5th Triennial International Fire and Cabin Safety Research Conference

Effectiveness of Handheld Extinguishers Against Hidden Fires in the Cabin Overhead Areas of Transport Aircraft

Presented to: Session on Materials Fire Safety

By: Tim Marker, FAA Technical Center

Date: October 31, 2007

Federal Aviation Administration

NTSB review of crew actions during inflight fires has resulted in a series of recommendations calling for improved crew training and modification of cabin interiors to improve access to fires burning behind panels.

Incidents Reviewed by NTSB Included:

Delta Flight 2030, MD-88, emergency landing at Cincinnati, Sept 17, 1999
Flight attendant discharged halon extinguisher into return grills to extinguish fire.

AirTran Flight 913, DC-9-32, emergency landing at Greensboro Aug 8, 2000
Electrical fire in cockpit bulkhead, no attempt made by flight attendants to extinguish fire.

American Flight 1683, MD-80, emergency landing at Dulles Nov 29, 2000
Lightening strike induced arcing above cabin ceiling. Halon extinguisher discharged into access hole cut with pocketknife, extinguishing fire.

Air Canada Flight 797, DC-9, emergency landing at Cincinnati June 2, 1983
Fire in aft lavatory behind sidewall, eventually destroyed aircraft, 23 fatalities.

Fire in Hidden Area Below Cabin Floor (Cheek)

Delta Flight 2030, MD-88, emergency landing at Cincinnati, Sept, 1999 F/A discharged halon extinguisher into return grills to extinguish fire.

Fire in Hidden Area Outboard of Cargo Comp (Cheek)

Delta Flight 2030, MD-88, emergency landing at Cincinnati, Sept, 1999 F/A discharged halon extinguisher into return grills to extinguish fire.

Fire in Bulkhead, Spread to Area Above Cabin Ceiling (Overhead)

AirTran Flight 913, DC-9-32, emergency landing at Greensboro Aug 8, 2000 Electrical fire in cockpit bulkhead, no attempt made by flight attendants to extinguish fire.

Fire in Bulkhead, Spread to Area Above Cabin Ceiling (Overhead)

Fire in Bulkhead, Spread to Area Above Cabin Ceiling (Overhead)

Fire in Cheek Area, Spread to Area Above Cargo Compartment

Fire in Cheek Area, Spread to Area Above Cargo Compartment

Fire in Cheek Area, Spread to Area Above Cargo Compartment

Fire in Hidden Area Above Cabin Ceiling (Overhead)

American Flight 1683, MD-80, emergency landing at Dulles Nov 29, 2000
Lightening strike induced arcing above cabin ceiling. Halon extinguisher discharged into access hole cut with pocketknife, extinguishing fire.

AAL N3507A
DC9-82 11/30/00

Fire in Hidden Area Above Cabin Ceiling (Overhead)

Fire in Hidden Area Below Cabin Floor (Cheek)

Delta Flight 15, L-1011, Frankfort to Atlanta Mar 17, 1991. Diverted to Goose Bay, Canada due to hidden fire below cabin floor. Halon extinguisher discharged into return air grille, extinguishing fire.

What is Common Denominator?

Accessibility of Fire

New Recommendations for 2002

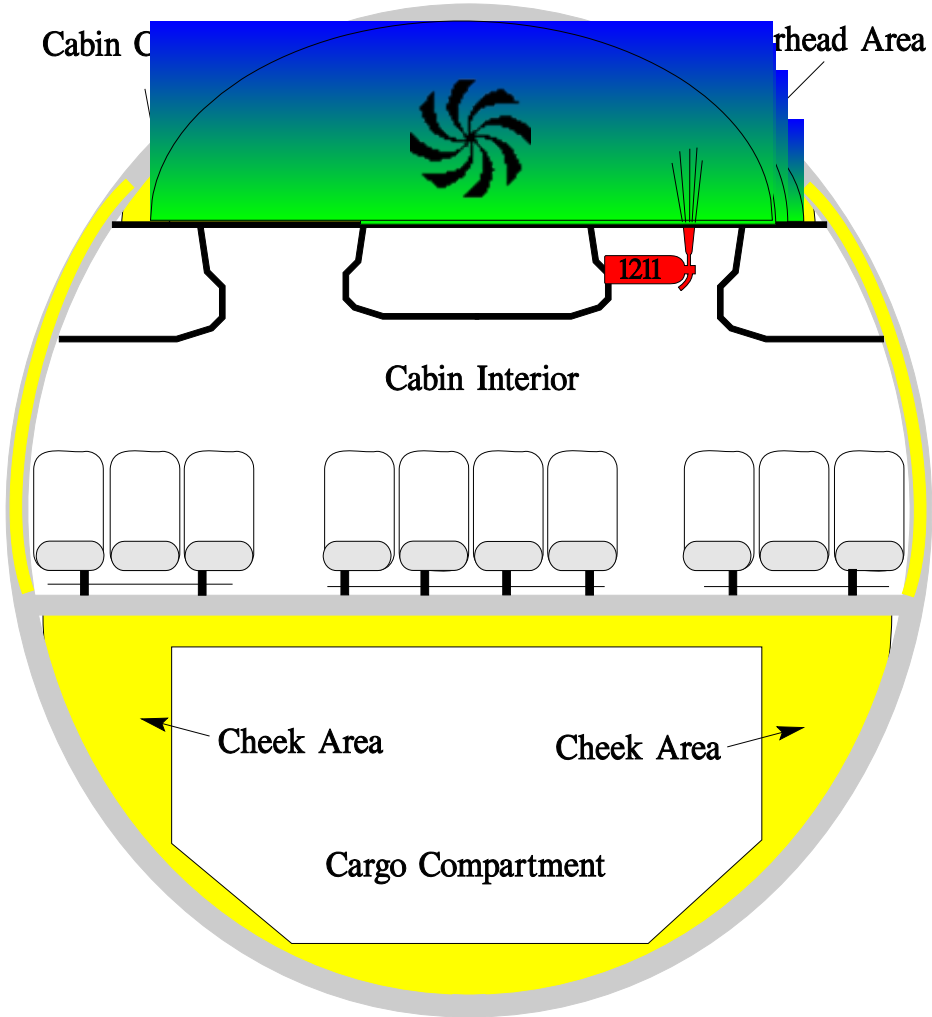
(A-01-83) Issue Advisory Circular (AC) that describes the need for crewmembers to take immediate and aggressive action in response to signs of an inflight fire.

(A-01-84) Require principal operations inspectors to ensure that the contents of the advisory circular are incorporated into crewmember training programs.

