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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Accelerated Life of Nickel-Chromium and Nickel-Chromium-Iron Alloys for Electrical Heating[1]

This standard is issued under the fixed designation B 76; 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.

ε[1] NOTE—Section 14 was added editorially in June 1995.

1. Scope

1.1 This test method[2] covers the determination of the resistance to oxidation of nickel-chromium and nickel-chromium-iron electrical heating alloys at elevated temperatures under intermittent heating. Procedures for a constant-temperature cycle are provided. This test method is used for internal comparative purposes only.

1.2 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

1.3 *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 determine the applicability of regulatory limitations prior to use.*

2. Significance and Use

2.1 This test method is used by producers of electrical heating alloys to measure the cyclic oxidation resistance of these alloys.

2.2 Because of the effect of the environment, design, and use, the life values obtained from this test method may not correlate with that of an appliance or industrial heating unit.

3. Test Panel

3.1 *Size and Location*—The dimensions of the test panel shall be similar to those shown in Fig. 1. The test panel shall be located in a position free from drafts of air.

NOTE 1—The enclosure shall fit tightly on the panel and the glass slide shall fit snugly to prevent leakage of air at this point during the operation of the test, as even a slight draft of air in contact with the specimen will cause excessive variation in length of life. A screen of 40 wire mesh, 0.010-in. (0.025-mm) wire diameter, market grade, may be used as a cover over the individual stations.

3.2 *Upper Terminal*—The upper terminal shall consist of a binding post attached to a rod passing through another binding post or through the upper bus bar. This provides for adjustment laterally and vertically, as shown in Fig. 1.

3.3 *Lower Terminal*—A 10-g weight shall be attached to the lower end of the specimen. A flexible silver foil (approximately 0.375 in. (9.52 mm) wide and 0.0015 in. (0.038 mm) thick) connected to the 10-g weight shall constitute the lower terminal.

NOTE 2—Experiments have shown that with high temperatures alloys of nickel-chromium and nickel-chromium-iron are subject to plastic flow when under relatively light load. The weight specified in 3.3 does not cause appreciable increase in length during the test.

4. Apparatus

4.1 The test apparatus shall be similar to the requirements specified in 4.2 to 4.8, inclusive, and shall be connected as shown in Fig. 2.

4.2 *Power Supply*—The transformer or motor generator set shall be capable of delivering a controlled voltage of from 10 to 20 V to the circuit. It shall have a continuous current capacity of at least 20 A/specimen.

4.3 *Voltage Control*—The automatic voltage control shall be capable of maintaining across the bus bars a constant voltage within ± 0.5 %.

NOTE 3—It has been found impossible to make accurate tests without voltage control, as changes in line voltage were sufficient to cause considerable variation in the results obtained (see Annex A1).

4.4 *Variable Transformer*—The transformer shall be capable of adjusting the voltage across the specimen so that current is controlled to approximately 0.25 % of desired value, and shall have a continuous current rating of approximately 25 A.

4.5 *Ammeter and Voltmeter*—The ammeter and voltmeter shall have an accuracy of 1 % of normal test deflection (approximately 15 A and 15 V, respectively). For alternating current the range used shall be such as to give a reading above the lower fifth of the scale range. The ammeter has appreciable resistance. A compensating resistance shall be cut into the circuit to replace the resistance of the ammeter so that the overall resistance of the circuit is not changed. This resistance

[1] This test method is under the jurisdiction of ASTM Committee B-4 on Metallic Materials for Thermostats and for Electrical Resistance, Heating, and Contacts and is the direct responsibility of Subcommittee B04.01 on Electrical Heating and Resistance.

