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MILITARY SPECIFICATION

CORROSION PREVENTIVE, AIRCRAFT ENGINE

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force

1. SCOPE

1.1 **Scope.** This specification covers an oil-type corrosion preventive which shall be a satisfactory lubricant for aircraft engines when applied as specified

1.2 **Classification.** The corrosion preventive shall be one of the three following types, as specified (see 6.2):

Type I—Concentrate material.

Type II—Ready-mixed material for reciprocating aircraft engines.

Type III—Ready-mixed material for turbojet aircraft engines which use Specification MIL-O-6081 lubricating oil.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publication, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

- O-M-232—Methanol (Methyl Alcohol)
- P-S-661—Solvent, Dry-Cleaning
- QQ-S-636—Steel; Carbon (Low-Carbon), Sheets and Strips
- TT-T-291—Thinner; Paint, Volatile Mineral Spirits (Petroleum-Spirits)

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- JAN-H-792—Humidity Cabinet; Operation of

MIL-D-3716—Desiccants (Activated) for Dynamic Dehumidification

MIL-G-5572—Gasoline, Aviation; Grades 80/87, 91/96, 100/130, 115/145

MIL-O-6081—Oil, Lubricating, Jet Engine

MIL-L-6082—Lubricating Oil; Aircraft Reciprocating (Piston) Engine

MIL-C-11796—Corrosion Preventive Petrolatum, Hot Application

MIL-C-16173—Corrosion Preventive, Solvent Cutback, Cold-Application

STANDARDS

FEDERAL

- | | |
|------------------------------|--|
| Fed. Test Method Std No. 791 | Lubricants, Liquid Fuels, and Related Products; Methods of Testing |
|------------------------------|--|

MILITARY

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

AIR FORCE-NAVY AERONAUTICAL BULLETIN

- No. 143 Specifications and Standards: Use of

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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

FSC 6850P

MIL-C-6529C**INTERSTATE COMMERCE COMMISSION****49 CFR Interstate Commerce Commission Rules and Regulations for the Transportation of Explosives and Other Dangerous Articles**

(The Interstate Commerce Commission regulations are now a part of the Code of Federal Regulations (1949 Edition-Revised 1950) available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Orders for the above publications should cite "49 CFR 71-78 (Rev. 1950).")

3. REQUIREMENTS

3.1 Qualification. The compound furnished under this specification, except as specified in 4.2.1, shall be a product which has been tested and has passed the Qualification tests specified herein.

3.2 Materials.

3.2.1 Type I. The Type I compound, concentrate material, shall be an additive designed to be used with any lubricating oil qualified under either Specification MIL-L-6082 or MIL-O-6081, in the proportions by volume of 1 part concentrate to 3 parts lubricating oil. The specified corrosion-preventive mixture shall be a satisfactory lubricant for reciprocating engines when blended with lubricating oil qualified under Specification MIL-L-6082, and shall be a satisfactory lubricant for turbojet engines which require Specification MIL-O-6081 oil, when blended with lubricating oil qualified under Specification MIL-O-6081.

3.2.2 Type II. The Type II compound, ready-mixed material for reciprocating aircraft engines, may be a blend, by volume, of 3 parts of any lubricating oil qualified under Specification MIL-L-6082, Grade 1100, and 1 part of any qualified Type I concentrate of this specification. No Qualification Tests will be required for this blend. Type II material may also be prepared directly, using any lubricating oil qualified under Specification MIL-L-6082, Grade 1100, and a corrosion-inhibitive material, in which case it will be necessary to qualify the Type II material as specified in 4.2.

3.2.3 Type III. The Type III compound, ready-mixed material for jet aircraft engines which require lubricating oil qualified under Specification MIL-O-6081, shall be a blend by volume, of 3 parts of any lubricating oil

qualified under Specification MIL-O-6081, Grade 1010, and 1 part of any qualified Type I concentrate of this specification. The blend is required to meet all applicable Acceptance Tests. Type III material shall be a satisfactory lubricant for jet engines which require Specification MIL-O-6081 lubricating oil for normal operation.

3.2.4 Toxicity. The corrosion preventive shall contain no material of known toxicity. The vapor shall not cause discomfort or injury to workmen engaged in the application of the material. (See 6.7.)

3.2.5 Selection of materials. Specifications and standards for all materials, parts, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with ANA Bulletin No. 143 for Air Force and Navy purchases. For Army purchases selection shall be in accordance with instructions issued by the procuring activity.

3.3 Properties.

3.3.1 The following requirements shall apply to Type I concentrate material blended with aircraft lubricating oil or to Type II ready-mixed materials, where applicable. One part of Type I concentrate material shall be blended by volume with three parts of a lubricating oil qualified under Specification MIL-L-6082, Grade 1100. A similar blend shall be prepared, using a lubricating oil qualified under Specification MIL-O-6081, Grade 1010. Tests shall be performed on both blends.

3.3.1.1 High- and low-temperature stability. Type I concentrate blended as specified in 3.3.1 and Type II ready-mixed materials shall show no separation when tested as specified in 4.5.1. In addition, Type I concentrate shall be soluble and miscible with any lubricating oil qualified under Specification MIL-L-6082, Grade 1100, or Specification MIL-O-6081, Grade 1010, at temperatures above 50° F.

3.3.1.2 Protection. When tested as specified in 4.5.2, not more than 1 panel out of 5 shall fail after being covered with Type I material, blended as specified above, or Type II ready-mixed material. If more than 1 panel fails,

the product shall be retested by repeating the test with an additional 10 panels. Not more than 4 panels shall fail out of the total of 15 panels (5 on the original test plus 10 on the retest).

3.3.1.3 Storage stability. When stored for 12 months at $77^{\circ} \pm 5^{\circ}$ F, as specified in 4.5.3. Type I material blended as specified above or Type II ready-mixed material, where applicable, shall show no evidence of separation and shall again be subjected to the Protection test (4.5.2). Samples for the Protection test shall be withdrawn from the top third of the unstirred corrosion preventive. If the corrosion preventive passes all other tests of the specification, tentative approval shall be granted. However, failure to pass this test shall be cause for rejection. Final approval is subject to the results of this test.

