SWISSAIR FLIGHT 111

Transportation Safety Board of Canada (TSB)

The Third Triennial International Aircraft Fire & Cabin Safety

Research Conference

22- 25 Oct 2001

Presented by

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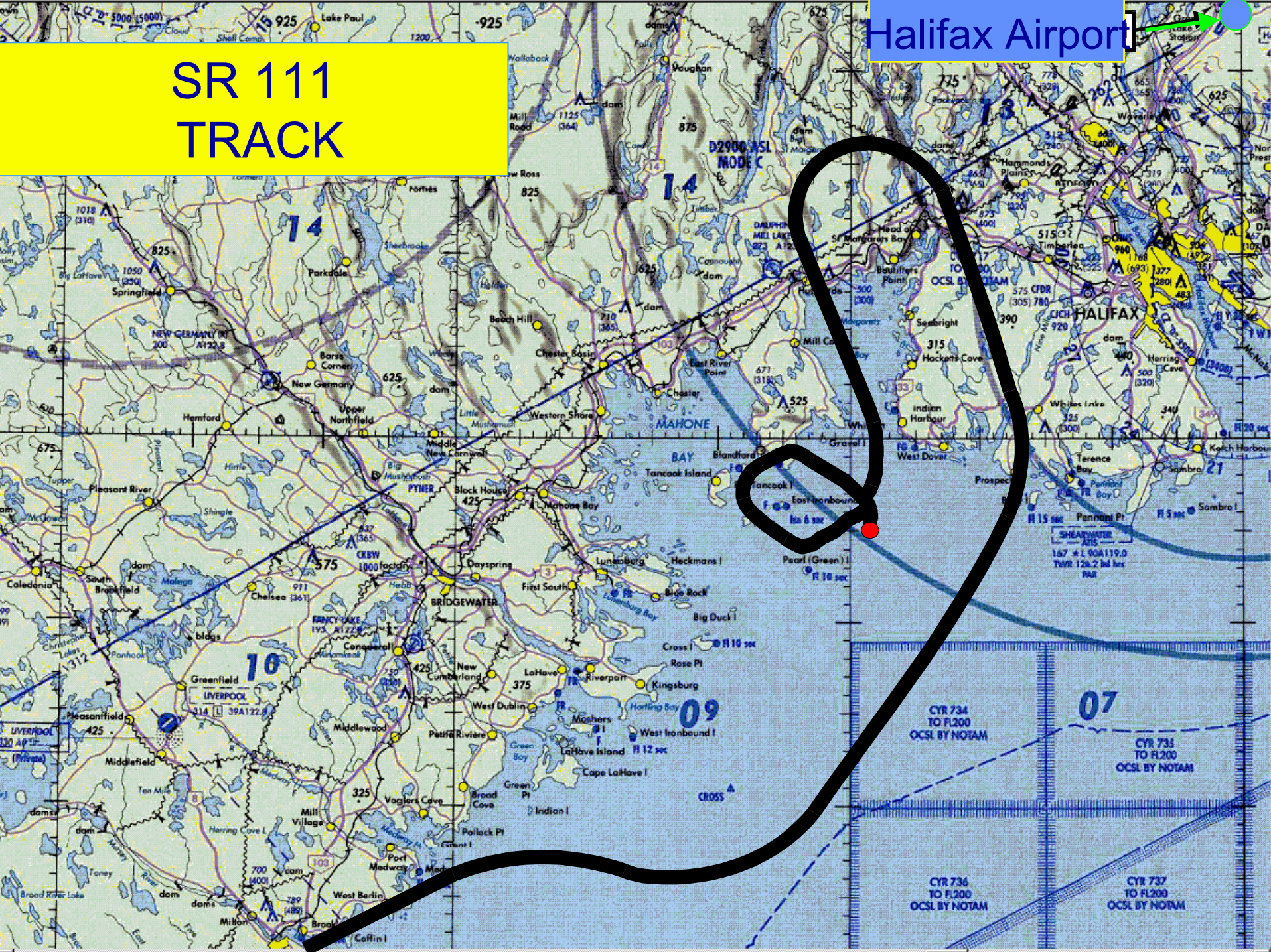
Methodology

