 2 Strip Or Better
Conradson Carbon Residue (on 10% bottoms)	D-189	0.35% (Max.)	0.35% (Max.)
Water And Sediment	D-1796, D-2709	0.05% (Max.)	0.05% (Max.)
Cloud And Pour Point	D-2500, D-97	Note 2	Note 2
Flash Point	D-93	Note 3	Note 3
Organic Chlorides	U.O.P. Method No. 588-65	20 ppm Total Chloride (Max.)-Note 4	20 ppm Total Chloride (Max.)-Note 4
Filtration Cleanliness Test (solid matter such as rust, cracking catalyst, and clays)	EMD Standard Laboratory Practice No. 102	1.3 mg. Per Liter (Max.) Of Ash Residue On 0.80 Micron Filter - Note 5.	1.3 mg. Per Liter (Max.) Of Ash Residue On 0.80 Micron Filter - Note 5.
Viscosity	D-445	1.9 – 4.1 cSt at 40 °C (32.5-40.0 SUS)	1.9 – 4.1 cSt at 40 °C (32.5-40.0 SUS)
Ash, Weight %	D-482	0.02% (Max.)	0.02% (Max.)
Lubricity (HFRR wear scar Dia. @ 60 °C)	D-6079	0.52 mm (Max.)	0.52 mm (Max.)

Note 1: High Sulfur Fuels

For maximum engine life, the fuel sulfur content should not exceed the 0.5% recommended in this M.I.

As fuel sulfur content increases, engine wear and maintenance costs will also increase. As a result, the user should carefully weigh the economics of less expensive high sulfur fuels against such increases in maintenance costs.

The effect of high sulfur fuels on the diesel engine lubricant is also one of increased severity, and demands the use of high alkaline reserve lubricants as well as more frequent laboratory analysis and oil change intervals to assist in minimizing the effects of high sulfur fuels as well as insuring effective levels of engine protection. In this regard, EMD will assist, upon request, in the selection of a qualified lubricant formulated for such applications. Considerations must he given to legal limits on fuel sulfur content where they apply.

Note 2: Cloud and Pour Points

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 6 °C (10 °F) below the lowest expected fuel temperature to preclude the plugging of filtration media with wax precipitates.

Note 3: Flash Point

Fuels normally used have minimum flash points of 65.5 °C (150 °F). Fuels with lower flash points can be used without affecting engine operation; however, fuel handling and storage may require added precautions.

Note 4: Organic Chlorides Warning

The use of fuel containing organic chlorides results in rapid wear of chrome plated and iron surfaces in the combustion chamber. The presence of organic chlorides in fuel is rare but can occur from the use of halogenated dewaxing agents in cold weather pipeline operations, or from improper desalting of crude oils at an inexperienced refinery, followed by a reaction between the olefins and salt in the distillation unit. From past experiences, most refineries in the United States. are able to prevent the presence of chlorides in the fuel. Their precautions are now so automatic that cases of chlorides in the fuel seldom occur, and since routine control testing for chlorides is a time consuming procedure involving relatively large samples of fuel, it is not considered necessary in the United States.

When testing for chlorides, EMD prefers the U.O.P. method No. 588-65, which employs the sodium biphenyl reduction procedure to obtain ppm of the organic chloride.

Note 5: Filtration Cleanliness Tests

Until recently, "Filtration Cleanliness Tests" have not been generally employed or required in connection with diesel fuel. Experience has been that usual foreign contaminants (rust for instance) are removed by the filtration facilities at fueling stations, and by the filtration equipment normally supplied with engines. The increasing use of catalytically cracked fuels, however, has produced instances where minute catalyst fines were accidentally introduced into the diesel fuel production. These cannot be removed by the commercial filters used at fueling stations and on engines. The "Filtration Cleanliness Test" has been added to our diesel fuel recommendations to guard against contaminants of this nature.

