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FEDERAL SPECIFICATION

CUTTING FLUIDS: EMULSIFIABLE OILS

The General Services Administration has authorized the use of this federal specification, by all federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers three types of emulsifiable oils which, when diluted with water, are intended for use in metal-cutting operations (see 6.1).

1.2 Classification. The cutting fluids shall be of the following types, as specified (see 6.2).

Type I - Mineral oil and emulsifier. (NATO code number O-214, Military symbol OS).

Type II - Mineral oil, fatty oil, and emulsifier.

Type III - Mineral oil, emulsifier, and extreme-pressure additives.

2. APPLICABLE DOCUMENTS

2.1 Government publications. The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be used in improving this document should be addressed to: Defense Supply Center Richmond, Standardization Program Branch, ATTN: DSCR-VBD, 8000 Jefferson Davis Highway, Richmond, VA 23297-5610.

AMSC N/A

FSC 9150

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FEDERAL SPECIFICATIONS

QQ-S-698 - Steel, Sheet and Strip, Low-Carbon

FEDERAL STANDARDS

FED-STD-791 - Lubricants, Liquid Fuels, and Related Products; Method of Testing

(Activities outside the Federal Government may obtain copies of federal specifications, standards and commercial item descriptions as specified in the General Information section of the Index of Federal Specifications, Standards and Commercial Item Descriptions. The index is for sale on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

(Single copies of this specification, and other federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service Bureau, Specification Section, Suite 8100, 470 L'Enfant Plaza, SW, Washington, DC, 20407.)

(Federal Government activities may obtain copies of federal standardization documents and the Index of Federal Specifications, Standards, and Commercial Item Descriptions from established distribution points in their agencies.)

MILITARY STANDARDS

MIL-STD-290 - Packaging, Packing, Marking of Petroleum and Related Products

(Copies of military specifications and standards required by contractors in connection with specific procurement functions are obtained from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	Gray Iron Castings, Standard Specification For
ASTM B 36	Plate, Brass, Sheet, Strip, And Rolled Bar
ASTM B 121	Plate, Lead Brass, Sheet, Strip, And Rolled Bar
ASTM B 152	Copper Sheet, Strip, Plate, And Rolled Bar
ASTM D 130	Copper Corrosion from Petroleum Products by the Copper Strip

	Tarnish Test, Detection Of
ASTM D 92	Test for Flash and Fire Points by Cleveland Open Cup. (DoD adopted)
ASTM D 94	Saponification Number of Petroleum Products
ASTM D 95	Water in Petroleum Products and Bituminous Materials by Distillation
ASTM D 97	Pour Point of Petroleum Oils

(Private sector and civil agencies may purchase copies of these voluntary standards from the American Society for Testing and Materials, 100 Barr Harbor Drive, W. Conshohocken, PA 19428-2959).

(DoD activities may obtain copies of those adopted voluntary standards listed in the DoD Index of Specifications and Standards free of charge from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

3. REQUIREMENTS

3.1 Material. The emulsifiable oils shall consist of mineral oil, emulsifier, and additives. The oils shall contain sufficient bactericide to prevent bacterial growth under normal conditions of use.

3.2 Physical and chemical requirements. The emulsifiable oils shall conform to the requirements specified in Table I and in paragraphs 3.3 through 3.10.

Table I. Physical and chemical requirements.

Performance Requirements	Type I	Type II	Type III
Saponifiable oil, percent, minimum	No requirement	10	No requirement
Water content, percent, maximum	10	10	10
Pour point, degrees F, maximum	35	35	35
Flashpoint, degrees F, minimum	275	275	275

3.3 Storage ability. The emulsifiable oils shall show no separation or gelling, when tested in accordance with 4.3.1.

3.4 Emulsion stability. The emulsion shall show no separation or sedimentation, when tested in accordance with 4.3.2.

3.5 Frothing. The volume of froth at the top of the emulsion shall not exceed one mL, when tested in accordance with 4.3.3.

3.6 Gumming. The residue shall show no gumminess, and shall show not more than one . of separated oil, when tested in accordance with 4.3.4.

3.7 Corrosion. There shall be no staining, pitting, nor etching of steel, copper, brass, or cast iron, when tested in accordance with 4.3.5.

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3.8 Film strength. The diluted emulsifiable oil shall be capable of carrying the following jaw load without seizure or welding and shall not exceed the following torque (see Table II), when tested in accordance with 4.3.6.

Table II. Film strength.

Types	Jaw Load	Maximum Torque
Type I	1,500 pounds	50 in. lb.
Type II	2,000 pounds	70 in. lb.
Type III	3,750 pounds	80 in. lb.

