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GENERAL DYNAMICS | CONVAIR

(11) Report No. 8926-123

(7) Rept. on Material - Insulation - Thermal - Structural Laminating

(6) "Heat Barrier" Characteristics

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18 October 1957

Published and Distributed
under
Contract AF 33(600)-8926

Post Office Box 1950, San Diego 12, California 296-6611
Material Post Office Box 2071 273-8000 | Accounting Post Office Box 510

Report No. 8926-123

Material - Insulation - Thermal - Structural
Laminating

"Heat Barrier" Characteristics

Abstract:

The effectiveness of CTL-91-D (Cincinnati Test Laboratories, Cincinnati, Ohio), and Rocketon and Missileon (Haveg Industries, Wilmington, Delaware), when interposed as a laminate between a clad 2024-T3 aluminum alloy plate and a 2024-T3 aluminum alloy extrusion and fastened with 2017-T31 aluminum alloy rivets, was observed in terms of the temperature difference between the hot side of the plate and the extreme edge of the outstanding web of the Tee-extrusion stiffener on the cold side of the heated plate stiffener combination. The transfer of heat from the plate into the Tee-extrusion through the metallic path provided by the rivets rendered the "heat barrier" ineffective. The effectiveness of silicone rubber and foamed silastic (Dow Corning, Midland, Michigan), and teflon sheet (Shamban, Culver City, California) as "heat barriers" in .07 to .25 inch thicknesses was checked by observing the temperature drop through them when they were placed on a heated hotplate. The small temperature drop observed in these materials during test indicated their ineffectiveness as "heat barriers."

Reference: Stier, H. H., Sutherland, W. M., "Heat Barrier Efficiency Tests," General Dynamics/Convair Report MP57-490, San Diego, California, 18 October 1957, (Reference attached).

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO

STRUCTURES-MATERIALS LABORATORIES

REPORT 57-490
DATE 10-18-57
MODEL R & D

TITLE

REPORT NO. 57-490

"HEAT BARRIER" EFFICIENCY TESTS

MODEL: R & D

PREPARED BY H. H. Stier
H. H. Stier

GROUP MATERIALS & PROCESSES LAB.

REFERENCE

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Group Engineer

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E. F. Strong,
Chief of Test Laboratories

NO. OF PAGES 19
NO. OF DIAGRAMS 6

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REPORT NO. 57-490
"HEAT BARRIER" EFFICIENCY TESTS

OBJECT:

The object of this test is to determine experimentally the temperature gradient that may be obtained across a typical structural joint when a material having a low conductivity is interposed in the joint.

CONCLUSION:

1. The heat barrier is ineffective when rivets allow heat to pass through the structural joint.

2. The dense solid types of insulating materials cannot be used as heat barriers since they give only a slight thermal drop (no rivets through the barrier).

TEST SPECIMENS:

An aluminum spar (1) in the shape of a T-beam was riveted (2) to a 12" x 12" plate of aluminum (3) of .064" thickness. The heat barrier was interposed in the riveted joint as shown in Figures 1 and 2. Rocketon, missileon, and CTL-91-D were employed as barriers.

TEST PROCEDURE:

The panel was placed in an air circulating oven equipped with infra-red heating lamps with the underside of the panel and the spar enclosed in an insulated box of 12" x 12" x 4" dimensions. The outside of the panel was heated by infra-red (12 lamps of GE-T3 on 1" centers at distance of 4" from panel) and by convectional currents in the air circulating oven (low velocity air at 500°F. flowing parallel to the surface). Thermocouples peened into the skin and spar measured temperatures which were recorded on a Fisher Recordall. The temperature of the insulated test box was recorded also.

A more simplified procedure was used to test other insulating materials for use as barriers. Fiberglass with silicone rubber, solid teflon sheet, and foamed silastic in 5" x 5" x .07-.25" dimensions were heated by placing a hot plate against one surface with the other surface in contact with a .20" thick microballoon insulation. Thermocouples measured the temperature drop through the given materials. Phenolic CT-803 was tested according to a procedure described in Report No. 57-500.

