



# M.I. 1748 MAINTENANCE INSTRUCTION

\*Rev. E

## ENGINE COOLANT

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\*This publication is revised. It supersedes previous issue of this number.

## DESCRIPTION

Coolant is circulated throughout the engine to provide the means for heat transfer from the engine components. Water, corrosion inhibitor and, in some applications, antifreeze are used in coolant solutions.

Because the function of the coolant is necessary for efficient operation of the engine, it is important that the selection of a coolant solution be carefully considered.

Failure to meet any *one* of the following requirements will inevitably result in costly system damage, downtime and repair costs. Typical corrosion failures are shown in Figs. 1, 2, and 3.

## COOLANT SOLUTIONS

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 can't form scale or sludge deposits in the cooling system.
3. It must prevent corrosion within the cooling system.
4. It can't deteriorate any of the cooling system seal materials.

*These requirements are normally satisfied by combining a suitable water with a reliable corrosion inhibitor. Certain operating conditions may dictate the use of antifreeze-coolant. In this case the basic requirements can be satisfied with a combination of suitable water and an ethylene-glycol or propylene-glycol type antifreeze-coolant which contains an adequate corrosion inhibitor. However, the use of antifreeze-coolant involves special consideration regarding Items 1 and 3 above. This will be discussed in detail under "Antifreeze-Coolant."*

*It should be recognized that coolants which perform satisfactorily in other applications may not be satisfactory for use in EMD engine cooling systems. Differences in coolant volume-to-cooling system surface area ratios, coolant velocities, temperatures, and the types of materials employed make such comparisons meaningless.*

*The formulation of home-made corrosion inhibitors and antifreeze-coolants is not recommended. The formulations may lack individual inhibitor chemicals which are necessary to protect all the cooling system metals from corrosion. Improper blending sequences of the individual inhibitor chemicals may result in excessive precipitation of the total inhibitor package. This condition may result in reducing the effectiveness of the corrosion inhibitor. Further, the home-made corrosion inhibitor packages may be difficult to monitor and control. The ready availability of suitable proprietary products makes these practices uneconomical and impractical.*

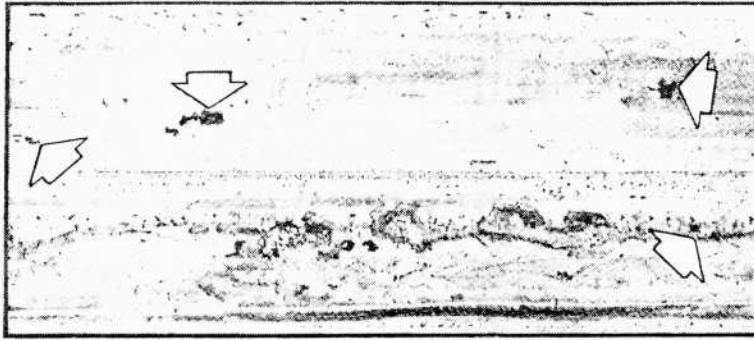
*Water quality should be evaluated whenever a new water source is to be used, or when changes in existing water sources occur. Likewise, the inhibitor concentration of the coolant solution should be tested when a new engine is put into service, and at regular intervals thereafter. The inhibitor concentration of coolant should always be known and should be maintained as required.*

Aids in determining the effectiveness of a corrosion inhibitor or antifreeze-coolant are as follows:

1. Glassware corrosion test.
2. Visual inspection of the coolant relative to its clarity.
3. Regular inspection of engine components such as the coolant jumper lines, coolant inlet deflectors, oil cooler tubes, and water pump impeller and seals.
4. Maintaining the recommended inhibitor concentration by regularly scheduled tests.

## WATER

The water used in the cooling system of EMD engines should be of such quality that it does not contain excessive solids, hardness salts, or corrosive elements such as chlorides. Water containing these constituents in undesirable amounts can either be softened or de-ionized to make it suitable for use. Steam condensate is also suitable for use in the cooling system as an equivalent to distilled water.

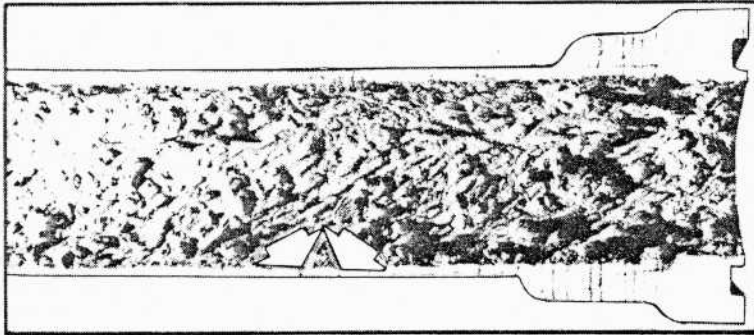


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Fig. 1 — Section Of Cooling Water Radiator Tube

Cooling water radiator tube cut apart and enlarged to show severe corrosion after approximately 1000 hours operation. Coolant consisted of fairly soft well water and an ethylene glycol antifreeze, without additional inhibitor.

This tube was photographed against a black background. The dark black areas show complete penetration of the tube wall.



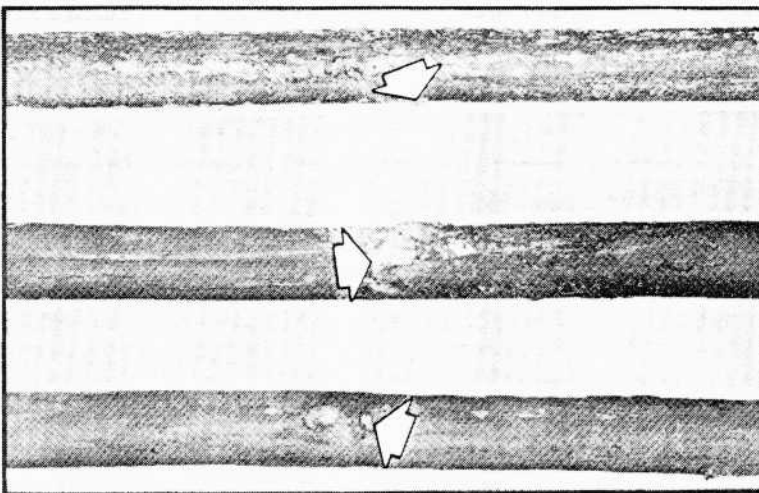
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Fig. 2 — Section Of Cylinder Liner Water Jumper

Cylinder liner water jumper sectioned to show corrosion after approximately 5000 hours operation. Coolant consisted of hard water, an ethylene glycol antifreeze and a corrosion inhibitor which obviously did not provide adequate protection.

