METRIC

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MILITARY SPECIFICATION

GREASE, HIGH PERFORMANCE,

MULTI-PURPOSE (METRIC)

This specification is approved for use by all interested Commands of the Department of the Navy and is available for use by all other Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one grade of grease for multi-purpose use and use in grease lubricated ball and roller bearings operating continuously at temperatures up to 149° Celsius (C) (300° Fahrenheit (F)) and intermittently up to 177°C (350°F) for periods up to 4 hours in any 24-hour period.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

P-D-680 - Dry Cleaning Solvent.
QQ-C-465 - Copper-Aluminum Alloy (Aluminum Bronze) Plate, Sheet, Strip, and Bar (Copper Alloy Numbers 606, 610, 613, 614, and 630).

MILITARY

MIL-B-17931 - Ball Bearing, Annular, For Quiet Operation.
MIL-G-23549 - Grease, General Purpose.
MIL-A-46106 - Adhesive-Sealants, Silicone, RTV, General-Purpose.

STANDARDS

FEDERAL

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

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-290 - Packaging, Packing, and Marking of Petroleum and Related Products.

(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.)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 217 - Cone Penetration of Lubricating Grease, Test for.
D 235 - Petroleum Spirits (Mineral Spirits).
D 740 - Methyl Ethyl Ketone.
D 942 - Oxidation Stability of Lubricating Greases by the Oxygen Bomb Method, Test for.
D 1264 - Water Washout Characteristics of Lubricating Greases, Test for.
D 1478 - Low-Temperature Torque of Ball Bearing Greases, Test for.
D 1743 - Rust Preventive Properties of Lubricating Greases, Test for.
D 2265 - Dropping Point of Lubricating Grease of Wide Temperature Range, Test for.
D 2266 - Wear Preventive Characteristics of Lubricating Greases (Four-Ball Method).
D 2595 - Evaporation Loss of Lubricating Greases Over Wide-Temperature Range.
D 2596 - Extreme Pressure Properties of Lubricating Grease (Four-Ball Method), Measurement of.
D 2714 - Calibration and Operation of the Alpha Model LFW-1 Friction and Wear Testing Machine.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

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

3. REQUIREMENTS

3.1 Qualification. Grease furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

3.2 Material. The grease shall consist essentially of a wide temperature range liquid lubricant and suitable gelling agent. The grease shall not be comprised of silicones nor contain silicone additives.

3.3 Composition. The composition of the grease shall be provided by the manufacturer to the Naval Ship Engineering Center at the time of qualification. Material purchased under contract shall be the same, within normal manufacturing tolerances, as that given qualification approval.

3.4 Odor. The grease shall not have an objectionable odor, or odor of rancidity, perfume, or free alcohol.

3.5 Dropping point. The dropping point of the grease shall be not less than 232°C (450°F) when determined as specified in 4.5.1.

3.6 Worked penetration. The worked penetration of the grease, when determined as specified in 4.5.1, shall be not less than 265 nor more than 320.

3.7 Corrosiveness (copper strip). The grease, when tested as specified in 4.5.1, shall show no green color, pitting or etching on copper, nor shall a dark brown or black stain remain on the copper strip after washing with N-hexane. A slight brown stain will not be cause for failure.

3.8 Dirt. The grease, when tested as specified in 4.5.1, shall not contain dirt or other foreign particles exceeding the following limits:

(a) 1,000 particles per cubic centimeter (cm^3) of grease for particles 25 micrometers (μm) or larger.
(b) None of particles 75 μm or larger.

3.9 Oxidation stability. When tested in accordance with 4.5.1, the grease shall not cause a pressure drop exceeding 172 kilopascals (kPa) (25 pounds per square inch (lb/in^2)) in 500 hours on qualification test or more than 103 kPa (15 lb/in^2) in 100 hours on inspection tests.

3.10 Water resistance. Not more than 10 percent of the grease shall be washed from the bearing when tested as specified in 4.5.1 at 38°C (100°F).

3.11 Steel on steel wear. When the grease is tested in accordance with 4.5.1, the average diameter of wear scars on the three steel balls shall not exceed 1.30 millimeters (mm).

3.12 Penetration after prolonged working. The penetration of the grease tested in accordance with 4.5.1 shall be not more than 350 after 100,000 double strokes.

3.13 Oil separation. The grease shall separate not more than 10 percent of its weight in 30 hours when tested at 177°C ± 3°C (350°F ± 5°F) as specified in 4.5.1.

3.14 Load carrying capacity. The load carrying capacity of the grease shall be not less than 30 millimeter scar diameter when tested as specified in 4.5.1.

3.15 Evaporation. When tested as specified in 4.5.1, the grease shall not lose more than 12 percent of its weight after 22 hours at 177°C ± 3°C (350°F ± 5°F).

3.16 Homogeneity. The grease shall be completely homogeneous at the time of inspection or during storage awaiting completion of the other qualification tests. It shall possess a smooth unctuous consistency without lumps, crusts, or granular particles.

3.17 Low temperature torque. The grease shall not cause a starting torque exceeding 0.441 newton meter (Nm) or a running torque exceeding 0.147 Nm at -29°C (-20°F) when tested as specified in 4.5.1.

3.18 Rust preventive properties. The grease, when tested as specified in 4.5.1, shall give a maximum bearing rating of two.

3.19 Performance life. The grease shall lubricate a size 315 radial ball bearing satisfactorily for at least 7000 hours at 104°C (200°F) when tested as specified in 4.5.2.1.

3.20 Bearing temperature rise and grease leakage. The grease, when tested as specified in 4.5.2.2, shall show performance equivalent to Navy Reference Grease Z-1 + 5 percent when judged by the criteria given in 4.5.2.2.4.2.

3.21 Storage stability. After the grease has been stored for six months at a temperature of 38°C ± 3°C (100°F ± 5°F), the undisturbed penetration shall be not less than 200 and the worked penetration shall not have changed from the original worked penetration by more than 30 points. The grease shall show no formation of crystalline material when stored for a total of one year at a temperature of 38°C ± 3°C (100°F ± 5°F). Both tests shall be conducted as specified in 4.5.3.

3.22 Rubber swell. The average rubber swell volume shall not exceed 10 percent when the L type synthetic rubber (see 6.5) is immersed in grease for seven days as specified in 4.5.1.

