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DATA REPORT NO. 82

INVESTIGATION OF THE FLAMMABILITY CHARACTERISTICS OF
INTERIOR MATERIALS FROM AN FAA, DC3 AIRCRAFT (N-7)

PROJECT NO. 503-301-05X

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Purpose

To determine the flammability characteristics of several interior materials removed from the cockpit and cabin areas of a Federal Aviation Administration, DC3 aircraft that crashed and experienced fire damage.

Background

Aircraft accident report N-70 NAR-111

In the early part of January 1971, a Federal Aviation Administration DC3 aircraft, N-7, crashed and caught fire while making an ILS approach to LaGuardia Airport, New York. As a result of the fire damage to the aircraft interior, the accident investigation group requested through the NAFEC Aviation Safety Officer, NA-304, that flammability tests on some of the interior materials salvaged from the accident be conducted at this activity. A list of the materials, their use and composition as near as can be determined, are contained in Table 1.

Test Procedure

There were two methods of testing used.

1. Federal Aviation Regulation (FAA), Part 25.853, Notice of Proposed Rule Making, August 1969. The test apparatus shown in Figure 1 was utilized for this test.

a. The test specimens were cut to size 3 by 12 inches as near as possible and conditioned for 24 hours at 70°F and 50-percent relative humidity.

b. The burner flame was adjusted to 1½ inches in height.

c. The specimen to be tested was taken from the conditioning chamber and clamped in the holder, placed inside the test cabinet, and hung vertically from a horizontal bar with the bar extended across the centerline of the cabinet and supported by the v-blocks at each end.

The specimen was positioned so that its edge was 3/4 inch directly above the center of the burner barrel. The burner was slid into position under the specimen to start the test.

d. Ignition time was measured from the instant the burner was placed under the specimen until the time the specimen began to flame.

e. The burner was removed from beneath the specimen after a 12-second exposure.

f. Total flaming time was measured from the instant flaming was observed until the time that flaming ceased.

g. Flame-out time was measured from the time the burner was withdrawn until the time the flame was self-extinguished or until the full length of the specimen was burned.

h. Glow time was measured from the instant flaming stopped until the time the specimen ceased to emit light.

i. Burn length is the distance from the original edge to the farthest point showing evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement.

j. Char length is the more severely damaged areas caused from burning and is determined by the portion of the specimen exhibiting total destruction of some part of the body or surface area of the material as evidenced by melting or carbon formation.

2. The "Horizontal Rate of Burning" test method is as specified in Flight Standards Service Release FSS No. 453 (November 1961) and the present Federal Aviation Regulation, Part 25.853 effective since October 1968. The test apparatus is shown in Figure 2.

a. The test specimens were cut for each sample to measure as near as possible 13½ by 3 inches and conditioned for 24 hours at 70°F and 50-percent relative humidity.

b. The burner flame was adjusted to 1½ inches in height.

c. The specimen was clamped in the holder and positioned inside the test cabinet with 3/4 inch of the flame directly below the starting edge of the specimen.

d. Ignition time, or the time for the material to start flaming, was measured from the instant the specimen was slid into position over the flame until the specimen started to flame.

e. Flaming time was measured from the time the flame front reached the start wire to the time the flame was self-extinguished or reached the stop wire (10 inches).

f. Burn length was measured from the start wire position. The specimens for which burning did not extend beyond the start wire (less than 1½ inches) is identified in the tabulation of the test data by the numeral I.

g. Burn rate was measured by dividing the burn length from the start wire to the point of self-extinguishment or to the stop wire by the flaming time between these points.

Test Results

There were two groups of materials received for testing. The first group was received with the original request for tests and is identified in Table 1 by an asterisk at the side of the material number. Because of the small amount of material received, it was decided to test these in accordance with the Notice of Proposed Rule Making, Federal Aviation Regulation 25.853b described as test method (1) under Test Procedure. The results of these tests are shown in Table 2. To satisfy the requirements set forth in this test method, the average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than 3 seconds after falling.

Only one of the five materials tested satisfied the requirements of this test method.

Because of the low number of acceptable materials found in the preceding tests, additional materials were requested and tested under the less severe test method (2) described in the test procedure. The results obtained from this series of tests are shown in Table 3. Although additional information relating to the burning characteristics of the materials tested is given in Table 3, the only requirement is that if the material is not self-extinguishing, the average burn rate must not exceed 4 inches per minute.

Summary of Tests

A review of the results of the tests in Table 2, tested in accordance with the Notice of Proposed Rule Making, Federal Aviation Regulation Part 25.853b, showed that:

1. Material Number 3, a wool upholstery, was the only material of the group that satisfied the requirements.

2. Material Number 7, cabin rug, was self-extinguishing within the allowable burn length limits but exceeded the 15-seconds flame-out time after removal of the burner. A heavy white smoke was produced from burning of the material.

