The Cleveland Aircraft Fire Tests

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On June 30 and July 1, 1966, tests were conducted to evaluate high expansion foam's ability to extend the time for which an aircraft passenger cabin environment would remain survivable during a post-crash fire. While some results tend to confirm those of similar tests, others may shed new light on the problem.

THE Cleveland tests were conducted to determine if survival time in an aircraft cabin could be extended under post-crash fire conditions by using high expansion foam to completely fill the occupied portions of the cabin interior. It was believed that the high expansion foam would hold the temperature within survivable limits while controlling smoke, toxic gases, and other products of combustion, thus providing a cool, breathable atmosphere for a prolonged period of time for the occupants, pending ultimate evacuation or rescue.

A secondary objective was to determine the composition of the smoke, gases and other products of combustion or pyrolysis that may be present in a post-crash fire in which typical modern aircraft cabin materials such as vinyl, polypropylene, polyvinyl chloride, etc., and plastics are involved in the fire.

The tests were only to prove the concept, since the foam equipment used was "off the shelf" hardware, and not suitable for use as an "on board" system.

THE AIRCRAFT

Two North American AJ-2P patrol bombers were used in an all-gear-up landing configuration with the wings level. The center section (bomb bay) of each aircraft was fitted out to represent, as closely as possible, the insulation and interior of a typical commercial aircraft passenger cabin. The cabin mock-up section measured approximately 5 ft wide, 5½ ft high, and 14¾ ft long. Fibrous glass insulation (approximately 3 in. thick) with a resin binder and an aluminum-colored plastic skin was installed in the sidewalls and ceiling. Interior finish panels were vinyl-coated Dynel* fabric, fibrous glass sheet, vinyl-coated Dynel fabric bonded to sheet aluminum, and vinyl-coated fibrous glass with vinyl foam padding.

*Trade name of the Union Carbide Corporation.
forward and aft bulkheads of the cabin section were honeycomb panels. The forward bulkhead panels had a resin-impregnated paper core; the aft, aluminum-cored. Plastic sheets were bonded to the honeycomb panel. Twelve complete seat cushions and backs were suspended from steel wires in the cabin. Half of the cushions were latex foam, and the remainder were urethane foam. The floor was covered with carpeting composed of a polypropylene pile with a jute base and polyethylene back. The total weight of cabin materials and insulation was 238 1/4 lbs per airplane.

**INSTRUMENTATION AND TEST SETUP**

Ten thermocouples were located at floor level, seat back height, and ceiling level in the cabin mock-up section, and two, at the high point of the aircraft beneath the cockpit canopy (see Figure 1). Eight thermocouples had simple metallic tubing shields, and four were completely shielded in blackened copper spheres. All thermocouples were connected to multi-point or single-point Honeywell recorders to provide a constant temperature record throughout the test period. The thermocouple series designated TA were assigned three alternating channels each, and the thermocouple series designated TS and TR were assigned six alternating channels, each to provide closely spaced recording points.

![Diagram of thermocouple locations](image)

- TR1 & TA1 — Cockpit, pilot’s head
- TR2 & TA2 — Center cabin, 3 in. below ceiling, centerline
- TR3 & TA3 — Rear of cabin, 3 in. above floor, port side
- TR4 & TA4 — Center cabin, head high sitting position, centerline
- TS5 — Center seat, 4th row, head high sitting position, centerline
- TS6 — Forward bulkhead, 6 in. below ceiling, 1 ft inboard port side
- TS7 — Forward bulkhead, 3 in. above floor, 1 ft inboard port side
- TS8 — Center cabin, 2 in. below ceiling, centerline

*Figure 1. Thermocouple locations for Cleveland fire tests.*

It was deemed desirable to obtain data on smoke density in the cabin area as a function of time. Two detectors were used in each aircraft for this purpose. In each case, one detector was suspended about 6 in. from the ceiling, and the other about 20 in. from the ceiling. The suspension