Next Generation Fire Test Burner for Powerplant Fire Testing Applications

International Aircraft Systems Fire Protection Working Group
Atlantic City, NJ
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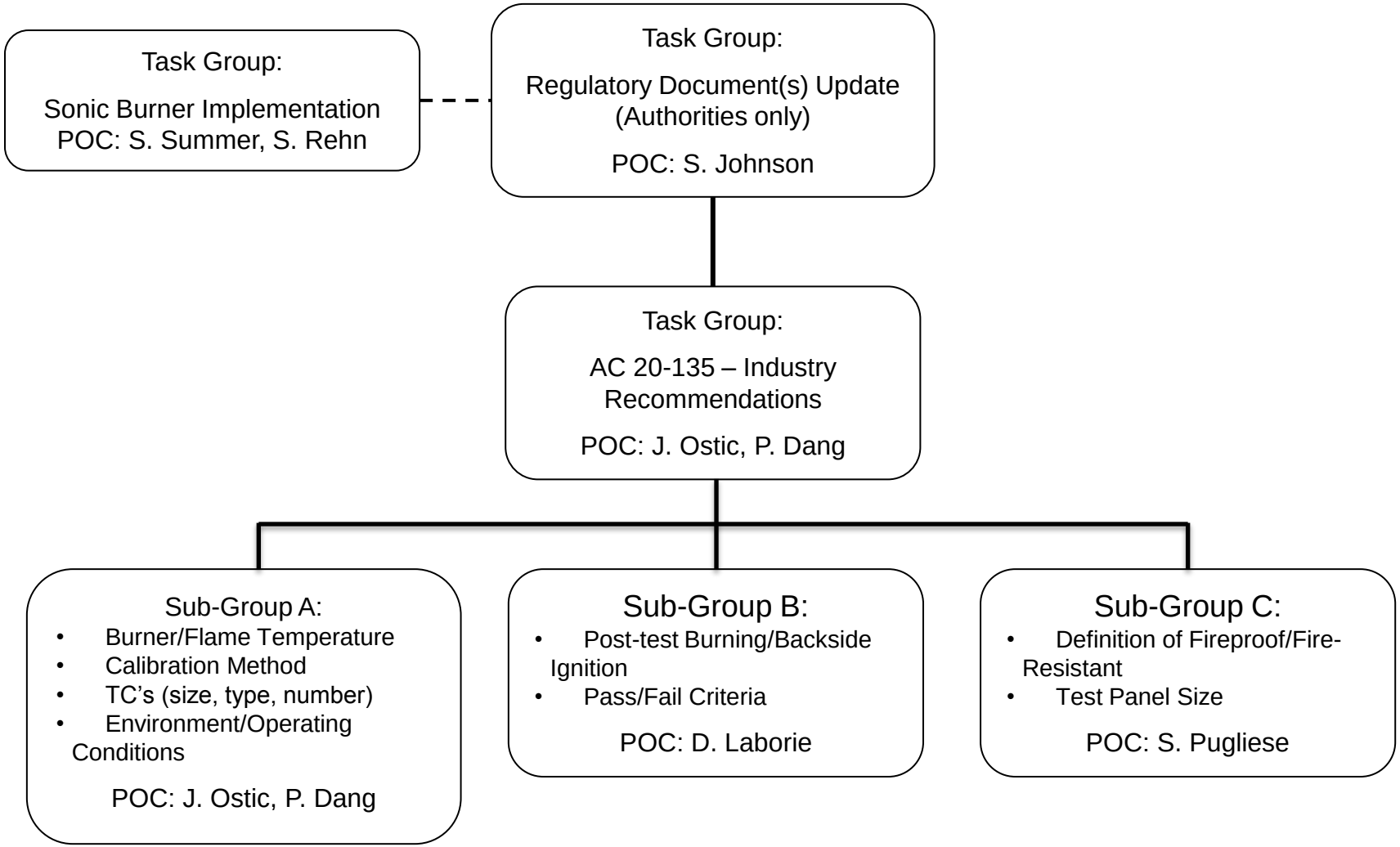
http://www.fire.tc.faa.gov

Background

- **Currently specified oil burners are no longer commercially available**
- **Industry is utilizing legacy oil and propane burners**
- **Propane burner has been shown to be less severe than an engine flammable fluid flame**
- **New Technology Sonic Burner developed and approved for use in interior and fuselage testing.**
  - Sonic Burner provides numerous advantages to legacy burners
- **FAA Tech Center Fire Safety Branch has been tasked by Transport Standards Branch (TSB) to develop burner performance standards for the next-generation fire test burner for powerplant fire testing**
  - New burner should be much easier to calibrate, provide more consistent results, and be readily available for industry use.