3. Material Number 8, a curtain, was not of the required size for a valid test but burned rapidly and was not self-extinguishing.

4. Material Number 9, a latex foam seat cushion, was not of sufficient length for a test; however, the 4-inch-long sample that was tested burned completely, and the drippings continued to burn for over 6 minutes. A very heavy black, sooty smoke was produced from the burning of this material.

5. Material Number 10, a vinyl/cotton material, was not self-extinguishing and produced a smoke that was very irritating to the nose and throat.

The second group of materials tested under the less severe horizontal Test Method showed that:

1. There were three materials, Numbers 1, 2, and 3, that were self-extinguishing. Of these, three materials, two did not reach the start wire (burned less than 1.5 inches).

2. One material, Number 7, a rug, had a burn rate of less than 4 inches per minute. However, the surface of the material that would be exposed in use had already been burned as a result of the fire in the aircraft. Therefore, this was not considered to be a valid test.

3. Five materials, Numbers 4, 5, 6, 8, and 9, all exceeded the 4-inch-per-minute burn rate. Numbers 4 and 6 showed severe flashing on the vinyl surface and produced a smoke that was very irritating to the nose and throat. Number 5 continued to glow or smolder for 3.56 minutes after flaming had stopped. Dripping from material Number 8 fell to the floor and continued to burn for a period of time ranging from 1 to 5 seconds. The latex foam seat cushion melted rapidly and formed puddles on the floor of the test cabinet. These continued to burn for 4.98 minutes, and a very heavy black, sooty smoke resulted from the burning of this material.

The investigation of the materials taken from the DC3, N-7 showed that the flammability of many of the materials used in this aircraft exceeded the limits as defined in FSS Release 453 of 1961 or FAR 25.853 of August 1968.