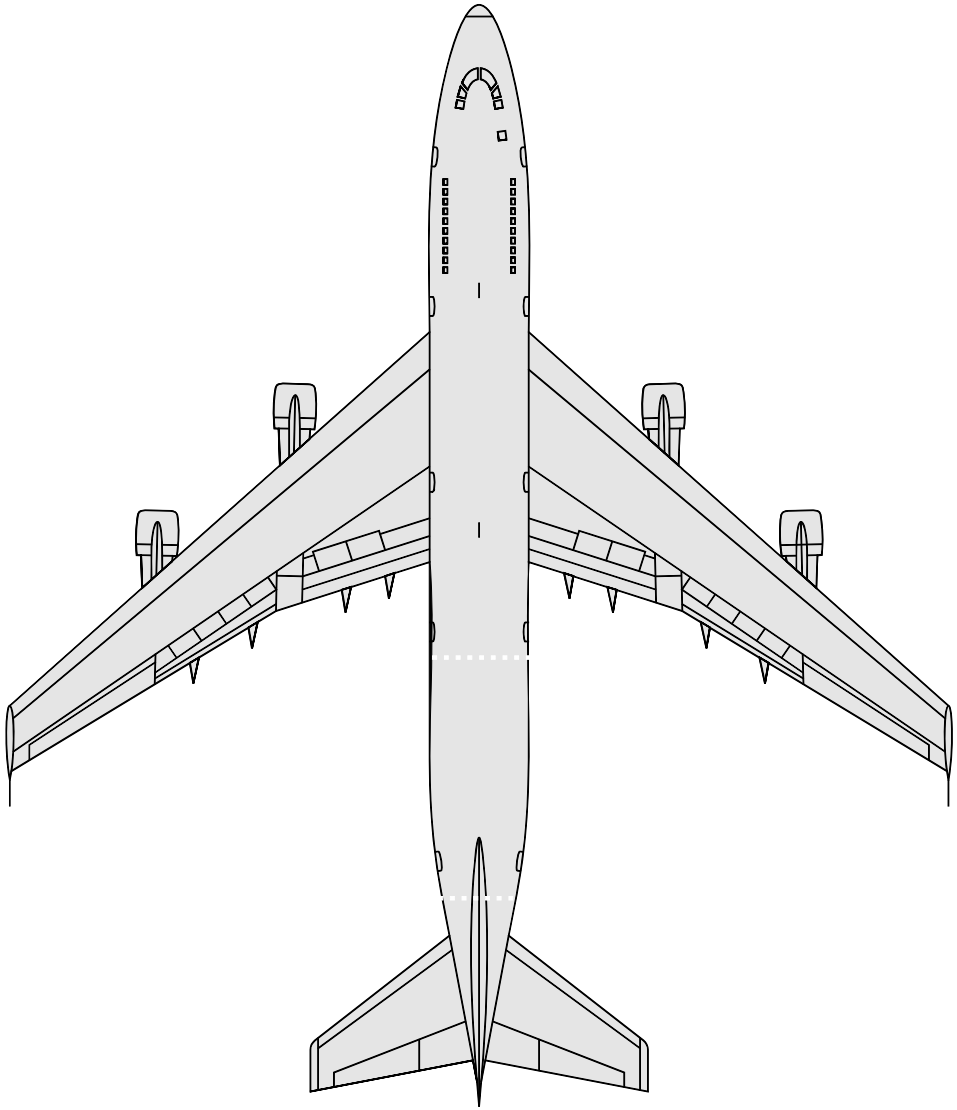
(A-01-85) Amend Part 121.417 to require participation in firefighting drills that involve actual or simulated fires during crewmember recurrent training and to require that those drills include realistic scenarios on recognizing potential fire situations, locating the origin of the fire, and fighting hidden fires.

(A-01-86) Develop and require implementation of procedures or airplane modifications that will provide the most effective means for crewmembers to gain access to areas behind interior panels for the purpose of applying extinguishing agent to hidden fires. As part of this effort, the FAA should evaluate the feasibility of equipping interior panels of new and existing planes with ports, access panels, or some other means to apply extinguishing agent behind interior panels.

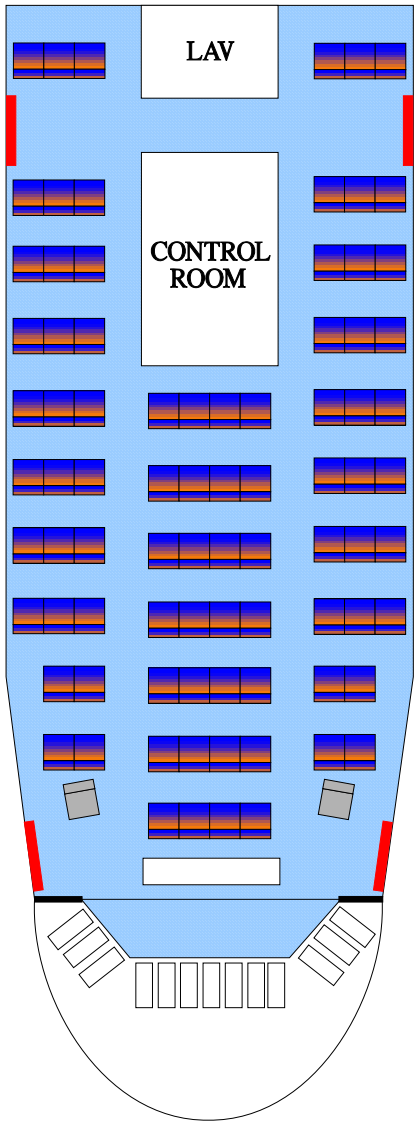
Effectiveness of Handheld in Widebody Overhead Area



