In-service Contamination of Thermal Acoustic Insulation

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Background

- **Following the Swissair MD-11 in-flight fire accident in 1998, flammability requirements for Thermal Acoustic Insulation (TAI) have been improved**
- **However, some contaminants on TAI are known to be flammable**
  - Dust/lint, Hydraulic Oil and Corrosion Inhibiting Compounds shown to be flammable in Transport Canada studies
  - There has been many contaminated TAI fire events, including the significant in-flight Dust/Lint fire on a Tristar near Goose Bay in 1991
- **This study looks closer at contamination on TAI and Electrical Wiring Interconnection System (EWIS)**

Objectives

- **Conduct aircraft surveys to:**
  - Measure dust/lint accumulation rate based on hours and cycles
  - Identify factors influencing dust/lint accumulation rate
- **Conduct flammability testing to:**
  - Establish indicative flammability threshold for dust/lint (g/m^2)

Survey Technique

1. Remove cabin and cargo bay lining panels
2. Visually identify area with heaviest dust/lint contamination on TAI
3. Extract dust/lint sample(s) 50mm x 50mm
4. Establish hours and cycles since specific area last cleaned
5. Investigate reasons for any variation in dust and lint contamination levels
6. Look for other contaminants – hydraulic oil, corrosion inhibiting compounds, etc.

Survey Data

- **14 aircraft surveyed incorporating:**
  - 11 aircraft types
  - 13 turbojets and 1 turboprop
  - Short, medium and long haul
  - Economy, business and first class cabins
  - 6 different Maintenance Repair Organizations

Survey Data

- **Hidden Areas with highest density of dust/lint**
  - Behind dado panel just above cabin floor
  - In cheek just below cabin floor
  - Near outflow valves and air recirculation inlets
- **Cleaner Areas**
  - Avionics bay
  - Flight deck (based on limited opportunities)

See following photographs:

Survey Data

Typical dust/lint above cabin floor behind dado panel

Survey Data

Typical dust/lint below cabin floor

Survey Data

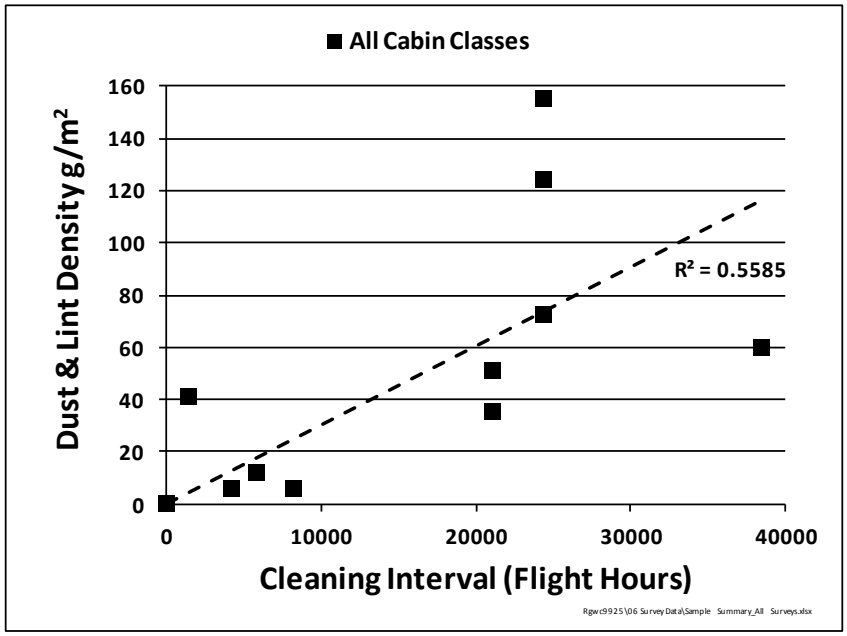
Contaminated EWIS and TAI in cheek near air recirculation inlet