3.3.2 The following requirements shall apply to a blend, by volume, of 1 part of Type I concentrate and 3 parts of a lubricating oil qualified under Specification MIL-L-6082, Grade 1100, and to Type II ready-mixed material, where applicable.

3.3.2.1 Carbon residue. The carbon residue shall be loose and flaky, when tested as specified in 4.5.4.1, and shall not exceed 2.0 percent.

3.3.2.2 Pour point. The pour point shall be not above 10° F, when determined as specified in 4.5.4.1.

3.3.2.3 Volatility. The volatile content shall not exceed 3 percent by weight when determined as specified in 4.5.4.1.

3.3.2.4 Viscosity. The viscosity determined after eliminating the volatile content under the conditions specified in 4.5.4.1 shall be 90 to 110 seconds, Saybolt Universal viscosity, at 210° F, when determined as specified in 4.5.4.1.

3.3.2.5 Viscosity index. The viscosity index shall be not less than 95 when calculated as specified in 4.5.4.1.

3.3.2.5 Flash point. The flash point shall be at least 400° F when determined as specified in 4.5.4.1.

3.3.2.7 Precipitation number. The precipitation number shall not exceed 0.1 when determined as specified in 4.5.4.1.

3.3.2.8 Corrosion. When tested as specified in 4.5.4.1, the copper strip shall show no pitting and the discoloration shall not exceed 2a

according to ASTM copper strip corrosion standards.

3.3.2.9 Ash. The ash content shall not exceed 0.015 percent when determined as specified in 4.5.4.1.

3.3.2.10 Hydrobromic acid neutralization. When tested as specified in 4.5.5, the three grit-blasted exposed panels shall show no discernible increase in corrosion, pitting, or other attack involving either surface over that of the control panels.

3.3.2.11 Effect on color-indicating property of silica-gel impregnated by cobalt chloride. The material shall have no adverse effect on the property of silica-gel conforming to Specification MIL-D-3716, Type IV, to indicate the degree of saturation and equivalent relative humidity when tested as specified in 4.5.6.

3.3.2.12 Lead corrosion. When tested as specified in 4.5.10, the oil shall not cause a weight loss of more than 70 mg per square inch in the 300° F test nor more than 40 mg per square inch in the 250° F test.

3.3.2.13 Engine cylinder-exposure. When tested as specified in 4.5.9, the corrosion-preventive material being qualified shall afford protection for engine cylinders comparable to that afforded by the reference corrosion-preventive material.

3.3.2.14 100-Hour single-cylinder engine. When run for 100 hours as Specified in 4.5.7, a modified Cooperative Universal Engine (CUE) utilizing an R-2800 engine cylinder shall show no deleterious effect attributed to the corrosion preventive. The weight loss from each panel shall be measured in the same manner as in the S. O. D. (Standard Oil Development) lead-corrosion test (4.5.10), and reported as part of the data for this test. The corrosion preventive shall perform as well as or better than the reference corrosion preventive qualified under this specification. This test shall be performed at the University of Kentucky Aeronautical Research Laboratory. After a qualification sample has passed all Wright Air Development Center laboratory tests, the manufacturer must have this single-cylinder engine test performed before the full-scale engine test will be conducted.

3.3.2.15 50-Hour aircraft engine. When run for 50 hours as specified in 4.5.8, an R-4360

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engine shall show no deleterious effect attributed to the corrosion preventive. The cumulative mean lead loss of the lead test panels shall not exceed 35 mg per square inch after 50 hours of engine operation. The corrosion preventive shall perform as well as or better than the reference corrosion preventive qualified under this specification.

3.3.2.16 Used-oil control. The right is reserved to subject any sample removed from the engine test to all the tests of this specification. Additional tests which are considered necessary to assure the serviceability of the material may be run, upon mutual agreement between the manufacturer and the procuring activity. Significant changes in physical or chemical properties, as a result of engine operation, may be cause for rejection.

3.4 Identification of product.

3.4.1 Use of AN or MIL designations. AN or MIL designations shall not be applied to a product, except for Qualification Test samples, nor referred to in correspondence, until notice of approval has been received from the activity responsible for qualification.

3.5 Workmanship. All details of workmanship shall be in accordance with the best commercial practice covering this type of material.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of tests. The inspection and testing of oil-type corrosion-preventive compound shall be classified as follows:

- (a) Qualification Tests (4.2)
- (b) Acceptance Tests (4.3)

4.2 Qualification Tests.

4.2.1 Application. Both Types I and II materials shall be qualified except where the Type II material is a blend of an approved Type I material and an oil qualified under Specification MIL-L-6082, Grade 1100. In such applications, only the Acceptance Tests on the Type II material will be required. Qualification testing of Type III is not required. However, this material is required to meet all applicable Acceptance Tests.

4.2.2 Sampling instructions. Qualification Test samples shall be selected, and shall consist of the quantity and type, as specified in the letter of authorization from the activity responsible for qualification. Samples shall be

appropriately identified with securely attached durable tags marked with the following information and sent to the activity responsible for qualification, designated in the letter of authorization from that activity (see 6.4):

Sample for Qualification Test
CORROSION PREVENTIVE, AIR-CRAFT ENGINE.

Manufacturer's Code No.

Name of manufacturer

Submitted by (name) (date) for Qualification Test in accordance with the requirements of Specification MIL-C-6529C under (reference authorizing letter).

4.2.3 Test report. Qualification Test samples shall be accompanied by a certified test report containing complete information as to the type of base stock and additive materials used, including the specific chemical name or trade name of each. The report shall include laboratory data showing quantitative results of all tests required in this specification, except the Storage-stability test (4.5.3), the 100-hour single-cylinder engine test (4.5.7), and the 50-hour aircraft engine test (4.5.8), and the engine cylinder exposure test (4.5.9). Exact formulation in terms of relative percentage will not be required, but the right is reserved to request complete and exact formulation data should the need arise.

4.2.4 Requalification. Requalification will be required in the event any change is made in quantity, quality, or composition of any of the ingredients.

4.2.5 Tests. The Qualification Tests of Type I or Type II material shall consist of all the tests of this specification as described under "Test methods." Approval shall not await results of the Storage-stability test as specified in 4.5.3. Tentative approval shall be granted until such time as the 12-month period storage-stability test is completed.