Task Group:
Sonic Burner Implementation
POC: S. Summer, S. Rehn
Task Group:
Regulatory Document(s) Update (Authorities only)
POC: S. Johnson
Task Group:
AC 20-135 – Industry Recommendations
POC: J. Ostic, P. Dang
Sub-Group A:
• Burner/Flame Temperature
• Calibration Method
• TC's (size, type, number)
• Environment/Operating Conditions
POC: J. Ostic, P. Dang
Sub-Group B:
• Post-test Burning/Backside Ignition
• Pass/Fail Criteria
POC: D. Laborie
Sub-Group C:
• Definition of Fireproof/Fire-Resistant
• Test Panel Size
POC: S. Pugliese

Current Status - Testing

- **Previous round robin consisted of aluminum, PAN and copper slug calorimeter**
- **Searching for additional non-metallic materials to test in a round robin with objectives of**
  - Utilizing results to ensure proper settings of sonic burner
  - Ensure consistency of testing within lab using sonic burner
  - Ensure repeatability across burners at various labs

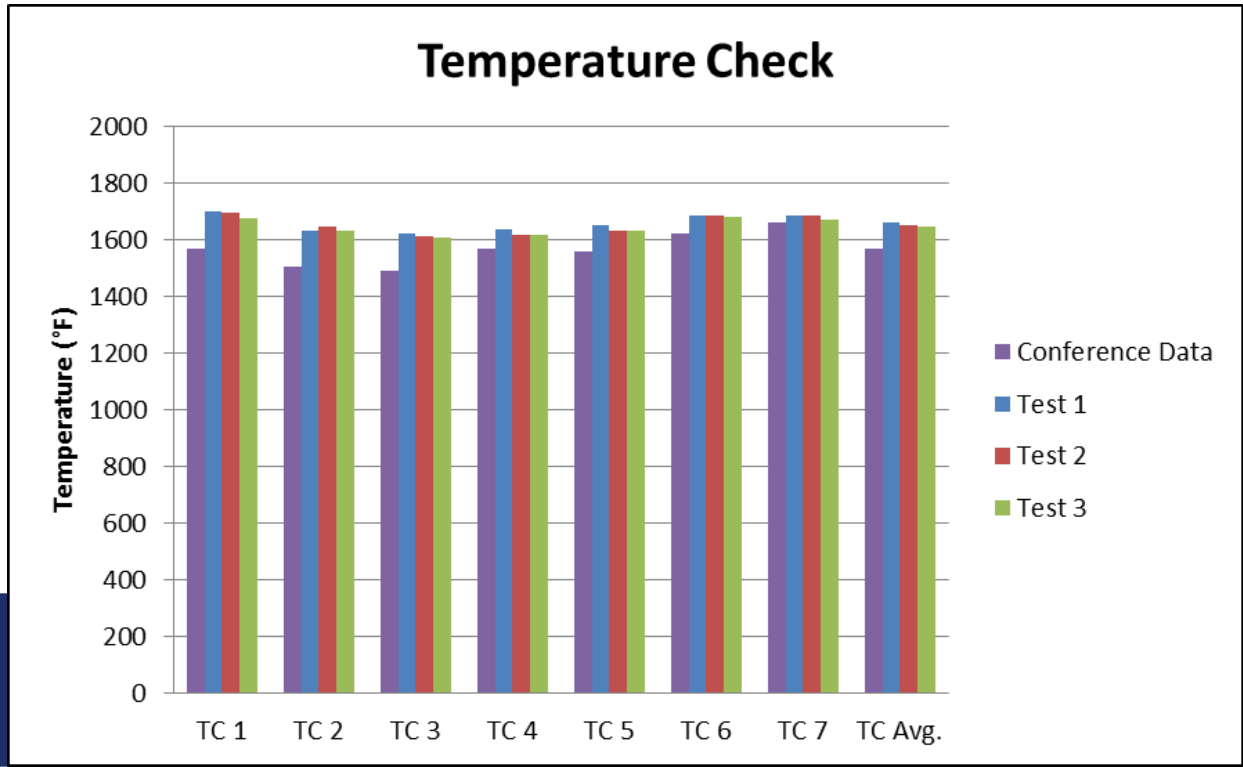
Materials Previously Evaluated

- **10-ply carbon composite**
- **Carbon Fiber – 1-ply, 2-ply & 3-ply**
- **Fiberglass – 1-ply, 2-ply & 3-ply**
- **Garolite**
- **¼” Honeycomb Panel**
- **Fiberglass cargo liner**