3.23 High temperature performance. The grease, when tested as specified in 4.5.1, shall satisfactorily lubricate ball bearings for 400 hours at 177°C ± 3°C (350°F ± 5°F). The average of four tests shall be 400 hours minimum.

3.24 Gear wear. The grease coated brass gear of a helical gear set shall not wear more than 2.5 mg per thousand cycles under a 2-1/2 kg (5-pound) load nor more than 3.5 mg per thousand cycles under a 5 kg (10-pound) load when tested as specified in 4.5.1.

3.25 Oscillation tests.

3.25.1 Friction and wear testing machine. The grease when tested as specified in 4.5.1 shall perform satisfactorily for 35,000 cycles.

3.25.2 Friction oxidation tester. The grease when tested as specified in 4.5.4 shall perform satisfactorily for 200 hours.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

(a) Qualification inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 Qualification tests. Qualification tests shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center. Qualification tests shall consist of the tests specified in 4.5. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3 and 6.3.1).

4.4 Quality conformance inspection.

4.4.1 Lot. For purposes of sampling, a lot shall consist of all grease manufactured as one batch.

4.4.2 Examination of filled containers. A sample of filled containers selected from each lot in accordance with MIL-STD-105 at inspection level I and acceptable quality level (AQL) of 2.5 percent defective shall be examined to verify compliance with all stipulations of this specification regarding fill, closure, marking, and other requirements not involving tests. Containers shall be examined for defects of the container and the closure, for evidence of leakage, and for unsatisfactory markings; each sample filled container shall also be weighed to determine the amount of the contents. Any container in the sample having one or more defects, or under required fill shall cause rejection of the container, and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, this shall cause rejection of the lot represented by the sample.

4.4.3 From each lot, containers shall be selected as follows, and sealed, marked, and forwarded to a testing laboratory satisfactory to the command or agency concerned:

(a) If grease is furnished in 250 g (one-half pound) or 500 g (one-pound) containers, enough containers to form two separate specimens of 2-1/2 kg (five pounds) each shall be furnished.
(b) If grease is furnished in 2-1/2 kg (5-pound) containers two containers shall be furnished.

One of the two 2-1/2 kg (5-pound) sample specimens shall be subjected to the tests specified in 4.5.1 except those for 500 hours oxidation stability, high temperature performance, rust preventive properties, rubber swell, storage stability, gear wear, and oscillation. The other 2-1/2 kg (5-pound) sample specimen shall be retained by the manufacturer for verification testing, if required, at a later date.

4.4.4 Sampling for production check tests. From the first lot produced on a contract or order and thereafter at such intervals as may be considered necessary by the Naval Ship Engineering Center to verify the consistency of production quality, one 2-1/2 kg (5-pound) sample and two 500 g (1-pound) samples of grease shall be forwarded to a laboratory satisfactory to the command or agency concerned. These samples shall be subjected to any of the tests specified in 4.5 deemed necessary by the command or agency concerned to determine that the sample conforms with that given qualification.

4.5 Test procedures.

4.5.1 The following tests shall be performed in accordance with the applicable methods of FED-STD-791, ASTM standards on petroleum and lubricants, or applicable test paragraphs as shown in table I.

TABLE I. Test methods.

Test	FED-STD-791	ASTM
Dropping point		D 2265
Penetration, worked		D 217
Corrosiveness (copper strip)	5309	
Oxidation stability, 100 and 500 hours[1/]		D 942
Water resistance		D 1264
Evaporation[2/]		D 2595
Oil separation[3/]	321	
Load carrying capacity		D 2596
Low temperature torque		D 1478
Steel on steel wear		D 2266
Penetration after prolonged working		D 217
Dirt	3005	
Rust preventive properties		D 1743
High temperature performance[3/]	333	
Rubber swell	3603	
Gear wear	335	
Oscillation (Friction oxidation and tester)	6516	
Storage stability (see 4.5.3)		

[1/] When tested in accordance with ASTM D 942, the grease shall not cause a pressure drop exceeding 172 kPa (25 lb/in^2) in 500 hours on qualification tests or more than 103 kPa (15 lb/in^2) in 100 hours on inspection tests.

[2/] Test temperature shall be 177°C ± 3°C (350°F ± 5°F). An air bath (oven) may be used to perform this test provided the exit temperature is within 3°C (5°F) of the test temperature. To insure this, it may be necessary to include an additional length of coiled tubing in the line contained in the air bath (oven).

[3/] Test temperature shall be 177°C (350°F).

4.5.2 Performance tests.

4.5.2.1 Performance life test.

4.5.2.1.1 Apparatus. The test apparatus shall consist of the following:

(a) Vertical shaft double bearing grease life test unit with pneumatic loading piston for applying a thrust load of 4000 newtons (900 pounds force) to the end-most bearing outer race (see figures 1a and 1b). Test assembly shall be mounted on shock mounts. The test bearing cylinder shall have an electric heater tape of sufficent capacity to maintain specified bearing temperature, wound around its outer surface, 13 mm by 1.2 m (1/2-inch by 4 foot) long, (288 watt tape with heavy duty insulation for use on metal surfaces has been found suitable for this purpose). The outer (or load end) bearing should have two thermocouples located so as to contact the bearing outer diameter at mid-width; one thermocouple shall be used to determine bearing outer race temperature, the second, to actuate a temperature controller for the heater tape. The inner (or motor end) bearing shall have one thermocouple in contact with the bearing outside diameter at mid-width to determine outer race temperature of this bearing. Details of the test bearing spindle and cylinder are shown in figure 2.

(b) Driving motor, 3550 ± 50 revolutions per minute (r/min) rated speed, 3.7 kilowatt (kw) (5 horse-power (hp)), with double end shaft connected to one test unit on each end through flexible couplings. The motor circuit shall incorporate a motor overload breaker which will secure the unit when motor current exceeds breaker setting. Rating of breaker to be 140 percent of normal running current of a typical motor driving two operating test units after running 24 hours with no external heat following installation of four new freshly greased bearings in the two test units.

(c) Housing; sheet metal to form an oven around each test unit. The housing may have an air intake opening on one side and a small exhaust fan (approximate 100 mm (4 inch) diameter) on the opposite side (connected to the heater controller so the fan is on when the heater is off and vice versa) if desired for better temperature control.