4.3 Acceptance tests. The Acceptance tests shall consist of Sampling tests.

4.3.1 Sampling tests. Acceptance tests of oil-type corrosion-preventive materials shall consist of the tests specified for samples selected in accordance with either Plan A or Plan B, as applicable. Plan A samples shall be selected from the first lot of the first production order

after qualification, and Plan B samples shall be selected from each lot thereafter. A lot shall consist of one type of material manufactured at one time from one batch of material constituents and submitted for inspection at the same time and place. Inspection shall be in accordance with Method 9601 of Federal Test Method Standard No. 791.

4.3.1.1 Sampling Plan A. Ten gallons (5 gallons for Type I and 5 gallons for Type II) from the first lot of the first production order after qualification shall be selected by the Government Inspector in accordance with the applicable requirements of Federal Test Method Standard No. 791 and forwarded prepaid to the Commander, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, Attention: WCLPF-2, for confirmation of the manufacturer's ability to produce material in actual plant operation.

The tests to be conducted and reported shall include all the tests of this specification, as described under "Test methods," with the exception of the 100-Hour single-cylinder engine test (4.5.7), the 50-Hour aircraft engine test (4.5.8), the Engine cylinder-exposure test (4.5.9), and the storage-stability test (4.5.3).

4.3.1.1.1 Test reports. The sample shall be accompanied by certified test reports countersigned by the Government Inspector showing quantitative results of the Acceptance Tests conducted by the contractor on samples of the same material.

4.3.1.2 Sampling Plan B. Ten gallons (5 gallons for Type I and 5 gallons for Type II), selected by the Government Inspector from each production lot, after the initial lot, shall be subjected to all the tests of this specification as described under "Test methods," with the exception of the 100-Hour single-cylinder engine test (4.5.7), the 50-Hour aircraft engine test (4.5.8), the Engine cylinder-exposure test (4.5.9) and the storage-stability test (4.5.3).

4.3.2 Material release. Material under Plan A or Plan B may be released after a representative sample has successfully passed, at either the contractor's or a commercial laboratory acceptable to the procuring activity, all the tests of this specification with the exception of the 100-Hour single-cylinder engine test (4.5.7), the 50-Hour aircraft engine test (4.5.8), the

engine cylinder-exposure test (4.5.9), and the Storage-stability test (4.5.3). If a sample submitted under Plan A fails to pass the tests conducted by the Wright Air Development Center, the contractor's name shall be removed from the Qualified Products List, or each subsequent batch of material shall be tested against those tests of this specification deemed necessary by the activity responsible for qualification, prior to release, until such time as the procuring activity is satisfied that the contractor is able to supply acceptable materials consistently. Subsequent failure of a material to pass Acceptance Tests shall cause removal of the contractor's name from the Qualified Products List.

4.3.3 Rejection and retest. Material which has been rejected may be reworked or replaced to correct the defects, and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original shall be furnished the Inspector. Material rejected after retest shall not be resubmitted without specific approval of the procuring activity.

4.4 Test conditions. The test conditions shall be as specified for each particular test.

4.5 Test methods.

4.5.1 High- and low-temperature stability. Approximately 25 cc of the material specified in 3.3.1.1 shall be poured into a heat-resistant glass tube 150 mm long by 19 mm diameter. The test tube shall be placed in an oven maintained at $205^{\circ} \pm 5^{\circ}$ F for 24 hours, allowed to cool to room temperature in still air, and then further cooled by placing the tube in a cold box maintained at $0^{\circ} \pm 5^{\circ}$ for 16 hours, followed by the sample being allowed to return to room temperature. The material shall then be allowed to stand for 10 days at room temperature. At the end of this period, the tube shall be examined by transmitted light for any evidence of separation of insoluble material.

4.5.2 Protection test.

4.5.2.1 Panel composition and size. Steel panels shall be fabricated from open hearth, cold-finish, dead-soft-temper, low-carbon steel conforming to Specification QQ-S-636, 1020 steel. The panels shall be $\frac{1}{8}$ by 2 by 4 inches.

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conforming to the description contained in Specification JAN-H-792.

4.5.2.2 Panel finishing and cleaning. The panel test surface shall be so prepared, by use of 240- or 280-grit Alundum or Carborundum abrasive with cloth or paper backing, as to produce a surface finish of 6 to 12 microinches rms. The use of iron oxide abrasives, "wet or dry" cloths, or "wet or dry" papers is prohibited. The final abrasion marks shall be in the direction parallel to the length of panel. The surface shall be thoroughly cleaned by a method which will reduce all types of superficial contamination to the practical minimum. A cleaning method which has proved satisfactory is described in 6.3.1.

4.5.2.3 Procedure. Five panels prepared as above shall be so dipped in a suitable sample of Type II or Type III material, as applicable, as to completely submerge all surfaces. The panels shall then be suspended by stainless steel hooks for 4 hours in a chamber or cabinet where the relative humidity does not exceed 50 percent and the temperature is $77^{\circ} \pm 5^{\circ}$ F. At the end of this period, the panels shall be suspended in a humidity cabinet conforming to Specification JAN-H-792 for a period of at least 336 hours (14 days) taking care that the top of the panel is level, bending the hooks if necessary for minor adjustment. The humidity cabinet shall be maintained at a dry-bulb temperature of $120^{\circ} \pm 2^{\circ}$ F. The panels shall be removed from the cabinet, cleaned with naphtha (Specification TT-T-291, Grade 1), and examined.

A panel shall be considered as having failed the protection test if at the end of the test period one of the following conditions exists in the significant area of the panels as defined by Specification JAN-H-792, considering both sides of the panel:

- (a) One or more corroded areas of 2 mm diameter or larger.
- (b) Two or more spots of between 1 and 2 mm diameter.
- (c) One spot between 1 and 2 mm diameter and 2 or more dots of less than 1 mm diameter.
- (d) Four or more dots of less than 1 mm diameter.

