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O-I-490a
April 26, 1965

SUPERSEDING
Fed. Spec. O-I-490
November 27, 1957

FEDERAL SPECIFICATION

INHIBITOR, CORROSION, LIQUID COOLING SYSTEM

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 This specification covers one type and one grade of corrosion inhibitor intended for inhibiting water and/or O-A-548, Antifreeze, Ethylene Glycol, Inhibited, type I (see 6.1).

2. APPLICABLE SPECIFICATIONS, STANDARDS, AND OTHER PUBLICATIONS

2.1 **Specifications and standards.** The following specifications and standards, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

Federal Specifications:

O-S-639—Sodium Phosphate, Dibasic, Anhydrous, Technical.
SS-S-535—Sodium Borate, Decahydrate, Technical (Borax).
PPP-B-585—Boxes, Wood, Wirebound.
PPP-B-591—Boxes, Fiberboard, Wood-Cleated.
PPP-B-601—Boxes, Wood, Cleated-Plywood.
PPP-B-621—Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636—Box, Fiberboard.
PPP-C-96—Cans, Metal, 28 Gage and Lighter.
PPP-T-76—Tape, Pressure-Sensitive Adhesive Paper, (For Carton Sealing).

Federal Standards:

Fed. Std. No. 102—Preservation, Packaging, and Packing Levels.
Fed. Std. No. 123—Marking for Domestic Shipment (Civilian Agencies).

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Washington, D. C., Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, and Seattle, Wash.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standard:

MIL-STD-129—Marking for Shipment and Storage.

(Copies of Military Specifications and Standards required by the contractor in connection with specific procurement functions, should be obtained from the procuring activity or as directed by the contracting officer.)

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2.2 Other publications. The following publications form a part of this specification. Unless otherwise specified, the issue in effect on date of invitation for bids shall apply.

American Society for Testing and Materials (ASTM) Standards:

D 664—Method of Test for Neutralization Value (Acid and Base Numbers) by Potentiometric Titration.

D 1121—Method of Test for Reserve Alkalinity of Concentrated Engine Antifreezes.

D 1287—Method of Test for pH of Concentrated Engine Antifreezes.

(Copies may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also widely distributed among technical groups and Federal agencies.)

3. REQUIREMENTS

3.1 Material. The raw materials used in the manufacture of the corrosion inhibitor shall be intimately mixed and processed so as to produce a uniform free-flowing product conforming to all the requirements of this specification.

3.2 Composition. The corrosion inhibitor shall consist of a blend of sodium borate, mercaptobenzothiazole and disodium phosphate mixed in the proportions necessary to conform to the weight requirements specified in table I (see 6.3).

3.2.1 *Sodium borate decahydrate.* The sodium borate used shall conform to the requirements of SS-S-535, type II.

3.2.2 *Mercaptobenzothiazole.* The mercaptobenzothiazole used shall be of a technical grade and shall have a purity of not less than 92 percent.

3.2.3 *Disodium phosphate anhydrous.* The disodium phosphate used shall conform to the requirements of O-S-639.

3.3 Other chemical requirements. In addition to conforming to the requirements of 3.2, 3.2.1, 3.2.2, 3.2.3, and table I the corrosion inhibitor shall conform to the chemical requirements specified in 3.3.1 to 3.3.4, inclusive.

3.3.1 *pH value.* When tested as specified in 4.4.3.4, the initial pH of the corrosion inhibitor when dissolved in ethylene glycol shall be 5.8 to 6.3 and when diluted with distilled water, the pH shall be 7.5 to 8.0.

3.3.2 *Reserve alkalinity.* The reserve alkalinity shall be not less than 8.7 when tested as specified in 4.4.3.5.

3.3.3 *Insoluble matter.* The insoluble matter shall not be greater than 1.4 percent by weight when tested as specified in 4.4.3.6.

3.3.4 *Chlorides, sulfates, and carbonates.* The corrosion inhibitor shall not contain chlorides, sulfates, or carbonates when tested as specified in 4.4.2.1 and 4.4.2.2.

