International Aircraft Materials Fire Test Working Group Meeting

Cargo Liner Test

Presented to: International Aircraft Materials Fire Test Working Group

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Federal Aviation Administration

Introduction

- **Cargo Liner Sonic Burner Round Robin**
  - Setup, Sample Materials, and Test Results
- **Burner Cone Deformation Study**
  - A closer look at different alloys and manufacturing process
- **Recent Chapter 8 Handbook Revisions**
  - Since it was posted on the FAA Fire Safety website
- **Future Work**
  - What comes next?

NexGen Burner Development

Park Burner

NexGen Burner

Cargo Liner Round Robin Study

Cargo Liner Round Robin Study

- **Purpose:**
  - **Conduct a round robin study using NexGen burner with igniterless stator configuration to determine if the overall burner configuration can be used as an acceptable alternative to the Park burner for cargo liner certification tests**
    - **Igniterless configuration eliminates igniters and associated wiring to minimize airflow obstructions within the burner draft tube**
    - **Eliminating wires and internal igniters reduces potential differences within the burner among test labs, increasing the potential for repeatable results**

Cargo Liner Round Robin Study

- **Round Robin Guidance**
  - All labs provided with the same type and number of sample test materials by the FAA
  - All Labs instructed to configure burners as per the recent Chapter 8 Handbook update, which includes the latest NexGen configuration (igniterless stator)
  - Labs asked to provide sample test result and any additional pertinent data
    - Fuel pressure, flame temperature measurement, ventilation airflow rates, etc.

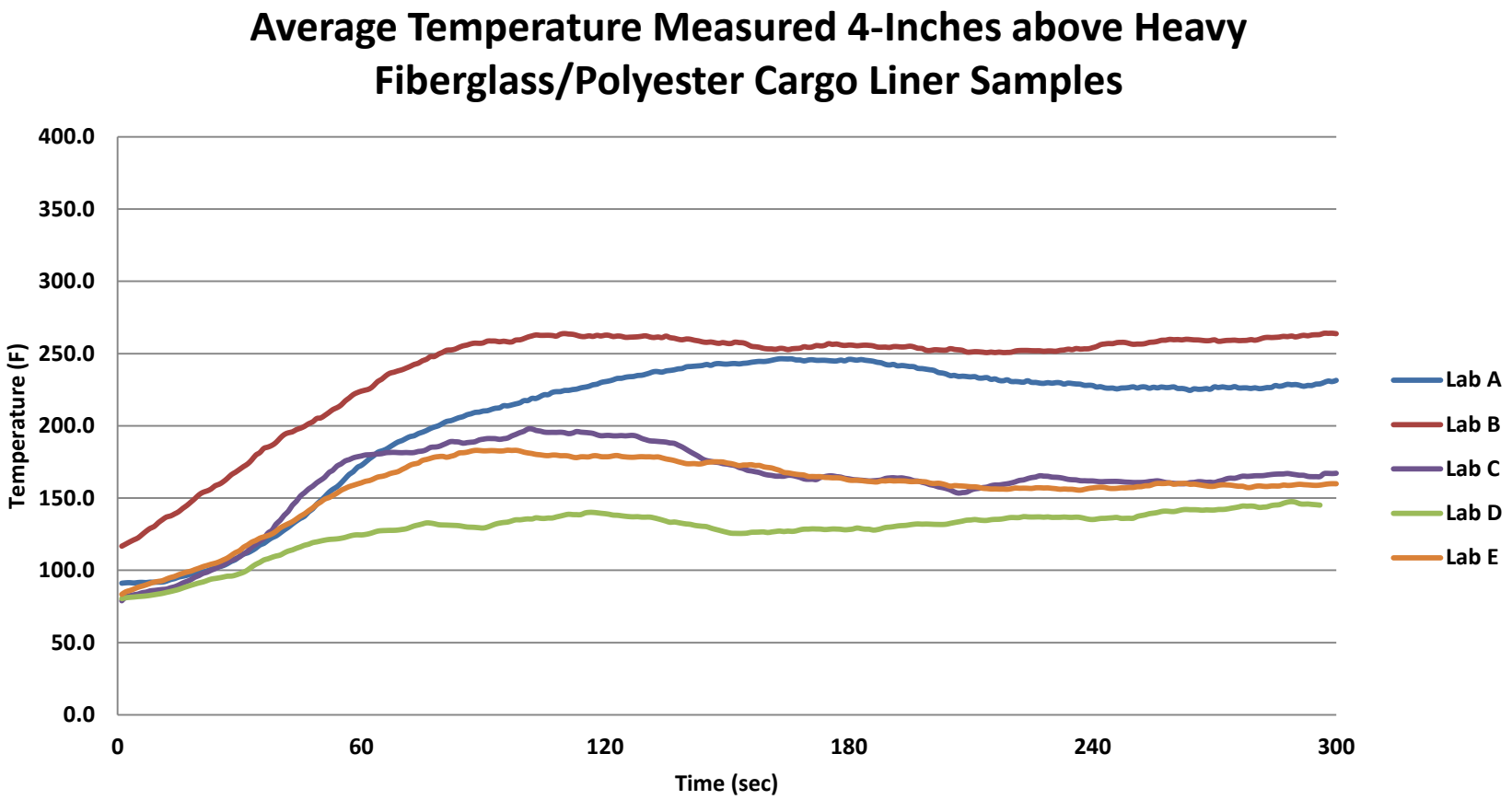
Cargo Liner Round Robin Study

- **Cargo Liner Sample Materials**
  - Cargo liner materials used in commercial aircraft
    - (5) Heavy woven fiberglass/polyester
    - (5) Light woven fiberglass/phenolic
  - Temperature measured per Chapter 8 Handbook for the standard five minute burner flame exposure period
    - Temperatures measure four inches above liner sample using a 1/16” thermocouple