(d) Test bearing; single row, radial, deep groove, single shield, with riveted, pressed steel retainer, size 315, grade NT3 conforming to MIL-B-17931, made of SAE 52100 steel. A second separable shield or a shield manufactured locally shall be used with each bearing to simulate a double shield bearing configuration.

(e) Temperature controller (for heater actuation) capable of maintaining plus or minus 1°C (2°F) of set temperature.

(f) Temperature recorder; to record outer race temperatures of both bearings in each test unit.

4.5.2.1.2 Cleaning materials.

(a) Solvent dry-cleaning, type 1 of P-D-680.
(b) Solvent, naphtha (hexanes, technical).

4.5.2.1.3 Preparation. Each test bearing shall be washed by slowly spinning it partially submerged in dry-cleaning solvent, and repeating this operation in fresh solvent until the bearing is clean and free from all preservative. It shall then be rinsed by slowly spinning in clean solvent and flash dried in an oven at 71°C (160°F) just prior to lubrication. Each test bearing shall be packed by hand with 31 ± 0.1 grams (g) of the grease to be tested (for a grease specific gravity of 0.9).[1/] The grease shall be packed into the bearing using a narrow-blade spatula so both sides of the bearing receive an equal amount of grease; grease shall not extend beyond the face of the races. The loose shield shall then be installed in the bearing outer race. If the loose shield is not snapped or crimped into place in the outer race, it shall be cemented to the outer race with an adhesive sealant similar to type I of MIL-A-46106 using caution so that no cement can enter the bearing. Two test bearings shall be installed on each test spindle so the single shield which was in the bearing as supplied is in the downmost position for each bearing in operation.

4.5.2.1.4 Procedure. A test load of 410 kg (900 pounds) shall be supplied by the load piston and the unit started without any external heat. After 24 hours the temperature controller is set to give an outer race temperature of 93°C ± 4°C (200°F ± 7°F). Since the test unit inner (or motor end) bearing may run at a slightly lower temperature than the outer bearing (due to heat transfer from the shaft), the temperature control should be set to hold the two bearings in a unit to the same differential above and below 93°C (200°F) within the overall limit of 93°C ± 4°C (200°F ± 7°F). Test operation is cyclic, consisting of continuous running for 6 days followed by a shut down of 24 hours on the seventh day (bearing load is not removed during this shutdown period). This cycle is continued until failure occurs. Lubrication failure shall be considered to have occurred when any of the following conditions prevail for either of the two bearings in a test unit:

(a) Tripping of the motor cut-out switch indicating that frictional torque has increased sufficiently to over load the motor.

[1/] For greases of specific gravity other than 0.9, the weight to be packed shall be equal to 34 multiplied by the specific gravity.

(b) Temperatures in excess of 135°C (275°F) accompanied by audible change in noise and vibration.[2/]

4.5.2.1.4.1 The performance life test shall be run with 10 bearings (5 test units with 2 bearings each). The grease shall be reported as passing if all ten bearings complete 7000 hours of satisfactory operation or if eight bearings (4 test units) complete 7000 hours with only one "failure due to other cause" as provided in 4.5.2.1.4.1.1.[3/]

4.5.2.1.4.1.1 Since it is possible occasionally to have a bearing failure for other than lubricant causes, allowance is made for one such failure. The lubricant shall be reported as, "passing with one failure due to other causes," if the first failure in the test lot of 10 bearings is accompanied by readily apparent satisfactory conditions in the companion bearing to the failed bearing from the same test unit. Criteria for judging satisfactory conditions in the companion bearing are given in 4.5.2.1.4.1.2.

4.5.2.1.4.1.2 Criteria for satisfactory conditions in the companion bearing shall be based on observed obvious differences in bearing and grease characteristics when comparing the failed bearing with its companion bearing. The companion bearing must conform to all the following requirements:

(a) No abnormal operating temperature, noise, or vibration attributable to this bearing up to time of test shut-down.
(b) No noticeable increase in torque (drag or tight spots) or roughness on rotating this bearing by hand as removed from the test unit. Torque failure shall be determined by tripping of overload heater which will secure the unit when motor current exceeds breaker setting. Rating of breaker to be 140 percent of normal running current of a typical motor driving two operating test units after running 24 hours with no external heat following installation of four new freshly greased bearings in the two test units.
(c) Grease texture. Shall essentially resemble new grease in consistency and presence of oil; no hard or carbonaceous deposits.
(d) Grease appearance. No indication of exposure to high temperature as indicated by oxidized odor, color, and baking onto bearing areas. Color shall be only slightly varied from new grease.
(e) Grease homogeneity. Uniform, no excessive oil separation, liquefaction, or lumps.
(f) Grease quantity. A supply of grease having characteristics as outlined in (c), (d), and (e) above shall be visible on the bearing shields retainer, and race surfaces adjacent to the ball track indicating that grease has not run out or been thrown out of the bearing. Balls and ball track to show presence of grease film.

4.5.2.1.4.1.3 When a "failure due to other causes" occurs, the test will be continued on the eight bearings in the remaining four test units.

4.5.2.1.4.1.4 Not more than one "failure due to other causes" will be allowed.

4.5.2.2 Bearing temperature rise and grease leakage test.

4.5.2.2.1 Apparatus.

(a) Vertical shaft single test bearing unit with hydraulic loading cylinder for applying a 410 kg (900 pound) thrust load as shown in figure 3. Details of the test bearing spindle and housing are shown in figures 4a and 4b.

2/ It is sometimes possible for the outer bearing which controls test temperature to generate just enough heat from failure so that the heater is cut off and the failed bearing maintains test temperature without registering an abnormally high temperature on the recorder; noise or vibration, plus an abnormally low temperature for the inner bearing (due to no heat from the heater), identify such a failure.

3/ Unless there is a very definite difference between the failed bearing and its companion bearing on inspection, using the criteria given, the failure shall be considered bonafide and not a "failure due to other causes."

(b) Test bearing; single row, radial, deep groove, single shield with pressed steel retainer, size 315, grade NT3 conforming to MIL-B-17931. A second separable shield or a shield manufactured locally shall be used with each bearing to simulate a double shield bearing configuration in the test. The test bearing shall have a thermocouple located so as to contact the bearing outer diameter at mid-width.

