NATIONAL BUREAU OF STANDARDS REPORT

7182

Temperature Measurements
of a
500-Watt, Flush Runway-Light Installation

by

James E. Davis

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS PROJECT

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for

Bureau of Naval Weapons
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Washington 25, D. C.

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Report on Temperature Measurements of a 500-Watt, Flush Runway-Light Installation

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ABSTRACT

The purpose of this test was to investigate the rise of temperature of the components of a 500-watt flush-type runway light when it was mounted on a 16-inch deep base containing the isolating transformer in an installation similar to that used in a regular airfield lighting installation. From these measurements the feasibility of using the 500-watt light in this type of installation and the requirements of components suitable for such installations may be determined. Temperature measurements made at four points on the transformer, one on the light assembly, two of the free air inside the base, and of certain ambient conditions are given in this report. The effects of positioning the transformer and of shielding the transformer from direct heat of the lamp by the use of aluminum foil were investigated. Because of the limited range of external ambient temperature during these tests, additional tests are being planned for a site where higher temperatures will occur. Only one test showed any adverse effects on the light or transformer. During this test, seams of the transformer opened allowing some potting compound to run out.

1. MATERIAL TESTED

The light assembly used in the installation was a Class B15 flush light manufactured by Multi-Electric Manufacturing Inc. The lamps used in the tests were type 20A/PAR56/3, 500-watt, 20-ampere, PAR-56 lamps. No filter was used in the light during these tests. The transformers used were 500-watt, 6.6/20-ampere, series-series, rubber-covered transformers manufactured by Jefferson Electric Company, catalog number 345-001-013. These units were mounted in a type MS24526 base assembly which had a depth of 16 inches and an inside diameter of 13 inches. The base assembly was installed in the ground adjacent to the concrete apron at the Arcata Airport. The top of the concrete encasement in which the top of the base assembly was centered was 30" x 30" x 4" thick and the lower portion of the base assembly was surrounded by approximately six inches of concrete. Conduit was connected to one hub of the base assembly for connecting power to the transformer and for bringing in the thermocouple wires for the temperature measurements.

2. TEST PROCEDURE

During each test, the lamp was energized at rated current by adjusting the primary current to the transformer to its rated current, 6.6 amperes. A new lamp was used in each test. The current was controlled by a continuously variable auto-transformer and a constant-voltage regulator was used to reduce the effects of line voltage fluctuations. The lamps were energized continuously at rated current for periods of 48 to 72 hours.

Temperature measurements were made with a 16-point, self-balancing potentiometer using copper-constantan thermocouple sensing elements located as shown on figure 1. Other thermocouple elements were located in the internal free air and the external ambient air, in the ground adjacent to the installation, and as a reference in boiling water in the laboratory. The thermocouple sensing elements were attached to the surfaces or points of measurement on the components of the light with "Scotch Brand" high-temperature electrical tape No. 27 and "Insulment" cement to obtain good thermal contact. The temperatures were recorded continuously for several hours after energizing and after turning off the lamps and for five minutes at hourly intervals during the rest of the test.

Four tests were made with test conditions as follows.

1. The transformer was installed in the usual upright position, as shown in figure 1. The test was made when the ground was very dry and the ambient air temperature ranged from 49 to 63 degrees Fahrenheit.

2. A second transformer was placed in the upright position but with a thermal shield of two thicknesses of aluminum foil (kitchen variety) between the transformer and lamp. This test was made after the ground was wet although it had not rained for two weeks. The outside air temperature ranged from 29 to 60 degrees Fahrenheit.

3. A third transformer was laid on its side with primary and secondary leads near the bottom of the base assembly. The ground was wet but there was only limited light rain before and during the test. The outside air temperature ranged from 29 to 64 degrees Fahrenheit.

4. The transformer position was the same as in test No. 1, but the transformer of test No. 3 was used. The ground had been soaked recently but there had been no rain for one week. The ambient air temperature ranged from 42 to 59 degrees Fahrenheit.

During the first test the range of the recording potentiometer was from -50 to 300 degrees Fahrenheit and the temperatures at several of the test points exceeded the upper limit. The range of the recorder was changed to cover from 0 to 800 degrees Fahrenheit for the other tests.

The components were examined for damage after completion of each test.

3. RESULTS

The results of the temperature measurements are given in figures 2 through 8. (See figure 1 for identification of thermocouples.) Test No. 1 was discontinued after 48 hours but tests No. 2, 3, and 4 were continued for a total of 72, 67, and 72 hours, respectively. The temperatures of only the first 48 hours operation are shown in the figures. For those tests in which the lamps were operated longer, the temperatures rose less than 10 degrees above those obtained at 48 hours.