(1) .064" CLAD 2024-T3 ALUMINUM ALLOY
(2) 3/16" DIA 2017-T31 ALUMINUM ALLOY RIVETS
(3) 2024-T3 ALUMINUM ALLOY

RESULTS AND DISCUSSION:

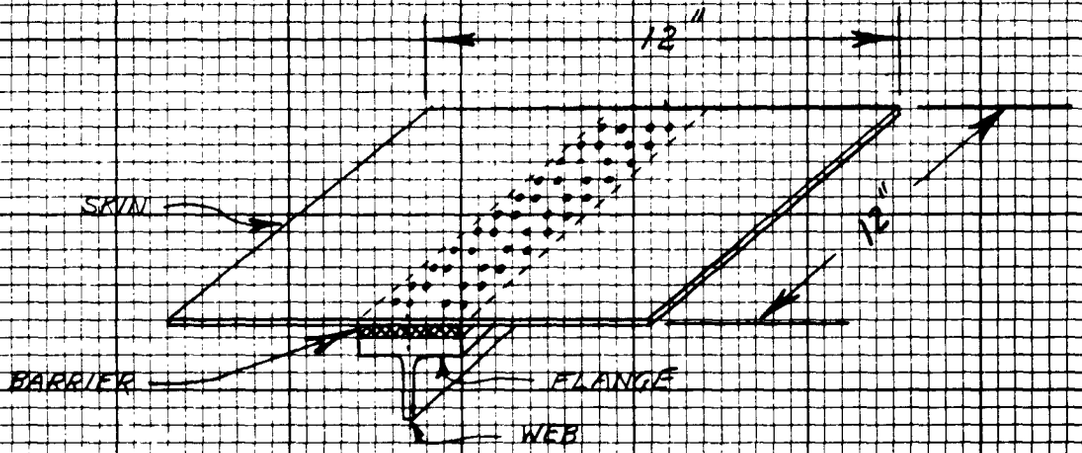
The curves given in Figures 2 and 3 show the thermal gradient through the structural joint employing missileon, rocketon, and CTL-91-D (phenolic with fiber glass) as insulating barriers. The large gradient between thermocouples #1 and #2 (T.C. #1 and T.C. #2 in Figure 2) is due to the rapid transfer of heat to the massive spar via the numerous rivets. If the temperatures at T.C. #2 and T.C. #3 are used as the test reference, the temperature gradient across the barrier is nil. The sharp peaks in the heating curves are due to turning off the lamps. The theoretical skin temperature could not be achieved within the required short time using air at 500°F. with infra-red lamps at 4 inch distance. Using circulating air at 650°F. gave similar results as shown in Figure 4.

The curves given in Figures 5 and 6 show that dense solid types of insulating materials cannot be used as heat barriers since they give only a slight thermal drop even when there are no rivets to carry heat through the barrier. A thick foamed material similar to Q-9315 silastic could produce the desired gradient if rivets could be eliminated. (See Figure 6).

NOTE: The data from which this report is taken are recorded on Recordall chart paper on file in Engineering Test Laboratories.

VENDOR LIST

Material	Company
CTL - 91 - D	Cincinnati Test Labs., Cincinnati, Ohio.
Rocketon	Haveg Industries, Wilmington, Delaware.
Missileon	Haveg Industries, Wilmington, Delaware.
CT - 803	Cincinnati Test Labs., Cincinnati, Ohio.
Silicone Rubber	Dow Corning, Midland, Michigan.
Teflon Sheet	Shamban, Culver City, California.
Foamed Silastic	Dow Corning, Midland, Michigan.



SKIN THICKNESS = .064"
FLANGE THICKNESS = .375", FLANGE WIDTH = 3.25"
WEB THICKNESS = .094", WEB HEIGHT = 1.50"

SKETCH SHOWING POSITION OF HEAT BARRIER IN TEST SPECIMEN.

FIGURA 1.