Because an involved laboratory procedure is required to distinguish the objectionable catalyst particles from other impurities, EMD suggests that all ashable material should not exceed 1.3 mg per liter of fuel when filtered through a 0.80-micron millipore paper. In those cases where contamination from catalyst fines is suspect, a sample of at least one gallon should be taken at the refinery where any significant ash content is most likely attributable to catalyst fines.

In checking the cleanliness of diesel fuel samples taken from tank cars or customer fuel storage tanks, the sample should be taken by acceptable sampling methods. Cleanliness properties are then evaluated using EMD Standard Laboratory Practice No. 102 (Section

5), which utilizes the entire fuel sample as a measure of the ashable solids present in the fuel.

Although the "Filtration Cleanliness Test" will check the fuel for ashable contaminants, it does not limit the amount of combustible organic contaminants. If fuel filters plug prematurely, the fuel should be checked for bacteria or fungus contamination and be treated with suitable biocide, if necessary.

4.0 Biodiesel Fuels

Biodiesel fuels can be produced from a broad variety of sources including vegetable oil, animal fat and cooking oil. The oils are converted to biodiesel fuel by a process called transesterification through a chemical reaction with methanol in the presence of a catalyst. The by-products of this chemical reaction are glycerols and water, both of which need to be removed from the fuel along with any residual methanol, unreacted oils, and catalyst.

Specifications for neat biodiesel (100% biodiesel fuel) have been adopted by ASTM (D-6751), German Standard (DIN 51606), and European Standard (EN 14214). It is recommended that customers use these specifications to establish a comprehensive internal biodiesel specification. The distillate fuel used for any biodiesel blend should meet the requirements described in this MI.

EMD does not have first hand experience regarding the use of biodiesel fuels in its engines. EMD certifies its engines using the specified EPA and European Certification Fuels. It is the responsibility of the user to obtain the proper local, regional, and/or national exemptions required for the use of biodiesel in any emission regulated EMD engine.

EMD does not approve or prohibit the use of biodiesel fuels or biodiesel blends with distillate diesel fuel. EMD is not able to evaluate the many variations of biodiesel fuels and blends and the long-term effects on performance, durability, or emissions compliance. The use of biodiesel fuels may affect EMD warranty. EMD warranty covers only EMD materials and workmanship. If a failure arises as a result of using a specific fuel, it will be the responsibility of the fuel supplier and/or the customer to accept the costs incurred.

EMD recommendations for those customers considering the use of biodiesel fuels are as follows:

- Biodiesel in its neat form and in blends has a lower energy content than #2 diesel fuel, thus resulting in higher fuel consumption to make equivalent power and torque. Fuel system components may require modification to accommodate the lower energy content of higher content biodiesel blends or neat biodiesel fuels. A related issue to the increased fuel consumption to make equivalent power is the negative impact to range between refueling.

- Biodiesel fuels require special care at low temperatures to avoid excessive rise in viscosity and loss of fluidity. Consult the fuel and additive supplier for cloud and pour point additive recommendations.
- Biodiesel is hygroscopic and special care is needed to prevent high water content and subsequent risk of corrosion of fuel system components.
- Biodiesel fuels have poorer stability than #2 diesel fuel and require additives to retard fuel degradation during long-term storage in tanks. The poor oxidation stability characteristic may accelerate fuel oxidation in the engine fuel system accelerate fuel oxidation in the engine fuel system leading to injection component wear and filter plugging. Consult the fuel supplier for oxidation stability additives.
- The oil change interval can be affected by the use of biodiesel fuel. Regular laboratory analysis of the oil is necessary to monitor engine oil condition. See also appropriate M.I. for recommended used oil limits.
- Elastomer compatibility with biodiesel may be adversely affected. The condition of seals and hoses should be monitored regularly.
- Biodiesel fuels provide an excellent medium for microbial growth. The presence of microbes may cause operational problems, fuel system corrosion, premature filter plugging, and sediment build-up in fuel systems. Consult your fuel and additive supplier for biocide recommendations.

5.0 EMD Standard Laboratory Practice No. 102

This Practice deals with the determination of particulate contaminant in fuel oil by laboratory filtration.

