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NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 220
VOLUME 3

CORROSION AND CONTAMINATION CONTROL FOR DIESEL ENGINE COOLING WATER SYSTEMS

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CHAPTER 220
CORROSION AND CONTAMINATION CONTROL FOR DIESEL ENGINE COOLING WATER SYSTEMS

SECTION 40. INTRODUCTION

220−40.1 PURPOSE

220−40.2 Shipboard water chemistry control requirements for main propulsion and auxiliary diesel jacket water cooling systems are described in this volume. The theories of water treatment upon which the controls are based are included also. In many instances, information is given to provide engineering guidance to operating forces and industrial activities should a situation be encountered that is not specifically addressed by the chemistry control requirements.

220−40.3 Guidance data and information to aid personnel in making sound engineering judgments (as differentiated from mandatory requirements amplifying Navy instructions) is identified as such to eliminate confusion.

220−40.4 Mandatory requirements specified in this volume shall be met. Request for deviation from the specific requirements shall be made in writing to the Type Commander with an information copy to the immediate superior in the chain of command (ISIC), the Naval Sea Systems Command (NAVSEA), and the Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station (NSWCCD−SSES) Philadelphia, PA. In extreme situations, deviations are authorized by the Commanding Officer and shall be reported. The requirements of this chapter apply during industrial availabilities. The Commander, Naval Shipyard, or Supervisor of Shipbuilding, Conversion, and Repair shall submit requests for deviation from the specific requirements to NSWCCD−SSES with information copies to the cognizant Type Commander, ISIC, the ship, and NAVSEA. The Type Commander, ISIC, NAVSEA, and NSWCCD−SSES should be advised and assistance should be requested whenever unusual conditions arise which are not covered in this volume.

220−40.5 SCOPE. This volume contains instructions and guidance for maintenance of proper water chemistry in diesel jacket water cooling systems and waste heat distribution systems. The systems include all main propulsion diesel engines, ship's service and emergency diesel generators.

220−40.6 FEEDBACK. Any apparent error, omission, or possible beneficial change (no matter how small or large) which a user considers to be an improvement to this volume should be reported to the Naval Surface Warfare Center, Port Hueneme Division, Code 5B00. The NAVSEA Technical Manual Deficiency/Evaluation Report (TMDER), NAVSEA Form 4160/1 (Rev 5−89) should be used for transmitting feedback comments. Copies of the TMDER are included at the end of this volume. All feedback comments will be evaluated and originators will be advised of action resulting therefrom.

SECTION 41. PRINCIPLES OF DIESEL ENGINE COOLING WATER TREATMENT

220−41.1 BACKGROUND. Engine coolant accepts heat from the hot areas of an engine and rejects heat at a heat exchanger. The coolant thus provides a medium for transferring heat from the hot engine to the cool heat exchanger. Without engine coolant, engine components would rapidly overheat and fail due to the large amounts of heat produced by combustion.

220−41.2 EFFECTS OF UNTREATED COOLANT. Scale, corrosion and cavitation corrosion will occur in engine cooling systems if untreated coolant is used. In order to minimize these problems, high quality water treated with corrosion inhibitors is used in engine cooling systems. There are five types of corrosion inhibitor treatments currently authorized for use by the Navy in engine cooling systems. These are: MIL−A−53009 inhibitor, Nalcool 2000, inhibited Antifreeze (MIL−A−46153), Soluble Oil (MIL−I−24453), and Combination Treatment.

220−41.3 WATER. Water is used as coolant because it is readily available and because of its large heat capacity (i.e., the quantity of heat it can absorb). Depending on its source, water quality can vary widely. Seawater contains large amounts of dissolved salts. Shore waters contain significantly lower levels of dissolved salts than seawater, though they vary in composition from location to location. Shore waters include municipal water (tap, city, potable, fresh or dock) and water from rivers, lakes or wells.

220−41.4 WATER IMPURITIES. Certain constituents of the dissolved salts in both shore waters and seawater can be troublesome.

1. **Hardness.** Hardness (dissolved calcium and magnesium) can lead to scale formation. Scale consists of compounds of calcium and magnesium which form deposits on hot metal surfaces. Scale acts as an insulator, thereby reducing the transfer of heat from hot metal surfaces in the engine to the coolant. This can cause overheating of the engine. Hardness also causes separation of the oil in Soluble Oil treatment.

2. **Chloride and sulfate.** Chloride and sulfate tend to break down the protective layers formed on metal surfaces by corrosion inhibitor treatment chemicals and make the layers more difficult to reform. Thus, chloride and sulfate can lead to corrosion problems.

220−41.5 Impurities in Shore Source Waters and Seawater. Unprocessed shore waters (shore source potable waters) contain varying amounts of hardness, chloride and sulfate. Seawater contains significantly greater amounts of these constituents. Since most diesel engine cooling systems use seawater cooled heat exchangers, heat exchanger leaks can allow seawater to contaminate the engine coolant. Seawater contamination is detected by testing the engine coolant for chloride. Unfortunately, no test procedures for hardness or sulfate are available that are suitable for shipboard use.

220−41.6 Water Purification. Water purification processes such as distillation, demineralization or reverse osmosis remove most hardness, chloride and sulfate from water. The use of purified water is essential to the maintenance of clean diesel cooling systems.

SECTION 42. REQUIREMENTS FOR DIESEL COOLING WATER SYSTEMS

220−42.1 WATER REQUIREMENTS. An important part of a coolant treatment program is the use of high quality water. High quality water contains minimal amounts of hardness, chloride and sulfate. High quality water shall be used for final flushing, freshly filling or topping off of cooling systems or for pre−mixing treatment chemicals for addition to cooling system. Water used for these purposes shall be as follows, in order of precedence:

1. Shipboard boiler feedwater or condensate meeting the requirements of **NSTM Chapter 220 Volume 2, Boiler Water/Feedwater Water Chemistry, Test and Treatment**.

2. Shore source water meeting the requirements of **NSTM Chapter 220, Volume 2, Boiler Water/Feedwater Water Chemistry, Test and Treatment,** for shore source feedwater.

3. Water produced by shore−based or shipboard distilling plants, demineralizers or reverse osmosis units. This includes water from pier−side demineralizers (rainmakers). Prior to use, the water shall be tested for conductivity using the procedure specified in paragraph 220−42.11. The maximum acceptable limit is 150 micromhos per centimeter (μmhos/cm).

4. Potable water (brominated or chlorinated) produced by shipboard distilling plants. Potable water from shipboard potable water tanks may only be used if it is known that the water was produced by shipboard distilling plants. Prior to use, the water shall be tested for conductivity using the procedure specified in paragraph 220−42.11. The maximum acceptable limit is 150 micromhos per centimeter (μmhos/cm).

NOTE

The use of shore source potable water is prohibited except in emergency situations. Potable water used to fill engine cooling systems shall be tested for conductivity and the results noted in the remarks section of the engine coolant treatment log. Engines that have been filled with shore source potable water shall be dumped and flushed with one of the above waters as soon as practicable.

CAUTION

The use of shore source potable water can result in accelerated scaling and/or corrosion of cooling system internals. In addition, hardness from shore source potable water will cause Soluble Oil treatment to separate, resulting in oil contamination of the coolant.

NOTE

Shore source potable water may be used for cleaning and flushing cooling systems provided that a final flush is performed with water meeting the above requirements.

220−42.2 AUTHORIZED TREATMENTS. There are five coolant treatments authorized for use in different shipboard applications. Refer to Table 220−42−1 for a listing of inhibitor treatments for each ship class. The treatments are:

Table 220−42−1. INHIBITOR TREATMENTS AUTHORIZED FOR VARIOUS SHIP CLASSES

Treatment	Ships
Inhibitor Treatment, MIL−A−53009 (see Note a)	ARS Class, ASR Class, ATS−1 Class LSD−41 Class, LST 1182 Class YTB Class, YTM Class MTS Class, Submarines All diesel engines and generators on ships not listed below
Nalcool 2000 (see Note b)	FFG−7 Class PB Mk III, PB Mk IV, PBR Mk II Seafox Boats
Inhibited Antifreeze, MIL−A−46153 (see Notes a,b, and c)	All small craft and all small boats not listed All engines requiring freeze protection
Soluble Oil, MIL−I−24453 (see Note c)	MSO Class, MCM 1, 2
Combination Treatment	MCM 3 through 14, MHC Class

Notes:

(a) Ships authorized to use MIL−A−53009 shall use Antifreeze when freezing protection is required. Refer to Section 45 and to 220−43.6.
(b) Ships authorized to use Nalcool 2000 shall use Nalcool 2000 plus Antifreeze when freezing protection is required. Refer to paragraphs 220−44.6 through 220−44.8.
(c) Ships authorized to use Soluble Oil shall use Antifreeze when freezing protection is required. Refer to Section 45 and to paragraphs 220−46.6 through 220−46.7.

1. **MIL−A−53009 Inhibitor.** MIL−A−53009 inhibitor is authorized for any system not specifically assigned to another treatment. This treatment does not provide any freezing protection. Ships authorized to use MIL−A−53009 treatment which require freezing protection shall use MIL−A−46153 Antifreeze in place of MIL−A−53009 inhibitor. MIL−A−53009 treatment is discussed in detail in Section 43.

2. **Nalcool 2000** proprietary treatment. Nalcool 2000 is authorized for systems prone to cavitation corrosion, such as the FFG−7 class Detroit Diesel Ship Service Diesel Generators. This treatment does not provide any freezing protection. If freezing protection is required for ships authorized to use Nalcool 2000, then MIL−A−46153 Antifreeze must be added to the Nalcool 2000. Nalcool 2000 is a patented formula manufactured by Nalco Chemical Company and Penray Chemical Company. No other manufacturers' products are authorized substitutes for Nalcool 2000. This treatment (with and without Antifreeze) is discussed in detail in Section 44.

3. **MIL−A−46153 Inhibited Antifreeze.** Antifreeze is authorized for use by all small craft except those which require Nalcool 2000 (see Table 220−42−1). It is also used, either alone or in combination with certain other treatments, for any cooling system requiring freezing protection.

Only Antifreeze that was made specifically to the requirements of MIL−A−4613 shall be used. The use of proprietary or commercial brands of Antifreeze is prohibited. Antifreeze treatment is discussed in detail in Section 45.

4. **MIL−I−24453 Soluble Oil.** Soluble Oil treatment is authorized for use in engines with aluminum blocks (or large amounts of aluminum heat−rejecting surfaces) and single−loop waste heat distilling plants. Heat−rejecting aluminum is particularly prone to corrosion. Ships with single−loop waste heat distilling plants are vulnerable to contamination of distillate and potable water by engine coolant. Soluble Oil is practically non−toxic, and is effective at protecting aluminum heat−rejecting surfaces. This treatment does not provide any freezing protection. If freezing protection is required by these engines, MIL−A−46153 Antifreeze must be used in place of Soluble Oil, and precautions must be taken to prevent and detect possible contamination of distillate. Follow the changeout procedures in paragraph 220−46.7. Soluble Oil treatment is discussed in detail in Section 46.

5. **Combination Treatment.** Combination treatment consists of a mixture of MIL−A−53009 inhibitor plus MIL−A−46153 Antifreeze (see above). It was developed for the special needs of the MCM and MHC class Isotta Fraschini (IF) engines which contain heat−rejecting aluminum and large amounts of iron and copper alloys. These cooling systems have been subject to unusually high corrosion, especially of aluminum, resulting in formation of deposits on the cooler cores. The presence of these deposits causes the engines to overheat. A procedure for cleaning the cooler cores is described in paragraphs 220−50.9 through 220−50.11. Combination treatment provides some freezing protection. Combination treatment is discussed in detail in Section 47.

6. **Other treatments. Chromate treatment** is no longer authorized for use on any Navy engine cooling system. Due to its highly toxic nature, the Chromate treatment was replaced by MIL−A−53009. Chromate treatment is used on some LSD−41 class engines prior to commission. Engines treated with chromate shall be drained, thoroughly flushed, and retreated with MIL−A−53009. For specific instructions on changing out from chromate to MIL−A−53009, contact NSWCCD−SSES. **Paxcool Antifreeze** is used on PC−1 Class Paxman diesel engines for one year following delivery because of warrantee considerations. Paxcool treated engines should be tested in accordance with the manufacturer's instructions, in addition to the tests described in Section 45. Following the one−year warrantee period, these engines shall be drained, flushed, and retreated with MIL−A−46153 Antifreeze. **Liquidewt treatment** was used on some LSD−41 class engines prior to commission. Liquidewt is not, however, an authorized treatment. Engines treated with Liquidewt shall be drained, thoroughly flushed, and retreated with MIL−A−53009 inhibitor. For specific instructions on changing out from Liquidewt to MIL−A−53009, contact NSWCCD−SSES.

220−42.3 PREPARATION FOR TREATMENT. Before initiating coolant treatment, the cooling system of the engine shall be inspected. If oil is present the system shall be cleaned using the detergent flush procedure described in paragraphs 220−50.2 through 220−50.4. If corrosion or scale deposits are noted the system shall be cleaned using the diammonium citrate procedure described in paragraphs 220−50.5 through 220−50.8. If these procedures are found to be ineffective, contact NSWCCD−SSES, Philadelphia PA. After any cleaning, the system shall be thoroughly flushed with water meeting the requirements of paragraph 220−42.1 to ensure complete removal of all cleaning chemicals.

220−42.4 Fresh Fill and Treatment of Cooling Systems. Refer to Table 220−42−1 for a listing of inhibitor treatments for each ship class. The capacity of the cooling system, in gallons of water, shall be determined in order to calculate the correct dosage of chemicals. Add water meeting the requirements of paragraph 220−42.1 to the system. (If the system is to be hydrostatically tested, do not fill the system until just before the hydro. Delay chemical treatment until completion of a satisfactory hydro). The chemical solution may usually be added to the system at the jacket water expansion tank

or the chemical injection tank. The engine shall be operated within 24 hours of treatment. A sample shall be obtained 10 to 60 minutes after reaching operating temperature.

WARNING

Wear face shield, rubber gloves, and rubber apron when handling concentrated cooling water treatment chemicals.

CAUTION

The cooling system shall be recirculated as soon as possible following the addition of chemicals in order to mix them thoroughly. Delay in recirculation can result in corrosion of the cooling system internals due to the presence of pockets of concentrated treatment chemicals. The engine shall be operated within 24 hours of treatment. Earlier operation is preferable. Do not sample a cooling system until it has been recirculated so that a representative sample will be obtained.

220−42.5 SAMPLING. Samples of engine coolant are obtained and tested to ensure that the coolant contains the correct level of inhibitor chemicals and to detect any seawater contamination of the cooling system.

220−42.6 Sampling Frequency. Engine coolant samples for all treatments shall be obtained and tested in accordance with the following requirements:

1. After freshly filling and treating.
2. After adding water to the cooling system.
3. After adding inhibitor to the cooling system.
4. At least monthly.
5. In accordance with the Planned Maintenance System (PMS).

220−42.7 Whenever treatment chemicals or makeup water have been added the engine shall be operated within 24 hours. A sample shall be obtained within 10 − 60 minutes of reaching operating temperature. Samples shall be tested within 1 hour after sampling. Sampling of secured engines is not required. In the event that an engine is secured when a routine (monthly) sample is scheduled to be taken, that fact should be noted on the engine coolant treatment log. The routine sample shall be taken the next time the engine is operated.

220−42.8 Sampling Procedure. Obtain engine coolant samples as follows:

WARNING

Wear face shield, rubber gloves and apron when sampling a cooling system.

1. Allow engine coolant to flow from the drain cock long enough to thoroughly flush the drain cock.
2. Rinse the sample bottle and cap with coolant.
3. Fill the sample bottle with coolant.

4. Cap the bottle after collecting the sample.
5. Cool the sample to 100˚F (38˚C) or less before testing.

220−42.9 TEST FACILITY. Test facilities used for testing diesel engine coolant samples shall be well lighted and ventilated and shall be maintained in a clean and orderly condition and equipped as follows:

1. Sink with drain and running water.
2. Source of distilled water.
3. Six month supply (minimum) of in date test chemicals and equipment as specified for the treatment used.
4. Safety equipment required for the treatment used.
5. Stowage space for the chemicals and equipment.
6. Container for hazardous waste storage.
7. Chemical test procedures available for ready reference and a workbook containing a current copy of each test procedure protected in plastic (recommended for ease of use).
8. A current copy of NSTM Chapter 220 Volume 3, Corrosion and Contamination Control for Diesel Engine Cooling Water Systems.

220−42.10 DISPOSAL GUIDANCE. Used/Excess hazardous material collected as the result of normal operation and maintenance of diesel engine cooling systems shall be disposed of in accordance with OPNAVINST 5100.19C and NSTM Chapter 593. Sources of used/excess hazardous materials include, but are not limited to, the following:

1. Coolant drained from cooling water systems.
2. Coolant used to flush sample line, sample bottle and sample cap during sample collection.
3. Waste associated with the testing of cooling water systems.
4. Expired test, treatment, and cleaning chemicals.
5. Cooling system flushing and chemical cleaning solutions.

220−42.11 CONDUCTIVITY TEST FOR WATER. The conductivity test is performed by placing the conductivity cell in the water sample and reading the result on the digital display.

1. Apparatus

    a. Meter, conductivity, Orion Model 122, conductivity range 0 − 199.990 μmho/cm; automatic temperature compensation; requires 9 volt battery

    b. Cell, conductivity, dip type, 0.609 cell constant with temperature compensator; connected to conductivity meter

    c. Bottle, glass, square, 8 oz.

2. Reagents

    a. Distilled water

3. Interferences

    a. Oil and suspended matter may coat the electrode, making it inoperable.

4. Procedure

   a. Rinse the conductivity cell and test bottle with distilled water and then with the sample.
   b. Place the cell in the test bottle. Add sufficient sample water to cover the slot in the cell by 1/2 inch.
   c. Set the conductivity range selector to 199.9 µmho/cm.
   d. Turn on the meter.
   e. Move the cell up and down several times to remove entrapped air bubbles. Repeat until there is no change in the reading.
   f. Read the conductivity value of the water in µmho/cm. Record the result in the remarks section of the Diesel Engine Jacket Cooling Water Treatment Log.
   g. Turn off the meter.
   h. Rinse the cell and test bottle with distilled water. Store the cell in distilled water. The distilled water is to be changed daily.

Table 220−42−2. SUPPLY INFORMATION FOR CONDUCTIVITY TEST

Item	NSN	U/I	Qty	Notes
Meter, conductivity, Orion model 122, with conductivity cell, thermister, and case			1	1
Bottle, Square, 8 oz	9G 8125−00−543−7699	EA	2	

Note:

1. Item not yet available in stock system. Item may be purchased from any of the following:

   Fisher Scientific, 1−800−766−7000, P/N 09−357−1
   Thomas Scientific, 1−800−524−1364, P/N 3239−S04
   VWR Scientific, 1−800−932−5000, P/N 23197−939

SECTION 43. MIL−A−53009 INHIBITOR TREATMENT

WARNING

Skin or eye contact with MIL−A−53009 inhibitor or coolant containing MIL−A−53009 inhibitor shall be avoided. Wear face shield, rubber gloves and apron when handling concentrated MIL−A−53009 inhibitor or when sampling a cooling system containing MIL−A−53009 inhibitor. Wear goggles, plastic gloves and rubber apron when handling coolant samples.

220−43.1 MIL−A−53009 consists of a blend of inhibitor chemicals in aqueous solution. These chemicals are: sodium metaborate, potassium silicate and mercaptobenzothiazole (MBT). Sodium metaborate is an alkaline buffer which neutralizes acidic by−products resulting from combustion blow−by gases leaking into the coolant. Potassium silicate forms a silicate film on metal surfaces which provides effective corrosion protection for mixed metal systems. MBT chemically bonds with copper contained in copper alloys resulting in formation of a protective layer on the surface.

220−43.2 LIMITS. The following limits apply to MIL−A−53009 inhibitor treated coolant:

MBT	100 to 500 ppm
Reserve Alkalinity	6 RA units minimum
Chloride	100 ppm maximum

NOTE

MBT levels in a properly treated freshly filled and treated system will be approximately 300−400 ppm.

MBT levels below 100 ppm can result in accelerated corrosion. Reserve alkalinity levels less than 6 RA units can also result in accelerated corrosion. MBT levels in excess of 500 ppm indicate over−treatment to an undetermined degree (since the maximum level detectable by the MBT procedure is 500 ppm). Gross over−treatment can result in corrosion inhibitor chemicals precipitating out of solution which can restrict heat transfer. Chloride levels above 100 ppm indicate that seawater has leaked into the cooling system, which makes the coolant more corrosive. In addition, seawater contains hardness which will cause scale formation on hot metal surfaces.

220−43.3 INITIAL TREATMENT DOSAGE. Freshly fill the cooling system in accordance with paragraphs 220−42.3 through 220−42.4 using three gallons (12 quarts) of MIL−A−53009 inhibitor for each 100 gallons of cooling system capacity.

NOTE

Since the actual engine cooling system capacity may differ from the volume given in the applicable NAVSEA technical manual, ships using MIL−A−53009 inhibitor treatment can determine the actual cooling system volume as follows:

1. Freshly fill and treat the system using the system volume from the applicable NAVSEA Technical manual.
2. Recirculate the coolant for at least ten minutes after the engine has reached operating temperature. Obtain a sample and test for MBT in accordance with paragraph 220−42.7.
3. Determine the actual system volume using the following equation:

$$V = (350/MBT) \times VTM$$

Where:

V = Actual cooling system volume (gallons)
MBT = MBT sample test result (ppm)
VTM = Volume from technical manual (gallons)

4. The calculated cooling system volume should be recorded in the log for each jacket cooling water system and should be used for all future treatments.

220−43.4 SAMPLING. Requirements for sampling are described in paragraphs 220−42.5 through 220−42.8.

220−43.5 ACTIONS FOR OUT−OF−LIMITS RESULTS. Whenever test results are not within the limits specified, the following actions shall be taken:

NOTE

Use water meeting the requirements of paragraph 220−42.1 for flushing the cooling system or adding water to the cooling system.

1. If the MBT level is less than 100 ppm, add one gallon of MIL−A−53009 inhibitor for each 100 gallons of cooling system capacity.
2. If the reserve alkalinity level is less than 6 RA units, add 1.5 gallons of MIL−A−53009 inhibitor for each 100 gallons of cooling system capacity.
3. If both MBT and reserve alkalinity are below limits, add 1.5 gallons of MIL−A−53009 inhibitor for each 100 gallons of cooling system capacity.
4. If MBT exceeds the 500 ppm upper limit, dump some of the treated coolant and replace with water meeting the requirements of paragraph 220−42.1.
5. If the chloride concentration exceeds 100 ppm:

   a. Dump and flush the entire system.
   b. Locate and correct the source of seawater contamination.
   c. Fill the cooling system with water meeting the requirements of paragraph 220−42.1, then dump again.
   d. Sample and test the flush water for conductivity using the procedure specified in paragraph 220−42.11.
   e. Repeat steps c and d until the conductivity level in the flush water is less than 150 μmho/cm.
   f. Freshly fill and treat using the treatment dosage in paragraph 220−43.3.