More than 1 panel in 5 failing as defined above shall be sufficient cause for retest. Retests shall consist of repeating the protection test, using an additional 10 panels. Upon completion of the retest, the failure of more than 4 panels, adding failures of both test and retests, shall be cause for rejection of the material.

4.5.3 Storage stability. A 1-gallon sample stored for 12 months in the dark in a clean, wide-mouth glass container (10 by 5½ inches OD with an opening of 2½ inches) shall be examined after the storage period for any evidence of separation. The Protection test (4.5.2) shall then be performed on a sample that has been drawn from the top third of the stored material.

4.5.4 Solubility in lubricating oil. Examination for separation of the compound from the oil shall be made during all the tests specified below.

4.5.4.1 The following tests shall be conducted in accordance with applicable methods of Federal Test Method Standard No. 791:

Test	Method No
(a) Carbon residue (Conradson).....	5001
(b) Pour point.....	201
(c) Viscosity (after elimination of the volatile content).....	304 or 305 and 9101
(d) Flash point (open-cup method).....	1103
(e) Precipitation number.....	3101
(f) Corrosion (copper strip, 212° F.).....	5325
(g) Ash.....	5421
(h) Viscosity index.....	9111
(i) Volatility.....	3480

4.5.5 Hydrobromic acid neutralization.

4.5.5.1 Preparation of panels. Five panels shall be cut from steel conforming to Specification QQ-S-636, 1020 steel. The size of the panels and location of the holes shall be as shown in Specification JAN-H-792. All burrs and sharp edges, including edges of holes, shall be removed. The panels shall be uniformly grit-blasted, using No. 36 nonmetallic grit. Unless the panels are to be used immediately, they shall be preserved in an atmosphere having a relative humidity not greater than 20 percent. Immediately prior to use, the panels shall be cleaned by washing in a solvent conforming to Specification TT-T-291, drained thoroughly, followed by sloshing in boiling 95-percent methanol (Specification O-M-232).

and finally in boiling absolute methanol. After cleaning, the panels shall be cooled in a desiccator. Care must be taken during cleaning and preparation that the surface is not contaminated by fingerprints. The panels shall be handled by tongs during the cleaning operation and by hooks during and after immersion.

4.5.5.2 Preparation of emulsion. Six hundred ml of 10-percent-by-volume emulsion, consisting of 0.20 ± 0.02 percent hydrobromic acid solution and lubricating oil qualified under Specification MIL-L-6082, Grade 1100, shall be prepared by placing the oil and acid in a beaker of suitable size and thoroughly emulsifying by a mechanical stirrer operated at 1,700 to 2,500 rpm for approximately 1 hour. The bottom tips of the blades should be kept within $\frac{1}{4}$ inch of the bottom of the beaker to prevent separation of the hydrobromic acid layer.

4.5.5.3 Procedure. Three panels shall be immersed singly in the specified emulsion and sloshed vigorously for 1 minute at $77^\circ \pm 3^\circ$ F. These panels shall be removed from the emulsion, allowed to drain for 1 minute, and then dipped 10 times per minute for 1 minute in 360 to 380 ml of the preservative compound contained in a 400-ml tall-form beaker. A new portion of preservative oil shall be used for each panel. The three panels shall then be suspended by monel or stainless-steel test hooks for 2 hours in an atmosphere maintained at a relative humidity not exceeding 50 percent and a temperature of $77^\circ \pm 5^\circ$ F. At the end of this period, the panels shall be suspended in the humidity cabinet previously referred to and subjected to the specified conditions for 24 hours.

Two additional panels shall be suspended in the humidity cabinet previously referred to and subjected to the specified conditions for 24 hours. Two additional panels shall be immersed and drained in the emulsion as specified above and immediately after the 1-minute drain period, the emulsion shall be quickly removed from the panels by sloshing in a beaker of water-displacing compound conforming to Specification MIL-C-16173, Grade 3, followed by washing in solvent conforming to Specification TT-T-291, Grade 1. The panels shall immediately be placed in a desiccator for stor-

age until completion of the humidity exposure test on the other three panels.

Immediately after removal of the three panels from the humidity cabinet, they shall be cleaned with Specification P-S-661 (Stoddard solvent) or preceding solvent and compared with the two panels stored in the desiccator. If there is evidence of any discernible increase in pitting, corrosion, or other attack involving either surface of one of the three exposed panels over that of the control panels in the significant area (defined in Specification JAN-H-792), the test shall be repeated. If, on retest one of the three exposed panels still shows evidence of discernible increase in pitting, corrosion, or other attack over that shown by the control panels, the compound shall be rejected.

4.5.6 Effect of material on cobalt chloride indicating-type desiccant.

4.5.6.1 Setup. The apparatus shall consist of a 1,000-ml flask fitted with a tight-fitting cork stopper carrying a glass air inlet tube to within 1 cm of bottom, a 200° F thermometer with the bulb reaching well below the 800-ml material sample level, and a glass outlet tube for conveying air from the top of the flask to a U-shaped drying tube. A stopper and rubber tube for conveying air from the U-tube shall be provided to measure airflow periodically. Measurement of the airflow may be accomplished by placing the end of the outlet air tube beneath water and under the mouth of an inverted water-filled graduate. All apparatus contacting the oil or air and vapors from the oil must be clean prior to testing a sample of the material. There shall be no leaks of air from the apparatus. (For setup of apparatus see figure 1.)