All shown to not be suitable for round-robin testing

Burner Settings

- **Nozzle: 80° B 2.0 gph**
- **Flow-checked 2.00 gph @ 102 psi**
- **Air Pressure: 50 psi**
- **Copper Tube Heat Flux (3 test average): 5111.3 Btu/hr**
- **Temperature check (first 3 tests with brand new 1/8” exposed-bead thermocouples**



Composite Tests

- **0.060” FR4 Glass Epoxy**
  - Flame resistant material used in printed circuit boards
- **Did not burn through after 15:00**

Composite Tests

- **0.007” 1-Ply Unidirectional Carbon Fiber**
- **Burn-through times*:**

Test 1	7:35
Test 2	6:36
Test 3	9:34

- ***Material split along grain in first few seconds, but the test was continued hoping that the fibers would burn through.**
- ***Fibers did not actually burn through, they just became unclamped from the top**
- **Material is unsuitable for round robin testing**

Resonate Testing

Resonate TESTING LIMITED
A NACELLE GROUP COMPANY

- **Composite panels supplied by Bombardier/Shorts**
  - 2 plies (0°/45°), roughly 0.030″ thick
- **Burner calibrated to minimum avg of 2000°F across 7 T/C's, Heat Flux >4500 btu/hr**
  - stabilized on Cu tube for 1 minute
- **Total of 6 panels tested**
  - 3 with vibration applied at differing times during test
  - 1 with no vibration
  - 1 with a bolt installed in the middle
  - 1 with bolt installed with a 5 kg weight applied in tension

Resonate Testing

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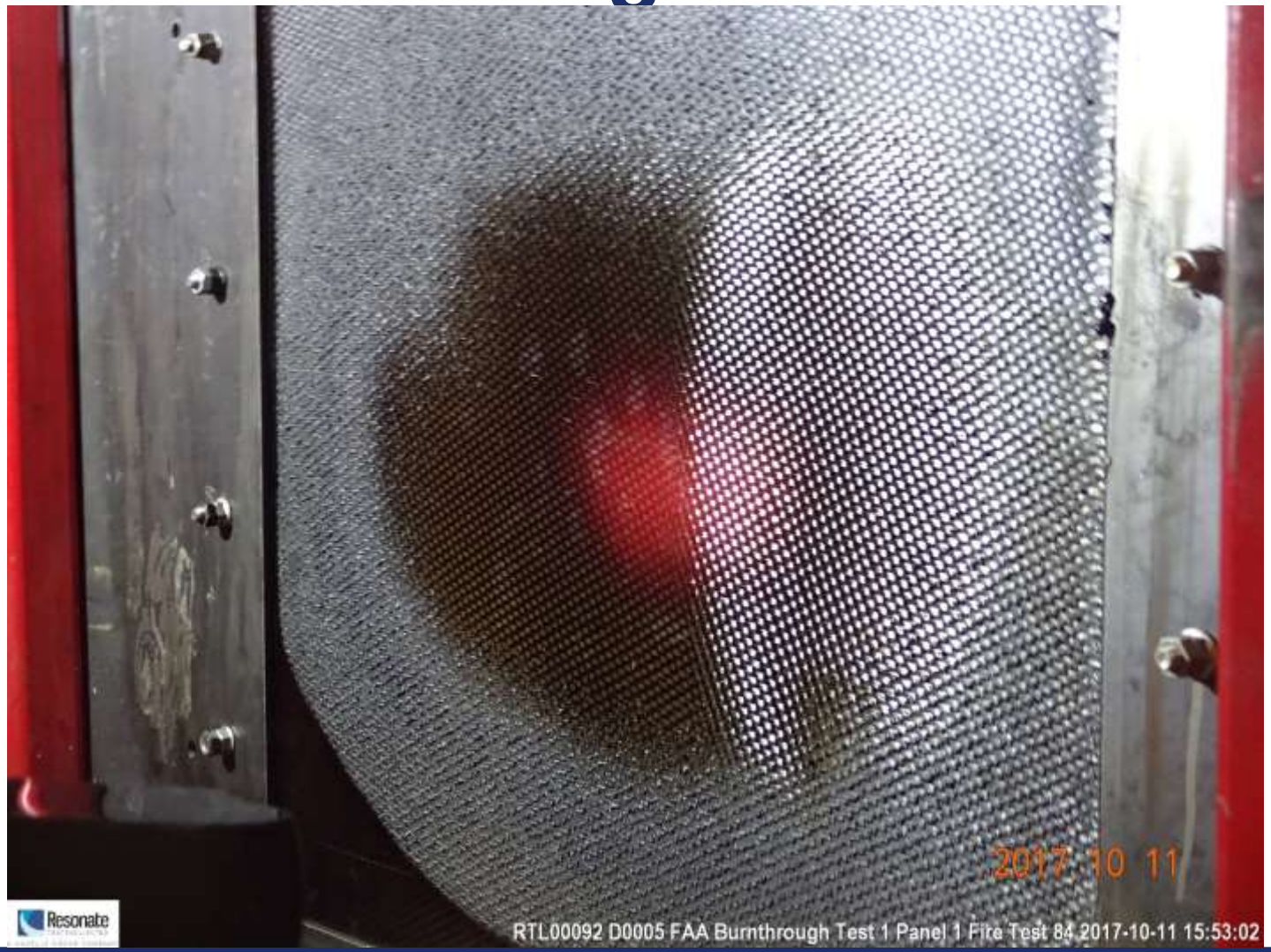
Resonate Testing



