Development of a Flammability Test for Aircraft Wiring

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Aircraft Wiring Program

- Thermal Acoustical/Insulation NPRM of September 2000 prompted formation of new task groups.
- One such task group was developed to review, update, or develop (if needed) new flammability tests for all materials in hidden areas of the aircraft.
- Aircraft wiring falls in to these hidden areas.

Aircraft Wiring Program

(Continued)

- The mandated flammability test for aircraft wire and cable (60 Degree Flammability Test) is specified in the Federal Aviation Regulations (FAR) Part 25.869.
- This is a Bunsen burner test.
- Pass/Fail criteria is based on:
  - Burn Length,
  - After flame, and
  - Drippings

Aircraft Wiring Program

Does the 60 Degree Test **effectively** screen the flammability of aircraft wiring?

Test Program

- 60-degree flammability test was performed according to FAR 25.869
- Intermediate-scale vertical flammability test
- Intermediate-scale cabin attic flammability test

Test Program
(continued)

- Description and temperature rating of Wire Samples Evaluated:
  - Aircraft Wire:
    - PVC/Nylon: 105°C - 20 AWG
    - crosslinked ETFE - 150°C.- 20 AWG
    - PTFE/polyimide/PTFE - 150°C.- 20 AWG
    - PTFE/mica - 260°C.- 20 AWG
    - polyimide - 200°C – 22 AWG
    - crosslinked polyalkene -150°C.- 20 AWG

Test Program
(continued)

- Description (continued):
  - Telecommunications cable, “zero” halogen
  - Plenum rated cable: 60°C, “loaded vinyl jacket”
    - 4 twisted pair (primaries) FEP insulated
    - 24 AWG
  - Riser cable: 60°C, Hybrid PVC
    - 4 twisted pair (primaries)
    - 24 AWG