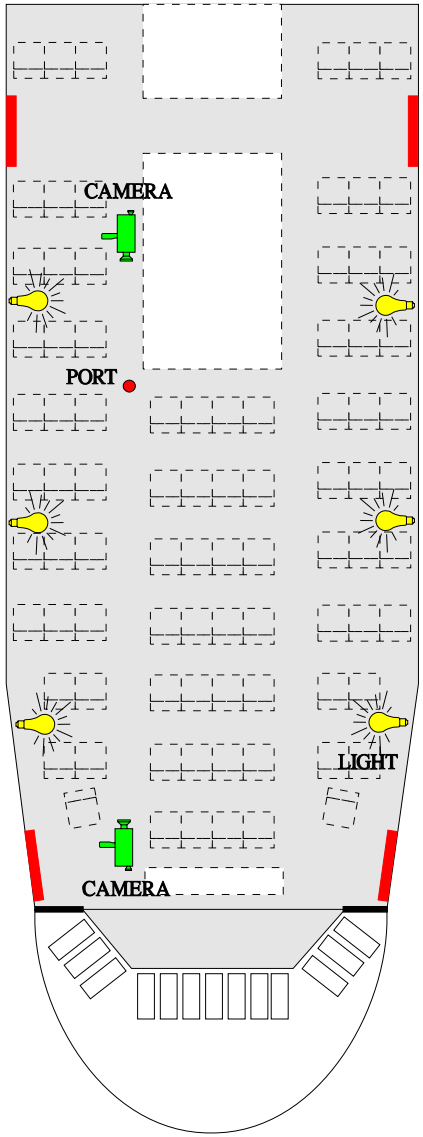
747SP Test Article



747SP Test Section



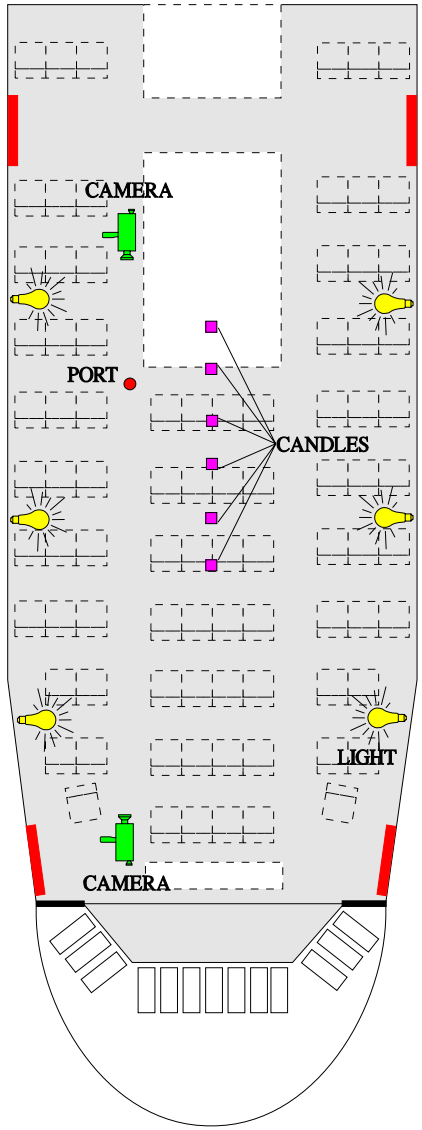
747SP Overhead Section



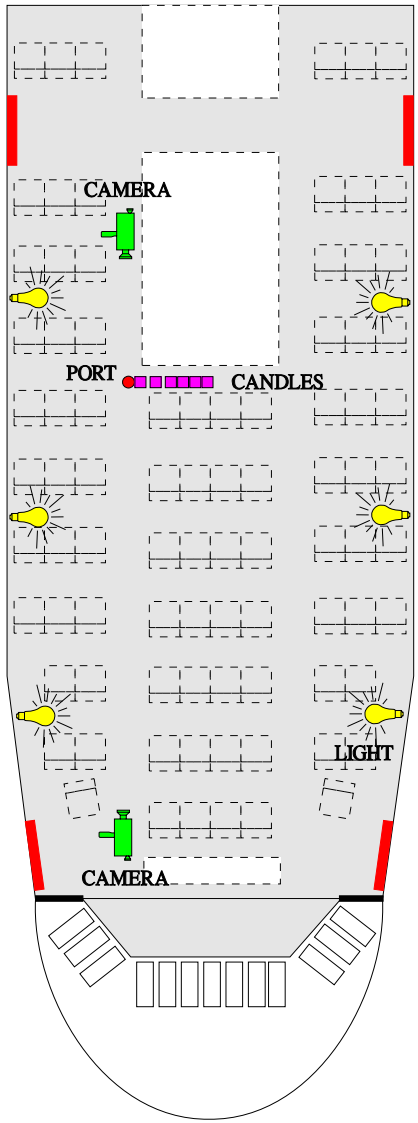
Overhead Area of 747SP