Resonate Testing

Resonate Testing

Resonate Testing

	TEMP (min Avg)	BTU/Hr	Burnthrough TIME	Vibration applied @	Summary	Comment
Panel 1	2025	4696	00:27:16	20:20	Wednesday Afternoon.	Vibration applied in the expection of generating expeditated Burnthrough- No significant impact observed.
Panel 2	2010	4606	00:25:18	20:20	Wednesday Afternoon.	
Panel 3	2011	4641	00:26:30	00:00	Thursday Morning Applied vibration has no impact?	Vibration 4G applied from start. NO IMPACT- Vibration discontinued.
Panel 4	2116	5234	0:24:45	No Vibe	Thursday Afternoon Increased BTU does not significantly affect burnthrough time	Excess Flame temp and BTU/hr applied. NO IMPACT.
Panel 5	2035	4720	0:20:00		Bolt installed in center of panel	1 week later returned with new approach. Stopped test- Bolt making no impact
Panel 6	2019	4839	0:22:34		Bolt installed in center of panel with a 5kg load	Pull through eventually achieved!

Test 4 Flame artificially high, no significant impact.

Test 6 Pull Through load, no significant impact.

Composite Testing - Next Steps/Questions

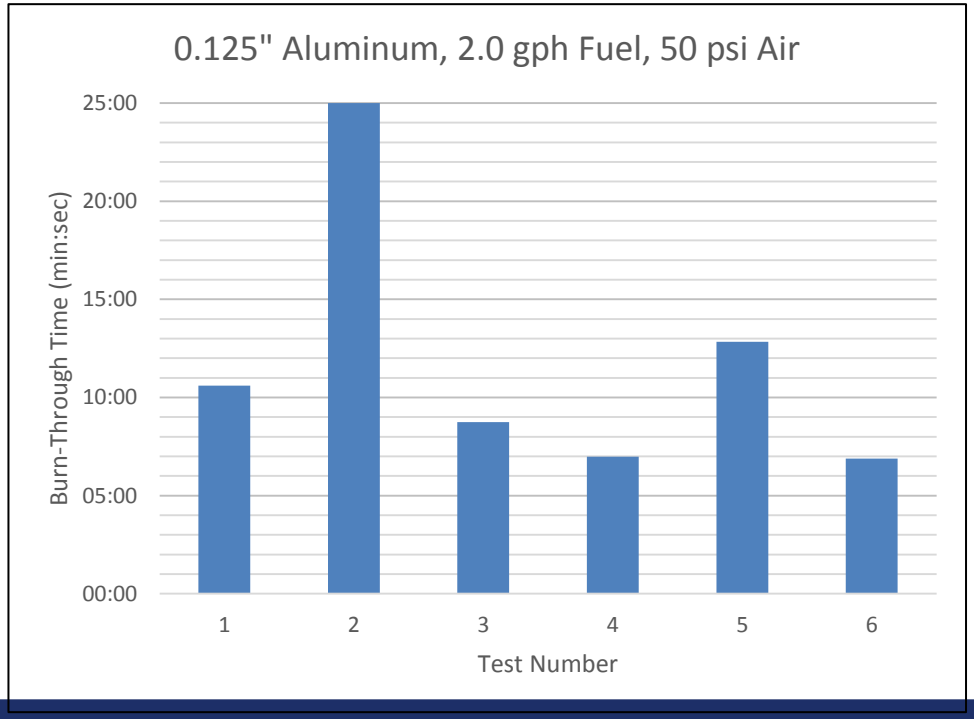
- **Bombardier (Shorts) will continue to support provision of the material panels: the definition to be agreed.**
- **Is burnthrough the proper measure of failure for this type of material? How else can we measure failure?**
- **It is possible that composite materials are just not suitable for round robin testing, and other options need to be explored.**
  - Felt Materials (Nomex, Kevlar, PAN)
  - Varying thickness of aluminum
  - ???

