



**Federal Aviation
Administration**

Development of a New Flammability Test for Aircraft Ducting

ROUND-ROBIN PRELIMINARY RESULTS

Presented to: The International Aircraft Material
Fire Testing Working Group

By: John Reinhardt, Project Manager, PMP

Date: June 17-18 2009

Location: Cologne, Germany



Outline



Presentation will include:

- ✓ Micro-scale Combustion Calorimeter (MSCC) & Radiant Heat Panel Test Procedures

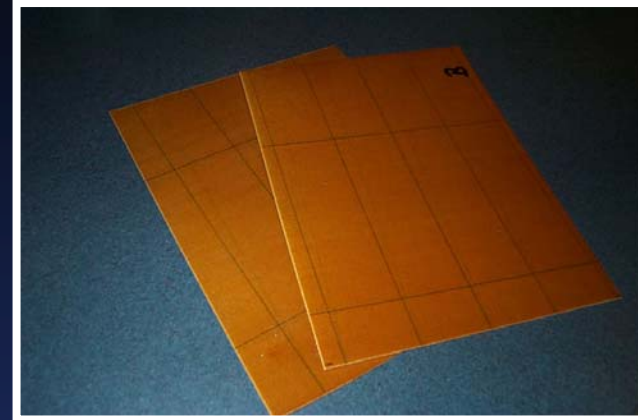
- ✓ Tested Round Robin Samples

- ✓ Micro-scale Combustion Calorimeter Results

- ✓ Preliminary Radiant Heat Panel Test Results

- ✓ Future Work

- ✓ Final Comments



Test Procedures



Micro-Scale Combustion Calorimeter Test:

Test Protocol: ASTM D 7309-07

Sample Size: 5 milligram

Heat Source: Heating Coils (900 °C)

Heat Source Exposure: 1°C per second from room temperature to 900 °C

Not a compliance test



Test Procedures



Radiant Heat Panel Test Protocol:

Sample Size: 21.59 cm x 27.54 cm

Sample Placement: 19.05 +/-3 cm below panel

Heat Source: Radiant Heat Panel & Propane Flame (1.3 kW/m² panel, +1093°C pilot)

Heat Source Exposure: 1 minute pre-heat, then pilot flame impingement for 15 seconds

Acceptance Criteria:

Max Flame Propagation: =< 5.08 cm

Max Flame Time: =< 45 seconds



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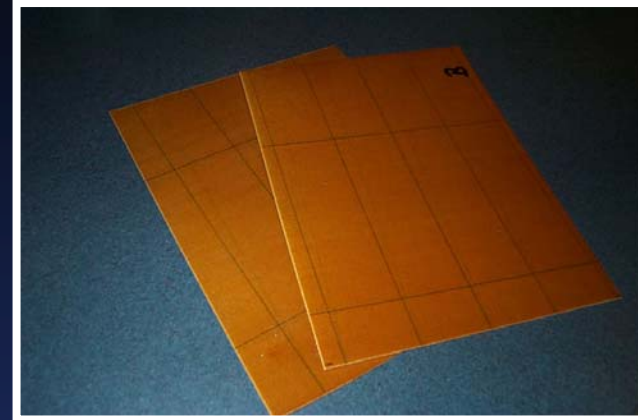
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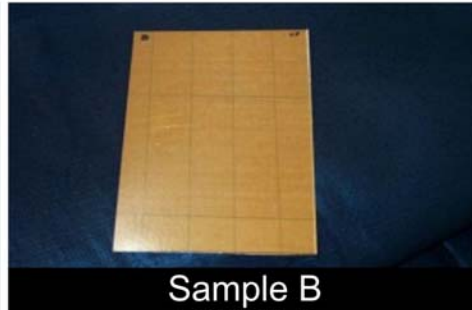
- ✓ Final Comments