NOTE

If overheating occurred during the contamination incident, inspect the cooling system prior to refilling for the presence of scale or corrosion deposits to determine the need for chemical cleaning. Inspection is also recommended if it is suspected that the contamination was severe or long term. If necessary, clean the system in accordance with paragraphs 220−50.5 through 220−50.8.

220−43.6 CONVERTING BETWEEN MIL−A−53009 INHIBITOR AND INHIBITED ANTIFREEZE. Ships authorized to use MIL−A−53009 inhibitor treatment shall convert to inhibited Antifreeze if freezing protection is required. Maintain Antifreeze treatment in accordance with Section 45. When freezing protection is no longer required, reconvert to MIL−A−53009 inhibitor during the next normal change out of engine coolant. If it is anticipated that freezing protection will again be required in the near future, continue maintaining Antifreeze treatment rather than reconvert to MIL−A−53009 inhibitor. To convert from MIL−A−53009 to Antifreeze or from Antifreeze to MIL−A−53009:

1. Open all low point drains and completely drain the cooling system
2. Fill the system with water meeting the requirements in paragraph 220−42.1, then drain.
3. Freshly fill and treat in accordance with paragraph 220−43.3 or 220−45.3 (as appropriate).

WARNING

Antifreeze shall only be used in the main engines of ships with single−loop waste heat distilling plants during periods when freezing protection is necessary. Refer to paragraphs 220−45.7 through 220−45.8. As soon as freezing protection is no longer required, reconvert to MIL−A−53009 inhibitor treatment.

220−43.7 DISTILLATE ON SHIPS WITH SINGLE−LOOP WASTE HEAT DISTILLING PLANTS. In the event of distiller heat exchanger failure on ships with single−loop waste heat distilling plants, MIL−A−53009 inhibitor treated coolant will leak into the distiller. The potential would then exist for contaminating distillate (and therefore potable water) with toxic MIL−A−53009 inhibitor. Personnel shall be alert for signs of unexplained coolant loss such as a decrease in expansion tank level.

WARNING

Distillate contaminated with MIL−A−53009 inhibitor shall not be used as drinking water.

220−43.8 Distillate Sampling Requirements. Distillate shall be sampled and tested for the presence of MIL−A−53009 inhibitor prior to sending distillate to a potable water tank and whenever unexplained coolant losses occur. These sampling requirements apply when waste heat from diesel engines is used to operate the distilling plant. Distillate test results shall be recorded in the engineering log.

220−43.9 Distillate Sampling Procedure. Obtain distillate samples as follows:

1. Allow distillate to flow from the drain cock long enough to thoroughly flush the drain cock.
2. Using a one quart plastic bottle, thoroughly rinse the sample bottle and cap using distillate.
3. Fill the bottle to the top and immediately cap the bottle.

NOTE

The distillate contamination test shall be completed within 30 minutes of sampling. The sample shall be 100˚F (38˚C) or less before testing. Cool the sample if necessary. Designate a specific sample bottle for distillate samples.

NOTE

When testing for distillate contamination, never use a sample bottle which has been used for engine coolant or boiler water samples.

220−43.10 Distillate Limit and Corrective Action. Distillate shall be colorless to phenolphthalein when tested in accordance with paragraph 220−43.16. If a pink color is noted when the test is performed, immediate corrective action shall be taken. Do not send distillate to potable water tanks. Dump all potable water tanks to which distillate was sent subsequent to the last sample which had satisfactory test results. Do not use potable water from these tanks. Locate and correct the source of the contamination in the distiller. Flush the potable water tanks with distillate (when satisfactory distillate is available). Sample during the flush operations. Continue flushing until the samples are colorless to phenolphthalein.

220−43.11 ENGINE COOLANT RECORD, MIL−A−53009 INHIBITOR TREATMENT LOG. The requirements for keeping engine coolant records (logs) and personnel responsibilities are described in Section 49.

220−43.12 TESTING PROCEDURES FOR MIL−A−53009 INHIBITOR TREATMENT. Effective treatment of cooling systems is based upon the accurate performance and interpretation of the tests that determine coolant quality. If these tests are not performed properly, the coolant will not be treated properly. It is necessary to carefully follow these test procedures in order to ensure accurate results.

220−43.13 CHLORIDE TEST FOR COOLANT TREATED WITH MIL−A−53009. Two dippers of cupric sulfate are added to a 10 ml sample of MIL−A−53009 inhibitor treated coolant. After a brief standing period, the sample is filtered. The end of a Quantab chloride test strip is immersed in the sample. After an exposure interval, the Quantab is removed from the solution and the scale reading is obtained. The reading is converted to ppm chloride by using a conversion chart.

1. Apparatus

    a. Filter paper
    b. Funnel
    c. Brass dipper
    d. Beaker, 50 ml (2)
    e. Graduated cylinder, 10 ml
    f. Quantab chloride test strips
    g. Stirring rod

2. Reagents

    a. Distilled water
    b. Cupric sulfate

3. Interferences

   a. The MBT present in MIL−A−53009 inhibitor interferes with the Quantabs. The addition of cupric sulfate to the sample causes the MBT to precipitate out, thus eliminating the interference.

WARNING

Wear goggles, plastic gloves and rubber apron when handing cupric sulfate.

4. Procedure

   a. Rinse the graduated cylinder, the funnel, the stirring rod and two 50 ml beakers with distilled water.
   b. Rinse the graduated cylinder with a small portion of sample.
   c. Measure 10 ml of sample in the graduated cylinder. Pour the sample into one of the 50 ml beakers.
   d. Add 2 dippers of cupric sulfate to the sample in the beaker. Stir to mix using the stirring rod.
   e. Let the solution stand five minutes.
   f. Filter the sample as follows:

      (1) Fold the circular filter paper in half and then fold in half again.
      (2) Open the folded filter paper to form a cone and place the cone in the funnel.
      (3) Place the funnel in the other 50 ml beaker.
      (4) Carefully pour the sample into the filter paper cone inside the funnel. Do not allow the level to reach the upper edge of the paper.

   g. Open the Quantab bottle, remove one test strip and recap the bottle.

NOTE

Check the expiration date on the Quantab bottle label. Do not use the Quantabs if the expiration date has passed.

NOTE

The Quantab bottle shall be kept tightly closed.

   h. Place the test strip with the word “Quantab” up into the beaker containing the filtered sample, with the numbered scale facing the person performing the test. Note the time.

NOTE

Never immerse the entire Quantab strip beneath the level of the solution being tested; otherwise the test strip will give a false low result.

   i. Leave the test strip in the beaker until the horizontal yellow−orange band across the top of the strip turns dark blue. This normally takes about 10−20 minutes. The blue color signals that the

test is ended. Remove the test strip from the beaker within 5 minutes after the blue color appears.

j. Read the number on the scale corresponding to the highest point at the upper tip of the white color change. Estimate to the nearest half division. Each division equals 0.2. Record the scale reading in the log.
k. Find the scale reading and the corresponding chloride level (column marked "ppm Cl^-") on the calibration chart provided with the bottle of Quantabs. Record the chloride result in the log. If the scale reading is lower than the lowest reading on the chart, record "<(lowest chloride concentration on the chart)". For example, if the lowest scale reading on the chart is 1.4 and this corresponds to 30 ppm chloride, record "<30" in the log.
l. Pour the samples containing MIL−A−53009 inhibitor into a plastic 5 gallon or smaller bottle identified as containing borate and cupric sulfate wastes.
m. Rinse the graduated cylinder, funnel and beakers with distilled water. Pour the sample waste water into the waste bottle. Place the soiled filter paper into the waste bottle.

NOTE

Bottles containing borate and cupric sulfate wastes shall be turned in to the Public Works Officer or Public Works Center at any naval facility.

220−43.14 MBT TEST FOR COOLANT TREATED WITH MIL−A−53009. A sample of MIL−A−53009 inhibitor treated coolant is drawn into a Titret containing reagents that are pink in color. The sample is drawn in until the color changes to a pale yellow. When the color change occurs, the Titret is inverted and the liquid level is measured on the scale marked on the Titret. The scale reading multiplied by 50 gives the MBT concentration in ppm.

1. Apparatus

   a. Valve assembly
   b. Sample cup

2. Reagents

   a. Titret − A glass vial under vacuum which contains the needed reagents is supplied. Principal ingredients are potassium permanganate, phosphoric acid, and water.
   b. Distilled water

3. Interferences

   a. None normally present in this type of sample.

4. Procedure

   a. Remove one Titret, one valve assembly and the sample cup from the test kit box.
   b. Rinse the sample cup with distilled water, then rinse with a small portion of the sample.
   c. Fill the sample cup to approximately the 25 ml mark with sample.
   d. Slide the open end of the valve assembly over the tapered tip of the Titret so that it fits snugly. See Figure 220−43−1.
   e. Carefully snap the tip of the Titret.

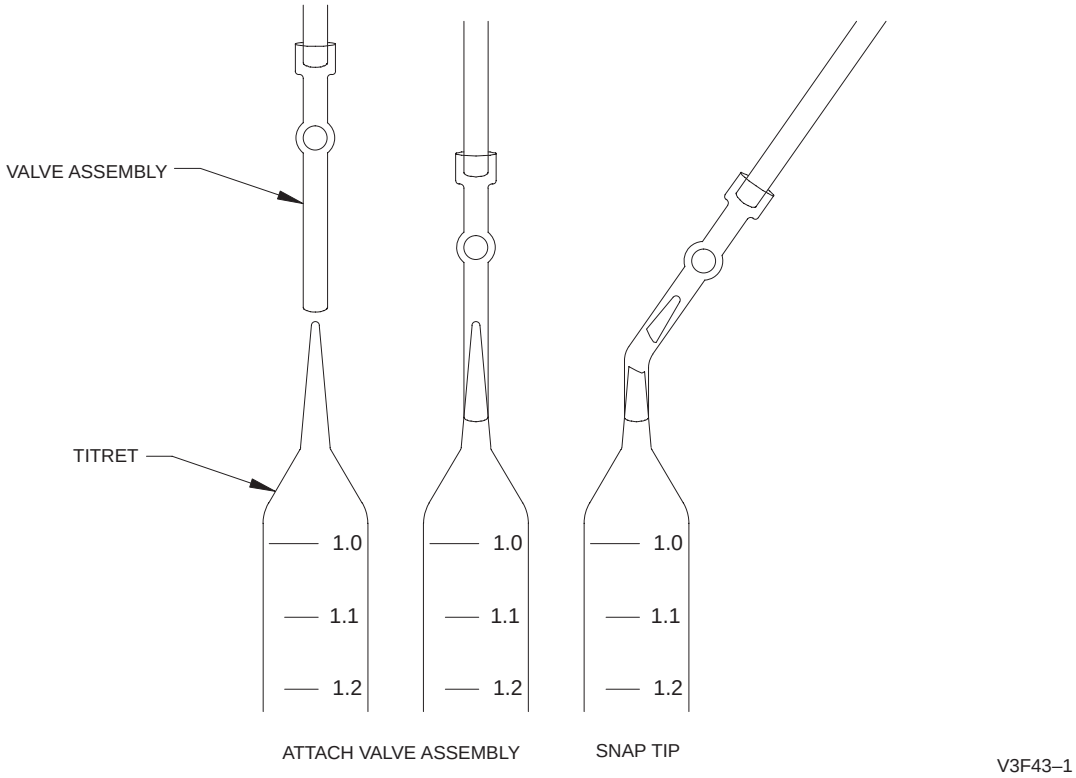

Figure 220−43−1. MBT Test: Titret and Valve Assembly

f. Immerse the tip of the sample tube in the sample.
g. Squeeze the bead valve briefly to draw sample into the Titret. Draw enough sample into the Titret to raise the liquid level one−third to one−half of one scale division. See Figure 220−43−2.
h. Rock the Titret back and forth several times to mix the contents. Watch for a color change from pink to pale yellow.

NOTE

Do not squeeze the bead valve unless the tip of the sample tube is immersed in the sample.

i. Repeat steps g and h until the color change occurs.
j. After the color change occurs, hold the Titret upright so that the numbers on the scale are right side up. Read the number of the scale corresponding to the level of liquid in the Titret. Record the scale reading in the log.

NOTE

Read the liquid level at the bottom of the meniscus (curvature at the upper surface of the liquid).

k. MBT Titrets are provided with two different scales, 1 to 10 and 50 to 500. Depending on the Titret scale, record the result as follows:

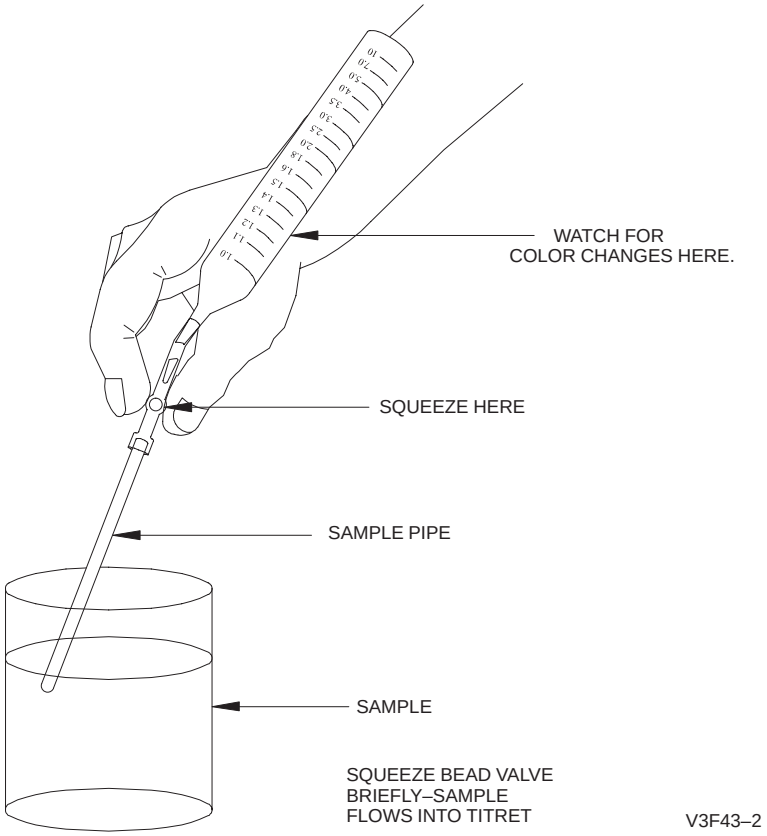

Figure 220−43−2. MBT Test: Drawing Sample into Titret

(1) If the scale on the Titret reads from 1 to 10, record the scale reading in the scale reading column in the log and then multiply the scale reading by 50 and record the result in ppm MBT column in the log. For example, for a scale reading of 7, MBT is calculated as follows:

$$7 \text{ X } 50 = 350 \text{ ppm MBT}$$

(2) If the scale reading on the Titret reads from 50 to 500, record the scale reading in both the scale reading and the ppm MBT columns in the log.

NOTE

If the liquid level does not reach the scale, record "> 500" for ppm MBT.

l. Dispose of the used Titret and valve assembly in such a manner that the broken glass does not present a safety hazard to personnel.

m. Retain the sample in the sample cup for use in the reserve alkalinity test.

220−43.15 RESERVE ALKALINITY TEST FOR COOLANT TREATED WITH MIL−A−53009. A reserve alkalinity test stick is dipped into a sample of MIL−A−53009 inhibitor treated coolant. After

a brief development time, the color on the stick's second zone as shown in Figure 220−43−3 (not the one on the end) is compared to a color chart to determine the reserve alkalinity level.

1. Apparatus

    a. Reserve alkalinity test kit (Radi−Aider or CoolTrak)

2. Interferences

    a. None normally present in this type of sample.

3. Procedure

    a. Open the bottle of reserve alkalinity test sticks, remove one test stick and recap the bottle.

NOTE

Check the expiration date on the bottle of reserve alkalinity test sticks. Do not use the test sticks if the expiration date has passed. In addition, inspect the second test zone (not the one the end) on the test stick. The zone should be yellow. Discard the test stick if the zone is pale blue or white since this indicates deterioration of the test stick due to moisture. The test zone on the end of the stick is not used.

NOTE

The reserve alkalinity test stick bottle shall be kept tightly closed.

    b. Dip the test stick, test zone down, into the sample far enough to immerse the second test zone. Remove immediately.

    c. Shake excess fluid from the test area and wait 15 seconds for the color to develop.

    d. Compare the color on the second test zone of the test stick (see Figure 220−43−3) with the corrosion protection color chart on the side of the test stick bottle. Do not use the percent glycol color chart.

NOTE

The reserve alkalinity color comparison chart on Radi−Aider test bottles has three squares labeled 3, 6, and 10. The reserve alkalinity color comparison chart on some CoolTrak test bottles has four unnumbered squares while on others it has three unnumbered squares. For kits with four unnumbered squares, label the color squares 1, 3, 6, and 10 from left (yellow) to right (blue−green) by writing the numbers under the squares. For kits with three unnumbered squares, label the color squares 3, 6, and 10 from left (yellow−green) to right (blue−green).

    (1) If the color on the stick matches the 6 square or the 10 square in the color chart, record that reserve alkalinity value (6 or 10) in the log.

    (2) If the color on the stick is a darker blue than the 10 square, record ">10" in the log.

    (3) If the color on the stick is between the 6 and the 10 squares, record "8" in the log.

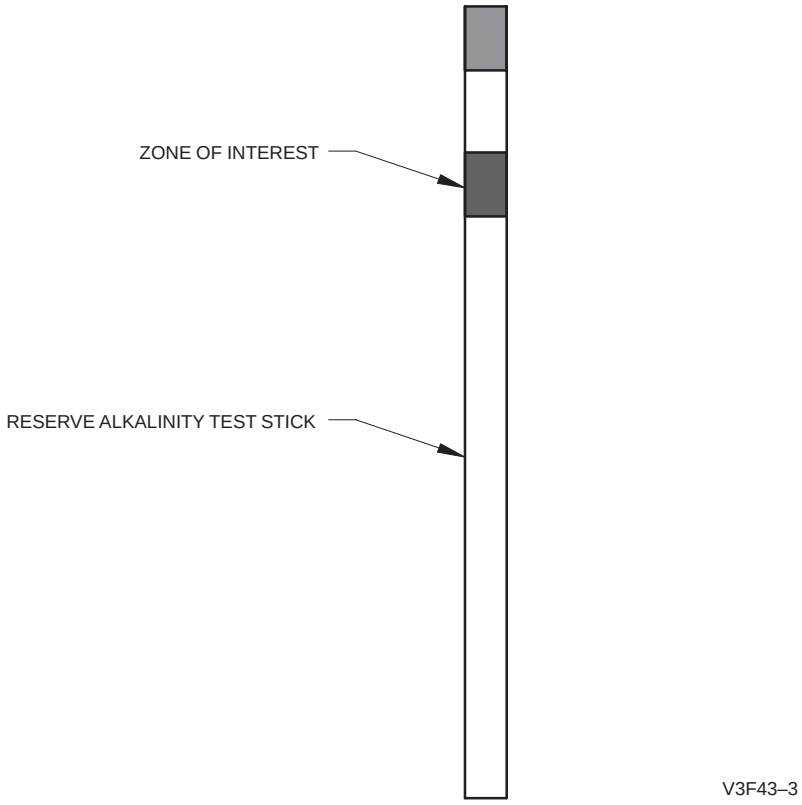

Figure 220−43−3. Reserve Alkalinity Test Stick

(4) If the color on the stick is more yellow or green than the 6 square, record "<6" in the log.

f. Pour the sample containing MIL−A−53009 inhibitor into a plastic 5 gallon or smaller bottle identified as containing borate wastes.

NOTE

Bottles containing borate wastes shall be turned into the Public Works Officer or Public Works Center at any naval facility.

220−43.16 DISTILLATE CONTAMINATION TEST FOR SHIPS WITH SINGLE−LOOP WASTE HEAT DISTILLING PLANTS. Phenolphthalein indicator is added to a 200 ml sample of distillate. MIL−A−53009 inhibitor contamination of distillate is indicated by the presence of a pink color.

NOTE

Minimize exposure of the sample to atmosphere. The test shall be completed within 30 minutes after obtaining the sample.

1. Apparatus

   a. Casserole
   b. Graduated cylinder, 100 ml

2. Reagents

   a. Phenolphthalein indicator (prepared in accordance with step 4)
   b. Distilled water

3. Interferences

   a. Absorption of carbon dioxide from the atmosphere can mask the presence of MIL−A− 53009 inhibitor in the distillate sample.

4. Preparing phenolphthalein indicator

WARNING

Isopropyl alcohol is toxic and flammable. Wear goggles, plastic gloves and rubber apron when handling isopropyl alcohol.

   a. Rinse the phenolphthalein indicator dropper bottle and its stopper with a small portion of isopropyl alcohol.
   b. Using a brass dipper, measure 2 level dippers of the phenolphthalein into the dropper bottle.

NOTE

Thoroughly clean the dipper before and after measuring phenolphthalein.

   c. Rinse a 100 ml graduated cylinder with distilled water and then with a small portion of isopropyl alcohol.
   d. Measure 25 ml of isopropyl alcohol with the graduated cylinder and pour into the dropper bottle, washing down any of the phenolphthalein powder clinging to the inside walls.
   e. Stopper the bottle in closed position and shake until all of the phenolphthalein is dissolved.
   f. Measure 25 ml of distilled water with the graduated cylinder and pour it into the dropper bottle.
   g. Stopper the bottle in the closed position and shake to mix.

NOTE

Phenolphthalein indicator has an indefinite shelf−life, both in powder form and in the prepared solution.

5. Procedure

   a. Rinse the casserole with distilled water.

NOTE

A clean casserole free from stains is necessary in order to observe the presence or absence of color. A specific casserole shall be designated for use in this test procedure only.

   b. Rinse the 100 ml graduated cylinder with distilled water and then with some of the water to be tested.
   c. Using the graduated cylinder, measure 200 ml of the sample into the casserole.
   d. Hold the casserole under a bright, direct light. Add 5 drops of phenolphthalein indicator. Watch the sample carefully while adding the phenolphthalein.

