Designation: D7107 – 04 (Reapproved 2010)

Standard Test Method for Creep Measurement of Self-Lubricating Bushings[1]

This standard is issued under the fixed designation D7107; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method determines the amount of creep exhibited by self-lubricating bushings exposed to a high load for an extended period of time.

1.2 This test method is designed to reproduce conditions typical of those encountered by trunnion bushings in hydropower applications and any other bushings subjected to high continuous loading and low-speed oscillating applications.

1.3 This test method is conducted on cut segments of the bushings.

1.4 The values given in SI units are to be regarded as the standard in all property and dimensional tables.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *creep strain, n*—total strain, at any given time, produced by the applied stress during a creep test.

3. Summary of Test Method

3.1 Segments of the bushing are mounted in-line on the test apparatus such that when load is applied at one end of the apparatus, by means of a hydraulic cylinder, all specimens are simultaneously loaded exactly the same.

3.2 Bearing test pressure is maintained at 55 160 kPa (8000 psi) on the projected area of the bushing specimen.

3.3 Pressure is held constant by means of an automatic pumping system and an accumulator.

3.4 The actual amount of creep is measured over an extended period of time.

4. Significance and Use

4.1 Self-lubricating bushings with low creep rates are used in hydropower turbines and other applications in which bushing distortion could cause misalignment of shafts and linkages.

4.2 An assumption is made that if the creep is satisfactory at 55 160 kPa (8000 psi), it will also be satisfactory at lower pressures.

5. Apparatus

5.1 The loading frame shall be capable of applying and maintaining the required load on the specimens, despite any change in the dimensions of the specimens.

5.2 Bushing specimens are mounted in-line on the test apparatus such that when load is applied at one end of the apparatus (by means of a hydraulic cylinder) all specimens receive the same load.

5.3 Bearing test pressure is maintained at 55 160 kPa (8000 psi) on the projected area of the bushing specimen.

5.4 Pressure is held (nearly) constant by means of an automatic pumping system and an accumulator.

5.5 A suitable test frame configuration is shown in Annex A1.

5.6 The creep-measuring device consists of an eddy-current sensor anchored to one end of a specimen group (four test samples) directed at a target attached to the other end of the group.

5.7 The overall change in lengths of the four specimens is monitored to an accuracy of 2.54 μm (0.0001 in.).

6. Test Specimens and Test Units

6.1 Paragraph 6.2 and Fig. 1 define the test sample configuration. The samples are clamped into sample supports as described in Section 7.