### NOTE

Severe reduction of tube section. This jumper was removed because of leakage from several holes corroded through the tube wall.

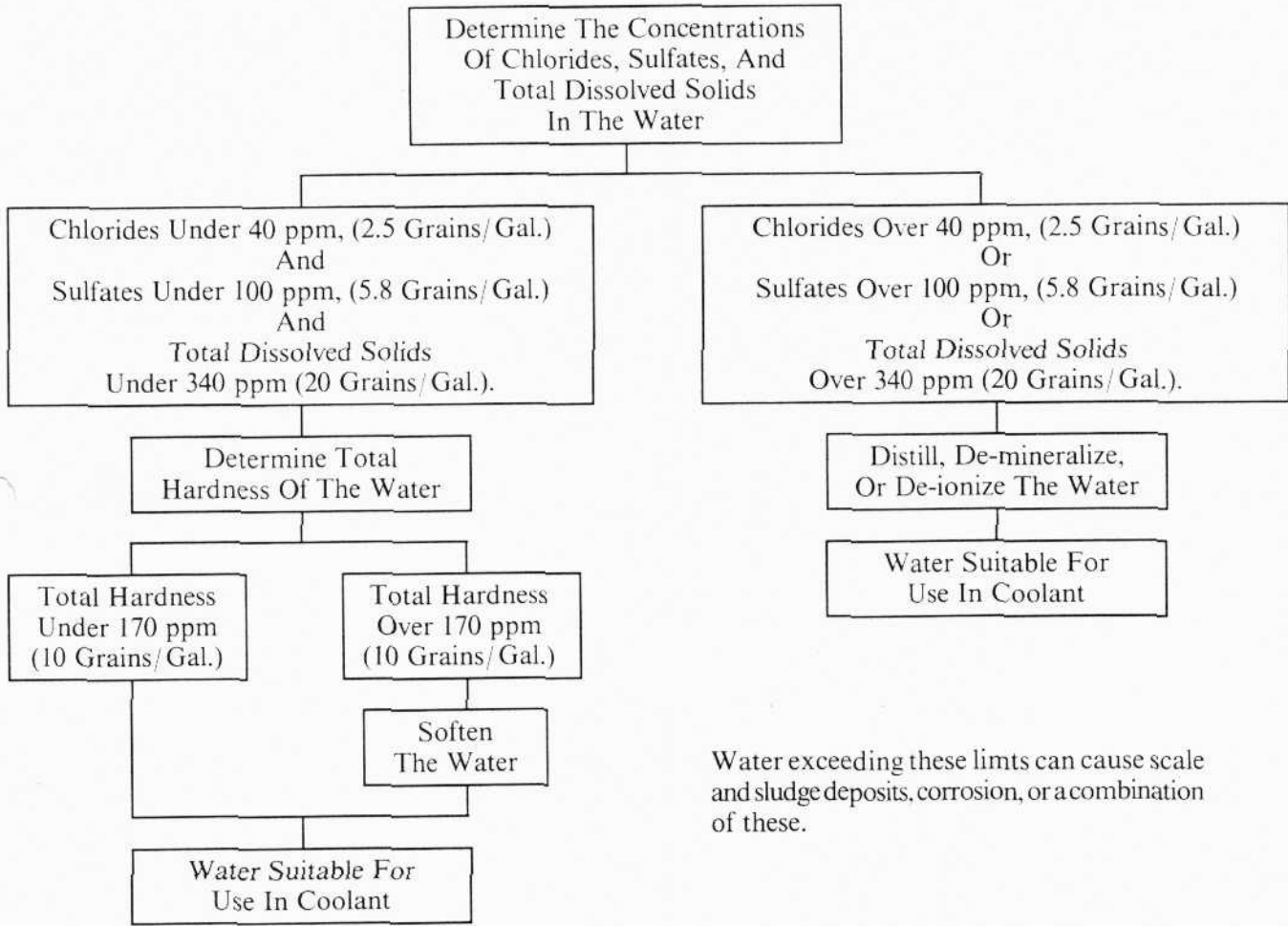


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Fig. 3 — Section Of Heat Exchanger Tubes

Heat exchanger tubes sectioned to show corrosion failures after approximately 6 months operation. Coolant consisted of untreated brackish water.

**TABLE 1**



Water exceeding these limits can cause scale and sludge deposits, corrosion, or a combination of these.

**INHIBITOR**

**CAUTION**

Uninhibited water should never be used to fill a cooling system (even temporarily) because of the possibility of rapid corrosion and rusting. This applies to all uninhibited water but is especially true for distilled, de-ionized, or demineralized waters, including steam condensate. Prior to application, the water should be mixed with the inhibitor or inhibited antifreeze-coolant which is to be used in the coolant.

Two basic types of inhibitors, chromate and borate-nitrite, are the most commonly used in EMD cooling systems.

Soluble oil and an organic product, have seen very limited use in EMD cooling systems in field service.