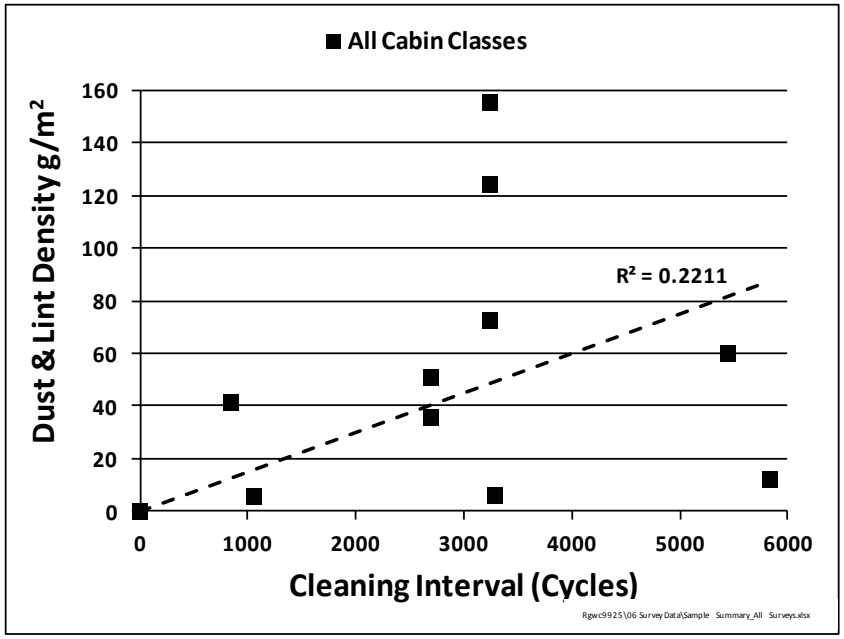
Survey Data

Avionics bays - EWIS and TAI much cleaner

Survey Data

Dust/lint accumulation appears to correlate better with Hours than Cycles



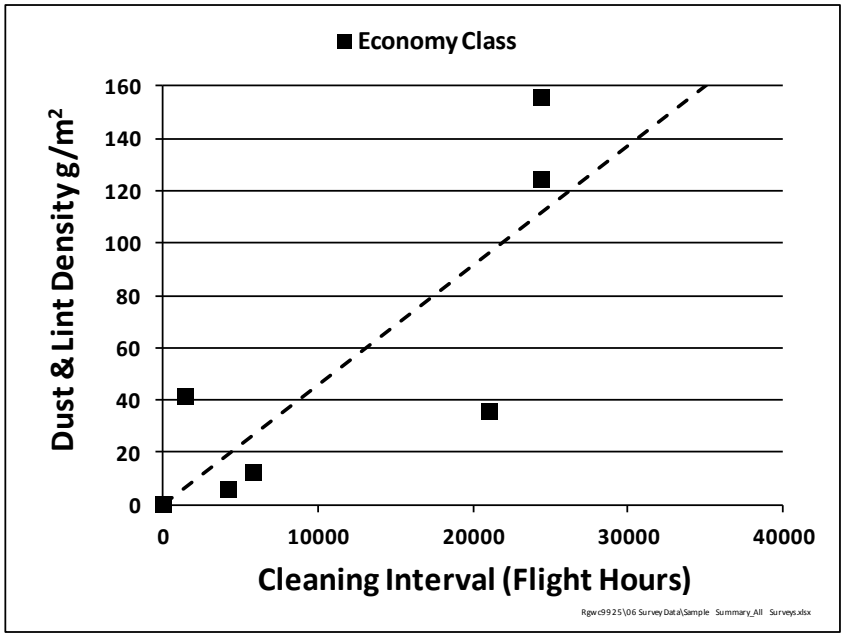


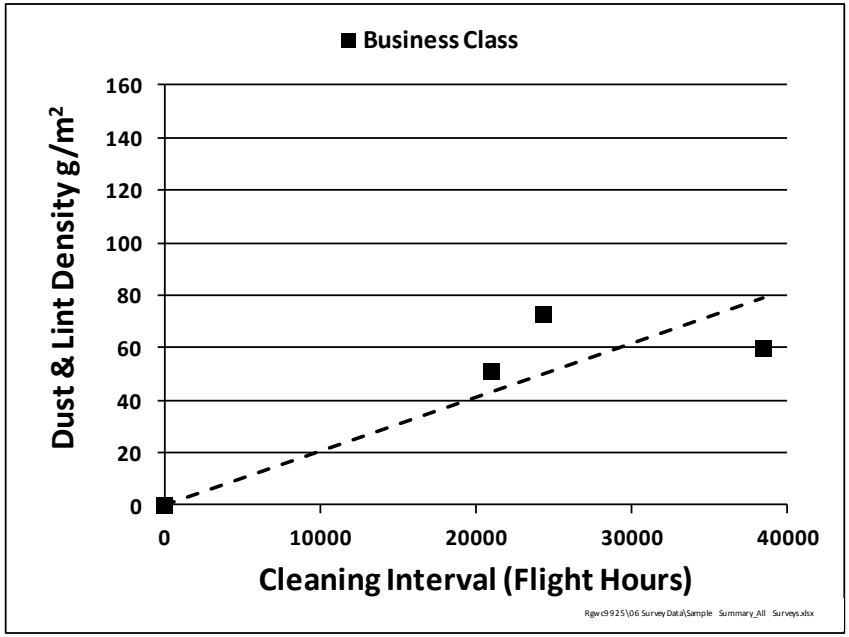
Flight Hours

Flight Cycles

Survey Data

Dust/lint accumulation rate appears to be greater adjacent to economy class than business class