6.2 Each test shall use four identical bushing material specimens meeting the following requirements (reference Fig. 1):

6.2.1 *Inside Radius of Tubular Form*—6.350 ± 0.013 cm (2.500 ± 0.005 in.),

6.2.2 *Thickness*—0.952 ± 0.005 cm (0.375 ± 0.002 in.),

6.2.3 *Length*—6.98 + 0.000/-0.013 cm (2.75 + 0.000/-0.005 in.),

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

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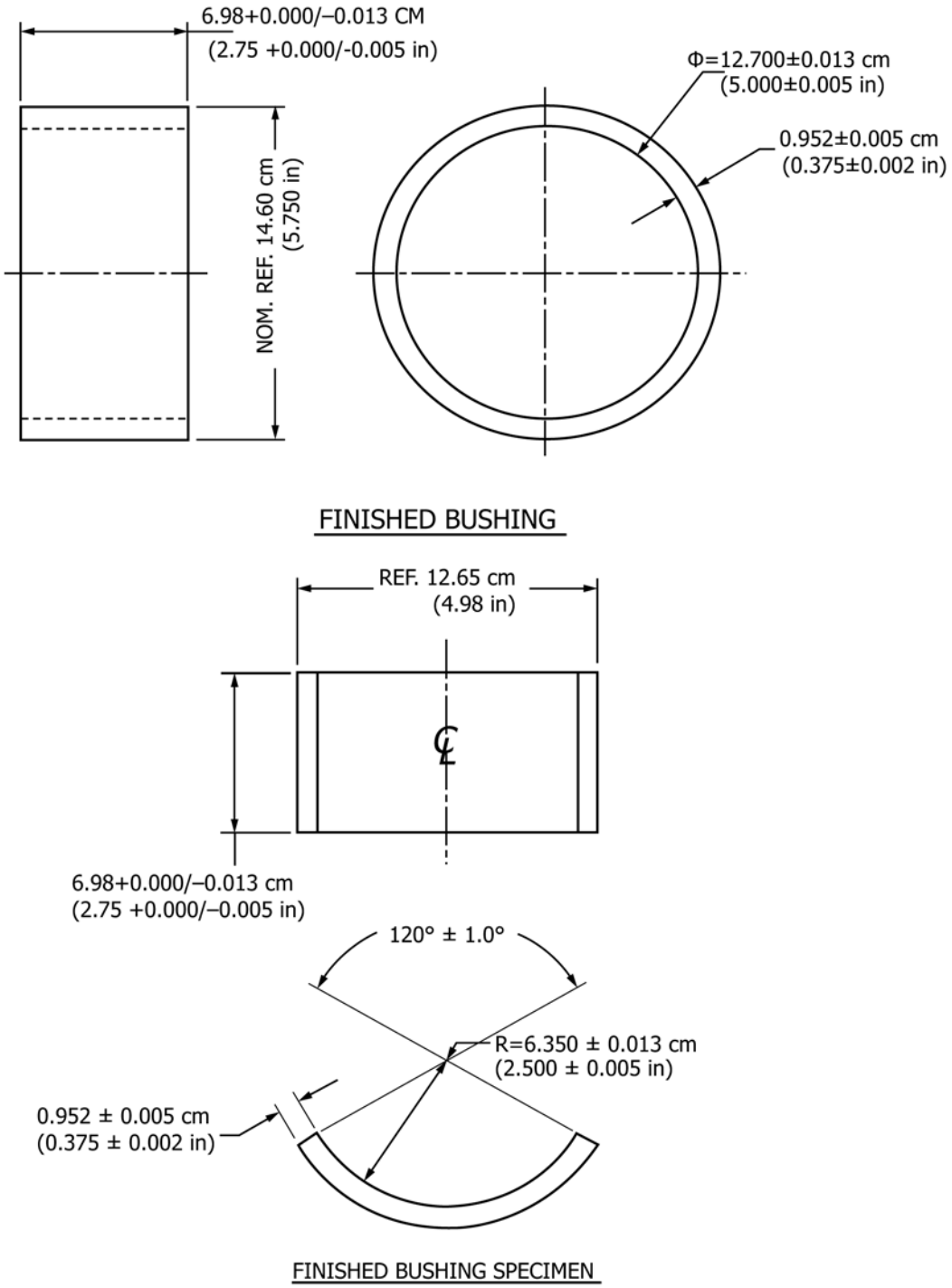


FIG. 1 Test Sample Configuration

6.2.4 *Angle of Arc (Each Finished Specimen)*—120 ± 1.0°, and

6.2.5 *Surface Finish—R_a* 3.2 µm (125 µin.) minimum.

7. Preparation of Apparatus

7.1 *Sample Spacer:*

7.1.1 *Material and Temper*—AL 6061 T6 or T6511,

7.1.2 *Diameter*—2.700 ± 0.005 cm (5.000 ± 0.002 in.),

7.1.3 *Length*—6.985 + 0.000/-0.025 cm (2.75 + 0.000/-0.010 in.),

7.1.4 *Perpendicularity*—Ends perpendicular with cylinder axis within 50 µm (0.002 in.), and

7.1.5 *Surface Finish—R_a* 0.4 µm (16 µin.) minimum.

7.2 *Sample Supports:*

7.2.1 *Material and Temper*—AL 6061 T6 or T6511,

7.2.2 *Radii*—7.302 ± 0.025 cm (2.875 ± 0.010 in.),

7.2.3 *Length*—6.985 + 0.000/-0.025 cm (2.75 + 0.000/-0.010 in.), and

7.2.4 *Radii Surface Finishes*—R_a 0.8 µm (32 µin.) minimum.

7.3 *Other Machined Parts and Sample Clamps:*

7.3.1 *Material and Temper*—AL 6061 T6 or T6511 and

7.3.2 *Finish*—R_a 3.2 µm (125 µin.).

7.4 *Assembly*

7.4.1 The test specimens and the inside surface of the specimen supports shall be cleaned with dishwashing detergent and water followed by a thorough rinse with water and dried. (Air dry thoroughly before assembly.)