4. DISCUSSION

The free air temperature inside the base may be over 100 degrees higher near the top of the base than near the bottom. Similarly, the temperatures on the surface of the transformer were related to the height above the bottom of the base. The lower temperatures of the transformer when it was laid on the side in test No. 3 were largely the result of the lower positions of the thermocouples relative to the bottom of the base.

During test No. 1 the transformer case opened at the seams on one side and at the bottom. Some of the potting compound ran out and the rubber case sagged on the top. Sections of the secondary

lead from the transformer to the lamp which were in the vicinity of the lamp became brittle and the insulation cracked when the lead was flexed. An oily substance was found on the prism. This was apparently from the prism mounting compound. This oily substance was not observed during or after any of the other tests. Except for a slight sagging of the top of the transformer case and for the secondary leads becoming brittle, no damaging effects to the light assembly or transformers were apparent during the other three tests. The cover gasket remained soft and pliable throughout all of the tests.

Additional tests in an area where the outside air temperatures are higher than those encountered during these tests are required before the maximum temperature rises can be determined and before requirements for components suitable for these worst possible conditions can be determined. However, the results of these tests indicate that by providing simple shielding between the lamp and transformer, by placing the transformer on its side, and by properly positioning the primary and secondary leads, satisfactory operation with the 500-watt lamps and transformers can be obtained during the short 100-percent-intensity duty cycles which are typical of airfield lighting circuits.

JEDavis
August 1961

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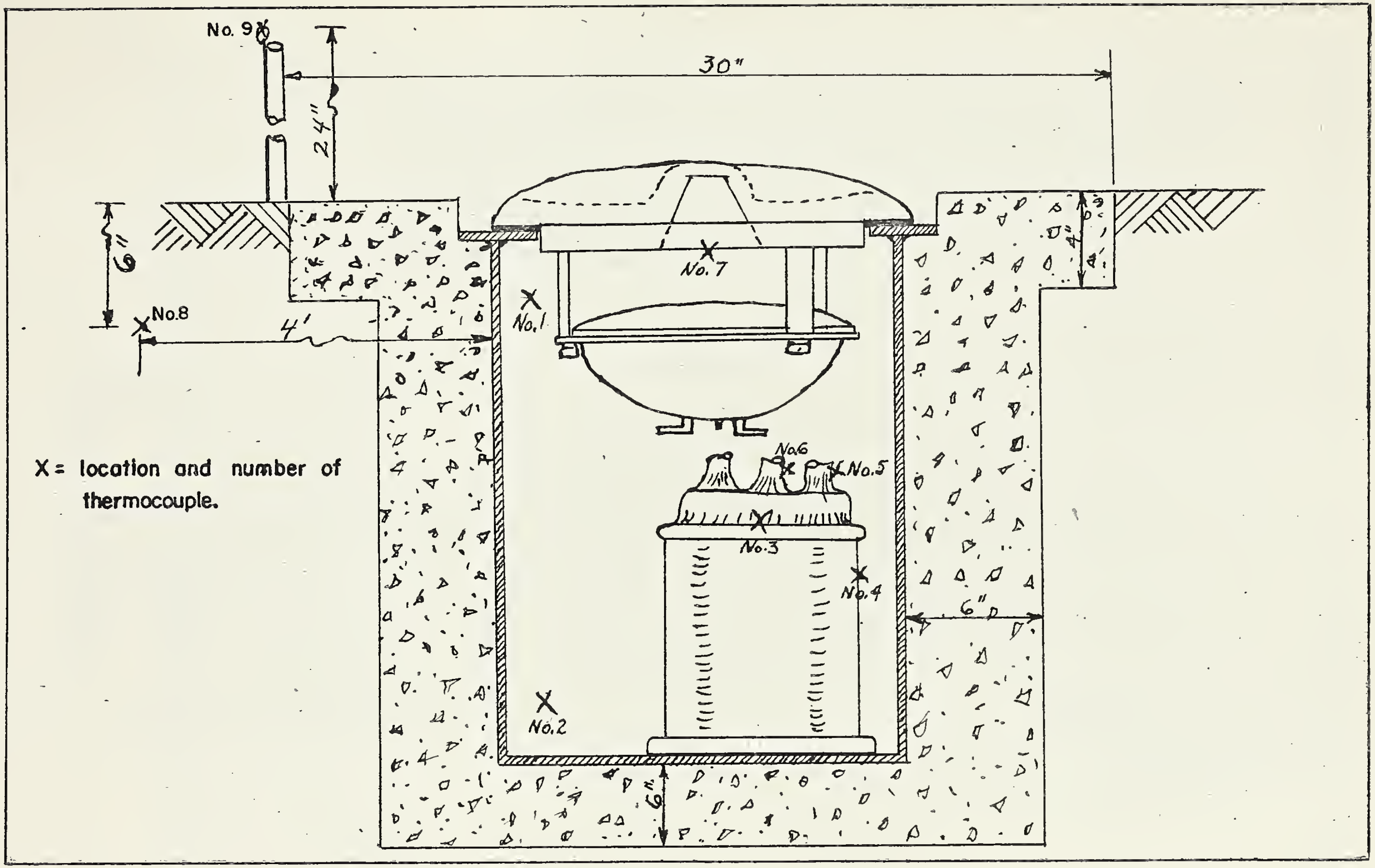