- SR111 Sequence of Events / Timeline
- Event - Wreckage Analysis
- Deficiency Validation
- Safety Communication

The Event

- Swissair Flight 111
- Wednesday, September 2, 1998
- 22:31 Atlantic Daylight Time
- New York to Geneva
- 215 passengers and 14 crew
- 18 different nationalities
- just off Peggy's Cove, Nova Scotia


SR 111
TRACK
Halifax Airport
HALIFAX
MAHONE BAY
BRIDGEWATER
LIVERPOOL
CYR 734
TO FL200
OCSL BY NOTAM
CYR 735
TO FL200
OCSL BY NOTAM
CYR 736
TO FL200
OCSL BY NOTAM
CYR 737
TO FL200
OCSL BY NOTAM

Timeline

- 00:00 - smell something unusual
- 02:37 - smoke assessed as visible
- 03:37 - Pan Pan Pan
- 04:58 - decision to go to Halifax
- 10:10 - decision to dump fuel
- 13:11 - cabin bus P/B on
- 13:32 - A/P 2 kicks off
- 14:04 - declare emergency
- 15:03 - loss of recorders / communications
- 20:40 - water impact

Recovery
(Challenges and Opportunities)

Reconstruction

Fire-Related Deficiencies

- Thermal Acoustic Insulation Material
- In-Flight Firefighting
- Material Flammability Standards