3.9 Toxicity. The emulsifiable oils shall have no adverse effect on the health of personnel, in either concentrated or dilute form, when used for the intended purpose. Questions regarding to toxicity shall be referred by the procuring activity to the appropriate departmental medical service which will act as advisor to the procuring activity (see 4.3.7).

3.10 Workmanship. The emulsifiable oils shall be clear, homogeneous fluids. The oils and their emulsions shall be free from objectionable odors such as rancidity or hydrogen sulfide.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility of inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by 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 supplies and services conform to prescribed requirements.

4.2 Quality conformance inspection. The conformance inspection shall consist of all of the examinations and tests listed in Table II and paragraphs 4.3.1 through 4.3.2, unless explicitly waived in the contract.

4.2.1 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in FED-STD-791, Method 9601.

4.2.1.1 Examination of preparation for delivery. Examine samples selected for compliance with MIL-STD-290 with regard to fill, closure, sealing, leakage, packaging, and marking requirements. Reject any container having one or more defects or under the required fill. If the number of defective or underfilled containers exceeds the acceptance number for the appropriate sampling plan (as listed in the contract), reject the lot represented by the sample (see 6.2).

4.3 Test methods. All tests are classified as quality conformance tests. Perform tests and evaluations in accordance with the applicable test methods given in Table II and paragraphs 4.3.1 through 4.3.7.

Table III. Test methods.

Test	ASTM Method No.
Saponifiable oil	D 94
Water content	D 95
Pour point	D 97
Flash point	D 92 ¹

¹ Before determining the flash point, heat the sample to 220°F. (104°C.) for one hour in a low-form evaporating dish having an open surface approximately 10 cm. in diameter. (The purpose of this preheating procedure is to remove water which, if present, might interfere with the flash point determination.)

4.3.1 Storage stability. Pour a 100mL sample of the emulsifiable oil into a glass-stoppered, 100 mL cylinder and store it for 168 hours in an oven maintained at 130° +/- 5° F (54° +/- 3° C). Remove the cylinder from the oven and allow the sample to cool to room temperature 77° +/- 5° F (25° +/- 3° C). Examine the sample visually for separation or gelling. If none is observed, store the sample at minus 40° +/- 2° F (4° +/- 1° C) for 4 hours; allow it to warm to room temperature, and examine it for separation and gelling, as before. If none is observed, save the sample for the emulsion stability test (see 4.3.2).

4.3.2 Emulsion stability. Prepare synthetic hard water by dissolving 0.40 grams of anhydrous calcium chloride in one liter of reagent-grade water (see 6.5) water. Pour 95 mL of the synthetic hard water so prepared into a 100 mL glass-stoppered graduated cylinder. Cool the water to 45° +/- 2° F (7° +/- 1° C) and add 5 mL of emulsifiable oil that has passed the storage stability test (see 4.3.1). Agitate the contents vigorously by inverting the cylinder 100 to 120 times within a period of one minute. Allow the mixture to stand for 24 hours at room temperature 77° +/- 5° F (25° +/- 3° C) and examine it for separation and sedimentation.

4.3.3 Frothing. Pour 190 mL of reagent-grade water (see 6.5) into a 250mL, glass-stoppered, graduated cylinder. Add 10 mL of emulsifiable oil. Agitate the contents vigorously by inverting the stoppered cylinder 100 to 120 times within a period of one minute. Allow the cylinder to stand for 15 minutes at a temperature of 77° +/- 5° F (25° +/- 3° C) and record the volume of froth at the top of the emulsion.

4.3.4 Gumming. Prepare 100 mL of emulsion as described in 4.3.3, and pour it into a 100 mL beaker. Place the uncovered beaker in a forced draft oven maintained at 160° +/- 5° F (71° +/- 3° C) for 16 hours. Remove the beaker from the oven and allow it and the residue to cool to room temperature. Add 10 mL of reagent-grade water (see 6.5) and stir the contents vigorously for one minute with a glass rod. Examine the mixture for undissolved

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solids, polymerized particles, or gels. The presence of any one of these substances constitutes gumminess. If no gumminess is found, add 80 mL of reagent-grade water (see 6.5) to the beaker and stir the contents for one minute. Transfer the mixture to a 100 mL glass-topped graduated cylinder having one mL, subdivisions, and fill it to the 100 mL mark with reagent-grade water (see 6.5). Mix the contents by inverting the cylinder several times, and allow it to stand for one hour. Examine the upper part of the fluid and record the volume of any separated oil.

4.3.5 Corrosion. The corrosion test shall be performed according to paragraphs 4.3.5.1 through 4.3.5.4. After completion of the corrosion test, examine and compare both the exposed and duplicate metal strips under 5X magnification to determine whether staining, pitting, or etching has occurred on the exposed strips.