Candle Lantern Used in Testing

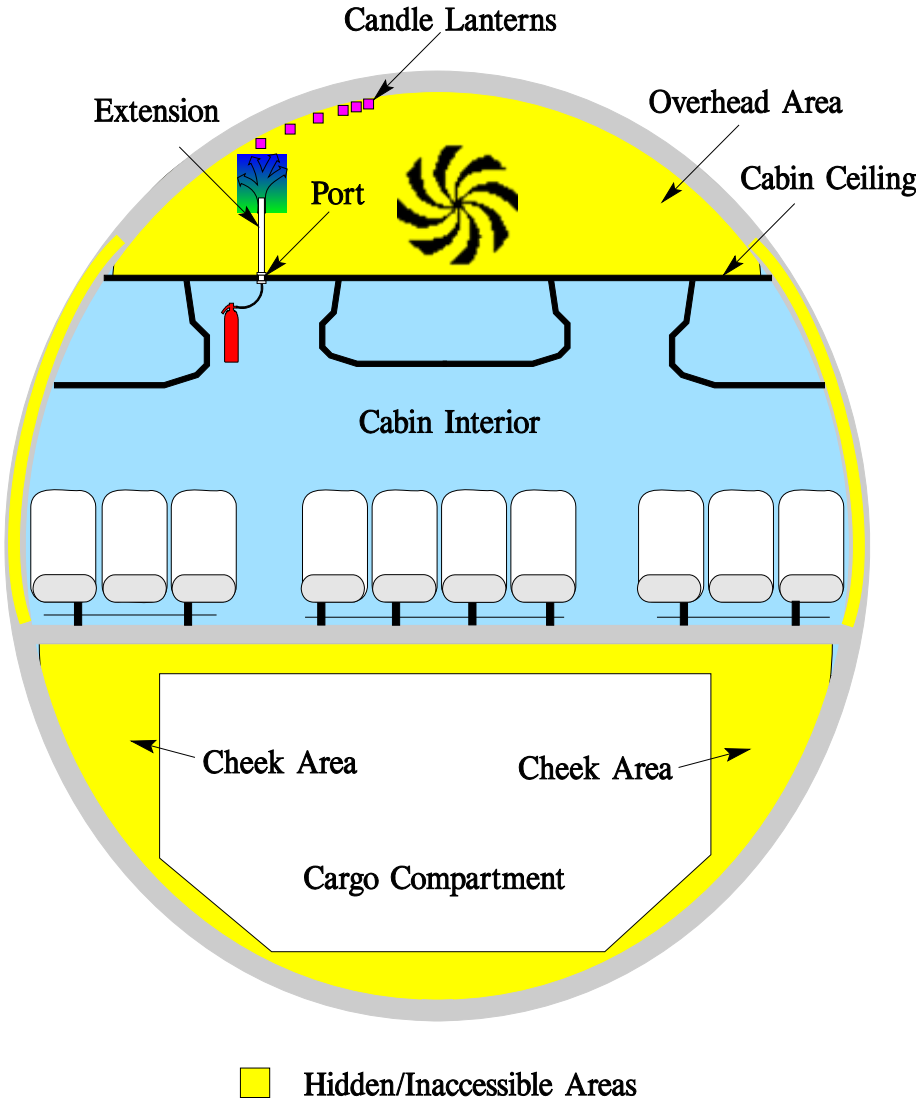
Initial Crown Area Test Configuration



Modified Overhead Area Test Configuration



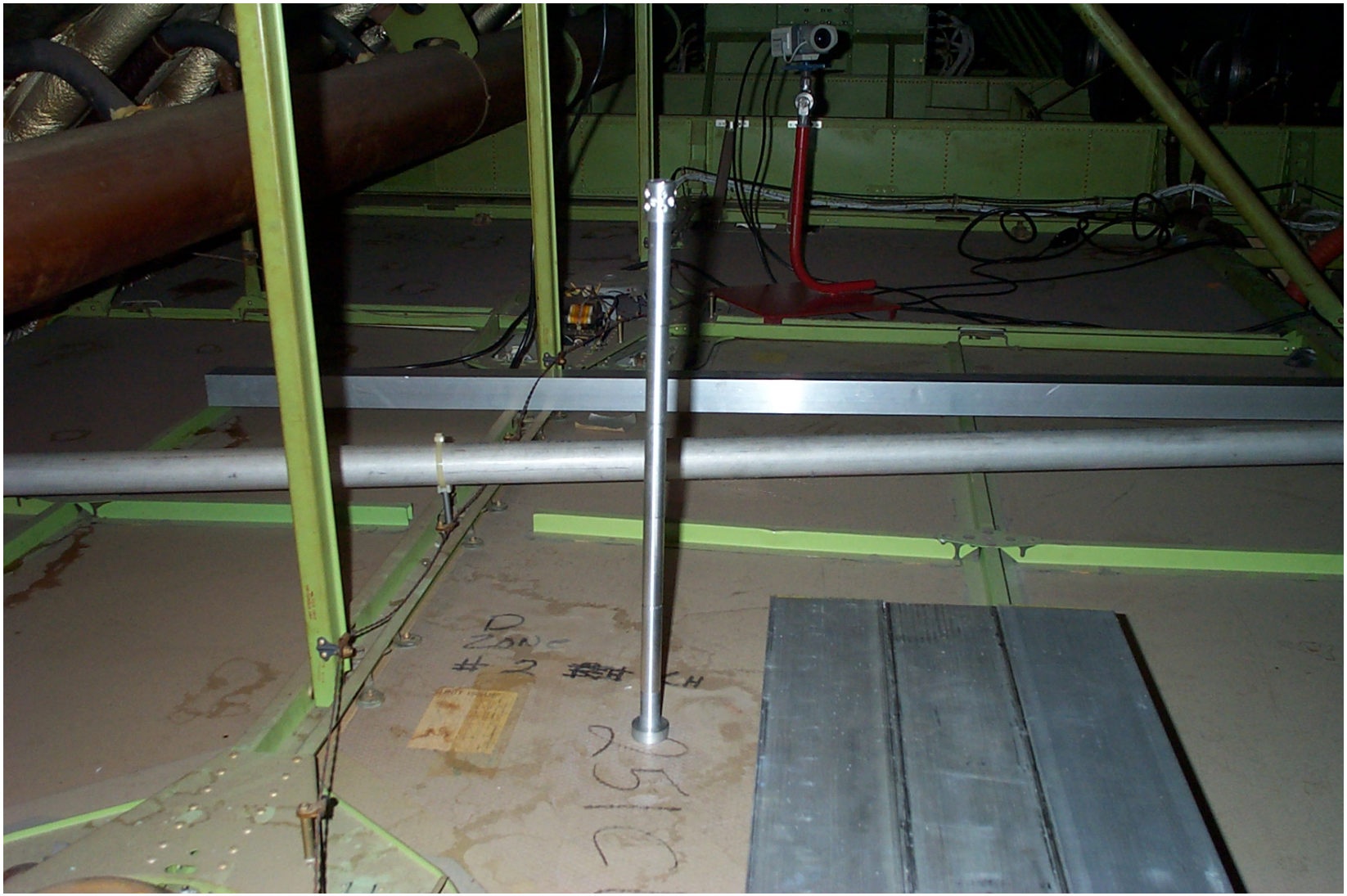
Modified Overhead Area Test Configuration