4.5.6.2 Procedure. A blank test shall be made by placing 800 ml of oil conforming to Specification MIL-L-6082, Grade 1100, in a flask. The flask shall be connected by the air inlet tube to the air supply and by the air outlet tube to the U-tube carrying glass wool on the inlet side and 5 grams of desiccant conforming to Specification MIL-D-3716, Type IV, or the air outlet side. An airflow of 1.5 liters/hour shall be bubbled continuously into the oil during the period of heating to the required temperature of $160^\circ \pm 2^\circ$ F and during test period, in which the oil is maintained at

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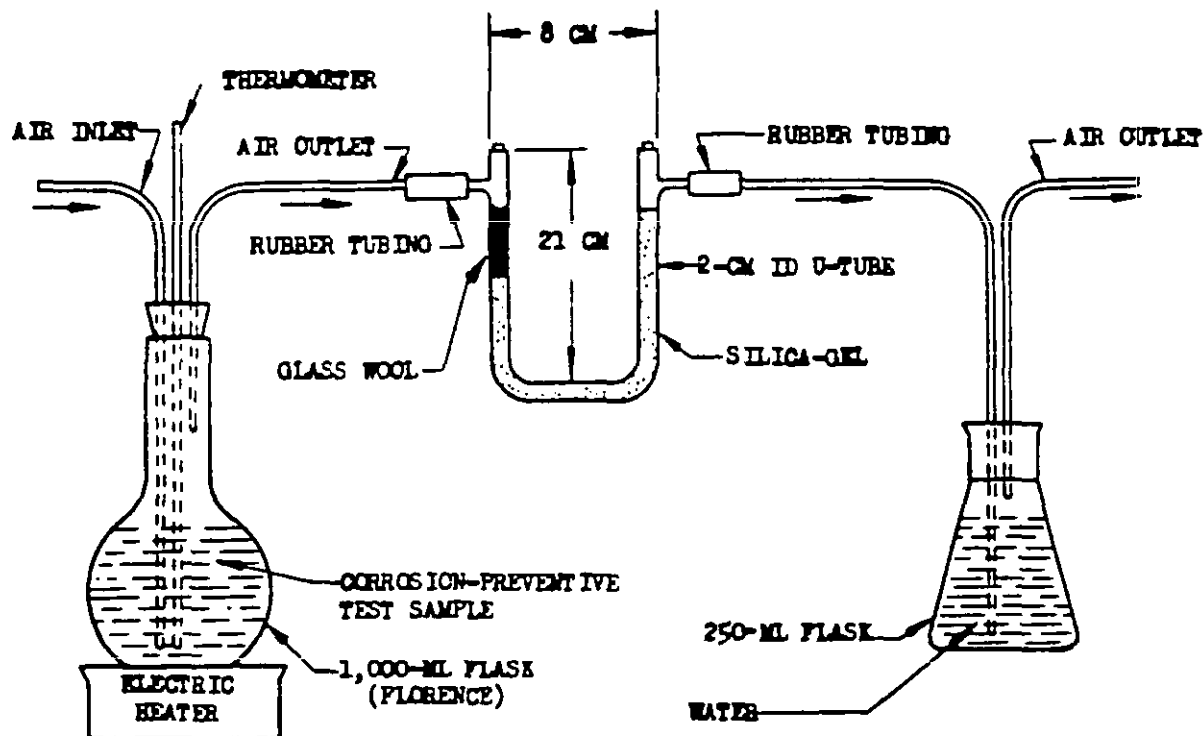


FIGURE 1. Test Apparatus—silica-gel.

the required temperature for 3 hours. The air, with entrained vapors, shall be continuously passed through the U-tube containing the desiccant during the period of heating and period of test. After exposure, the desiccant shall be removed and placed in an airtight container.

Eight hundred ml of the material being tested shall then be substituted for the Specification MIL-L-6082 oil, and the test repeated using a new 5-gram sample of desiccant conforming to Specification MIL-D-3716, Type IV. The two samples of desiccant (that exposed in the blank test, and that exposed in the test conducted on the material being tested) shall be placed in separate Petri dishes of the same size and placed in a 100-percent static

humidity chamber (a desiccator body partially filled with water). After overnight exposure to 100-percent relative humidity, the two samples shall be removed and compared. Any granules of desiccant remaining blue in color after exposure overnight in 100-percent relative humidity will require a retest of the material, using a new sample of desiccant. If granules of the desiccant again remain blue after exposure to 100-percent relative humidity on retests, the material shall be rejected.

4.5.7 100-Hour single-cylinder engine test.

4.5.7.1 Preparation. A modified Cooperative Universal Engine (CUE) utilizing an R-2800 engine cylinder shall be mounted on a test stand at the University of Kentucky Aeronautical Research Laboratory. The fol-

lowing parts shall be new at the beginning of each engine test:

- (a) Piston rings
- (b) Valves
- (c) Valve guides
- (d) Valve tappets
- (e) Valve springs
- (f) Valve inserts
- (g) Piston pin bushings
- (h) Crank pin bearing
- (i) Rocker arms
- (j) Spark plugs

The following parts shall be factory reconditioned at the beginning of each engine test:

- (a) Cylinder
- (b) Piston

4.5.7.2 Break-in run. Before the 100-Hour test is started, the engine shall be given a break-in run in accordance with the conditions of Table I.

TABLE I. Break-in Schedule

Period	Time (min)	Rpm	Bhp ¹	Hd temp (°F) ¹
1.....	15	1,200	18	350
2.....	15	1,400	20	350
3.....	30	1,600	22	400
4.....	30	1,800	25	425
5.....	45	2,000	27	425
6.....	45	2,200	32	425
7.....	45	2,400	35	450
8.....	45	2,600	45	450
9.....	3	2,800	54	450

¹ These are typical values which shall be adhered to as closely as possible.

4.5.7.3 Test cycle. The test shall be conducted under simulated flight and altitude conditions as described in Table II. These cycles shall be repeated until the engine has been operated for 100 hours. The fuel used shall conform to Specification MIL-G-5572, Grade 115/145.

TABLE II. Test cycle

Period	Time	Rpm	Bhp ¹	Abs dry man. press (in. Hg) ¹	Fuel-to-air ratio ¹	Hd temp. (°F) ¹
Warmup.....	15 min.....	1,400	24	28	0.075	420
Takeoff.....	5 min.....	2,800	107	60	0.103	480
Climb.....	30 min.....	2,600	91	55	0.104	480
Max cruise.....	2 hr.....	2,300	69	42	0.080	450
Cruise.....	8 hr.....	2,150	65	42	0.063	450
Idle.....	10 min.....	1,400	24	27	0.075	350

¹ These are typical values which shall be adhered to as closely as possible.

The following conditions shall apply:

- (a) Exhaust back pressure set at 35 in. Hg at takeoff.
- (b) Spark advance 20/20 degrees before tap center.
- (c) Simulated altitudes to approximately 40,000 ft.
- (d) Oil inlet temperature 195° ± 5° F.