      (1) If the sample remains colorless, the test result is satisfactory.
      (2) If the sample turns pink, the distillate is contaminated with MIL−A−53009 inhibitor.

   e. Record the test result in the engineering log.

WARNING

If the sample turns pink upon addition of phenolphthalein indicator, immediate corrective action shall be taken. Refer to paragraph 220−43.10.

   f. Discard the sample. Rinse the casserole and graduated cylinder with distilled water.

220−43.17 SUPPLY INFORMATION FOR MIL−A−53009 INHIBITOR TREATMENT. Supply information for MIL−A−53009 treatment is given in Table 220−43−1.

Table 220−43−1. SUPPLY INFORMATION FOR MIL−A−53009 TREATMENT

Item	NSN	U/I	Qty	Notes
Treatment Chemicals				
Inhibitor, Corrosion, MIL−A−53009, 1 Qt	9G 6850−01−160−3868	QT	(a)	1,3
Inhibitor, Corrosion, MIL−A−53009, 1 Gal	9G 6850−01−287−8067	GL	(a)	1,3
Sampling Equipment				
Bottle, Screw Cap, Polyethylene, 1 Quart (32 oz)	9G 8125−00−819−6085	EA	(b)	2
Bottle, Screw Cap, Polyethylene, 1/2 Pint (8 oz)	9G 8125−00−680−0141	EA	(b)	2
Test Equipment and Chemicals				
Thermometer, Dial Type, 0 to 220˚F	9G 6685−00−373−3436	EA	2	
Chloride Test Strips, Quantab (50 per bottle)	9G 6850−00−180−6165	BT	(c)	3
Cupric Sulfate, ACS, 500 Grams	9G 6810−00−241−1203	BT	1	
Test Kit, Antifreeze (Reserve Alkalinity) (50 per bottle)	9L 6630−01−011−5039	EA	(c)	3
Graduated Cylinder, Plastic, 10 ml	9L 6640−00−982−7495	EA	2	
Beaker, 50 ml (pk of 12)	9L 6640−01−328−9684	PG	(d)	
Rod, Glass Stirring, 7 inches	9L 6640−00−290−0154	EA	3	
Funnel, Plastic	9L 6640−00−350−6343	EA	2	
Filter Paper (pk of 100)	9L 6640−00−866−1645	HD	1	
Dipper, Brass Measuring	9C 4410−01−077−2467	EA	2	
Test Kit, MBT (30 per box)	9L 6630−01−327−0617	SE	(e)	
Bottle, Screw Cap, 5 Gallons	9L 6640−01−083−9756	EA	1	4
Bottle, Screw Cap, 2.5 Gallons	9L 6640−01−083−9755	EA	1	4
Test Equipment and Chemicals for Distillate				
Phenolphthalein powder, 100 Grams	9G 6810−00−223−7612	BT	1	
Isopropyl Alcohol, 1 Gallon	9G 6810−00−227−0410	GL	1	
Casserole, Porcelain, White	9L 6640−00−412−8400	EA	2	
Graduated Cylinder, Plastic, 100 ml	9L 6640−00−889−7089	EA	1	
Bottle, Dropper, Plastic, 60 ml (pk of 12)	9L 6440−01−077−2468	PG	1	
Safety Equipment: See Table 220−48−3				

Notes:

(a) 24 quarts (6 gallons) of inhibitor are required for every 100 gallons of total engine coolant.
(b) 2 bottles (of either size) for each engine.
(c) 1 for each 4 engines.
(d) 4 beakers
(e) 1 for each 2 engines.

1. Inhibitor may be purchased in either size container, at the convenience of the ship.
2. Either size sample bottle may be used.
3. Shelf−life item.
4. Either size bottle may be used for storing waste from coolant testing.

SECTION 44. NALCOOL 2000 TREATMENT

WARNING

Skin or eye contact with Nalcool 2000 inhibitor or coolant containing Nalcool 2000 inhibitor shall be avoided. Wear face shield, rubber gloves and apron when handling concentrated Nalcool 2000 or when sampling a cooling system containing Nalcool 2000. Wear goggles, plastic gloves and rubber apron when handling coolant samples.

CAUTION

Nalcool 2000 is a patented formula manufactured by Nalco Chemical Company and Penray Chemical Company. No other manufacturers' products are authorized substitutes for Nalcool 2000.

220−44.1 Nalcool 2000 consists of a blend of inhibitor chemicals in aqueous solution. The major components are: sodium nitrite, sodium borate, sodium silicate and an organic copper inhibitor. Sodium nitrite aids in the formation of a protective oxide layer on ferrous metal surfaces. Sodium borate is an alkaline buffer which neutralizes acidic byproducts resulting from combustion blowby gasses leaking into the coolant. This provides a less corrosive environment in the engine coolant. Sodium silicate forms a silicate film on metal surfaces and provides effective corrosion protection for mixed metal systems. The organic copper inhibitor chemically bonds with copper contained in copper alloys resulting in a protective layer on the surface.

220−44.2 LIMITS. The following limits apply to Nalcool 2000 treated coolant:

Nitrite (NO_2^-) 1000 ppm minimum

Chloride 100 ppm maximum

If the nitrite level is below 1000 ppm, the Nalcool 2000 will not provide adequate corrosion protection. Chloride levels above 100 ppm indicate that seawater has leaked into the cooling system. This makes the coolant more corrosive and decreases the effectiveness of the Nalcool 2000. In addition, seawater contains hardness which will cause scale formation on hot metal surfaces.

220−44.3 INITIAL TREATMENT DOSAGE. Freshly fill the cooling system in accordance with paragraphs 220−42.3 through 220−42.4 using three gallons of Nalcool 2000 for each 100 gallons of cooling system capacity.

CAUTION

The cooling system shall be recirculated as soon as possible following the addition of chemicals in order to mix them thoroughly. Without recirculation, there will be variations in the Nalcool 2000 concentration throughout the coolant. This can result in accelerated corrosion in areas exposed to dilute coolant. The engine shall be operated within 24 hours of treatment. Earlier operation is preferable.

220−44.4 SAMPLING. Requirements for sampling are described in paragraphs 220−42.5 through 220−42.8.

220−44.5 ACTIONS FOR OUT−OF−LIMIT RESULTS. Whenever test results are not within the limits specified, the following actions shall be taken:

NOTE

Use water meeting the requirements of paragraph 220−42.1 for flushing the cooling system or adding water to the cooling system.

1. If the nitrite level is below 1000 ppm, add 1 gallon (8 pints) of Nalcool 2000 for each 100 gallons of cooling system capacity.

2. If the chloride concentration exceeds 100 ppm:

   a. Dump and flush the entire system.
   b. Locate and correct the source of seawater contamination.
   c. Fill the cooling system with water meeting the requirements of paragraph 220−42.1, then dump again.
   d. Sample and test the flush water for conductivity using the procedure specified in paragraph 220−42.11.
   e. Repeat steps c and d until the conductivity level in the flush water is less than 150 μmho/cm.
   f. Freshly fill and treat using the treatment dosage in paragraph 220−44.3.

NOTE

If overheating occurred during the contamination incident, inspect the cooling system prior to refilling for the presence of scale or corrosion deposits to determine the need for chemical cleaning. Inspection is also recommended if it is suspected that the contamination was severe or long term. If necessary, clean the system in accordance with paragraphs 220−50.5 through 220−50.8.

220−44.6 USE OF ANTIFREEZE AND NALCOOL 2000. Ships authorized to use Nalcool 2000 treatment shall use a mixture of Nalcool 2000 plus inhibited Antifreeze (MIL−A−46153) when freezing protection is required. Although inhibited Antifreeze contains corrosion inhibitors, Nalcool 2000 shall also be used in order to ensure adequate corrosion protection. The diesel engines on ships authorized to use Nalcool 2000 treatment are subject to cavitation corrosion of cylinder liners if Nalcool 2000 is not used.

220−44.7 Treatment Doses for Antifreeze and Nalcool 2000. When converting from Nalcool 2000 to inhibited Antifreeze/Nalcool 2000, the cooling system shall first be dumped. For each 100 gallons of cooling system capacity, add 33 gallons of inhibited Antifreeze and 3 gallons of Nalcool 2000. This provides freezing protection to 0°F. If additional freezing protection is required, use 40 gallons (instead of 33 gallons) of Antifreeze, plus 3 gallons of Nalcool 2000, per 100 gallons of cooling system capacity. This provides freezing protection to −10°F.

CAUTION

Dilute the Antifreeze with an equal amount of water meeting the requirements of paragraph 220−42.1 in the cooling system before adding the Nalcool 2000. Do not combine concentrated Antifreeze and Nalcool 2000 together; otherwise inhibited chemicals will precipitate out, adversely impacting engine reliability.

WARNING

Do not use higher doses of Antifreeze and Nalcool 2000 than specified. Use of higher doses can result in the formation of silicate gel deposits in heat exchangers. This can result in overheating.

220−44.8 Maintenance of Antifreeze and Nalcool 2000. The limits for Nalcool 2000 treatment also apply when Nalcool 2000 and Antifreeze are used together. However, the chloride test procedure for Antifreeze treated coolant (paragraph 220−45.11) shall be used. This procedure is the same as the chloride test for Nalcool 2000 treated coolant except that the sample is diluted (due to the presence of ethylene glycol in the Antifreeze) and the result is multiplied by two. In addition to chloride and nitrite, all samples shall be tested for freezing protection. Freezing protection shall be maintained between 5 and −19° F (30−44% Antifreeze). Table 220−44−1 gives Antifreeze mixtures which provide different degrees of freezing protection. The testing procedure to determine freezing protection is given in paragraph 220−45.13. Results of the freezing protection test shall be recorded in the remarks section of the treatment log.

Table 220−44−1. Freeze Protection of Antifreeze Mixtures (Nalcool 2000 Treatment)

Lowest Anticipated Temperature	Quarts of Antifreeze	Quarts of Water	Antifreeze Concentration (Percent)
5 °F	3	7	30
1 °F	1	2	33
−10 °F	2	3	40
−19 °F	4	5	44
Note: A 33% concentration of Antifreeze is normally recommended when used with Nalcool 2000			

220−44.9 WASTE HEAT RECOVERY LOOP ON FFG−7 CLASS. FFG−7 class ships are equipped with a distilled water loop which transfers waste heat from the engine coolant to the distilling plant. In the event of dual heat exchanger failures, Nalcool 2000 treated coolant can leak into the waste heat recovery loop and then into the distiller. The potential would then exist for contaminating distillate (and therefore potable water) with toxic Nalcool 2000. Personnel shall remain alert for signs of unexplained coolant loss such as a decrease in expansion tank level.

220−44.10 Waste Heat Recovery Loop Sampling Requirements. The waste heat recovery loop shall be sampled and tested for nitrite level daily. This requirement applies when waste heat is used to operate the distilling plant at any time during the day. Waste heat recovery loop test results shall be recorded in the engineering log.

220−44.11 Waste Heat Recovery Loop Sampling Procedure. Obtain the sample from a convenient location in the common line upstream of the supplementary electric heater as follows:

1. Allow sample to flow from the drain cock long enough to thoroughly flush the drain cock.
2. Thoroughly rinse the sample bottle and cap with sample.
3. Fill the sample bottle with sample and cap.

NOTE

Designate a specific sample bottle for waste heat recovery loop samples. Never use a sample bottle which has been used for engine coolant samples to test for distillate contamination.

220−44.12 Waste Heat Recovery Loop Nitrite Limit and Corrective Action. The nitrite level in the waste heat recovery loop shall not exceed 25 ppm. If the nitrite level exceeds 25 ppm, take the following corrective actions immediately:

1. Secure the distilling plant.
2. Dump the waste heat recovery loop.
3. Locate and correct the source of contamination.
4. Flush the waste heat recovery loop with distillate.
5. Sample and test during the flush operations.
6. Continue flushing until the nitrite level is satisfactory.

220−44.13 ENGINE COOLANT RECORD NALCOOL 2000 TREATMENT. The requirements for keeping engine coolant records (logs) and personnel responsibilities are described in Section 49.

220−44.14 TESTING PROCEDURES FOR NALCOOL 2000 TREATMENT. Effective treatment of cooling systems is based upon the accurate performance and interpretation of the tests that determine coolant quality. If these tests are not performed properly, the coolant will not be treated properly. It is necessary to carefully follow these test procedures in order to ensure accurate results.

220−44.15 CHLORIDE TEST FOR COOLANT TREATED WITH NALCOOL 2000. This procedure is not suitable for coolant treated with Nalcool 2000 plus Antifreeze. For coolant treated with Nalcool 2000 plus Antifreeze, use the procedure in paragraph 220−45.11. Two dippers of cupric sulfate are added to a 10 ml sample of Nalcool 2000 treated coolant. After a brief standing period, the sample is filtered. The end of a Quantab chloride test strip is immersed in the sample. After an exposure interval, the Quantab is removed from the solution and the scale reading is obtained. The reading is converted to ppm chloride by using a conversion chart.

1. Apparatus

    a. Filter paper
    b. Funnel

c. Brass dipper
d. Beaker, 50 ml (2)
e. Graduated cylinder, 10 ml.
f. Quantab chloride test strips
g. Stirring rod

2. Reagents

a. Distilled water.
b. Cupric sulfate.

3. Interferences

a. The organic copper inhibitor present in Nalcool 2000 interferes with the Quantabs. The addition of cupric sulfate to the sample causes the organic copper inhibitor to precipitate out, thus eliminating the interference.
b. Ethylene glycol in Antifreeze causes the Quantab to work very slowly. For engines treated with Nalcool 2000 plus Antifreeze, use the procedure in paragraph 220−45.11.

WARNING

Wear goggles, plastic gloves, and a rubber apron when handling cupric sulfate.

4. Procedure

NOTE

The following chloride test procedure is for use on ships using Nalcool 2000 alone. Ships using Nalcool 2000 plus Antifreeze shall use the procedure in paragraph 220−45.11.

a. Rinse the 10 ml graduated cylinder, the funnel, the stirring rod and two 50 ml beakers with distilled water.
b. Rinse the 10 ml graduated cylinder with a small portion of sample.
c. Measure 10 ml of sample in the graduated cylinder. Pour the sample into one of the 50 ml beakers.
d. Add 2 dippers of cupric sulfate to the sample in the beaker. Stir to mix using the stirring rod.
e. Let the solution stand five minutes.
f. Filter the sample as follows:

(1) Fold the circular filter paper in half and then fold in half again.
(2) Open the folded filter paper to form a cone and place the cone in the funnel.
(3) Place the funnel in the other 50 ml beaker.
(4) Carefully pour the sample into the filter paper cone inside the funnel. Do not allow the level to reach the upper end of the paper.

g. Open the Quantab bottle, remove one test strip and recap the bottle.

NOTE

Check the expiration date on the Quantab bottle label. Do not use the Quantab if the expiration date has passed.

NOTE

The Quantab bottle shall be kept tightly closed.

h. Into the beaker containing the filtered sample, place the test strip with the word "Quantab" up and the numbered scale facing the person performing the test. Note the time.

NOTE

Never immerse the entire Quantab strip beneath the level of the solution being tested; otherwise the test strip will give a false low result.

i. Leave the test strip in the beaker until the horizontal yellow−orange band across the top of the strip turns dark blue. This normally takes about 10−20 minutes. The blue color signals that the test is ended. Remove the test strip from the beaker within 5 minutes after the blue color appears.
j. Read the number on the scale corresponding to the highest point at the upper tip of the white color change. Estimate to the nearest half division. Each division equals 0.20. Record the scale reading in the log.
k. Find the scale reading and the corresponding chloride results (column marked "ppm Chloride") on the calibration chart provided with the bottle of Quantabs. Record the chloride result in the log. If the scale reading is lower than the lowest reading on the chart, record "< (lowest chloride concentration on the chart)". For example, if the lowest scale reading on the chart is 1.4 and this corresponds to 30 ppm chloride, record "<30" in the log.
l. Pour the samples containing Nalcool 2000 into a plastic 5−gallon bottle identified as containing nitrite, borate and cupric sulfate wastes.
m. Rinse the graduated cylinder, funnel and beakers with distilled water. Pour the sample waste water into the waste bottle. Place the soiled filter paper into the waste bottle.

NOTE

Bottles containing nitrite, borate and cupric sulfate wastes shall be turned in to the Public Works Officer or Public Works Center at any naval facility.

220−44.16 NITRITE TEST FOR COOLANT TREATED WITH NALCOOL 2000. One ml of Nalcool 2000 treated coolant is diluted to 100 ml with distilled water. A nitrite test stick is dipped into the diluted sample. After a brief development time, the color on the stick is compared to a color chart to determine the nitrite content.

1. Apparatus

   a. Nalfleet test kit (includes graduated dropper, 100 ml measuring cylinder and nitrite test stick).

2. Reagents

a. Distilled water.

3. Interferences

a. The sample shall be diluted so that the nitrite level will be within the range of the test sticks.

4. Procedure

a. Rinse the graduated dropper with distilled water and then with a small portion of sample.
b. Using the graduated dropper, add one ml of sample to the 100 ml measuring cylinder.
c. Add distilled water to the 100 ml mark and mix well.
d. Open the container of nitrite test sticks, remove one test stick and recap the container.

NOTE

Check the expiration date on the nitrite test stick container label. Do not use the test sticks if the expiration date has passed.

NOTE

The nitrite test stick container shall be kept tightly closed.

e. Dip a nitrite test stick, test zone down, into the dilute solution for three seconds.
f. After removing the test stick, wait 15 seconds to allow the color to develop.
g. Compare the color on the test stick with the color chart on the side of the test stick container.

(1) If the color is equal to or darker than 10, the nitrite level is equal to or greater than the 1000 ppm minimum required. Record “1000 or >1000” in the log as appropriate.
(2) If the color is lighter than 10, the nitrite level is less than the 1000 ppm minimum required. Record “<1000” in the log.

h. Pour the sample containing Nalcool 2000 into a plastic 5 gallon bottle identified as containing nitrite and borate wastes.
i. Rinse the graduated dropper and measuring cylinder with distilled water. Pour the sample waste water into the waste bottle.

NOTE

Bottles containing nitrite and borate wastes shall be turned in to the Public Works Officer or Public Works Center at any naval facility.

220−44.17 WASTE HEAT RECOVERY LOOP NITRITE TEST FOR FFG−7. A nitrite test stick is dipped into a sample from the waste heat recovery loop. After a brief development time, the color on the stick is compared to a color chart to determine the nitrite concentration.

1. Apparatus

a. Nitrite test sticks

2. Interferences

   a. None normally present in this type of sample

3. Procedure

   a. Open the container of nitrite test sticks, remove one test stick and recap the container.

NOTE

Check the expiration date on the test stick container label. Do not use the test sticks if the expiration date has passed.

NOTE

The nitrite test stick container shall be kept tightly closed.

   b. Dip the nitrite test stick, test zone down, into the sample for three seconds.
   c. After removing the test stick, wait 15 seconds to allow the color to develop.
   d. Compare the color on the test stick with the color chart on the side of the test stick container.

      (1) If the color is equal to or lighter than 25, the nitrite level is equal to or less than the 25 ppm limit. In the engineering log, record the concentration that most closely matches the color.

      (2) If the color is darker than 25, the nitrite level exceeds the 25 ppm limit. In the engineering log, record the concentration that most closely matches the color.

WARNING

If the nitrite concentration is 25 ppm or more, immediate corrective action shall be taken. Refer to paragraph 220−44.12.

220−44.18 SUPPLY INFORMATION FOR NALCOOL 2000 TREATMENT. Supply information for Nalcool 2000 treatment is given in Table 220−44−2.

Table 220−44−2. Supply Information for Nalcool 2000 Treatment

Item	NSN	U/I	Qty	Notes
Treatment Chemicals				
Inhibitor, Corrosion, Nalcool 2000, $ gal (2 qt)	9G 6850−01−085−4718	BT	(a)	1
Inhibitor, Corrosion, Nalcool 2000, 15 gal	9G 6850−01−087−4045	DR	(a)	1
Inhibitor, Corrosion, Nalcool 2000, 55 gal	9G 6850−01−086−3438	DR	(a)	1
Sampling Equipment				
Bottle, Polyethylene, Screw Cap, 1 Quart (32 oz)	9G 8125−00−819−6085	EA	(b)	2
Bottle, Polyethylene, Screw Cap, $ Pint (8 oz)	9G 8125−00−680−0141	EA	(b)	2
Test Equipment and Chemicals				
Nalfleet test kit	9G 6850−01−154−3655	BX	1	3
Nitrite test sticks (2 tubes of 100)	9G 6850−01−154−3653	BX	1	4
Thermometer, Dial Type, 0 to 220 °F	9G 6685−00−373−3436	EA	2	
Chloride Test Strips, Quantabs (50 per bottle)	9G 6850−00−180−6165	BT	(c)	4
Cupric Sulfate, ACS, 500 Grams	9G 6810−00−241−1203	BT	1	
Graduated Cylinder, Plastic, 10 ml	9L 6640−00−982−7495	EA	2	
Beaker, 50 ml (pk of 12)	9L 6640−01−328−9684	PG	(d)	
Rod, Glass Stirring, 7 inches	9L 6640−00−290−0154	EA	3	
Funnel, Plastic	9L 6640−00−350−6343	EA	2	
Filter Paper (pk of 100)	9L 6640−00−866−1645	HD	1	
Dipper, Brass Measuring	9C 4410−01−077−2467	EA	2	
Bottle, Screw Cap, 5 Gallons	9L 6640−01−083−9756	EA	1	5
Bottle, Screw Cap, 2.5 Gallons	9L 6640−01−083−9755	EA	1	5
Safety Equipment: See Table 220−48−3				

Notes:

(a) 24 quarts (6 gallons) of inhibitor for every 100 gallons of total engine coolant.
(b) 2 bottle (of either size) for each engine.
(c) 1 for each 4 engines.
(d) 4 beakers.
1. Inhibitor may be purchased in any size container at the convenience of the ship.
2. Either size sample bottle may be used.
3. Kit Contains 100 ml graduated cylinder with stopper top, and nitrite test sticks. Also contains pH test strips which are not used.
4. Shelf−life item.
5. Either size bottle may be used for storing waste from coolant testing.

SECTION 45. MIL−A−46153 INHIBITED ANTIFREEZE

WARNING

Skin or eye contact with Antifreeze or coolant containing Antifreeze shall be avoided. Wear face shield, rubber gloves and apron when handling concentrated Antifreeze or when sampling a cooling system containing Inhibited Antifreeze. Wear goggles, plastic gloves and rubber apron when handling coolant samples.