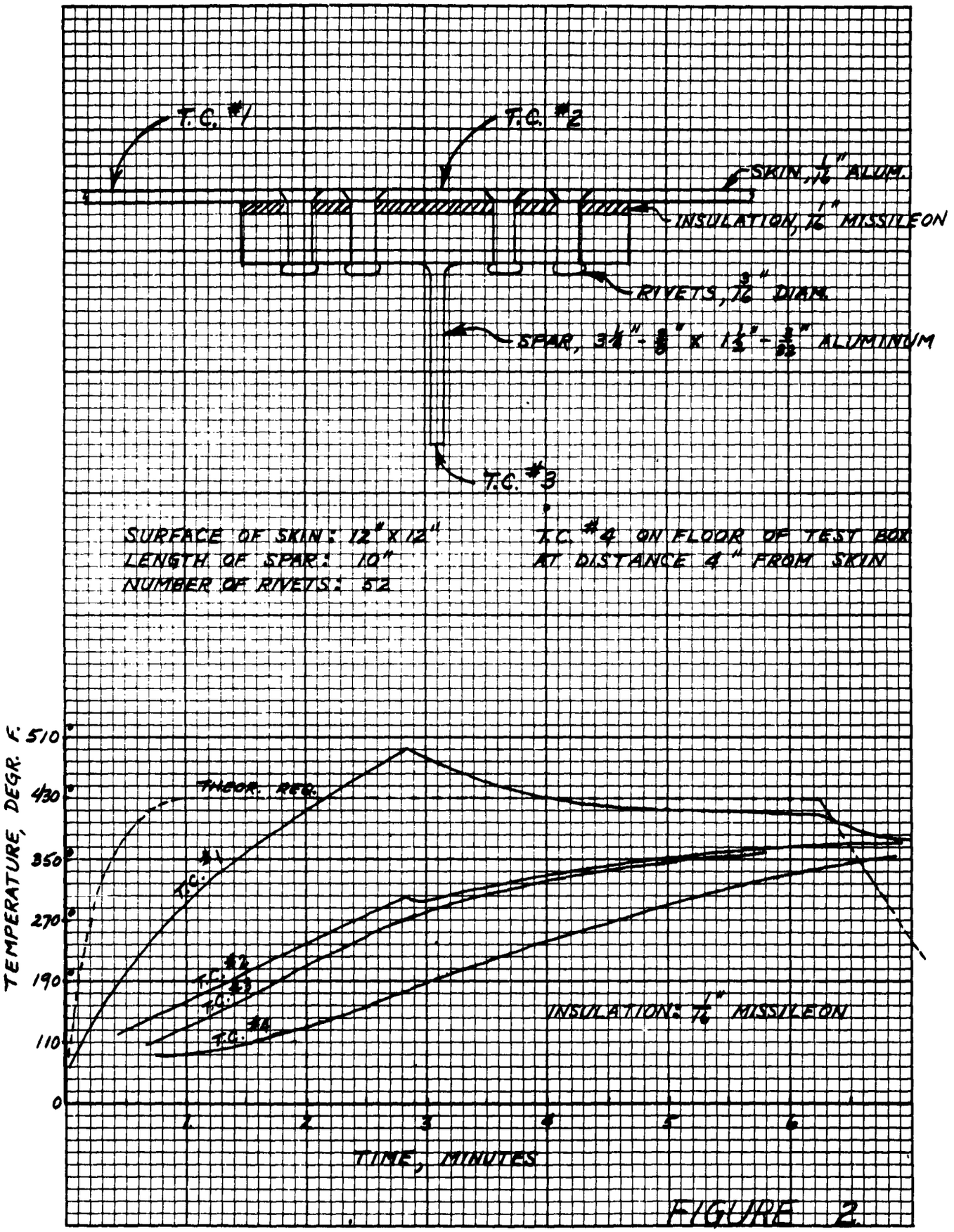

T.C. #1
T.C. #2
SKIN, 1/16" ALUM.
INSULATION, 1/16" MISSILEON
RIVETS, 3/16" DIAM.
SPAR, 3 1/4" - 3/8" X 1 1/2" - 3/32" ALUMINUM
T.C. #3
T.C. #4 ON FLOOR OF TEST BOX AT DISTANCE 4" FROM SKIN
SURFACE OF SKIN: 12" X 12"
LENGTH OF SPAR: 10"
NUMBER OF RIVETS: 52
TEMPERATURE, DEGR. F.
510
430
350
270
190
110
0
THEOR. REQ.
T.C. #1
T.C. #2
T.C. #3
T.C. #4
INSULATION: 1/16" MISSILEON
1
2
3
4
5
6
TIME, MINUTES

FIGURE 2.