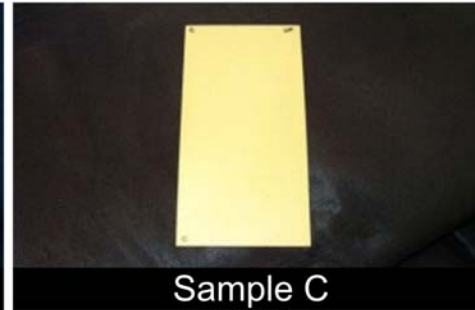
Tested Samples



Sample A



Sample B



Sample C



Sample D



Sample E



Sample F



Sample G



Sample H



Sample I

Tested Samples

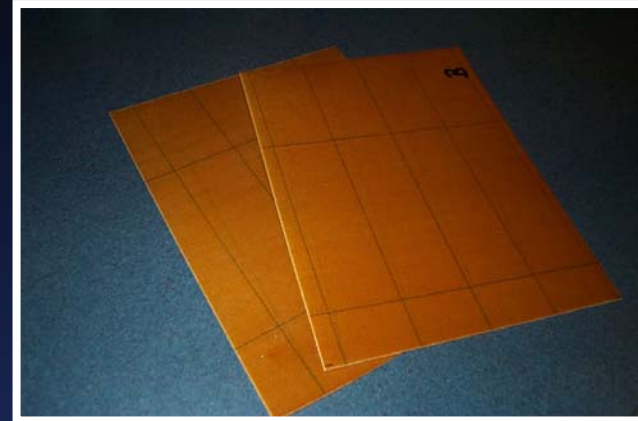


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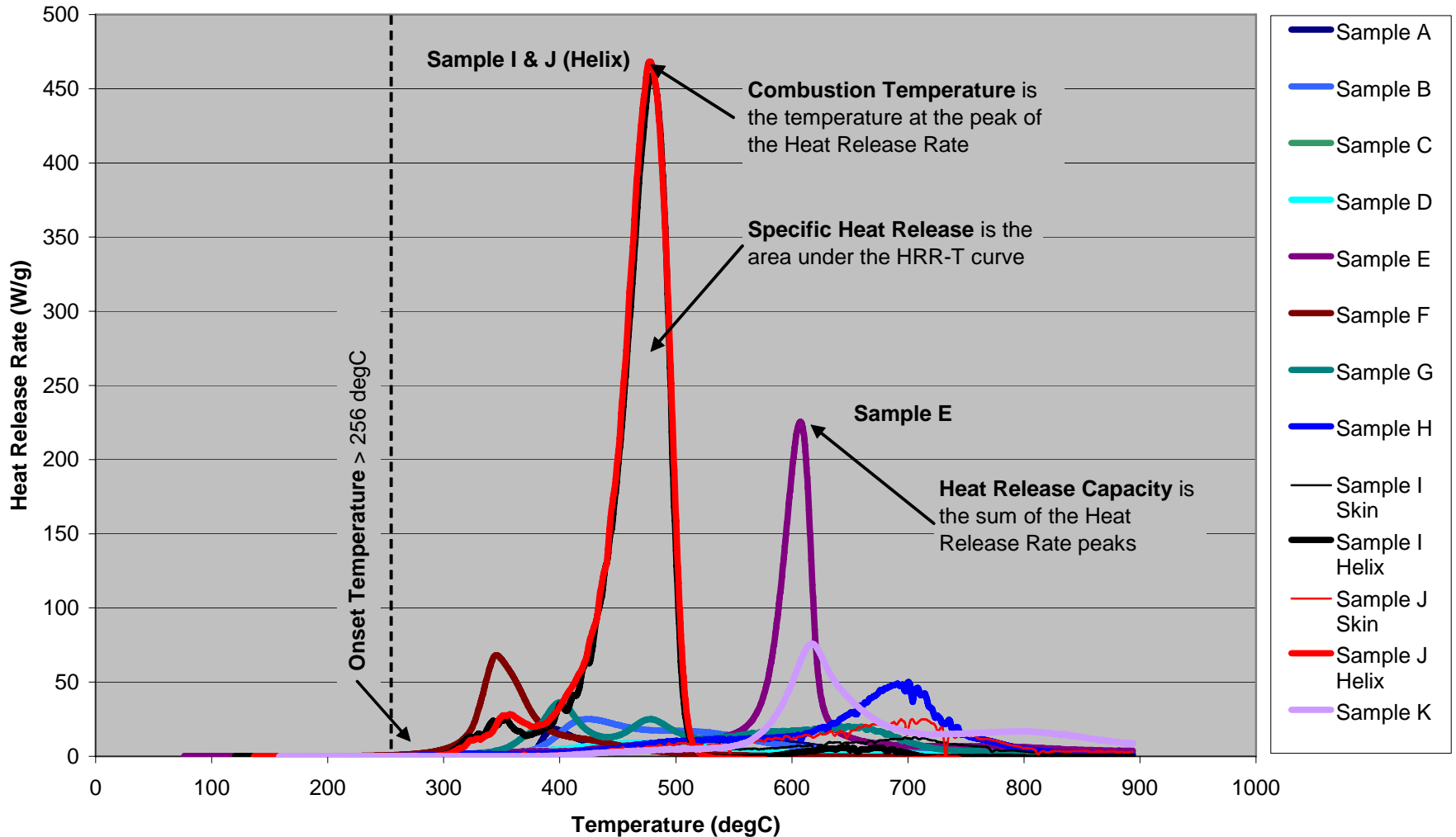
Micro-Scale Combustion Calorimeter (MSCC) Results