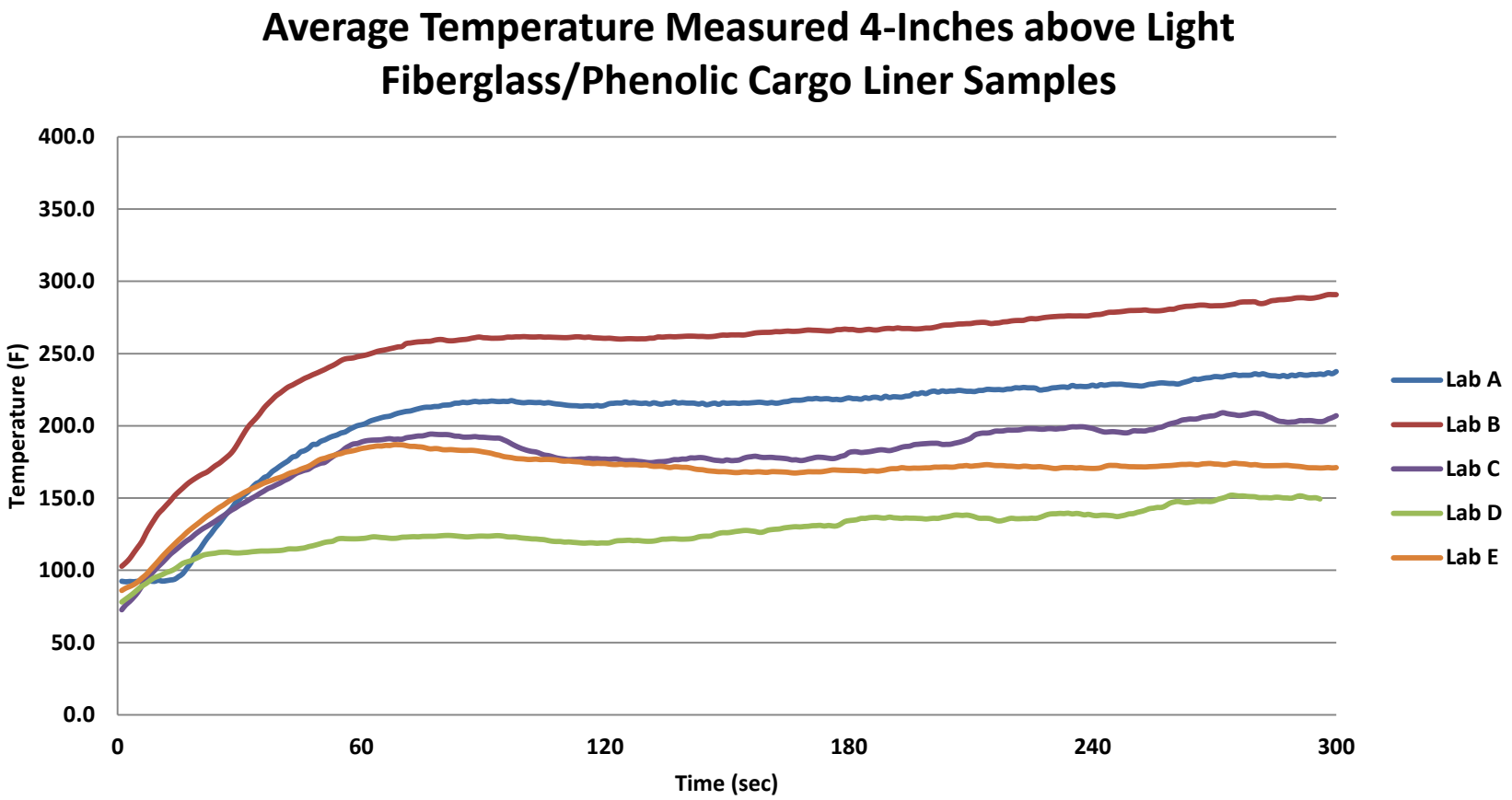
Cargo Liner Round Robin Study

- **Burnthrough Materials**
  - Materials design to burnthrough under 5 minutes
    - (5) Garolite (CE) 0.125” thick, cotton-base phenolic
      - McMaster-Carr # 8491K15
    - (5) Garolite (LE) 0.25” thick, cotton-base phenolic
      - McMaster-Carr # 8474K144
    - The materials are commonly referred to as “Bakelite”
  - A variety of materials available through McMaster-Carr were initially tested
    - The two supplied sample materials were selected based on their consistent burnthrough characteristics
      - Measured time required until flame penetration of material