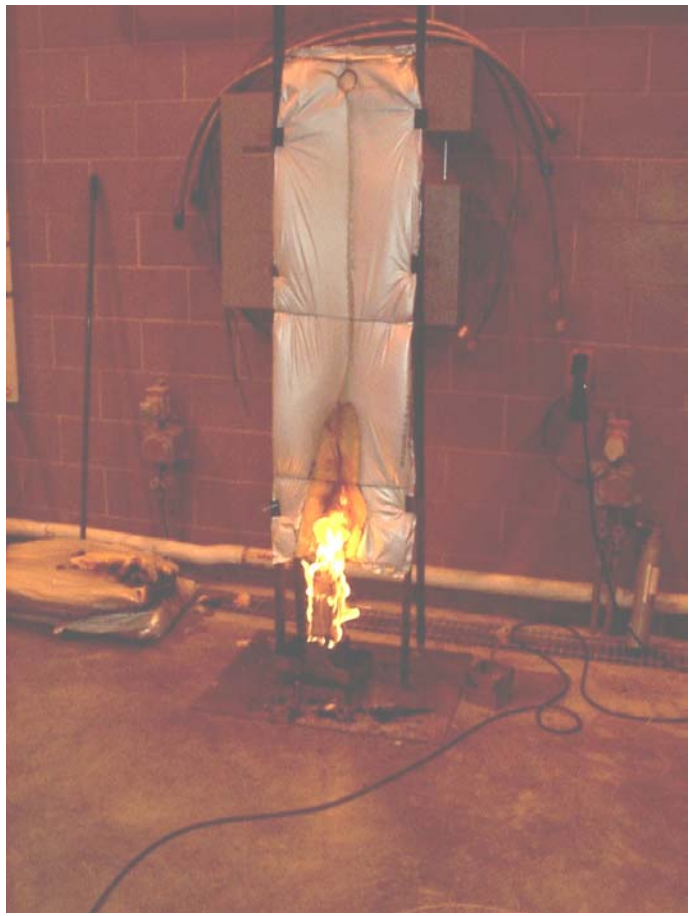
60-degree Flammability Test Results

Wire/Cable	Burn Length (inches)	After Flame (seconds)	Drippings
Polyimide	1.5	0	0
PVC/nylon	14.8	121	0
Tefzel™	2	0	0
X-linked Tefzel™	1.8	0	0
PTFE/polyimide/PTFE	1.2	0	0
Spec 2112	2.1	1.7	0
Plenum cable (A)	2.5	0	0
Riser cable (A)	2.5	0	0
Telecommunication cable zero halogen	3.1	60.3	0
Limited combustible, CMP CAT 6	2	0	0
Riser cable, CMR CAT 5E	2.5	0	0
Plenum cable, CAT 5-E	1.8	0	0