Candle Lanterns Mounted in 747SP Overhead

Candle Lanterns Mounted in 747SP Overhead

FastPort Prototype System Extended Above Ceiling



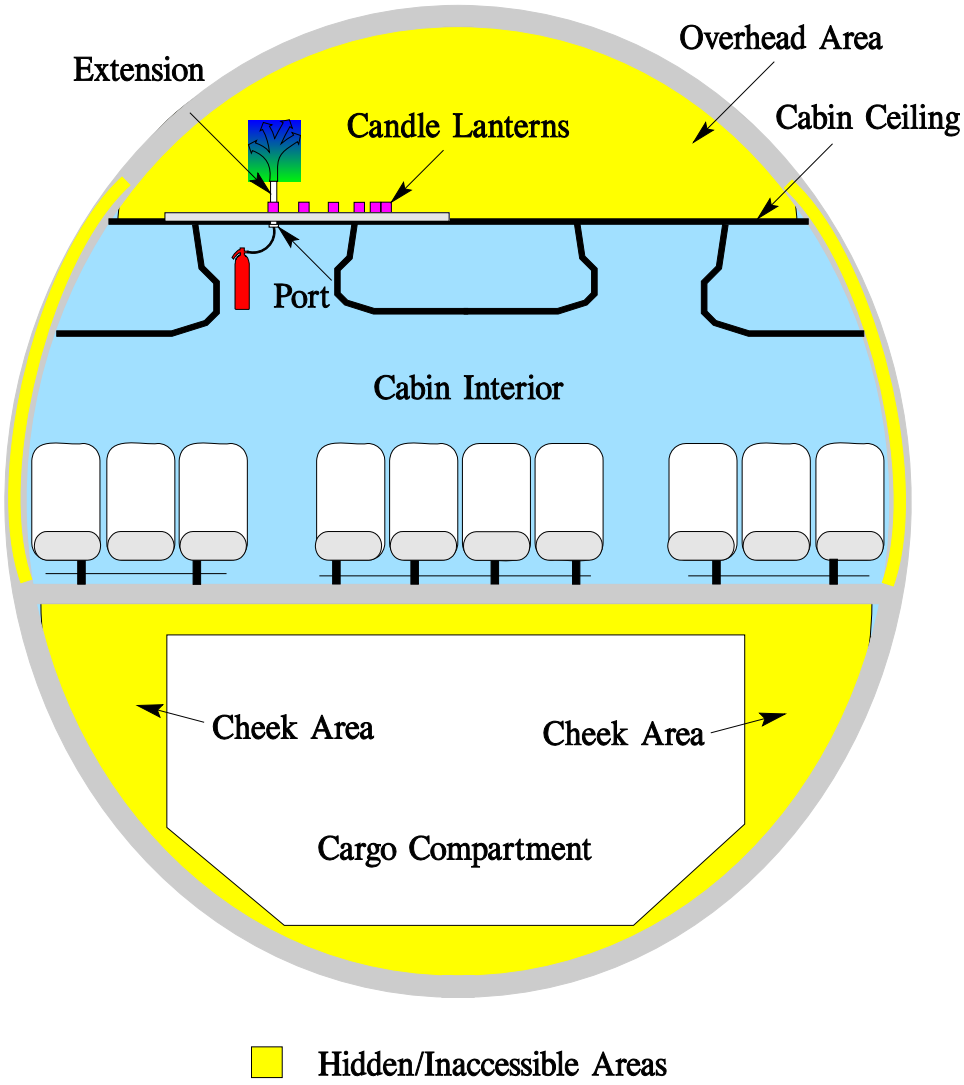
FastPort Prototype Head

Revised Discharge Heads Tested

Grille Design Head

Feedthrough Design Head

Candle Lanterns Sitting on Ceiling Panel



Agent Discharge Through Ceiling Port

Test Results in 747SP

	Hole in Ceiling	Prototype with five extensions	Grill Design with no extension	Feedthrough Design with no extension	Grill Design with one extension	Feedthrough Design with one extension	Two extensions with no head
		Test 1					
6 Along Crown (axial)	X	0	X	X	X	X	X
	Test 3	Test 2	Test 4	Test 5	Test 6	Test 7	
6 Near Crown (perp)	6	1	5[a]	5[b]	5[c]	6	X
	Test 12		Test 11	Test 10	Test 9	Test 8	Test 13
6 on Top of Ceiling Panel	0	X	3	3	4	6	4

a. Candle directly above discharge NOT extinguished
b. Candle farthest from discharge NOT extinguished
c. 4th candle from discharge NOT extinguished
X Not tested

Preliminary Findings Widebody Overhead

Extinguishers/port ineffective against initial candle configuration.

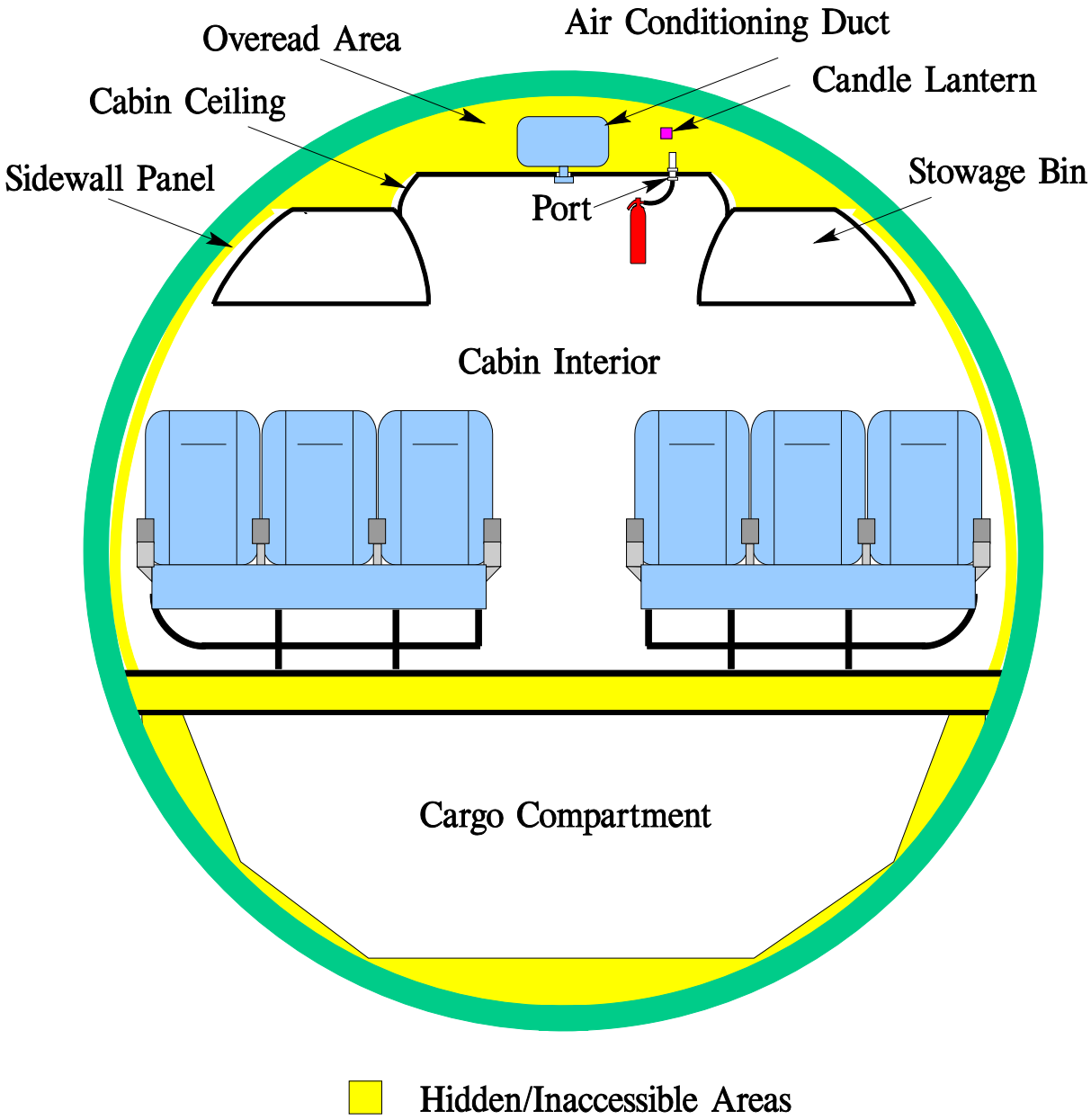
Extinguishers/port minimally effective against modified candle configuration.

Extinguishers/port even less effective against candles on ceiling.

Prototype nozzle too restrictive, did not allow agent expansion.

Grill and feedthrough nozzles allowed increased agent expansion and ext.

Effectiveness of Handheld Extinguishers and Ceiling Mounted Ports Against Overhead Area Fires In Narrowbody Aircraft


Overead Area
Air Conditioning Duct
Cabin Ceiling
Candle Lantern
Sidewall Panel
Stowage Bin
Port
Cabin Interior
Cargo Compartment
Hidden/Inaccessible Areas