Cargo Liner Round Robin Study



Cargo Liner Round Robin Study



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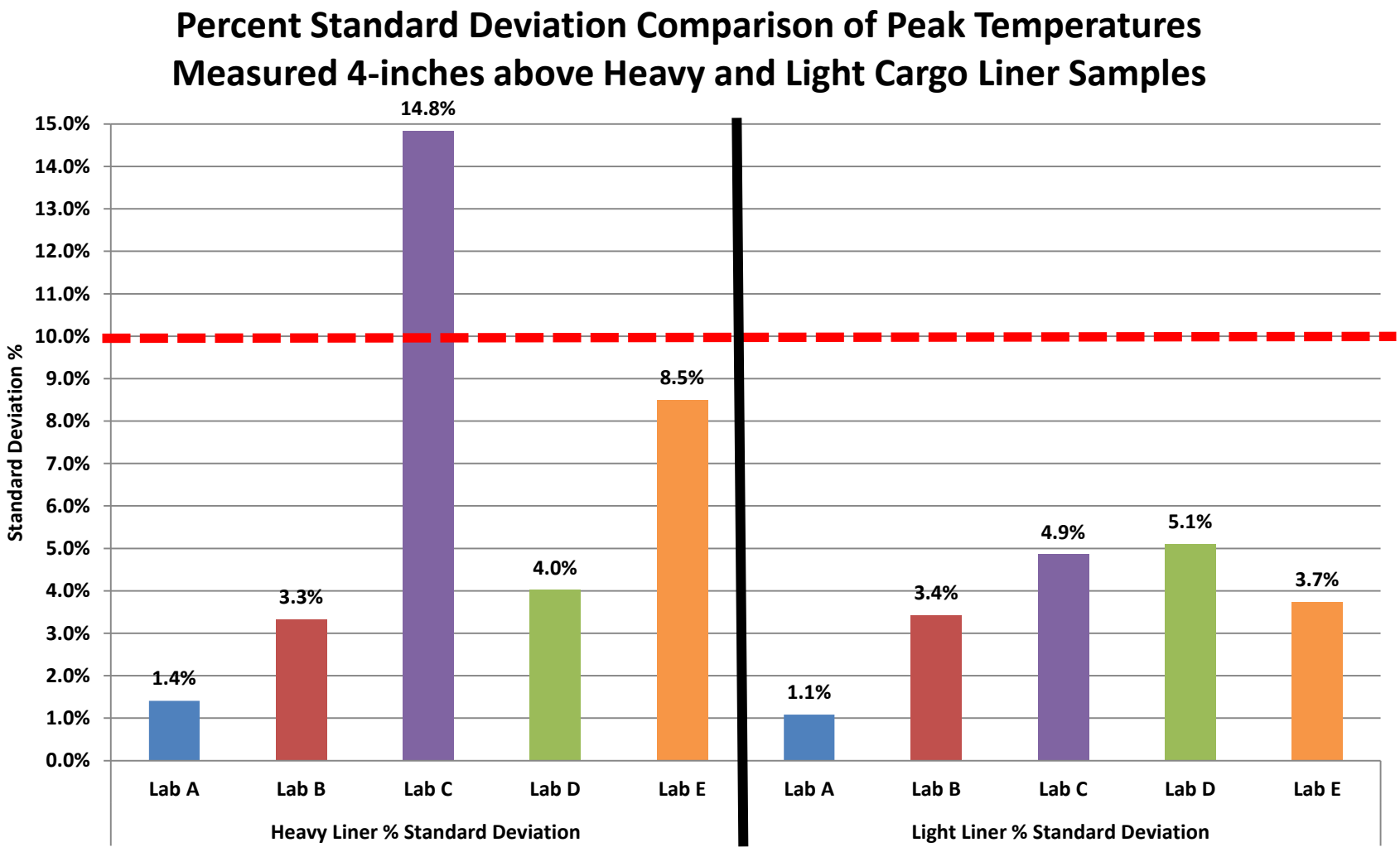

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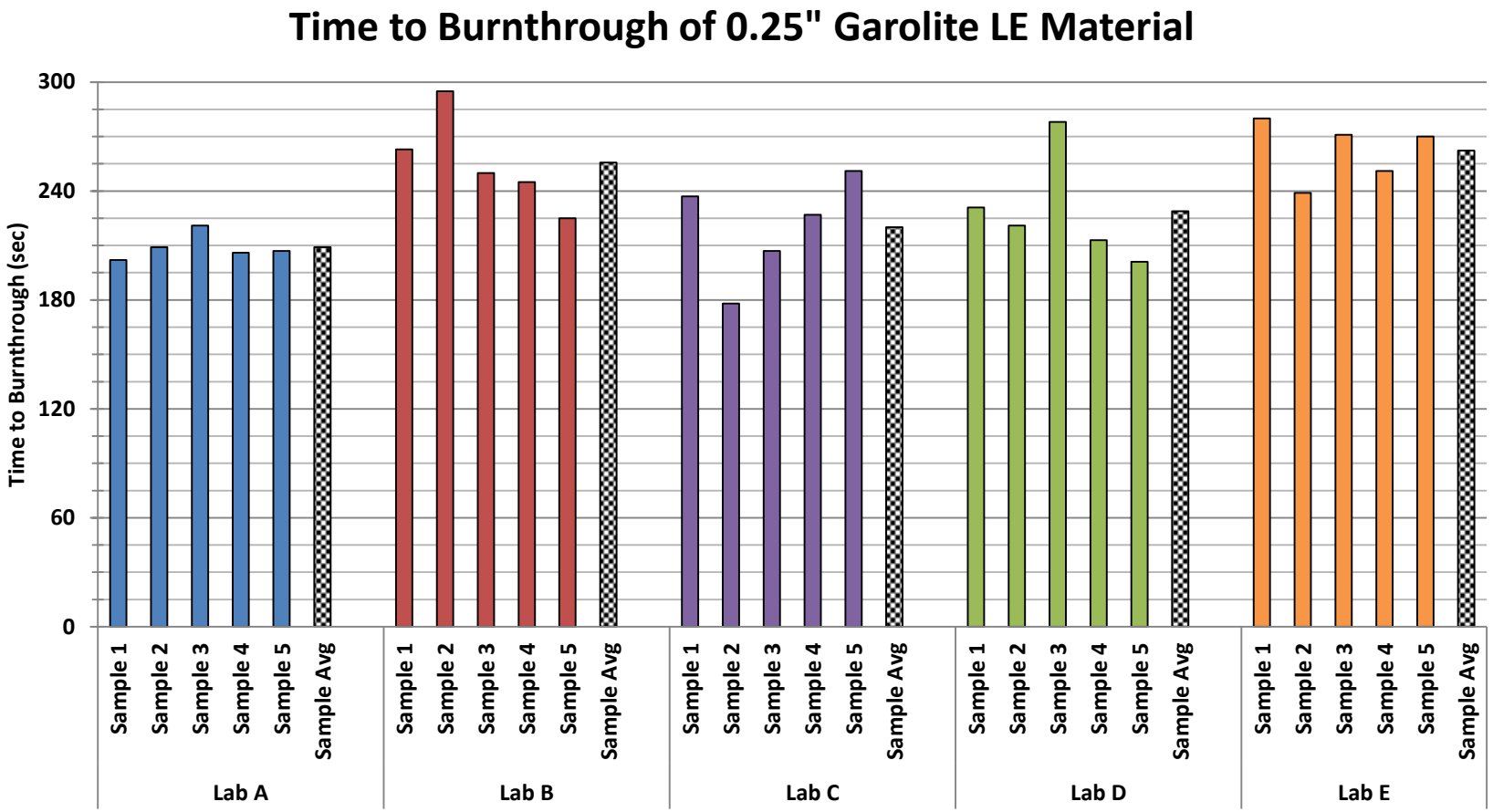

