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DATA REPORT NO. 86

FLAMMABILITY AND SMOKE TESTS OF FAA AIRCRAFT
INTERIOR MATERIALS

PROJECT NO. 503-301-05X
Prepared by: E. B. Nicholas

Purpose

To determine the flammability characteristics of materials used in cabin and cockpit interiors of FAA aircraft for compliance with the Federal Aviation Regulation (FAR) Part 25.853, "Compartment Interiors."

Background

A group of materials removed from an FAA aircraft following a fire accident was recently tested and reported in Data Report No. 82 titled, "Investigation of the Flammability Characteristics of Interior Materials From an FAA DC-3 Aircraft (N-7)." As a result of the data obtained from these tests, which indicated for closer quality control by the user, Flight Standards Service, Aircraft Programs Division, Operations and Maintenance Branch (FS-743), supplied this facility with 32 additional materials representative of the type used in FAA aircraft. Flight Standards Service, FS-743, requested that these materials be tested for compliance with the Federal Aviation Regulation, Part 25.853. A list of the material specimens, their use and the FAR test requirements are contained in Table 1.

Test Procedure

The test criteria for showing compliance with the Federal Aviation Regulations are outlined in FAR, Part 25.853 effective since October 1968. The test methods used are contained in Federal Standard CCC-T-191b, Vertical Burn Test Method 5903 and Horizontal Rate of Burning Test Method 5906. These test methods are available

from the General Services Administration, Business Service Center, Region 3, Seventh and D Streets, S. W., Washington, D. C. 20407.

A description of the terminology, test equipment, and an explanation of the methods used for obtaining the data contained in Tables 2 and 3 are given in FAA Technical Report No. ADS-3 (AD600387), January 1964 and FAA Final Report No. NA-68-30, (ADS673084), July 1968. Copies of these reports are available from the National Technical Information Service, Springfield, Virginia 22151.

Smoke generation studies under flaming conditions were accomplished by using the test apparatus and procedures developed by the National Bureau of Standards and described in the Special Technical Publication STP No. 422 published in 1967 by the American Society for Testing and Materials (ASTM).

A description of the terminology, equipment, and an explanation of the methods used for determining the data and table headings, contained in Table 5, are included in FAA Final Report No. NA-68-36 (AD675513).

Discussion

Under the present requirements specified in Federal Aviation Regulation, Part 25.853, the materials and test methods are divided into two categories. Category (a) includes materials used for interior wall panels, interior ceiling panels, draperies, structural flooring, baggage racks, partitions, thermal insulation, and coated fabric insulation. This category must be self-extinguishing after flame removal, the average burn length may not exceed 8 inches when tested vertically and may not exceed 4 inches when tested horizontally. Category (b) includes all other materials not specified in Category (a) and must be at least flame resistant, determined by having an average burn rate not exceeding 4 inches per minute when tested horizontally (Method 5906).

Although smoke tests are not a requirement at the present time, but are being used in the selection of materials for the latest wide-bodied jet transport, smoke emission tests under flaming conditions were conducted on the material specimens in addition to the flammability tests, in anticipation of a forthcoming Notice of Proposed Rule Making, expected to be issued by the end of this year.

The test method used for smoke measurements has been recommended to the Federal Aviation Administration, Flight Standards Service for establishing standards governing the smoke-emission characteristics of aircraft interior materials.

Summary of Test Results

A tabulation of the flammability test results, given in Table 4, shows that 15 of the 32 material specimens tested meet all of the requirements specified in FAR, Part 25.853a and/or 25.853b.

As shown in Table 5, the first 26 specimens were tested to show their smoke emission characteristics. Eleven (11) of the 26 specimens meet the flammability requirements; however, 7 of the 11 acceptable material specimens have high maximum Specific Optical Density values (D_m over 200). Four (4) of these material specimens tested (Nos. 11, 15, 18 and 23) meet the flammability requirements and have low smoke emission values.

Materials Nos. 29, 30, 31 and 32 also meet the flammability requirements; however, there was not enough material to conduct smoke emission tests.

TABLE 1 MATERIAL IDENTIFICATION AND TEST REQUIREMENTS

Specimen No.	FS-743 Identification of Material, Use	Test Requirements			
		25. 853a		25. 853b	
		Vertical 8 inch burn	Horizontal 4 inch burn	Vertical 8 inch burn	Horizontal 4 in/min
1	Bulkhead, cabin and lavatory door panels	X	X		
2	Removable bulkhead panels	X	X		
3	Insert material for all seats				X
4	Bulkhead panels, doors, cockpit seats		X		X
5	Cockpit seats, console chairs				X
6	Bulkhead and door panels	X	X		
7	Floor board padding				X
8	Chair covers				X
9	Scuff pad on cockpit panels	X	X		
10	Seats (ticking)				X
11	Control surface covers				X
12	Smoke mask bags	X	X		
13	Upholstery, lower sidewall covering	X	X		X
14	Cabin, picture window and night curtains	X	X		X
15	Bags for night curtain and tiedown straps				X
16	Seat padding				X
17	Cockpit, cabin and lavatory insulation	X	X		
18	Seat panels, padding				X