Figure I. *Light installation, showing thermocouple locations.*

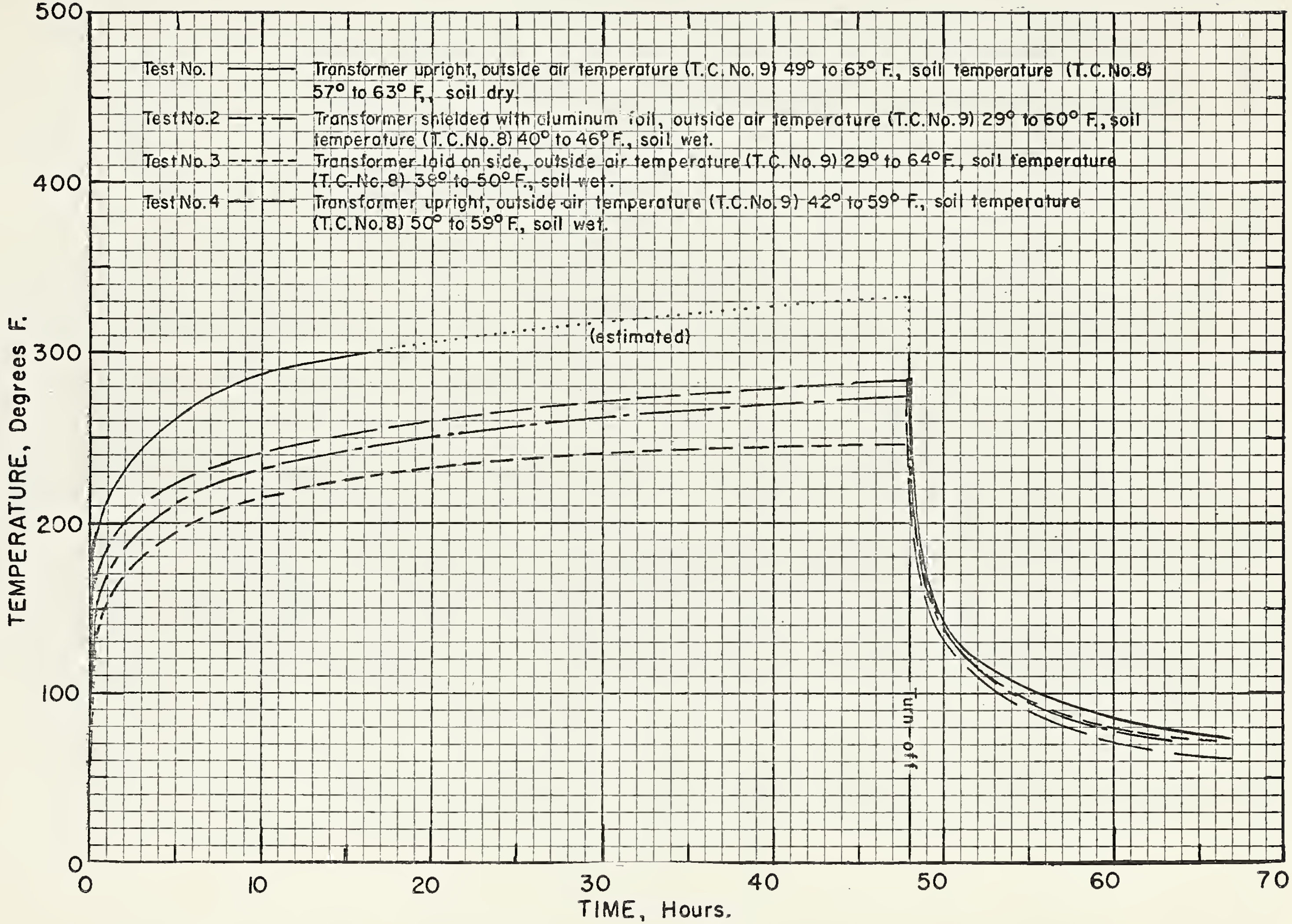

Figure 2. *Time - temperature curve of thermocouple No. 1, free air inside base near the top.*