220−45.1 Inhibited Antifreeze (MIL−A−46153) consists of ethylene glycol and corrosion inhibiting chemicals (sodium borate, trisodium phosphate and an organic copper inhibitor). A mixture (solution) of ethylene glycol and water has a lower freezing point than either water or ethylene glycol alone. Thus, treating a cooling system with a mixture of ethylene glycol and water provides freezing protection. Sodium borate is an alkaline buffer which neutralizes acidic by products resulting from combustion blowby gases leaking into the coolant. Trisodium phosphate contributes additional alkalinity and aids in the formation of a protective layer on metal surfaces. The organic copper inhibitor chemically bonds with copper contained in copper alloys resulting in a protective film on the surfaces.

CAUTION

Use only MIL−A−46513 inhibited Antifreeze. This Antifreeze is labeled: “U.S. Government Property, Ethylene Glycol, Antifreeze”. The label also contains the stock number. Verify that the stock number matches the appropriate number (depending on container size) given in Table 220−45−2. Different brands of commercial Antifreezes are formulated with different corrosion inhibiting chemicals which may or may not be effective. The different inhibitor packages may also be incompatible with each other and with the inhibitors in MIL−A−46153 Antifreeze. In addition, the Antifreeze test procedures will only give accurate results for coolant treated with MIL−A−46153 inhibited Antifreeze.

220−45.2 LIMITS. The following limits apply to Antifreeze treated coolant:

Reserve Alkalinity	6 RA units minimum
Chloride	100 ppm max
Freeze Protection	1° F to −30° F (33−50% Antifreeze)

(See Table 220−45−1 and paragraph 220−45.3)

Reserve alkalinity levels less than 6 RA units can result in accelerated corrosion. Chloride levels above 100 ppm indicate that seawater has leaked into the cooling system. This makes the coolant more corrosive and decreases the ability of the inhibited Antifreeze to inhibit corrosion. In addition, seawater contains hardness which can result in scale formation on hot metal surfaces.

Table 220−45−1. Freeze Protection of Antifreeze Mixtures

Lowest Anticipated Temperature	Quarts of Antifreeze	Quarts of Water	Antifreeze Concentration (Percent)
1 ˚F	1	2	33
−10 ˚F	2	3	40
−19 ˚F	4	5	44
−30 ˚F	1	1	50
−77 ˚F	2	1	67
Note: A 50% concentration of Antifreeze is normally recommended			

220−45.3 TREATMENT DOSAGES

CAUTION

Never use Antifreeze concentrations greater than 67 percent or less than 33 percent.

CAUTION

Use water meeting the requirements of paragraph 220−42.1 when adding water to a cooling system.

Table 220−45−1 gives Antifreeze mixtures which provide different degrees of freezing protection. However, the treatment dosage normally recommended is 50 percent Antifreeze (one gallon of Antifreeze mixed with one gallon water for every two gallons of cooling system capacity.) This mixture provides freezing protection down to −30 ˚F and supplies an ample amount of corrosion inhibitors. If conditions are such that additional freezing protection is required, up to 67 percent Antifreeze can be used (six gallons of Antifreeze mixed with three gallons of water.) This mixture provides freezing protection down to −77˚ F.

CAUTION

Never use Antifreeze concentrations greater than 67 percent because the following will occur:

a. Less freezing protection is provided (pure Antifreeze freezes at 9˚ F).

b. The engine may overheat because ethylene glycol has a lower heat transfer capability than water.

c. The corrosion inhibitors will not function properly.

CAUTION

Do not use Antifreeze concentrations less than 33 percent (one gallon of Antifreeze mixed with two gallons of water) because there will not be sufficient corrosion inhibitors to provide adequate corrosion protection.

220−45.4 Antifreeze treated coolant shall be changed out every two years.

220−45.5 SAMPLING. Requirements for sampling are described in paragraphs 220−42.5 through 220−42.8.

220−45.6 ACTIONS FOR OUT−OF−LIMITS RESULTS. Whenever test results are not within the limits specified, the following actions shall be taken:

NOTE

Use water meeting the requirements of paragraph 220−42.1 for flushing the cooling system or adding water to the cooling system.

1. If freezing protection is inadequate for anticipated weather conditions or if the Antifreeze concentrations is less than the 33 percent minimum, dump some of the coolant and replace with a quantity of Antifreeze sufficient to provide the needed freezing protection.
2. If the Antifreeze concentration exceeds the 67 percent maximum (specific gravity greater than 1.0970 at 60° F), dump some of the coolant and replace with water meeting the requirements of paragraph 220−42.1.
3. If the reserve alkalinity is less than 6 RA units:

    a. Dump the entire cooling system.
    b. Freshly fill and treat.

4. If the chloride concentration exceeds 100 ppm:

    a. Dump and flush the entire system.
    b. Locate and correct the source of seawater contamination.
    c. Fill the cooling system with water meeting the requirements of paragraph 220−42.1, then dump again.
    d. Sample and test the flush water for conductivity using the procedure specified in paragraph 220−42.11.
    e. Repeat steps c and d until the conductivity level in the flush water is less than 150 μmho/cm.
    f. Freshly fill and treat using the treatment dosage in paragraph 220−45.3.

NOTE

If overheating occurred during the contamination incident, inspect the cooling system prior to refilling for the presence of scale or corrosion deposits to determine the need for chemical cleaning. Inspection is also recommended if it is suspected that the contamination was severe or long term. If necessary, clean the system in accordance with paragraphs 220−50.5 through 220−50.8.

220−45.7 ANTIFREEZE USE ON SHIPS WITH SINGLE−LOOP WASTE HEAT DISTILLING PLANTS. When Antifreeze treatment is used in the main diesel engine on ships equipped with single−loop waste heat distilling plants, failure of the heat exchanger supplying waste heat to the distiller will allow Antifreeze to leak into the distiller. If this happens, tests have shown that the distillate (and therefore potable water) will become contaminated with toxic ethylene glycol.

WARNING

Antifreeze contaminated distillate shall not be used as drinking water.

NOTE

Antifreeze shall only be used on ships with single−loop waste heat distilling plants during periods when freezing protection is necessary. As soon as freezing protection is no longer required, convert to the cooling system treatment authorized for use when freezing protection is not required (refer to Table 220−42−1).

220−45.8 Required Precautions For Ships With Single−Loop Waste Heat Distilling Plants. When Antifreeze is used in the main diesel engines on ships with single−loop waste heat distillers, the following actions shall be taken:

1. Log the jacket water expansion tank level hourly.
2. The log shall be reviewed prior to sending distillate to a potable water tank.
3. If coolant loss has occurred, do not send distillate to the potable water tank until the source of the loss is determined.
4. If the source of the loss cannot be found, assume that a leak has occurred in the heat exchanger supplying waste heat to the distiller.

WARNING

In the event of a heat exchanger leak, immediate corrective action shall be taken. Do not send distillate to potable water tanks. Dump all potable water tanks to which distillate has been sent since the leak occurred or since the last satisfactory expansion tank reading. Locate and correct the source of the leakage. Thoroughly flush the affected potable water tanks with distillate (when satisfactory distillate is available).

220−45.9 ENGINE COOLANT RECORD ANTIFREEZE TREATMENT. The requirements for keeping engine coolant records (logs) and personnel responsibilities are described in Section 49.

220−45.10 TESTING PROCEDURES FOR INHIBITED ANTIFREEZE TREATMENT. Effective treatment of cooling systems is based upon the accurate performance and interpretation of the tests that determine coolant quality. If these tests are not performed properly, the coolant will not be treated properly. It is necessary to carefully follow these test procedures in order to ensure accurate results.

220−45.11 CHLORIDE TEST FOR COOLANT TREATED WITH ANTIFREEZE. A 10 ml sample of Antifreeze treated coolant is diluted with 10 ml of distilled water. Two dippers of cupric sulfate are added to the diluted sample. After a brief standing period, the sample is filtered. The end of a Quantab chloride test strip is immersed in the sample. After an exposure interval, the Quantab is removed from the solution and the scale reading is obtained. The reading is converted to ppm chloride by using a conversion chart and multiplying the result by two.

1. Apparatus

   a. Filter paper
   b. Funnel
   c. Brass dipper
   d. Beaker, 50 ml (2)
   e. Graduated cylinder, 10 ml.
   f. Quantab chloride test strips
   g. Stirring rod

2. Reagents

   a. Distilled water.
   b. Cupric sulfate.

3. Interferences

   a. The organic copper inhibitor present in inhibited Antifreeze interferes with the Quantabs. The addition of cupric sulfate to the sample causes the copper inhibitor to precipitate out, thus eliminating the interference.

   b. The ethylene glycol in the Antifreeze causes the Quantab to work very slowly. Diluting the sample eliminates the problem.

WARNING

Wear goggles, plastic gloves and rubber apron when handling cupric sulfate.

4. Procedure

   a. Rinse the 10 ml graduated cylinder, the funnel, the stirring rod and two 50 ml beakers with distilled water.
   b. Rinse the 10 ml graduated cylinder with a small portion of sample.
   c. Measure 10 ml of sample in the graduated cylinder. Pour the sample into one of the 50 ml beakers.
   d. Rinse the graduated cylinder with distilled water. Measure 10 ml of distilled water in the graduated cylinder. Pour the distilled water into the beaker containing the sample.
   e. Add 2 dippers of cupric sulfate to the diluted sample in the beaker. Stir to mix using the stirring rod.
   f. Let the solution stand five minutes.
   g. Filter the sample as follows:

      (1) Fold the circular filter paper in half and then fold in half again
      (2) Open the folded filter paper to form a cone and place the cone in the funnel ml beaker.
      (3) Place the funnel in the other 50 ml beaker
      (4) Carefully pour the sample into the filter paper cone inside the funnel. Do not allow the level to reach the upper edge of the paper.

h. Open the Quantab bottle, remove one test strip and recap the bottle.

NOTE

The Quantab bottle shall be kept tightly closed.

i. Into the beaker containing the filtered sample place the test strip with the word "Quantab" up and the numbered scale facing the person performing the test. Note the time.

NOTE

Never immerse the entire Quantab strip beneath the level of the solution being tested; otherwise the test strip will give a false low result.

j. Leave the test strip in the beaker until the horizontal yellow−orange band across the top of the strip turns dark blue. This normally takes about 10−20 minutes. The blue color signals that the test is ended. Remove the test strip from the beaker within 5 minutes after the blue color appears.
k. Read the number on the scale corresponding to the highest point at the upper tip of the white color change. Estimate to the nearest half division. Each division equals 0.2. Record the scale reading in the log.
l. Find the scale reading and the corresponding chloride result (column marked "ppm Cl^-") on the conversion chart provided with the bottle of Quantabs. Record the chloride reading in the log. If the scale reading is lower than the lowest reading on the chart, record "<(lowest chloride concentration on the chart)". For example, if the lowest scale reading on the chart is 1.4 and this corresponds to 30 ppm chloride, record "<30" in the log.
m. Multiply the chloride reading from the chart by 2 and record the result in ppm chloride in the log. Using the above example, <30 x 2 = <60. Record <60 in the log.
n. Pour the samples containing inhibited Antifreeze into a plastic 5 gallon bottle identified as containing ethylene glycol, borate and cupric sulfate wastes.
o. Rinse the graduated cylinder, funnel and beakers with distilled water. Pour the sample waste water into the waste bottle. Place the soiled filter paper into the waste bottle.

NOTE

Bottles containing ethylene glycol, borate and cupric sulfate wastes shall be turned in to the Public Works Officer or Public Works Center at any Naval Shipyard or other Navy industrial facility.

220−45.12 RESERVE ALKALINITY TEST FOR COOLANT TREATED WITH ANTIFREEZE. A reserve alkalinity test stick is dipped into a sample of Antifreeze treated coolant. After a brief development time, the color on the stick's second test zone (see Figure 220−45−1) is compared to a color chart to determine the corrosion inhibitor level.

1. Apparatus

   a. Reserve alkalinity test kit (Radi−Aider or CoolTrak)

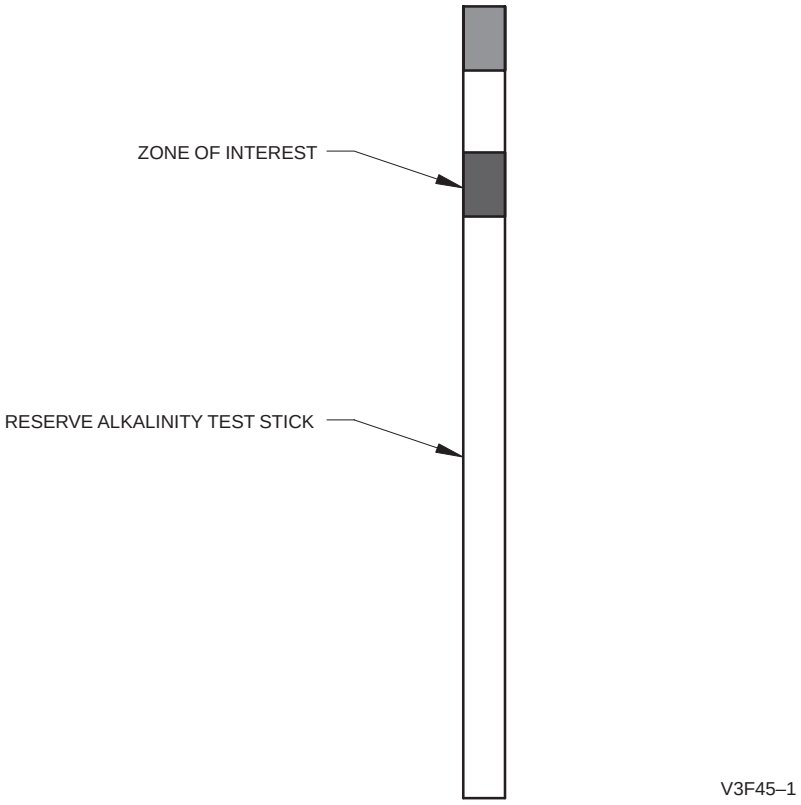

Figure 220−45−1. Reserve Alkalinity Test Stick

2. Interferences

   a. None normally present in this type of sample

3. Procedure

   a. Open the bottle of reserve alkalinity test sticks, remove one test stick and recap the bottle.

NOTE

Check the expiration date on the bottle of reserve alkalinity test sticks. Do not use the test sticks if the expiration date has passed. In addition, inspect the second test zone (not the one on the end) on the test stick. The zone should be yellow. Discard the test stick if the zone is pale blue or white since this indicates deterioration of the test stick due to moisture. Although the test zone on the end of the test stick is designed for determining freezing protection, it is not used in Navy tests. Only the freezing protection test procedure in paragraph 220−45.13 is authorized.

NOTE

The reserve alkalinity test stick bottle shall be kept tightly closed.

b. Dip the test stick, test zone down, into the sample far enough to immerse the second test zone. Remove immediately.
c. Shake excess fluid from the test area and wait 15 seconds for the color to develop.
d. Compare the color on the second test zone of the stick (see Figure 220−45−1) with the corrosion protection color chart on the side of the test stick bottle. (Do not use the percent glycol color chart.)

NOTE

The reserve alkalinity color comparison chart on Radi−Aider test bottles has three squares labeled 3, 6, and 10. The reserve alkalinity color comparison chart on some CoolTrak test bottles has four unnumbered squares while on others it has three unnumbered squares. For kits with four unnumbered squares, label the color squares 1, 3, 6, and 10 from left (yellow) to right (blue−green) by writing the numbers under the squares. For kits with three unnumbered squares, label the color squares 3, 6, and 10 from left (yellow−green) to right (blue−green).

(1) If the color on the stick matches the 6 square or the 10 square in the color chart, record that reserved alkalinity value (“6” or “ 10”) in the log.
(2) If the color on the stick is a darker blue than the 10 square, record “>10” in the log.
(3) If the color on the stick is between the 6 and the 10 squares, record “8” in the log.
(4) If the color on the stick is more yellow or green than the 6 square, the corrosion inhibitor level is below the required level. Record “<6” in the log.

e. Pour the sample containing Antifreeze into a plastic 5 gallon bottle identified as containing ethylene glycol and borate wastes.

NOTE

Bottles containing ethylene glycol and borate wastes shall be turned in to the Public Works Officer or Public Works Center at any naval facility.

220−45.13 FREEZING PROTECTION TEST. A sample of Antifreeze treated coolant is drawn into an Antifreeze tester. Float and temperature readings are taken. Freezing protection is determined using a temperature variance table.

1. Apparatus

   a. Antifreeze tester

2. Reagents

   a. Distilled water

3. Interferences

   a. None normally present in this type of sample

4. Procedure

   a. Draw distilled water into the Antifreeze tester and rinse it.

   b. Insert the tester into the sample.

   c. Draw sample into the tester and rinse.

   d. Insert the tester into the sample.

   e. Draw sample into the tester.

   f. Observe coolant protection float and temperature readings.

   g. Determine the adjusted coolant protection (freezing protection) using the temperature variance table provided with the Antifreeze tester.

   h. Pour the sample containing Antifreeze into a plastic 5 gallon bottle identified as containing ethylene glycol and borate wastes.

   i. Rinse the Antifreeze tester with distilled water. Pour the sample waste water into the waste bottle.

NOTE

Bottles containing ethylene glycol and borate wastes shall be turned in to the Public Works Officer or Public Works Center at any naval facility.

220−45.14 SUPPLY INFORMATION FOR INHIBITED ANTIFREEZE TREATMENT. Supply information for Antifreeze treatment is given in Table 220−45−2.

Table 220−45−2. Supply Information for Antifreeze Treatment

Item	NSN	U/I	Qty	Notes
Treatment Chemicals				
Antifreeze, Inhibited, MIL−A−46153, 1 gal	9G 6850−00−181−7929	GL	(a)	1
Antifreeze, Inhibited, MIL−A−46153, 5 gal	9G 6850−00−181−7933	CN	(a)	1
Antifreeze, Inhibited, MIL−A−46153, 55 gal	9G 6850−00−181−7940	DR	(a)	1
Sampling Equipment				
Bottle, Polyethylene, Screw Cap, 1 Quart (32 oz)	9G 8125−00−819−6085	EA	(b)	2
Bottle, Polyethylene, Screw Cap, 1/2 Pint (8 oz)	9G 8125−00−680−0141	EA	(b)	2
Test Equipment and Chemicals				
Antifreeze Tester (freeze protection) (hydrometer)	9L 6630−00−247−2968	EA	1	
Thermometer, Dial Type, 0 to 220 ˚F	9G 6685−00−373−3436	EA	2	
Chloride Test Strips, Quantabs (50 per bottle)	9G 6850−00−180−6165	BT	(c)	3
Cupric Sulfate, ACS, 500 Grams	9G 6810−00−241−1203	BT	1	
Test Kit, Antifreeze (Reserve Alkalinity) (50 per bottle)	9L 6630−01−011−5039	EA	(c)	
Graduated Cylinder, Plastic, 10 ml	9L 6640−00−982−7495	EA	2	
Beaker, 50 ml (pk of 12)	9L 6640−01−328−9684	PG	(d)	
Rod, Glass Stirring, 7 inches (pk of 6)	9L 6640−00−290−0154	EA	3	
Funnel, Plastic	9L 6640−00−350−6343	EA	2	
Filter Paper (pk of 100)	9L 6640−00−866−1645	HD	1	
Dipper, Brass Measuring	9C 4410−01−077−2467	EA	2	
Bottle, Screw Cap, 5 Gallons	9L 6640−01−083−9756	EA	1	4
Bottle, Screw Cap, 2.5 Gallons	9L 6640−01−083−9755	EA	1	4
Safety Equipment: See Table 220−48−3				

Notes:

(a) 100 gallons antifreeze for every 100 gallons total engine coolant.
(b) 2 bottles (of either size) for each engine.
(c) 1 for each 4 engines.
(d) 4 beakers.

1. Antifreeze may be purchased in any size container at the convenience of the ship.
2. Either size sample bottle may be used.
3. Shelf−life item.
4. Either size bottle may be used for storing waste from coolant testing.

SECTION 46. MIL−I−24453 SOLUBLE OIL TREATMENT

WARNING

Skin or eye contact with Soluble Oil shall be avoided. Wear face shield, rubber gloves and apron when handling concentrated Soluble Oil or when sampling a cooling system containing Soluble Oil. Wear goggles, plastic gloves and rubber apron when handling coolant samples.

220−46.1 Soluble Oil provides a thin protective oil film on metal surfaces which helps minimize corrosion. This treatment is authorized for ships with heat rejecting aluminum surfaces (e.g. aluminum blocks) and single−loop waste heat distilling plants.

220−46.2 LIMITS. The following limits apply to Soluble Oil treated coolant:

Soluble Oil	1.0 to 2.0 percent
Chloride	100 ppm maximum

Soluble Oil levels below 1.0 percent will not provide adequate corrosion protection. Soluble Oil levels above 2.0 percent can lead to the formation of insulating films which restrict heat transfer and can cause overheating. High Soluble Oil levels can also cause the Soluble Oil to separate from the water. Chloride levels above 100 ppm indicate that seawater has leaked into the cooling system. This makes the coolant more corrosive. Seawater contains hardness which will cause scale formation on hot metal surfaces. In addition, seawater can cause the Soluble Oil to separate from the water.

220−46.3 INITIAL TREATMENT DOSAGE. When freshly filling the cooling system, premix one pint of Soluble Oil with one gallon of water meeting the requirements of paragraph 220−42.1 for each 8 gallons of cooling system capacity. Mix thoroughly before adding to the cooling system. Freshly fill the cooling system in accordance with paragraphs 220−42.3 through 220−42.4.

CAUTION

Premixing of the Soluble Oil prior to installation is essential to obtain adequate corrosion protection and to avoid separation of the Soluble Oil from the water in the cooling system. Do not add Soluble Oil directly to the cooling system.

CAUTION

The presence of any hardness in the coolant (from seawater or shorewater contamination or from the use of shore source potable water) will cause the Soluble Oil to separate from the water.

220−46.4 SAMPLING. Requirements for sampling are described in paragraphs 220−42.5 through 220−42.8.

220−46.5 ACTIONS FOR OUT−OF−LIMITS RESULTS. Whenever test results are not within the limits specified, the following actions shall be taken:

NOTE

Use water meeting the requirements of paragraph 220−42.1 for premixing Soluble Oil, flushing the cooling system or adding water to the cooling system.

1. If the Soluble Oil content is below 1.0 percent, add 1 pint of Soluble Oil premixed with 1 gallon of water for every 16 gallons of cooling system capacity.
2. If the Soluble Oil content is above 2.0 percent, drain some of the treated coolant and replace with water.
3. If the chloride concentration exceeds 100 ppm:

    a. Dump and flush the entire system.
    b. Locate and correct the source of seawater contamination.
    c. Fill the cooling system with water meeting the requirements of paragraph 220−42.1 and dump.
    d. Sample and test the flush water for conductivity using the procedure specified in paragraph 220−42.11.
    e. Repeat steps c and d until the conductivity level in the flush water is less than 150 μmho/cm.
    f. Freshly fill and treat using the treatment dosage in paragraph 220−46.3.

