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METRIC

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# PERFORMANCE SPECIFICATION

# GREASE, AIRCRAFT AND INSTRUMENT

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

### 1.1 Scope.

This specification covers the general requirements for a multipurpose, water resistant, high speed grease for use in the -54°C to +177°C temperature range.

## 2. APPLICABLE DOCUMENTS

### 2.1 General.

The documents listed in this section are specified in *sections 3* and *4* of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in *sections 3* and *4* of this specification, whether or not they are listed.

Comments, suggestions, or questions on this document should be emailed to Engineering.Standards@wpafb.af.mil or addressed to ASC/ENOI, 2530 Loop Road West, Wright-Patterson AFB OH 45433-7101. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at assist.daps.dla.mil.

**AMSC:NA** **FSC 9150**

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## 2.2 Government documents.

### 2.2.1 Specifications, standards, and handbooks.

The following standard forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the solicitation or contract (see *6.2).*

FEDERAL STANDARDS

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

(Copies of federal and military specifications, standards, and handbooks are available from the Department of Defense Single Stock Point, Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia PA 19111-5094. Access via ASSIST online at http://assist.daps.dla.mil.)

## 2.3 Non-Government publications.

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 97 - Pour Point of Petroleum Products (DoD adopted)
ASTM D 942 - Oxygen Stability of Lubricating Grease by the Oxygen Bomb Method
ASTM D 217 - Cone Penetration of Lubricating Grease
ASTM D 445 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity) (DoD adopted)
ASTM D 1264 - Water Washout Characteristic of Lubricating Greases
ASTM D 1478 - Low Temperature Torque of Ball Bearing Greases
ASTM D 2265 - Dropping Point of Lubricating Grease Over a Wide Temperature Range
ASTM D 2266 - Wear Preventive Characteristics of Lubricating Greases (Four-Ball Method)
ASTM D 2595 - Evaporation Loss of Lubricating Greases Over Wide-Temperature Range
ASTM D 2596 - Extreme-Pressure Properties of Lubricating Grease (Four-Ball Method), Measurement of
ASTM D 3336 - Life of Lubricating Greases at Elevated Temperatures in Ball Bearings
ASTM D 4057 - Manual Sampling of Petroleum and Petroleum Products (DoD adopted)
ASTM D 4048 - Copper Corrosion from Lubricating Greases, Detection of
ASTM D 5706 - Determining Extreme Pressure Properties of Lubricating Greases Using a High-Frequency, Linear Oscillation (SRV) Test Machine
ASTM D 5949 - Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)
ASTM D 5969 - Corrosion Preventive Properties of Lubricating Greases in the Presence of Dilute Synthetic Sea Water
ASTM D 6184 - Oil Separation from Lubricating Greases (Conical Sieve Method)

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(Copies of this document are available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania, USA 19428-2959. Order electronic standards online at www.astm.org.)

### 2.4 Order of precedence.

In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in the document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

### 3.1 Qualification.

Items furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see *4.* and *6*.).

### 3.2 Materials.

The materials used in formulating this grease shall consist of a base oil conforming to requirements in *table I* and suitable additives. A polyalphaolefin, lithium soap thickened formulation is recommended, but is not mandatory. The thickener system proposed must be compatible with lithium soap thickened grease.

**Table I. Properties of base oil.**

| Viscosity @ | | ASTM Method |
|---|---|---|
| 40°C, cSt, max | 140 | D 445 |
| 100°C, cSt, min | 16 | D 445 |
| Pour Point, °C, min | -35 | D 97 or<br>D 5949 |

### 3.3 Finished grease.

The properties of the finished grease shall be as specified in *table II*.