Sample ID	Onset Temperature (degC)	Combustion Temperature (degC)	Specific Heat Release (kJ/g)	Heat Release Capacity (J/g-K)	Prediction
A	377	395	2.8	18	Pass
B	420	464	4.1	25	Pass
C	427	567	1.4	9	Pass
D	436	568	1.6	9	Pass
E	408	607	9.5	224	Pass
F	319	345	4.3	69	Pass
G	347	401	6.8	37	Pass
H	412	519	6.7	54	Pass
I	302	352	24.5	494	Fail
J	303	357	25.5	477	Fail
K	592	606	6.4	72	Pass

Prediction Criteria:	> 256 degC	> 320 degC	< 15 kJ/g	< 300 J/g-K
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AIRCRAFT DUCTING MATERIALS OF ROUND ROBIN EXERCISE

Micro-Scale Combustion Calorimeter Test Data

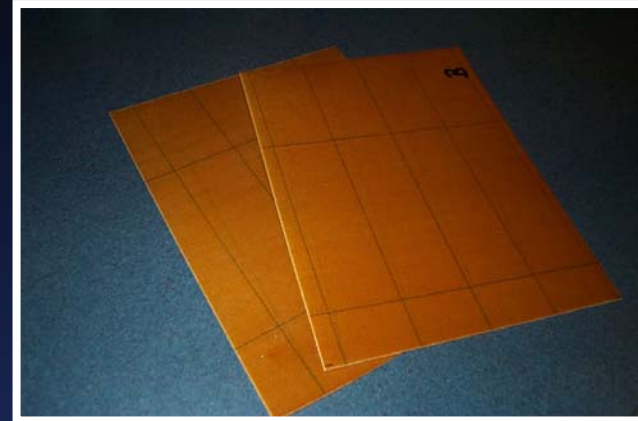


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Preliminary Results



Round Robin Average Results

Sample ID	Average of All Labs								Pass/Fail Criteria	MSCC Prediction
