technical note technical note

Burning Behavior Within a Seat Armrest Cavity

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16. Abstract

The purpose of this technical note is to document the results of fire tests conducted to examine the characteristics of fire that may occur in the cavity of an aircraft seat armrest and the fire-containment capability of the cavity. In all the tests conducted with actual seat armrests, the fire self-extinguished, the armrest materials did not ignite, and the fire was contained within the armrest cavity.

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INTRODUCTION

This technical note documents the results of fire tests conducted to examine the characteristics of fires that may occur in the cavity of an aircraft seat armrest and the fire-containment capability of the cavity.

BACKGROUND.

Combustible material consisting of gum wrappers, napkins, and other paper products have been found in the armrest cavity of aircraft seats. The presence of electrical wiring in the cavity is a potential source of ignition. Thus, an electrical arc or spark may initially start a fire involving the paper products found in the armrest cavity. A concern has been raised to whether or not this type of fire would spread to cavity materials and become a fire hazard, depending on the ventilation provided in the cavity.

DISCUSSION

TEST ARTICLE.

A series of fire tests were conducted in three test articles. The first series of tests were conducted in a metal box constructed to simulate an armrest and tray stowage area. The physical size and volume was slightly larger than a typical armrest with tray storage area. The second series of tests were conducted in armrests removed from surplus aircraft seats obtained by Airport and Aircraft Safety R&D Division at the William J. Hughes Technical Center for fire tests. The third series of tests were conducted in an armrest furnished by a major seat manufacturer through the Transport Airplane Directorate.

TEST PROCEDURE.

In each of the tests, crumpled paper products were placed in the armrest cavity and ignited with a paper match. The burning behavior was observed visually and by a thermocouple that was placed within the cavity.

METAL BOX. Test nos. 1 through 4 were completed using a metal box simulating a typical passenger seat armrest containing a service tray.

Test no. 1 used the box without the lid in place (figure 1). The fuel load was one-half sheet of newspaper to create a worst-case scenario. The starting temperature was 70°F, and the maximum temperature reached 265°F as the newspaper burned. Practically all of the newspaper was consumed in the open cavity.

Test No. 2: The same scenario as test no. 1 was employed with a lid placed on the box immediately after ignition (figure 2). The starting temperature was 69°F. At 31 seconds, the maximum temperature was 296°F and the fire self-extinguished with only partial burning of the paper. The quantity of paper consumed was significantly less than in test no. 1, likely due to oxygen starvation.

Test No. 3: The same fire load was used as in test nos. 1 and 2. The box had three 3/8″ holes in the lid and three 3/8″ holes in the base of the box. This would simulate air leakage into the armrest compartment. The starting temperature was 70°F, and at 13 seconds, the maximum temperature was 276°F. The lid was removed at 1 minute 22 seconds. There was no flaming present. The temperature decreased to 97°F and a considerable amount of unburned paper was still in place.

Test No. 4: The same fire load and the same box with holes in the top and bottom were used as in test 3. The start temperature was 82°F, reaching 390°F at 15 seconds and 254°F at 30 seconds. The lid was removed at 30 seconds, much earlier than in test no. 3 to observe the conditions inside the cavity. A flame-up occurred, indicating oxygen replenishment, and the lid was placed back on the box, extinguishing the fire.

The tests conducted in a metal box used an oversized fire load to simulate a worst-case condition and a generous quantity of available air. In the closed lid tests, the fires self-extinguished due to oxygen starvation with a substantial quantity of the paper left unburned.

SURPLUS ARMRESTS. Test nos. 5 through 8 were completed using surplus armrests removed from aircraft seats. The surplus armrests did not have any large air gaps. Although the lid fit was loose, it did not provide a source for air circulation inside the cavity.

Test No. 5: The fire load was one-quarter sheet of newspaper. The temperature at the start of the test was 72°F. A maximum temperature of 1015°F occurred at 50 seconds, apparently due to flame contact with the thermocouple. At 3 minutes 30 seconds, the temperature had decreased to155°F. The plastic sides of the armrest sustained severe melting damage, but did not ignite.