(c) Motor for driving test spindle, 2.2 kW (3 hp), 3550 ± 50 r/min rated speed. The motor circuit shall incorporate a motor overload breaker which will secure the test when frictional torque has increased sufficiently to overload the motor.

(d) Temperature recorder; to record outer race temperature of test bearing and ambient (room) temperature.

(e) Hydraulic power source which with the hydraulic cylinder shown in figure 3 will produce a thrust load of 410 kg (900 pounds) on the test spindle.

(f) A locally improvised transparent plastic collector basin (with a center hole sufficient to clear the rotating shaft and sides sufficiently high to touch the underside of the mounting plate) shall be supported so as to collect any grease dropping down or thrown outward from the bearing and rotating shaft lower portion.

4.5.2.2.2 Cleaning materials. The same cleaning materials as specified in 4.5.2.1.2 for the performance life test shall be used.

4.5.2.2.3 Preparation. The test bearing shall be washed by slowly spinning it partially submerged in dry-cleaning solvent, and repeating this operation in fresh solvent until the bearing is clean and free from all preservative or grease. It shall then be rinsed by slowly spinning in clean naphtha and flash dried in an oven at 71°C (160°F) just prior to lubrication. The test bearing shall be packed by hand with 47 ± 0.1 g of the grease to be tested.[4/] The grease shall be worked into the bearing using a narrow blade spatula so both sides of the bearing receive the same amount of grease; grease shall not extend beyond the face of the races. The loose shield shall then be installed in the bearing outer race. If the loose shield is not snapped or crimped into place in the outer race, it shall be cemented to the outer race with an adhesive sealant conforming to type I of MIL-A-46106 using caution so that no cement can enter the bearing. The bearings shall be installed on the test spindle so the single shield which was in the bearing as supplied is in the downmost position in operation.

4.5.2.2.4 Procedure. A test load of 410 kg (900 pounds) shall be applied by the load piston and the unit started. No external heat is supplied to the test unit throughout the test. The test is operated continuously for 20 hours. At the end of the required time, the unit is secured. Appearance of any grease deposited in the plastic collector basin is visually noted with respect to oil separation or change in grease consistency and recorded. Any grease leakage (and oil, if separation occurred) is wiped from the shaft and from the interior of the plastic collector basin and weighed. Sufficient disassembly of the apparatus shall be made so grease adhering to exterior test bearing surfaces and adjacent tester areas above and below the upper and lower shields can be collected and weighed.

4.5.2.2.4.1 Two test runs shall be made on the candidate grease and two runs shall be made in the same apparatus using Navy Reference Grease Z-1. The order of running the candidate grease and reference grease shall be by random selection. The same test bearing shall be used for all four test runs with thorough cleaning as outlined in 4.5.2.2.3 before each test run.

4.5.2.2.4.2 Criteria for evaluating the temperature rise and grease leakage performance of the candidate grease shall be as follows:

(a) The mean of the maximum test bearing temperature rise for the candidate grease observed during each of the two 20-hour tests shall not exceed the mean maximum temperature rise observed in the two tests made with Navy Reference Grease Z-1 + five percent.

[4/] For grease of specific gravity of 0.9. For greases of specific gravity other than 0.9, the weight to be packed shall be equal to 52.2 multiplied by the specific gravity.

(b) The mean of the test bearing temperature rise at 20-hours for the two tests with the candidate grease shall not exceed the mean of the corresponding temperature observed with Navy Reference Grease Z-1 + five percent.
(c) Mean leakage of candidate grease from the bearing for the two test runs shall not exceed the mean leakage obtained in the two tests runs with Navy Reference Grease Z-1. There shall be no grease droppage or slinging into the plastic collecting basin and no indication of oil separation in any test run; any grease leakage from the test bearing shall adhere to the top and bottom bearing shields and bearing and housing areas immediately adjacent to the test bearing.

4.5.3 Storage stability. This test method is basically method 3467 of FED-STD-791 with the modifications stated herein. Two standard grease worker cups (ASTM D 217) shall be filled with the grease sample, one struck flush with the top of the cup for undisturbed penetration, and the second filled with an additional quantity of grease to insure sufficient sample to conduct the worked penetration. The sample for unworked penetration shall be covered with a watch glass. The sample for worked penetration shall be covered with aluminum foil. The cups shall be stored covered in an oven at a temperature of 38°C ± 3°C (100°F ± 5°F) for six months subsequent to the original determination of the penetration. Upon termination of storage, the samples are allowed to cool to 25°C (77°F) prior to determining the undisturbed and worked penetration in accordance with ASTM D 217. The undisturbed penetration sample shall be stored at 38°C ± 3°C (100°F ± 5°F) for an additional six months. The sample shall be covered in such a way as to provide an air space above the grease and prevent the surface of the grease from being disturbed. The sample shall then be examined for presence of crystalline material.

4.5.4 Oscillation.

4.5.4.1 Apparatus. The apparatus used consists of:

(a) Alpha LFW-1 or equivalent friction and wear testing machine equipped with an oscillatory drive mechanism, load cell transducer, and a transducer amplifier/indicator (see 6.6).
(b) Measuring magnifier glass, with metric or English unit calibration with a precision of 0.05 mm (0.002 in) or equal.
(c) Analytical balance, capable of weighing to the nearest 0.1 mg.

4.5.4.2 Testing. The test ring shall be made of SAE steel having a Rockwell hardness of C58 to C63. The ring shall have a ground face 8.15 ± 0.127 mm (0.321 ± 0.005 in) wide and diameter of 35 $^{+0.0025}_{-0.0127}$ mm (1.3775 $^{+0.0001}_{-0.0005}$ in) having an eccentricity between the inner and outer surface no greater than 0.038 mm (0.0015 in). The surface finish range of the outside diameter surface of the ring shall be 5 to 15 micro in rms in the direction of the motion.

4.5.4.3 Test block. The test block shall be made of copper alloy conforming to QQ-C-465, Alloy 642 with the test surface (6.35 $^{+0.012}_{-0.000}$ mm) 0.250 $^{+0.0005}_{-0.0000}$ in wide and 15.7 ± 0.127 mm (0.620 ± 0.005 in) long. The height of the test block shall be 10.16 ± .051 mm (0.400 ± 0.002 in). The Rockwell hardness shall be B88 ± 3. Each block shall have a test surface polished to a surface finish of 4 to 8 micro in rms, being perfectly square with all outside edges.