Intermediate-Scale Vertical Test Sequence

Before Burn

Beginning of Burn



Intermediate-Scale Vertical Test Sequence

Wires Igniting

Middle of Burn

Intermediate-Scale Vertical Test Sequence

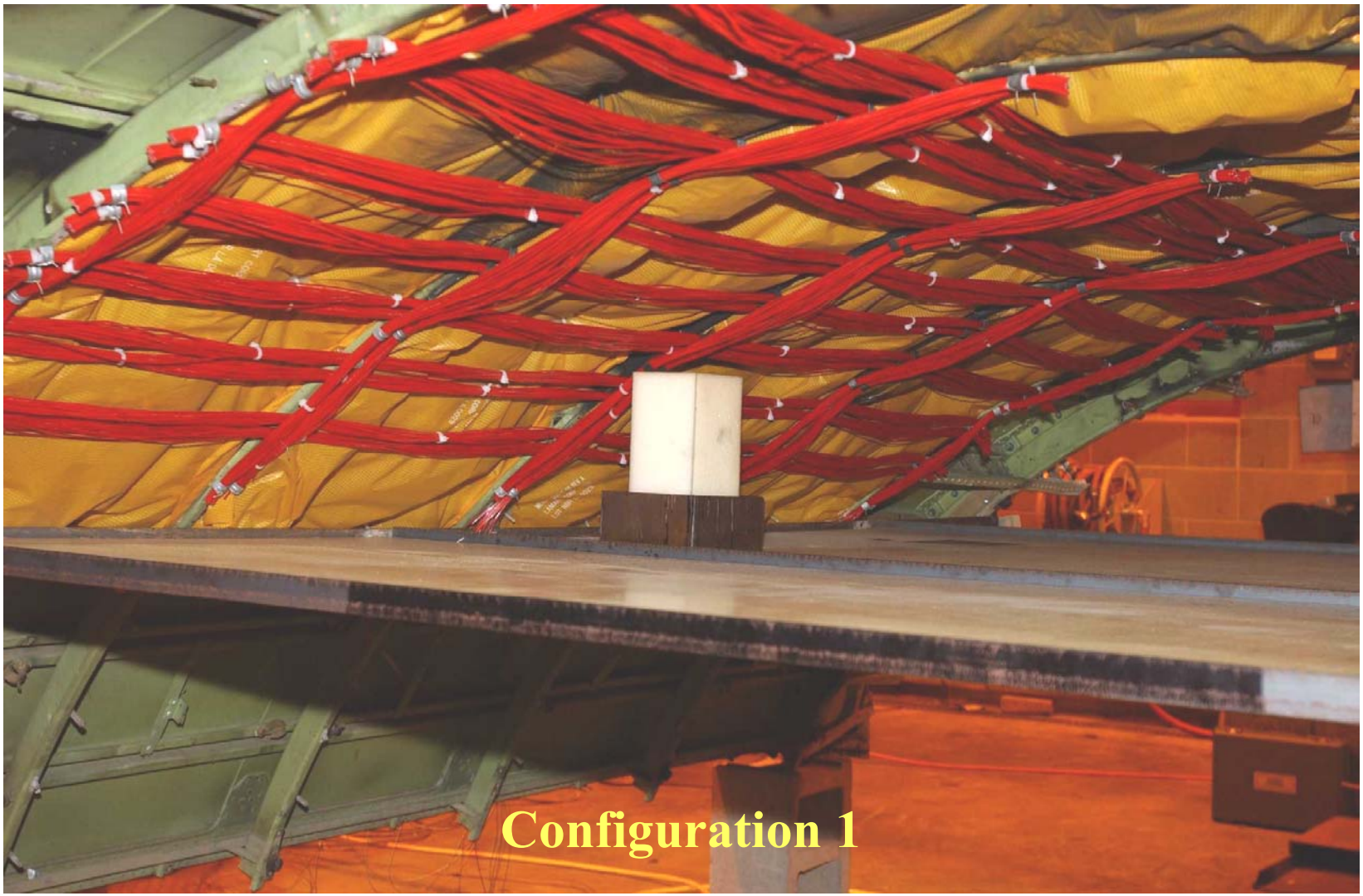
End of Burn

After the Burn

Intermediate-Scale Cabin Attic Test

- In this phase of testing, 5 of the original 12 types of wire and cable were evaluated.
- They included PTFE/polyimide/PTFE, Tefzel™, Spec 2112, riser cable (A), and PVC/nylon.
- A 9-inch- high by 4-inch- wide by 4-inch -deep polyurethane foam block sitting on a metal peg in a small pan was used as the ignition source.
- Heptane was poured on the block, and the block was compressed to distribute the heptane throughout.

Intermediate-Scale Cabin Attic Test



Intermediate-Scale Cabin Attic Test Results

Wire Bundle Type	Flame Propagation (upon foam block extinguished)	Burn Area (length by width) inches	Drippings
PTFE/polyimide/PTFE	No	10 by 9.5	No
Tefzel™	No	12 by12	No
Spec 2112	No	16 by10.5	No
Riser cable (A)	Yes	27 by 28	Yes
PVC/nylon	Yes	Nearly all consumed	Yes