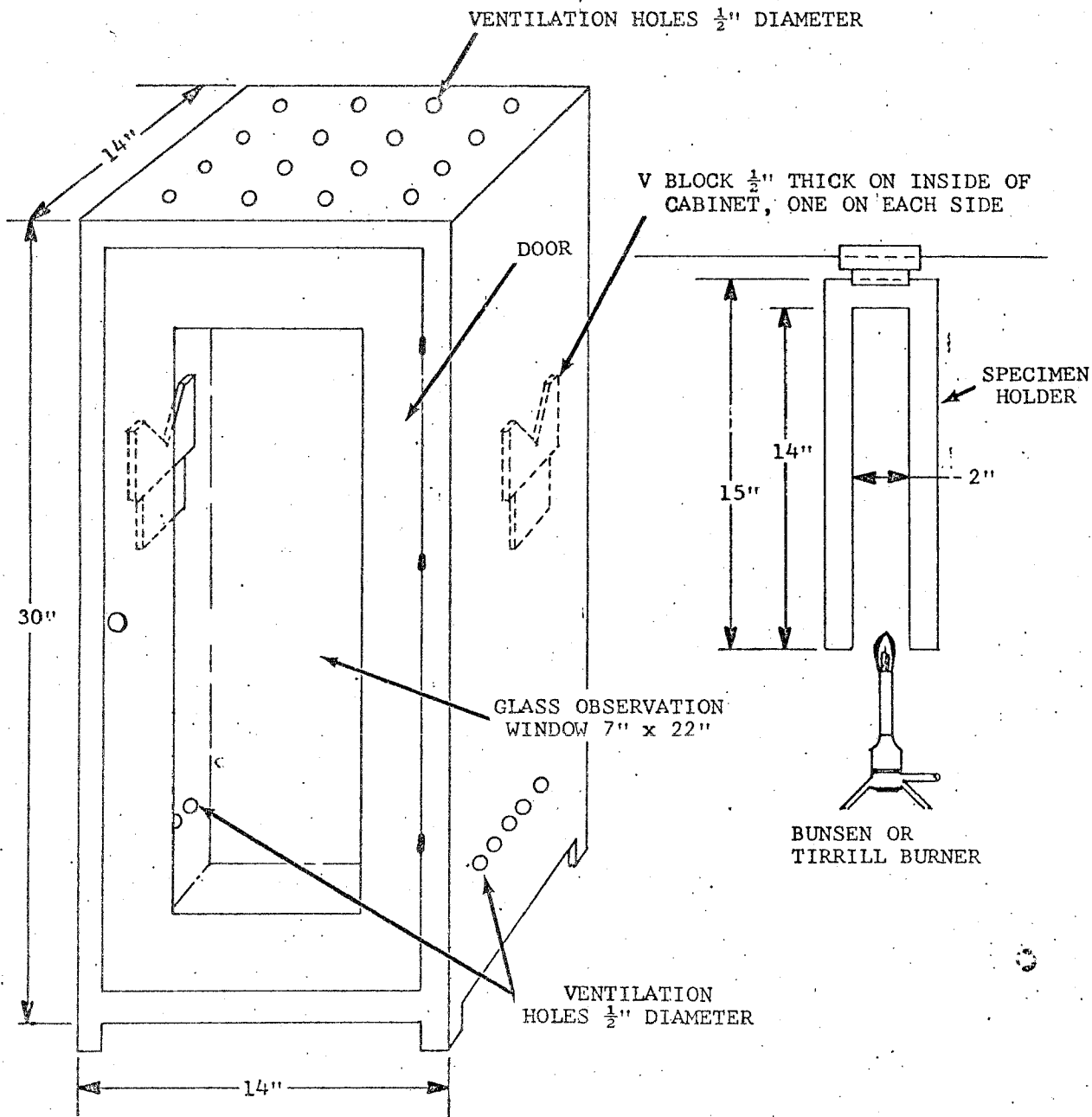


FIG. 1 VERTICAL RATE OF BURNING APPARATUS

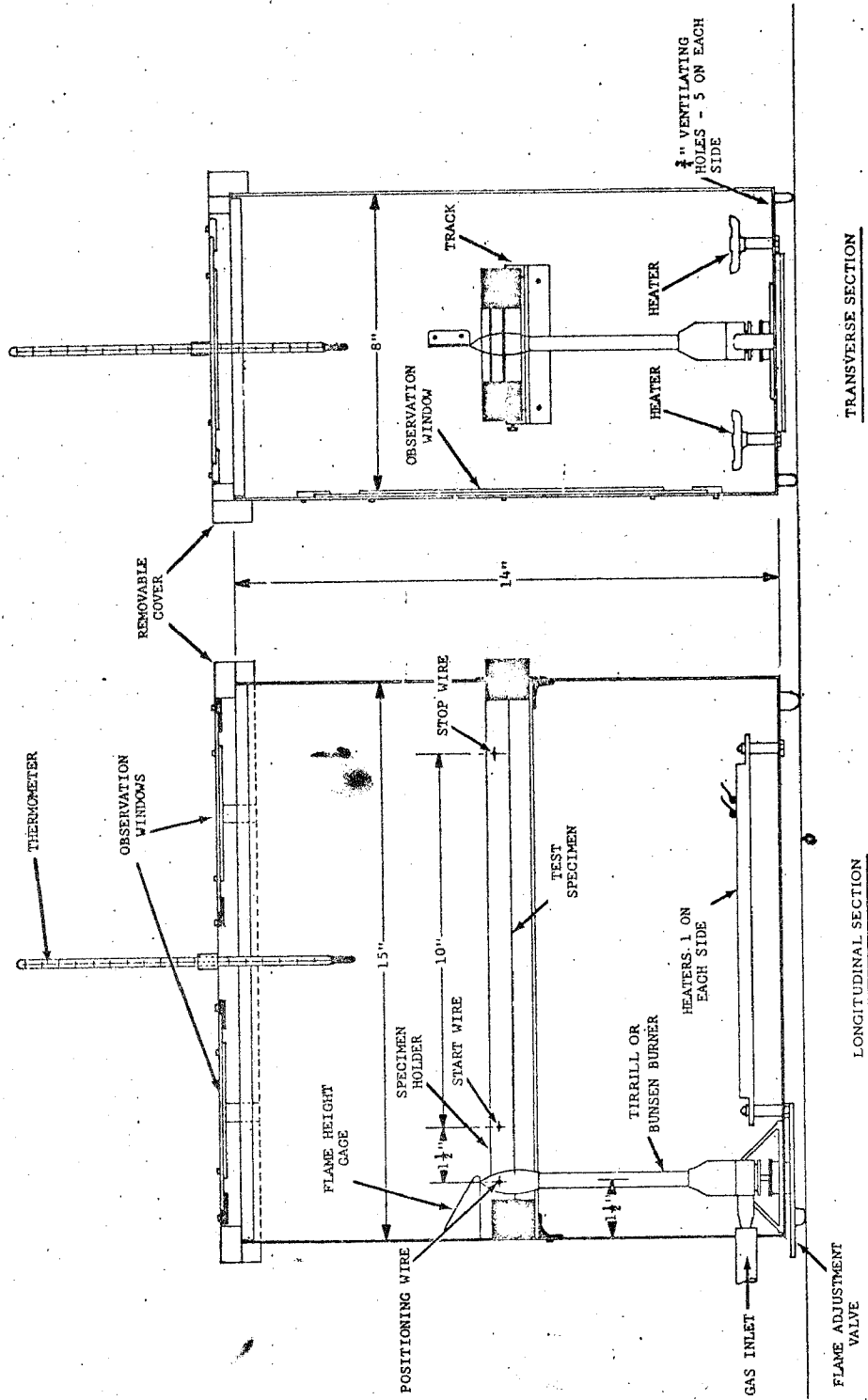


FIG. 2 HORIZONTAL RATE OF BURNING APPARATUS

TABLE 1.--MATERIAL DESCRIPTION

Material No.	Use	Thickness in.	Composition
1	Forward Cabin Ceiling	0.225	0.025-inch-thick perforated vinyl coated cotton fabric/0.175-inch-thick fiberglas insulation blanket/0.025-inch-thick cotton backing - (quilted together).
2	Forward Cabin Rug	0.030	Vinyl coated glass fabric.
3*	Cabin Seat Upholstery	0.050	Wool
4	Cabin Ceiling	0.023	Vinyl coated cotton fabric.
5	Cabin Seat Backing	0.035	Cotton
6	Cabin Side Wall	0.022	Vinyl coated cotton fabric.
7*	Cabin Rug	0.365	0.115-inch-thick rug of unknown material (badly burned) with a 0.250-inch-thick neoprene pad.
8*	Cabin Curtain or Drapery	0.035	Nylon blend.
9*	Seat Padding	0.500	Latex foam.
10*	Unknown	0.030	Vinyl coated cotton fabric.

* Materials in Group 1.

TABLE 2.--F.A.R., PART 25.853 NOTICE OF PROPOSED RULE MAKING VERTICAL TEST METHOD

Material No.	Ignition Time min	Total Flaming Time min	Flame-out Time Following 12- Second Burner Exposure min	Glow Time min	Burn Length in.	Char Length in.	General Remarks
3*	0.03	0.27	0.10	0.00	3.8	1.5	Material was self-extinguishing.
7	0.05	2.45	2.30	0.00	4.3	2.0	Self-extinguishing but not in allowable time limit. Heavy white smoke.
8	0.01	0.49	0.30	0.00	Com- plete	Com- plete	Sample not large enough for valid test (was only 1 inch wide by 8 inches long).
9	0.03	1.02	0.75	0.00	Com- plete	Com- plete	Very heavy smoke, material drips and continued to burn on floor for 6.03 minutes. Sample was only 1/3 the required size for a valid test.
10	0.01	1.07	0.88	0.00	Com- plete	Com- plete	Very heavy irritating smoke sample was only 7 inches long. Should have been 12 inches.

