

NOT MEASUREMENT SENSITIVE

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SUPERSEDING
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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.

1.2.1 Type. 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

1.3 International standardization agreement code number.

STANAG 1135 (see 6.6)

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data that may improve this document should be sent to: STDZNMGT@dla.mil or Defense Supply Center Richmond, ATTN: DSCR-VEB, 8000 Jefferson Davis Highway, Richmond, VA 23297-5616. Since contact information can change, you may want to verify the currency of this address information using the ASSIST database at <https://assist.daps.dla.mil>.

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2. APPLICABLE DOCUMENTS

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

Federal Specifications

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

(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 General Services Administration, Federal Supply Service, Specification Section, East 470 L'Enfant Plaza SW, Suite 8100, Washington, DC 20407.)

(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, Specification Section, East 470 L'Enfant Plaza SW, Suite 8100, 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 and 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 Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Electronic copies of specifications and standards may be obtained from <https://assist.daps.dla.mil>.)

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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 the date of invitation for bids or request for proposal shall apply.

ASTM International

ASTM A 48/A 48M	- Standard Specification for Gray Iron Castings.
ASTM B 36/B 36M	- Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar.
ASTM B 121/B 121M	- Standard Specification for Leaded Brass Plate, Sheet, Strip, and Rolled Bar.
ASTM B 152/B 152M	- Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar.
ASTM D 92	- Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester.
ASTM D 94	- Standard Test Methods for Saponification Number of Petroleum Products.
ASTM D 95	- Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation.
ASTM D 97	- Standard Test Method for Pour Point of Petroleum Products.
ASTM D 130	- Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test.
ASTM D 4057	- Standard Practice for Manual Sampling of Petroleum and Petroleum Products.

(Private sector and civil agencies may purchase copies of these voluntary standards from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. Electronic copies may be obtained from <http://www.astm.org/>.)

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.

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

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3.3 Storage stability. The emulsifiable oils shall show no separation or gelling when tested in accordance with 4.4.1.

3.4 Emulsion stability. The emulsion shall show no separation or sedimentation when tested in accordance with 4.4.2.

3.5 Frothing. The volume of froth at the top of the emulsion shall not exceed one milliliter (mL) when tested in accordance with 4.4.3.

3.6 Gumming. The residue shall show no gumminess, and shall show not more than one mL of separated oil when tested in accordance with 4.4.4.

3.7 Corrosion. There shall be no staining, pitting, nor etching of steel, copper, brass, or cast iron when tested in accordance with 4.4.5.

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 torques (see table II) when tested in accordance with 4.4.6.

TABLE II. Film strength.

Types	Jaw load	Maximum torque
Type I	1,500 pounds	50 in.-lbs.
Type II	2,000 pounds	70 in.-lbs.
Type III	3,750 pounds	80 in.-lbs.

3.9 Toxicity. The emulsifiable oils shall have no adverse effect on the health of personnel, in either concentrated or diluted form, when used for the intended purpose. Questions pertaining to toxicity shall be referred by the procuring activity to the appropriate departmental medical service that will act as advisor to the procuring activity (see 4.4.7).

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 for inspection. Unless otherwise specified in the contract (see 6.2), 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.

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4.2 Sampling for inspection. Unless otherwise specified (see 6.2), sampling of bulk and packaged lots for inspection shall be in accordance with ASTM D 4057.

4.3 Quality conformance inspection. The conformance inspection shall consist of all of the examinations and tests listed in table III and paragraphs 4.4.1 through 4.4.7, unless explicitly waived in the contract.

4.3.1 Inspection conditions. The contractor shall maintain a system to preserve the cutting fluid without contamination from the time of manufacture until final delivery. The system shall document the quality, testing, quantity, packaging, marking, and loading of the cutting fluid. Records shall be maintained for at least one year after the completion of the relevant contract.

4.3.1.1 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. The sampling plan acceptance level shall be as stated in the contract (see 6.2). If the number of defective or under-filled containers exceeds the acceptance number for the appropriate sampling plan, reject the lot represented by the sample.

4.4 Test methods. All tests are classified as quality conformance tests. Perform tests and evaluations in accordance with the applicable test methods given in table III and paragraphs 4.4.1 through 4.4.7.

TABLE III. Test methods.

Test	Test method
Saponifiable oil	ASTM D 94
Water content	ASTM D 95
Pour point	ASTM D 97
Flash point	ASTM D 92 ¹

¹Before 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 to remove water that might interfere with the flash point determination.

4.4.1 Storage stability. Pour a 100 mL sample of the emulsifiable oil into a 100-mL glass-stoppered graduated cylinder and store it for 168 hours in an oven maintained at 130 °F ± 5 °F (54 °C ± 3 °C). Remove the cylinder from the oven and allow the sample to cool to room temperature 77 °F ± 5 °F (25 °C ± 3 °C). Examine the sample visually for separation or gelling. If none is observed, store the sample at 40 °F ± 2 °F (4 °C ± 1 °C) for 4 hours. Allow it to warm to room temperature, and examine it for separation and gelling again. If none is observed, save the sample for the emulsion stability test (see 4.4.2).

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4.4.2 Emulsion stability. Pour 95 mL of synthetic hard water (see 6.3.2) into a 100-mL glass-stoppered graduated cylinder. Cool the water to $45\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$ ($7\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$) and add 5 mL of emulsifiable oil that has passed the storage stability test (see 4.4.1). 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 $77\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$ ($25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$) and examine it for separation and sedimentation.

4.4.3 Frothing. Pour 190 mL of reagent-grade water (see 6.3.1) into a 250-mL 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 $77\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$ ($25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$) and record the volume of froth at the top of the emulsion.