Economy Class

Business Class

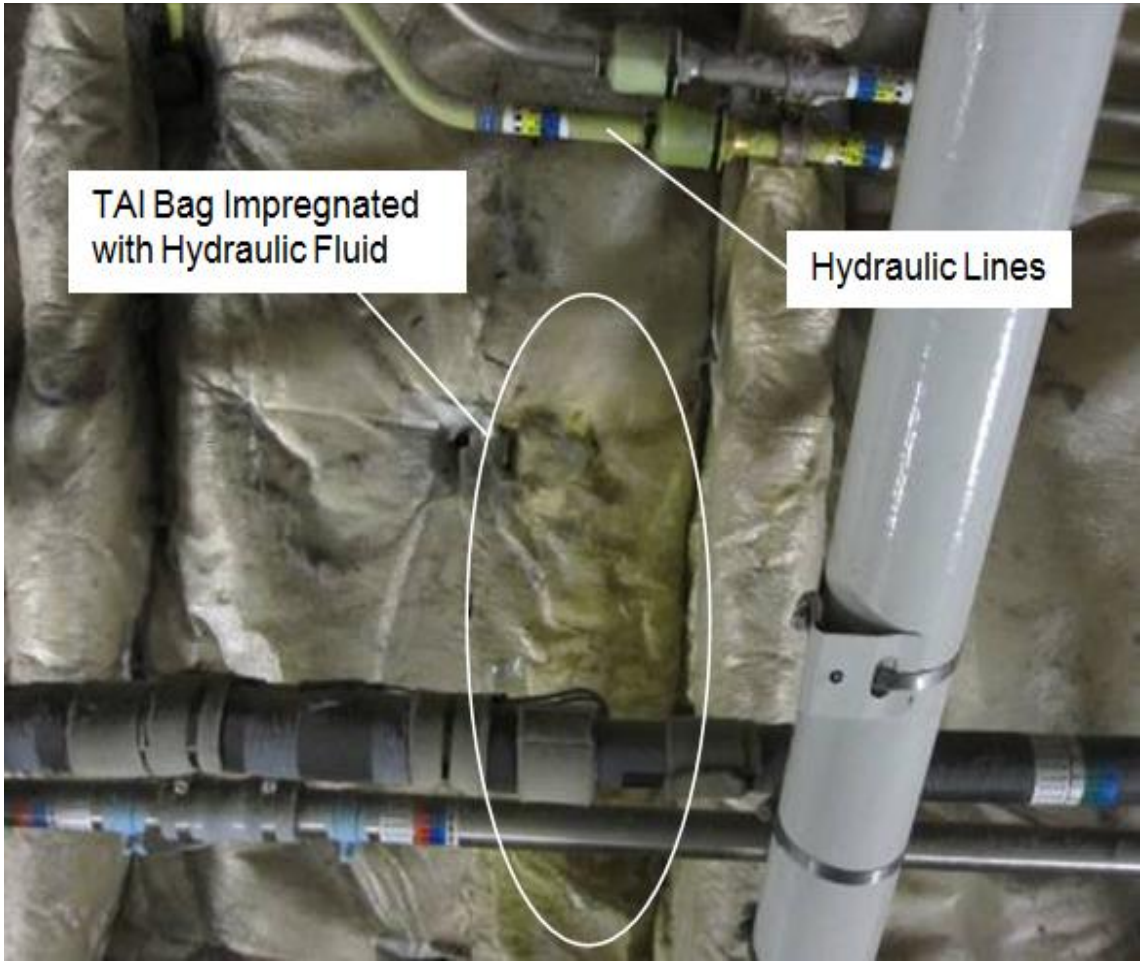
Survey Data

- **Other TAI Contamination**
  - Hydraulic oil – remains a threat (see picture)
  - Corrosion Inhibiting Compound (CIC) – none found. (testing previously shown variation in flammability of CICs)
  - Food wrappers – relatively common
- **TAI Degradation**
  - Moisture degradation of TAI at door surround – one occurrence found
  - Moisture degradation of TAI in keel – one occurrence found

See following photographs:

Survey Data

Hydraulic Oil



Survey Data

Moisture degraded TAI at door surround

Flammability Testing

- **Transport Canada Arc Test Rig Used**
  - Dust/lint laid on Kapton/fiberglass blanket
  - Ambient temperature 20 deg C (no radiant heat)
  - Sample at 20 degrees from horizontal

Flammability Testing

- **Test Results**

DUST/ LINT LEVEL (g/m^2)	SAMPLE ATTITUDE	DUST/LINT IGNITED	AFTER-FLAME TIME (s)	PROPAGATION DISTANCE (inch)	TEST RESULT
120	Horizontal	Yes	2.4	1.1	PASS
120	20 deg from horizontal	Yes	7.2	1.9	FAIL
80	20 deg from horizontal	Yes	12.1	2.1	FAIL
40	20 deg from horizontal	Yes	10.3	2.5	FAIL
20	20 deg from horizontal	Yes	0.6	1.0	PASS
20	20 deg from horizontal	No	0.0	0.0	PASS