NOTE

If overheating occurred during the contamination incident, inspect the cooling system prior to refilling for the presence of scale or corrosion deposits to determine the need for chemical cleaning. Inspection is also recommended if it is suspected that the contamination was severe or long term. If necessary, clean the system in accordance with paragraphs 220−50.5 through 220−50.8. Before this cleaning method can be applied, Soluble Oil residues must be removed from the cooling system because these residues render the cleaning procedure ineffective. Soluble Oil residues shall be removed by flushing the cooling system with detergent in accordance with paragraphs 220−50.2 through 220−50.4.

220−46.6 FREEZE PROTECTION FOR SHIPS AUTHORIZED TO USE SOLUBLE OIL TREATMENT. Soluble Oil treatment does not provide any freezing protection. When ships authorized to use Soluble Oil treatment require freezing protection they must convert to Antifreeze treatment.

WARNING

Antifreeze shall only be used when freezing protection is necessary in engines in ships authorized to use Soluble Oil treatment. As soon as freezing protection is no longer required, convert to Soluble Oil treatment.

220−46.7 Converting Between Soluble Oil and Antifreeze. Antifreeze and Soluble Oil treatments are not compatible. Cooling system fouling can result from having Soluble Oil and Antifreeze together in the same system.

1. Converting from Soluble Oil to Antifreeze:
   a. Open all low point drains and completely dump the cooling system.
   b. Remove Soluble Oil residues by flushing the cooling system with detergent in accordance with paragraphs 220−50.2 through 220−50.4.
   c. Freshly fill and treat with Antifreeze in accordance with paragraph 220−45.3.
   d. Maintain Antifreeze treatment in accordance with Section 45.

2. Converting from Antifreeze to Soluble Oil:

   a. Open all low point drains and completely dump the cooling system.
   b. Fill the system with clean, fresh water, then dump.
   c. Repeat step 2. until the drained out water is clear to ensure complete removal of all Antifreeze. (Blue or green drained out water indicates the presence of Antifreeze).
   d. Fill the system with water meeting the requirements of paragraph 220−42.1.
   e. Dump the water, then freshly fill and treat with Soluble Oil in accordance with paragraph 220−46.3.

220−46.8 ENGINE COOLANT RECORD FOR SOLUBLE OIL TREATMENT. The requirements for keeping engine coolant records (logs) and personnel responsibilities are described in Section 49.

220−46.9 TESTING PROCEDURES FOR SOLUBLE OIL. Effective treatment of cooling systems is based upon the accurate performance and interpretation of the tests that determine coolant quality. If these tests are not performed properly, the coolant will not be treated properly. It is necessary to carefully follow these test procedures in order to ensure accurate results.

220−46.10 SOLUBLE OIL TEST. Calcium chloride is added to a sample of Soluble Oil treated coolant contained in a Stoddard solvent bottle. The calcium chloride causes the Soluble Oil to separate from the water. The sample is allowed to stand while the separation occurs. The depth of the separated oil is determined and a conversion chart is used to convert the reading to percent Soluble Oil.

1. Apparatus

   a. Stoddard solvent (unsaturation) bottle.
   b. Spatula, scoop (scoopula)
   c. Funnel

2. Reagents

   a. Calcium chloride, anhydrous
   b. Isopropyl alcohol
   c. Distilled water

3. Interferences

   a. Incomplete separation of the Soluble Oil can occur if the sample is not allowed to stand for the specified time following the addition of the calcium chloride.

4. Procedure

   a. Rinse a Stoddard solvent bottle and stopper with distilled water.
   b. Rinse the Stoddard solvent bottle and stopper with a small portion of sample.
   c. Fill the Stoddard solvent bottle to the 0 percent mark with sample.
   d. Using the scoopula and funnel, add calcium chloride to the sample until the liquid level reaches the 100 percent mark.

CAUTION

The bottle will heat up while calcium chloride is dissolving and shall therefore be handled with care.

   e. Allow the sample to stand for four (4) hours while the oil is separating from the water.
   f. Determine the depth of the oil layer by counting divisions on the bottle.
   g. Refer to the Soluble Oil conversion chart, Figure 220−46−1. Find the number of oil divisions from the bottle on the left of the chart. Read across to the diagonal line and then down to percent Soluble Oil.

      (1) For example, if the depth of the oil layer is six divisions, the Soluble Oil content is 2.0 percent.
      (2) Empty the sample bottle and rinse three times with isopropyl alcohol and allow to drain dry.

CAUTION

Isopropyl alcohol is toxic and flammable. Wear goggles, plastic gloves and rubber apron when handling isopropyl alcohol.

220−46.11 CHLORIDE TEST FOR COOLANT TREATED WITH SOLUBLE OIL. Sodium chromate solution and a chloride test tablet are added to 50 ml of Soluble Oil treated coolant or untreated water. The tablet is dissolved and the chloride concentration is determined by the color of the solution.

1. Apparatus

   a. Graduated cylinder, 100 ml with stopper
   b. Dropper bottle
   c. Teaspoon

2. Reagents

   a. Chloride test tablets
   b. Sodium chromate, anhydrous, technical
   c. Distilled water

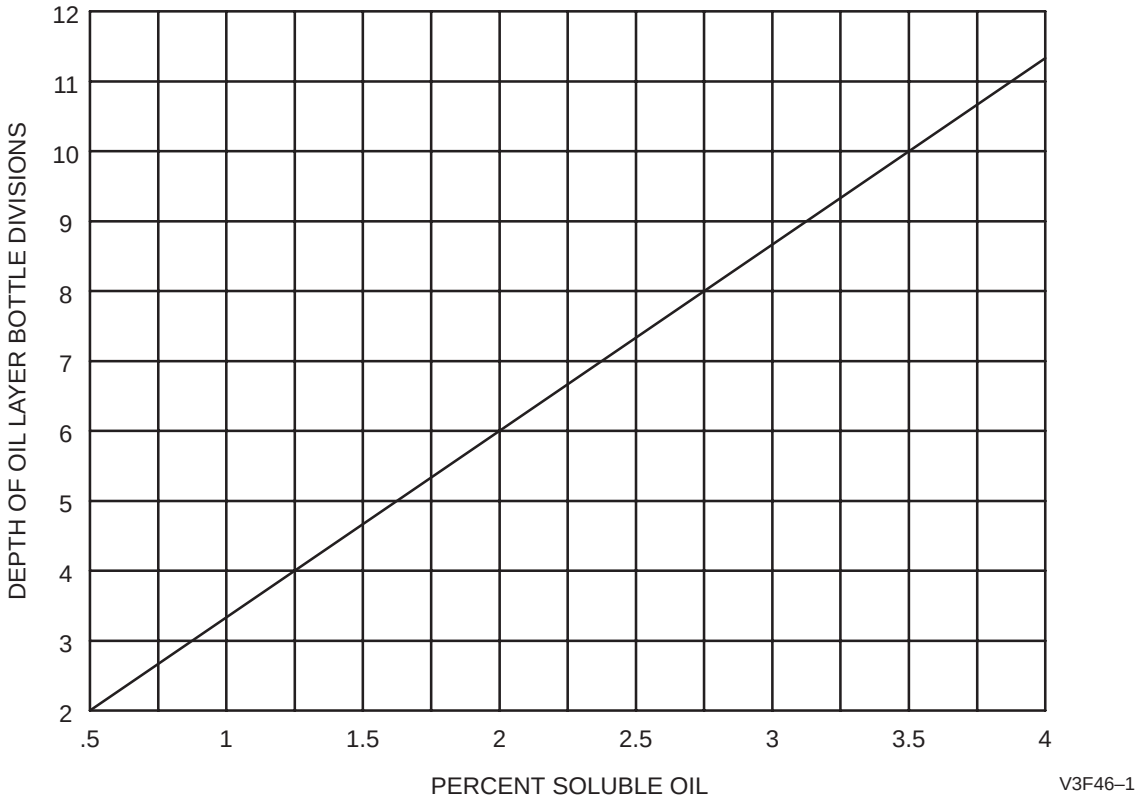

Figure 220−46−1. Soluble Oil Conversion Chart

3. Interferences

   a. The test will not work unless chromate is present in the sample. The addition of sodium chromate solution to the sample provides the necessary chromate.

4. Preparation of Sodium Chromate Solution

WARNING

Wear goggles, plastic gloves and rubber apron when handling sodium chromate powder or solution. A dust respirator shall also be worn when handling sodium chromate powder.

a. Rinse the 100 ml graduated cylinder with distilled water
b. Fill the graduated cylinder to the 50 ml mark with distilled water
c. Add one level teaspoon of sodium chromate, insert the stopper and shake to dissolve

WARNING

The teaspoon used to measure sodium chromate shall not be used for any other purpose.

d. Carefully pour the sodium chromate into a dropper bottle
e. Label the bottle “sodium chromate solution”
f. Rinse the graduated cylinder with distilled water and pour the rinsing into a 5 gallon plastic bottle identified as containing chromate wastes.

5. Procedure

a. Rinse the 100 ml graduated cylinder with distilled water.
b. Rinse the graduated cylinder with a small portion of sample.
c. Fill the graduated cylinder to the 50 ml mark with sample.
d. Add 10 drops of sodium chromate solution to the sample.
e. Insert the stopper and shake the graduated cylinder.
f. Remove the stopper and add one chloride test tablet.
g. Insert the stopper and shake the cylinder until the tablet dissolves.
h. Inspect the sample color:

(1) If the sample develops a reddish−brown color, the chloride is within the 100 ppm limit. Record “<100” in the log.
(2) If the sample develops a yellow−green color, the chloride exceeds the 100 ppm limit. Record “>100” in the log.

i. Pour the samples containing chromate into a 5 gallon plastic bottle identified as containing chromate wastes.
j. Rinse the graduated cylinder with distilled water. Pour the sample waste water into the waste bottle.

NOTE

Bottles containing chromate wastes shall be turned in to the Public Works Officer or Public Works Center at any naval facility.

220−46.12 SUPPLY INFORMATION FOR SOLUBLE OIL TREATMENT. Supply information of Soluble Oil treatment is given in Table 220−46−1.

Table 220−46−1. Supply Information for Soluble Oil Treatment

Item	NSN	U/I	Qty	Notes
Treatment Chemicals				
Soluble Oil Corrosion Inhibitor, MIL−I−24453, 1 Gal	9G 6850−00−139−5318	GL	(a)	
Soluble Oil Corrosion Inhibitor, MIL−I−24453, 5 Gal	9G 6850−00−139−5319	DR	(a)	
Sampling Equipment				
Bottle, Polyethylene, Screw Cap, 1 Quart (32 oz)	9G 8125−00−819−6085	EA	(b)	
Bottle, Polyethylene, Screw Cap, 1/2 Pint (8 oz)	9G 8125−00−680−0141	EA	(b)	
Test Equipment and Chemicals				
Thermometer, Dial Type, 0 to 220 ˚F	9G 6685−00−373−3436	EA	2	
Teaspoon	9Q 7330−00−272−7876	EA	1	1
Bottle, Dropper, Plastic, 60 ml (pk of 12)	9L 6640−01−077−2468	PK	1	
Graduated Cylinder with Stopper, 100 ml (Fisher comes as pk of 4)	9L 6640−00−420−6000 P/N 08−566−10D	EA pk	2	2
Bottle, Unsaturation, (case of 12)	P/N 13−559	cs	3	2
Brush, Bottle (pk of 12)(3/4 x 3−1/2 inch)(19 x 89 mm)	9Q 7920−01−091−1759 P/N 03−574	pk	2	
Spatula, Scoop (Scoopula)	9L 6640−00−706−6414 P/N 14−357 (pk of 6)	PG pk	(c)	2
Chloride Test Tablets	9G 6850−00−201−1257	HD	1	
Sodium Chromate, Anhydrous, 1 pound	9G 6810−00−240−2119	LB	1	
Calcium Chloride, Anhydrous	9G 6810−01−126−2694	BT	2	
Isopropyl Alcohol (Isopropanol, 2−Propanol)	9G 6810−00−227−0410	GL	1	
Bottle, Screw Cap, 5 Gallons	9L 6640−01−083−9756	EA	1	3
Bottle, Screw Cap, 2.5 Gallons	9L 6640−01−083−9755	EA	1	3
Safety Equipment: See Table 220−48−3				

Notes:

(a) 3 gallons of inhibitor for every 100 gallons of total engine coolant.
(b) 2 bottles (of either size) for each engine.
1. Teaspoon comes in a set of four measuring spoons.
2. Item may be difficult or impossible to get from the stock system. P/N refers to Fisher Scientific Catalog. 1−800−766−7000.
3. Either size bottle may be used for storing waste from coolant testing.

SECTION 47. COMBINATION TREATMENT

WARNING

Skin or eye contact with MIL−A−53009 inhibitor, Antifreeze, or coolant containing Combination Treatment shall be avoided. Wear face shield, rubber gloves and apron when handling concentrated MIL−A−53009 inhibitor or Antifreeze or when sampling a cooling system containing Combination Treatment. Wear goggles, plastic gloves and rubber apron when handling coolant samples.

220−47.1 Combination treatment consists of a mixture of MIL−A−53009 Inhibitor and MIL−A−46153 Inhibited Antifreeze. In this case, Antifreeze is used for its corrosion inhibitors, not its freeze protection capabilities. MCM and MHC class propulsion engines rarely, if ever, require freezing protection. The corrosion inhibitor package in MIL−A−46153 Inhibited Antifreeze was specifically formulated to complement and be compatible with MIL−A−53009. Combination treatment has been shown to provide the most effective corrosion inhibition known for MCM and MHC class IF engines.

1. MIL−A−53009 consists of a blend of inhibitor chemicals in aqueous solution. The major components of MIL−A−53009 are: sodium metaborate, potassium silicate, and mercaptobenzothiazole (MBT).

2. MIL−A−46153 Antifreeze consists of ethylene glycol and corrosion inhibiting chemicals (sodium borate, trisodium phosphate and an organic copper inhibitor).

NOTE

It is not usually advisable to mix different coolant inhibitors in the same system. The chemicals in different formulations may not be compatible and may cause inadequate corrosion protection or precipitation of treatment chemicals. In this case, however, MIL−A−53009 was specifically formulated to complement and be compatible with MIL−A−46153 Inhibited Antifreeze.

220−47.2 LIMITS. The following limits apply to coolant treated with Combination Treatment:

MBT	100 − 1000 ppm
Reserve Alkalinity	6 RA units minimum
Chloride	100 ppm max
Antifreeze	30 − 40% (5° F to −10° F)

(see Table 220−47−1 and paragraph 220−47.3)

Table 220−47−1. Freeze Protection of Antifreeze Mixtures (Combination Treatment)

Freeze Protection	Quarts of Antifreeze	Quarts of Water	Antifreeze Concentration (Percent)
5 °F	3	7	30
1 °F	1	2	33
−10 °F	2	3	40
Note: A 33% concentration of Antifreeze is normally recommended for Combination Treatment			

NOTE

Engines are normally treated with 33% Antifreeze. This provides protection to 1° F. Use higher levels of Antifreeze only when greater freezing protection is required. Never use more than 40% Antifreeze (provides freezing protection to −10°F).

MBT levels below 100 ppm can result in accelerated corrosion. Reserve alkalinity levels less than 6 RA units can also result in accelerated corrosion. MBT levels above 1000 ppm indicate overtreatment to an undetermined degree since the maximum level detectable by the MBT test procedure is 1000 ppm). Gross overtreatment can result in corrosion inhibitor chemicals precipitating out of solution which can restrict heat transfer. Chloride levels above 100 ppm indicate that seawater has leaked into the cooling system. This makes the coolant more corrosive and decreases the effectiveness of the cooling treatment corrosion inhibitors. In addition, seawater contains hardness which will cause scale formation on hot metal surfaces.

220−47.3 TREATMENT DOSAGES. Freshly fill the cooling system in accordance with paragraphs 220−42.3 and 220−42.4 using 8 gallons Antifreeze and 3 quarts MIL−A−53009 for each 24 gallons of cooling system capacity.

CAUTION

Never use Antifreeze concentrations greater than 40 percent or less than 30 percent in coolant treated with Combination Treatment.

CAUTION

Use water meeting the requirements of paragraphs 220−42.1 when adding water to a cooling system.

NOTE

Table 220−47−2 is used to convert the results of the freeze protection test (detailed in paragraph 220−47.12) from “freeze protection” into percent Antifreeze. The treatment dosage normally recommended for combination treatment is 33% Antifreeze. This

mixture, when combined with 3% MIL−A−53009, supplies an ample amount of corrosion inhibitors. No more than 40% Antifreeze shall be used.

Table 220−47−2. Conversion of Freeze Protection into Percent Antifreeze (Combination Treatment)

Freeze Protection	+15° F	+10° F	+5° F	+1° F	−5° F	−10° F	−15° F	−20° F
Antifreeze Protection	20%	25%	30%	33%	38%	40%	42%	44%
Note: The treatment dosage recommended for Combination Treatment is 33% Antifreeze. Never use less than 30% or more than 40% Antifreeze in Combination Treatment.								

220−47.4 Combination Treatment treated coolant shall be changed out every two years.

220−47.5 SAMPLING. Requirements for sampling are described in paragraphs 220−42.5 through 220−42.8.

220−47.6 ACTIONS FOR OUT−OF−LIMITS RESULTS. Whenever test results are not within the limits specified, the following actions shall be taken:

1. If the freeze protection is higher than 1°F, (concentration of Antifreeze is less than 33%), or if the freezing protection is inadequate for anticipated weather conditions, dump some of the coolant and replace with a quantity of Antifreeze sufficient to provide the needed concentration.
2. If the freeze protection is lower than −30°F (concentration of Antifreeze is greater than 50%), dump some of the coolant and replace with water.
3. If the MBT level is more than 500, dump some of the treated coolant from the system and replace with water.
4. If MBT is less than 100 ppm, add 1 quart MIL−A−53009.
5. If reserve alkalinity is less than 6 RA units, add 1.5 quarts MIL−A−53009.
6. If the chloride concentration exceeds 100 ppm:

    a. Dump and flush the entire system.
    b. Locate and correct the source of seawater contamination.
    c. Fill the cooling system with water meeting the requirements of paragraph 220−42.1, then dump again.
    d. Sample and test the flush water for conductivity using the procedure specified in paragraph 220−42.11.
    e. Repeat steps c and d until the conductivity level in the flush water is less than 150 μmho/cm.
    f. Freshly fill and treat using the treatment dosage in paragraph 220−47.3.

NOTE

If overheating occurred during the contamination incident, inspect the cooling system prior to refilling for the presence of scale or corrosion deposits to determine the need for chemical cleaning. Inspection is also recommended if it is suspected that the contamination was severe or long term. If necessary, clean the system in accordance with paragraphs 220−50.5 through 220−50.8.

220−47.7 ENGINE COOLANT RECORD COMBINATION TREATMENT. The requirements for keeping engine coolant records (logs) and personnel responsibilities are described in Section 49.

220−47.8 TESTING PROCEDURES FOR COMBINATION TREATMENT. Effective treatment of cooling systems is based upon the accurate performance and interpretation of the tests that determine coolant quality. If these tests are not performed properly, the coolant will not be treated properly. It is necessary to carefully follow these test procedures in order to ensure accurate results.

220−47.9 CHLORIDE TEST FOR COOLANT TREATED WITH COMBINATION TREATMENT. A 10 ml sample of coolant treated with Combination Treatment is diluted with 10 ml of distilled water. Two dippers of cupric sulfate are added to the diluted sample. After a brief standing period, the sample is filtered. The end of a Quantab chloride test strip is immersed in the sample. After an exposure interval, the Quantab is removed from the solution and the scale reading is obtained. The reading is converted to ppm chloride by using a conversion chart and multiplying the result by two.

1. Apparatus

    a. Filter paper
    b. Funnel
    c. Brass dipper
    d. Beaker, 50 ml (2)
    e. Graduated cylinder, 10 ml.
    f. Quantab chloride test strips
    g. Stirring rod

2. Reagents

    a. Distilled water.
    b. Cupric sulfate.

3. Interferences

    a. The organic copper inhibitor present in inhibited Antifreeze interferes with the Quantabs. The addition of cupric sulfate to the sample causes the copper inhibitor to precipitate out, thus eliminating the interference.
    b. The ethylene glycol in the Antifreeze causes the Quantab to work very slowly. Diluting the sample eliminates the problem.

WARNING

Wear goggles, plastic gloves and rubber apron when handling cupric sulfate.

4. Procedure

   a. Rinse the 10 ml graduated cylinder, the funnel, the stirring rod and two 50 ml beakers with distilled water.
   b. Rinse the 10 ml graduated cylinder with a small portion of sample.
   c. Measure 10 ml of sample in the graduated cylinder. Pour the sample into one of the 50 ml beakers.
   d. Rinse the graduated cylinder with distilled water. Measure 10 ml of distilled water in the graduated cylinder. Pour the distilled water into the beaker containing the sample.
   e. Add 2 dippers of cupric sulfate to the diluted sample in the beaker. Stir to mix using the stirring rod.
   f. Let the solution stand five minutes.
   g. Filter the sample as follows:

      (1) Fold the circular filter paper in half and then fold in half again
      (2) Open the folded filter paper to form a cone and place the cone in the funnel ml beaker.
      (3) Place the funnel in the other 50 ml beaker
      (4) Carefully pour the sample into the filter paper cone inside the funnel. Do not allow the level to reach the upper edge of the paper.

   h. Open the Quantab bottle, remove one test strip and recap the bottle.

NOTE

Check the expiration date on the Quantab bottle label. Do not use the Quantabs if the expiration date has passed.

NOTE

The Quantab bottle shall be kept tightly closed.

   i. Into the beaker containing the filtered sample place the test strip with the word “Quantab” up and the numbered scale facing the person performing the test. Note the time.