The corrosion preventive shall not be drained from the engine during the 100-hour run. Additional corrosion preventive shall be added as needed during the test. At the completion of the test, the engine shall be completely disassembled and inspected.

4.5.7.4 Used-oil tests. The following laboratory tests shall be conducted on the used oil after 50 and 100 hours of engine operation by the University of Kentucky Aeronautical Research Laboratory:

- (a) Ash content
- (b) Viscosity at 100° F.
- (c) Viscosity at 210° F.
- (d) Viscosity index
- (e) Protection
- (f) HBr neutralization
- (g) Copper-strip corrosion

4.5.7.5 Lead-panel corrosion test. Ten lead panels, 1½ by 1½ by ¼ inches, shall be sus-

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placed in the outlet stream of corrosion-preventive oil at a point between the heat exchanger and the sump. The composition of the panels shall be either 4-pound chemical lead or USS Electro corroding-grade lead or equal. Four of these panels shall be removed, washed with an organic solvent, weighed, and returned to the system after completing the following number of hours of total engine operating time: 0, 3, 7, 11, 16, 22, 29, 39, 50, 61, 72, 84, 100. Two other panels shall be removed, washed with an organic solvent, weighed, and returned to the system after completing the following number of hours of total engine operating time: 0, 50, 100.

The remaining four panels shall be removed, washed with an organic solvent, weighed, buffed with No. 00 steel wool, reweighed, and returned to the system after completing the following number of hours of total engine operating time: 0, 3, 7, 11, 16, 22, 29, 39, 50, 61, 72, 84, 100. The weight change shall be reported as milligrams per square inch of panel surface. The weight loss from each panel shall be measured in the same manner as in the S. O. D. lead-corrosion test (4.5.10)

4.5.8 60-Hour aircraft engine test. An R-

4360-59B engine shall be mounted on a test stand and provisions shall be made for the following readings:

- (a) Engine speed.
- (b) Manifold pressure.
- (c) Manifold temperature.
- (d) Main oil pressure.
- (e) Inlet oil pressure.
- (f) Outlet oil pressure.
- (g) Inlet oil temperature.
- (h) Outlet oil temperature.
- (i) Fuel pressure.
- (j) Fuel temperature.
- (k) Fuel flow.
- (l) Cylinder-head temperature.
- (m) Cylinder-base temperature.
- (n) Carburetor air temperature.
- (o) Oil consumption.
- (p) Oil flow.
- (q) Torquemeter pressure.
- (r) Crankcase pressure.
- (s) Barometric pressure.
- (t) Exhaust back pressure.

4.5.8.1 *Break-in run.* Before the 50-Hour test is started, the engine shall be given a break-in run according to the conditions of Table III.

TABLE III. Break-in Schedule

Period	Duration (min)	Speed (rpm)	Torque press. (psi)	Max cyl hd temp (° F)	Max man. press. (in. Hg)	Mixture	Fuel Flow (lb/hr)	Airflow (lb/hr)	Exhaust back. press. (in. Hg)
1.....	15	1,400		415	22.0	AL*	Warmup.....	Warmup.....	
Shut down—inspect oil screens									
2.....	15	1,400		415	22.0	AR†	Warmup.....	Warmup.....	
3.....	45	2,120	155	465	37.5	AL	865.....	13,580.....	32 ± 1. Check filter
4.....	45	2,300	158	465	39.0	AL	885.....	14,300.....	32 ± 1
5.....	45	2,550	198	510	50.5	AR	1,880.....	18,800.....	34 ± 1
6.....	5	2,700	247	510	60.0	AR	2,030.....	23,700.....	35.5 ± 1.
7.....	10	1,400	(wet)	390	22.0	AR	Cooldown.....	Cooldown.....	Check filter

* Automatic lean

† Automatic rich

4.5.8.2 *Test cycle.* The test shall be conducted under simulated flight conditions as described in Table IV. These cycles shall be repeated until the engine has been operated for 50 hours. The corrosion preventive shall not be drained from the engine during the 50-hour engine test. However, a 2-gallon sample of

the used oil will be collected for laboratory testing after 15, 30, and 50 hours of engine test time have been completed. Additional corrosion preventive shall be added as needed during the test. At the completion of the test, the engine shall be completely disassembled and inspected.

TABLE IV. Test Cycle¹

Period	Duration (min)	Speed (rpm)	Torque press. (psi)	Max cyl hd temp (° F)	Max man. press. (in. Hg)	Mixture	Fuel Flow (lb/hr)	Airflow (lb/hr)	Exhaust back press. (in. Hg)
1.....	15	1,400	.....	415	22.0	AL	Warmup.....	Warmup.....	.....
2.....	5	2,700	247	510	60.0	AR	2,030.....	23,700.....	35.5 ± 1.
			(wet)						
3.....	30	2,550	198	510	50.5	AR	1,850.....	18,600.....	34.0 ± 1
4.....	120	2,300	158	465	39.0	AL	855.....	11,300.....	32.0 ± 1.
5.....	480	2,120	124	465	37.5	AL	865.....	13,580.....	82.0 ± 1
6.....	10	1,400	.....	390	22.0	AR	Cooldown.....	Cooldown.....	.....

¹ Fuel conforming to Specification MIL-G-3572, Grade 115-145, shall be used.

The following operating limits shall also be observed:

(a) Oil inlet temperature	205° ± 5° F	(d) Manifold pressure	80 in. Hg max
(b) Fuel pressure	14 psi idling 25 psi continuous 25 psi max	(e) Cylinder-head temperature	515° F max
(c) Oil pressure	25 psi idling 80 psi at 1,200 rpm 85 to 100 psi at 1,600 rpm 80 to 110 psi at 2,000 to 2,700 rpm 110 psi max	(f) Maximum speed	2,800 rpm
		(g) Torquemeter pressure	280 psi max (dry)

4.5.8.3 *Used-oil tests.* The following laboratory tests shall be conducted on the used-oil samples:

- Viscosity at 100° F.
- Viscosity at 210° F.
- Protection.
- HBr neutralization.