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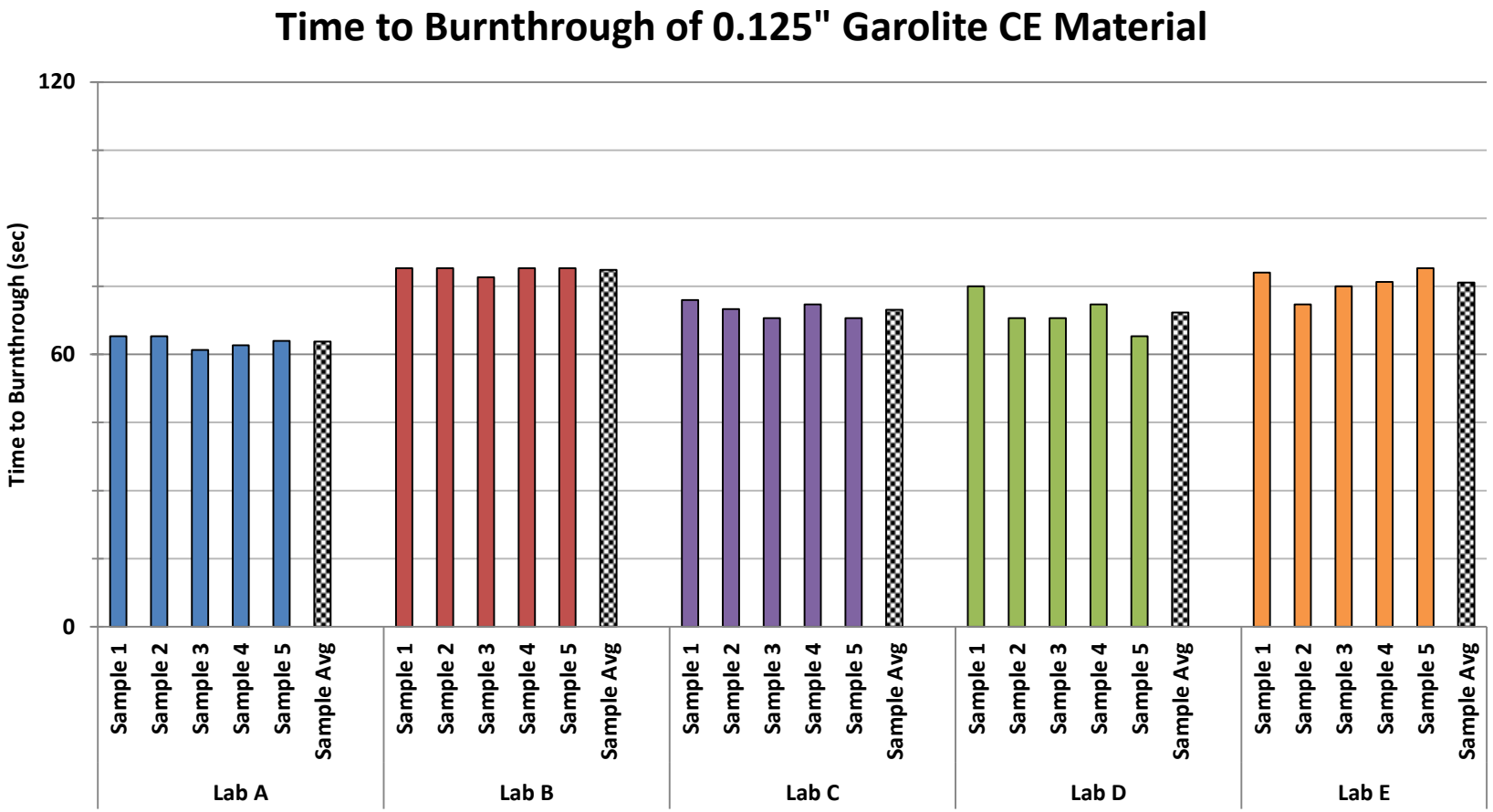

