A380 Kevlar hose update

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Agenda

- Issue
- Background
- Current status
- Solution & next steps

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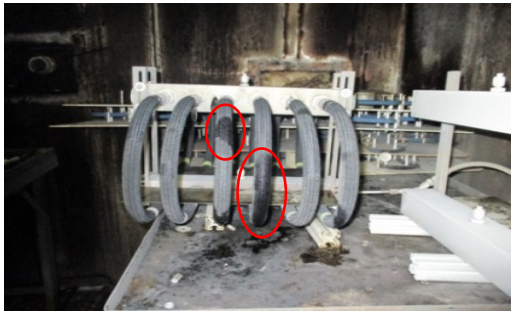
Issue

- A380 hoses experiencing “weeping”
- “Weeping” phenomenon attributed to microvoids in Kevlar hose inner tube
- “Weeping” occurs predominantly between 250 to 900 flight cycles
- Severity & occurrence varies by application
- Kevlar hoses replaced with steel braided hose in some instances
- “Weeping” hoses are removed and replaced causing disruption in airline operations

Examples of “weeping” phenomenon



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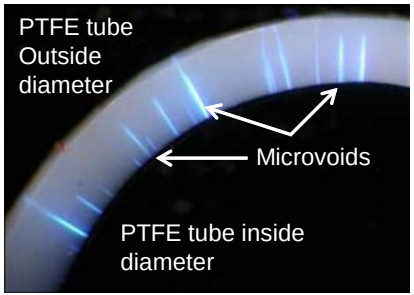
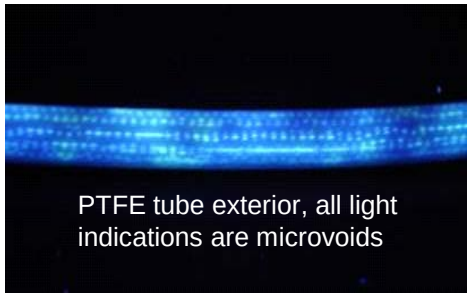
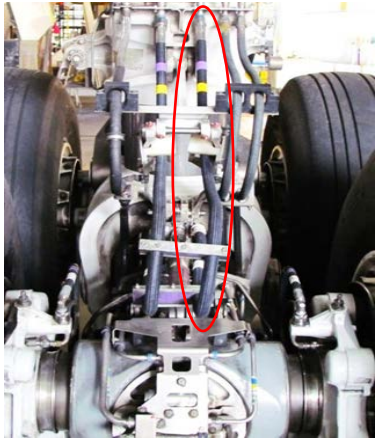
Background

- First identified on A380 landing gear in 2009 (AE717558-046)
- Source identified as through-wall Microvoids which ran from inner diameter to outer diameter of inner PTFE tube
- Surfaced as an industry-wide problem
  - Internal benchmarking
  - SAE committee investigations



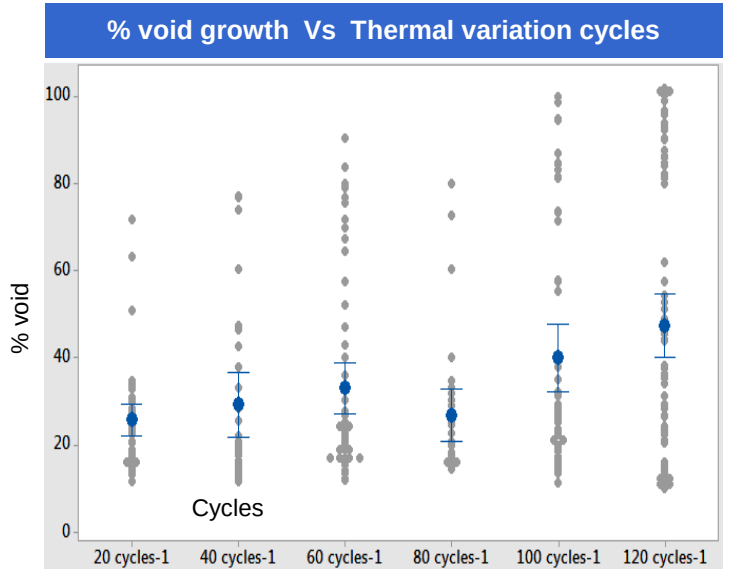


Original landing gear hose with "weeping" condition



Background

- As hose experiences thermal variation under pressure, microvoids grow until they are “through-wall”
- Weeping does not always occur when microvoids are through-wall but are indicators of potential weepage
- Severity depends on location, application and other factors