4.5.8.4 *Lead-panel corrosion test.* Ten lead panels, 1½ by 1½ by ¼ inches, shall be suspended in the inner oil hopper. The panels must be completely submerged in the corrosion-preventive oil. The composition of the panels shall be either 4-pound chemical lead or USS Electro corroding-grade lead or equal. Four of these panels shall be removed, washed with an organic solvent, weighed, and returned to the system after completing the following number of hours of total engine operating time: 0, 3, 6, 10, 14, 19, 24, 30, 36, 43, 50. Two other panels shall

remain in the oil hopper throughout the engine test. Following the test, they shall be removed, washed with an organic solvent, and weighed. The remaining four panels shall be removed, washed with an organic solvent, weighed, buffed with No. 00 steel wool, reweighed, and returned to the system after completing the following number of hours of total engine operating time: 0, 3, 6, 10, 14, 19, 24, 30, 36, 43, 50. The weight change shall be reported as milligrams per square inch of panel surface.

4.5.9 *Engine cylinder exposure test.*

4.5.9.1 *Preparation of cylinders.* Cylinders from the engine used in the 50-hour aircraft engine test (4.5.8), if available and suitable, shall be used for conducting this test. If these are not available or suitable, the cylinders removed from an R-985 engine, after 10-hour

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run-in, shall be used. Prior to removal of the cylinders, the R-985 engine shall be given a run-in using oil conforming to Specification MIL-L-6082, Grade 1100, and aviation fuel conforming to Specification MIL-G-5572, 115/145, as shown in Table V.

TABLE V. Conditions for engine cylinder exposure test

Time (hr:min)	Rpm	Abs man. press. (in. Hg)
0:15	2,200	33.6 to 35.6
0:03	2,300	38
0:02	1,000	
0:03	2,300	38
0:02	1,000	
8:35	2,000	28

At the completion of either the 50-hour aircraft engine test (4.5.8) or a 10-hour run-in, whichever is applicable, the cylinders shall be removed from the engine and each cylinder flushed with 115/145 aviation fuel. Three cylinders shall then be prepared for testing and the remaining cylinders preserved with an approved preservative. Each test cylinder interior shall be separated into two longitudinal sections by applying two strips, each 1 inch wide, of material conforming to Specification MIL-C-11796, one on the thrust side and one on the antithrust side. The aircraft engine corrosion preventive being qualified shall be brushed on one section of each cylinder and on the other section a reference corrosion preventive. A brass plug or a spark plug shall be installed in one of the spark plug holes. The other end of each cylinder shall be covered with a suitable cover to keep out foreign matter. The prepared cylinder shall be placed in a vertical position with the base up.

4.5.9.2 *Tropical-room exposure.* The prepared cylinders shall be exposed in a tropical room capable of maintaining the conditions outlined below. The room shall be operated in 24-hour cycles as follows:

- (a) 8 hours at 115° F and 100-percent relative humidity.
- (b) 4 hours cooling and dehumidifying.

(c) 8 hours at 70° F and 65-percent relative humidity.

(d) 4 hours heating and humidifying.

Cycling shall be continued until the relative protective qualities of the corrosion preventive being tested can be determined. For the corrosion preventive to pass this test, it shall have protective qualities comparable to those of the reference corrosion preventive. If the corrosion preventive fails this test or the relative protective qualities of the test corrosion preventive and the reference material are not clearly defined, the test shall be repeated using an additional six cylinders. If the corrosion-preventive material fails in the retest, it shall be rejected.

4.5.10 *S. O. D. lead-corrosion tests.* Two modified S. O. D. (Standard oil development) lead-corrosion tests shall be conducted on the corrosion-preventive oil in accordance with Method 5321 of Federal Test Method Standard No. 791 except that the following changes shall be made:

(a) *Test No. 1:*

- (1) Either USS Electro corroding-grade lead or equal, or 4-pound chemical lead shall be used for the test panel.
- (2) No copper panel shall be used.
- (3) Test duration shall be 4 hours.
- (4) Operating temperature shall be 300° ± 2° F.

(b) *Test No. 2:*

- (1) Either USS Electro corroding-grade lead or equal, or 4-pound chemical lead shall be used for the test panel.
- (2) No copper panel shall be used.
- (3) Test duration shall be 4 hours.
- (4) Operating temperature shall be 250° ± 2° F.

5. PREPARATION FOR DELIVERY

5.1 *Application.* The requirements of Section 5 apply only to direct purchases by or direct shipments to the Government.

5.2 *Packaging, Packing, and Marking.* The packaging, packing, and marking of containers of corrosion preventive shall be in accordance with the provisions of Standard MIL-STD-290.

The type and size of the containers shall be as specified by the procuring activity.

5.2.1 In addition to the material specified in 5.2, the information required by Code of Federal Regulations 49 CFR 71-78 shall appear on each individual container and on all shipping containers. Also, the following marking shall be included:

(a) Containers filled with Type I material:

Directions: For use, mix 1 part of this compound with 3 parts of lubricating oil conforming to Specification MIL-L-6082 for use in reciprocating engines, or to Specification MIL-O-6081 for use in turbojet engines.

(b) Containers filled with Type II material:

Caution: The compound contained herein is mixed with lubricating oil conforming to Specification MIL-L-6082, Grade 1100, and is to be used without further dilution.

Manufacturer of concentrate.

Manufacturer of blending oils.

(c) Containers filled with Type III material:

Caution: The compound contained herein is mixed with lubricating oil conforming to Specification MIL-O-6081, Grade 1010, and is to be used without further dilution.

Manufacturer of concentrate.

Manufacturer of blending oils.

5.2.2 All containers shall be examined prior to filling to assure that they are in suitable condition to receive the product, and are free from all contaminants which would affect the satisfactory performance of the lubricant. Containers, after being filled, shall be sealed in such a manner as to prevent access to the contents except by destruction of the seal or container.

6. NOTES

6.1 **Intended use.** Types I and II materials are intended for use in the preservation of reciprocating engines and equipment for the prevention of damage by corrosion. Types I and III are intended for use in the preservation of turbojet engines and equipment. Type I material is to be diluted for use, with three parts of lubricating oil qualified under Specifi-

cation MIL-L-6082 or MIL-O-6081. Types II and III materials are intended for use as supplied and require no further dilution.