4.4.4 Gumming. Prepare 100 mL of emulsion as described in 4.4.2 and pour it into a 100-mL beaker. Place the uncovered beaker in a forced draft oven maintained at $160\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$ ($71\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$) 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 and stir the contents vigorously for one minute with a glass rod. Examine the mixture for undissolved 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 to the beaker and stir the contents for one minute. Transfer the mixture to a 100-mL glass-stoppered graduated cylinder that has one milliliter subdivisions and fill it to the 100-mL mark with reagent-grade water. 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.

4.4.5 Corrosion. The corrosion test shall be performed according to paragraphs 4.4.5.1 through 4.4.5.5. 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.

4.4.5.1 Procedure. Prepare two strips, each measuring approximately 3 X 1/2 X 1/8 inches, of each type of metal listed in table IV in accordance with ASTM D 130. Using forceps, place one strip of each type of metal in a separate test tube that measures approximately 32 millimeters (mm) outside diameter by 2,000 mm in length. Place the duplicate strips in a bottle filled with the commercial grade normal hexane. Keep this bottle tightly stoppered until time to examine the strips. CAUTION: Normal hexane is flammable. Use only in a well ventilated area. Keep all flames away from the normal hexane.

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TABLE IV. Metal test strips.

Metal	Requirement
Copper	ASTM B152, C11000 (electrolytic tough pitch), cold-rolled, half-hard temper
Brass	ASTM B36, C26000 (cartridge brass), half-hard temper and ASTM B121, C33500 (composition 2), half-hard temper
Cast iron	ASTM A48, class 20
Steel	QQ-S-698, physical quality, cold-rolled, half-hard temper (CR half-hard No. 2 temper)

4.4.5.2 Cutting fluid solution preparation. 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 graduated cylinder. Stopper the graduated cylinder and invert it several times. Continue inverting the graduated cylinder 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.

4.4.5.3 Bubble tower preparation. Fill a 500-mL bubble tower with the sodium hydroxide solution and connect the tower, through the air pressure regulator, to a source of clean, 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.

4.4.5.4 Test execution. 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 $77\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$ ($25\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{C}$) 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.

4.4.5.5 Examination of sample strips. Remove the duplicate metal strips from the bottle of normal hexane and allow them to air dry. Examine 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.

4.4.6 Film strength. Use a Falex lubricant tester or its equal to determine film strength. The tester's V-blocks shall be made of UNS 1335 or equivalent steel and have a hardness of Rockwell C22 to C30. The tester's pins (No. 8) shall be made of UNS 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 diluted emulsifiable oil solution prepared by combining 190 mL of reagent-grade water and 10 mL emulsifiable oil into a 250-mL glass stoppered graduated cylinder and agitating vigorously. Place the cup on its holder and raise it to immerse the blocks and pin. Install a type m (0-4,500 lbs.) gage on the tester. Turn on the motor

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and while the pin is rotating at about 290 RPM and increase the jaw load from 0 to 250 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.

4.4.7 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. Unless otherwise specified in the acquisition order (see 6.2), The requirements for packaging, packing, and marking shall be in accordance with MIL-STD-290.

5.2 Unit quantity. The cutting fluid should be provided in a 2-ounce, 1-gallon, 5-gallon, or 55-gallon unit quantity as specified in the acquisition order (see 6.2).

6. NOTES

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use. The 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 that 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.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, revision, and date of this specification.
- b. Part or identification number (PIN) (see 6.4).
- c. Type cutting fluid (see 1.2.1).
- d. Responsibility for inspection, if other than contractor (see 4.1).
- e. Sampling method, if other than specified (see 4.2)
- f. Acceptance level (see 4.3.1.1).
- g. Packaging, packing, and marking required, if other than specified (see 5.1).
- h. Unit quantity required (see 5.2).

6.3 Definitions.

6.3.1 Reagent-grade water. Reagent-grade water is distilled water or water of equal purity (including deionized water).

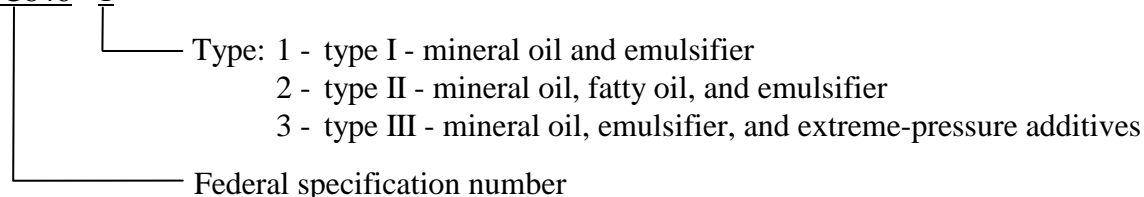
6.3.2 Synthetic hard water. Synthetic hard water is a solution of 0.4 grams anhydrous CaCl (calcium chloride) dissolved in 1 liter of reagent-grade water.

6.3.3 Bulk lot. A bulk lot is 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.

6.3.4 Packaged lot. A packaged lot is 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 PIN. The following PIN procedure is for government purposes and does not constitute a requirement for the contractor.

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6.5 Subject term (key word) listing.

fatty oil
 mineral oil

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6.6 International interest. When amendment, revision, or cancellation of this specification is proposed that 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 1.2.1, type I, consisting of mineral oil and emulsifier (NATO code number O-214, military symbol OS), and any reference to type I emulsifiable oil throughout this document are subject to the international standardization agreement STANAG 1135.

6.7 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This is done as a convenience only, and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

MILITARY INTERESTS:

Custodians:

Army - AT

Navy - AS

Air Force - 68

Review Activities:

Army - MI

Navy - SA, SH

CIVIL AGENCY
COORDINATING ACTIVITY:

GSA - FSS

Preparing Activity:

DLA - GS3

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