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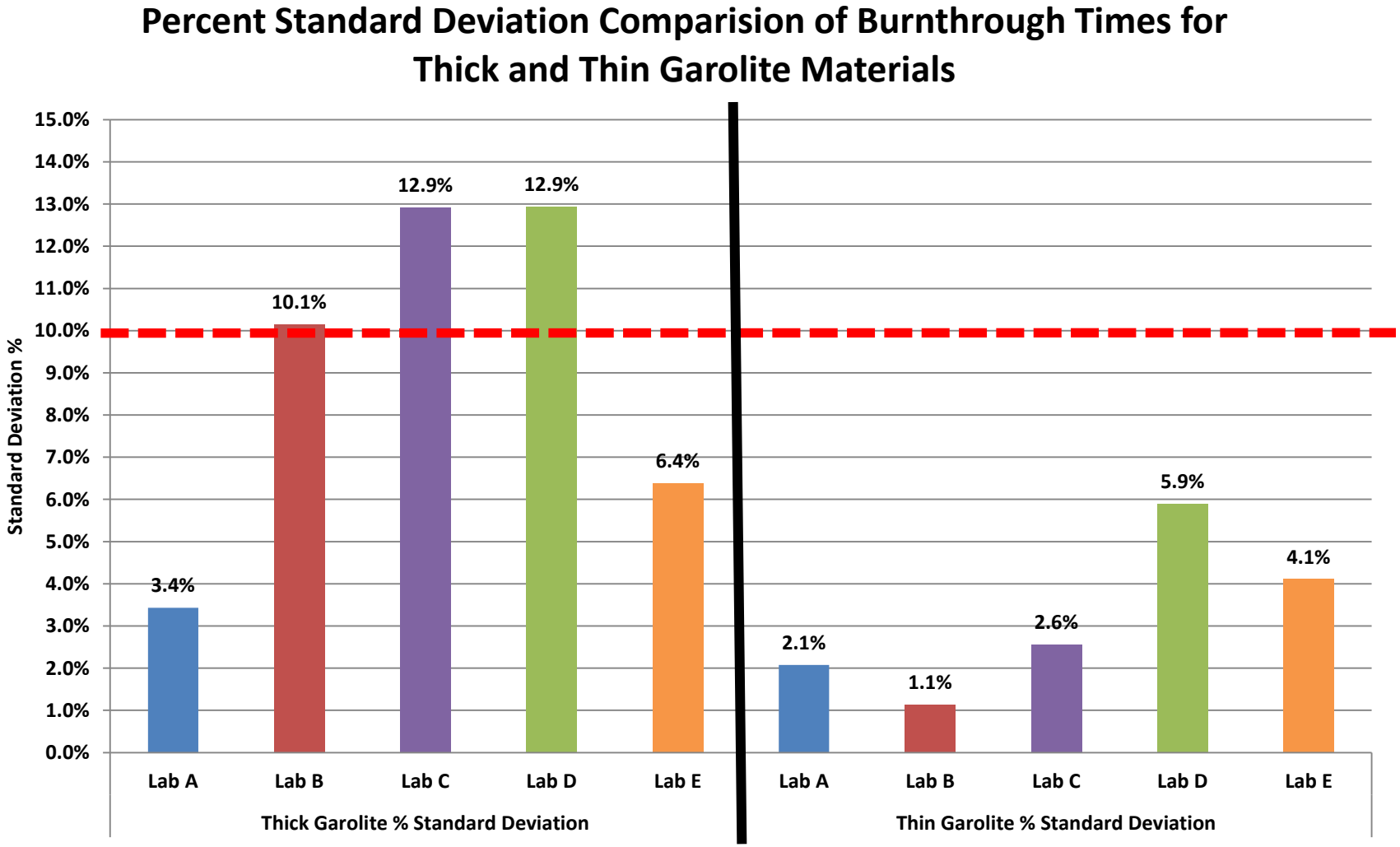

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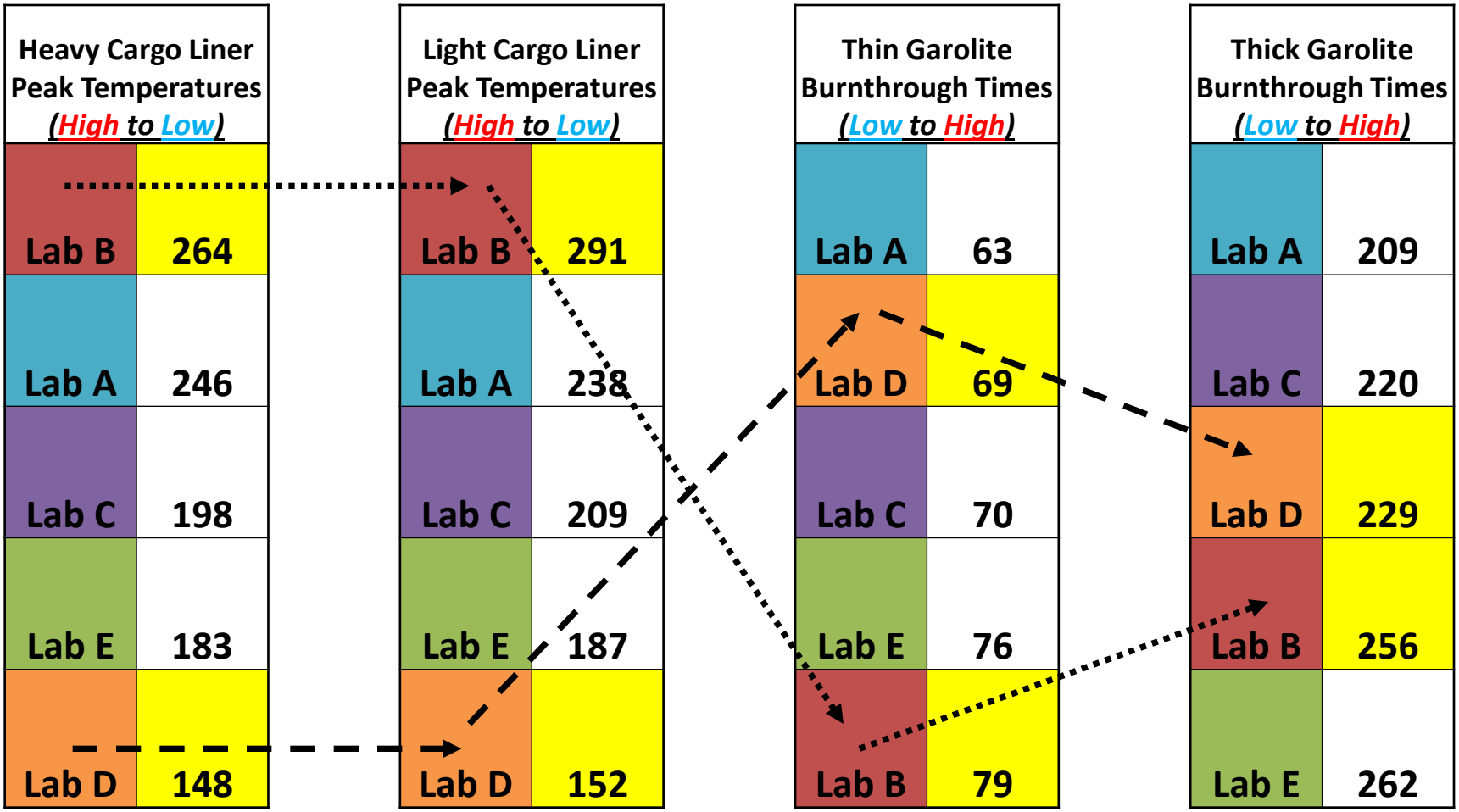