Thermal Acoustical Insulation Material

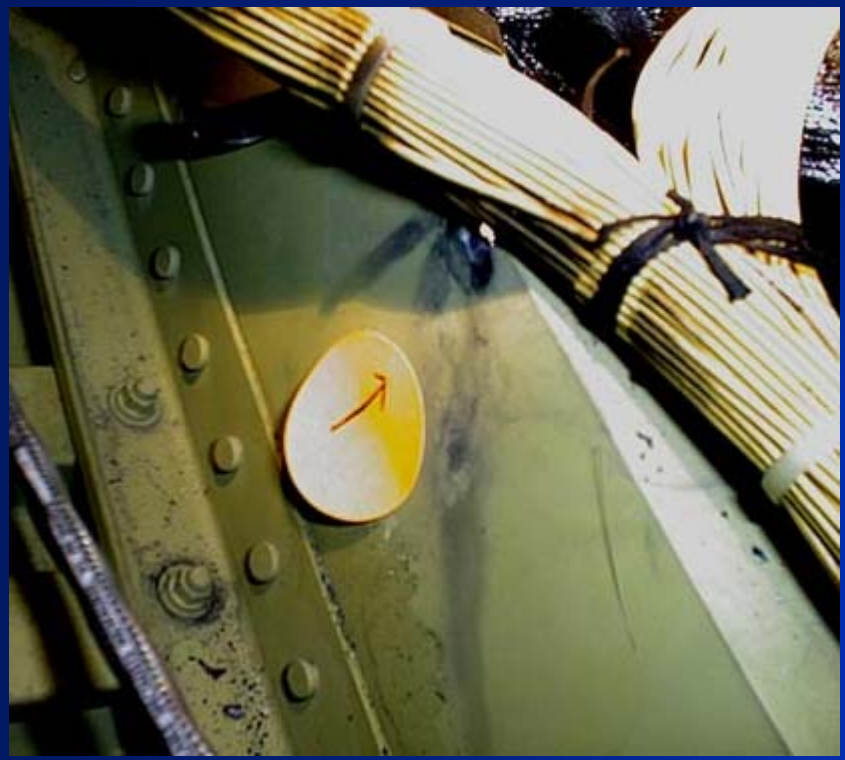
- Recovered Insulation Material

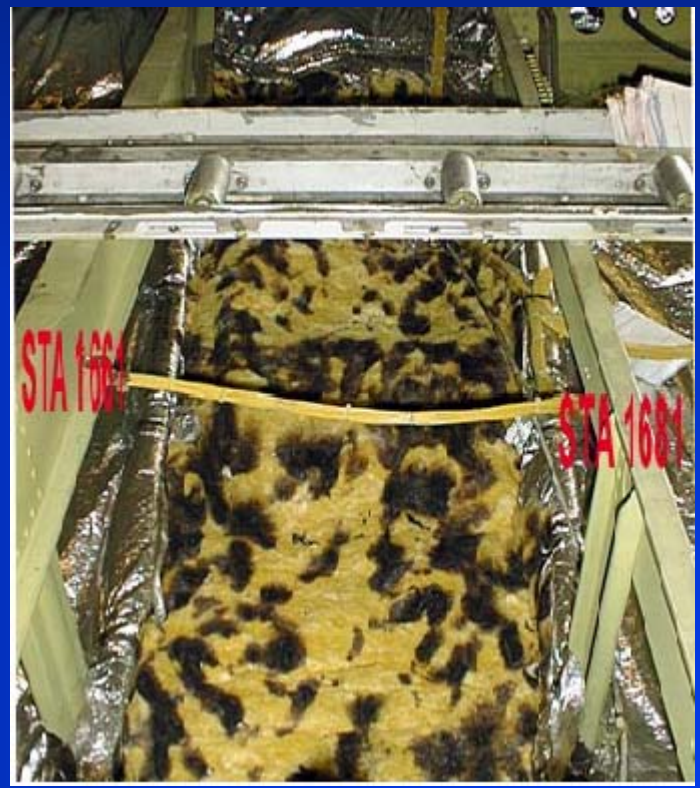
Thermal Acoustical Insulation Material

- Regulatory Requirements
  - FAR 25.853 Appendix F
  - Vertical Bunsen Burner Test
- History
  - various aircraft fires in which MPET provided fuel
  - other cover materials

World Airways

(NTSB DCA99SA051 refers)





Thermal Acoustical Insulation Material

- Materials Testing - Research
  - FAA partnership critical to s

Thermal Acoustical Insulation Material

- Conclusions:
  - MPET exhibits inappropriate flammability characteristics
  - Test Criteria requires review

Thermal Acoustical Insulation Material

TSB Recommendations

…action be taken reduce or
eliminate the risk associated with the use of MPET covered
insulation blankets in aircraft, and

…that all thermal acoustic insulation materials be validated
against more rigorous test criteria that are representative
of actual in-service system performance

In-Flight Firefighting

- Ongoing investigation revealed deficiencies in:
  - design;
  - equipment;
  - crew training;
  - awareness; and
  - procedures.
- Time is the critical resource

In-Flight Firefighting

- ***Smoke/Fire Detection and Suppression***
  - requirement for built-in systems is based on presence of:
    - **fuel; and**
    - **ignition source**
  - most of the rest of the aircraft relies on human intervention
  - presence of known ignition sources and flammable materials

- therefore, the Board recommended that:
  - ….more needs to be done to improve detection and suppression capabilities in the pressurized areas of the aircraft

In-Flight Firefighting

- ***Risk of Remaining Airborne - Emergency Landing***
  - experience based “non-event” perception
  - company culture, commercial considerations, safety concerns, etc
  - preparing for a diversion often the last item on the list…

- therefore, the Board recommended that:
  - ….industry standards reflect a philosophy that when odour/smoke from an unknown source is present, the most appropriate course of action is to prepare to land the aircraft expeditiously

In-Flight Firefighting

- ***Firefighting Efficiency in the Pressurized Portion of the Aircraft***
  - handheld extinguishers
  - inherent limitations
  - accessibility
  - crew coordination
    - **roles, responsibilities, and training**

- therefore, the Board recommended that:
  - ….a review of current in-flight firefighting standards including procedures, training, equipment, and accessibility….to ensure aircraft crews are prepared to respond immediately, effectively and in a coordinated manner any in-flight fire

In-Flight Firefighting

- ***Time Required to Troubleshoot in Odour/Smoke Situations***
  - in presence of odour/smoke environment checklists are crucial…they may involve
  - electrical power removal and/or isolating systems
  - no regulatory requirement
  - checklist completion time is variable…up to 30 minutes!!
  - goal should be…
    - **to eliminate source before or soon after ignition**