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**TABLE II. Properties and test methods.**

| Property | Test Limits | Test Method | |
|---|---|---|---|
| | | FED-STD-791 | ASTM |
| Cone penetration, worked<br>worked stability, 100,000 double strokes | 265-305<br>350 max | | D 217 |
| Copper corrosion (1) | 1b max | | D 4048 |
| Corrosion Prevention(2)<br>Synthetic Sea Water, 5% | <br>Pass | | <br>D 5969 |
| Dirt, particle per millimeter of grease<br>25-74 micrometers, diameter<br>>75 micrometers, diameter | <br>1000 max<br>None | 3005.4 | |
| Dropping point, °C | 200 min | | D 2265 |
| Evaporation loss, 177± 3°C for 22 hours, percent | 10 max | | D 2595 |
| Extreme pressure properties, wear scar, mm (3) | 0.80 max | | D 5706 |
| High speed bearing performance, hours | 25 min | | See 4.4.5 |
| High speed bearing performance, after 6 mo. humidity storage, hours | 25 min | | See 4.4.6 |
| Life of lubrication greases at elevated temperature in ball bearings, 160± 2°C, hours | 400 min | | D 3336 |
| Load wear index, Kgf | 30 min | | D 2596 |
| Low temperature torque of ball bearings, -54± 1°C start/run @ 1 hour, Newton-meter (Nm) | 1.4/0.5 max | | D 1478 |
| Odor | No odor of rancidity, perfume or free alcohol | | |
| Oil separation, percent weight loss | 8 max | | D 6184 |
| Oxidation stability, after 500 hours, psi | 35 max | | D 942 |
| Storage stability, penetration, 2 mo., 20-25°C<br>Worked (change from original), points | <br>30 max | 3467.1 | |
| Water washout, 41± 1°C, percent | 15 max | | D 1264 |
| Wear preventative characteristics, wear scar average, mm | 0.65 max | | D 2266 |

NOTES:

(1) The grease shall show no green color in that portion contacting the copper strip. The copper strip shall not tarnish more than a classification of 1b when compared with the ASTM copper corrosion standards.

(2) Water shall be prepared the day of the testing.

(3) See 4.4.4.

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### 3.4 Workmanship.

The grease, when examined visually, shall be a smooth and homogeneous mixture, free from lumps and extraneous materials.

### 3.5 Compatibility.

The grease shall be compatible with all previously qualified greases when tested in accordance with 4.4.7. Immediately after mixing, and after undisturbed storage for seven days, the mixture shall not form resinous gums, sludge, or insoluble solid materials and shall comply with the worked penetration and worked stability requirements (see table II). In the event of failure, the previously qualified grease (unmixed with other greases) shall be tested to verify that it meets the worked penetration and worked stability requirements under the conditions specified in 4.4.7. If the previously qualified sample fails to meet the worked penetration or worked stability requirement, a fresh sample shall be obtained and the compatibility test repeated. Additional mix ratios of 90 percent previously qualified and 10 percent new and vice versa may be used during qualification testing.

## 4. VERIFICATION

### 4.1 Classification of inspections.

The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see *4.2*).
b. Conformance inspection (see *4.3*).

### 4.1.1 Inspection conditions.

Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in *4.2*.

### 4.2 Qualification inspection.

### 4.2.1 Qualification sample.

Qualification samples shall consist of four one pound containers of grease and one-half pint of base oil. The additives, in 4-ounce quantities, may be requested at the option of the qualifying activity.

### 4.2.2 Qualification tests.

Qualification sample(s) shall be subject to all the tests specified under *4.4*, methods of inspection.

### 4.2.3 Retention of qualification.

In order to retain qualification of a product approved for listing on the QPL, the manufacturer shall verify, by certification, to the Qualifying Activity that the manufacturer's product complies with the requirements of this specification. The time of periodic verification by certification shall be after five years from the date of manufacture and every two years thereafter. The Government reserves the right to re-examine the qualified product whenever deemed necessary to determine the product continues to meet any or all of the specification requirements. The

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product will be requalified every five years; to retain qualification, new samples shall be submitted to the qualifying activity.

### 4.3 Conformance inspection.

The quality conformance inspection shall consist of examination of the sample of filled containers and all of the required tests except for base oil kinematic viscosities and pour point. For grease, text exceptions include extreme pressure properties, high speed bearing tests, life of lubrication greases at elevated temperature in ball bearings, low temperature torque of ball bearings, and storage stability. Samples shall be labeled completely with information that identifies the purposes of the sample, name of product, specification number, lot and batch number (see *6.4*), date of sampling, and contract number.