TABLE 1 MATERIAL IDENTIFICATION AND TEST REQUIREMENTS (Continued)

Specimen No.	FS-743 Identification of Material, Use	25, 853a		25, 853b	
		Vertical 8 inch burn	Horizontal 4 inch burn	Vertical 8 inch burn	Horizontal 4 in/min
19	Cockpit and passenger chairs (ticking)				X
20	Floor board and heat duct covering	X	X		X
21	Upper sidewall and ceiling covering	X	X		
22	Pitot covering, survival kits				X
23	Certificate holder	X	X		X
24	Aluminum foil with adhesive backing	X	X		
25	Chair padding				X
26	Padding used on some passenger seats				X
27	Removable bulkhead door seal	X			
28	Removable bulkhead door weather strip	X			
29	Airstrain beading around door	X			
30	Shoulder harness				X
31	Tie down straps				X
32	Pilot and copilot seat belt and shoulder harness				X

TABLE 2 FLAMMABILITY TEST RESULTS
VERTICAL TEST METHOD 5903

Specimen No.	Flame-out time after .20 min burner exposure (min)	Glow Time (min)	Char Length (in)	Burn Length (in)	Remarks
1	2.88	2.42	12	12	2 in flame jets emitted from specimen
2	6.77	1.99	12	12	Flames reached top of test chamber (18")
3	0.55	0.56	12	12	
5	0.13	0.00	3.5	4.5	
6	5.31	60.0+	8.6	12.0	
7	0.00	0.00	0.5	1.5	
8	0.10	0.10	1.5	2.5	
9	0.06	0.00	0.6	1.1	
11	0.41	0.00	4.7	5.1	Dripping continues to burn for .3 min
12	0.37	0.00	4.9	7.4	Flashing caused flames to go out
13	0.84	0.00	12.0	12.0	
14	1.17	0.00	12.0	12.0	Dripping on floor continues to burn for .05 min
15	0.06	0.00	5.3	6.3	Melts and drips to floor but does not flame
16	2.4	0.00	12.0	12.0	
17	0.00	0.00	0.4	0.6	
18	0.30	0.80	12.0	12.0	
19	0.77	5.11	12.0	12.0	
20	0.03	0.00	1.6	3.3	
21	0.71	0.00	12.0	12.0	Heavy flashing

TABLE 2 FLAMMABILITY TEST RESULTS (Continued)
VERTICAL TEST METHOD 5903

Specimen No.	Flame-out time after .20 min burner exposure (min)	Glow Time (min)	Char Length (in)	Burn Length (in)	Remarks
22	0.06	0.00	1.7	3.9	
23	0.00	0.00	3.6	4.7	
24	1.05	0.00	12.0	12.0	Adhesive material only burned
25	0.13	0.00	12.0	12.0	Drippings continued to burn on floor
26	0.00	38.00	12.0	12.0	Completely consumed for smoldering, no flame
27	1.18	0.00	12.0	12.0	Drippings continued to flame on floor (.15 min)
28	1.59	0.00	12.0	12.0	Melting, drops on floor continued to burn (.55 min)
29	1.46	0.67	1.0	2.3	
30	1.38	0.00	4.2	4.2	
31	2.25	0.00	3.5	3.5	Melts, drops on floor continued to burn (.15 min)
32	3.77	0.00	8.0	8.0	Melts, drops on floor continued to burn (.44 min)

TABLE 3 FLAMMABILITY TEST RESULTS
HORIZONTAL TEST METHOD 5906

Specimen No.	Ignition Time (min)	Burn length measured from start wire (in)	Flame time measured from start wire (min)	Burn Rate (in/min)	Remarks
1	0.11	I		0	
2	0.18	I		0	
3	0.03	10.0	1.59	6.3	
4	0.04	10.0	1.51	6.6	Flashing on face side of material
5	0.05	I		0	
6	0.32	10.0	16.02	0.6	
7	0.00	I		0	Material melted away from flame, did not burn
8	0.15	I		0	
9	0.14	I		0	
10	0.03	10	1.49	6.7	
11	0.00	I		0	Material melted away from flame, did not burn
12	0.05	I		0	
13	0.03	10.0	1.17	8.5	
14	0.04	10.0	1.08	9.3	Melts, continued to burn on floor (0.06 min)
15	0.04	0.5	0.26	1.9	
16	0.02	10.0	2.42	4.1	Drops on floor continued to burn for .6 min
17	0.00	I		0	
18	0.02	10.0	1.13	8.8	Face material burns ahead of backing