Dry Measure:  
16 Ounces = 1 Pound = 453.6 Grams

Liquid Measure:  
32 Fluid Ounces = 1 Quart = 0.946 Liter  
4 Quarts = 1 Gallon = 3.785 Liters

## CHROMATE TYPE

Chromate type inhibitors are generally furnished in the form of powder or pellets. The pH of these inhibitors, when mixed with water, ranges from 7.5 to 9.0. The recommended inhibitor dosage for an initial fill is 4.5 grams per liter (0.6 ounce per gallon [4500 ppm]). Thereafter, the inhibitor concentration should be maintained above 3.0 grams per liter (0.4 ounce per gallon [3000 ppm]). Dissolve the inhibitor in water before adding it to the cooling system. When coolant is lost from the system, the makeup coolant should contain inhibitor in the recommended dosage (0.4 ounce/gallon).

All states have restrictions relative to the discharge of chromates. Federal, state and local pollution restrictions should be investigated before discharging of chromate inhibitors.

Chromate type inhibitors should not be used in cooling systems containing antifreeze-coolant. The use of chromate with antifreeze-coolants may, under certain conditions, result in an insoluble sludge forming in the cooling system.

## BORATE-NITRITE TYPE

Borate-nitrite type inhibitors are furnished in the form of powder, pellets, and liquids. The pH of these inhibitors, when mixed with water, ranges from 8.5 to 10.0. They also contain a dye, which is distinctive in color and stable at 88°C (190°F). The recommended inhibitor dosage for the powder or pellets at the initial fill is 7.5 grams per liter (1.0 ounce per gallon of water [7500 ppm]). Dissolve the inhibitor in water before adding it to the cooling system. Thereafter, the inhibitor concentration should be maintained above 5.6 grams per liter (0.75 ounce per gallon [5625 ppm]).

The recommended dosage of liquid inhibitor for an initial fill is 23.4 cubic centimeters per liter (3.0 fluid ounces per gallon). Thereafter, the inhibitor concentration should be maintained above 15.6 cubic centimeters per liter (2 fluid ounces per gallon). When coolant is lost from the system the makeup coolant should contain inhibitor in the recommended 15.6 cubic centimeters per liter (2 fluid ounces per gallon) dosage.

## SOLUBLE OIL (EMULSIFIABLE OILS) INHIBITORS

Soluble oils are not considered suitable for use in EMD engine cooling systems for the following reasons:

1. It is difficult to run quick tests to determine the concentration.
2. The emulsifiers tend to break down causing an oily film to float on the water.
3. In some instances the oil layer may interfere with heat transfer or cause sludge accumulation in the system.
4. They may be harmful to the elastomers in the cooling system thereby causing coolant leaks.
5. The soluble oil type inhibitors do not contain an element which can be used as a tracer to detect the presence of coolant leaks into the lubricating oil.

## INHIBITOR GUIDELINES

### WARNING

Safety and hygienic precautions should always be exercised when handling corrosion inhibitors to avoid possible irritation of eyes, nose, and skin. This is especially important when handling chromate inhibitors.

1. The recommended inhibitor concentrations have been found suitable for most corrosion inhibitors. However, the user should always contact the inhibitor supplier for recommendations as to the proper concentration level for his application.

2. When used in EMD systems, inhibitors should contain specific concentrations of a strong tracer element to help determine the degree of water contamination in lube oil analysis.
3. It is important that the inhibitor concentration be determined. Most suppliers are prepared to furnish a kit for this purpose. Instructions for EMD recommended laboratory and field evaluation appear later in this instruction.
4. The chemicals in corrosion inhibitors are slowly depleted in service. The effective life of an inhibitor depends on such factors as the cooling system condition, hours of operations, coolant and metal temperatures, aeration, and rate of contamination of the coolant. As a general rule the coolant should be discarded at least annually, and the cooling system filled with new inhibited coolant.
5. Draining an inhibited coolant from one engine and reusing in another is not recommended. If drained coolant is reused, particular attention should be given to piping and holding tanks to *ensure freedom from dirt and oil*.
6. 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.
7. Prior to fleetwide application of a new inhibitor formulation, it is advisable to test these formulations in a few engines. This will determine whether the inhibitor is compatible with the operating environment to which it will be exposed.

## **SILICATE DROPOUT**

With the increased use of aluminum in automobile engines, many of the antifreeze coolant manufacturers have introduced high silicate antifreeze formulations. The primary purpose of the new formulations is to prevent corrosion of the aluminum heat rejection surfaces as well as other aluminum parts.

The combination of a high silicate antifreeze, supplemental corrosion inhibitors and hard water results in silicate dropout (gelation). The resultant silica creates deposits which plugs radiators and heat exchanger equipment.

To reduce silicate dropout in EMD engine cooling systems, the following is recommended:

1. Use a low-silicate, (no more than 0.10%) sodium silicate antifreeze-coolant meeting GM standard 6038-M (ASTM D4985). Generally, the recommended antifreeze-coolant concentration shall never exceed 68% by volume.
2. Do not add supplemental inhibitors or additives to either fresh or used antifreeze-coolant. Further, do not mix different brands of antifreeze-coolant.

## **DRAINING OF COOLING SYSTEMS CONTAINING ANTIFREEZE-COOLANT**

If it is necessary to drain the cooling system, it is suggested that the antifreeze-coolant be placed into a clean retention tank such as a rubber bag. Reusing antifreeze-coolant solution from one engine in another engine is a poor practice which can cause corrosion. If it becomes necessary to discard the antifreeze-coolant, remember that the antifreeze-coolant or inhibitor ingredients may be considered pollutants. Federal, state and local pollution restrictions should be investigated before discarding the antifreeze-coolant solution.

## **ANTIFREEZE**

### **ALCOHOL TYPE**

Alcohol type antifreeze-coolants are not recommended for use in EMD engine cooling systems because of the high coolant operating temperatures.