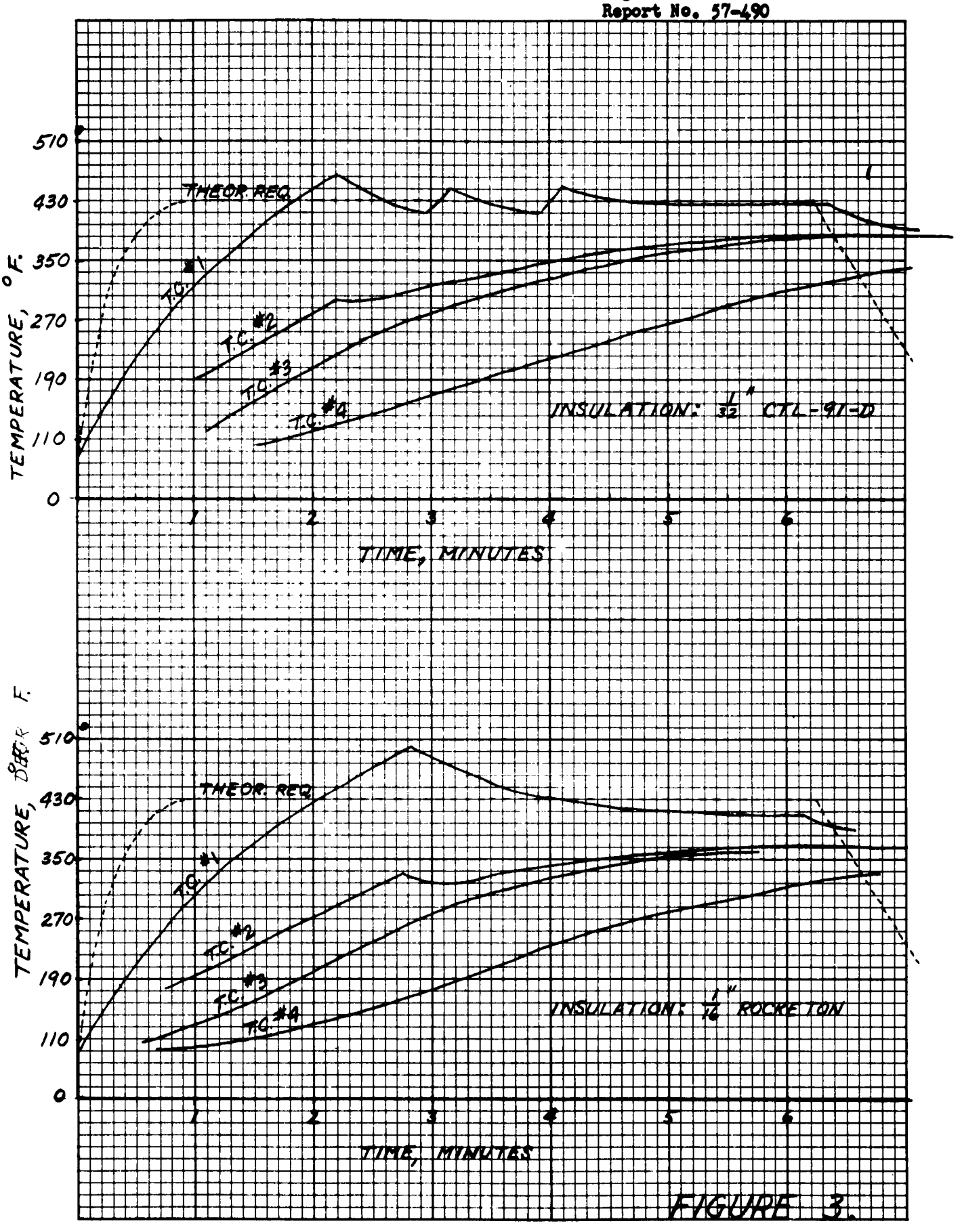

TEMPERATURE, °F.
510
430
350
270
190
110
0
THEOR. REQ.
T.C. #1
T.C. #2
T.C. #3
T.C. #4
INSULATION: 1/32" CTL-91-D
1
2
3
4
5
6
TIME, MINUTES
TEMPERATURE, °F.
510
430
350
270
190
110
0
THEOR. REQ.
T.C. #1
T.C. #2
T.C. #3
T.C. #4
INSULATION: 1/16" ROCKETON
1
2
3
4
5
6
TIME, MINUTES

FIGURE 3.