* Satisfies the test requirements.

TABLE 3.--F.A.R. PART 25.853 OCTOBER 1968 HORIZONTAL TEST METHOD

Sample No.	Ignition Time min	Flaming Time Measured from Start Wire min	Burn Length Measured from Start Wire in.	Burn Rate Measured from Start Wire in./min	General Remarks
1*	0.07 0.07 0.07	1.27 0.81 0.89	4.5 3.5 4.0	3.5 4.3 4.5	This material was self-extinguishing before reaching stop wire. Burn rate was measured from the surface covering. Insulation material was glass and burned only in the area of burner. Backing was protected by insulation and did not reach start wire.
2*	0.09 0.06	I I	I I	I I	Self-extinguishing before reaching start wire.
3*	0.12	I	I	I	Self-extinguishing, also passed vertical test requirements.
4	0.08 0.08	1.43 1.45	10 10	7 6.9	Flashing along vinyl surface, smoke was very irritating to the nose and throat.
5	0.05	2.31	10	4.3	Material continued to glow for 3.56 min after flaming stopped.
6	0.07 0.07	1.20 1.20	10 10	8.3 8.3	Severe flashing on vinyl surface, smoke was very irritating to the nose and throat.
7	0.06	11.33	10	0.9	Neoprene pad produced a heavy black, sooty smoke.

TABLE 3.--F.A.R. PART 25.853 OCTOBER 1968 HORIZONTAL TEST METHOD (Continued)

Sample No.	Ignition Time min	Flaming Time Measured from Start Wire min	Burn Length Measured from Start Wire in.	Burn Rate Measured from Start Wire in./min	General Remarks
8	0.08 0.08	1.22 1.27	10 10	8.2 7.9	Material melted and dripping continued to burn on floor from 0.02 to 0.09 minutes.
9	0.06 0.06	1.10 1.08	10 10	8.3 6.3	Drippings on the floor continued to burn for 4.98 minutes. Produced very heavy black, sooty smoke.

I - Burned less than 1½ inches (zero burn rate).

* - Satisfies the test requirements.