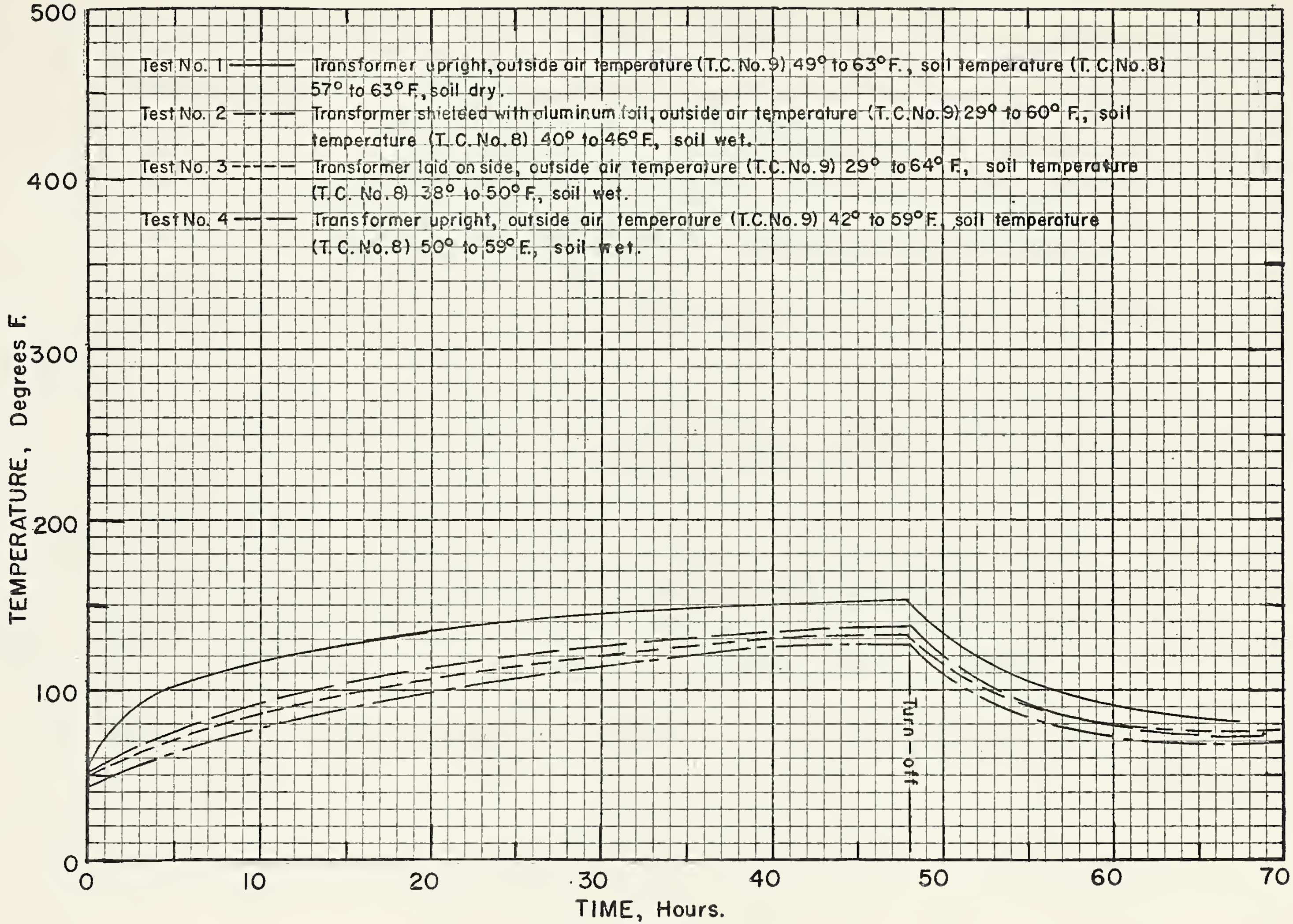

Figure 3. *Time-temperature curve of thermocouple No. 2, free air inside base near the bottom.*