NOTE

Never immerse the entire Quantab strip beneath the level of the solution being tested; otherwise the test strip will give a false low result.

   j. Leave the test strip in the beaker until the horizontal yellow−orange band across the top of the strip turns dark blue. This normally takes about 10−20 minutes. The blue color signals that the test is ended. Remove the test strip from the beaker within 5 minutes after the blue color appears.

k. Read the number on the scale corresponding to the highest point at the upper tip of the white color change. Estimate to the nearest half division. Each division equals 0.2. Record the scale reading in the log.

l. Find the scale reading and the corresponding chloride result (column marked "ppm Cl^-") on the calibration chart provided with the bottle of Quantabs. Record the chloride reading in the log. If the scale reading is lower than the lowest reading on the chart, record "<(lowest chloride concentration on the chart)". For example, if the lowest scale reading on the chart is 1.4 and this corresponds to 30 ppm chloride, record "<30" in the log.
m. Multiply the chloride reading from the chart by 2 and record the result in ppm chloride in the log. Using the above example, <30 x 2 = <60. Record <60 in the log.
n. Pour the samples containing inhibited Antifreeze into a plastic 5 gallon bottle identified as containing ethylene glycol, borate and cupric sulfate wastes.
o. Rinse the graduated cylinder, funnel and beakers with distilled water. Pour the sample waste water into the waste bottle. Place the soiled filter paper into the waste bottle.

NOTE

Bottles containing ethylene glycol, borate and cupric sulfate wastes shall be turned in to the Public Works Officer or Public Works Center at any Naval Shipyard or other Navy industrial facility.

220−47.10 MBT TEST FOR COOLANT TREATED WITH COMBINATION TREATMENT. A sample of coolant treated with Combination Treatment is drawn into a titret containing reagents that are pink in color. The sample is drawn in until the color changes to a pale yellow. When the color change occurs, the Titret is inverted and the liquid level is measured on the scale marked on the Titret. The scale reading multiplied by 50 gives the MBT concentration in ppm.

1. Apparatus

   a. Valve assembly
   b. Sample cup

2. Reagents

   a. Titret − A glass vial under vacuum which contains the needed reagents is supplied. The principal ingredients are potassium permanganate, phosphoric acid and water.
   b. Distilled water

3. Interferences

   a. None normally present in this type of sample

4. Procedure

   a. Remove one Titret, one valve assembly and the sample cup from the test kit box.
   b. Rinse the sample cup with distilled water, then rinse with a small portion of the sample.
   c. Fill the sample cup to approximately the 25 ml mark with sample.
   d. Slide the open end of the valve assembly over the tapered tip of the Titret so that it fits snugly. See Figure 220−47−1.

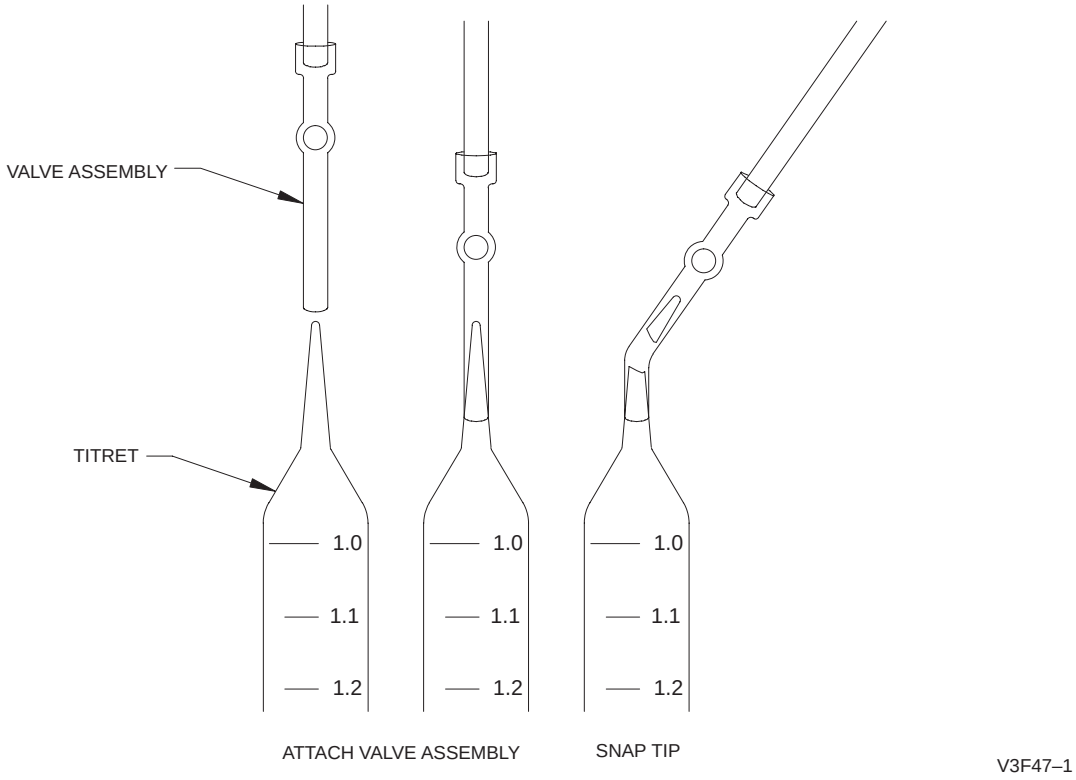

Figure 220−47−1. MBT Test: Titret and Valve Assembly

e. Carefully snap the tip of the Titret.
f. Immerse the tip of the sample tube in the sample.
g. Squeeze the bead valve briefly to draw sample into the Titret. Draw enough sample into the Titret to raise the liquid level one−third to one−half of one scale division. See Figure 220−47−2.
h. Rock the Titret back and forth several times to mix the contents. Watch for a color change from pink to pale yellow.

NOTE

Do not squeeze the bead valve unless the tip of the sample tube is immersed in the sample.

i. Repeat steps g and h until the color change occurs.
j. After the color change occurs, hold the Titret upright so that the numbers on the scale are right side up. Read the number of the scale corresponding to the level of liquid in the Titret. Record the scale reading in the log.

NOTE

Read the liquid level at the bottom of the meniscus (curvature at the upper surface of the liquid).

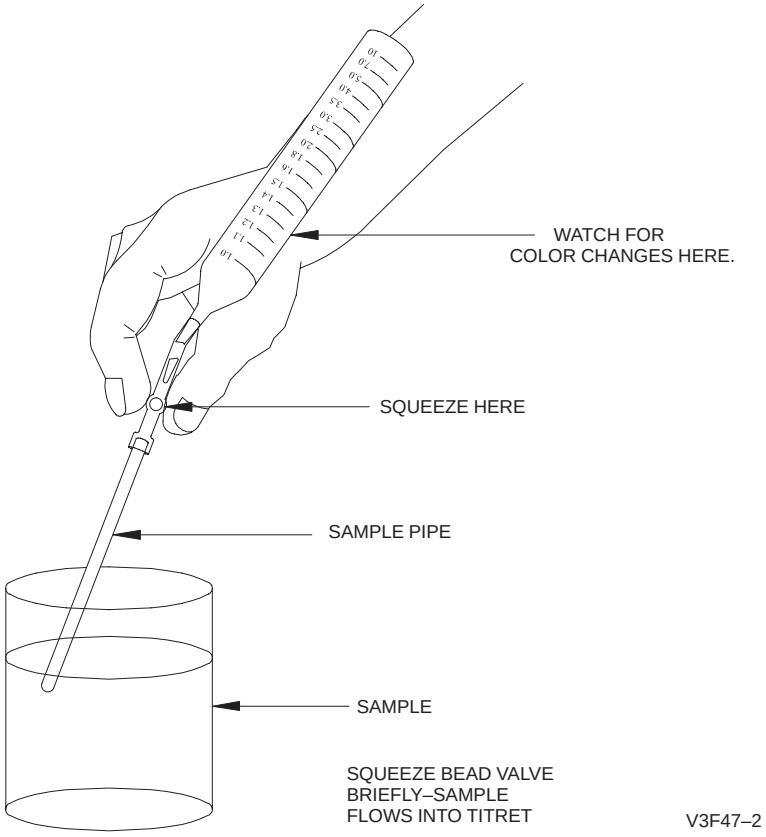

Figure 220−47−2. MBT Test: Drawing Sample into Titret

k. MBT Titrets are provided with two different scales, 1 to 10 and 50 to 500. Depending on the Titret scale, record the result as follows:

(1) If the scale on the Titret reads from 1 to 10, record the scale reading in the scale reading column in the log and then multiply the scale reading by 50 and record the result in ppm MBT column in the log. For example, for a scale reading of 7, MBT is calculated as follows:

7 X 50 = 350 ppm MBT

(2) If the scale reading on the Titret reads from 50 to 500, record the scale reading in both the scale reading and the ppm MBT columns in the log.

NOTE

If the liquid level does not reach the scale, record "> 500" for ppm MBT.

l. Dispose of the used Titret and valve assembly in such a manner that the broken glass does not present a safety hazard to personnel.
m. Retain the sample in the sample cup for use in the reserve alkalinity test.

220−47.11 RESERVE ALKALINITY TEST FOR COOLANT TREATED WITH COMBINATION TREATMENT. A reserve alkalinity test stick is dipped into a sample of coolant treated with Combination Treatment. After a brief development time, the color on the stick's second test zone as shown in Figure 220−47−3 (not the one on the end) is compared to a color chart to determine the corrosion inhibitor level.

1. Apparatus

    a. Reserve alkalinity test kit (Radi−Aider or CoolTrak)

2. Interferences

    a. None normally present in this type of sample

3. Procedure

    a. Open the bottle of reserve alkalinity test sticks, remove one test stick and recap the bottle.

NOTE

Check the expiration date on the bottle of reserve alkalinity test sticks. Do not use the test sticks if the expiration date has passed. In addition, inspect the second test zone (not the one on the end) on the test stick. The zone should be yellow. Discard the test stick if the zone is pale blue or white since this indicates deterioration of the test stick due to moisture. Although the test zone on the end of the test stick is designed for determining freezing protection, it is not used in Navy tests. Only the freezing protection test procedure in paragraph 220−47.10 is authorized.

NOTE

The reserve alkalinity test stick bottle shall be kept tightly closed.

    b. Dip the test stick, test zone down, into the sample far enough to immerse the second test zone. Remove immediately.

    c. Shake excess fluid from the test area and wait 15 seconds for the color to develop.

    d. Compare the color on the second test zone of the stick (see Figure 220−47−3) with the corrosion protection color chart on the side of the test stick bottle. (Do not use the percent glycol color chart.)

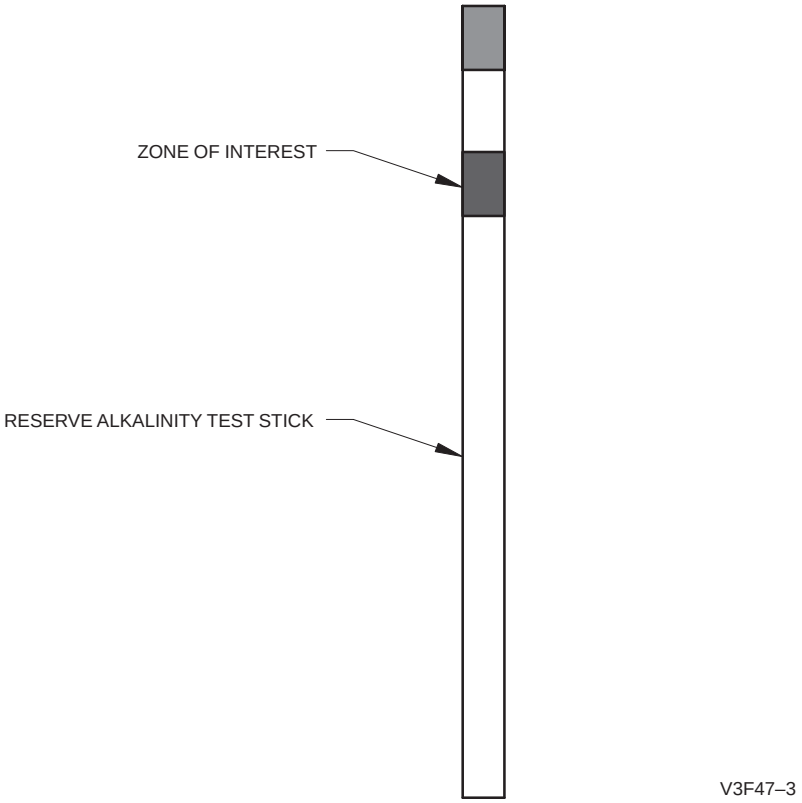

Figure 220−47−3. Reserve Alkalinity Test Stick

NOTE

The reserve alkalinity color comparison chart on Radi−Aider test bottles has three squares labeled 3, 6, and 10. The reserve alkalinity color comparison chart on some CoolTrak test bottles has four unnumbered squares while on others it has three unnumbered squares. For kits with four unnumbered squares, label the color squares 1, 3, 6, and 10 from left (yellow) to right (blue−green) by writing the numbers under the squares. For kits with three unnumbered squares, label the color squares 3, 6, and 10 from left (yellow−green) to right (blue−green).

(1) If the color on the stick matches the 6 square or the 10 square in the color chart, record that reserved alkalinity value (“6” or “ 10”) in the log.
(2) If the color on the stick is a darker blue than the 10 square, record “>10” in the log.
(3) If the color on the stick is between the 6 and the 10 squares, record “8” in the log.
(4) If the color on the stick is more yellow or green than the 6 square, the corrosion inhibitor level is below the required level. Record “<6” in the log.

e. Pour the sample containing Antifreeze into a plastic 5 gallon bottle identified as containing ethylene glycol and borate wastes.

NOTE

Bottles containing ethylene glycol and borate wastes shall be turned in to the Public Works Officer or Public Works Center at any Naval Shipyard or other Navy industrial facility.

220−47.12 FREEZING PROTECTION TEST. A sample of coolant treated with Combination Treatment is drawn into an Antifreeze tester. Float and temperature readings are taken. Freezing protection is determined using a temperature variance table.

1. Apparatus

    a. Antifreeze tester

2. Reagents

    a. Distilled water

3. Interferences

    a. None normally present in this type of sample

4. Procedure

    a. Draw distilled water into the Antifreeze tester and rinse it.
    b. Insert the tester into the sample.
    c. Draw sample into the tester and rinse.
    d. Insert the tester into the sample.
    e. Draw sample into the tester.
    f. Observe coolant protection float and temperature readings.
    g. Determine the adjusted coolant protection (freezing protection) using the temperature variance table provided with the Antifreeze tester.
    h. Pour the sample containing Antifreeze into a plastic 5 gallon bottle identified as containing ethylene glycol and borate wastes.
    i. Rinse the Antifreeze tester with distilled water. Pour the sample waste water into the waste bottle.

NOTE

Bottles containing ethylene glycol and borate wastes shall be turned in to the Public Works Officer or Public Works Center at any Naval Shipyard or other Navy industrial facility.

220−47.13 SUPPLY INFORMATION FOR COMBINATION TREATMENT. Supply information for Combination Treatment is given in Table 220−47−3.

Table 220−47−3. Supply Information for Combination Treatment

Item	NSN	U/I	Qty	Notes
Treatment Chemicals				
Antifreeze, Inhibited, MIL−A−46153, 1 gal	9G 6850−00−181−7929	GL	(a)	1
Antifreeze, Inhibited, MIL−A−46153, 5 gal	9G 6850−00−181−7933	CN	(a)	1
Antifreeze, Inhibited, MIL−A−46153, 55 gal	9G 6850−00−181−7940	DR	(a)	1
Inhibitor, Corrosion, MIL−A−53009	9G 6850−01−160−3868	QT	(b)	1,3
Inhibitor, Corrosion, MIL−A−53009	9G 6850−01−287−8067	GL	(b)	1,3
Sampling Equipment				
Bottle, Polyethylene, Screw Cap, 1 Quart (32 oz)	9G 8125−00−819−6085	EA	(c)	2
Bottle, Polyethylene, Screw Cap, 1/2 Pint (8 oz)	9G 8125−00−680−0141	EA	(c)	2
Test Equipment and Chemicals				
Antifreeze Tester (freeze protection)(hydrometer)	9L 6630−00−247−2968	EA	1	
Thermometer, Dial Type, 0 to 220 ˚F	9G 6685−00−373−3436	EA	2	
Chloride Test Strips, Quantabs (50 per bottle)	9G 6850−00−180−6165	BT	(d)	
Cupric Sulfate, ACS, 500 Grams	9G 6810−00−241−1203	BT	1	
Test Kit, Antifreeze (Reserve Alkalinity)(50 per bottle)	9L 6630−01−011−5039	EA	(d)	
Graduated Cylinder, Plastic, 10 ml	9L 6640−00−982−7495	EA	2	
Beaker, 50 ml (pk of 12)	9L 6640−01−328−9684	PG	(e)	
Rod, Glass Stirring, 7 inches (pk of 6)	9L 6640−00−290−0154	EA	3	
Funnel, Plastic	9L 6640−00−350−6343	EA	2	
Filter Paper (pk of 100)	9L 6640−00−866−1645	HD	1	
Dipper, Brass Measuring	9C 4410−01−077−2467	EA	2	
Test Kit, MBT	9L 6630−01−327−0617	SE	(f)	
Bottle, Screw Cap, 5 Gallons	9L 6640−01−083−9756	EA	1	4
Bottle, Screw Cap, 2.5 Gallons	9L 6640−01−083−9755	EA	1	4
Safety Equipment: See Table 220−48−3				

Notes:

(a) 70 gallons antifreeze for every 100 gallons total engine capacity.
(b) 24 quarts (6 gallons) of inhibitor for every 100 gallons total engine capacity.
(c) 2 bottles (of either size) for each engine.
(d) 1 for each 4 engines.
(e) 4 beakers.
(f) 1 for each 2 engines.

1. Antifreeze and Inhibitor may be purchased in any size container, at the convenience of the ship.
2. Either size sample bottle may be used.
3. Shelf−life item.
4. Either size bottle may be used for storing waste from coolant testing.

SECTION 48. CHEMICAL SAFETY, HANDLING, AND STORAGE

220−48.1 A number of safety precautions shall be observed when treating or testing engine coolant. Many of the chemicals employed are alkalies. Some are acids. All are poisons when ingested. Refer to Table 220−48−1. Protective equipment shall be worn when handling any of the chemicals. Refer to Table 220−48−2. Do not handle any of the chemicals directly. Immediate medical attention shall be obtained if eye contact or ingestion of any chemical occurs. Contaminated clothing shall be laundered prior to reuse. Do not store, carry or consume food or tobacco in areas where the chemicals are stored, handled or dispensed.

220−48.2 ALKALIES. MIL−A−53009, Antifreeze, and Nalcool 2000 all contain strong alkalies (are strongly alkaline). Coolant treated with MIL−A−53009, Nalcool 2000, Antifreeze or Combination treatment are somewhat alkaline. Sodium bicarbonate is mildly alkaline.

1. Do not mix alkalies directly with acids because the heat generated may cause the chemicals to spatter. All alkalies shall be stored separately from acids.
2. If alkalies contact the skin, flush the affected skin with cold water until the slippery feeling disappears. If a burning or itching sensation persists, seek medical attention.
3. If alkalies come in contact with the eyes, flush with large amounts of potable water and seek immediate medical attention.

220−48.3 ACIDS. Cupric sulfate (used in the chloride test), the contents of the MBT test titrets, and sulfamic acid are acids.

1. Do not mix acids directly with strong alkalies because the heat generated may cause the chemicals to spatter. All alkalies shall be stored separately from acids.
2. If acids contact the skin, flush the affected skin area with cold water. If a burning or itching sensation persists or a skin rash develops, seek medical attention.
3. If acids come in contact with the eyes, flush with large amounts of potable water and obtain immediate medical attention.

220−48.4 POISONS. All of the test and treatment chemicals are poisons having varying degrees of toxicity. If any of these chemicals contact the skin, flush the affected skin area with cold water. If a burning or itching sensation persists or a skin rash develops, seek medical attention. If any of the following chemicals is ingested, seek medical attention immediately.

1. Isopropyl alcohol (also know as “rubbing alcohol”) is very different from ethyl alcohol. Small amounts of isopropyl alcohol, if swallowed, can cause serious illness.
2. Sodium chromate is very poisonous by ingestion, inhalation or skin absorption and is irritating to the eyes, skin and mucous membranes.
3. Inhibited Antifreeze consists primarily of ethylene glycol which is toxic by ingestion. Ethylene glycol vapors from hot Antifreeze are also toxic.
4. MIL−A−53009 inhibitor and Nalcool 2000 are both toxic by ingestion, and may be irritating to the eyes and skin.
5. Cupric sulfate is toxic and is irritating to the eyes, skin and mucous membranes.
6. Phenolphthalein is used medicinally in extremely small amounts but in larger amounts it is a poison.
7. Soluble Oil, although relatively low in toxicity, can irritate the eyes and skin. In addition, soluble oil shall not be ingested.

Table 220−48−1. Chemical Classification and Safety Precautions

Chemical	Class	Use Conc.	Precaution
MIL−A−53009	Alkali	3%	a,b
Nalcool 2000	Alkali	3%	a,b
Antifreeze, MIL−A−46153	Alkali, Poison	33−67%	a,b,c
Soluble Oil, MIL−I−24453		1−2%	b
Combination Treatment: MIL−A−53009 Antifreeze	Alkali, Poison	 3% 30−50%	a,b,c
Cupric Sulfate	Acid, Poison		a,b
Isopropyl Alcohol	Poison	99%	b,c
Phenolphthalein	Poison	1%	b
MBT Titret	Acid, Poison		a,b
Sodium chromate	Poison		a,b,d,e
Detergent, MIL−D−16791 Type I			b
Diammonium citrate			a,b,d
1,3−Diethylthiourea (DETU)	Poison		a,b,e
Sulfamic acid	Acid		a,b
Sodium bicarbonate			a

Precaution Key:

a. May burn or irritate skin. Causes burns to eyes. Avoid contact with eyes, skin and clothing. In case of contact, flush skin with large amounts of water; for eyes, flush with potable water for at least 15 minutes, then obtain medical attention.
b. Poisonous. Obtain medical attention if swallowed.
c. Do not breath vapor. Use in well ventilated area. Obtain medical attention if exposure occurs.
d. Do not breath dust. Wear a respirator when handling powder. Obtain medical attention if exposure occurs.
e. May cause cancer. Exposure should be minimized.

Table 220−48−2. Required Safety Equipment for Various Operations

Operation	Equipment to be Worn
Handling concentrated treatment solutions of: MIL−A−53009 Nalcool 2000 Antifreeze (MIL−A−46153) Soluble Oil (MIL−I−24453)	Face shield, rubber gloves, rubber apron
Sampling a cooling system	Face shield, rubber gloves, rubber apron
Handling cooled engine coolant samples	Goggles, plastic gloves, rubber apron
Handling test chemicals except chromate powder	Goggles, plastic gloves, rubber apron
Measuring out chromate powder (for soluble oil chloride test)	Goggles, plastic gloves, rubber apron, dust respirator
Performing maintenance or repair work on engines or on cooling system in which personnel might come in contact with treated engine coolant.	Goggles, rubber gloves, rubber apron
Detergent Flush	Goggles, rubber gloves, rubber apron
Diammonium Citrate Cleaning	Face shield, rubber gloves, rubber apron
IF Engine Cooler Core Cleaning	Face shield, rubber gloves, rubber apron

220−48.5 FLAMMABLES. Isopropyl alcohol is a flammable and combustible material. The flash point of isopropyl alcohol is 59 ˚F (15 ˚C). Isopropyl alcohol shall be stored in a flammable storage locker.