5.1 Scope

This method covers time gravimetric procedure for determination of particulate contaminant in fuel oil by laboratory filtration.

5.2 Summary of Method

A known volume of fuel is filtered through a preweighed membrane filter and the increase in membrane weight determined after washing and drying.

5.2.1 Apparatus

Refer to Figure 1 for the apparatus used in determining the total contaminant. The following apparatus is used:

1. Analytical balance, single or double-pan, whose precision standard deviation must be 0.07 mg or better.
2. Oven, of the static type (without fan assisted circulation), controlling to 90 ± 5° C.

3. Petri dish, approximately 125 mm in diameter with removable glass supports for membrane filters.
4. Forceps, flat-bladed with unserrated non-pointed tips.
5. Vacuum system.
6. Test membrane filters, plain 47 mm diameter, nominal pore size 0.8 pm .
7. Filtration apparatus, funnel and funnel base with a filter support, such that a membrane filter can be clamped between the sealing surfaces of the funnel and its base, by means of a metal clamp. (Millipore Filter Corp. apparatus.)
8. Muffle furnace, capable of maintaining a temperature of 775 t 25^{e} C.
9. Porcelain crucible, wide form, glazed through-out, 29 to 31 ml capacity, 46 to 49 mm (1.81" to 1.93") in rim diameter.

5.2.2 Reagents

The following reagents are used. These reagents are filtered through a 0.45 pm membrane filter.

- Isopropyl Alcohol
- N-Pentane (flushing fluid)
- Distilled Water
- Liquid Detergent, Water Soluble

5.2.3 Preparation of Apparatus and Sample Containers

All components of the filtration apparatus, sample containers, and their caps must be thoroughly cleaned and rinsed thoroughly with filtered reagents.

5.2.4 Laboratory Filtration and Total Contaminant Determination

Thoroughly clean the outside of the sample container in the region of the cap by washing with detergent and water, rinsing with tap water and filtered isopropyl alcohol. Shake the sample container vigorously for about 1/2 minute. Remove the cap and any external contaminant that may be present in the threads of the sample container by washing with filtered flushing fluid ensuring that none of the washings enter the container.

Pour some of the sample into the filter funnel. Apply vacuum to the flask and maintain a liquid head in the funnel until completion of filtration by suitable transference of the remainder of the sample, agitating the sample container before each addition. Disconnect the vacuum and record the volume of filtered sample.

Use 250 ml to 350 ml of filtered flushing fluid in this and succeeding paragraph. Wash the sample container with four 50 ml quantities of filtered flushing fluid to complete the transference of the contaminant to the membrane filter.

Wash down the inside of the funnel and outside joint between the funnel and filter base with filtered flushing fluid. With the vacuum applied, carefully remove the clamp and funnel. Wash the periphery of the membrane filter by directing a gentle stream of flushing fluid from the edge to the center, taking care not to wash any of the contaminant from the surface of the membrane filter. Maintain vacuum after the final washing only for the few seconds necessary to remove the excess flushing fluid from the membrane filter.

Using the clean forceps, carefully remove the membrane filter from the filter base, and place it in a clean, covered Petri dish. Dry and reweigh membrane filter, taking care not to disturb the contaminant on the surface of the membrane filter.

5.2.5 Calculation And Report Of Total Contaminant

Subtract the initial weight of the test membrane filter from the final weight. Report the results to the nearest 0.01 mg/liter as total contaminant mg/liter and also the sample volume used in the test.

5.2.6 Determination Of Non-Combustible Contaminant

Place the membrane filter in a clean porcelain crucible and soak with filtered isopropyl alcohol. Ignite the membrane filter until it is charred. Place the crucible containing the charred membrane filter in a muffle furnace at 775 ± 25° C for 1 hour, allow to cool, and weigh.

5.2.7 Calculation And Report Of Non-Combustible Contaminants

Divide the increase in the crucible weight by the volume of sample filtered and report the results to the nearest 0.1 mg/liter as, total ash mg/liter and also the volume used in the test.