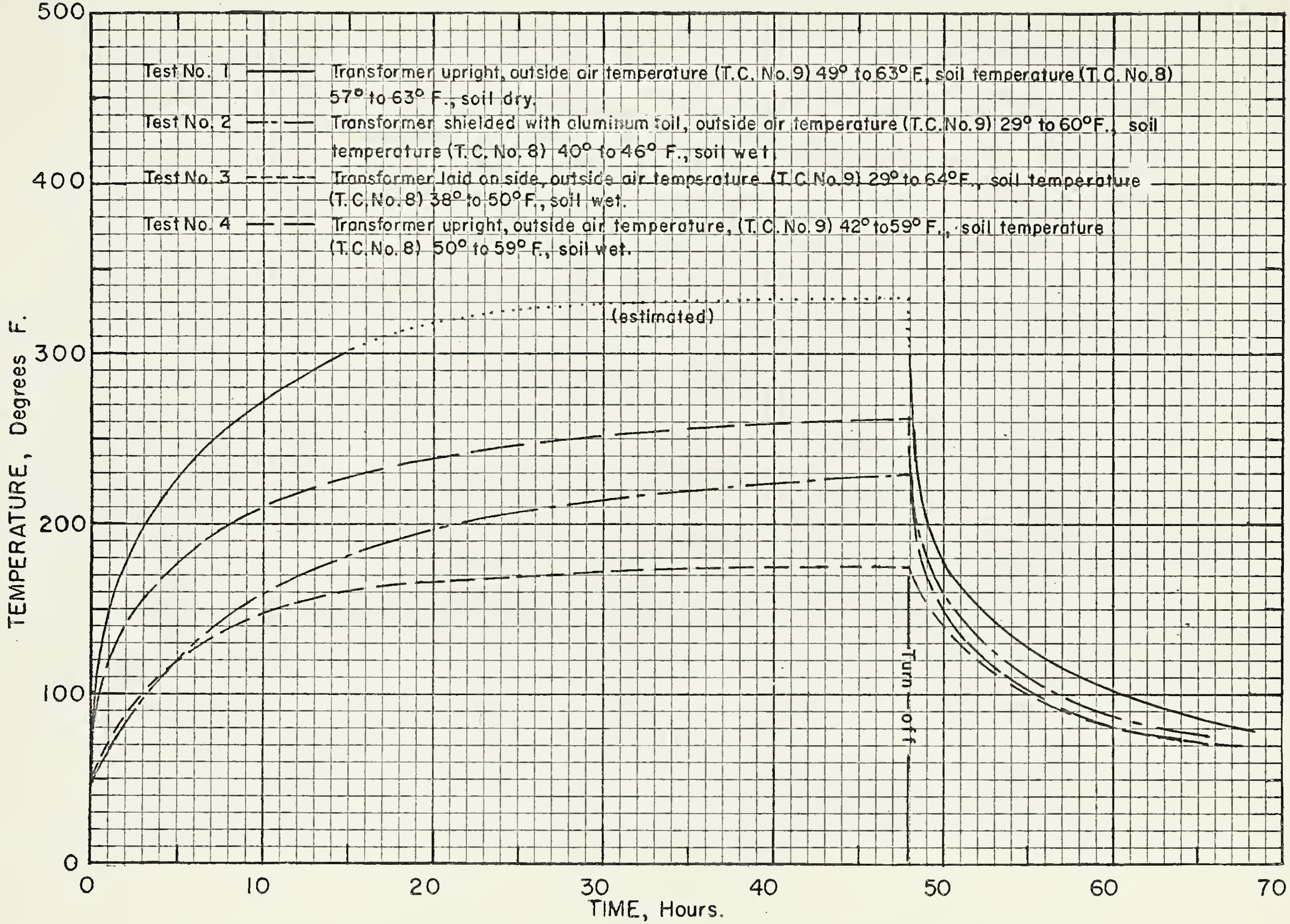

Figure 4. *Time-temperature curve of thermocouple No. 3, top of transformer case.*