	Burn Length (cm)	*Std Dev (cm)	After Flame Extinguishing Time (sec)	*Std Dev (sec)	Glow Time (sec)	*Std Dev (sec)	% Mass Loss	*Std Dev (%)		
A	3	0.65	0.6	0.58	0.6	0.66	1.2	0.72	Passed	Pass
B	2.9	0.45	7.3	4.63	0.4	1.06	2.1	0.44	Passed	Pass
C	2.4	0.38	0.4	0.96	1.7	2.14	2.8	1.22	Passed	Pass
D	2.7	0.61	1.4	1.38	3.8	5.54	1.6	0.36	Passed	Pass
E	3.5	1.24	3.4	1.19	1	2.04	4.1	1.11	Passed	Pass
F	4.1	1.02	0.5	0.77	1.1	1.31	1.7	0.38	Passed	Pass
G	2.9	0.79	34.5	8.62	6.8	16.7	1.5	1.32	Passed	Pass
H	2.9	0.46	12.5	3.91	1.9	4.74	0.7	0.6	Passed	Pass
I	+9.6	N/A	+120	N/A	N/A	N/A	+14.8	N/A	Failed	Fail
J	+5.7	N/A	+120	N/A	N/A	N/A	+11	N/A	Failed	Fail
K	2.7	0.55	0.2	0.44	0	0	1.2	1.17	Passed	Pass

Acceptance Criteria: Burn Length \leq 5.08 cm and After Flame Extinguishing Time \leq 45 seconds

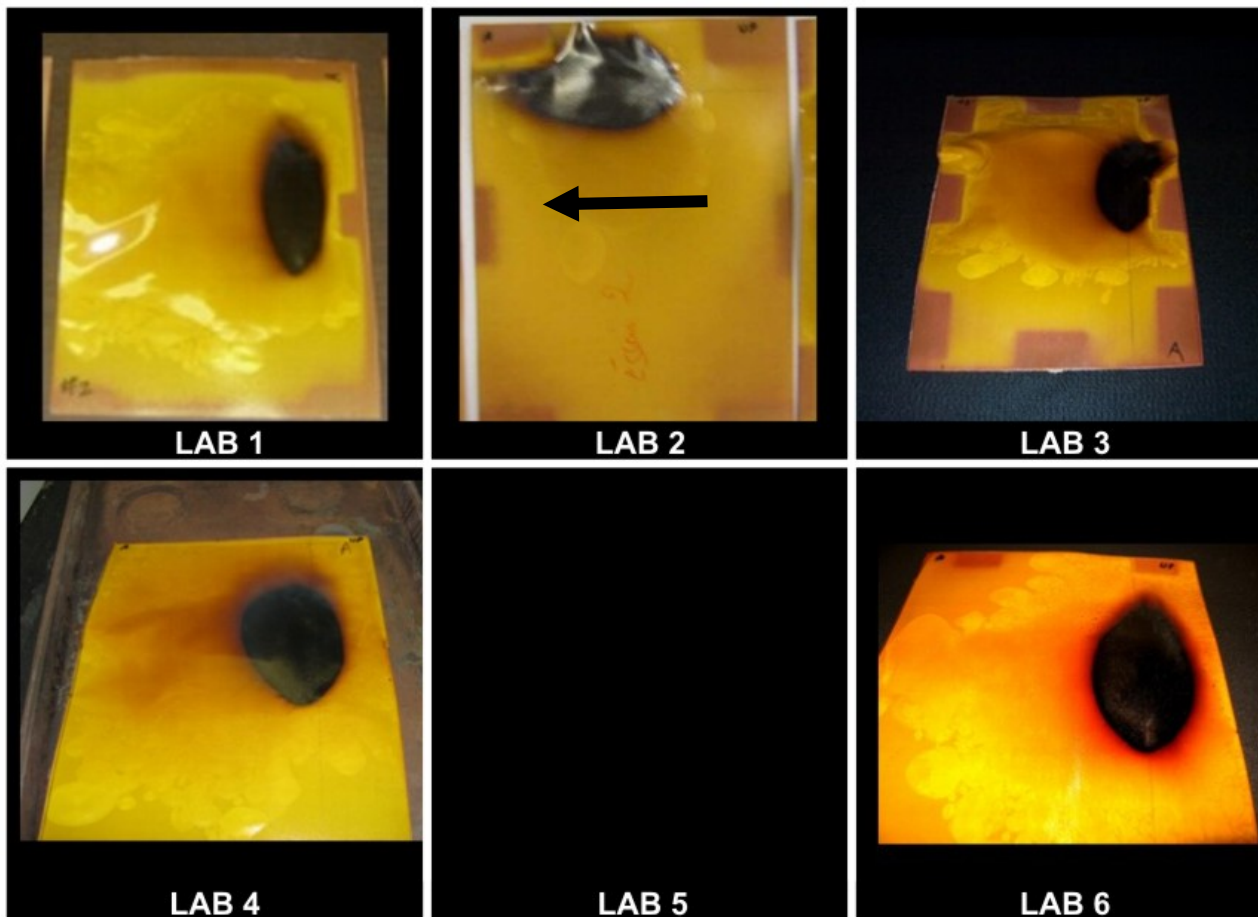
*Note: This is the standard deviation of the average values reported by the laboratories.