TABLE 3 FLAMMABILITY TEST RESULTS (Continued)
HORIZONTAL TEST METHOD 5906

Specimen No.	Ignition Time (min)	Burn length measured from start wire (in)	Flame time measured from start wire (min)	Burn Rate (in/min)	Remarks
19	0.06	10.0	2.26	4.4	
20	0.05	I		0	
21	0.04	10.0	1.59	6.3	
22	0.07	I		0	
23	0.08	0.2	0.26	7.6	
24	0.08	I		0	
25	0.03	10.0	1.04	9.6	Drops continued to burn on floor for .8 min
26	0.04	10.0	II		Continued to smolder until complete specimen was consumed, did not flame
29	0.04	I		0	
30	0.11	0.2	1.19	.16	
31	0.16	I		0	
32	0.15	7.0	5.87	1.2	Melts, drops on floor continued to burn for 1.0 min

I Burned less than 1-1/2 inches (zero burn rate time).

II Flame-out time before reaching start wire (1-1/2 inches), smoldering continued until specimen was completely consumed.

TABLE 4 FLAME TEST RESULTS SUMMARY

FAR Requirement

Specimen No.	25.853(a)		25.853(b)	Meets all FAR Requirements
	Vertical 8 in. burn length	Horizontal 4 in. burn length	Horizontal 4 in/min burn rate	
1	No	Yes		No
2	No	Yes		No
3			No	No
4		No	No	No
5			Yes	Yes
6	No	No		No
7			Yes	Yes
8			Yes	Yes
9	Yes	Yes		Yes
10			No	No
11			Yes	Yes
12	Yes	Yes		Yes
13	No	No	No	No
14	No	No		No
15			Yes	Yes
16			No	No
17	Yes	Yes		Yes
18			No	No
19			No	No
20	Yes	Yes	Yes	Yes
21	No	No		No
22			Yes	Yes
23	Yes	Yes	Yes	Yes
24	No	Yes		No

TABLE 4 FLAME TEST RESULTS SUMMARY (Continued)

Specimen No.	FAR Requirement			Meets all FAR Requirements
	25.853(a) Vertical 8 in. burn length	Horizontal 4 in. burn length	25.853(b) Horizontal 4 in/min burn.rate	
25			No	No
26			No	No
27	No			No
28	No			No
29	Yes	Yes		Yes
30			Yes	Yes
31			Yes	Yes
32			Yes	Yes

TABLE 5 SMOKE DENSITY MEASUREMENTS - ASTM TEST METHOD STP NO. 422

Specimen No.	Time to reach $D_s = 16$ (min)	D_m Corrected	Time to reach D_m (min)	Specific optical density D_g after 1.5 min	Remarks
1	3.9	55.3	12.7	13.9	
2	5.2	86.8	14.8	2.3	
3	0.3	104	3.8	92.4	
4	0.2	191	1.7	197	
5 ⁽¹⁾	0.2	309	1.7	321	High flames, reached D_m rapidly
6	3.0	121	13.2	1.9	
7 ⁽¹⁾	1.0	351	3.8	87.8	Material shrunk from specimen holder
8 ⁽¹⁾	0.2	291	3.5	254	
9 ⁽¹⁾	1.5	371	6.8	15.6	Large blisters developed on specimen
10	DNR ⁽²⁾	9.6	12.0	2.9	
11	DNR	15.3	13.2	6.6	
12 ⁽¹⁾	0.2	217	1.8	207	High flames, reached D_m rapidly
13	0.2	132	4.5	116	
14	9.9	32.6	19.8	3.5	

TABLE 5 SMOKE DENSITY MEASUREMENTS - ASTM TEST METHOD STP NO. 422 (Continued)

Specimen No.	Time to reach $D_s = 16$ (min)	D_m Corrected	Time to reach D_m (min)	Specific optical density D_s after 1.5 min	Remarks
15	17.0	16.8	18.5	1.4	
16	0.1	356	1.3	379	
17	DNR	1.7	16.8	0.7	
18	DNR	3.9	7.7	1.2	
19	DNR	4.5	7.5	1.9	
20 ⁽¹⁾	0.2	250	1.5	256	High flames, reached D_m rapidly.
21	0.3	142	4.7	127	
22 ⁽¹⁾	0.3	323	2.3	296	High flames
23	0.3	78.4	9.8	34.1	
24	13.4	40.8	19.2	0	Became very sooty after aluminum burnt away
25	2.1	44.1	11.0	8.8	
26	DNR	7.3	6.0	0.4	

(1) Specimens meet FAR Requirements but have a high specific optical density value (i. e., 200+)

(2) DNR - did not reach $D_s = 16$