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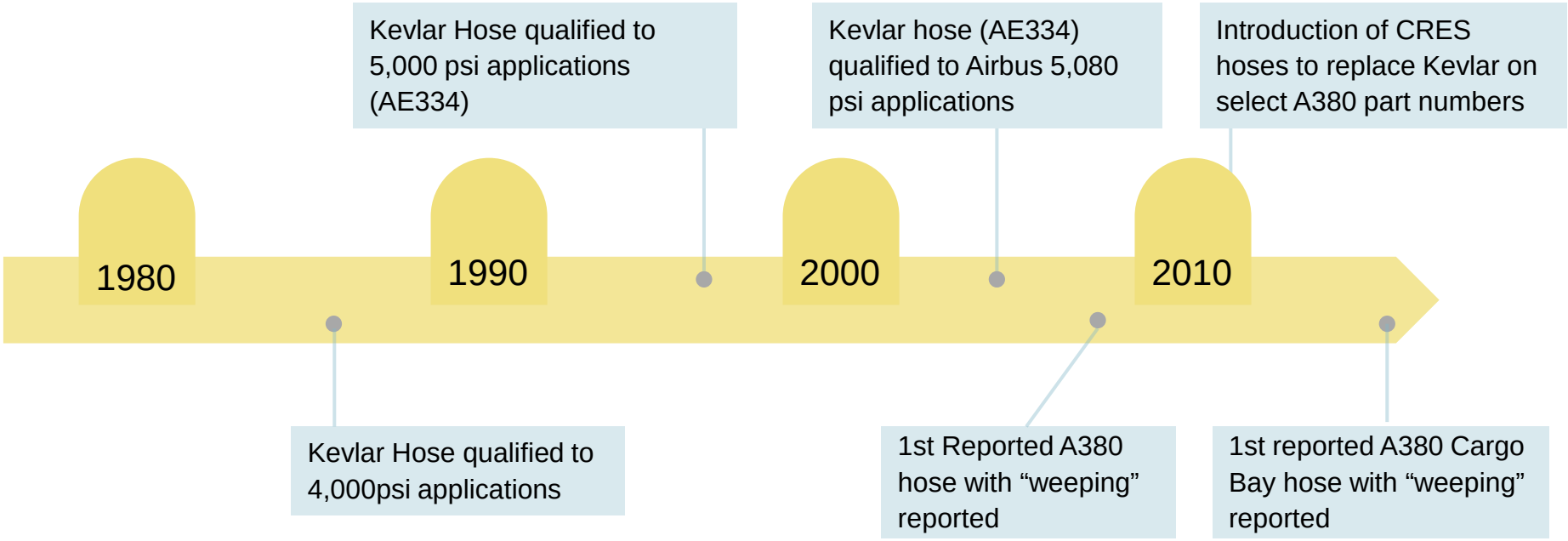
Background