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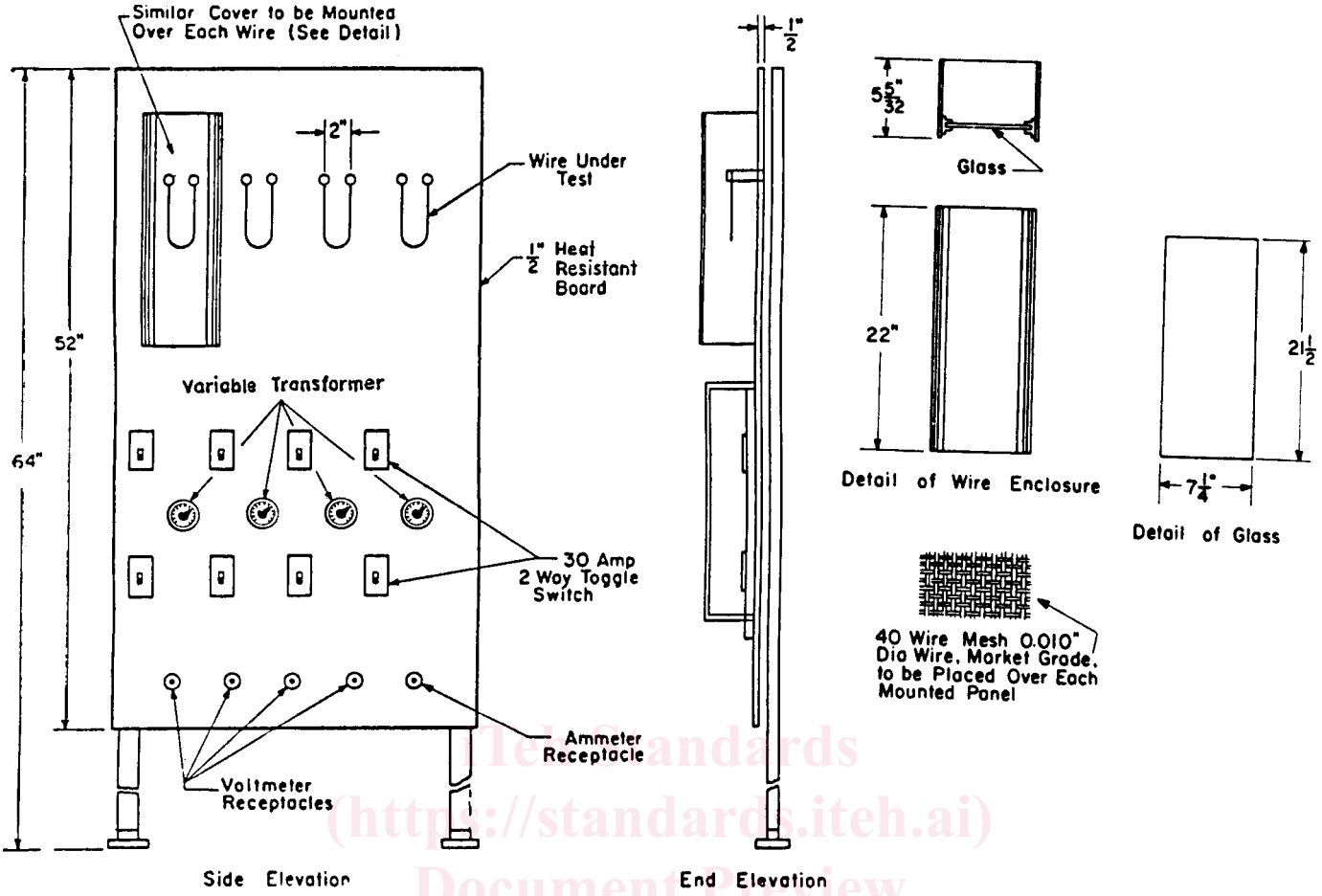
[2] Further information on this test method is given in a paper by F. E. Bash and J. W. Harsch, "Life Tests on Metallic Resistor Materials for Electrical Heating," *Proceedings*, ASTEA, American Society for Testing and Materials. Vol 29, Part II, 1929, p. 506.



Metric Equivalents

in.	½	5 5/32	7 ¼	21 ½	52	64
mm	12.7	131.0	184.2	546.1	1321	1626

FIG. 1 Test Panel for Accelerated Life Test

shall be inserted in series with the blade of the upper switch shown in Fig. 2.

4.6 *Optical Pyrometer or Infrared Thermometer*—The optical system shall be such as to provide a magnification of at least four diameters. This may be accomplished by the use of a special lens or combination of two standard lenses in the objective to provide a short focal length and the desired magnification. (See Annex A1.) These instruments must have an accuracy of ±10°F and NIST traceability.

NOTE 4—It is highly important that the temperature of the test specimen be adjusted as accurately as possible, as small variations in temperature result in considerable variation in length of life. An optical pyrometer or infrared thermometer makes it possible to determine the temperature at any particular point on the wire and with the arrangement described the temperature of a comparatively small wire may be taken quite readily.

4.7 *Interrupter*—Some form of apparatus shall be used as an interrupter to open and close the circuit.

4.8 *Apparatus for Recording Time of Burnout*—If no apparatus is available for recording the time of burnout, arrange-

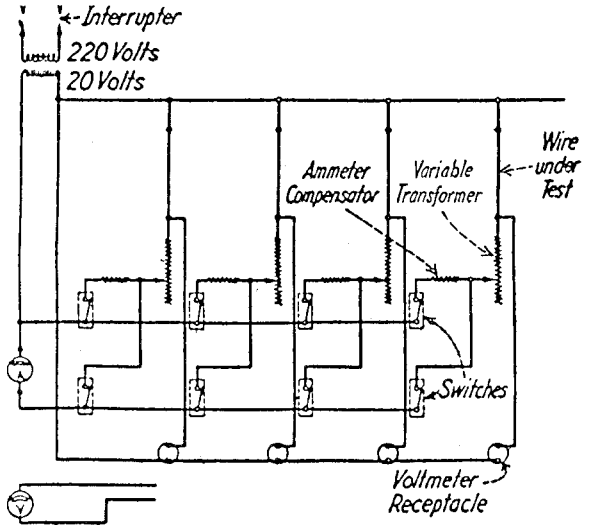


FIG. 2 Electrical Circuit Diagram for Accelerated Life Test

ments shall be made for hourly observations for burnouts. Some form of electric-clock mechanism which can be connected into the circuit may be used.