4.5.4.4 Reagents. The reagents used are:

(a) Hexane ACS grade.
(b) Methyl ethyl ketone conforming to ASTM D 740.
(c) Petroleum spirits conforming to ASTM D 235.

4.5.4.5 Calibration of apparatus. The apparatus shall be calibrated in accordance with ASTM D 2714.

4.5.4.6 Preparation of apparatus. Before each test, thoroughly clean the specimen holder, threaded section, locknut, and lockwasher. Use hexane as the cleaning agent and rinse with methyl ethyl ketone. Clean a new test ring and block for each test using the following procedure:

(a) Immerse in petroleum spirits and scrub with lint-free cloth.
(b) Rinse in a second bath of petroleum spirits.
(c) Suspend in the vapor of boiling hexane for 30 seconds.
(d) Immerse in boiling methyl ethyl ketone for 30 seconds.
(e) Allow part to drip dry.
(f) When part has dried, suspend it in vapor of boiling hexane for 30 seconds.
(g) Allow part to air dry.
(h) Weigh each test ring and block to the nearest 0.1 mg.
(i) Store specimens in desiccator until ready to use.

Lubricate the quarter segment of the specimen holder and the threaded section with grease conforming to MIL-G-23549. Apply the grease to be tested to the test ring surface, making sure that the entire wear surface is completely covered with test grease. Mount the test block in the quarter segment (clean lint-free cotton gloves should be used in handling the specimens) and position both in the specimen holder making sure that the quarter segment and block are securely positioned in the cylindrical slot. With one hand holding the test block mount, tighten with a torque wrench to 250 in-lbs. Apply the additional test grease to the area of the test block which overlaps the ring on both sides of the block. Place a 500 g (one-pound) weight in position on the bale rods. Align the two reference markers by adjusting the turn buckle on the friction rod. Tighten locknuts on the turn buckle. Position the friction force cut-off level. The cut-off level is set at 18 kg (40 lbs) for a 0.44 coefficient of friction. Adjust the amplitude of oscillation for a 90 degree arc.

4.5.4.7 Procedure. With the revolution counter set at zero start the machine and adjust the oscillating speed to 87.5 cycles per minute (c/m) making sure at this point that the reference markers are perfectly aligned. Add a 0.45 kg (one-pound) weight at 60 cycles and another 0.45 kg (one-pound) weight at 120 cycles. Run until failure is encountered due to excessive friction (cut-off 0.44 coefficient of friction) or excessive wear.

4.6 Inspection of preparation for delivery. The packaging, packing, and marking shall be inspected for compliance with section 5 of this specification.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.4)

5.1 Packaging, packing, and marking. Grease shall be packaged in 250 g (1/2-pound), 500 g (1-pound), or 2-1/2 kg (5-pound) containers. Packaging, packing, and marking shall be in accordance with MIL-STD-290, level A, B, or C, as specified (see 6.2).

6. NOTES

6.1 Intended use. The grease covered by this specification is intended for multi-purpose use and use in grease-lubricated ball and roller bearings operating at a continuous temperature up to 149°C (300°F) and up to 177°C (350°F) for periods up to 4 hours in any 24-hour period.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Applicable levels of packaging and packing requird (see 5.1).
(c) Unit container quantity (see 5.1).

6.3 With respect to products requiring qualification,, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List QPL 24508 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 orders for the products covered by this specification. The activity responsible for the Qualified Products List is Naval Ship Engineering Center, Department of the Navy,

Washington, DC 20362, and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.5 Standard "L" type rubber samples may be obtained from the Aero Materials Department, Naval Air Development Center, Warminster, Pennsylvania 18474.

6.6 The Alpha LFW-1 friction and wear testing machine is available from Dow-Corning Corporation, Testing Machine Department, Trumbell, Connecticut 06611.

6.7 Changes from previous issue. Due to extensive changes, the margins of this specification are not marked "*" to identify changes with respect to the previous issue.

Review activity:
AS

Preparing activity:
Navy - SH

(Project 9150-N475)