3.4 Stability. Stability shall be such that the corrosion inhibitor will conform to this specification after unheated warehouse

TABLE I—*Weight requirements for 6- and 8½-ounce packages*

Composition	6 oz. (170 g.) package weight in grams		8½ oz. (242 g.) package weight in grams		Test paragraph
	Min.	Max.	Min.	Max.	
Mercaptobenzothiazole	24.8	26.6	35.3	37.7	4.4.3.1
$Na_2B_4O_7$, anhydrous	67.0	68.8	95.5	97.9	4.4.3.2
Na_2HPO_4, anhydrous	14.7	16.5	21.1	23.5	4.4.3.3

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storage in the original unopened containers for a 12 month period under any climatic conditions. The material shall show no excessive caking and shall be readily removable from the container after the storage period. Certification by the manufacturer that the material furnished will meet this requirement will be acceptable.

3.5 Workmanship. The corrosion inhibitor shall be processed to produce a clean, uniform product which complies with all the requirements of this specification.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Resposibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that the supplies and services conform to prescribed requirements.

4.2 Lot. A lot shall consist of all the corrosion inhibitor produced in a single batch and offered for acceptance at one time. A batch is that quantity of material subjected to some physical mixing operation to make the final product substantially uniform.

4.3 Sampling.

4.3.1 *For examination of the preparation for delivery.* Unless otherwise specified, a random sample of containers fully prepared for delivery shall be taken from each lot in accordance with MIL-STD-105 at inspection level II and acceptable quality level (AQL) = 2.5 percent defective for examination in accordance with 4.5.

4.3.2 *For testing.* For testing as required in 4.4, two containers shall be taken at random from the containers comprising the lot (see 4.2). If a sample fails to meet any of the tests required by this specification, the lot represented by the sample shall be rejected.

4.4 Tests.

4.4.1 *Total weight determination.* Pour the contents of one package into a flask previously weighed with its stopper to one tenth of a gram. Stopper the flask and reweigh to the same degree of accuracy. This information is necessary in calculating the weight of each ingredient of the inhibitor as specified in table I.

4.4.2 *Qualitative tests.* The corrosion inhibitor shall meet the test requirements as specified in 4.4.2.1 and 4.4.2.2.

4.4.2.1 *Chlorides.* Dissolve 0.25 g. of the corrosion inhibitor in 10 ml. of distilled water. Add 10 drops of concentrated nitric acid and agitate. Add 1 ml. of a 3 percent aqueous solution of silver nitrate and filter. Discard the filtrate. Wash the residue with concentrated ammonium hydroxide, recovering the filtrate. Acidify the filtrate with concentrated nitric acid. No precipitate shall form. A slight turbidity is allowed.

4.4.2.2 *Sulfate and carbonates.* Dissolve 0.25 g. of the corrosion inhibitor in 10 ml. of warm 1:1 ethylene glycol and distilled water mixture. Add 1 ml. of 5 percent aqueous solution of barium chloride. A precipitate will form. Add 1 ml. glacial acetic acid. There shall be no undissolved precipitate or effervescence. A slight turbidity is allowed.

4.4.3 *Quantitative tests.*

4.4.3.1 *Mercaptobenzothiazole (MBT).* Weigh 2 g. of the inhibitor to the nearest mg. and extract in a Soxhlet apparatus with acetone until the drainings are colorless. Evaporate the acetone extract on a steam bath, dissolve the residue in 20 ml. of hot benzene, filter and wash any insoluble matter with five 10-ml. portions of warm benzene. To the combined filtrate and washings contained in a weighed 100-ml. centrifuge tube add an excess of five percent fil-

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tered solution of copper oleate in benzene so that the solution remains green. Let stand overnight, centrifuge the orange-yellow precipitate, wash twice with benzene and once with petroleum ether while in the centrifuge tube. Dry to a constant weight at 140° C., cool in a desiccator and weigh rapidly. The gravimetric factor for calculating mercaptobenzothiazole weighed as the cuprous salt is 1.4556.