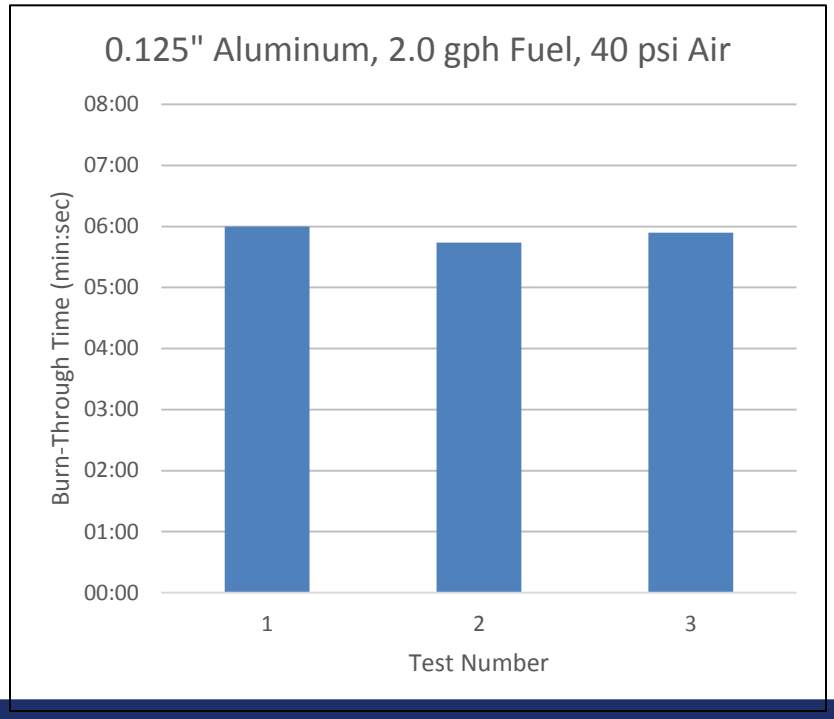
Aluminum Panel Tests

- **Questions arose during some Task Group meetings regarding aluminum burnthrough times**
- **Standards refer to aluminum as being fire-resistant (i.e. burnthrough >5mins)**
- **Strong desire from group to ensure that NexGen burner maintains this definition.**