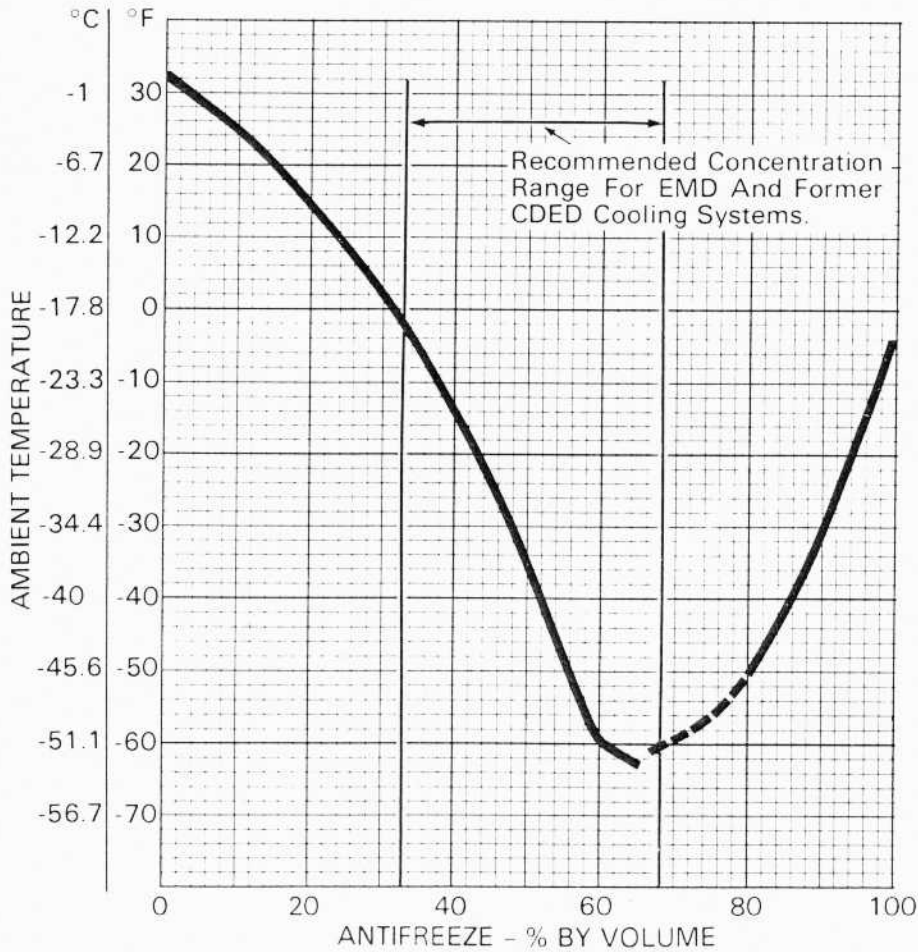
**ETHYLENE-GLYCOL TYPE**

Where EMD engine cooling systems must be protected from freezing, an antifreeze-coolant meeting GM 6038M (ASTM D4985) specification is recommended. The antifreeze-coolant shall contain a balanced blend of corrosion inhibitors, anti-foam and a distinctive color dye. Further, the antifreeze-coolant shall not contain more than 0.10% of sodium silicate. (Note: See comments under Silicate Dropout).

Ethylene-glycol type antifreeze should be used at concentrations between 33% and 68% by volume, as required to prevent freezing. Antifreeze concentrations below 33% do not provide sufficient inhibitors to give adequate corrosion protection. Using antifreeze concentrations above 68% will raise the freezing point and will not provide good heat transfer. Because antifreeze affects heat transfer rates, it should not be used without prior consultation with EMD Service representatives regarding the specific engine installation and possible engine derating requirements.

The corrosion inhibitors incorporated in antifreeze-coolant are slowly depleted in service. How long these inhibitors will remain effective depends on factors, such as, the cooling system condition, hours of operation, coolant and metal temperatures, aeration, and rate of contamination of the solution. Usually the antifreeze-coolant manufacturers recommend using their products for only one year.

In special applications involving large capacity systems, such as EMD engines, the antifreeze-coolant solutions may be usable for a longer period of time. The customer should contact the manufacturer for instructions which may include periodic tests of the antifreeze-coolant solution by the antifreeze-coolant manufacturer.



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Fig. 4 — Freezing Points of Aqueous Solutions Of Ethylene-Glycol Antifreeze

Fig. 4 depicts the freezing points of typical ethylene-glycol antifreeze and water solutions. The freezing points of specific brands may vary slightly from prints shown on the graph. However, the graph is sufficiently accurate for use in estimating antifreeze-coolant requirements, regardless of brands.

### **ETHYLENE-GLYCOL TYPE WITH DEIONIZED WATER**

Because hardness, total solids, and corrosiveness of water varies throughout the world, antifreeze containing inhibitors and deionized water should be used in areas where the water does not meet the standards listed in Table I "Water." This type of antifreeze contains the proper amount of ethylene-glycol to protect the cooling system from freezing to  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).

These products are generally identified as full-fill antifreeze-coolants. These products shall not be diluted with water.

### **PROPYLENE-GLYCOL TYPE ANTIFREEZE-COOLANT**

Propylene-glycol type antifreeze coolant are analogues of ethylene-glycol type antifreeze. The inhibitor package added to ethylene-glycol is also soluble in a propylene-glycol product. The reported advantage in using propylene-glycol is that it is less toxic. The specific heat and thermal conductivity of aqueous solutions of ethylene and propylene-glycols are similar. Lower freeze points may be obtained with propylene-glycols. The propylene-glycol products may be obtained as a concentrate or pre-diluted with deionized water.

The freezing point of aqueous solutions may be determined by hydrometer or refractometer field testers which are specifically calibrated for propylene-glycol. Ethylene-glycol field testers may be used, however, it will be necessary to obtain a conversion table from the supplier to convert the reading to propylene-glycol.

### **GENERAL COMMENTS**

The thermal conductivity of an antifreeze-coolant is lower than that of an inhibited water coolant. Thus, antifreeze-coolant should not be used without prior consultation with an EMD Service Representative regarding the specific installation and possible engine derating requirements.