$$W = \frac{A\ B \times 1.4556}{C}$$

W = weight of MBT in package, grams
A = total weight of material in package, grams (4.4.1)
B = weight of precipitate, grams
C = weight of sample, grams

4.4.3.2 *Sodium borate.* Weigh approximately 5 g. of the inhibitor to the nearest mg. into a 500-ml. Erlenmeyer flask. Dissolve in 200 ml. of freshly boiled distilled water. Add a five percent solution of $BaCl_2$ in slight excess while stirring. After settling for 30 minutes filter the solution through a fine textured filter paper (Whatman 42 or equivalent) into a 500-ml. volumetric flask. Wash the residue with two 10-ml. portions of boiled distilled water. Return the paper to the original flask. Dissolve the residue in 6 *N* HCl and add 50 ml. distilled water. Stir the sample to break up the paper. Reprecipitate the phosphate with 6 *N* NaOH. Add a few drops of sodium hydroxide and a few drops of barium chloride to check for completeness of precipitation. Filter and wash as before into the 500-ml. volumetric flask. Cool the filtrate to 20° C. and dilute to the mark with cooled, boiled distilled water. Take a 100-ml. aliquot for analysis. Each aliquot contains one-fifth of the sample weight.

Adjust the solution to pH 5.5 with 1*N* HCl, using glass electrodes and instrument described in method ASTM—D 664. Add 1 g. of mannitol and titrate to pH 8.5 with standardized 0.5 *N* NaOH. Add 0.5 g. of mannitol. If no change in pH is observed the titration is complete. If a change is observed, alternately titrate to pH 8.5 and add 0.5 g. portion of mannitol until no change in pH occurs on the addition of the mannitol. Calculate the weight of $Na_2B_4O_7$ as follows:

$$W = \frac{A \times B \times C \times 0.05032 \times 5}{D}$$

W = weight of $Na_2B_4O_7$, anhydrous, in package, grams
A = ml. of NaOH used in titration
B = normality of NaOH
C = total weight of material in package, grams (4.4.1)
D = weight of sample, grams
(5) = factor to convert sample weight to aliquot used
(0.05032) = milli-equivalent of $Na_2B_4O_7$ $\frac{(201.3)}{4 \times 1000}$

4.4.3.3 *Disodium phosphate.* Accurately weigh 4.0 g. of inhibitor to nearest mg. Dissolve in 300 ml. of freshly boiled distilled water and filter into a 500-ml. volmetric flask and fill to the mark. Pipette 100 ml. of this solution into a 400-ml. beaker and add 50 ml. of distilled water. Add 20 ml. concentrated nitric acid and 20 g. ammonium nitrate to the flask. Heat the solution to 30°-45°C. Add 50 ml. of ammoniacal molybdate solution (see note). Do not heat the solution after addition of the molybdate solution. Agitate the solution for 10 minutes, then allow to settle for about 30 minutes. Filter the solution through fine textured filter paper (Whatman 42 or equivalent) and rinse the beaker with five 15 - 20 ml. portions of 1.0 percent postassium nitrate solution. Wash the paper with 100 ml. of 1 percent potassium nitrate using small portions. Discard all filtrates. Return the paper and precipitate to the beaker and add standardized 0.5 *N* sodium hydroxide from a buret to decompose the precipitate. Add an excess of 2.0 ml. Record the volume of 0.5 *N* sodium hydroxide used. Wash the sides of the flask and dilute to about 150 ml. with distilled water. Titrate the solution with standardized 0.1 *N* nitric acid to

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pH 8.5, using glass electrodes and instrument described in method ASTM—D 664.