Aluminum Tests

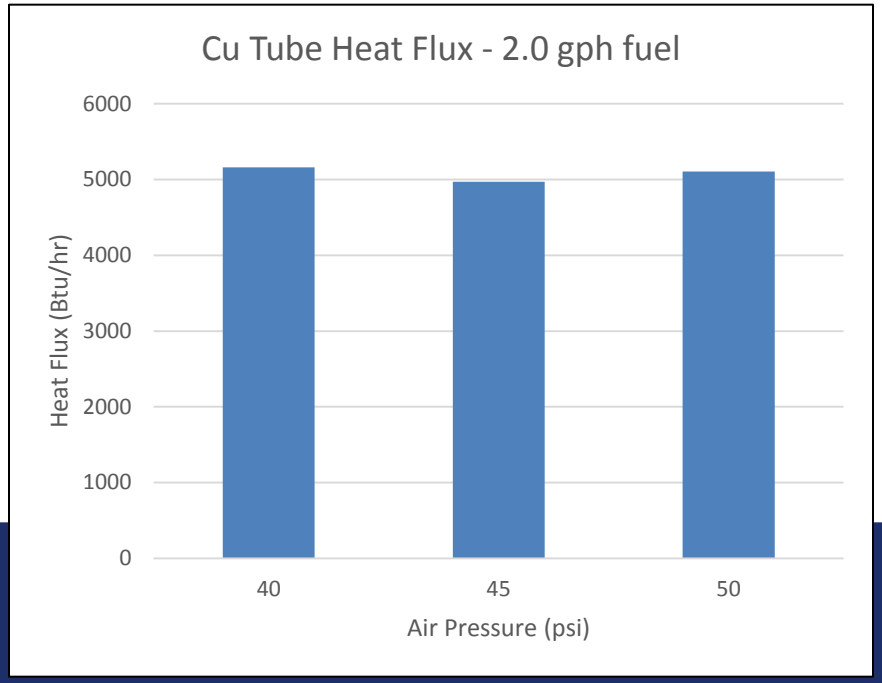
- **0.125” 2024-T3 Aluminum**
- **No repeatability with 50 psi air pressure**
- **Very repeatable with 40 psi air pressure**

