TCG-NNT-1 [redacted]

SEP 4 1953
Case No. 433.00
Ref. Symbol: 1611
Project No. ET-1190
Completed 2/14/53

UNCLASSIFIED

Mr. P. E. JOCKLE, JR - 1281

Re: H-198 Carrying Case Insulation Test

Object of Test

This test was designed to obtain some indication of the insulating characteristics of two types (manufactured models) of battery carrying cases. This information was to be obtained by determining (1) the magnitude of the temperature gradients existing at various points within each sealed case after it had been exposed to -65°F and (2) a coefficient of thermal conductivity applicable to each of the cases. The test was patterned directly after that of ET-1060 during which two manufacturers' models were so tested. Two of the four cases tested during the present test were standard 9-gallon AN cans internally insulated with approximately one cubic foot of Vibradamp. The other two cases were fabricated from reinforced Fiberglas (1/8-inch thick) and were internally insulated with Fiberglas (one-inch thick); the density of the insulation was 11 pounds per cubic foot in one of these cases and 13 pounds per cubic foot in the other. Both cases were manufactured by Owens-Corning Fiberglas Co.

Function of Object Tested

The H-198 battery-carrying case is designed for the storage, wherever extreme temperature conditions are encountered, of two MC-271's between servicing and actual installation of the units.

Authorization for Test

This test was requested by Division 1281 in a Work Order Authorization dated December 16, 1952. Mr. I. I. Pemberton was the consultant.

Summary of Results

The thermal gradients for the various points (Fig. 1) in the Vibradamp cases, averaged for a five-hour period, ranged from 3 to 6°F per hour; for similar points in the Fiberglas cases, the values ranged from 11 to 15°F per hour. The conductivity coefficient for the Vibradamp cases was calculated as 4.75×10^{-5} and 4.71×10^{-5} BTU's per second per degree Fahrenheit; for the Fiberglas

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cases the values were 11.4×10^{-5} and 12.13×10^{-5} BTU's per second per degree Fahrenheit for the 11 pounds per cubic foot case and the 13 pounds per cubic foot case, respectively.

Procedure

A. Test Conditions:

For the first part of this test, two discharged MC-271's with thermocouples at various points were placed within the carrying case. The batteries fitted into the Fiberglas case side by side; the location of the thermocouples is shown in Fig. 1a. The batteries fitted into the Vibradamp case with the terminal sides facing each other; the thermocouple positions were the exact same as shown in Fig. 1a. The case was sealed and placed in a cold chamber maintained at approximately -65°F. The thermocouples were automatically monitored for five hours with a Brown temperature recorder. As for the previous test (ET-1060), the following relationship was used for the definition of the conductivity coefficient to be calculated in the second part of the test:

$$K = \frac{q}{t_1 - t_2}$$

q is the steady rate of heat flow measured in BTU's per second.

t_1 is the stabilised temperature of the inside walls of the carrying case.

t_2 is the stabilised temperature of the outside of the carrying case.

All temperatures were measured in degrees Fahrenheit. Although this expression does not contain constants pertaining to case geometry, it does yield an over-all case coefficient suitable for use as an approximate figure for a quantitative comparison of all the cases tested for possible H-198 use.

To determine t_1, at least eight thermocouples were placed at various points along the inner walls of the cases. An electric heating unit (consisting of eight 20-ohm rubber-insulated strip heaters connected in parallel to a direct-current source) was inserted into each case. After the case had been exposed to chamber conditions of about -65°F for approximately six hours, the heater units were turned on. The applied voltage was varied until the average reading of the ten thermocouples was maintained at ± 1/4°F for a 3-hour period; t_1 was then considered stabilized. The outside temperature, t_2, was held to ± 1/2°F over the same period; hence, stabilization of t_2 was also assumed. To measure q (BTU's per second), the current and voltage required by the heater unit to maintain the stabilized temperature, t_1, were measured; from this, q

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was calculated from the expression:

$$q = (9.48 \times 10^{-4})\ ie$$

i is the current in amperes.

e is the potential difference in volts.

The constant is the conversion factor from joules per second to BTU's per second.