7.4.2 The specimen shall be placed in the supports and clamped in place.

7.4.3 The complete frame shall be assembled with specimens, spacers, and instrumentation.

8. Calibration and Standardization

8.1 Eddy-current probes are calibrated in accordance with manufacturers' recommendations.

8.2 Thermocouples are calibrated in accorrdance with manufacturers' recommendations.

9. Conditioning

9.1 All storage and testing of specimens shall be conducted at room temperature (18 to 25°C).

10. Procedure

10.1 The test frames shall be set up in an area in which temperature changes are limited to 20 ± 1°C (68 ± 2°F).

10.2 Each specimen shall be premounted in the test block and clamped in place.

10.3 The four specimens for each material shall be preassembled as a group.

10.4 Two groups of specimens shall be placed in the frame between the tension rods.

10.5 The hydraulic ram and loading block shall also be laid in the frame in alignment with the specimens.

10.6 The frame shall be inserted into a tank sufficiently large to contain the entire frame.

10.7 The tank shall be filled with distilled water completely covering the test specimens.

10.8 The eddy-current displacement probes shall be mounted on each group of specimens.

10.9 A load of 4082 ± 90 kg (9000 ± 200 lb) is applied for 24 h.

NOTE 2—This load is sufficient to provide pressure of 5171 kPa (750 psi) on the projected area of the bearing specimen.

10.10 Start the recording device to log temperature and displacement once an hour every hour for 24 h.

10.11 Apply a load of 43 200 ± 227 kg (95 250 ± 500 lb) (that is, ±0.5 %) and maintain the load for 360 days.

NOTE 3—This load is sufficient to provide pressure of 55 160 kPa (8000 psi) on the projected area of the bearing specimen.

10.12 Continue recording once every 4 h after the first 24 h. After one month, record once a day.

10.13 Monitor pressure on a weekly basis and increase if and when necessary.

11. Calculation

11.1 Plot displacement data (creep strain) versus elapsed time.

11.2 Determine elapsed time at which creep strain ceases.

11.3 Calculate amount of creep per unit thickness of the product.

12. Report

12.1 Name of the product tested and the name and address of the manufacturer.

12.2 Displacement data (see 11.1).

12.3 Observations made during test providing details of any variations of temperature, times when pressure (load) required adjustment, and details of unusual events that occurred.

13. Precision and Bias

13.1 Insufficient data are available at the present time to develop repeatability data. The test is expensive and time-consuming (360 days). Data will be developed and added within the earliest convenient timeframe.

14. Keywords

14.1 bushings; material creep

ANNEX

(Mandatory Information)

A1. COMPRESSION FRAME

A1.1 The general configuration of a test frame capable of holding two groups of four specimens is shown in Figs. A1.1-A1.3