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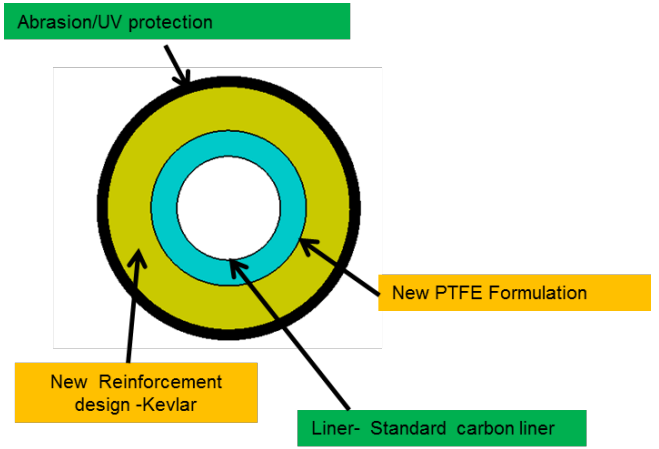
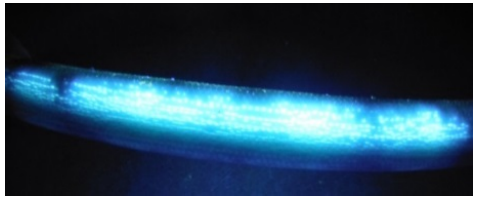
Current status

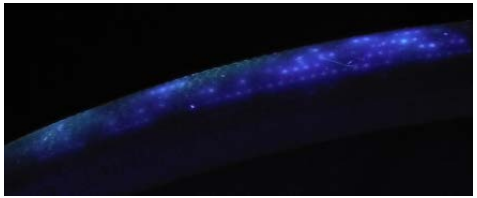
- Development of new Kevlar hose underway
- Investigation into critical design parameters which influence microvoid initiation and propagation
- Current focus on 2 parameters
  - PTFE Formulation
  - Kevlar reinforcement layer design



Current product with high microvoid content



Future product with minimal microvoids



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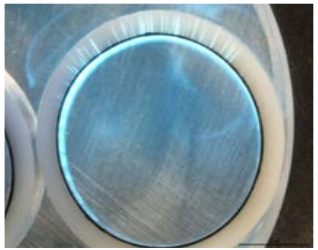
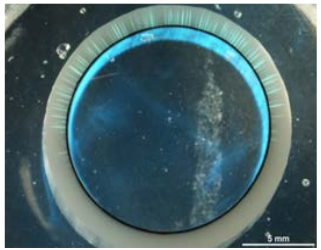
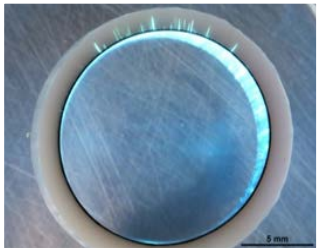
Current status