The corrosion inhibitors incorporated in antifreeze-coolants are slowly depleted in service. How long these inhibitors will remain effective depends on such factors as the cooling system condition, hours of operation, coolant and metal temperatures, aeration and rate of contamination of solution. Usually the antifreeze-coolant manufacturers guarantee their products for only one year. In applications involving large capacity systems, such as EMD diesel engines, the antifreeze solutions may be guaranteed for a longer period of time. In these applications, the customer should contact the manufacturer for instructions which may include periodic tests of the antifreeze-coolant solution by the antifreeze-coolant manufacturer.

The freezing point of antifreeze-coolants may be determined by hydrometer-thermometer field tester (ASTM method D1124) or refractometer (ASTM method D3321).

### **QUALIFICATION TESTS FOR CORROSION INHIBITORS AND ANTIFREEZE-COOLANT CONCENTRATES**

Before a cooling system additive is placed in general service, qualification tests should be undertaken on a sample of both new and old cooling systems.

A corrosion inhibitor or antifreeze-coolant is not considered suitable for use in EMD engine cooling systems until the product passes the qualification test. Placing an untested product in general field service may result in widespread cooling system damage and expensive repair. Unfortunately, damage to the cooling system may not appear early. It may take as long as a year before the damage is visible.

All corrosion inhibitors and antifreeze-coolants contain a blend of chemical compounds which prevents corrosion of the metals common to the cooling system. These compounds also maintain a suitable pH range, alkalinity and reduces foam and scale formation.

**CAUTION**

Do not place an unqualified additive in general service. Such additives may cause widespread cooling system damage, and result in very expensive repair.

To ensure adequate protection, the chemical compounds must be present in the proper proportions. Precipitation of these compounds in the corrosion inhibitor or antifreeze-coolant indicates improper blending sequence by the manufacturer. Improper blending sequences or inadequate reaction time will result in excessive precipitation of the chemical compounds. This condition will reduce the effectiveness of the corrosion inhibitor. Precipitation of the corrosion inhibitor compounds is considered unacceptable and the product is considered unsuitable for use in EMD engine cooling systems.

**LABORATORY EVALUATION TESTS**

The purpose of the laboratory tests is to ensure complete solubility of the corrosion inhibitor in soft and hard water. Further, the pH of the corrosion inhibitor, at a concentration of two times the recommended dosage, should range between 7.5 and 10.5. A pH of 11 or above will result in erosion-corrosion of the non-ferrous metals in the cooling system. Any engine coolant with a pH in excess of 10.5 is generally considered unsuitable for use in EMD engine cooling systems.

All corrosion inhibitors and antifreeze-coolant concentrates contain a blend of chemical compounds which protect metals, common to the cooling system, from corrosion. To ensure adequate protection, these compounds must be present in the coolant in proper proportions.

**NOTE**

It is essential to follow the blending sequence, especially when using liquid concentrated formulations. Improper blending sequence or inadequate reaction time will result in an excessive amount of precipitate in the liquid concentrate and reduce the effectiveness of the inhibitor.

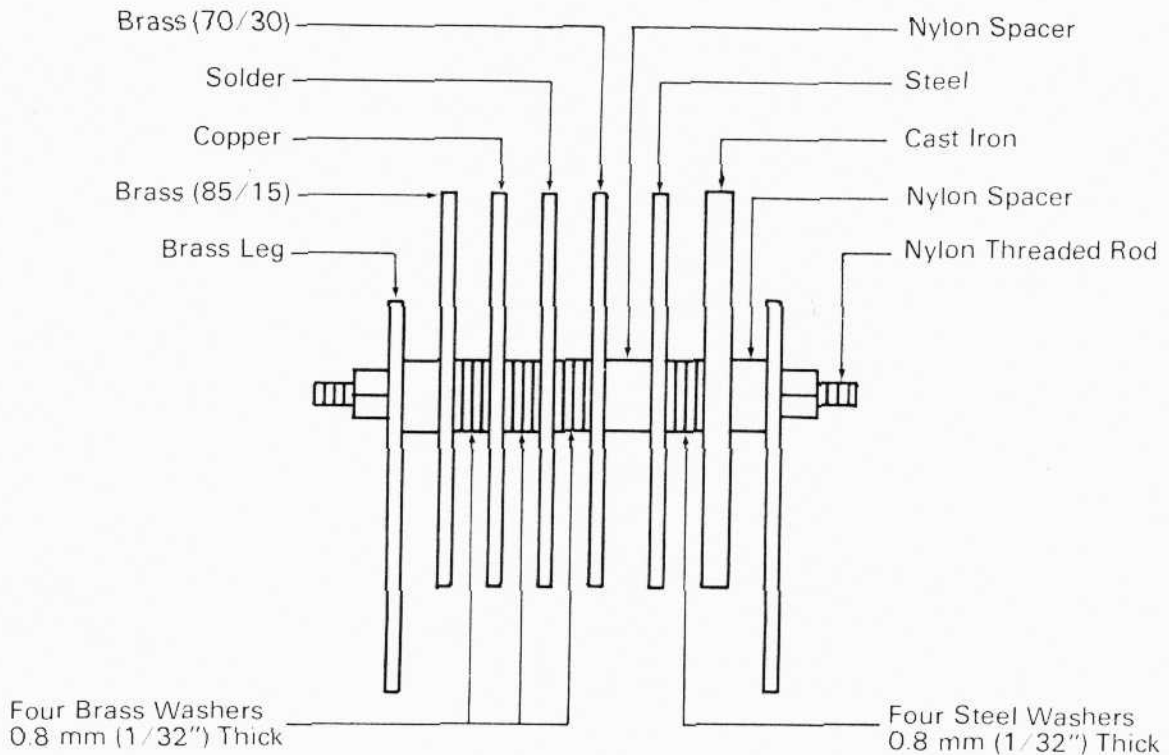
**GLASSWARE CORROSION TESTS FOR INHIBITORS AND ANTIFREEZE-COOLANTS**

The glassware corrosion test will generally differentiate between products having good corrosion inhibiting properties and those which are detrimental to the metal test specimens. This test must conform with the standards set forth in ASTM D1384-80 "Corrosion Test for Engine Coolants in Glassware." However, the glassware corrosion test should be modified to reflect the metals in the EMD cooling system, and the operational characteristics in the field. These modifications are as follows:

1. Do not incorporate aluminum in the coupon bundle, Fig. 5, since it is not present in EMD engine cooling systems. However, red brass (85% copper - 15% zinc) should be included in the coupon bundle since this metal is used in the cooling system.
2. Because some inhibitors react differently, the glassware corrosion test should be performed in both soft and hard waters. Corrosive water obtained by adding sodium salts to distilled water, as specified in D1384, is considered a soft water. Hard water containing calcium and magnesium compounds will often be used in the engine cooling system, but must be limited to 170 ppm. The laboratory sample of hard water should observe the same limitation.