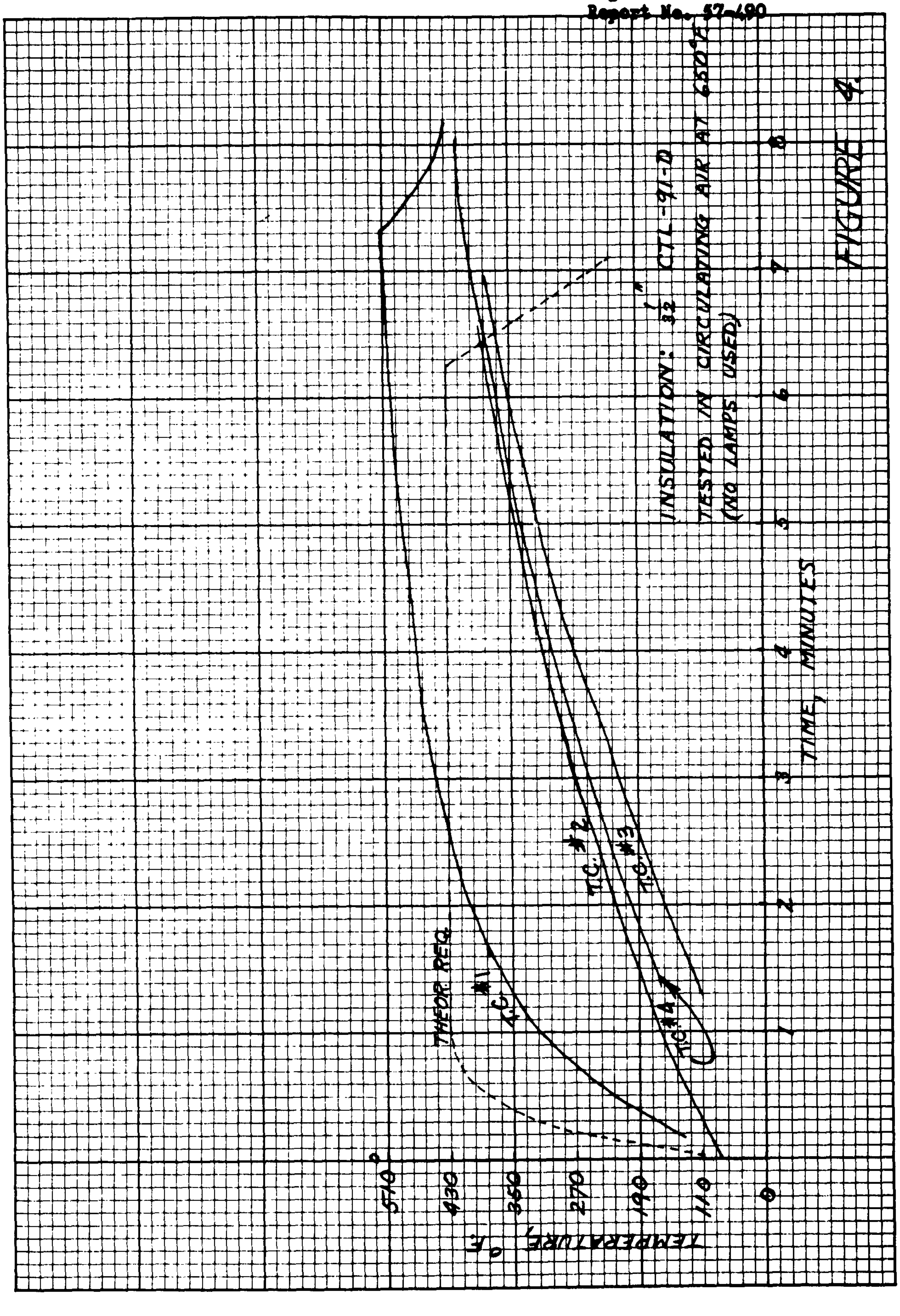

INSULATION: 1/32" CTL-91-D
TESTED IN CIRCULATING AIR AT 650°F.
(NO LAMPS USED)
THEOR. REQ.
T.C. #1
T.C. #2
T.C. #3
T.C. #4
TEMPERATURE, °F
510
430
350
270
190
110
0
TIME, MINUTES
1
2
3
4
5
6
7
8

FIGURE 4.