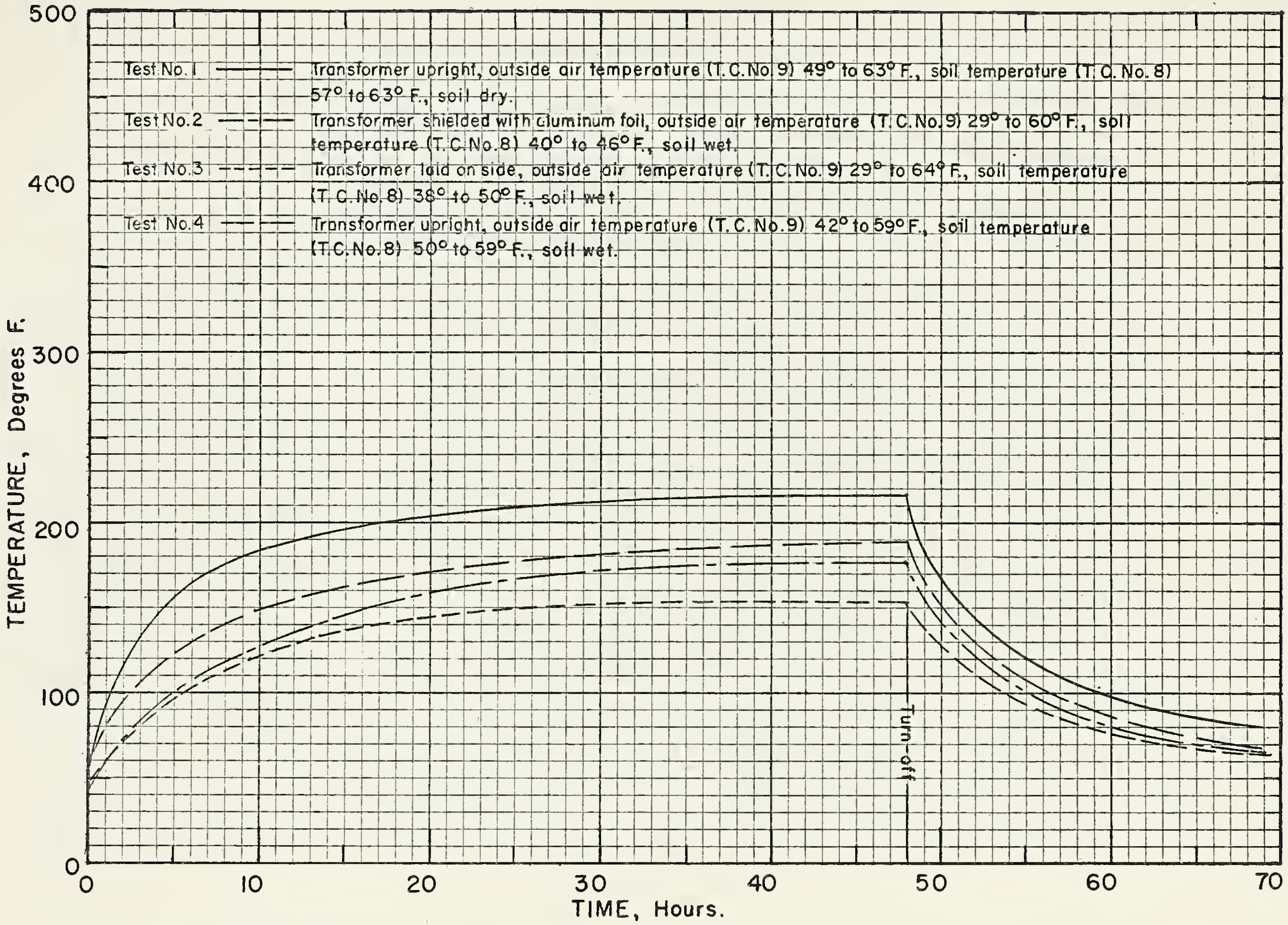

Figure 5. *Time-temperature curve of thermocouple No. 4, side of transformer case.*