**NOTE**

Before conducting glassware corrosion tests on unknown products, it is suggested that the user conduct tests on known quality products. Conducting glassware tests on a quality product will familiarize laboratory personnel with the test procedure and the variations which may be encountered.



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Fig. 5 — Arrangement Of Metal Test Specimens

**INTERPRETATION OF GLASSWARE CORROSION TEST RESULTS**

In general, an inhibitor or antifreeze-coolant is considered unsuitable for use in EMD engine cooling systems when the weight loss of the metal test specimens exceeds the following recommended limits:

- Cast Iron and Steel ..... 5 milligrams per coupon.
- Solder ..... 10 milligrams per coupon.
- Brass and Copper ..... 10 milligrams per coupon.

If the weight losses of the metal test coupons do not exceed the above limits but the coupons show signs of pitting or crevice-type corrosion, the corrosion protection properties of the coolant are considered inadequate. Further, an excessive amount of precipitate is undesirable. An excessive amount of precipitate may cause fouling or erosion in the cooling system.

**ELASTOMER IMMERSION TEST**

The elastomer immersion test determines whether exposure to a corrosion inhibitor or antifreeze-coolant solution will have adverse effects on the elastomeric seals used in the EMD engine cooling system. This procedure is a standard compression set determination utilizing excerpts from ASTM D1384, D395 (Method C), and D471 as follows:

**APPARATUS**

1. Container - D1384
2. Condenser - D1384

3. Oil Bath - D1384
4. Aerator Tube - D1384
5. Air Supply - D1384
6. Three compression set fixtures each consisting of:
  - a. Two 2-1/4" (57 mm) diameter steel discs with 3.8" (10 mm) diameter holes drilled into the center of each disc. Drill three 1.4" (6 mm) equally spaced holes, 3.4" (19 mm) from the bolt hole center.
  - b. An 8 mm (5/16") threaded bolt for insertion through drilled discs.
  - c. An 8 mm (5/16") nut to fit the bolt for compressing discs together upon tightening.
7. Several 13 mm (1/2") square spacers of a thickness necessary to produce a 30% deflection of elastomers as specified below in "Test Specimens" section.

### **TEST SPECIMENS (Figs. 6 and 8)**

Silicone Rubber Seals (See Service Data)

Fluoroelastomer Seals (See Service Data)

### **TEST SOLUTIONS**

The concentration of the engine coolant to be tested shall be as follows:

#### 1. Corrosion Inhibitor

Corrosion inhibitor shall be mixed with the proper quantity of distilled water to give the resulting solution twice the minimum concentration as specified by the manufacturer.

#### 2. Antifreeze

Antifreeze shall be mixed with distilled water in the ratio of 50% by volume (1 to 1).

### **PROCEDURE**

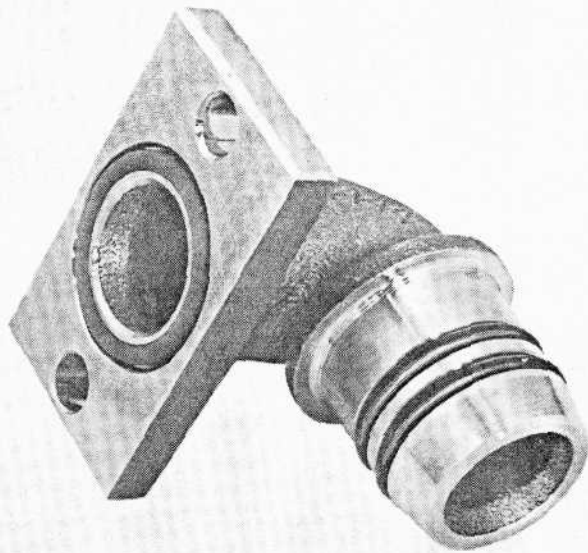
Cut a 30 mm (1-1/4") length from each of five silicone rubber and fluoroelastomer seals. Use three of each seal type in the test for compression set. The remaining seals will be used for volume change and durometer hardness change determination.

#### 1. Compression set determination (according to ASTM D395, Method C), except as follows:

Measure initial thickness of three silicone rubber seals. Prepare two sets of spacers of appropriate thickness to obtain a 30% deflection of the seals. Place the spacers on the flat side of a steel disc at the outside edges, diametrically opposed, Fig. 7.

Place the silicone seals on the disc allowing sufficient space between samples. Place the second disc on top, and insert bolt through the center holes from the bottom. Carefully tighten the nut with a wrench, using care not to dislodge the spacers. Tighten until solid contact is made between the spacers and steel disc.

Repeat procedure outlined above for fluoroelastomer seals using the second compression set fixture.