- therefore, the Board recommended that:
  - ….action be taken to ensure that odour/smoke checklist items be designed to be completed in a timeframe that will minimize the possibility of an in-flight fire being ignited or sustained

In-Flight Firefighting

- ***Integrated Firefighting Measures***
  - identify systemic deficiencies
  - aircraft and equipment design changes have been made in isolation
  - “systems” approach prevent, detect, control, and eliminate aircraft fires
  - all aspects should be integrated and complementary

- therefore, the Board recommended that:
  - …. authorities review the adequacy of in-flight firefighting as a whole, to ensure that aircraft crews are provided with a system whose elements are complementary and optimized to provide the maximum probability of detecting and suppressing any in-flight fire.

Material Flammability Standards

- ***Material Flammability Standards***
  - based on low probability of in-flight fire….focus on post crash fire
  - current FAR requirements result in:
    - **flammable materials with acceptable burn rate**
    - **materials that self-extinguish within acceptable burn time and length**
    - **selected cabin materials that self-extinguish and release minimum heat and smoke**

Hook & Loop Fastener System

Material Flammability Standards

- ***Material Flammability Standards***
  - toxicity & smoke generation issues need to be considered, however….
  - the Board believes that the most effective means to mitigate the risk is to eliminate materials that sustain or propagate fire

- therefore, the Board recommended that:
  - …. material used in the manufacture of an aeronautical product should not propagate or sustain a fire in any realistic operating environment

Material Flammability Test Requirements for Aircraft Wiring

Material Flammability Standards

- ***Material Flammability Test Requirements for Aircraft Wiring***
  - 20 wires exhibited evidence of arcing
  - wires as an ignition source in SR 111...have not been ruled out

Material Flammability Standards

- ***Material Flammability Test Requirements for Aircraft Wiring***
  - wiring is a critical system in modern
  - wires play a role in smoke/fire events
  - wires as an ignition source in SR 111...have not been ruled out
  - active vs passive….yet
  - material flammability tests for wires are the same as passive materials
  - wire protection limitations, e.g. circuit breakers
  - currently the dynamics of wire failures are unknown