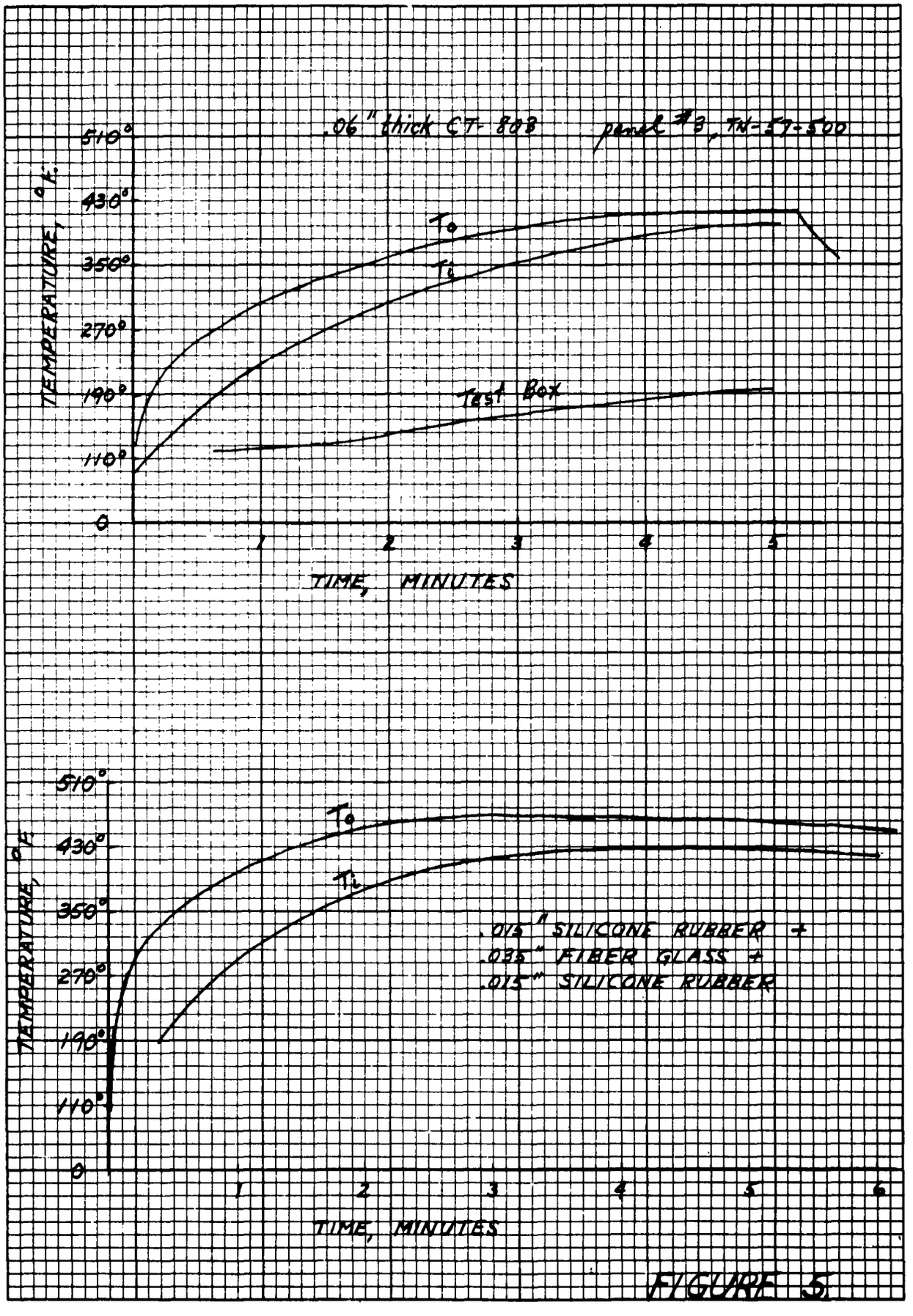

.06" thick CT-803 panel #3, TN-57-500
TEMPERATURE, °F.
510°
430°
350°
270°
190°
110°
0
T_o
T_i
Test Box
1
2
3
4
5
TIME, MINUTES
TEMPERATURE, °F
510°
430°
350°
270°
190°
110°
0
T_o
T_i
.015" SILICONE RUBBER +
.035" FIBER GLASS +
.015" SILICONE RUBBER
1
2
3
4
5
6
TIME, MINUTES