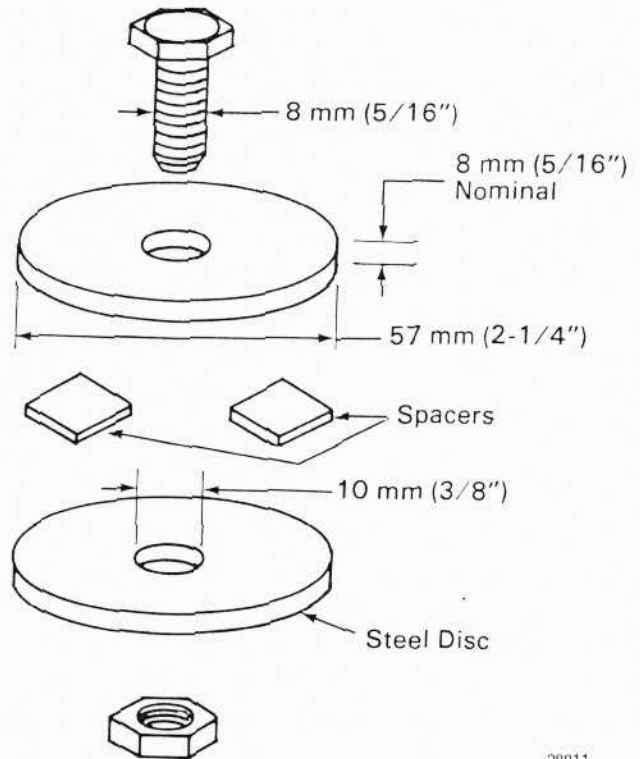


Red - 8305815

Black - 9317972

15798

Fig. 6 — Usage Reference For Test Sample Seals



28811

Fig. 7 — Compression Set Fixture And Spacers

## 2. Volume Change and Duro Hardness Change

### NOTE

Measure the initial durometer hardness and initial weight in air and water of the two silicone seals and the two fluoroelastomer seals per ASTM D471.

Place the two compression set fixtures and all the seals measured for volume change into the glassware corrosion container which has been filled with 600 ml of the test solution and insert the rubber stopper and aerating tube, as outlined in D-1384. Place the container in the oil bath heated to 88°C (190°F). Adjust air supply at a rate of 100 ml/min. Insert condenser tube into the rubber stopper.

After 70 hours in the heated oil bath, remove the container from the bath. Immediately remove the compression fixtures and disassemble. Remove the seals from the fixture and allow to cool on a thermally non-conducting surface, such as wood, for 30 minutes before measuring thickness and determining the compression set per ASTM D395.

Allow the volume change samples to remain in the container (do not drain any coolant). Place container in a water bath and cool to 25°C (77°F). After 30 to 60 minutes, remove the samples from the container, blot the surface, and quickly weigh in air and then weigh in water. Measure durometer hardness. Determine volume change and hardness change per ASTM D471.

## INTERPRETATION OF TEST RESULTS

If the changes in the elastomeric properties after the immersion tests exceed the limits listed below, the inhibitor or antifreeze-coolant is considered unsuitable for use in EMD cooling systems:

Volume change for —	Duro hardness change for —	Compression set for —
Fluoroelastomer } Silicone Rubber }	Fluoroelastomer } Silicone Rubber }	Fluoroelastomer } Silicone Rubber }
0 to + 10%	10 Points Max.	20% Max.

**FIELD QUALIFICATION TESTS FOR CORROSION INHIBITORS AND ANTIFREEZE-COOLANTS**

The glassware corrosion test should be recognized as a controlled laboratory test. It is possible that a coolant which appears satisfactory in glassware corrosion tests may fail in the field. The glassware corrosion test is conducted statically; the final evaluation of a coolant must be made in the field where the inhibitor will be subjected to the cooling system turbulence, heat, and flow rates.

Whenever possible, the recommended concentration of inhibitor or antifreeze-coolants should be tested in five new and five old engine cooling systems. The engines used in the qualification test should be in heavy duty service on the highest horsepower units available. New inlet water jumper lines and inlet deflectors should be installed on the right bank front and rear of the NEW engines tested in order to establish a valid baseline. The engines should be identified as test units. The first inspection of the cooling system components should be made three months after the initiation of the tests. This inspection should include the following:

1. Coolant Sample

Operate the engine for a minimum of 15 minutes before obtaining a representative coolant sample. Purge the sight glass to remove any accumulated sediment by draining a minimum of one quart of coolant. After sediment is purged from the glass, collect one quart in a clear, clean glass bottle. Allow the sample to settle for 24 hours; then inspect the bottom for sediment.

If sediment completely covers the bottom of the glass bottle, it may indicate that excessive corrosion or inhibitor depletion is occurring. Note the color of both the sediment and the coolant. (The density of the color dye in the coolant should be strong enough to indicate the presence of the inhibitor or antifreeze-coolant.) The inhibitor or antifreeze-coolant manufacturer should be contacted to analyze the coolant to determine whether there has been excessive depletion of the inhibitor ingredients.

2. Visual Inspection of Jumper Lines and Inlet Deflectors

Remove two water jumper lines and inlet deflectors from the right bank front and rear of engine. With a strong light, visually inspect the interior of the jumper lines for corrosion as indicated by well defined irregular spots or corrosion products 1 mm (1/32") or more in thickness. (Note that the removal of the solid corrosion products by pickling or abrasion will reveal pitting.)

Inspect both sides of the deflectors for signs of pitting which may indicate corrosion-erosion or impingement corrosion. Generally, the surface of the deflectors will have a tarnish coating. If the surfaces are clean and bright, this condition may indicate metal deterioration caused by inadequate inhibitor protection.

3. Visual Inspection of the Oil Cooler

Remove the most accessible oil cooler flexible coupling clamp plate from the oil ring and the water inlet pipe. With a strong light and telescoping mirror, inspect the interior of the oil cooler tubes. Clean bright metal or pitting are indications of corrosion. Also inspect the top of the tubes for erosion (wearing away of the metal).

4. Visual Inspection of the Water Pump

Remove and disassemble one of the water pumps. Inspect the carbon seal for excessive wear, and check the water pump impeller for bright shiny surfaces which may indicate corrosion.

## **INTERPRETATION OF FIELD QUALIFICATION TEST RESULTS**

If there are no indications of corrosion problems after three months, the field test may be continued. However, the cooling system should be inspected at 3-month intervals in the same manner as described for the 3-month inspection.