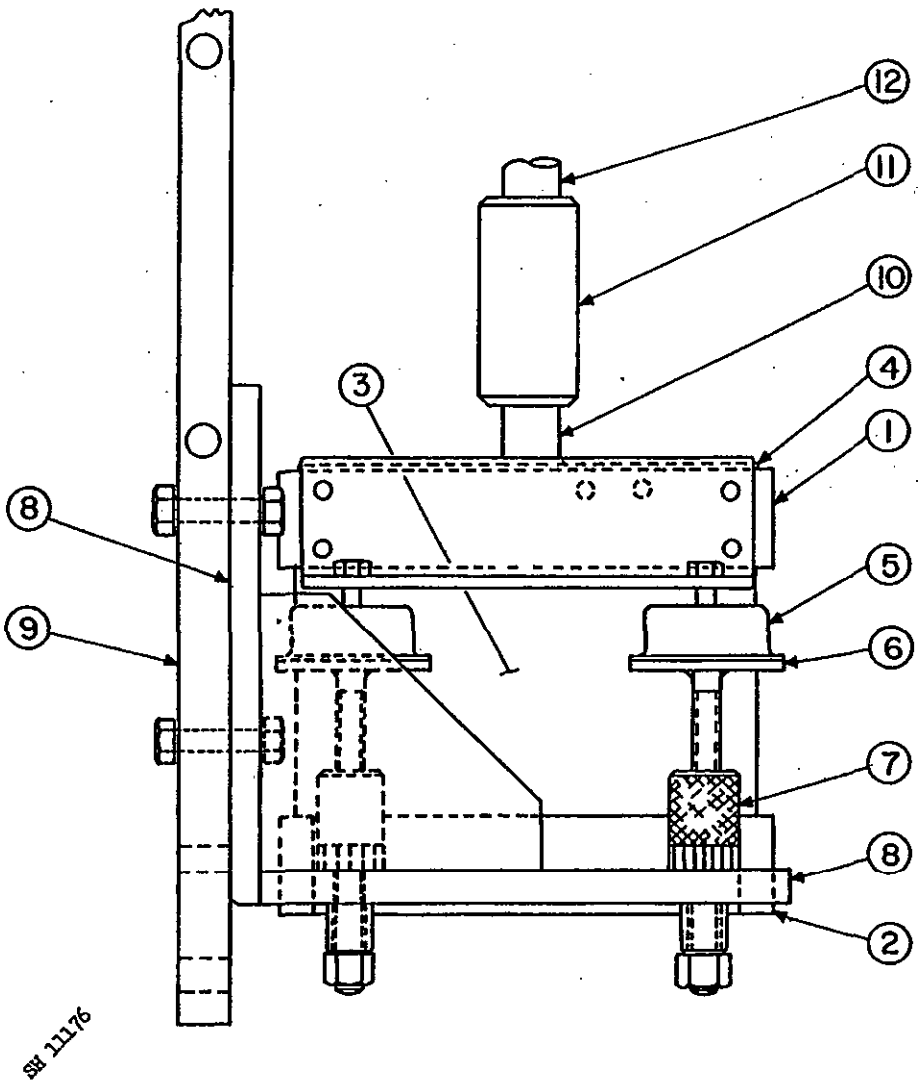


FIGURE 1a. Performance life apparatus - lower mounted assembly.

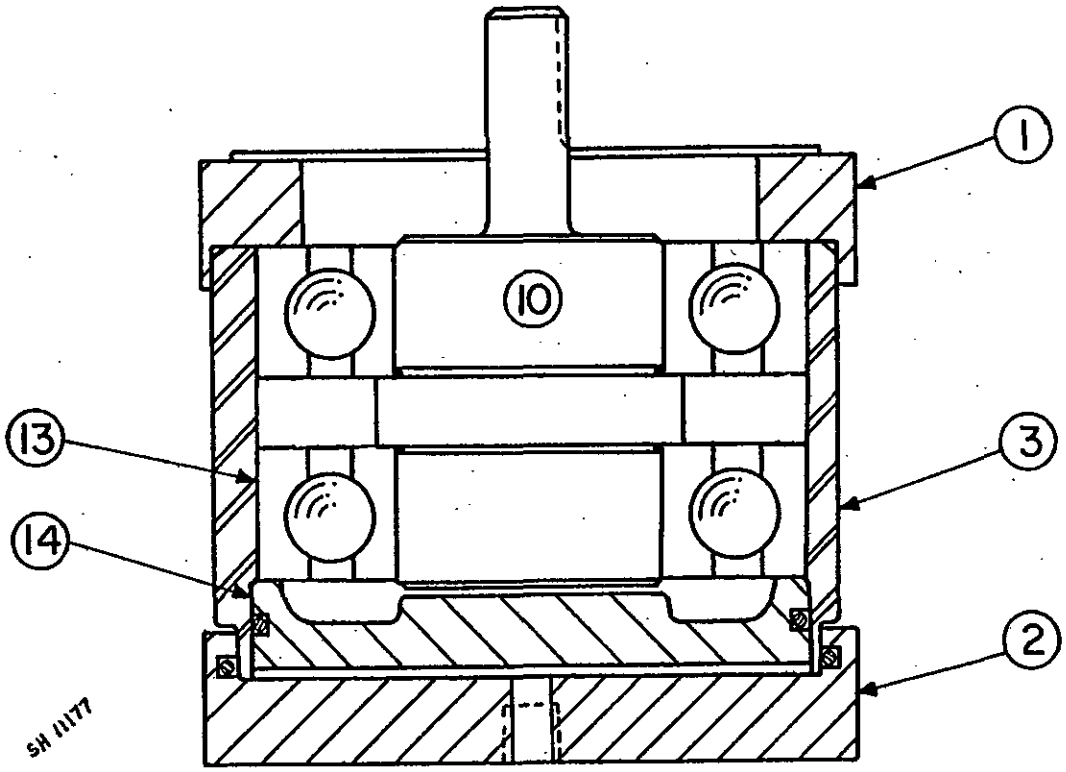
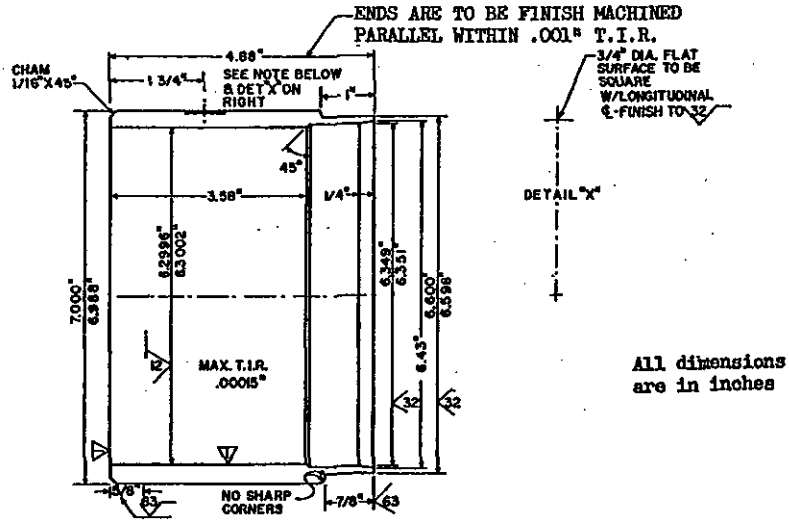


FIGURE 1b. Performance life apparatus - lower test unit section.

1. Cylinder flange, inner.
2. Cylinder flange, outer.
3. Test bearing cylinder.
4. Support bracket.
5. Plate form isolation mount.
6. Height adjuster stem.
7. Height adjuster.
8. Angle mount.
9. Support plate.
10. Test bearing shaft.
11. Coupling.
12. Drive motor shaft.
13. Test bearing (2).
14. Load piston.