4.3.5.1 Sample size. Approximately 10 mL of the fluid shall be tested.

4.3.5.2 References, standards, and apparatus. The following items are required for the corrosion test:

Standard: ASTM D 130, Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test.

Apparatus: A source of clean, compressed air.

An air-pressure regulator.

Approximately 24 feet of ¼ inch I.D. rubber tubing.

Four screw-type pinch clamps.

A bubble tower of 500mL capacity.

Four test tubes, approximately 32 mm. in O.D. by 200 mm. in length.

Four pieces of glass tubing, 6 +/- 1mm. in I.D. by 230 +/- 10 mm. in length.

A pair of stainless steel forceps.

A graduated cylinder of 250mL capacity.

A magnifier of 5X power.

4.3.5.3 Materials. The materials in 4.3.5.3.1 and 4.3.5.3.2 shall be used.

4.3.5.3.1 Metal strips. All metal strips shall be cut from strip stock and shall measure approximately 3 X 1/2 X 1/8 inches.

- a. Two copper strips, conforming to ASTM B 152, electrolytic tough pitch, cold-rolled, half-hard temper.
- b. Two brass strips, conforming to ASTM B 36 and ASTM B 121, composition 2 [cartridge brass], half-hard temper.
- c. Two cast iron strips, conforming to ASTM A 48, class 20.
- d. Two steel strips, conforming to QQ-S-698, physical quality, cold-rolled, half-hard temper (CR half-hard No. 2 temper).

4.3.5.3.2 Solvents, chemicals, and miscellaneous materials. Solvents, chemicals and miscellaneous materials shall be the following:

- a. 100 mL of sodium hydroxide solution containing approximately 25 percent NaOH by weight [3,0,1].
- b. Normal Hexane, commercial [1,3,0].
- c. Reagent-grade water (see 6.5).

4.3.5.4 Procedure. Prepare two strips of each type of metal listed in 4.3.5.3.1 in accordance with ASTM D 130. Using forceps, place one strip of each type of metal in a separate test tube. Place the duplicate strips in a bottle filled with the normal hexane. Keep this bottle tightly stoppered until time to examine the strips. NOTE. CAUTION: Normal hexane is flammable. Use only in a well ventilated area. Keep all flames away from the normal hexane. Prepare a solution of the cutting fluid by placing 190 mL of reagent-grade water and 10 mL of the cutting fluid in a 250 mL graduate. Stopper the graduate and invert it several times. Continue inverting the graduate until a uniform mixture is obtained. Place 50 mL of the cutting fluid solution in each of the four test tubes. Mark the fluid level on the outside of each test tube and maintain this level by the addition of distilled water during the course of this test. Fill the bubble tower with the sodium hydroxide solution and connect the tower, through the air pressure regulator, to the source of compressed air by means of the rubber tubing. Connect each length of glass tubing, by means of rubber tubing and an appropriate manifold or series of Y-tubes, to the discharge outlet of the bubble tower. Place a screw type pinch clamp on each piece of rubber tubing leading to the glass tubes. Insert each glass tube to the bottom of a test tube and adjust the air flow into each tube to produce approximately one bubble per second by means of the air pressure regulator and pinch clamps. Permit the air to bubble into the tubes at room temperature $77^{\circ} \pm 5^{\circ} \text{ F}$ ($25^{\circ} \pm 3^{\circ} \text{ C}$) for a period of 48 hours. At the end of the test period, remove the metal strips from the test tubes, wash the metal strips in normal hexane and permit them to dry. Remove the duplicate metal strips from the bottle of normal hexane and permit them to air dry. After examination of the exposed and duplicate metal strips under 5X magnification, if it is determined that any staining, pitting, or etching has occurred on the exposed strips, the sample shall be rejected.

4.3.6 Film strength. Use a Falex lubricant tester or its equal (see 6.6), to determine film strength. The blocks shall be made of FS 1335 or equivalent steel and have a hardness of Rockwell C22 to C30. There shall be no burrs at the edges of the blocks. Remove any burrs present by rubbing the surfaces on a honing stone. A stone having two surfaces at 90 degrees (± 1 degree) apart can be used so that the two surfaces of the blocks can be honed at one time. The pins (No. 8) shall be made of FS 3135 or equivalent steel and have a hardness of Rockwell B80 to B90. Clean the blocks and pins in hot petroleum naphtha or Stoddard solvent, rinse in reagent-grade n-hexane, dry, and insert them in the machine. Clean the cup in the same manner, then dry and fill it with the diluted emulsifiable oil prepared as described in 4.3.3. Place the cup on the holder provided for it and raise it to immerse the blocks and pin. Install a type m (0-4500 lb) gage on the tester. Turn on the motor and while the pin is rotating at about 290 r.p.m., increase the jaw load from 0 to 250

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pounds by engaging the eccentric arm to the ratchet wheel. When the jaw load has reached 250 pounds, disengage the eccentric arm and maintain the load for one minute. Take the torque reading at the beginning of the one-minute period. Re-engage the eccentric arm and allow the jaw load to increase to 500 pounds. Upon reaching the load, take the torque reading again and maintain the load for a period of one minute. Repeat this procedure in increments of 250 pound jaw load until the required jaw load has been reached.