$$W = \frac{A \times (B\,C - D\,E) \times 0.006173 \times 5}{F}$$

W = weight of Na_2HPO_4, anhydrous, in package, grams
A = total weight of material in package, grams (4.4.1)
B = ml. NaOH used
C = normality of NaOH
D = ml. HNO_3 used in titration
E = normality of HNO_3
F = weight of sample, grams
5 = factor to convert sample weight to aliquot used

$$0.006173 = \text{milli-equivalent of } Na_2HPO_4 \frac{(141.97)}{23 \times 1000}$$

Note: Ammoniacal molybdate solution: Weigh 61 g. ammonium molybdate and 57 g. ammonium nitrate into a one-liter beaker. Add 47 ml. concentrated ammonium hydroxide and 500 ml. distilled water. Warm the beaker to aid dissolution. Filter and make up to 1 liter in a volumetric flask.

4.4.3.4 *pH value.* To 1.0 g. of the corrosion inhibitor add 40 ml. of ethylene glycol which has been neutralized to a pH of 7.0 ± 0.1 and 2.0 ml. of distilled water. Warm and stir until the compound is dissolved and cool. The initial pH shall be measured at this point. To the solution prepared above add 80 ml. of distilled water and again determine the pH. The pH determinations shall be made at 25° ± 2°C. using the apparatus and procedure specified in ASTM-D 1287.

4.4.3.5 *Reserve alkalinity.* To 0.250 ± 0.001 g. add 100 ml. of distilled water. Warm and stir until dissolved. The reserve alkalinity shall be determined in accordance with ASTM-D 1121.

4.4.3.6 *Insoluble matter.* Dissolve 10.0 g. of the corrosion inhibitor in 900 ml. of a mixture of equal volumes of ethylene glycol and distilled water. Warm and stir. Filter through a suitable tared Gooch filtering crucible, rinse the container thoroughly with 1:1 glycol-water mixture, completely transferring all insoluble matter to the crucible. Wash with five 15-ml. portions of the glycol-water mixture. Rinse the crucible with 10 ml. of 1:1 ethanol-water mixture. Dry to constant weight at 105°C. Gain in weight is insoluble matter.

4.5 Examination of the preparation for delivery. Samples selected in accordance with 4.3.1 shall be examined for compliance with the packaging, packing, and marking requirements of section 5. In addition, each sample selected shall be examined for defects of the container and the closure, for evidence of leakage, and for unsatisfactory marking; each sample filled container shall also be weighed to determine the amount of the contents. Any container in the sample having one or more defects, or under the required fill (see table I), shall be rejected; and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105 the lot represented by the sample shall be rejected.

5. PREPARATION FOR DELIVERY

For civil agency procurement, the definitions and applications of the levels of packaging and packing shall be in accordance with Fed. Std. No. 102.

5.1 Packaging.

5.1.1 *Level A.*

5.1.1.1 *Unit packaging.* The corrosion inhibitor shall be packaged in metal cans conforming to the requirements of PPP-C-96, type V, class 1 and shall contain 6 ounces of material as specified in table I. Unless otherwise specified, exterior surfaces of the cans shall have plan B coating, with side seam striped in accordance with the can specification.

5.1.1.2 *Intermediate packaging.* Twenty-four unit cans of the corrosion inhibitor, packaged as specified in 5.1.1.1, shall be intermediately packaged in a snug-fitting W5c, style RSC fiberboard box conforming to PPP-B-636. In addition to box closure requirements, the box seams, corners, and

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manufacturer's joint shall be taped. Tape conforming to PPP-T-76 shall be used in lieu of the tape specified.

5.1.2 *Level B.*

5.1.2.1 *Unit packaging.*

5.1.2.1.1 *Military agencies.* The unit packaging shall conform to the requirements specified in 5.1.1.1.

5.1.2.1.2 *Civil agencies.* The corrosion inhibitor shall be packaged in a string opening, cylindrical pressed board container equipped with metal ends crimped, and shall contain 8-1/2 ounces of material as specified in table I. After crimping, the edge of the crimp shall be smooth, without excess gathering of metal or paper. The cover shall be furnished with metal ends crimped and provided with a skirt that can be slipped over the open end of the container and shall be tight enough not to fall off by its own weight when empty container is held in an inverted position.