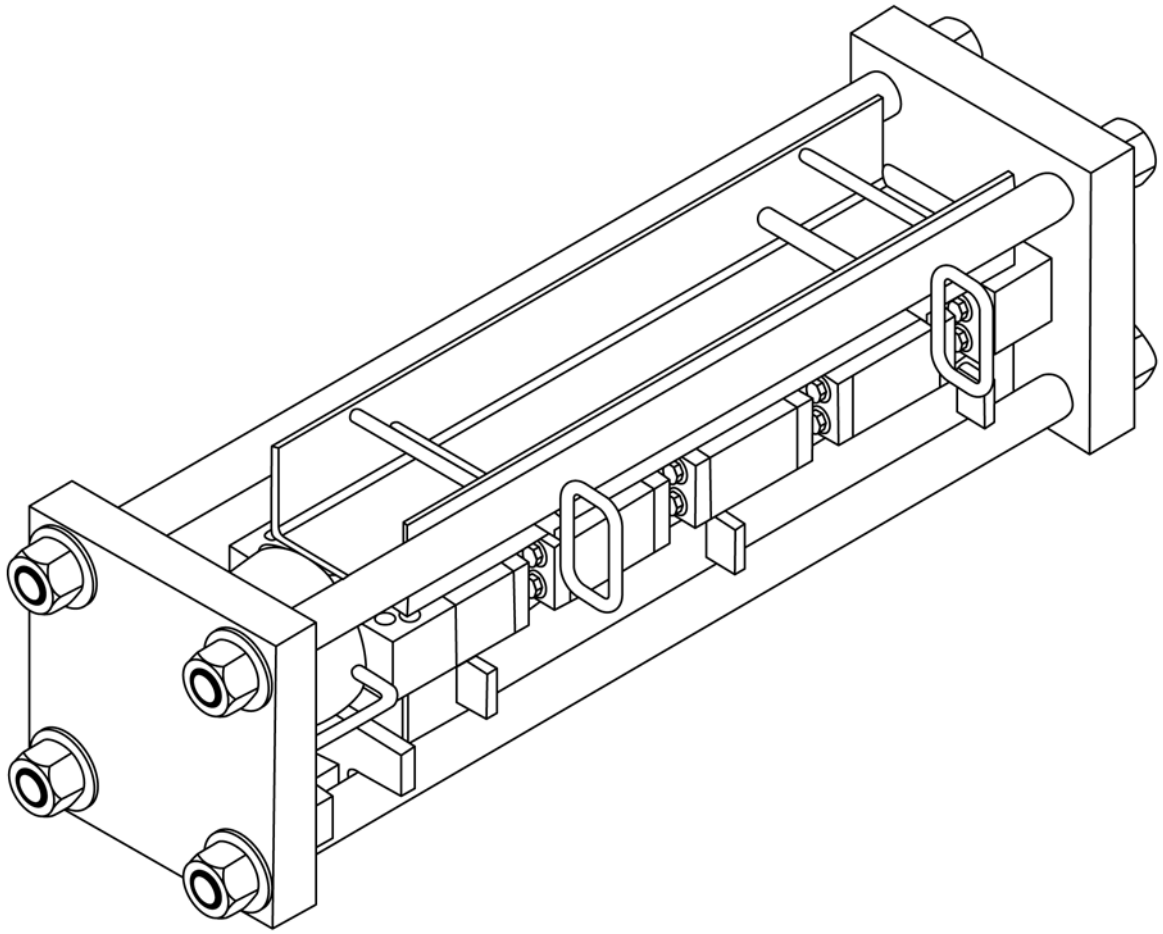
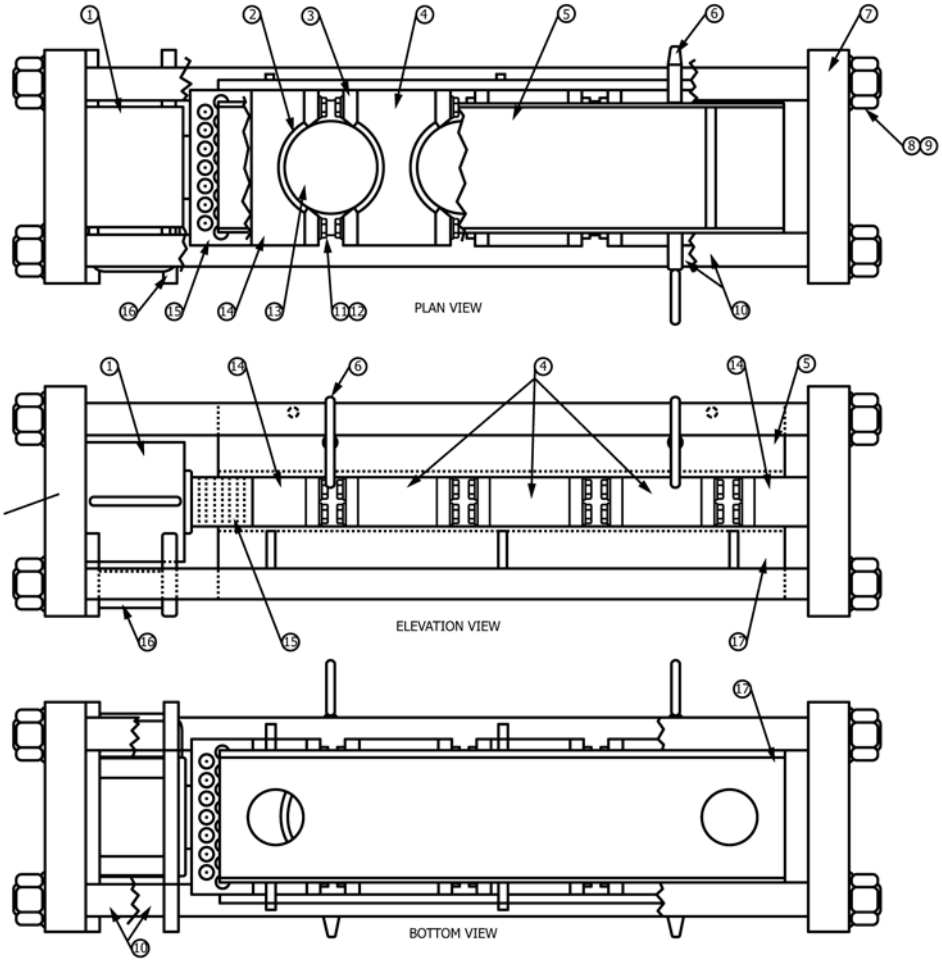