Narrowbody Test Article Showing Location of Candle Lanterns

Close-up of Overhead Area

Technician Applying Agent Through Ceiling-Mounted Port

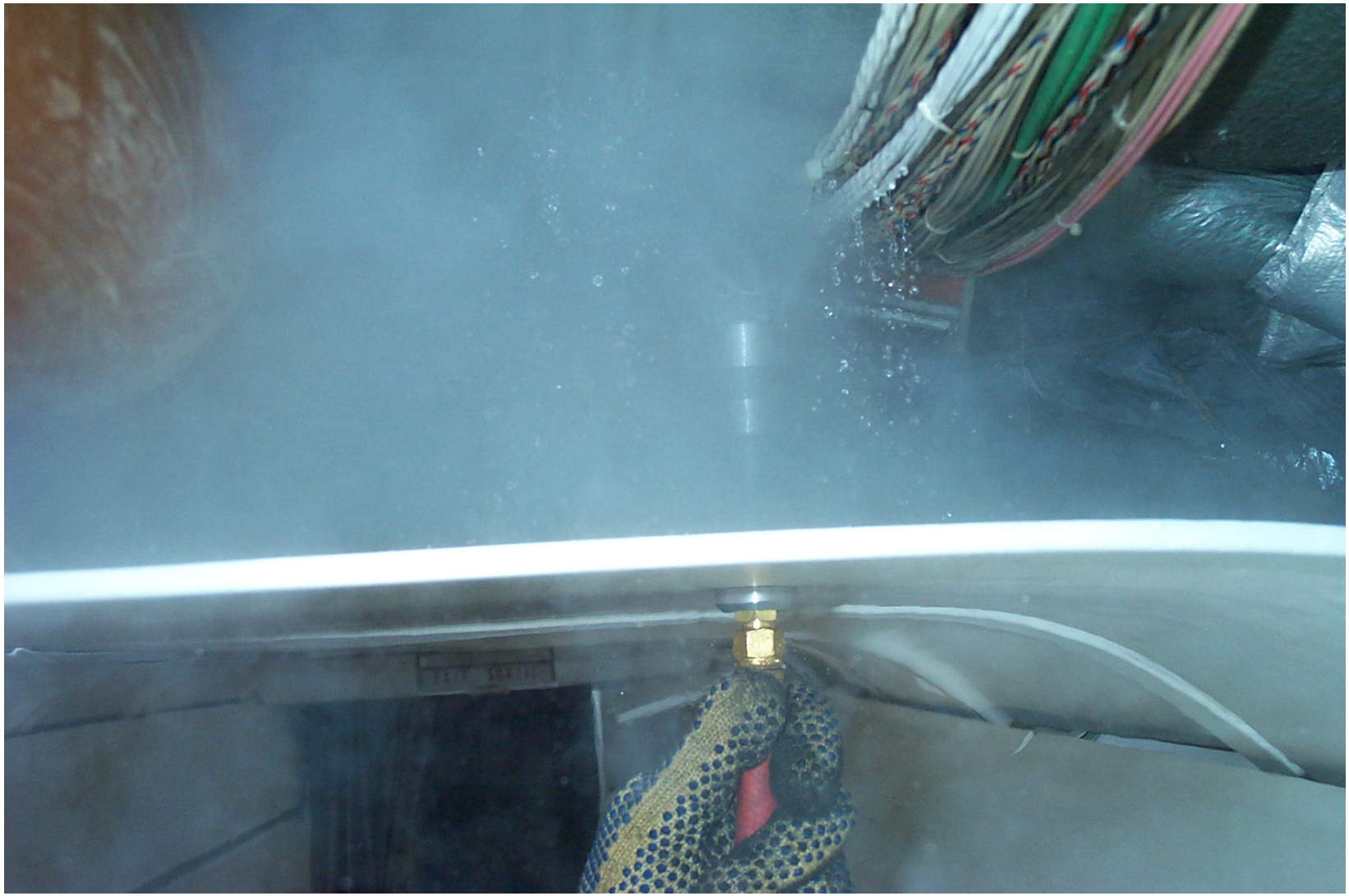
Extinguisher Port Test Results in Narrowbody

Port / Candle	Ceiling-mounted fitting only	Prototype head	Grill design head	Feedthrough design head	Hole in ceiling*
	Test 1	Test 2	Test 3	Test 4	Test 5
6 Along Crown (axial)	2	4	3	1	6
	Test 6	Test 7	Test 8	Test 9	Test 10
6 Along Crown (axial)	2	4	2	1	6