Cargo Liner Round Robin Study

- **Results**
  - Standard deviation percent within 10% acceptable limit within most labs (good repeatability)
  - Supports theory that data variations are due to test environment differences in each lab
  - *Labs with higher peak temperatures during cargo liner sample testing did not correlate with shorter burnthrough times of Garolite samples as anticipated…* ***Why?***
- **On a different note…**
  - There has been consistent pattern of errors noted in data recording for round robin studies
    - Unacceptable for this to occur for certification testing
  - *Double check your results! Do the numbers make sense?*

Cargo Liner Round Robin Study

- **Highly successful Round Robin completed**
- ***Lots* of useful data**
- **Further analysis of RR data is required**
- **RR data will help support research work currently underway regarding airflow study**
  - How can test cell environment conditions influence test results? What can be done about this?
- **Ultimately lead to minimizing differences in data among labs**

Burner Cone Deformation Study

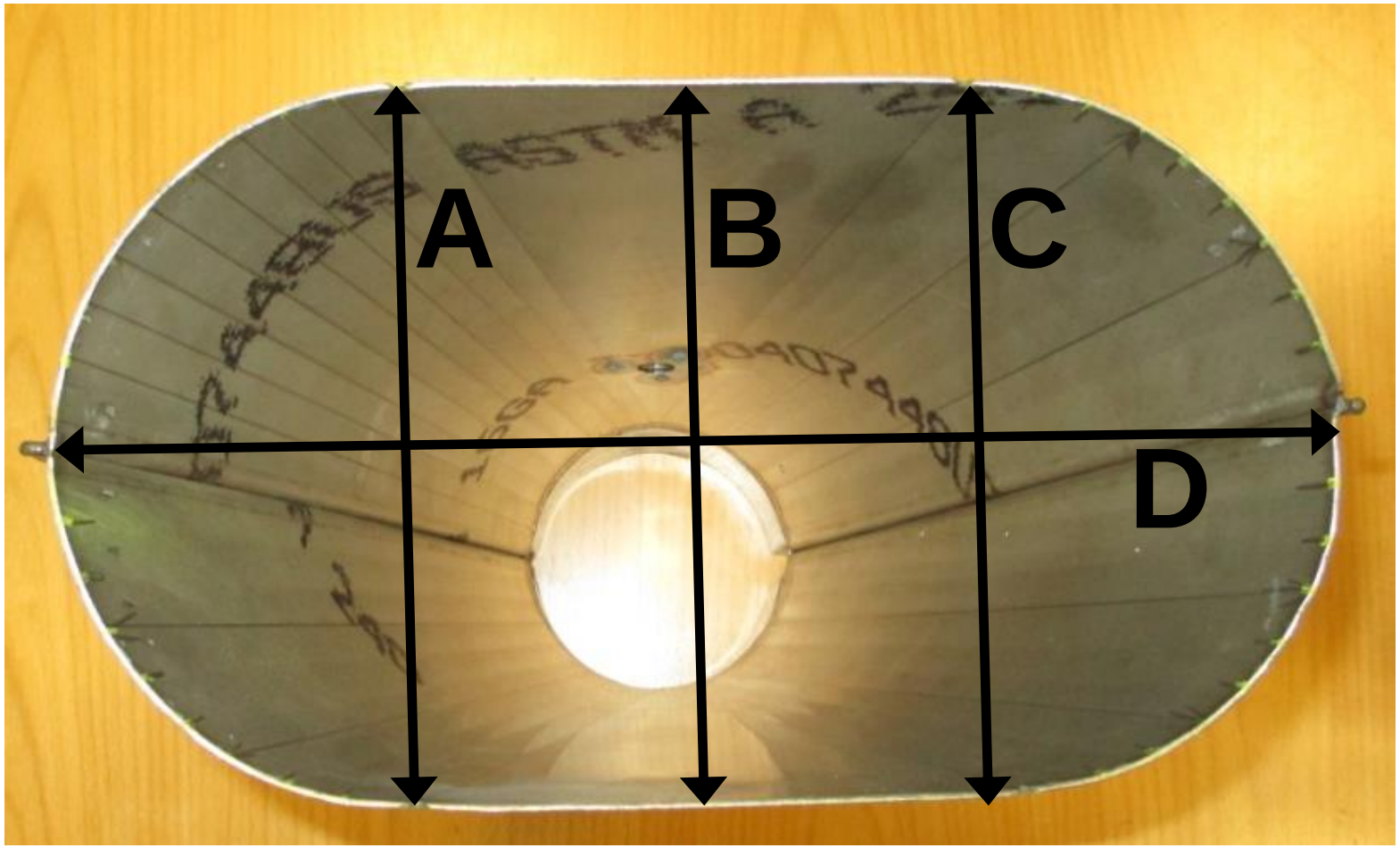
Burner Cone Deformation Study

- **Issues and Concerns**
  - Cones out of tolerance from manufacturer
  - Minimal heat cycles before cone out of tolerance
  - Cost of cone is too high to replace often
- **Testing Procedure**
  - Testing involved running the burner for 5 minutes, cool-down for 5 minutes before measuring cone, additional 5 minute cool-down, and repeat for 10 heat cycles