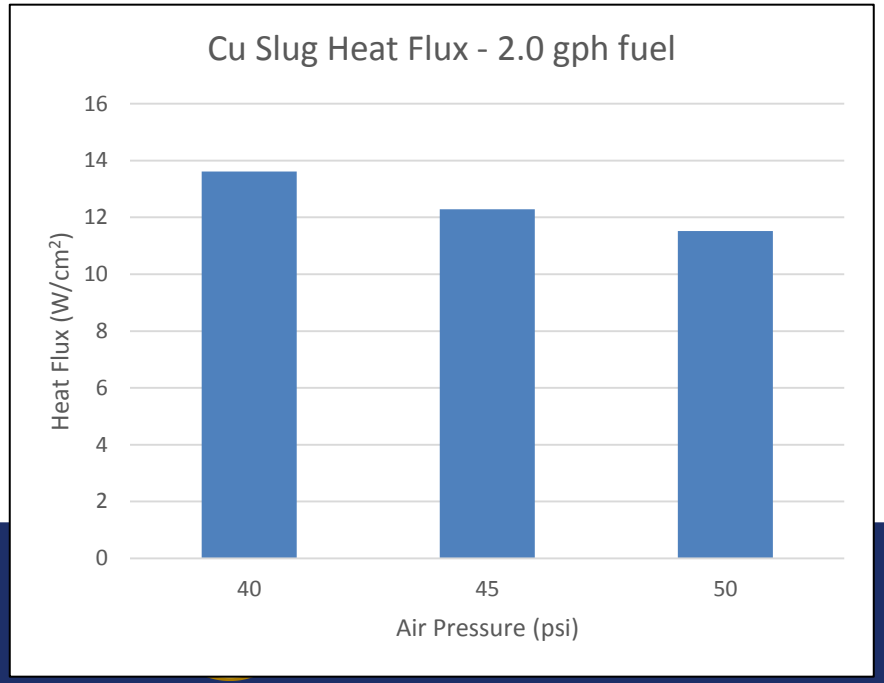


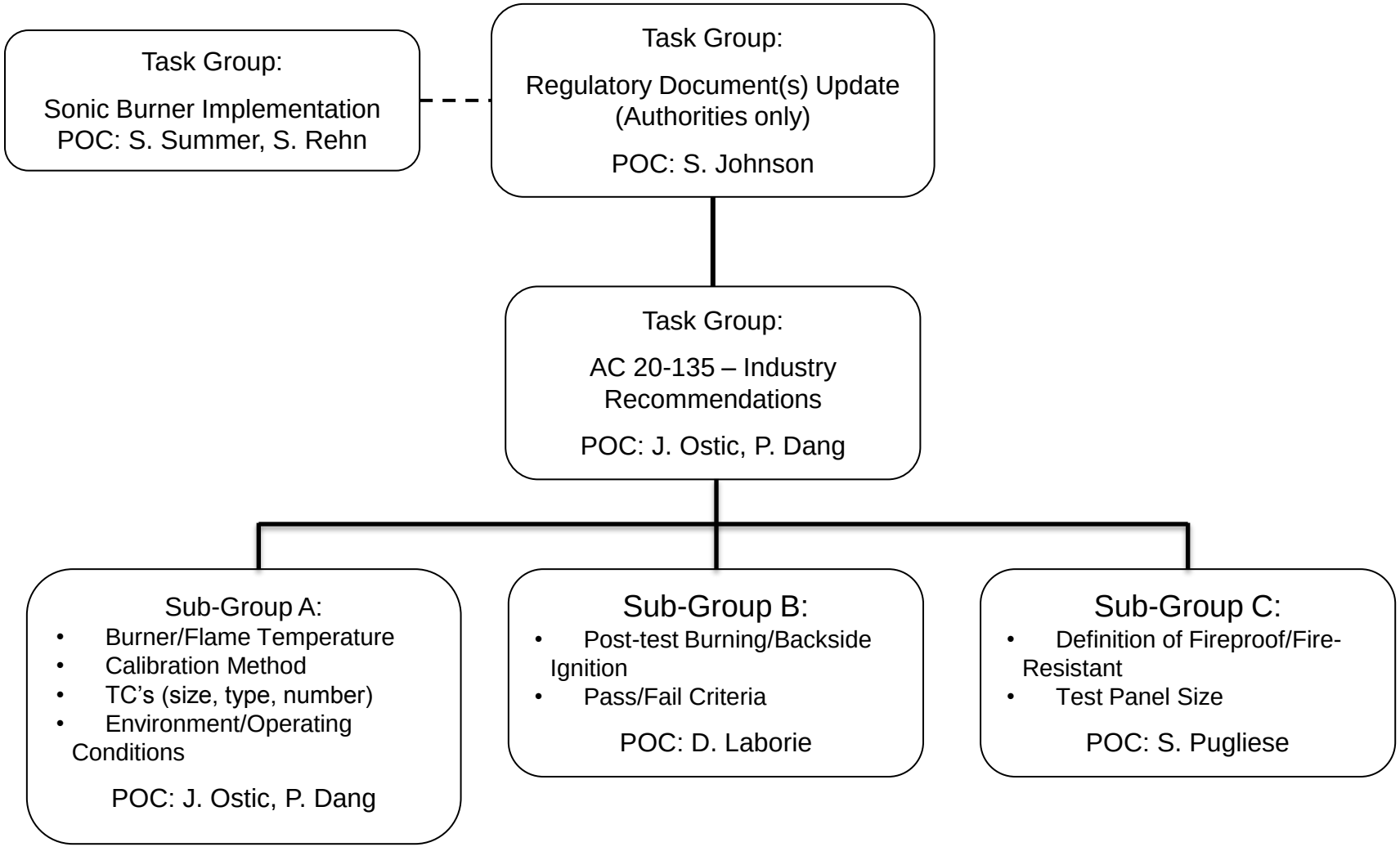


Air Pressure Comparison

- **50 psi air had highest temperatures in previous testing**
- **Copper tube heat flux was relatively constant**
- **40 psi air had highest copper slug heat flux**
- **Copper slug correlated best to aluminum burn-through times**