Test No. 6: The fire load was one-quarter sheet of newspaper. The temperature at the start of the test was 68°F; at 15 seconds, the temperature was 184°F. The lid was removed at 40 seconds and the fire had self-extinguished.

Test No. 7: The fire load was the same as test nos. 5 and 6. The passenger tray was in place for this test. The maximum temperature was 179°F. At 60 seconds, the lid was removed and the fire had self-extinguished.

Test No. 8: An actual arm section was used with a fire load of one-eighth sheet of newspaper on each side of the tray. At 33 seconds, the temperature was 890°F. At this point, the temperature oscillated until reaching the maximum temperature of 1078°F at 1 minute 30 seconds. The temperature then decreased steadily. At 2 minutes, the fire had self-extinguished, leaving some unburned paper.

In all of the tests with surplus armrests, the fires self-extinguished and the armrest material melted, but never ignited. When the lid was opened, in some of the tests, embers were observed on the paper but no flames were present.

ARMREST FROM TRANSPORT AIRPLANE DIRECTORATE (figure 4). Test nos. 9 through 12 were completed using an armrest supplied by the Transport Airplane Directorate with a fabric bag in the bottom of the cavity. The armrest had three 3/8-inch-diameter holes in the inner thermoplastic siding. The inner side had additional exposure which was covered by a fire-resistant cloth bag inside the armrest cavity.

Test No. 9: A fire load consisting of seven paper towels was used, which perhaps was more realistic to find in the cavity than newspaper. The start temperature was 77°F, and at 40 seconds, the temperature was 290°F. The armrest lid was opened at 2 minutes and only glowing embers were observed. At 4 minutes, the temperature had decreased to 110°F.

Test No. 10: In this test, the paper towel load was concentrated forward near the seat control panel. The start temperature was 80°F, and the temperature reached 500°F at 15 seconds, but decreased rapidly after 20 seconds. At 5 minutes, the temperature was 110°F and only glowing embers were observed.

Test No. 11: This test was a repeat of test no. 10. The start temperature was 85°F, reaching 110°F at 15 seconds, and then decreased. The results were similar to test no. 10.

Test No. 12: In the final test, the fire load consisting of seven paper towels was placed in the center section of the armrest cavity. After 30 seconds, the temperature was 350°F, decreasing to 165°F at 2 minutes. At 5 minutes, the fire had self-extinguished, terminating the test.

The armrest provided by the Transport Airplane Directorate had a cloth bag in the bottom of the cavity. The bag was fire resistant and sustained virtually no burn damage during the four tests.

SUMMARY

In all of the tests conducted with actual seat armrests, the fire self-extinguished, the armrest materials did not ignite, and the fire was contained within the armrest cavity. Significant portions of the paper fire load were unburned, indicating that the fire self-extinguished due to oxygen starvation. The test results indicated that a fire originating in the cavity of a seat armrest is not a fire hazard irrespective of the ventilation provided in the cavity.