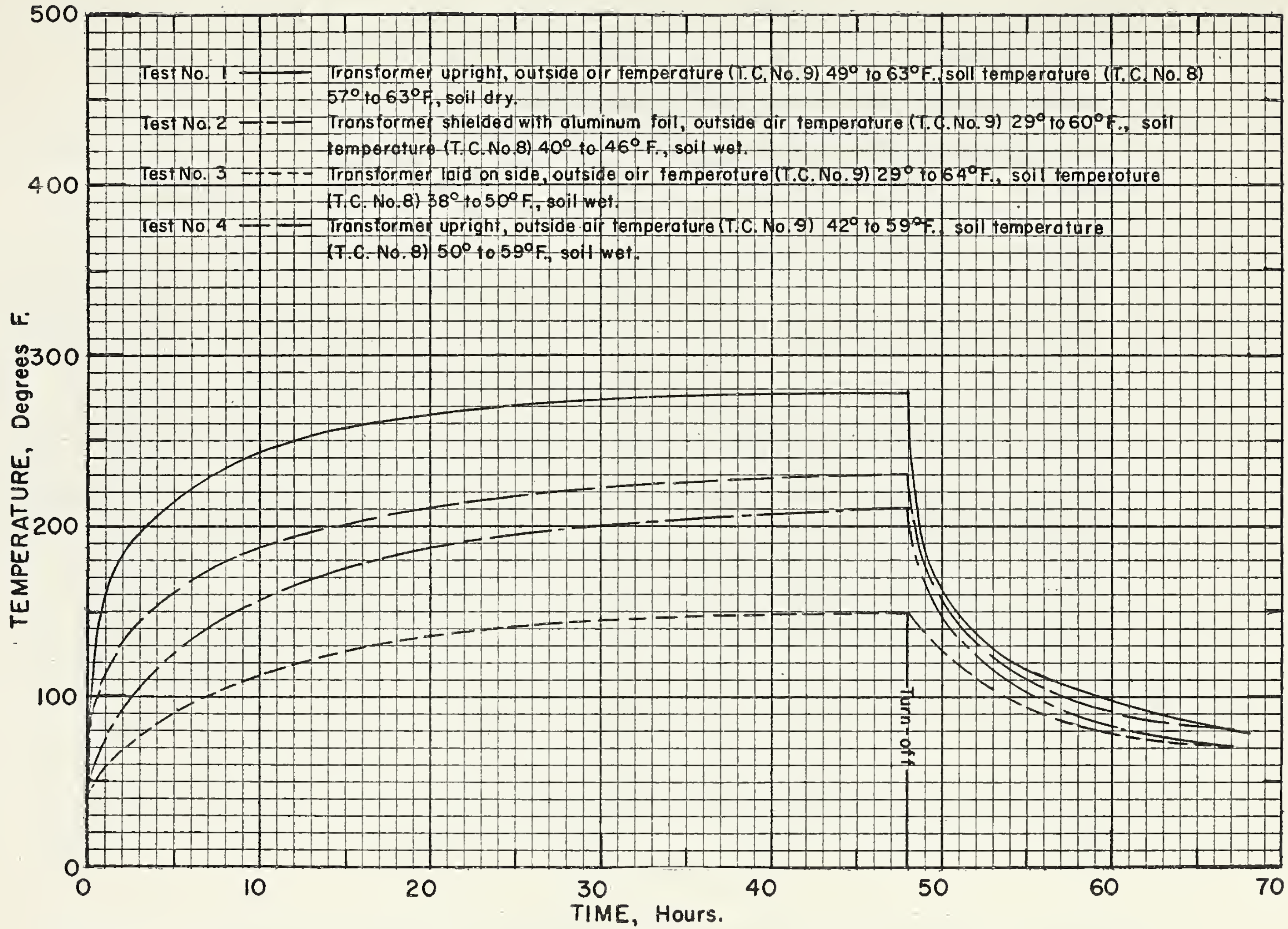

Figure 6. *Time-temperature curve of thermocouple No. 5, primary lead of transformer at transformer.*

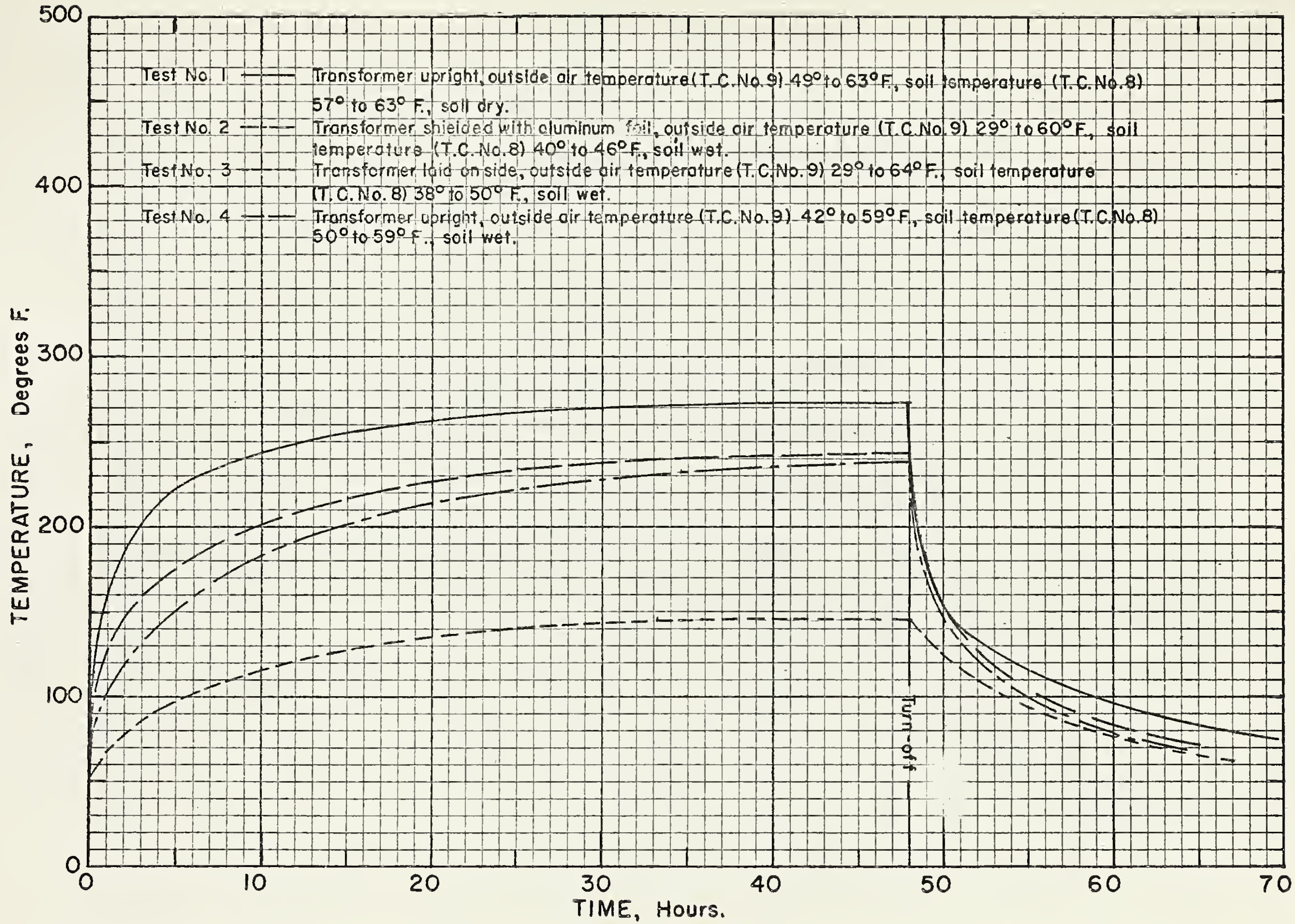

Figure 7. *Time-temperature curve of thermocouple No. 6, secondary lead of transformer at transformer.*