### 4.4 Methods of inspection.

#### 4.4.1 Inspection.

Inspection shall be in accordance with *method 9601* of *FED-STD 791*.

#### 4.4.2 Grease.

The grease shall conform to the requirements for base oil and finished grease which shall be determined by appropriate examination and testing in accordance with *4.4.3*.

#### 4.4.3 Physical and chemical values.

Tests shall be performed in accordance with the applicable methods specified in *tables II and III* and *4.4.4* through *4.4.7*. Physical and chemical values specified in *section 3* apply to the arithmetic average of the determinations made on the samples for those values which fall within any stated repeatability or reproducibility limits of the applicable test method.

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**TABLE III. Conformance properties and test methods.**

| Property | Test Limits | Test Method | |
|---|---|---|---|
| | | FED-STD-791 | ASTM |
| Cone penetration, worked<br>worked stability, 100,000 double strokes | 265-305<br>350 max | | D 217<br>or<br>D 1403 |
| Copper corrosion (1) | 1b max | | D 4048 |
| Corrosion Prevention (2)<br>Synthetic Sea Water, 5% | Pass | | D 5969 |
| Dirt, particle per millimeter of grease<br>25-74 micrometers, diameter<br>>75 micrometers, diameter | 1000 max<br>None | 3005.4 | |
| Dropping point, °C | 200 min | | D 2265 |
| Evaporation loss, 175± 3°C for 22 hours, percent | 10 max | | D 2595 |
| Load wear index, Kgf | 30 min | | D 2596 |
| Odor | No odor of rancidity, perfume or free alcohol | | |
| Oil separation, percent weight loss | 8 max | | D 6184 |
| Oxidation stability, after 500 hours, psi | 35 max | | D 942 |
| Water washout, 41± 1°C , percent | 15 max | | D 1264 |
| Wear preventative characteristics, wear scar average, mm | 0.65 max | | D 2266 |
| Workmanship | Pass | | See 3.4 |

NOTES:

(1) The grease shall show no green color in that portion contacting the copper strip. The copper strip shall not tarnish more than a classification of 1b when compared with the ASTM copper corrosion standards.

(2) Water shall be prepared the day of the testing.

**4.4.4 Modification of ASTM D 5706 for the use of the reciprocating tribometer.**

Follow ASTM D 5706 with these exceptions:

- Use disks polished to 4 microns or less
- Use individual washings of hexane, acetone, and isopropanol, for ultrasonic cleaning
- Use 0.5 gm of test grease
- Preload 10N for run-in for 2 min
- 2.3 mm (± 0.2 mm) stroke length
- Manually load to 600 N after run-in and run at 600 N thereafter
- Test time: 30 minutes total including run-in
- Report size of wear scar on ball using ASTM D 2266 for ball measurements
- Graph coefficient of friction and contact resistance for each test, if possible

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### 4.4.5 High speed bearing performance.

#### 4.4.5.1 Apparatus.

Performance shall be determined in a Marlin Rockwell 538°C grease testing unit developed for the CRC L-54 research technique, or equivalent, using *ASTM D 3336* test method with the following modifications: A variable-speed electric drive motor installed with a large balanced pulley and a light-weight flat belt to rotate a spindle supported by two ball bearings. The rig shall be modified to accommodate a 17 mm bore size 203 test ball bearing located at the opposite end of the spindle from the drive pulley. This bearing shall be made of M-50 tool steel and phenolic resin with aluminum side plates fastened with rivets. Dished side shields shall be used to retain additional lubricant. The spindle support bearing located next to the pulley shall be Marlin Rockwell type 204 S-17 or equivalent with races and balls made of M-50 tool steel and bore diameters of 20 mm or equivalent. The ball retainer shall be a stamped ribbon type made of silver plated beryllium copper. A thermocouple in contact with the outer race of the test bearing shall be connected to at temperature controller, a recorder, and a data logger. An oven capable of maintaining the test temperature is required. An air cylinder connected to a steel cable is required to apply thrust load to the test bearing housing.