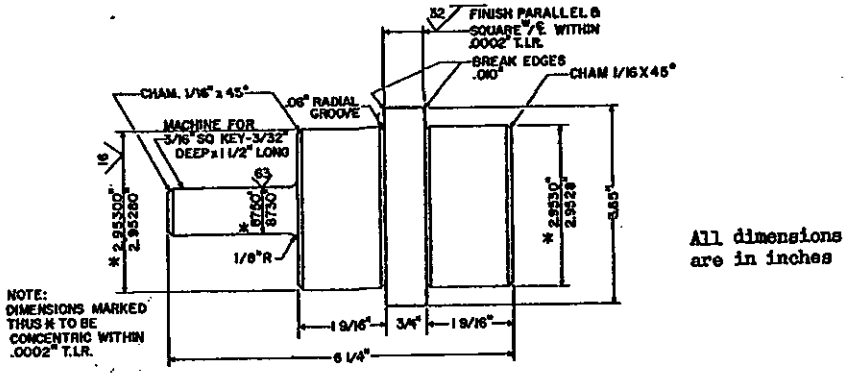
Part identification - figures 1a and 1b performance life apparatus.



SK 11178

FIGURE 2a - Cylinder - Mat'l-St'l - Rockwell C-30-40 before finishing.

NOTE: STRESS RELIEVE BEFORE FINISH MACHINING
3/4" DIA. FLAT SURFACE TO BE SQUARE WITH LONGITUDINAL ℄ - FINISH TO 32
ASSEMBLE WITH SPOTFACE IN VERTICAL TOP POSITION
▽ THESE SURFACES TO BE ⊥ WITHIN .0002 T.I.R.



SK 11179

FIGURE 2b - Shaft - Mt'l S.A.E. 52100 st'l.

NOTE: HARDEN - FULL PENETRATION - ROCKWELL C-60-65 & FINISH GRIND

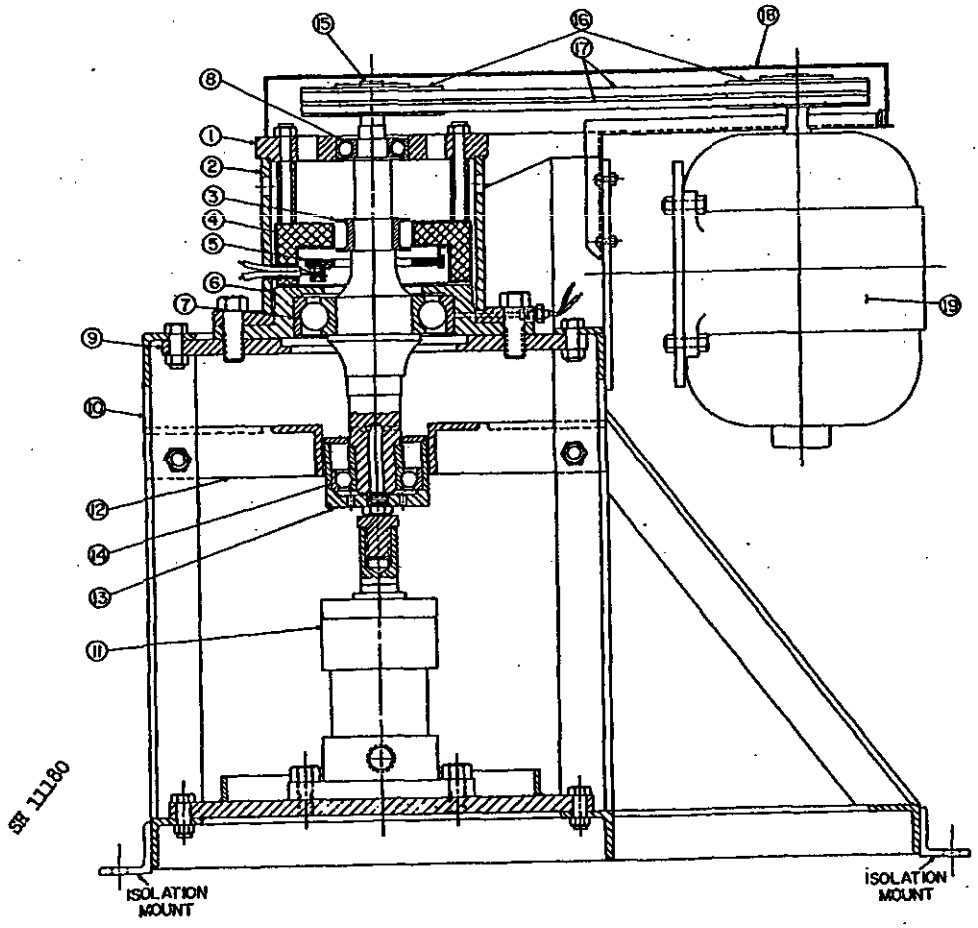


FIGURE 3. Packing and temperature rise vertical spindle.

1. Upper bearing housing.
2. Support housing.
3. Spinner.
4. Heater housing.
5. Heater (not used for temperature rise and leakage test).
6. Test bearing housing.
7. Test bearing.
8. Size 206 "Cartridge" bearing (removable shields).
9. Mounting plate.
10. Frame.
11. Hydraulic cylinder.
12. Torque bracket.
13. Support bearing cup.
14. Size 308 angular contact bearing.
15. Shaft.
16. Drive pulleys.
17. "V" belt.
18. Belt guard.
19. Drive motor (on separate stand).

Part identification - figure 3 temperature rise and leakage apparatus.