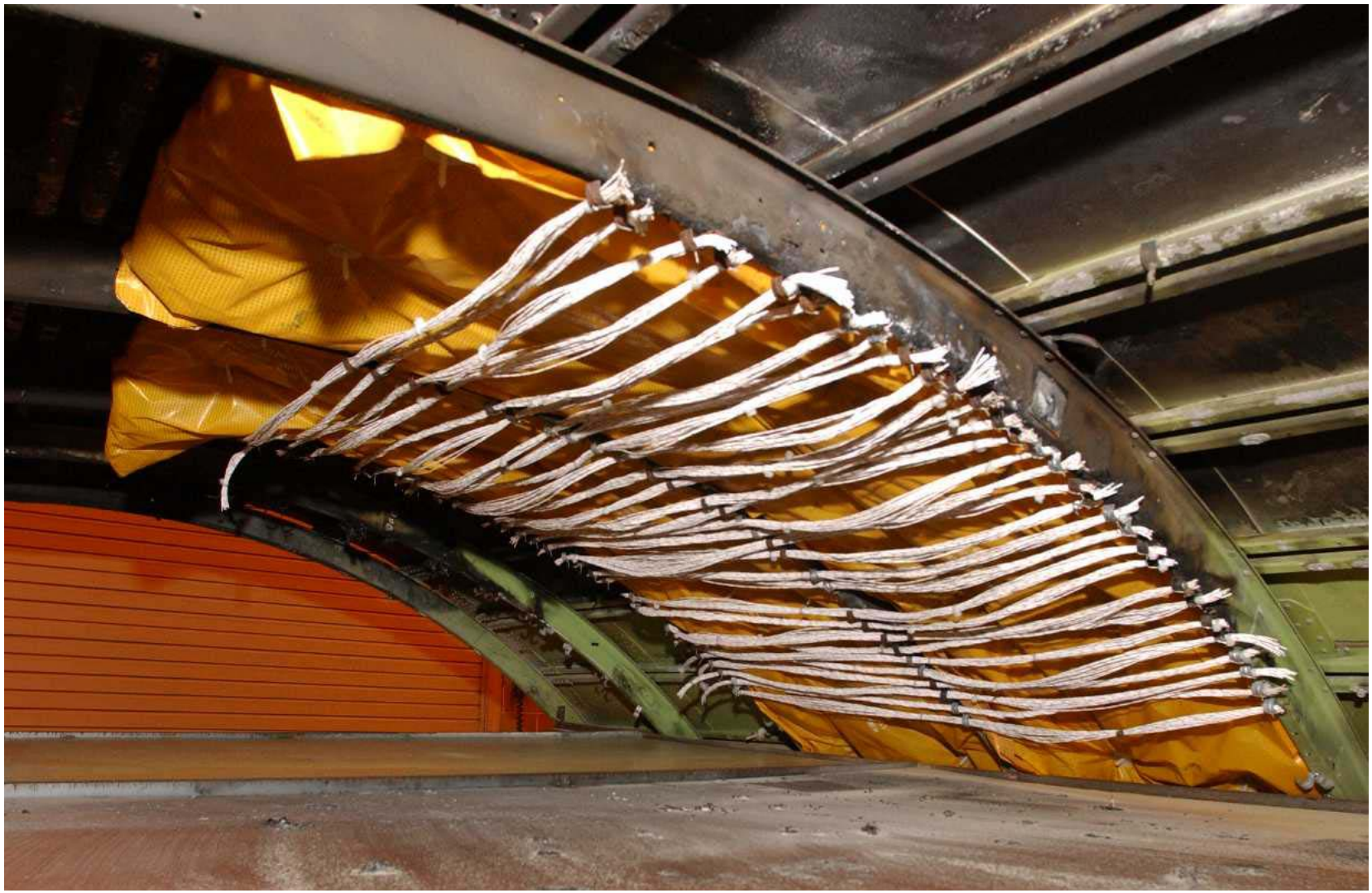
Intermediate-Scale Cabin Attic Flammability Tests

(Configuration 2)

- In order to verify the findings from the intermediate test, two further tests were run.
- PTFE/polyimide /PTFE and the riser (A) cable were chosen because the data showed them as being the best and the worst (disregarding PVC/nylon) in terms of wiring compliance with the 60° test.
- Spacing of the bundles appeared to have a bearing on the degree of flame propagation.
- Wire bundle configuration was changed for this series of tests; they were placed in the lengthwise direction only.

Intermediate-Scale Cabin Attic Flammability Tests

(Configuration 2)



Intermediate-Scale Cabin Attic Flammability Tests

(Configuration 2)

Intermediate-Scale Cabin Attic Flammability Tests

(Configuration 2)

Conclusions

- The 60° flammability test may not disqualify wiring that propagates a fire when subjected to a severe ignition source employed by the FAA to upgrade the fire test criteria of hidden fires.
- Certain types of aircraft wiring, particularly PTFE/polyimide/PTFE, exhibit a high degree of fire resistance when subjected to a severe ignition source. The degree of fire resistance appeared to be independent of wiring configuration (spacing) in the intermediate-scale cabin attic fire test.

Conclusions

(Continued)

- The flammability of the riser cable (A) was dependent on the wiring configuration during the intermediate-scale cabin attic fire test.
- Although some correlation existed between the 60° test and the intermediate-scale cabin attic fire test, it appeared to be limited to the most fire resistant samples that easily passed the 60° test. No correlation exists for materials that have greater burn lengths and marginally pass the test.
- The most flammable wiring sample tested was PVC/nylon.

New Wire Flammability Test Development

- Work is currently being done to develop a means to conduct wire flammability testing with the Radiant Panel test apparatus.
- Wire holders are being fabricated and evaluated for use in the Radiant Panel test apparatus.
- All variables associated with this testing, such as flame application time, preheat, etc., are being evaluated.

New Wire Flammability Test Development