Burner Cone Deformation Study

- **Current cone design for NexGen burner calls for 16 gage 310 stainless steel**
- **Cones have deformed up to 0.5” after only 1-3 heat cycles**
- **4 cone types tested**
  - **Hastelloy alloy**
  - **Inconel alloy**
  - **310 SS alloy**
  - **310 SS alloy designed to account for deformation after heat cycling**

Burner Cone Deformation Study



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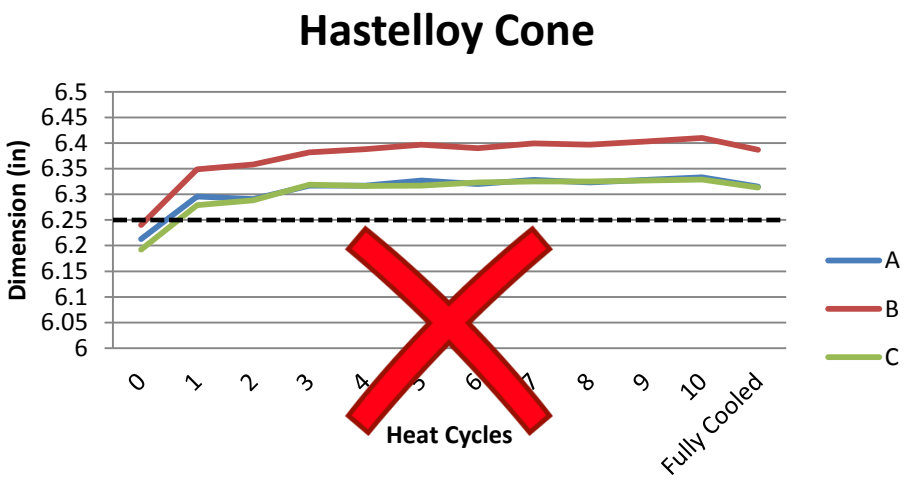