FIGURE 5

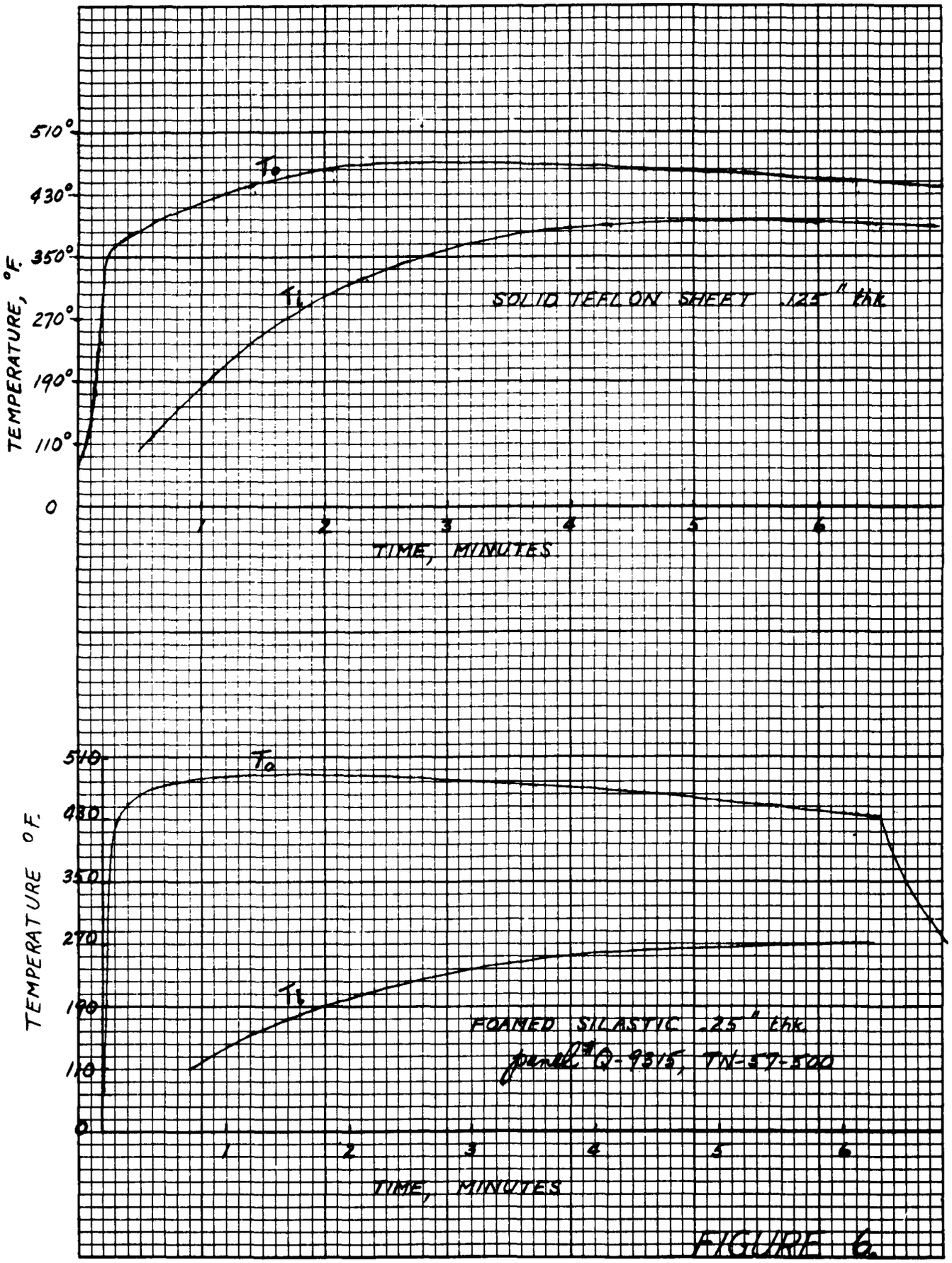

510°
430°
350°
270°
190°
110°
0
TEMPERATURE, °F.
T_o
T_i
SOLID TEFLON SHEET .125" thk.
1
2
3
4
5
6
TIME, MINUTES
510
430
350
270
190
110
0
TEMPERATURE °F.
T_o
T_i
FOAMED SILASTIC .25" thk.
formula Q-9315, TN-57-500
1
2
3
4
5
6
TIME, MINUTES

FIGURE 6.