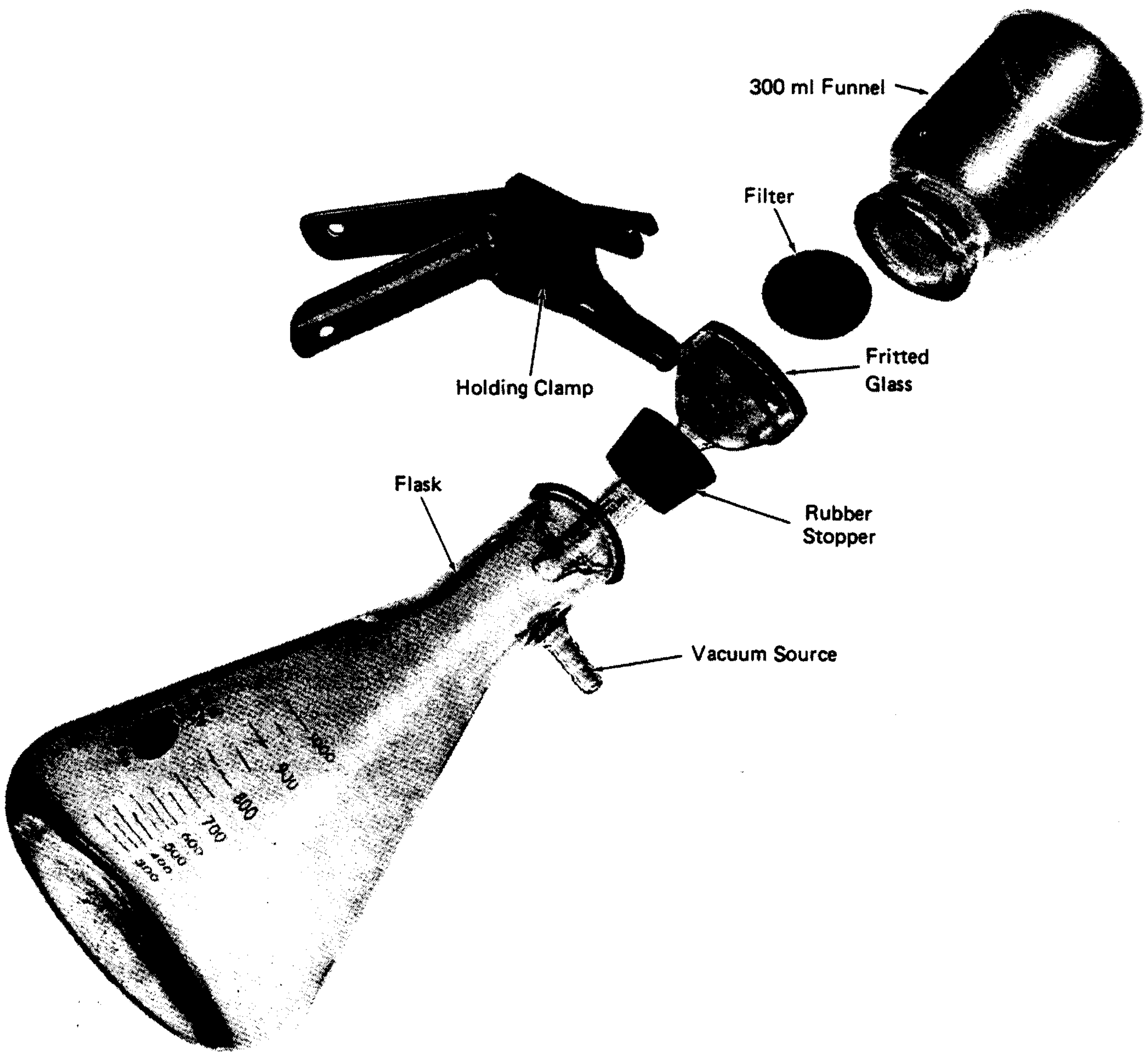

Figure 1. Millipore Filter Apparatus

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