220−48.6 OXIDIZERS. Sodium chromate is an oxidizing material and shall not be stored with or allowed to come in contact with reducing materials.

220−48.7 HANDLING PROCEDURES. Safety equipment required for various operations are listed in Table 220−48−1. Contact with engine coolant, engine coolant treatment chemicals, and engine coolant test chemicals shall be avoided. Inhalation of ethylene glycol vapors (from hot coolant treated with Antifreeze or Combination Treatment) shall be avoided. Supply information for this equipment is provided in Table 220−48−3.

Table 220−48−3. Supply Information for Safety Equipment

Item	NSN	U/I	Qty	Notes
Face Shield, Industrial	9Q 4240−00−542−2048	EA	2	
Apron, Synthetic Rubber	9D 8415−00−634−5023	EA	2	
Gloves, Rubber	9D 8415−00−266−8677	PR	2	
Gloves, Disposable	9L 6515−00−339−7880 9D 8415−00−682−6786 P/N 11−395−19A (small) P/N 11−395−19B (med) P/N 11−395−19C (large) P/N 11−395−19D (XL)	PR PR pk pk pk pk	(a)	1
Goggles, Chemical Safety	9G 4240−00−190−6432 9G 4240−01−364−2169	PR PR	2	
Respirator, Air Filter	9G 4240−00−629−8199			2
Eyewash station, Portable	9G 4240−01−258−1245	EA		3

Notes:

(a) 20 pairs of disposable gloves per engine.

1. Item may be difficult or impossible to get from the stock system. P/N refers to Fisher Scientific Catalog. 1−800−766−7000. Pack contains 100 pairs.
2. Required for soluble oil treatment only. Used in soluble oil chloride test due to hazardous nature of chromate dust.
3. Portable eyewash station is required during chemical cleanings. An eyewash station (portable or hard piped) is also required in the lab.

SECTION 49. DIESEL JACKET COOLING WATER SYSTEM RECORDS

220−49.1 MONTHLY COOLANT LOGS. Monthly coolant logs which appear in Appendix A provide a method for keeping records of all test results and treatment and other actions which affect the cooling system. The logs provide a tool to be used by the Engineer Officer and his assistants for ensuring proper cooling system maintenance. The review of these logs shall support the decision making process involved in an effective coolant treatment program. The log forms are contained in the sections pertaining to the specific coolant treatments. After recording the required information in the coolant log, test results and treatment actions shall also be recorded in the remarks section of the daily engine operating log. The monthly coolant logs shall be retained for 2 years. The requirements for filling out the logs is the same for each treatment. Each treatment log consists of the following sections:

1. Heading

2. Chemical Test Results

3. Chemical Treatment

4. Remarks

220−49.2 Heading. Initiate the monthly log for each engine by inserting the engine number, ship name, hull number, month and year.

220−49.3 Chemical Test Results Section. This section shall be maintained as follows:

1. On a 2400 hour clock basis, enter the date and time for the following:

    a. Completion of jacket water sampling.
    b. Completion of draining a portion of jacket water.
    c. Completion of dumping the entire jacket water system.
    d. Completion of freshly filling.
    e. Completion of water additions.

2. Enter the appropriate code as given on the back of the log. Some codes describe samples while others describe actions.

    a. Codes describing samples. One of these codes shall be used each time a sample is taken:

        (1) **ACA** (after chemical addition) denotes a jacket water sample obtained after chemical treatment. This includes samples obtained after freshly filling and treating.
        (2) **AWA** (after water addition) denotes a sample obtained following addition of water to the system.
        (3) **RTE** (routine) denotes a routine periodic sample.
        (4) **OTH** (other) sample taken for any other reason. The reason for taking the sample shall be described in the remarks section of the log.

    b. Codes describing actions:

        (1) **FF** (freshly filled) is used when a jacket water system is filled with water after being empty. An ACA sample shall follow FF.

(2) **DRN** (portion of coolant drained) is used when the jacket water system is partially drained. No sample is required following DRN. The reason for draining coolant from the system shall be noted in the Remarks section. If the coolant is to be returned to the engine later, this shall also be noted in the Remarks section.
(3) **D** (dumped) is used when the jacket water system is emptied. No sample is required following D. The reason for dumping the system shall be noted in the Remarks section. If the coolant is to be returned to the engine later, this shall also be noted in the Remarks section.
(4) **WA** (water addition) is used when water is added to the jacket water system. An AWA sample shall follow WA.
(5) **RF** (refill) is used when treated coolant that was previously drained or dumped is returned to the jacket water system. An OTH sample shall follow RF to ensure that the coolant has not become contaminated while stored outside the engine.
(6) **OTH** (other) is used to indicate events related to the jacket water system not covered by a specific code. An OTH sample may follow OTH.

NOTE

OTH may be used for either an action or a sample.

3. For each jacket water sample record the chemical results as appropriate to the treatment (described in the chemical test section for each treatment).

NOTE

Out−of−limits test results shall be circled.

4. The tester shall enter his or her initials and the reviewing EOOW and or EDO shall enter his or her initials upon completion of the tests

220−49.4 Chemical Treatment Sections. This section shall be maintained as follows:

1. Enter the amount of treatment chemical (as appropriate to the treatment) required. This includes freshly fill dosages.

2. Enter the date and time of completion of the chemical addition.

3. The person who performed the chemical treatment calculations shall enter his or her initials.

220−49.5 Remarks Section. The remarks section shall describe significant events related to the jacket cooling system of that diesel engine. Additional pages for remarks shall be inserted as necessary. All remarks are accompanied by the date and time as appropriate. If a doubt exists as to whether or not an entry should be made, enter it. The following types of information shall be recorded:

1. The source and type of water used for filling or topping off a cooling system.
2. Results of conductivity testing of water used to fill the cooling system.
3. The reason for partially draining or dumping a cooling system.
4. The reason for a chloride test result above the limit and follow up action taken.
5. Results of Freeze Protection testing for Nalcool 2000 plus Antifreeze treatment

220−49.6 DIESEL COOLANT TEST AND TREATMENT CHEMICAL INVENTORY LOG. This log provides a record of monthly inventory of test and treatment chemicals. It is required to ensure maintenance of sufficient onboard supplies of in−date material. Record the following information for each applicable chemical listed in the Diesel Coolant Test and Treatment Inventory Log:

a. The quantity onboard with less than six month's shelf life remaining. Do not record expired material.

b. The quantity onboard with six or more month's shelf life remaining. This includes all stocks of non−deteriorative material (cupric sulfate, phenolphthalein, isopropyl alcohol, calcium chloride, and sodium carbonate).

c. The minimum onboard stock required for a six−month deployment (see supply information for each treatment). For items that do not apply to this ship, record N/A in this column.

d. Indicate if the quantities onboard are sufficient by recording "yes" or "no" in the sufficient onboard stock column. If the quantity onboard is not sufficient, circle the "no" entry in the log. For items that do not apply to this ship, record N/A in this column.

220−49.7 ROUGH AND SMOOTH RECORDS. Every time that data is transferred from one sheet of paper to another, the likelihood of error exists. Any practice of increasing the number of times data is transferred, such as maintaining rough working logs and then preparing smooth logs for file, is prohibited. The individual who is recording data should record data on the appropriate log only. The logs may be prepared either in ink or pencil at the the option of the person who is developing the data. No erasure is permitted on the log. If an error is made, line through and initial the error, then enter the correct number.

220−49.8 MONTHLY LOG PACKAGE. A monthly log package consists of the monthly Diesel Engine Jacket Cooling Water System Treatment Logs for each engine, followed by the Diesel Coolant Test and Treatment Chemical Inventory Log. The treatment logs shall be included in order by engine number for each main propulsion diesel engine, ship's service diesel generator, emergency diesel generator, and ship's boat's engine. The pages in the monthly package shall be numbered consecutively, starting with page 1 each month.

220−49.9 PERSONNEL RESPONSIBILITIES. The responsibilities of personnel regarding logs are as follows:

1. **Tester**

   a. Maintains the diesel engine coolant log.
   b. Recommends treatment action based on log entries.
   c. Circles any result which is out of limits.

2. **Leading Chief Petty Officer (LCPO)**

   a. Supervises the maintenance of the records and reviews the records.
   b. Maintains the central file (and an adequate supply) of the logs.

3. **Engineer Officer of the Watch (EOOW) and/or Engineering Duty Officer (EDO)**

   a. Initials all test result limits.
   b. Initials any test result which is out of limits.

4. **Main Propulsion Assistant (MPA)**

   a. Reviews the logs.

5. **Engineer Officer**

   a. Responsible for decisions regarding all diesel engine jacket water cooling system treatment actions.
   b. Reviews the logs.
   c. Initials any test result which is out of limits and ensures that the cause, if known and/or when determined, is noted in the remarks section.
   d. Reviews and signs the logs.

220−49.10 Sample logs are provided in Figure 220−49−1 through Figure 220−49−6. The requirement listed in the sample logs for Diesel Coolant Test and Treatment Chemical Inventory Log (Figure 220−49−6, sheets 1 and 2) is based on four main propulsion engines and three ship's service diesel generators with 25−gallon capacity, each using Combination Treatment, and one ship's boat diesel engine with 5−gallon capacity using Antifreeze Treatment.

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
MIL-A-53009 TREATMENT

ENGINE 1A MPDE SHIP USS AMPHIB (LSD 62) DATE AUG 95 PAGE 1

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)		MBT (100-500 ppm)		RA	INITIALS	
			SCALE READING	ppm FROM CHART	SCALE READING	ppm	(6 RA UNITS MIN)	TESTER	EOOW
8/9/95	0906	RTE	0.4	<36	1.4	(70)	6	[illegible]	[illegible]
8/10/95	0810	ACA	0.4	<36	8	400	>10	[illegible]	[illegible]

CHEMICAL TREATMENT

MIL-A-53009 (quarts or gallons)	DATE	TIME	INITIALS
10 GALLONS	8/9	1135	[illegible]

NAVSEA 9255/31 (6-94)(FRONT)

Figure 220-49-1. Diesel Engine Jacket Cooling Water System Treatment Log MIL-A-53009 Treatment (Sheet 1 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
MIL-A-53009 TREATMENT

PAGE 2

DATE	TIME	REMARKS:
8/9	0906	RTE SAMPLE SHOWS LOW MBT. RECOMMEND TREAT WITH ONE GAL PER HUNDRED GALLONS SYSTEM VOLUME IAW 220-43.5

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE
[signature]	7 SEP 95	[signature]	9 Sep 95	[signature]	10 Sept 95

NAVSEA 9255/31 (6-94)(BACK)

Figure 220-49-1. Diesel Engine Jacket Cooling Water System Treatment Log MIL-A-53009 Treatment (Sheet 2 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
NALCOOL 2000 TREATMENT

ENGINE 1A SSDG SHIP USS FRIGATE (FFG 82) DATE JUN 95 PAGE 1

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)		NITRITE	INITIALS	
			SCALE READING	ppm FROM CHART	(1000 ppm min)	TESTER	EOOW
6/5	1035	FF				DC	
6/6	0920	ACA	0.5	<40	>1000	DC	

CHEMICAL TREATMENT

NALCOOL 2000 (gallons)	DATE	TIME	INITIALS
3 GALLONS	6/5/95	1345	DC

NAVSEA 9255/32 (6-94)(FRONT)

Figure 220-49-2. Diesel Engine Jacket Cooling Water System Treatment Log Nalcool 2000 Treatment (Sheet 1 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
NALCOOL 2000 TREATMENT

PAGE 2

DATE	TIME	REMARKS:
6/5	1035	FF WITH WATER FROM PIERSIDE RAINMAKER. CONDUCTIVITY = 10 µmhos/cm
6/6	0920	ACA SAMPLE SAT. NO FURTHER ACTION REQUIRED

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE
p.th	2 Jul 95	[illegible]	3 JUL 95	Jennifer A. Colemo	4 Jul 95

NAVSEA 9255/32 (6-94)(BACK)

Figure 220-49-2. Diesel Engine Jacket Cooling Water System Treatment Log Nalcool 2000 Treatment (Sheet 2 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
ANTIFREEZE TREATMENT

ENGINE 1 MPDE SHIP USS TUGBOAT (YTB 73) DATE JAN 95 PAGE 1

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)			RA	FREEZE PROTECTION			INITIALS	
			SCALE READING	ppm FROM CHART	ppm CHART X 2	(6 RA UNITS MIN)	FLOAT READING	TEMP (°F)	FREEZE PROT (°F)	TESTER	EOOW
1/16	1413	RTE	1.4	39	78	>10	H	90	-18	DC	TZ

CHEMICAL TREATMENT

MIL-A-46153 ANTIFREEZE (gallons)	DATE	TIME	INITIALS

NAVSEA 9255/33 (6-94)(FRONT)

Figure 220-49-3. Diesel Engine Jacket Cooling Water System Treatment Log Antifreeze Treatment (Sheet 1 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
ANTIFREEZE TREATMENT

PAGE 2

DATE	TIME	REMARKS:
1/16	1413	RTE SAMPLE SAT. NO FURTHER ACTION REQUIRED

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE
[illegible]	2/2/95	TJ	2/3/95	Charles Spencer	2/4/95

NAVSEA 9255/38 (6-94)(BACK)

Figure 220-49-3. Diesel Engine Jacket Cooling Water System Treatment Log Antifreeze Treatment (Sheet 2 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
SOLUBLE OIL TREATMENT

ENGINE 1B MPDE SHIP USS MINESWEEPER (MSO 560) DATE MARCH 95 PAGE 3

CHEMICAL TEST RESULTS

DATE	TIME	CODE	SOLUBLE OIL (1.0-2.0 %)		CHLORIDE	INITIALS	
			DIVISIONS ON BOTTLE	PERCENT	100 ppm MAX	TESTER	EOOW
3/5	1014	RTE	8	2.75	<100	MK	TS
3/5	1320	DRN				MK	
3/5	1340	WA				MK	
3/5	1430	AWA	5	1.6	<100	MK	TS

CHEMICAL TREATMENT

SOLUBLE OIL (pints) (NOTE: PREMIX SOLUBLE OIL BEFORE ADDING TO JACKET WATER SYSTEM)	DATE	TIME	INITIALS

NAVSEA 9255/34 (6-94)(FRONT)

Figure 220-49-4. Diesel Engine Jacket Cooling Water System Treatment Log Soluble Oil Treatment (Sheet 1 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
SOLUBLE OIL TREATMENT

PAGE 4

DATE	TIME	REMARKS:
3/5/95	1014	RTE SAMPLE SHOWS SOLUBLE OIL ABOVE LIMITS. RECOMMEND DRAIN OUT SOME COOLANT AND REPLACE WITH WATER IAW 220-46.5
		(1 - 2/2.75) x 60 GALLONS = 16.4 GALLONS
3/5/95	1320	DRAINED OUT 16.5 GALLONS COOLANT
3/5/95	1340	TOPPED OFF JACKET WATER SYSTEM WITH WATER FROM PIERSIDE RAINMAKER. CONDUCTIVITY = 40 µmhos/cm
3/5/95	1430	AWA SAMPLE SAT. NO FURTHER ACTION REQUIRED

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER) H. S. Murray 4/3/95 DATE
P2H	4/1/95	DC	4/2/95	

NAVSEA 9255/34 (6-94)(BACK)

Figure 220-49-4. Diesel Engine Jacket Cooling Water System Treatment Log Soluble Oil Treatment (Sheet 2 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
COMBINATION TREATMENT (MIL-A-53009 PLUS ANTIFREEZE)

ENGINE 1A SSDG SHIP USS MINESWEEPER (MCM 20) DATE JULY 95 PAGE 9

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)			MBT (100-500 ppm)		RA	FREEZE PROTECTION			INITIALS	
			SCALE READING	ppm FROM CHART	ppm CHART X 2	SCALE READING	ppm	(6 RA UNITS MIN)	FLOAT READING	TEMP (°F)	FREEZE PROT (°F)	TESTER	EOOW
7/12	1115	RTE	0.5	<40	<80	8	400	>10	F	100	-2	JR	TZ
7/20	2005	DRN										[illegible]	[illegible]
7/25	1416	RF										[illegible]	[illegible]
7/26	0930	OTH	0.8	<40	<80	7	350	>10	G	80	-5	JR	TZ

CHEMICAL TREATMENT

MIL-A-53009 INHIBITOR (quarts)	MIL-A-45153 ANTIFREEZE (gallons)	DATE	TIME	INITIALS

NAVSEA 9255/35 (6-94)(FRONT)

Figure 220-49-5. Diesel Engine Jacket Cooling Water System Treatment Log Combination Treatment (MIL-A-53009 Plus Antifreeze) (Sheet 1 of 2)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
COMBINATION TREATMENT (MIL-A-53009 PLUS ANTIFREEZE)

PAGE 10

DATE	TIME	REMARKS:
7/20	2005	COOLANT DRAINED TO HOLDING TANK FOR ENGINE REPAIRS
7/25	1416	COOLANT RETURNED TO ENGINE FROM HOLDING TANK
7/26	0930	OTH SAMPLE TAKEN TO ENSURE NO CONTAMINATION OCCURRED WHILE ENGINE REPAIRED. SAMPLE SAT. NO FURTHER ACTION REQUIRED

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE
NJW	8/3/95	TG	8/15/95	Charles B. Spencer	8/16/95

NAVSEA 9255/35 (6-94)(BACK)

Figure 220-49-5. Diesel Engine Jacket Cooling Water System Treatment Log Combination Treatment (MIL-A-53009 Plus Antifreeze) (Sheet 2 of 2)

DIESEL COOLANT TEST AND TREATMENT CHEMICAL INVENTORY LOG

SHIP USS MINESWEEPER (MCM 20) DATE JUNE 1995 PAGE 17

ITEM	NSN	QTY WITH LESS THAN 6 MONTHS SHELF LIFE REMAINING	QTY WITH 6 MONTHS OR MORE SHELF LIFE REMAINING	QTY REQUIRED FOR 6 MONTH DEPLOYMENT	SUFFICIENT ONBOARD STOCK? YES/NO
TREATMENT CHEMICALS					
MIL-A-53009 (Qt)	6850-01-160-3868	20	40	48 QUARTS	YES
MIL-A-53009 (Gal)	6850-01-287-8067	Ø	Ø		
Nalcool 2000 (1/2 Gal)	6850-01-085-4710			N/A	N/A
Nalcool 2000 (15 Gal)	6850-01-087-4045				
Nalcool 2000 (55 Gal)	6850-01-086-3438				
Antifreeze (1 Gal)	6850-00-181-7929	Ø	50	140 GALLONS	YES
Antifreeze (5 Gal)	6850-00-181-7933	Ø	20		
Antifreeze (55 Gal)	6850-00-181-7940	Ø	Ø		
Soluble Oil (1 Gal)	6850-00-139-5318			N/A	N/A
Soluble Oil (5 Gal)	6850-00-139-5329				
TEST EQUIPMENT AND CHEMICALS					
Chloride Test Strips (tube of 50)	6850-00-180-6165	1	2	2	YES
Radi-Aider Test Strips (tube of 50)	6630-01-011-5039	Ø	2	2	YES
MBT Test Kit (box of 30)	6630-01-327-0617	3	1	4	(NO)
Nitrite Test Sticks (tube of 100)	6850-01-154-3653			N/A	N/A
Cupric Sulfate (500 g)	6810-00-241-1203	Ø	1	1	YES
Phenolphthalein (100 g)	6810-00-223-7612			N/A	N/A
Isopropyl Alcohol (1 Gal)	6810-00-227-0410			N/A	N/A
Calcium Chloride	6810-01-136-2694			N/A	N/A
Sodium Chromate	6810-00-240-2119			N/A	N/A

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Figure 220-49-6. Diesel Coolant Test and Treatment Chemical Inventory Log (Sheet 1 of 2)

DIESEL COOLANT TEST AND TREATMENT CHEMICAL INVENTORY LOG

PAGE 18

DATE	TIME	REMARKS:
6/1/95		INSUFFICIENT ONBOARD STOCK OF MBT TEST KITS. REQUISITION SUBMITTED 23 MAY 95. AWAITING RECEIPT

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE
BAG	7/2/95			[signature]	7-4-95

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Figure 220-49-6. Diesel Coolant Test and Treatment Chemical Inventory Log (Sheet 2 of 2)

SECTION 50. CHEMICAL CLEANING PROCEDURES

220−50.1 The presence of excessive deposits in cooling systems, due to scale formation or corrosion products, can cause uneven heat transfer and overheating. This sets up stresses in the affected areas which can result in cracked heads, liners or other parts. The presence of lubricating oil (or separated Soluble Oil) in cooling systems can cause similar problems. Cleaning is necessary for removal of oil or excessive deposits from cooling systems.

220−50.2 CLEANING FOR OIL REMOVAL. Circulation of a hot detergent solution through a cooling system will remove Soluble Oil residues (for converting to Antifreeze treatment) or oil residue due to minor lube oil contamination.

220−50.3 Applicability. This procedure is authorized for use by ship's force. The procedure may not be completely successful in removing major lube oil contamination. If such a situation is encountered, consult with NAVSEA or NSWCCD−SSES, Philadelphia PA.

220−50.4 Procedure. The entire cooling system shall be flushed including the entire block, associated piping, expansion tank, and jacket water and lube oil coolers. Where applicable, the jacket water side of the distilling plant shall also be flushed. An external pump and tank with a heating coil shall be used for heating and circulating the detergent solution. The tank shall be located higher than the engine during the flush. Supply information for detergent flush is given in Table 220−50−1. The procedure is as follows:

1. Open all low point drains and completely dump the cooling system.

2. Fill the cooling system with clean, fresh water and fill the mixing tank to 1/3 capacity.

3. Circulate and heat the water to 145 to 155˚F (62 to 68˚C).

4. Add non−ionic detergent (MIL−D−16791 Type I)(NSN 7930−00−282−9699) to the tank. Add 1/2 ounce of detergent for each gallon of water in the system.