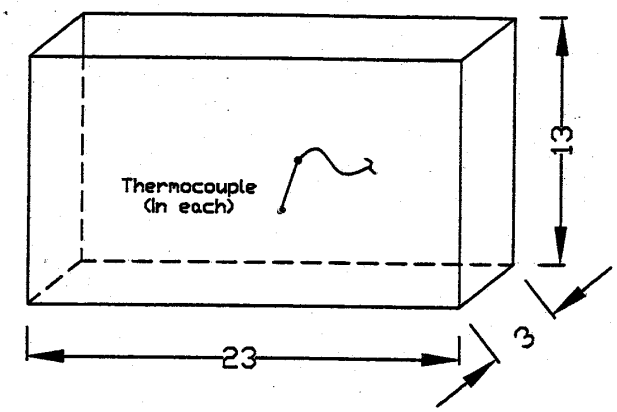

FIGURE 1. OPEN BOX

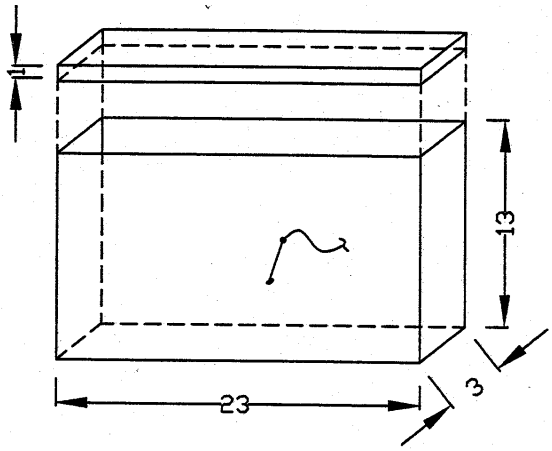

FIGURE 2. BOX WITH LID

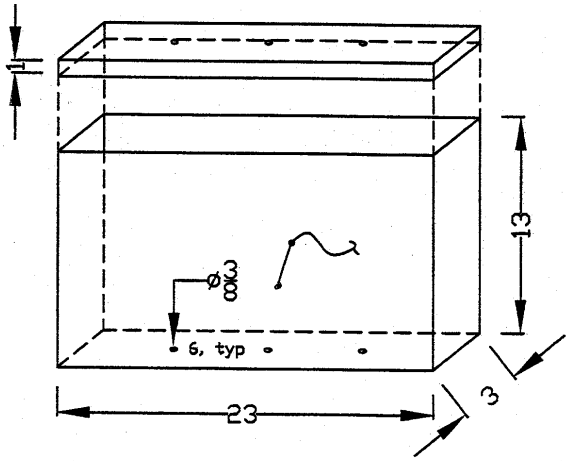

FIGURE 3. BOX WITH LID, HOLES IN BOTH

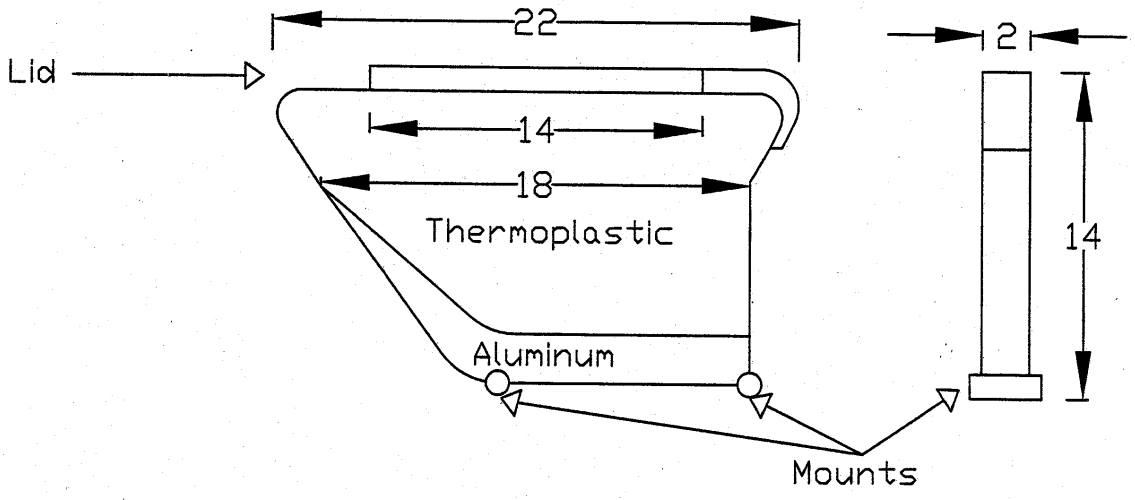

FIGURE 4. TYPICAL ARMREST