6.2 **Ordering data.** Procurement documents should specify the size of containers, type of materials (see 1.2), and what disposition will be made of blended material in case a sample from the first production batch fails to pass the Acceptance Tests. The material shall be purchased by volume, the unit being a US gallon at 60° F.

6.3 **Suggested testing procedures.**

6.3.1 *Preparation of specimens for Protection tests.*

6.3.1.1 *Cleaning.* The following procedure has been found to produce duplication specimen surfaces of a high level of cleanliness:

(a) After rounding the edges of the panel, reaming out the holes used for suspension, etc, wipe the surfaces as clean as possible by use of solvent-saturated rags.

(b) Scrub the panel with a clean cotton or surgical gauze swab in a beaker of hot petroleum naphtha (Specification TT-T-291, Grade 1).

(c) Rinse in clean hot petroleum naphtha.

(d) Rinse in hot commercial anhydrous methanol at least 10 seconds and let panel dry. If the specimens are not processed at once, preserve them in a desiccator.

(e) Buff the panels, ending with a new section of 240- or 280-grit Alundum or Carborundum abrasive paper with strokes in a direction parallel to the length of the panel, producing a surface finish of 6 to 12 microinches rms.

(f) Wipe off superficial dusts from the abrasion operation, using surgical gauze.

(g) Scrub abraded face of panel thoroughly with clean surgical gauze until there is no dark stain on a clean section of gauze.

(h) Wash in hot naphtha (Specification TT-T-291, Grade 1) by immersing the panel and swabbing it upon withdrawal from the naphtha with clean surgical gauze saturated with the naphtha. Rinse the panel by reimmersing in the naphtha. Both sides of the panel should be cleaned in this manner.

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- (i) Rinse in clean naphtha (ASTM D91-40). Allow the panels to be immersed for at least 10 seconds or longer before removing. Permit the specimens to dry thoroughly.
- (j) Spray the panel with hot naphtha (ASTM D91-40) from a wash bottle. The panel should be held in a rack at 20 ± 5 degrees from the vertical. The spray should be directed vertically downward on the panel flushing the test surface progressively downward. Spray both sides of the panel. Allow the panel to thoroughly dry.
- (k) Finally, rinse the panel in a fresh solution of boiling anhydrous methanol, allowing the panel to be immersed for at least 10 seconds to permit the panel to reach the temperature of the methanol before withdrawal.
- (l) Permit the specimen to dry and preserve in a desiccator, using it on the same day as prepared.

6.3.1.2 *Other precautions.* The following comments are also important or pertinent to the cleaning method:

- (a) The utensils and the solvents used in the preparation of the panels must be clean and free from contamination.
- (b) In all stages of treatment beginning with step (b) of 6.3.1.1, manual handling must be avoided. The panels must be handled with hooks or forceps, etc. and contact with the contaminated surfaces during cleaning procedures should be avoided.
- (c) In general, (1) the naphtha removes oily or grease-like contamination; (2) the methanol removes most water-soluble contaminants likely to be encountered, such as fingerprints, salt-like or acidic contaminants from atmospheric dust or fumes, etc.; (3) the rubbing and spraying operations aid in the removal of the foregoing as well as inert materials, adherent films and smuts, etc. The solvents are so heated that the specimen temperature is maintained above the ambient dew-point at all points where rapid solvent evaporation might cause moisture condensation and consequent rapid rusting.

(d) The following test method may be used in evaluating the surface cleanliness.

- (1) Place the panel directly under a burette on a table free of vibrations or drafts. A drop of distilled water 0.05 ml in volume is allowed to drop vertically and perpendicular to the panel from a distance of 30 cm above the panel. If the surface is absolutely clean, successive droplets on various parts of the surface will spread out completely in spots of closely reproducible dimensions. A clean panel should give a spread of 21 to 23 mm for each 0.05 ml of distilled water. This test is considered necessary and important because of variations found in different abrasive materials and because the personal factors involved in the procedure require some method of check on final results.

6.3.2 *Examining test panels.* It is recommended that examination of the test panels be carried out under a shaded fluorescent light (15w) of the analytical balance illuminator type, so suspended that the panel may be held at a distance of approximately 12 inches from the light, and further, that all examination be made without the aid of magnification.

6.3.3 *Maintaining constant humidity of test chamber.* It has been found that a satisfactory constant humidity test chamber to effect 50-percent relative humidity as required in 4.5.2.3 may be obtained by using a deep desiccator with a saturated magnesium nitrate solution in the base and by suspending the test specimens from a rack supported by a desiccator plate.

6.4 *Provisions for qualification.* With respect to products requiring qualification, awards will be made only for such products as have, prior to the bid opening date, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date.

6.4.1 The attention of suppliers is called to this requirement, 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 orders for the products covered by this specification. Requests for information pertaining to qualification of products covered by this specification should be addressed to the Commander, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, the activity responsible for qualification, with a copy to the Bureau of Aeronautics, Navy Department, Washington 25, D. C.

6.5 S. O. D. sample tubes. S. O. D. sample tubes may be obtained from Gottlieb Greiner, New York, New York

6.6 Uniformity of materials. It is to be understood that oil supplied under contract should be identical, within reasonable commercial limits, to the sample tested and found satisfactory except for changes previously approved by the Government. Any unapproved changes from the Qualification sample will constitute cause for rejection.

6.7 Toxic effects. Any questions regarding possible toxic effects on personnel from contact or by breathing vapors shall be referred to the departmental medical authority. In any case of Army procurement, the procuring activity will determine that the corrosion preventive when used for its intended purpose is not likely

to result in adverse effects on health of personnel. The Surgeon General will act as adviser where professional service is indicated.

Note: International agreement—Provisions of this specification are the subject of international standardization agreements. When amendment, revision, or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization Office (DepStd) in order that appropriate action may be taken respecting the international agreement concerned.

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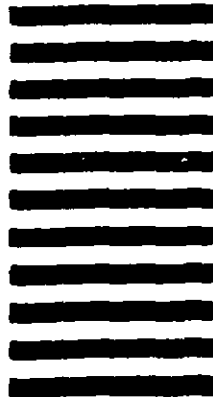


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