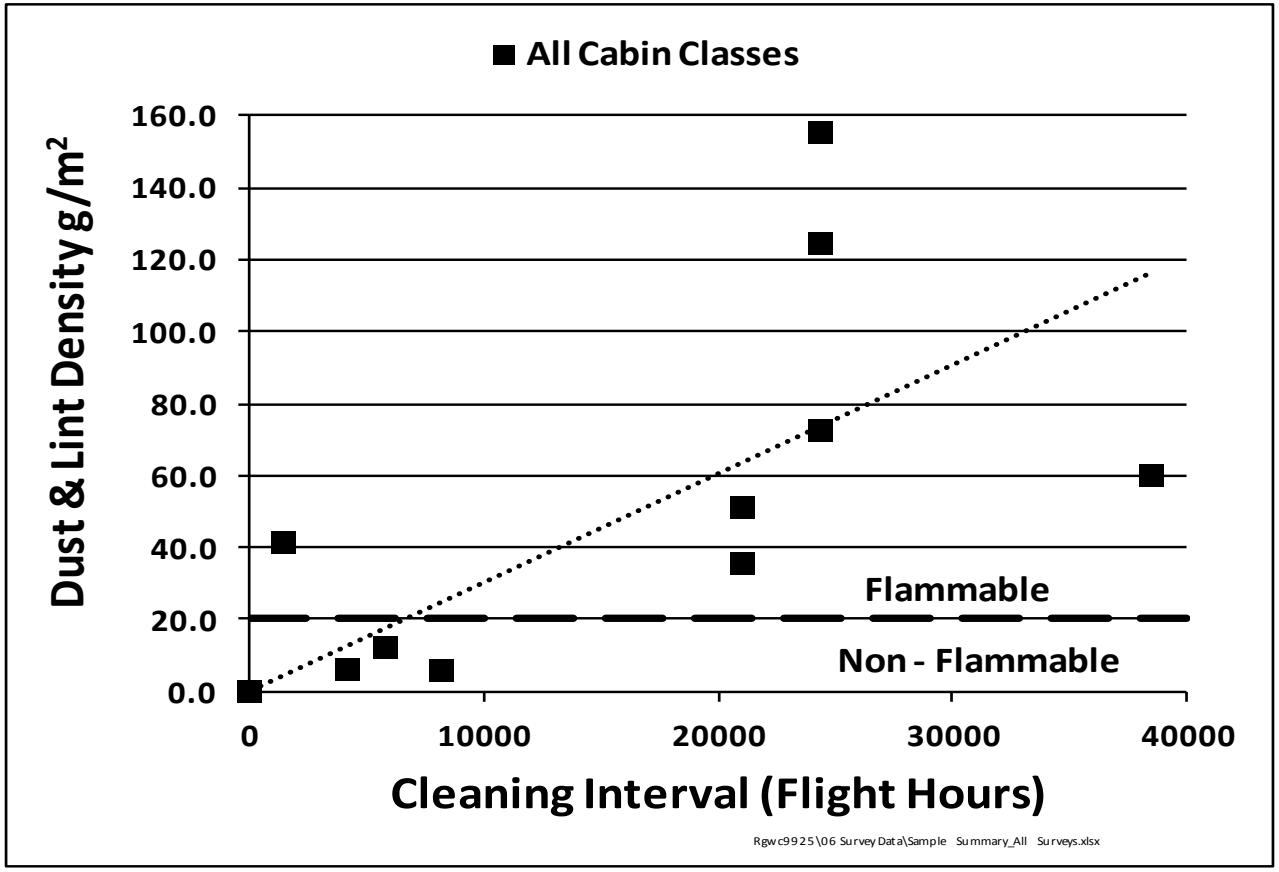
- **Pass/Fail criteria similar to FAA Radiant Panel Test**
  - FAIL if ignition occurs and flame propagates 2 or more inches, or for 3 seconds or more

Study Findings

- **The threshold level required for dust and lint to be ignitable by an electrical arc and propagate, when contaminating the surface of TAI at ambient temperature, is in the region of 20 g/m^2**
- **Levels of dust and lint above this threshold were observed on EWIS and TAI on the majority of aircraft surveyed**

See following graph:

Study Findings



Study Findings

- **No significant levels of dust and lint or other contaminants were observed on EWIS or TAI in aircraft avionics bays.**

- **Cleaning may not be sufficiently frequent to ensure dust and lint is kept below the level anticipated by current applicable guidance/advisory material.**

Study Findings

- **Once ignited, dust and lint at ambient temperature burned with a relatively weak flame. The heat flux output from such a flame and the propensity of the flame to propagate to other aircraft materials, has not been explored in this study.**
- **In some locations, dust and lint contamination on EWIS coexisted with large amounts of dust and lint on TAI, giving rise to a propagation risk in the event of electrical arcing.**

Study Findings

- **A precise dust and lint accumulation rate was not established in this study due to limited data.**
- **Dust and lint accumulation appears to be related more closely to flight hours than cycles.**
- **The rate of dust and lint accumulation appears to be greater adjacent to economy class than business class cabins and greater adjacent to business class than first class cabins.**

Study Findings

- **Some maintenance staff expressed view that ‘Clean as You Go’ philosophy was open to interpretation in relation to standard of cleanliness to be achieved and what the specific threats were.**

- **Maintenance staff commented that there may be ambiguity between what may be covered by a zonal inspection and what is covered by the EWIS activity.**

Study Findings

- **On-line EWIS Training/Certification (contract staff) may not be consistent with in-house training conducted by the MRO.**

- **Extra cleaning may be absorbed into MRO's task schedule precluding feedback to Aircraft Operator for modification to maintenance tasks.**

Study Observations

- **Cabin EWIS and return air routings do not appear to be optimised to minimise ignition risk in conjunction with dust and lint accumulation.**
- **Relatively simple design features might be considered for future aircraft to reduce dust and lint accumulation on EWIS or to protect EWIS from dust and lint accumulations.**
- **To be reviewed with Design Organisations (Phase 5)**