5. Circulate the detergent solution for 30 minutes at 145 to 155˚F (62 to 68˚C).

6. Drain the cooling system. Drain the tank separately to avoid reintroducing removed oil into the cooling system.

7. Repeat the flush if large amounts of oil are seen in the flush solution.

8. After completing the detergent flush, flush with clean, fresh water until the drained out water is clear and no sudsing is evident.

9. Flush once with water meeting the requirements of paragraph 220−42.1.

10. Inspect the cooling system to determine the success of the cleaning. (Inspection is not required if the cleaning was conducted for removing Soluble Oil residue to prepare for converting to a different inhibitor treatment.)

Table 220−50−1. Supply Information for Detergent Flush

Item	NSN	U/I	Qty	Notes
Chemicals				
MIL−D−16791, Type I, Non−ionic detergent	9Q 7930 00−282−9699	GL	(a)	
Safety Equipment: See Table 220−48−2 and Table 220−48−3				
Notes: (a) 1 pint per 30 gallons system capacity				

220−50.5 CLEANING FOR REMOVAL OF SCALE OR CORROSION PRODUCTS. Recirculation of a hot descalant solution is employed for the removal of scale or corrosion products. If oil residues are also present, the system shall first be cleaned using the procedure starting in paragraph 220−50.2; otherwise, the descalant will not work properly.

220−50.6 Applicability. Paragraphs 220−50.7 through 220−50.8 give the procedure for removing rust and water−formed deposits from cooling systems in which cast iron or aluminum are present. This procedure is authorized for use by ship's force.

CAUTION

During the cleaning operation, foul weather gear, rubber gloves, goggles and face masks shall be worn by personnel engaged in the cleaning operation. Adequate ventilation shall be provided. Smoking, welding or open flames shall not be permitted in the cleaning area.

220−50.7 Procedure. Figure 220−50−1 is a schematic for cleaning the cooling side of diesel engines. Supply information for Diammonium Citrate cleaning is given in Table 220−50−2. Procedure for cleaning the cooling water system is:

1. Blank off all parts of the system external to the engine
2. Determine the capacity of the system to be cleaned which can be done by filling the system and draining into a container of known capacity
3. After draining the system thoroughly, flush the watersides with clean, fresh water for 30 minutes
4. Isolate the engine cooling system pump to prevent contact with the descaling solution.
5. Connect an acid hose from the mixing tank to the suction side of the acid or brine pump. Attach another acid hose to the discharge side of the pump and to the engine coolant inlet. Attach an acid hose to the engine coolant outlet and return it to the mixing tank. Fasten the acid hose inside the tank to prevent whipping during circulation of the descalant.
6. Fill the system with clean, fresh water. Fill the mixing tank to 1/3 capacity. Circulate the water through the cooling system and mixing tank. Add steam to the heating coil to raise the temperature of the circulating water to 160˚F (71˚C).
7. While recirculating the hot water, slowly add the required quantities of chemicals based on the calculated system capacity, include the water in the mixing tank.
8. Recirculate the solution through the cooling system for 15 minutes maintaining the temperature at 160˚F (71˚C).

9. Continue cleaning for 6 hours. Every hour, recirculate the solution for 15 minutes. Use the heating coil to maintain the temperature at 160˚F (71˚C).
10. After 6 hours, dump the cleaning solution.

NOTE

All descalant and descalant solutions shall be turned in to the Public Works Officer or Public Works Center at any Naval Shipyard or other Naval Industrial Facility for proper disposal.

11. Fill the system with hot (120˚F or 50˚C) water, recirculate for 15 minutes and dump. Apply two additional rinses with water meeting the requirements of paragraph 220−42.1. Ensure that the system is emptied after each rinse.
12. Disconnect the cleaning equipment and reinstall the cooling system pump. Remove all blanks. Ensure that the cooling system is in proper operating condition.

CAUTION

Do not flush solution through the engine cooling system pump. Pump shall be bypassed or removed.

220−50.8 Hydrostatic Testing. Following the cleaning procedure, the cooling system should be subjected to a hydrostatic test in accordance with the equipment (NAVSEA) technical manual and PMS.

220−50.9 CLEANING PROCEDURE FOR JACKET WATER COOLER CORES ON MCM AND MHC CLASS ISOTTA FRASCHINI ENGINES. Copper−nickel cooler cores from IF engines are dipped in a hot sulfamic acid solution to remove scale and deposits. Supply information for IF Cooler Core cleaning is given in Table 220−50−3.

220−50.10 Applicability. This procedure is suitable for use by ship's force, intermediate maintenance activities (IMA, tenders), and shore intermediate maintenance activities (SIMA). This procedure is designed only for cleaning aluminum oxide fouling from jacket water cooler cores (removed from the engine) on MCM−class and MHC−class Isotta Fraschini (IF) engines. This procedure shall not be used to clean the other parts of the jacket water system without prior authorization from NAVSEA 03X or Carderock Division Naval Surface Warfare Center 624.

CAUTION

This procedure is not appropriate for use on aluminum, zinc, or stainless steel components.

220−50.11 Procedure.

CAUTION

This cleaning procedure uses chemicals which may be detrimental to aluminum. Do not perform this cleaning procedure near the engine.

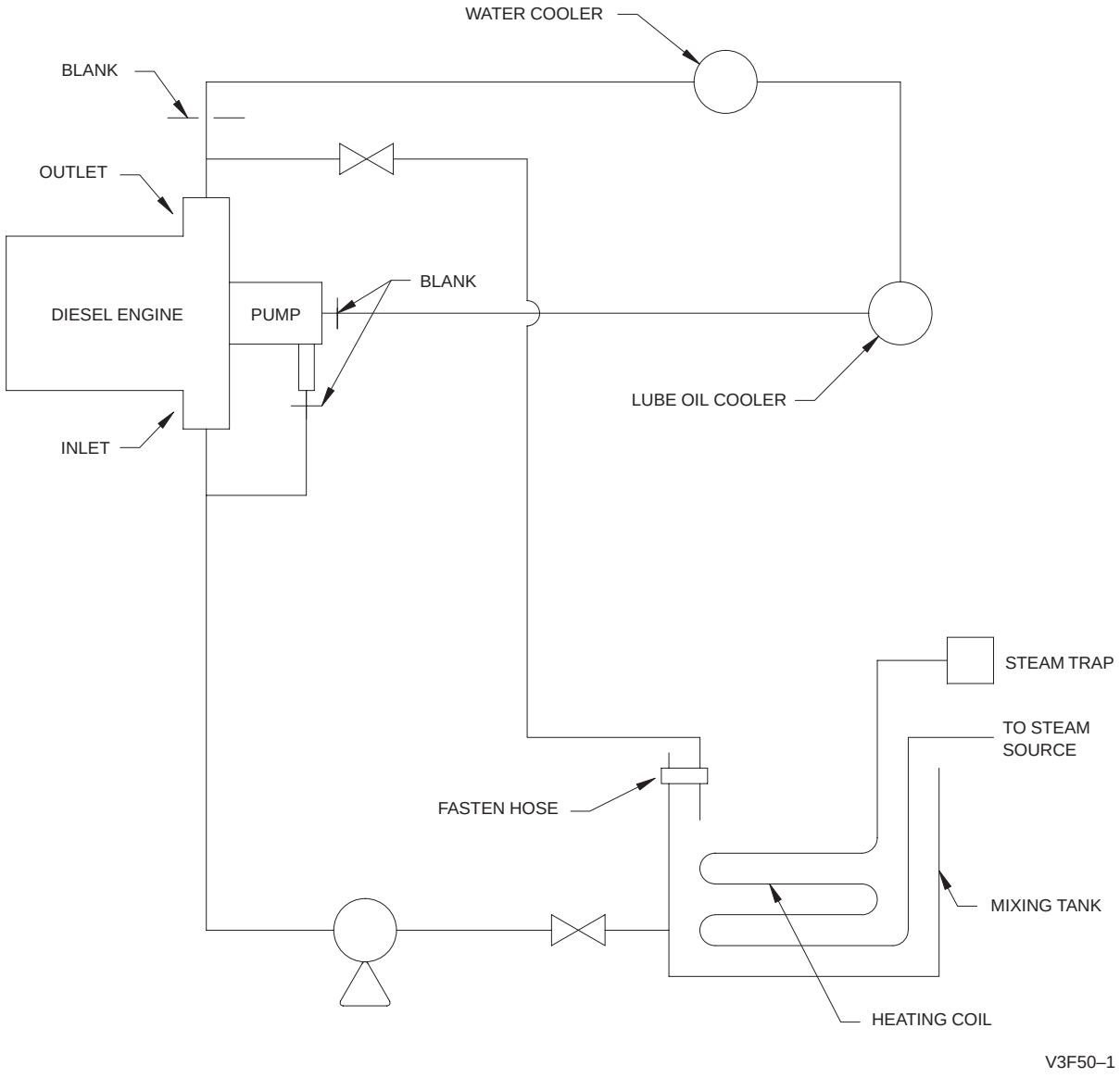

Figure 220−50−1. Typical Diagram for Cleaning the Cooling Side of a Diesel

Table 220−50−2. Supply Information for Diammonium Citrate Cleaning

Item	NSN	U/I	Qty	Notes
Chemicals and Supplies				
Ammonium citrate, dibasic, ACS grade	6810−00−975−2503		(a)	
1,3 Diethylthiourea, (also called DETU)			(b)	1
MIL−D−16791, Type I, Non−ionic detergent	9Q 7930−00−282−9699	GL	(c)	
Sodium Bicarbonate, Technical, Powder form	9G 6810−00−264−6618	LB	(d)	
Pump				2
Mixing Tank				3
Heating Coil				4
Acid Hose				5
Steam Hose				6
Steam Source				7
Safety Equipment: See Table 220−48−2, and Table 220−48−3				

Notes:

(a) 40 pounds per 50 gallons system capacity
(b) 2 pounds per 50 gallons system capacity
(c) 3 ounces per 50 gallons system capacity
(d) 5 pounds per 50 gallons system capacity

1. Available in 25kg (55 lb) bags from Sovereign Chemical Co, Akron OH (216)−869−0500.
2. The pump should be acid resistant, nonferrous, rubber or plastic construction; capable of pumping 5 to 10 gallons per minute against a static head of 5 to 20 psi. A brine pump similar to those employed with seawater evaporators is acceptable. Also acceptable is JABSCO Model 2187, JABSCO Pump Co., 2031 N. Lincoln St, Burbank, CA.
3. The tank capacity should be approximately 100 gallons. (Two nominal 50 gallon steel drums interconnected near the bottom with 1−1/2 inch pipe are acceptable).
4. This 3/4 inch ID coil should have 20 feet of heating surface capable of withstanding applied steam pressure, be fabricated to fit into the mixing tank, and contain a steam trap on the outlet side of the coil.
5. The acid hose shall be 1−inch ID acid resistant. The hose shall be capable of safely recirculating hot descaling solution (160° F or 71° C). Hoses shall be of sufficient length to connect the mixing tank and pump to the cooling side of the engine and return to the mixing tank.
6. The steam hose shall be 1 inch inside diameter. The hose shall be of sufficient length to connect the steam source to the heating coil.
7. Steam source shall be 25 to 100 psi.

NOTE

If acid spills occur, sprinkle sodium bicarbonate on the spill until foaming stops, then flush with fresh water to waste.

1. Inspect Water Cooler (i.e. core) for damage. If Water Cooler is unusable because of damage, replace rather than clean it.
2. Spray the Cooler with pressurized water (while the Cooler is still damp, if possible) to remove any loose deposit.
3. Add 4 gallons of fresh water (as hot as possible) to the bucket.
4. Heat the water to 150˚F by using a steam heating coil, or by direct steam injection through tubing submerged underwater in the bucket, or by some other suitable means. Maintain the temperature between 140 − 150˚F.

NOTE

In order for this cleaning procedure to be effective, it is essential that the cleaning solution be kept hot (140 to 150˚F). The solution is ineffective when cool.

5. Slowly add 3.4 lbs sulfamic acid to the bucket. Stir with wooden paddle to dissolve the chemicals.
6. When chemicals are dissolved stir in 15 milliliters (1 tablespoon) MIL−D−16791, Type 1, Non−Ionic detergent
7. Carefully submerge each jacket water cooler into the bucket one at a time. Ensure that each cooler is completely submerged. Allow each cooler to remain in the acid solution until deposits are dissolved. Occasionally lift cooler out of solution and re−submerge to improve cleaning.

NOTE

A rope may be tied around the cooler to facilitate the cleaning process.

8. Submerge cooler in bucket containing clean, fresh water for flushing. Use pH paper to verify that the pH of the water is greater than 6 (blue litmus paper does not turn red). If not, then replace the water and flush the cooler again.
9. Remove cooler from the bucket and spray with pressurized water to remove any loosened deposits.
10. Blow the cooler dry using compressed air.
11. Inspect the cooler for visible signs of damage. Conduct a hydrostatic test on each cooler at 58 psig (4 bar) to verify the absence of leakage.

NOTE

The acid solution may be reused, but will eventually become depleted and ineffective. Fresh acid solution will then be required for cleaning to continue.

NOTE

After completion of cleaning, the acid solution must be neutralized for disposal. Allow acid to cool to room temperature. Slowly and carefully sprinkle sodium bicarbonate until the pH of the solution is between 6 and 10. The solution will bubble when sodium bicarbonate is added. Turn neutralized cleaning solution in to Public Works for disposal.

Table 220−50−3. Supply Information for IF Cooler Core Cleaning

Item	NSN	U/I	Qty	Notes
Chemicals and Supplies				
Sulfamic acid (HSO_3NH_2) (10%) (100 lb)	9G 6810−00−146−1586	DR	(a)	1
MIL−D−16791, Type I, Non−ionic detergent	9Q 7930−00−282−9699	GL	(b)	
Sodium Bicarbonate, Technical, Powder form	9G 6810−00−264−6618	LB	(c)	
Bucket, 5 gallon			2	2
Bimetallic thermometer, 0 − 220˚F	9G 6685−00−373−3436	EA	1	
Rubber hose with connection for steam line			1	
Wooden Paddle			1	3
Mixing tank, Polyethylene, (for storing drained coolant, if desired)(optional)	9C 4940−01−130−0017	EA		
pH paper: multi−range litmus (turns red in acid)	1H 6850−01−154−3654 9L 6640−00−290−0146	BX HD	1	
Safety Equipment: See Table 220−48−2 and Table 220−48−3				

Notes:

(a) 3.4 pounds per 4 gallons (i.e. inside 5 gallon bucket).
(b) 15 milliliters per 4 gallons.
(c) 5 pounds per 4 gallons.

1. U/I contains 100 lb.
2. Bucket shall be made of steel. Galvanized materials **cannot** be used. (Plastic may be used provided it can withstand 150˚F.)
3. Paint stirrer is appropriate.

APPENDIX A. BLANK WATER TREATMENT LOGS

Log Number and Title **Page**

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
MIL–A–53009 TREATMENT

ENGINE _____ SHIP _____ DATE _____ PAGE _____

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)		MBT (100–500 ppm)		RA	INITIALS	
			SCALE READING	ppm FROM CHART	SCALE READING	ppm	(6 RA UNITS MIN)	TESTER	EOOW

CHEMICAL TREATMENT

MIL-A-53009 (quarts or gallons)	DATE	TIME	INITIALS

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DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
MIL–A–53009 TREATMENT

PAGE _____

DATE	TIME	REMARKS:

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE

NAVSEA 9255/31 (6–94)(BACK)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
NALCOOL 2000 TREATMENT

ENGINE _____ SHIP _____ DATE _____ PAGE _____

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)		NITRATE	INITIALS	
			SCALE READING	ppm FROM CHART	(100 ppm min)	TESTER	EOOW

CHEMICAL TREATMENT

NALCOOL 2000 (gallons)	DATE	TIME	INITIALS

NAVSEA 9255/32 (6–94)(FRONT)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
NALCOOL 2000 TREATMENT

PAGE _____

DATE	TIME	REMARKS:

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE

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DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
ANTIFREEZE TREATMENT

ENGINE _____ SHIP _____ DATE _____ PAGE _____

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)			RA	FREEZE PROTECTION			INITIALS	
			SCALE READING	ppm FROM CHART	ppm CHART X 2	(6 RA UNITS MIN)	FLOAT READING	TEMP (^{o} F)	FREEZE PROT (^{o} F)	TESTER	EOOW

CHEMICAL TREATMENT

MIL-A-46153 ANTIFREEZE (gallons)	DATE	TIME	INITIALS

NAVSEA 9255/33 (6–94)(FRONT)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
ANTIFREEZE TREATMENT

PAGE _____

DATE	TIME	REMARKS:

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE

NAVSEA 9255/33 (6–94)(BACK)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
SOLUBLE OIL TREATMENT

ENGINE _____ SHIP _____ DATE _____ PAGE _____

CHEMICAL TEST RESULTS

DATE	TIME	CODE	SOLUBLE OIL (1.0–2.0%)		CHLORIDE	INITIALS	
			DIVISIONS ON BOTTLE	PERCENT	100 ppm MAX	TESTER	EOOW

CHEMICAL TREATMENT

SOLUBLE OIL (pints) (NOTE: PREMIX SOLUBLE OIL BEFORE ADDING TO JACKET WATER SYSTEM)	DATE	TIME	INITIALS

NAVSEA 9255/34 (6–94)(FRONT)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
SOLUBLE OIL TREATMENT

PAGE _____

DATE	TIME	REMARKS:

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE

NAVSEA 9255/34 (6–94)(BACK)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
COMBINATION TREATMENT (MIL–A–53009 PLUS ANTIFREEZE)

ENGINE _____ SHIP _____ DATE _____ PAGE _____

CHEMICAL TEST RESULTS

DATE	TIME	CODE	CHLORIDE (100 ppm max)			MBT (100–500 ppm)		RA	FREEZE PROTECTION			INITIALS	
			SCALE READING	ppm FROM CHART	ppm CHART X 2	SCALE READING	ppm	(6 RA UNITS MIN)	FLOAT READING	TEMP (^{o} F)	FREEZE PROT (^{o} F)	TESTER	EOOW

CHEMICAL TREATMENT

MIL–A–53009 INHIBITOR (quarts)	MIL–A–45153 ANTIFREEZE (gallons)	DATE	TIME	INITIALS

NAVSEA 9255/35 (6–94)(FRONT)

DIESEL ENGINE JACKET COOLING WATER SYSTEM TREATMENT LOG
COMBINATION TREATMENT (MIL–A–53009 PLUS ANTIFREEZE)

PAGE _____

DATE	TIME	REMARKS:

LEGEND/TEST CODE

SAMPLES:

ACA	AFTER CHEMICAL ADDITION
AWA	AFTER WATER ADDITION
RTE	ROUTINE SAMPLE
OTH	OTHER

ACTIONS:

FF	FRESHLY FILLED AND TREATED
WA	ADDED WATER
DRN	PORTION OF COOLANT DRAINED
D	DUMPED
RF	REFILL
OTH	OTHER

LCPO		MPA		REVIEWED:	
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)	DATE

NAVSEA 9255/35 (6–94)(BACK)

DIESEL COOLANT TEST AND TREATMENT CHEMICAL INVENTORY LOG

SHIP _____ DATE _____ PAGE _____

ITEM	NSN	QTY WITH LESS THAN 6 MONTHS SHELF LIFE REMAINING	QTY WITH 6 MONTHS OR MORE SHELF LIFE REMAINING	QTY REQUIRED FOR 6 MONTH DEPLOYMENT	SUFFICIENT ONBOARD STOCK? YES/NO
TREATMENT CHEMICALS					
MIL–A–53009 (Qt)	6850–01–160–3868				
MIL–A–53009 (Gal)	6850–01–287–8067				
Nalcool 2000 (1/2 Gal)	6850–01–085–4710				
Nalcool 2000 (15 Gal)	6850–01–087–4045				
Nalcool 2000 (55 Gal)	6850–01–086–3438				
Antifreeze (1 Gal)	6850–00–181–7929				
Antifreeze (5 Gal)	6850–00–181–7933				
Antifreeze (55 Gal)	6850–00–181–7940				
Soluble Oil (1 Gal)	6850–00–139–5318				
Soluble Oil (5 Gal)	6850–00–139–5329				
TEST EQUIPMENT AND CHEMICALS					
Chloride Test Strips (tube of 50)	6850–00–180–6165				
Reserve Alkalinity Test Strips (tube of 50)	6630–01–011–5039				
MBT Test Kit (box of 30)	6630–01–327–0617				
Nitrite Test Sticks (tube of 100)	6850–01–154–3653				
Cupric Sulfate (500 g)	6810–00–241–1203				
Phenolphthalein (100 g)	6810–00–223–7612				
Isopropyl Alcohol (1 Gal)	6810–00–227–0410				
Calcium Chloride	6810–01–136–2694				
Sodium Chromate	6810–00–240–2119				

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DIESEL COOLANT TEST AND TREATMENT CHEMICAL INVENTORY LOG

PAGE _____

DATE	TIME	REMARKS:

LCPO		MPA		REVIEWED:
INITIALS	DATE	INITIALS	DATE	(ENGINEER OFFICER)

NAVSEA 9255/36 (6–94)(BACK)

INDEX

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(Insert Classif. of TMDER Here and At Bottom of Page) **CLASSIFICATION:**

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER) (NAVSEA S0005–AA–GYD–030/TMMP & NAVSEAINST 4160.3A)

INSTRUCTIONS: Continue on 8–1/2 " x 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, PROBLEMS, AND RECOMMENDATIONS RELATING TO PUBLICATION.
2. BLOCKS MARKED WITH "*" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.
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1. NAVSEA TECHNICAL MANUAL NO. *	2. VOL. PART*	3. TITLE*
S9086–GX–STM–030/CH–220	3	CORROSION AND CONTAMINATION CONTROL FOR DIESEL ENGINE COOLING WATER SYSTEMS

4. REV. NO./DATE OR TM CH. NO./DATE	5. SYSTEM/EQUIPMENT NOMENCLATURE	6. SYSTEM/EQUIPMENT IDENTIFICATION(MK/MOD/AN/PART NO.)

7. USER'S EVALUATION OF MANUAL (Check Appropriate Blocks)

	A. EXCELLENT		B. GOOD		C. FAIR		D. POOR		E. COMPLETE		F. INCOMPLETE

8. GENERAL COMMENTS:

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARA–GRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS TYPE OF PROBLEM [INDICATE SAFETY (S), MAJOR (M) OR MINOR (P)]

10. ORIGINATOR'S NAME AND WORK CENTER *(Please Print)*	11. SIGNATURE OF 3–M COORDINATOR	12. DATE SIGNED	13. AUTOVON/COMM. NO.

14. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

15. THIS SPACE ONLY FOR NSDSA

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		RECEIVED	FORWARDED	DUE		

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