B. Equipment Used:

Brown potentiometer, Model 153x60 P16-x-31F1, Serial No. 515968
Rubicon potentiometer, Serial No. 43676
Weston direct-current ammeter, Model 931, Serial No. 9313, range 0 to 5 amperes
Weston direct-current voltmeter, Model 931, Serial No. 5190, range 0 to 7.5 volts

<u>Results</u>

Table I gives the magnitude of the temperature gradients (in degrees Fahrenheit) existing at the various test points (Fig. 1) in the four test cases. The first case listed under the Fiberglas heading is the case fabricated with the 11 pounds per cubic foot insulation; the second case corresponds to 13 pounds per cubic foot. Values are given for the first hour and for the average degree per hour drop for the first five hours at -65°F. The coefficients calculated for the four cases in this present test and the two cases tested under ET-1060 are 5.75×10^{-5} and 5.90×10^{-5} BTU's per second per degree Fahrenheit for the two cases under ET-1060, 4.75×10^{-5} and 4.71×10^{-5} BTU's per second per degree Fahrenheit for the Vibradamp cases, and 11.4×10^{-5} and 12.1×10^{-5} BTU's per second per degree Fahrenheit for the Fiberglas cases.

The consultant advised that although all test results indicate the Vibradamp cases have the superior insulation, the Fiberglas case (by far the most transportable) has met the specification imposed upon the original design criteria and has been accepted for B-198 use.

Test Conducted by R. S. HOOPER - 1611

Signed By
R. L. WAGAR

Approved by R. L. WAGAR - 1611

RSH:1611:jf

Encls: Table I; Fig. 1

Copy to:
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TABLE I

Magnitude of Temperature Gradients During H-198 Temperature Test

Thermo-couple No.	Vibradamp First Case first hour	Vibradamp First Case average over 5 hrs (per hour)	Vibradamp Second Case first hour	Vibradamp Second Case average over 5 hrs (per hour)	Fiberglas First Case first hour	Fiberglas First Case average over 5 hrs (per hour)	Fiberglas Second Case first hour	Fiberglas Second Case average over 5 hrs (per hour)
	(All temperatures in degrees Fahrenheit)							
1	2	4	2	5	22	14	17	13
2	3	4	2	5	18	13	21	13
3	3	3	1	4	8	11	7	11
4	1	3	1	4	12	12	13	12
5	2	5	2	6	21	13	17	12
6	4	6	5	6	21	13	22	13
7	5	6	6	7	26	14	28	15
8	1	4	1	5	20	13	22	13
9	1	4	1	4	20	13	20	13

<u>NOTE</u>: Fiberglas first case, 11 pounds per cubic foot; second case, 13 pounds per cubic foot.

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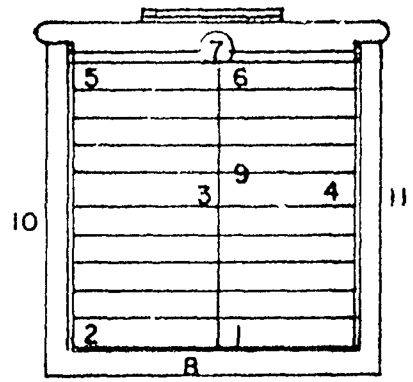
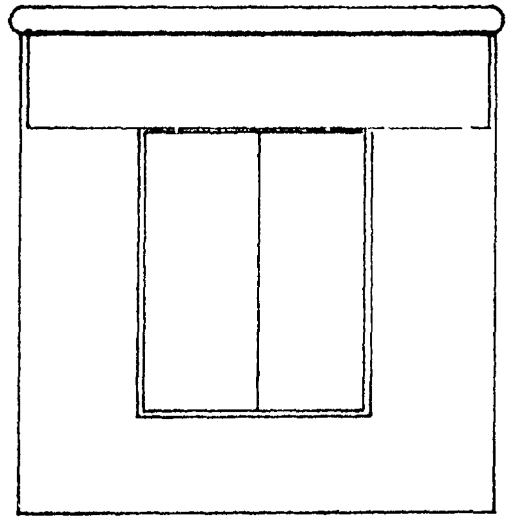


(a)
FIBERGLAS CASE



(b)
VIBRADAMP CASE

NUMBER	POSITION
1–6	IN THE ELECTROLYTE OF A DISCHARGED MC-271
7,8,9	ON THE SIDE OF THE BATTERIES
10,11	ON THE OUTSIDE OF THE CARRYING CASE

NOTE: THERMOCOUPLE POSITIONS FOR VIBRADAMP CASE SAME AS FOR FIBERGLAS CASE

FIG. 1 – THE H-198 TEST CARRYING CASES

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