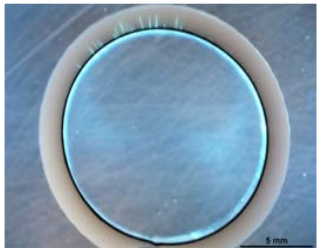
Baseline



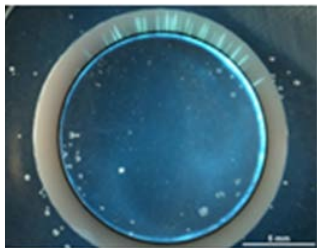
New Tube A



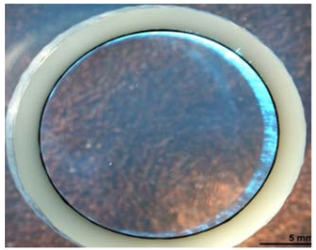
New Tube B



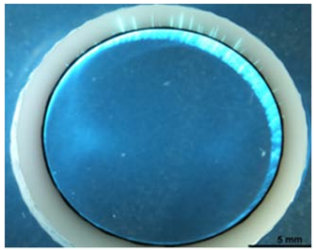
New Tube C



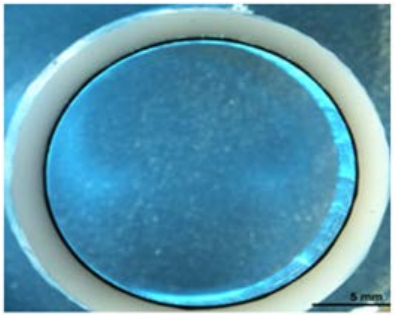
New Tube D



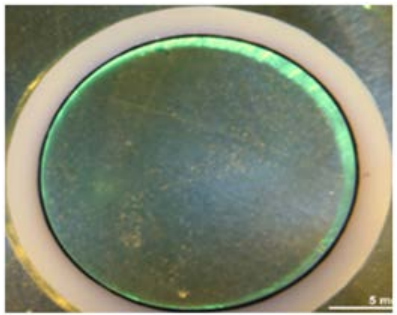
New Kevlar Reinforcement 1



New Kevlar Reinforcement 2



New tube & Kevlar Reinforcement 1



New tube & Kevlar Reinforcement 2

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Current status

- Manufacturing Updates

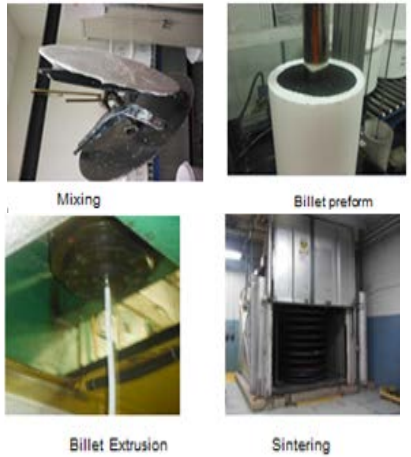
✓ Added data collection capability to preform press & extruder

✓ Studied lubrication variation in blended powder

✓ Room/powder temperature monitoring

✓ New batch oven (installed and operational)

✓ Additional inspection to evaluate concentricity of PTFE



Standard AE334-style hose construction

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Current status

- Currently investigating additional improvements in overall performance & maintenance
- Improved lay-line solution
- Improved abrasion resistance

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Solution & next steps

- Design Down-select & Configuration Freeze – July 2016
- Design Validation Testing Complete – September 2016
- Qualification of -10 size hose – December 2016
- Qualification of other size hoses - 2017

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Issue

- 2 hoses identified as having weepage in A380 aircraft cargo bay (ABS1401SAAKJH19, ABS1401SAAFFJ23)
- Hose assemblies consist of Kevlar (size -16) hose with a jump-sized, swaged titanium Rynglok fitting on each end
- To date, 7 hose assemblies have been returned to Eaton for investigation
  - 5 different hose material lots
  - Assembled between July 2006 – November 2008

ABS1401SAAFFJ23 (Eaton P/N AE710788-1)

ABS1401SAAKJH19 (Eaton P/N AE710831-1)

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Current status

- Investigation into cargo bay hoses ongoing
- All hoses (except one) were removed for weepage. No failure occurred
- FAR J8378 failed due to a pre-sintered defect which occurred during pressure test after installation
- Returned hoses have exhibited varying levels of abrasion where the hose is clamped

Typical installation

Abrasion location at clamp interface

Returned Sample with Abrasion

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Solution & next steps

Root cause investigation

- The hose is seeing movement during pressurization which is being constrained by the center clamp point
- As the hose moves, the surface of the hose rubs against the clamp resulting in abrasion of the outer cover

Next steps

- Airbus and Eaton working jointly on CRES wire braid replacement for Kevlar for this application
- CRES wire braid hose is more rigid and will not induce movement in the hose assembly
- CRES wire braid hose will replace 2 part numbers (ABS1401SAAKJH19, ABS1401SAAFFJ23)
- Redesign of the clamp will be required to accommodate the new CRES hose

Example of multi-directional stress cracks

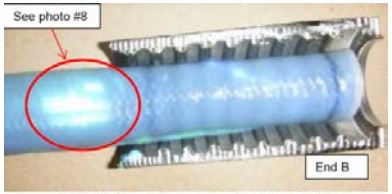

Photo #7- Showing stress cracks at socket skirt

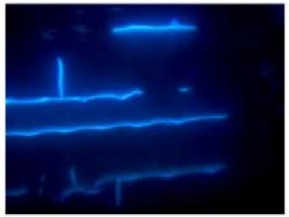

Photo #8- Enlarged view of stress cracks at End B

Abrasion location at clamp interface

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Questions/Comments

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