After completion of the 12-month field tests, if the results are considered satisfactory by EMD, the corrosion inhibitor or antifreeze-coolant can be considered suitable for use in EMD engine cooling systems.

## **CLEANING EMD ENGINE COOLING SYSTEMS**

Cooling systems on new EMD engines are protected from corrosion during testing and storage periods. Thus it is unnecessary, and it is not recommended, that the cooling system be cleaned prior to use.

Cooling systems which have been maintained with a quality inhibitor and water should not require cleaning. Field history has shown that EMD cooling systems are rarely cleaned.

Before cleaning a cooling system, symptoms of the cooling system problem should be identified. For example: excessive coolant and/or oil temperatures, excessive amount of rust and/or sediment in the coolant, or oil contamination of the coolant.

Excessive coolant and/or oil temperatures may be due to dirty radiator fins, fouled radiator coolant screens or plugged radiator tubes. Radiator fins and coolant screens should be cleaned as recommended in the EMD Maintenance Instructions. Plugged radiator tubes are difficult to clean by chemical treatment. It should be noted that chemical solutions that are capable of dissolving the debris may also, to some degree, attack the radiator metal. The only practical method of cleaning the radiator is to rod-out the tubes. The radiator should be pressure-tested to insure that the rodding operation did not damage the tubes.

Excessive oil temperature may be due to the oil cooler having dirty fins or tubes coated with water hardness salts. To remove carbonaceous deposits from the fin side, the cooler may be cleaned in a vapor degreaser or a water soluble cleaner. It should be noted that a strong alkaline cleaner shall not be used to clean the aluminum fins. *Strong alkaline cleaners will attack and/or dissolve aluminum.* The deposits in the tubes should be cleaned by mechanical rodding.

Excessive temperatures may also be attributed to hard water salts. The hardness salts of magnesium and calcium will coat the hot surfaces of the fire face side of the cylinder head. To a lesser extent, the hardness salts will coat the oil cooler tubes.

Generally, the only indication of excessive scale on the coolant side of the fire face is failure (cracking) of the cylinder head. To determine the severity of the scale coating, the failed cylinder head may be sectioned (cut) approximately one inch from the fire face (valve) seat side. Scale thickness greater than 1/64 inch (0.0156 inch) is considered detrimental to efficient heat transfer. If the other cylinder heads have been in the engine for a similar period of time as the failed head, it can be assumed that the scale thickness is also similar. The most efficient method, with the least damage to the engine, is to remove the cylinder head for cleaning. Cleaners based on inhibited sulfamic acid are recommended for removing water hardness scale. It is suggested that the acid be flushed thru the cylinder head. Flushing the head with acid will effect faster dissolution of the hardness scale.

Rust is an obvious sign of active corrosion in the cooling system. Generally the area most susceptible to corrosive attack are the coolant jumper lines. The coolant jumper lines should be inspected for pitting corrosion. Evidence of pitting corrosion indicates the jumper line has been weakened to some degree. Rather than cleaning the jumper lines, it is recommended that they be replaced. Rust may also plug the cylinder liner coolant ports. Past experience has shown that acid cleaners are not effective in dissolving rust in a blocked port. Further, the acid may damage the base metal. The only effective way of opening a blocked port is rodding.

Oil contamination of the coolant will adversely affect the heat transfer. Oil may be removed by flushing the cooling system with a mild automatic dishwashing detergent.

The cleaner concentrations must be decided on an individual basis. Generally the customer should contact the cleaner representative with information as to the type of scale to be removed. Cleaner concentration, time and temperature should be decided by the representative.

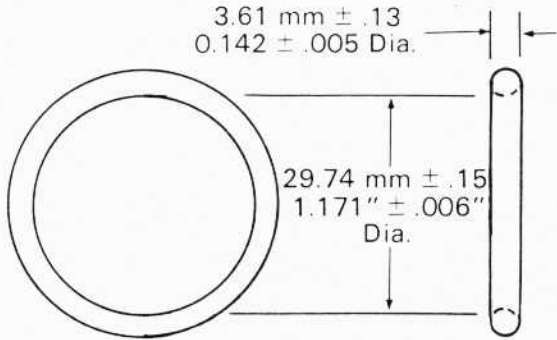
**NOTE**

Cleaning solutions containing hydrochloric acid (muriatic acid) shall not be used in EMD engine cooling systems.

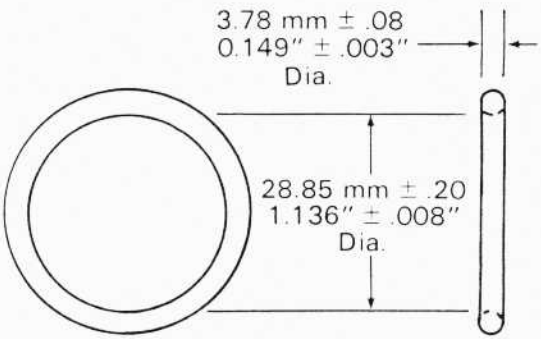
Questions concerning cleaning engine cooling systems should be directed to the EMD Service Department.

**SERVICE DATA**

Silicone Rubber Seals	.....	8305815 and 8384772
Fluoroelastomer Seals	.....	9317972



Silicone Rubber - 8305815  
(Red Seal)



Fluoroelastomer - 9317972  
(Black Seal)

27150

Fig. 8 — Dimensional Reference For Seal Applications

**U.S. TO METRIC CONVERSIONS**

1 to 3 fluid ounces per gallon	7.8 to 23.4 cubic centimeters per liter
0.4 fluid ounce per gallon	3 cubic centimeters per liter
1.0 fluid ounce per gallon	7.5 grams per liter
.75 ounce per gallon	5.6 grams per liter
2 to 4 fluid ounces per gallon	15.6 to 31.2 cubic centimeters per liter

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