#### 4.4.5.2 Procedure.

Prior to testing, the side shields of the 203 test bearing shall be removed and all the bearing components cleaned thoroughly with hexane. The bearing shall be packed with 0.535 ± 0.050 grams of test grease and 0.625 ± 0.050 grams of grease in each of the two shields. The shields shall then be replaced carefully. After installing on the tester, the test bearing shall be run at 30,000 rpm, thrust loading at 1769 ± 9 N. The test is started at room temperature for four hours and than at a temperature of 115.5 ± 2°C for a total test time of 25 hours.

### 4.4.6 High speed bearing performance after storage.

A 203 size bearing is also packed as in 4.4.5.2 and stored vertically from nichrome wire in an oven at 71±2°C and 98 to 100 percent relative humidity. After six months, the bearing is removed and tested as in 4.4.5.2.

### 4.4.7 Compatibility.

Fill standard grease cups with equal volumes of the grease being tested and previously qualified greases. The cup shall be filled by alternately adding 60 grams of each of the two greases being tested, until the cup is full (approximately 454 grams). Mix the two greases by working the sample for 60 double strokes in accordance with the worked penetration procedure of ASTM D217 or ASTM D 1403 and then let the mixture stand undisturbed for seven days at 19.0 to 29.5°C (65 to 85°F) and 50 ± 10 percent relative humidity. Examine the worked penetration and then the worked stability in accordance with table II, using the same sample of grease mixture for both tests. Small amounts of fresh grease may be added to the worker cup just prior to the worked stability, as needed to maintain a full cup for testing.

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## 5. PACKAGING

### 5.1 Packaging.

For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see *6.2*). When actual packaging is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity with the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

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

### 6.1 Intended use.

The grease covered by the specification is intended as a general purpose aircraft lubricant and is used to lubricate main shaft bearings in missile engines. It provides water resistance and corrosion protection for aircraft and missiles over an extended period. It will be operational between -54 and 175°C.

### 6.2 Acquisition requirements.

Acquisition documents must specify the following:

a. Title, number, and date of the specification.
b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see *2.3*).
c. Packaging requirements (see *5.1*).
d. Quantity desired.
e. Type and capacity of container (see *5.1*)

### 6.3 Qualification.

With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in *Qualified Products List QPL-32014* whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from AFRL/MLBT, Bldg 654, 2941 Hobson Way, Rm 136, WPAFB OH 45433-7750.

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**6.3.1 Data to accompany qualification samples.**

The samples will be accompanied by a Material Safety Data Sheet and a test report from the manufacturer or a commercial laboratory that contains complete information about the source and type of base stock and additive materials used, the formulation and composition of the finished grease, and laboratory data that show quantitative results of all the tests required by this specification except storage stability, high speed bearing tests and humidity storage test. Separate qualification inspection will be required for each base stock used. The samples will be plainly identified by securely attached, durable tags or labels marked with the following information:

Sample for Qualification Inspection

GREASE, AIRCRAFT AND INSTRUMENT

Specification *MIL-PRF-32014*
Name of ingredient (for ingredient material)
Name of manufacturer
Product code number
Date of manufacture

**6.3.2 Formulation sheet.**

An example of a satisfactory form for the formulation sheet, indicating the weight percentage and nature of each ingredient is as follows:

Base stock (chemical composition, CAS number, manufacturer's name and number) percentage
Thickener(chemical composition, CAS number, manufacturer's name and number) percentage
Each additive (chemical composition, CAS number, manufacturer's name and number) percentage

**6.4 Definitions.**

**6.4.1 Bulk lot.**

A bulk lot (batch) is an indefinite quantity of a homogeneous material mixture offered for acceptance in a single, isolated container or manufactured in a single-plant run (not to exceed 48 hours), through the same processing equipment, with no change in ingredient material.

**6.4.2 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 material mixture from one isolated container or filled with a homogeneous material mixture manufactured is a single-plant run (not to exceed 48 hours), through the same processing equipment, with no change in ingredient material.

**6.5 Subject term (key word) listing.**

General purpose grease
Missile engine grease
Water resistant grease

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**6.6 Changes from previous issue.**

Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians
Army - CR4
Navy - AS
Air Force - 11

Review activities
Army - AV, MI, AR, EA
Navy - SH
DLA - PS

Preparing Activity
Air Force 11

(Project No. 9150-2006-001)

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