4.9 *Apparatus for Measuring Length Changes*—Any form of optical apparatus such as a traveling microscope, an optical projection system, a projection microscope, or a contact microscope may be used for determining changes in length of the test specimen. A type of apparatus that has been found satisfactory consists of a telescope with a horizontal cross hair and leveling bubble. The apparatus may be mounted on a frame so that it can be readily moved from one position to another for examining specimens in the life test. The telescope mount should be adjustable in the vertical plane on guides by means of a threaded member. A movement of 2.5 in. (64 mm) is desirable. A piece of cross-section paper, 4 in. (102 mm) in length by 3 in. (76 mm) in width, calibrated 20 lines to 1 in. (25.4 mm) should be mounted on the test panel so that the lower edge is below a horizontal line drawn across the top of the lowest possible position of the weight attached to the lower end of the wire under test. A satisfactory arrangement is shown in Fig. 3. A steel scale 18 in. (457 mm) in length, calibrated to 0.01 in. (0.25 mm), may be used for length measurements.

5. Test Specimen

5.1 The test specimen shall be No. 22 Awg, 0.0253 in. (0.64 mm). The length of wire selected for test shall be such as to permit the use of a 12-in. (305-mm) test length between the two terminals.

5.2 The test specimen shall be representative, as regards surface, of the average of the coil or spool of wire which has been selected for test. Particular care shall be taken to see that the specimen selected is free from kinks. This is necessary, as a kink, even though later removed, may cause burnout at that point.

NOTE 5—It is also very desirable to select and keep as a reference standard for comparison a spool or coil of wire which is uniform in cross section from one end to the other. Tests may then be made at any time on the reference standard, and if conditions have changed they will be noted by the length of life on the standard. Comparisons between tests made at different times between the standards and other wires may be correlated in this manner (see Annex A1).

6. Mounting of Specimens

6.1 The test specimens shall be mounted on the test panel in a vertical position, as shown in Fig. 1, and shall have the following typical spacing:

Distance between test panel and specimens	2 in. (50.8 mm)
Distance between specimens	6 in. (152.4 mm)
Distance between specimen and shield	2 in. (50.8 mm)
Distance between upper bus bar and silver foil contact ... approximately	20 in. (508 mm)

NOTE 6—This recommendation is based on a series of tests run in four laboratories to determine the best position for the specimen in which horizontal mounting, catenary mounting, and vertical mounting were compared. The results of the tests indicated that the vertical mounting gave the best results and was most convenient. It might be expected that the vertical wire would be a great deal hotter near the top than near the bottom. This does not appear to be the case due to the fact that convection currents are greater near the top, and therefore largely compensate for variations that otherwise would occur.

6.2 In mounting a test specimen, one end of the specimen shall be inserted in the upper terminal and the weight attached to the other end. The upper terminal shall then be adjusted to give a test length of the wire of approximately 12 in. (305 mm) between the two terminals. Care shall be taken to see that the weight will be able to move freely after the specimen has expanded upon heating.

6.3 *Number of Test Specimens:*

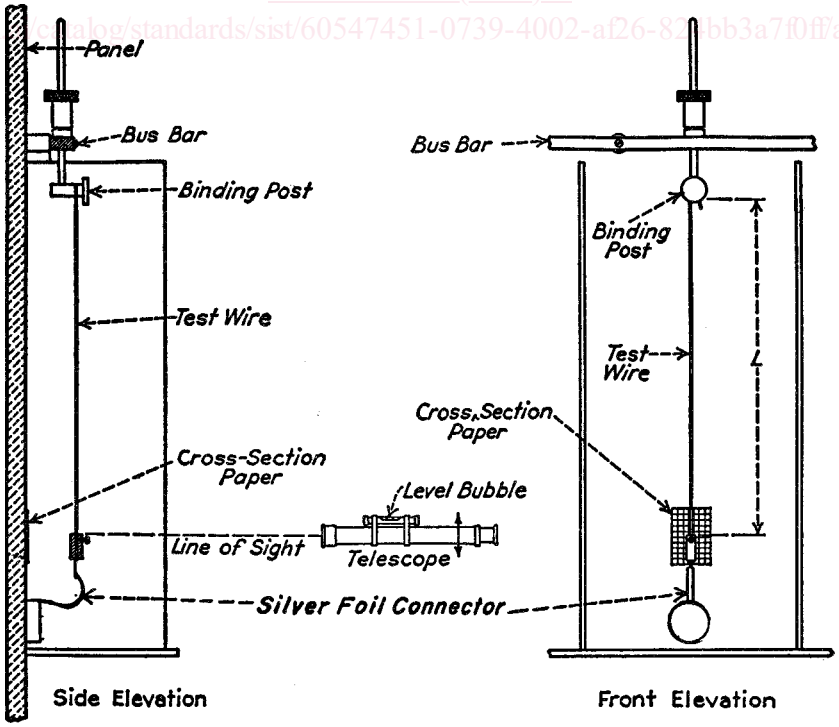


FIG. 3 Apparatus for Measuring Length Changes During Life Test