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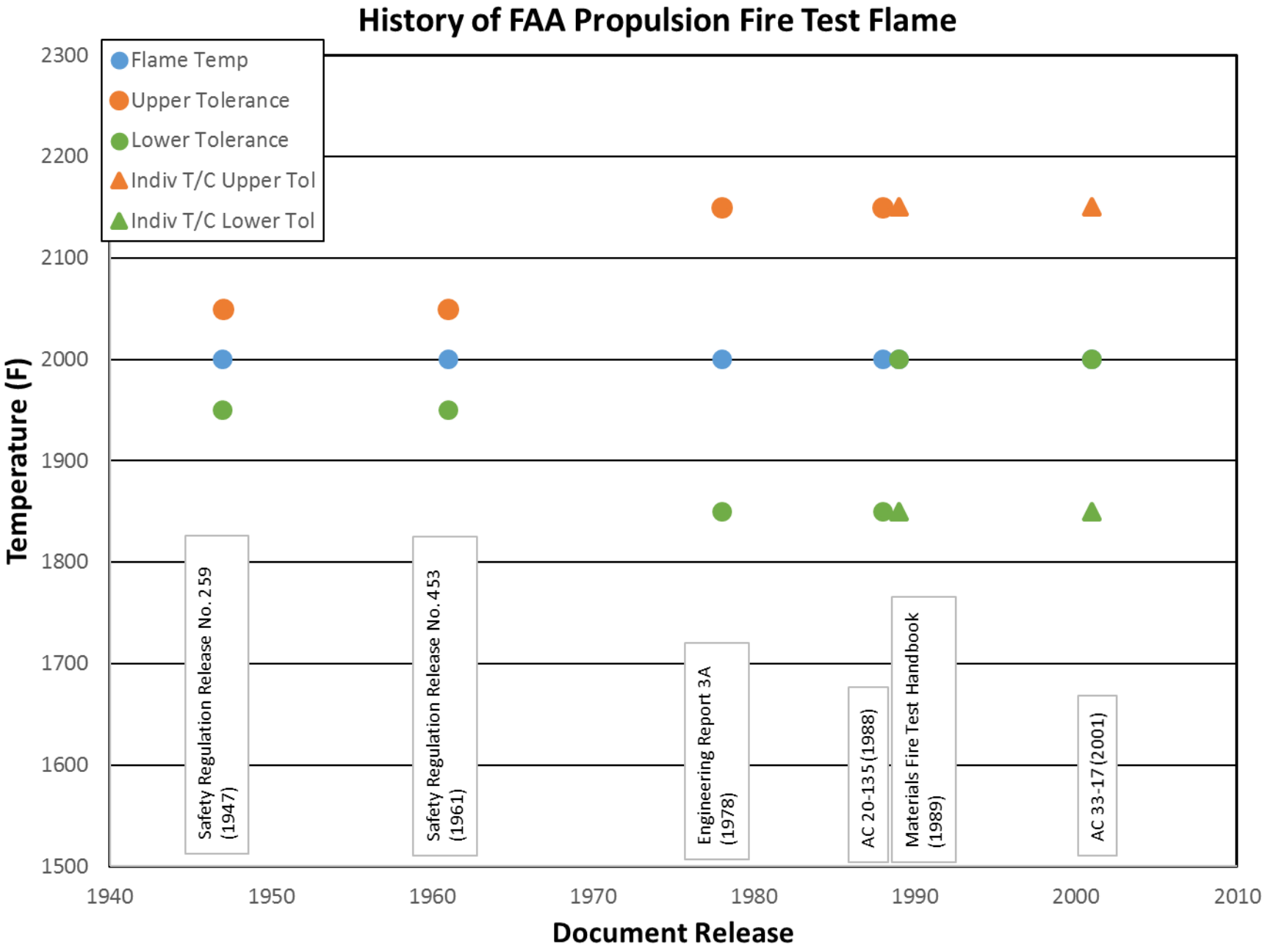
Current Status - Regulatory

- **Draft policy memo regarding the use of the Propane Burner (mentioned at May meeting)**
  - It has been decided to instead address this issue through a change to AC 20-135.
  - Anticipated release for public comment by end of year.
- **Continued effort to address industry concerns and harmonize with international authorities.**

Current Status - Regulatory

- **Flame Temperature Calibration**
  - Issue from industry was brought forth regarding the flame temperature requirement
  - Current requirement is a minimum average of 2000°F across 7 T/Cs
    - Tolerance on each individual T/C of ±150°F
  - This is a shift from the past requirement of an average flame temperature of 2000±150°F
  - TSB reviewed history of flame temperature requirement in attempt for a better understanding of changes and when/why they occurred.


History of FAA Propulsion Fire Test Flame
Flame Temp
Upper Tolerance
Lower Tolerance
Indiv T/C Upper Tol
Indiv T/C Lower Tol
Temperature (F)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1940
1950
1960
1970
1980
1990
2000
2010
Document Release
Safety Regulation Release No. 259 (1947)
Safety Regulation Release No. 453 (1961)
Engineering Report 3A (1978)
AC 20-135 (1988)
Materials Fire Test Handbook (1989)
AC 33-17 (2001)

- **TSB conclusion was *"The FAA has not changed our definition of the test flame. We have always intended the definition of fireproof to be 2000°F."***
- **Discussions surrounding appropriate flame calibration continue within industry group.**
  - Flame temperature
  - Flame Heat Flux
  - Standardized measurement methodology
- **Industry group to provide recommendation and substantiation data to authorities for review.**

Questions?

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