4.3.7 Toxicity. The contractor shall furnish the toxicological data and formulations required to evaluate the safety of the material for the proposed use.

5. PACKAGING

5.1 Packaging, packing, and marking. The requirements for packaging, packing, and marking shall be in accordance with MIL-STD-290, unless detailed requirements are specified in the contract.

6. NOTES. (This section contains information of a general or explanatory nature which is helpful, but is not mandatory.)

6.1 Intended use. Cutting fluids covered by this specification are intended for use as coolants and lubricants for metal cutting operations when diluted with water to approximately 5 percent by volume.

6.1.1 Type I. Type I emulsifiable oil is intended for easily-machined metals such as copper, brass, cast iron, and aluminum.

6.1.2 Type II. Type II emulsifiable oil is intended for metals which are moderately easy to machine such as bronzes, low carbon steel, or annealed high carbon steel. This type of oil is not intended for use in the machining of aluminum or copper alloys where staining is objectionable.

6.1.3 Type III. Type III emulsifiable oil is intended for difficult-to-machine high alloys or stainless steels and titanium.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Part identification number.
- c. Type cutting fluid (see 1.2).
- d. Quantity required.
- e. Type of packaging, packing, and marking required (see 5.1).
- f. Acceptance criteria (see 4.2.1.1).

6.3 Definitions.

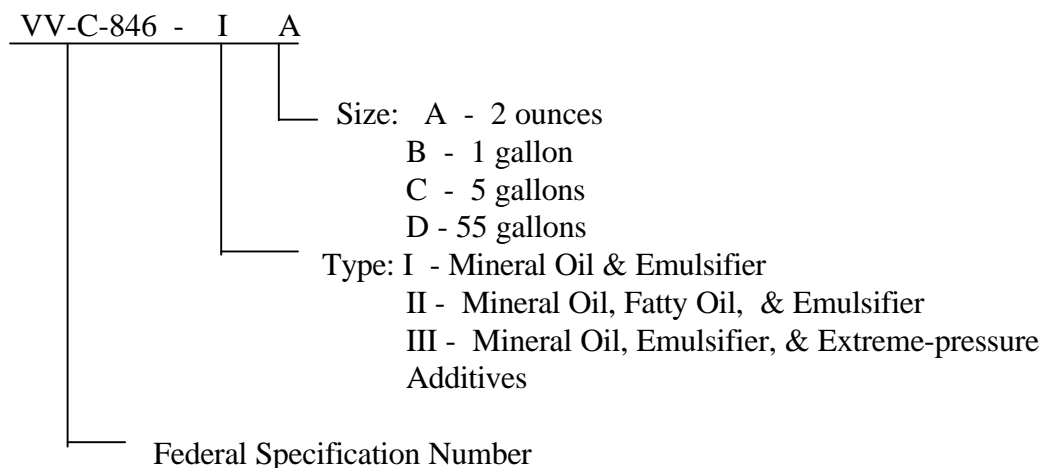
6.3.1 Reagent-grade water. Reagent-grade water shall be defined as distilled water or water of equivalent purity (including deionized water).

6.3.2 Bulk lot. An indefinite quantity of a homogeneous mixture of one type of emulsifiable oil offered for acceptance in a single, isolated container; or manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in the ingredient materials.

6.3.3 Packaged lot. An indefinite number of 55-gallon drums or smaller unit containers of identical size and type, offered for acceptance, and filled with a homogeneous mixture of one type of emulsifiable oil from a single, isolated container; or filled with a homogeneous mixture of one type of emulsifiable oil manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in the ingredient materials.

6.4 Source of test equipment. Information pertaining to the Falex Lubricant Tester can be obtained from Falex Corporation, 1020 Airpark Drive, Sugar Grove, IL 60554-9585.

6.5 Part identification number (PIN). The following part identification number procedure is for government purposes and does not constitute a requirement for the contractor.



6.6 International interest. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels including departmental standardization offices to change the agreement or make other appropriate accommodations. Identified below are the specific paragraph numbers and the international standardization agreements applicable to this specification; Section 1.2, Type I - Consisting of mineral oil and emulsifier. (NATO code number O-214 and Military symbol OS) and any reference to Type I emulsifiable oil throughout this document are subject to the international standardization agreement (NATO STANAG 1135).

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6.7 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:

Army - AT

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