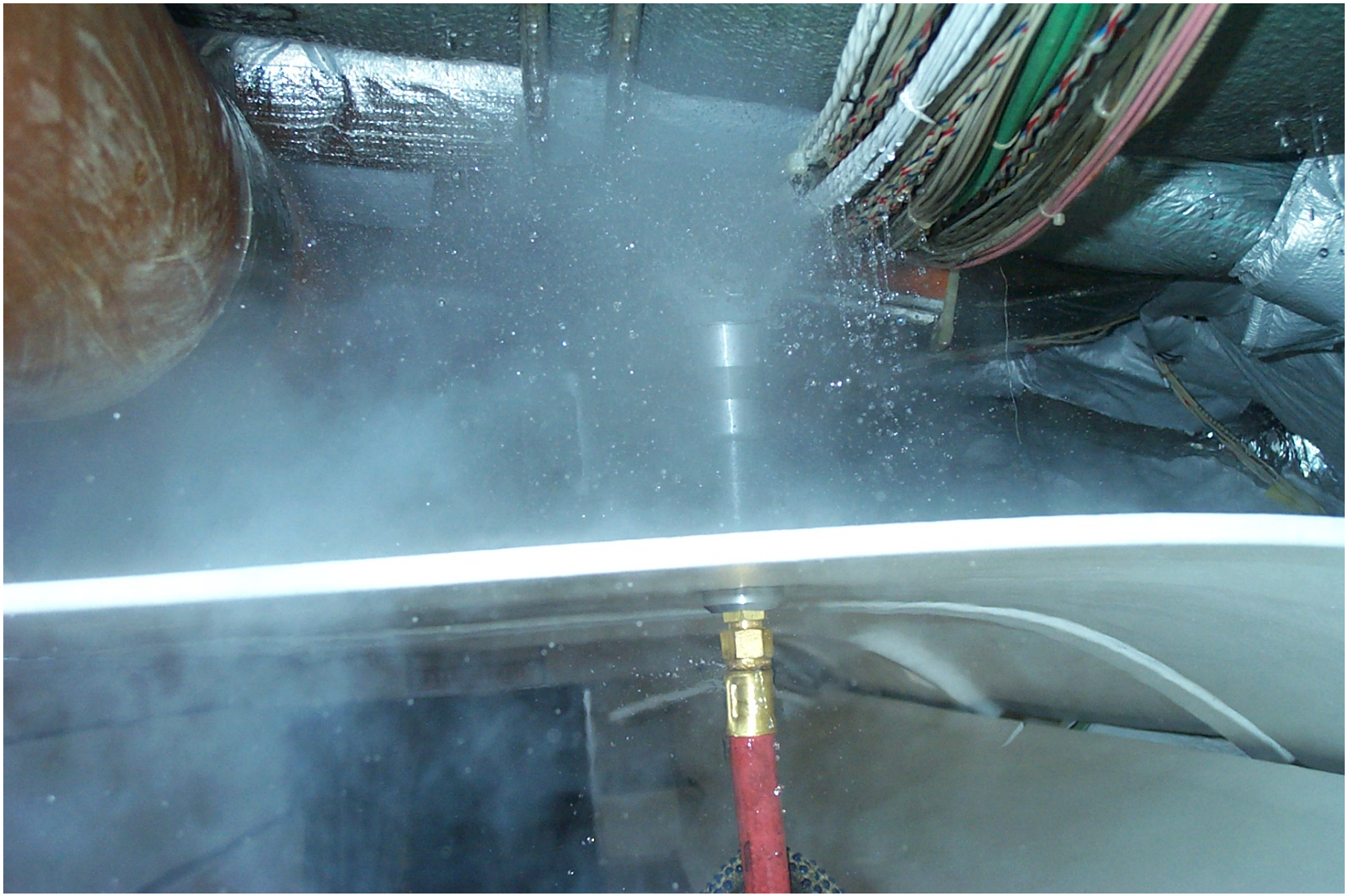
*Extinguisher aimed towards candles

Updated Agent Discharge Port w/Rotating Diffuser

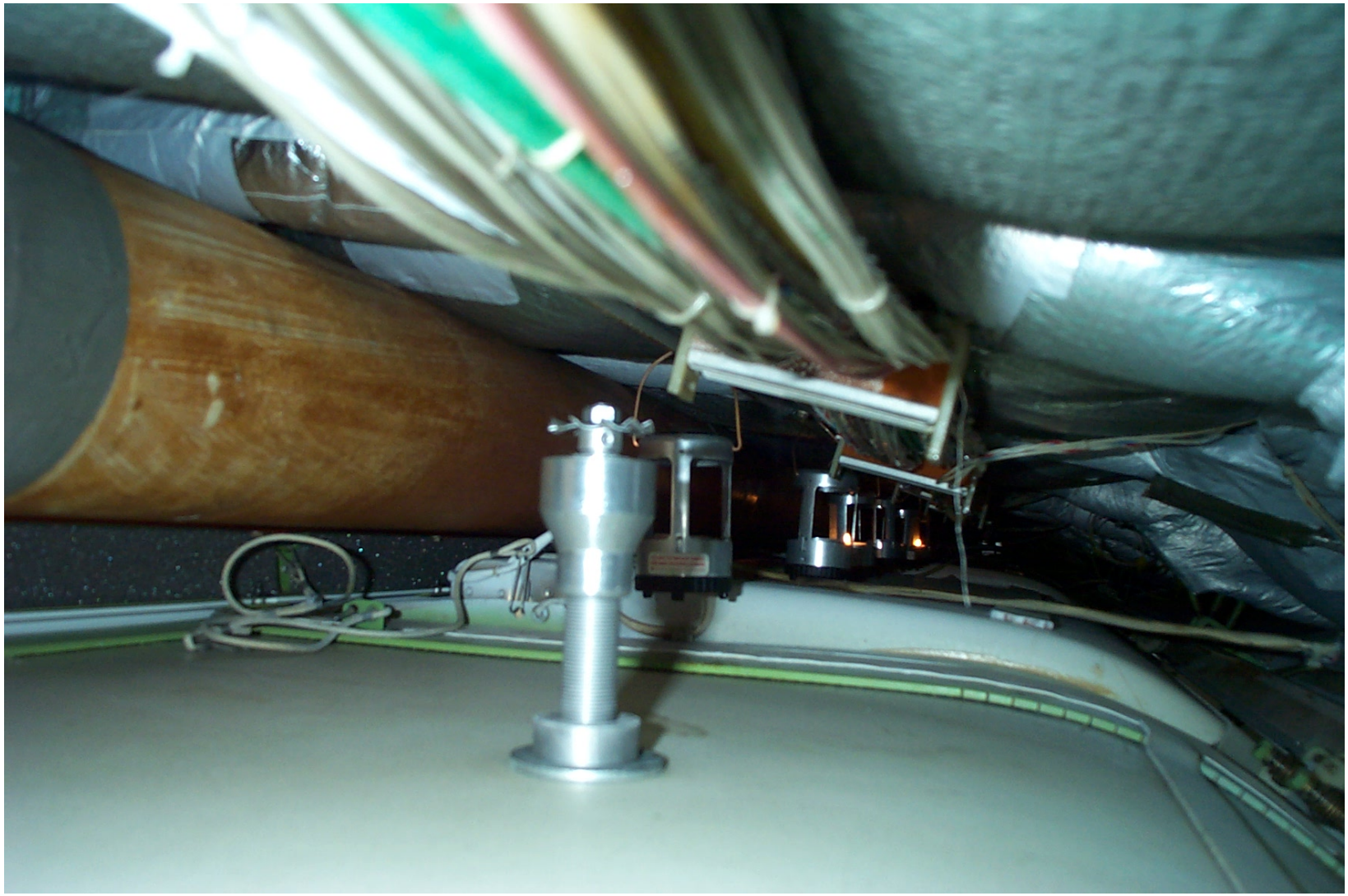
Agent Discharge Through Updated Port



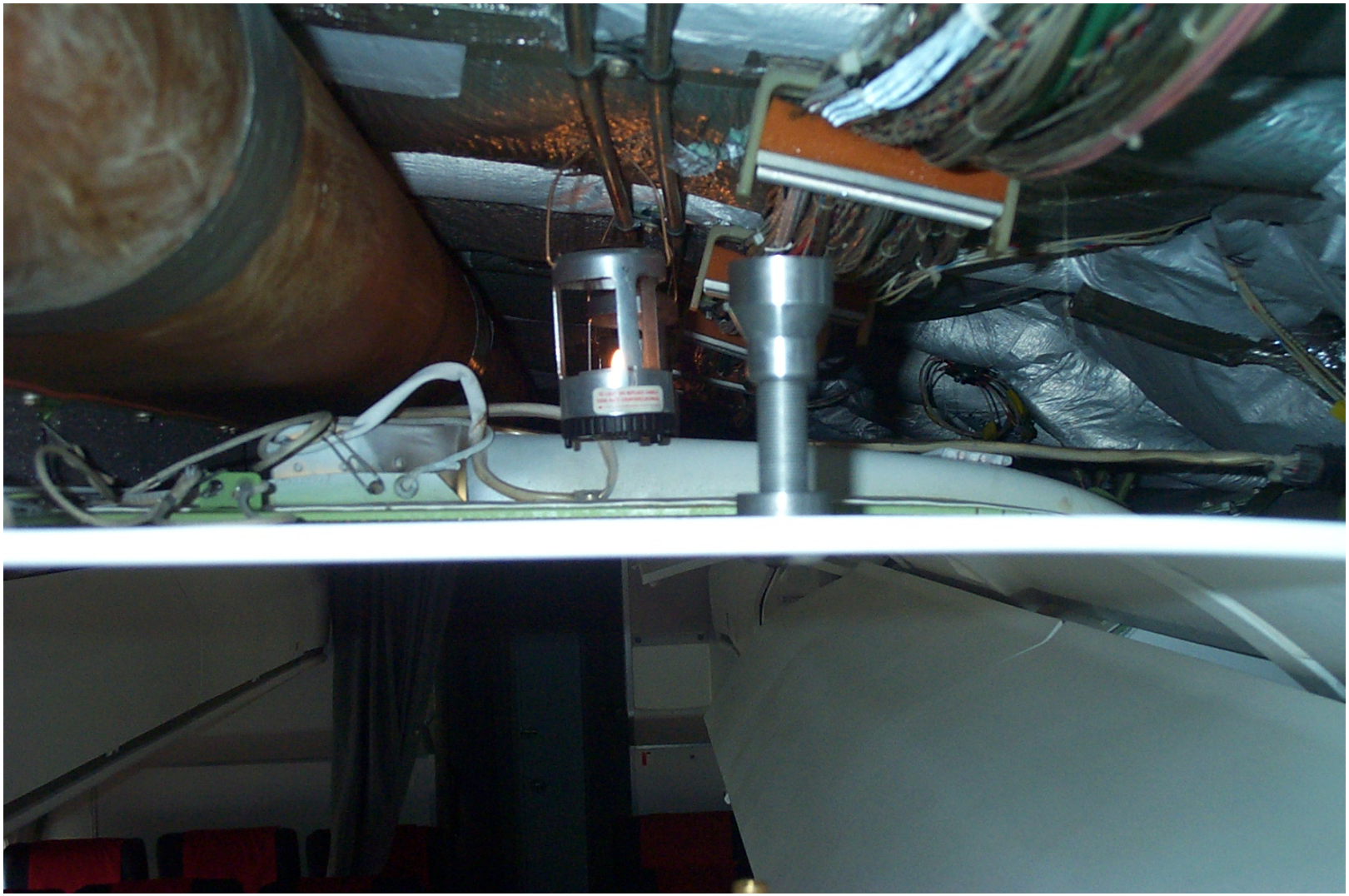
Agent Discharge Through Updated Port



2 of 6 Candle Lanterns Extinguished

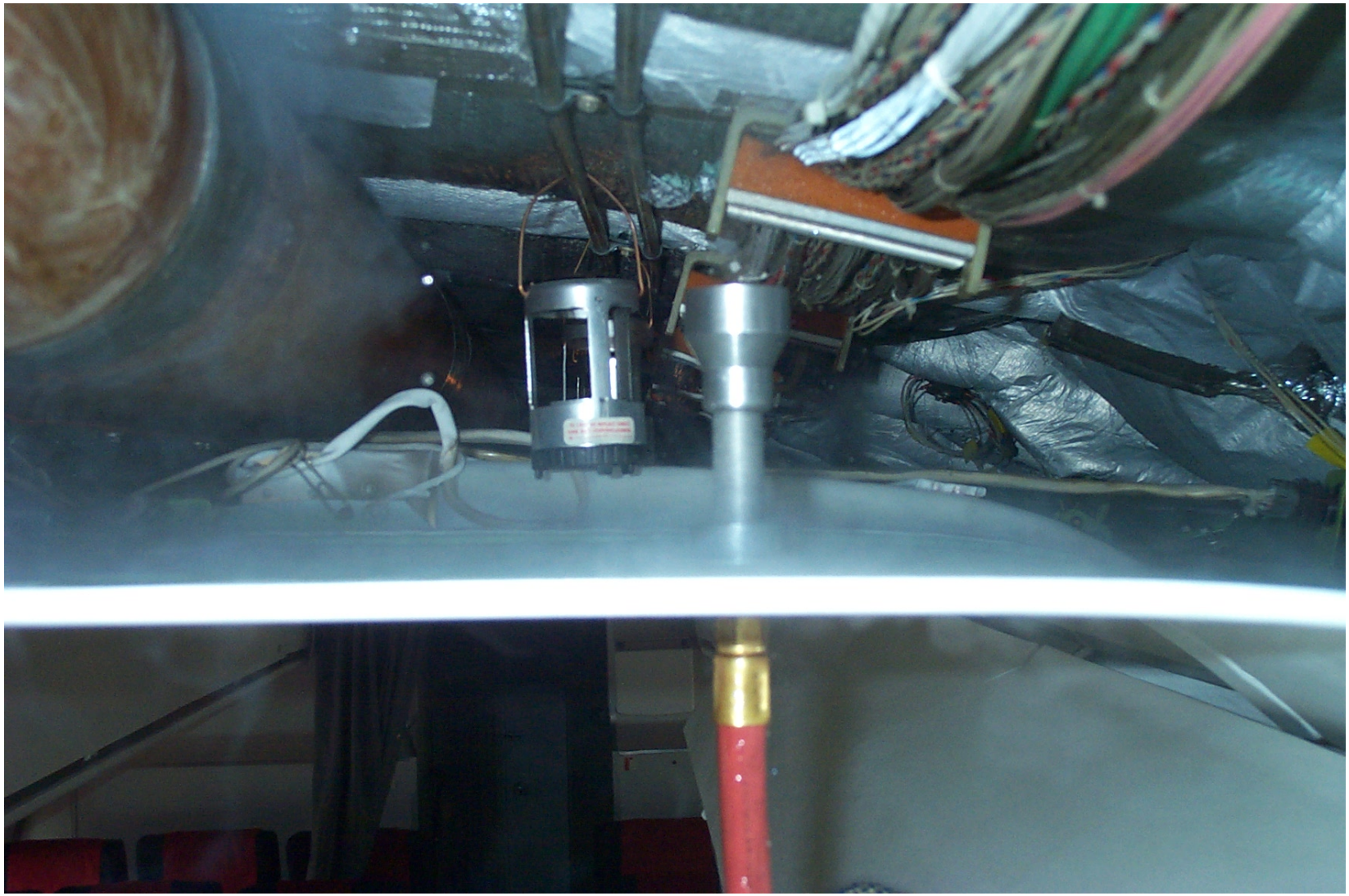


Diffuser Removed from Updated Port



Diffuser Removed from Updated Port

1 of 6 Candles Extinguished



Extinguisher Port Test Results in Narrowbody

Port / Candle	Fast-Port w/ Rotating Diffuser	Rotating Diffuser Removed
	Test 11	Test 13
6 Along Crown (axial)	2	1
	Test 12	Test 14
6 Along Crown (axial)	2	x

Extinguisher Port Testing in Overhead Areas

Conclusions:

1. Individual hand-held extinguishers did not predictably extinguish fires in the large-volume cabin overhead area typical of a widebody aircraft, regardless of port design.

2. The use of hand-held extinguishers and ports to combat overhead fires is more feasible in the more confined and smaller volume overhead area typical of a narow-body aircraft.

3. Effectiveness of the extinguisher is highly dependant on the nozzle design.

4. The most effective nozzle design was capable of providing a 4 ft radius of protection when using one 2.5 lb halon 1211 extinguisher. This capability would necessitate approximately 8 to 10 ports for a typical narrowbody cabin.

ote technical note technica

A Preliminary Examination of the Effectiveness of Hand-Held Extinguishers Against Hidden Fires in the Cabin Overhead Area of Narrow-Body and Wide-Body Transport Aircraft

Timothy R. Marker

July 2007

DOT/FAA/AR-TN04/33

U.S. Department of Transportation
Federal Aviation Administration