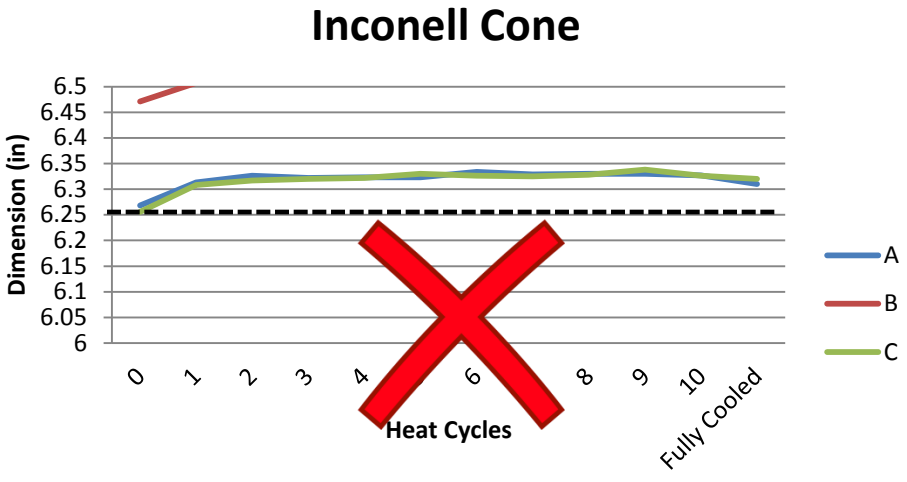

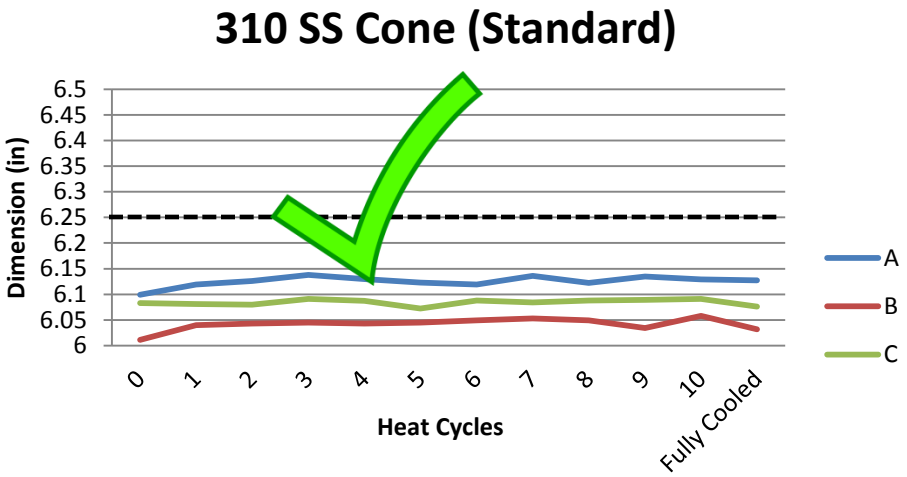

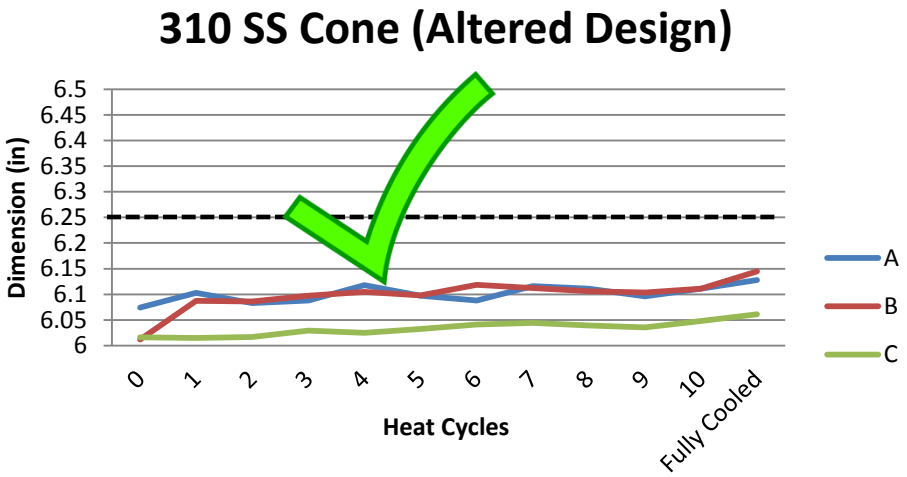

*** * * Dotted line indicates upper tolerance limit for cone dimension * * ***

Burner Cone Deformation Study

- **Study did not reveal advantages to using Hastelloy or Inconel compared to 310 SS cones**
- **Cost of Inconel/Hastelloy higher than 310 SS**
- **Hastelloy and Inconel cones out of spec as delivered from the manufacturer**
- **310 SS cones within spec upon delivery and remained as such during heat cycle testing**
- **Increase emphasis should be placed on quality control during manufacturing process**
  - During manufacturing process, take into account cone deformation due to heat cycling!

Chapter 8 Recent Updates

Chapter 8 Recent Updates

- **Guidance regarding a 60 second backside burning time**
  - Omitted from previous Chapter 8 Handbook update
- **Measuring air pressure at the sonic orifice**
  - More reliable than measuring at regulator port
- **Discussion in Task Group Meeting**
  - Additional suggestions or concerns

Future Work

Future Work

- **Test cell environment study**
  - Size, shape, airflow, ventilation hood, etc.
  - Make recommendations in the future

- **Air plenum**
  - May be used on burner to reduce overall height
  - Study to begin following meeting
  - Implications on burner test results?

Questions?

Discuss details in task group

Burner Cone Deformation Study

***Data included for those interested in having a closer look at the test results**

Hastelloy				
Heat Cycles	A	B	C	D
0	6.2130	6.2400	6.1920	11.0000
1	6.2960	6.3490	6.2790	10.8125
2	6.2910	6.3580	6.2880	10.8125
3	6.3170	6.3820	6.3190	10.8125
4	6.3170	6.3880	6.3160	10.8125
5	6.3270	6.3970	6.3170	10.8125
6	6.3200	6.3900	6.3230	10.8125
7	6.3280	6.3990	6.3250	10.8125
8	6.3230	6.3970	6.3250	10.8125
9	6.3280	6.4030	6.3270	10.8125
10	6.3330	6.4100	6.3290	10.8125
Fully Cooled	6.3150	6.3870	6.3130	10.8125

Inconell				
Heat Cycles	A	B	C	D
0	6.2680	6.4710	6.2560	10.9375
1	6.3130	6.5070	6.3080	10.8750
2	6.3260	6.5240	6.3170	10.8750
3	6.3220	6.5280	6.3200	10.8750
4	6.3230	6.5270	6.3220	10.8750
5	6.3230	6.5320	6.3300	10.8750
6	6.3340	6.5370	6.3260	10.8750
7	6.3290	6.5300	6.3250	10.8750
8	6.3300	6.5270	6.3280	10.8750
9	6.3300	6.5370	6.3380	10.8750
10	6.3270	6.5310	6.3260	10.8750
Fully Cooled	6.3100	6.5300	6.3200	10.8750

310 Stainless Steel				
Heat Cycles	A	B	C	D
0	6.0740	6.0120	6.0160	11.0625
1	6.1030	6.0870	6.0150	11.0625
2	6.0830	6.0860	6.0170	11.0625
3	6.0880	6.0970	6.0290	11.0625
4	6.1180	6.1050	6.0250	11.0625
5	6.0972	6.0982	6.0322	11.0625
6	6.0882	6.1182	6.0412	11.0625
7	6.1162	6.1122	6.0442	11.0625
8	6.1112	6.1062	6.0392	11.0625
9	6.0962	6.1032	6.0352	11.0625
10	6.1112	6.1112	6.0482	11.0625
Fully Cooled	6.1280	6.1450	6.0610	11.0625

310 Stainless Steel (Altered Design)				
Heat Cycles	A	B	C	D
0	6.0990	6.0110	6.0830	11.0000
1	6.1190	6.0400	6.0810	11.0000
2	6.1260	6.0430	6.0800	11.0000
3	6.1380	6.0450	6.0910	11.0000
4	6.1300	6.0430	6.0870	11.0000
5	6.1230	6.0450	6.0720	11.0000
6	6.1190	6.0490	6.0880	11.0000
7	6.1360	6.0530	6.0840	11.0000
8	6.1220	6.0490	6.0880	11.0000
9	6.1350	6.0340	6.0890	11.0000
10	6.1290	6.0580	6.0910	11.0000
Fully Cooled	6.1270	6.0320	6.0760	11.0000