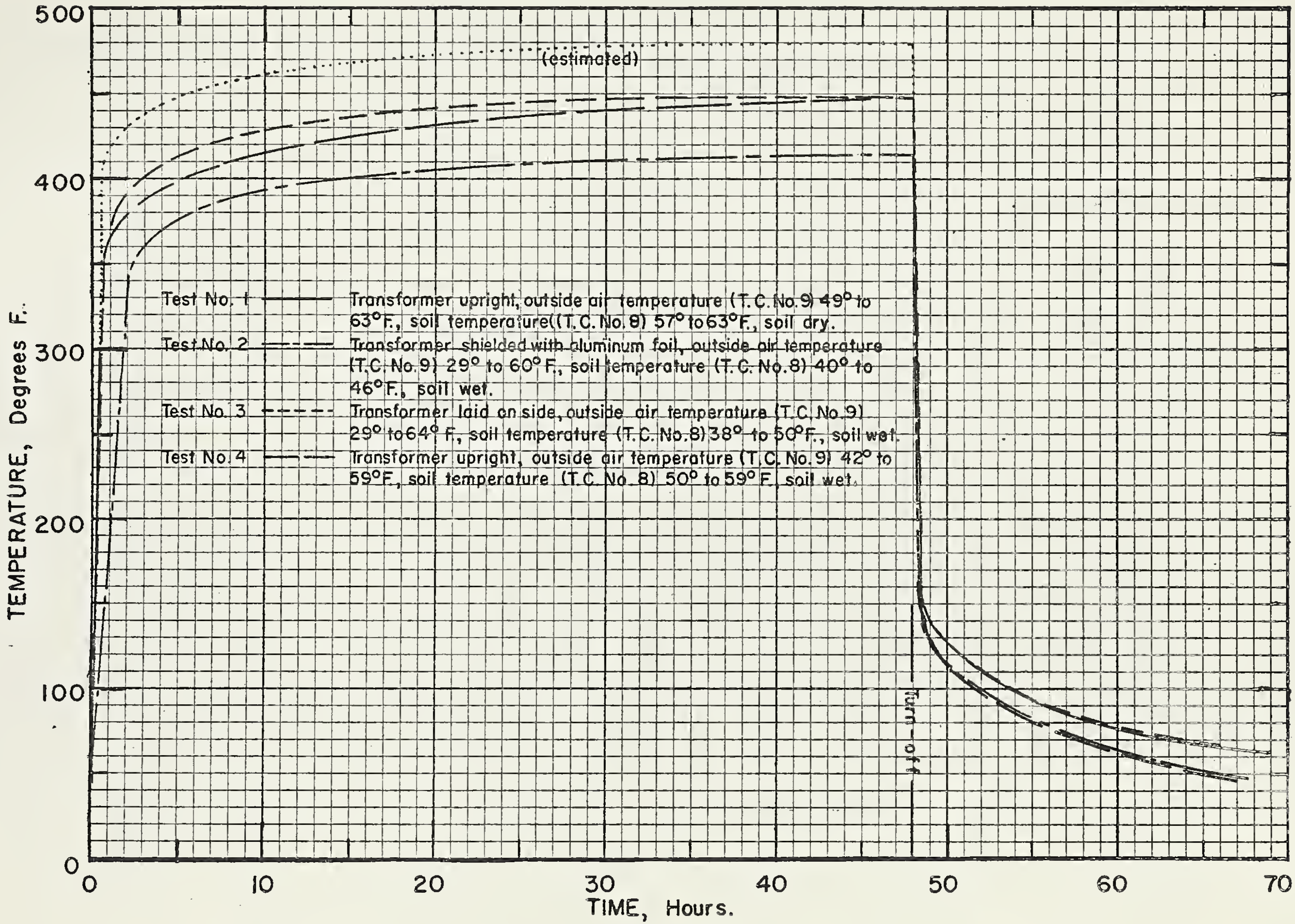

Figure 8. *Time-temperature curve of thermocouple No.7, inside top cover between prisms.*

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

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Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

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Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Crystal Growth. Physical Properties. Constitution and Microstructure.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Interval Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

Radio Systems. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

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