5.1.2.2 *Intermediate packaging.* Twenty-four unit containers of the corrosion inhibitor, packaged as specified in 5.1.2.1.1 or 5.1.2.1.2, shall be intermediately packaged in a snug-fitting W5c, style RSC fiberboard box conforming to PPP-B-636.

5.1.3 *Level C.* The corrosion inhibitor shall be packaged to afford adequate protection from the supply source to the first receiving activity for immediate use.

5.2 Packing.

5.2.1 *Level A.* Four intermediate packages, packaged as specified in 5.1, shall be packed into snug-fitting exterior boxes conforming to PPP-B-621, class 2; PPP-B-601, overseas type; or PPP-B-636, V3c, style RSC. Closures and strapping of containers shall be in accordance with the applicable box specification and its appendix.

5.2.2 *Level B.* Four intermediate packages, packaged as specified in 5.1, shall be packed into snug-fitting exterior boxes conforming to PPP-B-636, V3c, style RSC; PPP-B-585, class 1; PPP-B-591, domestic type; or PPP-B-621, class 1. Closure and strapping of containers shall be in accordance with the applicable box specification and its appendix.

5.2.3 *Level C.* The corrosion inhibitor, packaged as specified in 5.1, shall be packed to insure carrier acceptance and safe delivery to first destination. Containers shall comply with the rules or regulations of carriers applicable to the mode of transportation.

5.3 Marking. In addition to the marking required by 5.3.1 or 5.3.2, each container shall be marked as follows:

"Contents" ..... ounces by weight (insert 6 or 8-1/2 as applicable).
"Direction for use—Use one (1) ounce of inhibitor to two (2) quarts of water in the cooling system of internal combustion engines. Do not use in liquid cooled aircraft engines."

5.3.1 *Civil agencies.* Marking of unit and intermediate packages and shipping containers shall be in accordance with Fed. Std. No. 123.

5.3.2 *Military agencies.* In addition to any special marking required in the contract or order, marking of the interior packages and shipping containers shall be in accordance with MIL-STD-129. The nomenclature shall be "Inhibitor, Corrosion, Liquid Cooling System".

6. NOTES

6.1 Intended use. Corrosion inhibitor compound as specified herein, is intended for use in the cooling system of liquid-cooled internal combustion engines; specifically to inhibit water and/or O-A-548, Antifreeze, Ethylene Glycol, Inhibited, type I. It is intended for use at the optimum rate of 1 ounce of the inhibitor to 2 quarts of water. This corrosion inhibitor shall not be used in the cooling system of liquid cooled aircraft engines.

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6.2 Ordering data. Purchasers should exercise any desired options offered herein and procurement documents should specify the following:

(*a*) Title, number, and date of this specification.

(*b*) Size of container required (6 or 8-1/2 ounce).

(*c*) Quantity required, number of containers.

(*d*) Level of packaging and packing required (see 5.1 and 5.2).

6.3 Composition. The corrosion inhibitor is contemplated to be comparable to the following approximate composition by weight (see table II). However, the Government assumes no responsibility for the acceptance of a product claimed to be manufactured under the identical formula.

TABLE II—*Composition of corrosion inhibitor*

Ingredient	Optimum percent by weight
Mercaptobenzothiazole (Technical grade, 92% min.)	15.1
Sodium borate decahydrate, $Na_2B_4O_7 \cdot 10H_2O$	75.7
Disodium phosphate anhydrous Na_2HPO_4	9.2

6.4 Transportation description. Transportation descriptions and minimum weights applicable to this commodity are:

Rail:

Chemicals, not otherwise indexed by name.
Carload minimum weight 30,000 pounds.

Motor:

Chemicals, not otherwise indexed.
Truckload minimum weight 30,000 pounds, subject to Rule 115, National Motor Freight Classification.

CUSTODIANS:

Army—MR

Navy—SH

Air Force—68

Review activities:

Army—MO, MR, MU

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