FIG. A1.1 Overview of Creep Test Apparatus



ITEM	QTY	DESCRIPTION
1	1	HYDRAULIC CYLINDER, ENERPAC RCS-1002
2	8	SAMPLE
3	16	SAMPLE CLAMP
4	3	INTERMEDIATE SAMPLE SUPPORT
5	1	ANTI-BUCKLING SUPPORT
6	2	LOCKING PIN
7	2	END PLATE
8	8	NUT, HEX, S.S., 1 1/2-6UNC-2B
9	8	WASHER, PLAIN, S.S., 19/16 I.D., 3 1/4 O.D. × 0.14 THK
10	4	ROD
11	32	BOLT, S.S., 1/2-13UNC-2A × 2 LONG
12	32	WASHER, PLAIN, S.S, 17/32 I.D. × 1 1/8 O.D. × 0.08 THK
13	4	SAMPLE SPACER
14	2	END SAMPLE SUPPORT
15	1	SPACER BLOCK
16	1	HYDRAULIC CYLINDER SUPPORT
17	1	LOWER SAMPLE SUPPORT

FIG. A1.2 Parts Description of Creep Apparatus

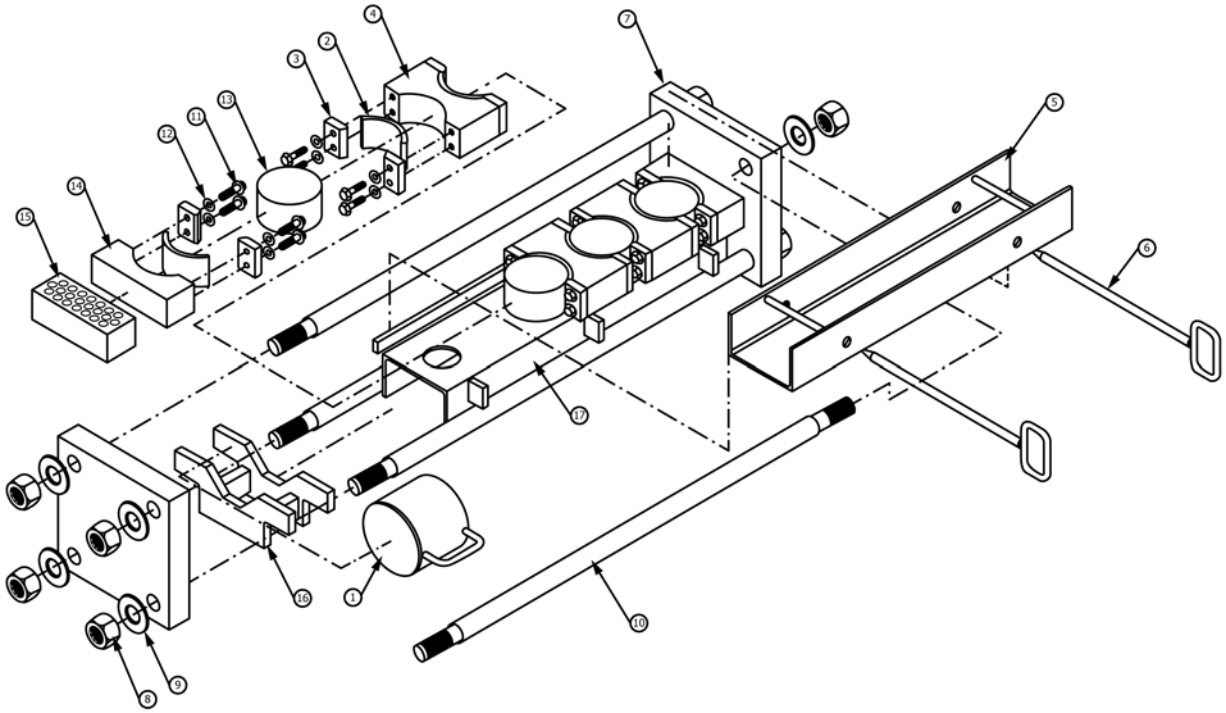


FIG. A1.3 Exploded View of Creep Apparatus