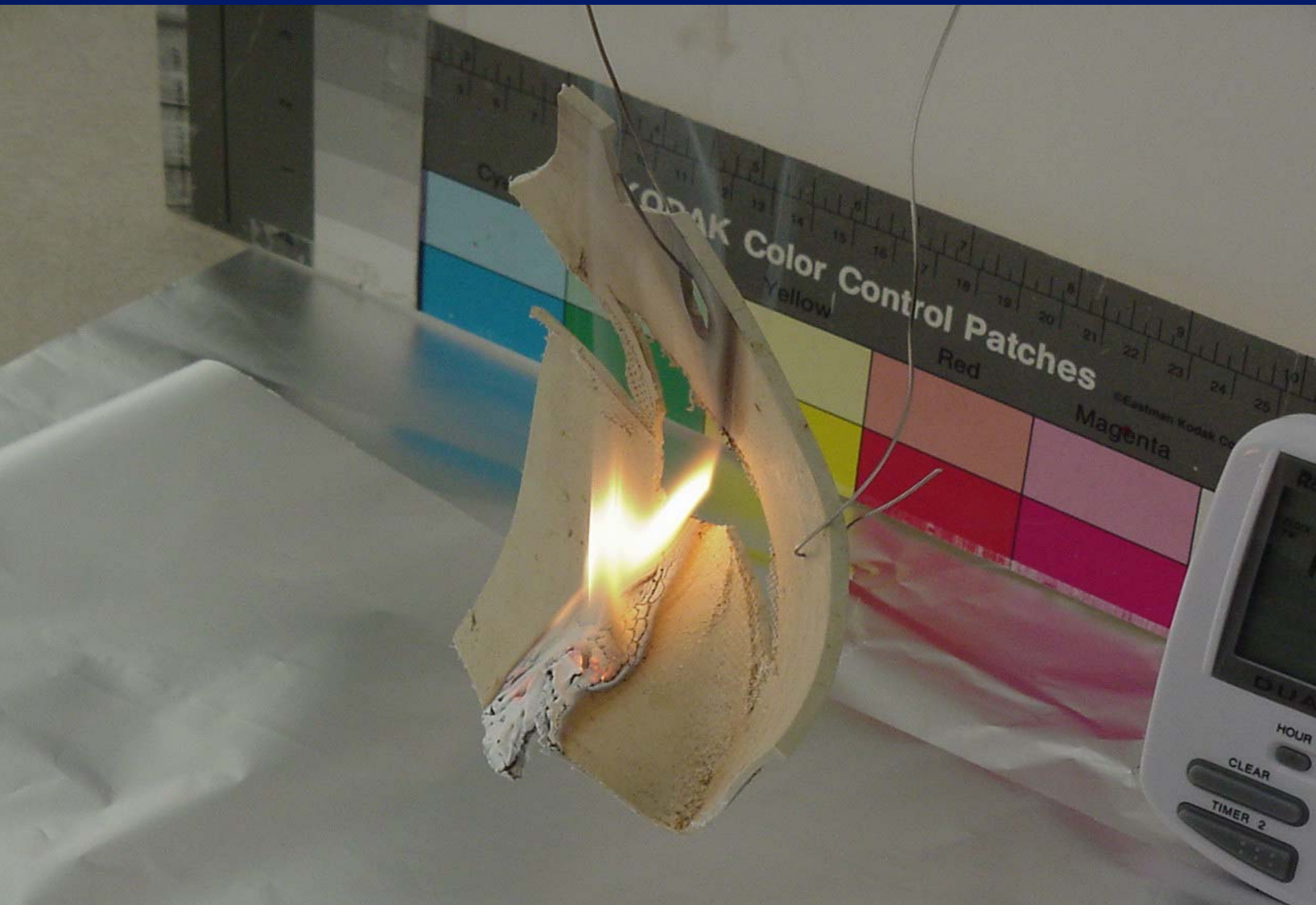
Material Flammability Standards

- therefore, the Board recommended that:
  - …. a certification test regime be mandated that evaluates aircraft electrical wire failure characteristics under realistic operating conditions and against specified performance criteria, with a goal of mitigating the risk of ignition

Material Flammability Standards

- ***System Evaluation: Fire Hardening Considerations***
  - various materials have exhibited less than ideal fire propagation characteristics
  - in most cases there is no requirement to determine how a material's failure might exacerbate an in-flight fire
  - FAR 25.1309 requires that the consequences of a system's failure be analysed, however
    - **not specifically in the face of an in-flight fire**
  - assessing a system's failure and designing system to delay failures
  - candidate systems include;
    - **oxygen, hydraulic, wiring, and air environmental**

Silicon Duct End Cap



Material Flammability Standards

- therefore, the Board recommended that:
  - ….as a prerequisite to certification all systems, whose failure could exacerbate a fire in progress, be evaluated to ensure they are designed to mitigate the risk of fire-induced failure

Safety Action Initiatives

- Regulatory Authorities
  - committed to harmonization of regulations

- Swissair
  - Land as soon as possible
  - modified checklists, procedures and training
  - maintenance - best practices awareness
  - MD-11 Modification Plus Program, which involves
    - **installation of detection and suppression system in attic area**
    - **includes video surveillance**

Safety Action Initiatives

- FAA
  - MPET ADs
  - Thermal Acoustic Insulation Materials test NPRM
  - Review of existing programs
    - **Fire Tests for Materials in Inacessible Areas**
    - **Review of Fire Tests for Wires**
    - **Detection & Extinguishing in Inacessible Areas**
    - **Establish industry standards for**
      - **emergency landing**
      - **checklist procedures for smoke of unknown origin**
      - **comprehensive in-flight firefighting procedures**
- Enhanced Airworthiness Program for Airplane Systems
  - umbrella program to coordinate all wire related initiatives

Remaining Issues

- Thermal Acoustic Insulation Materials Residual Risk
- Limitations of Radiant Panel Test
- Toxicity, smoke, heat release standards

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