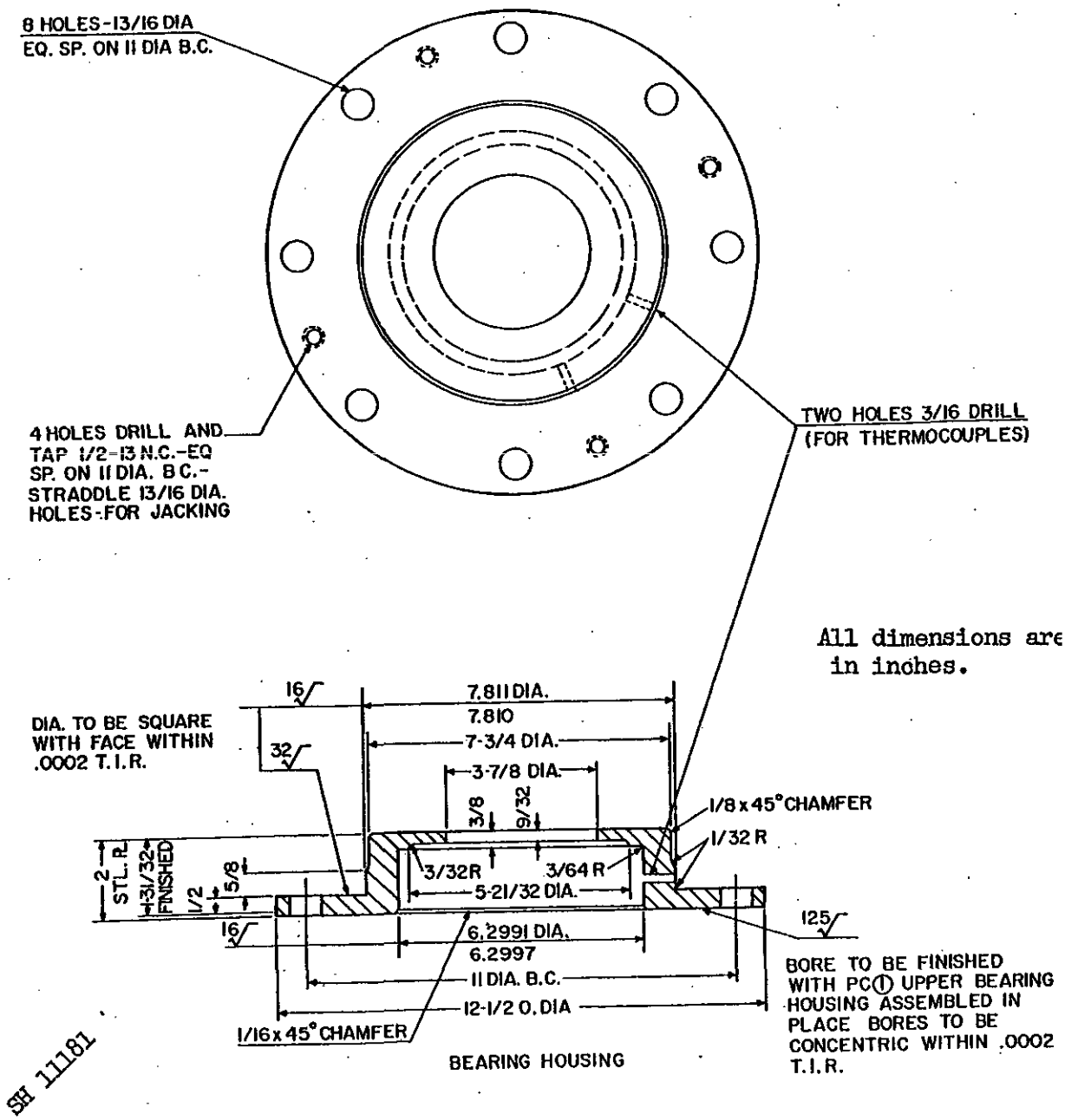


FIGURE 4a. Mat'l-HY-100 stl PL-heat treat-30-35 rock 'C'.

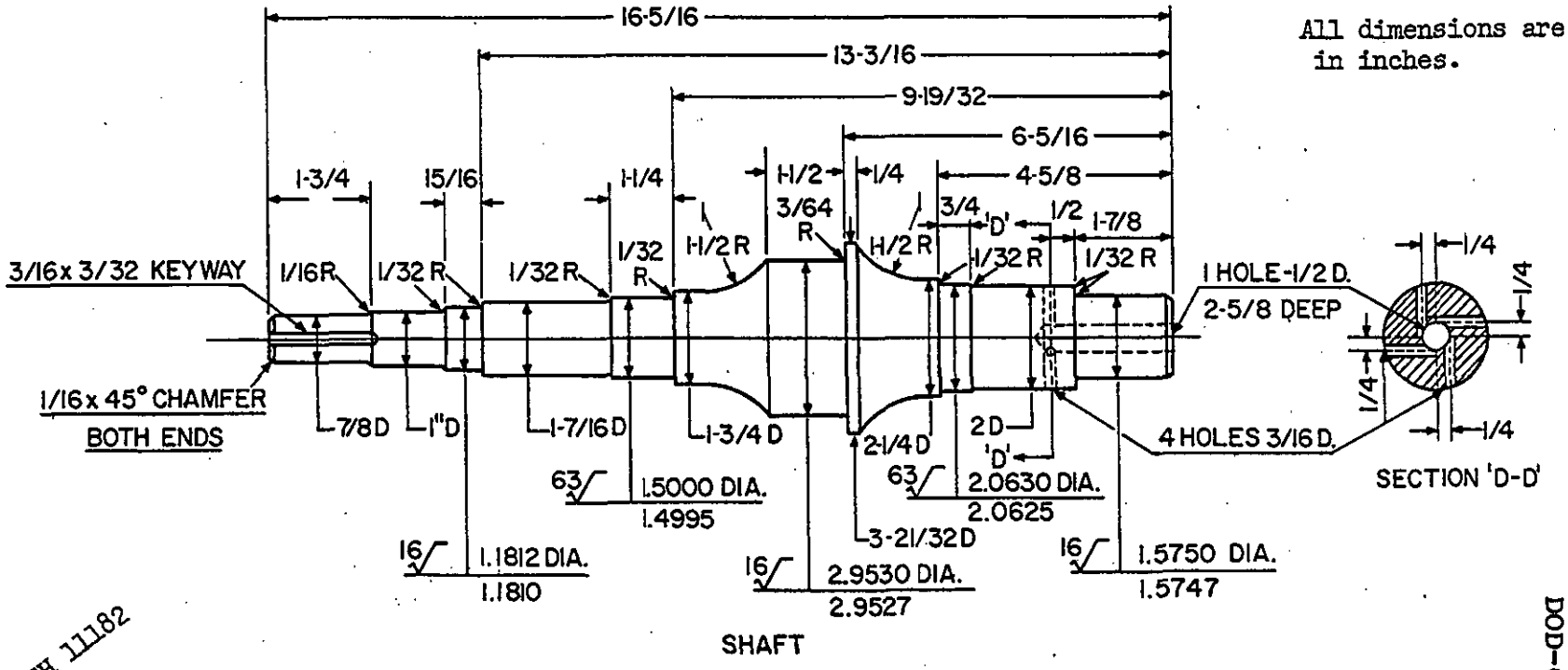


FIGURE 4b. Mat'l-SAE-4340 stl-heat treat-40-45 rock 'C'.