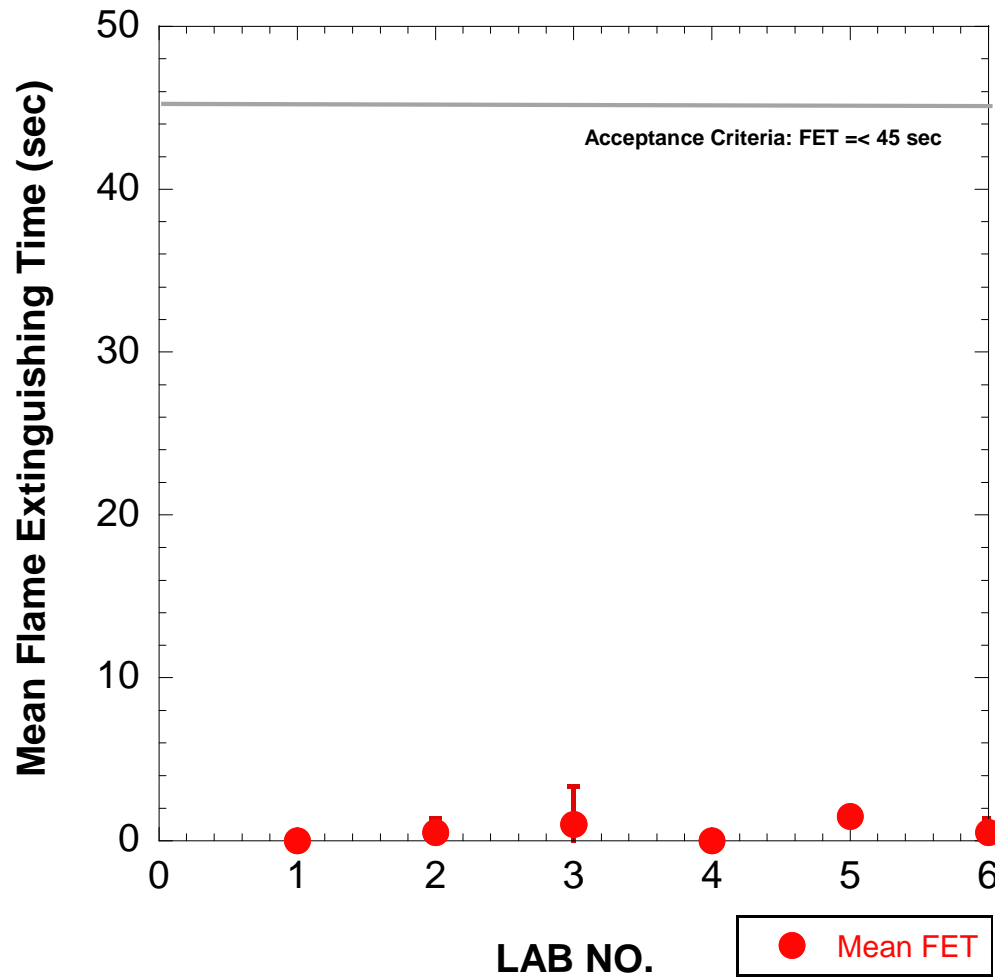
Preliminary Results



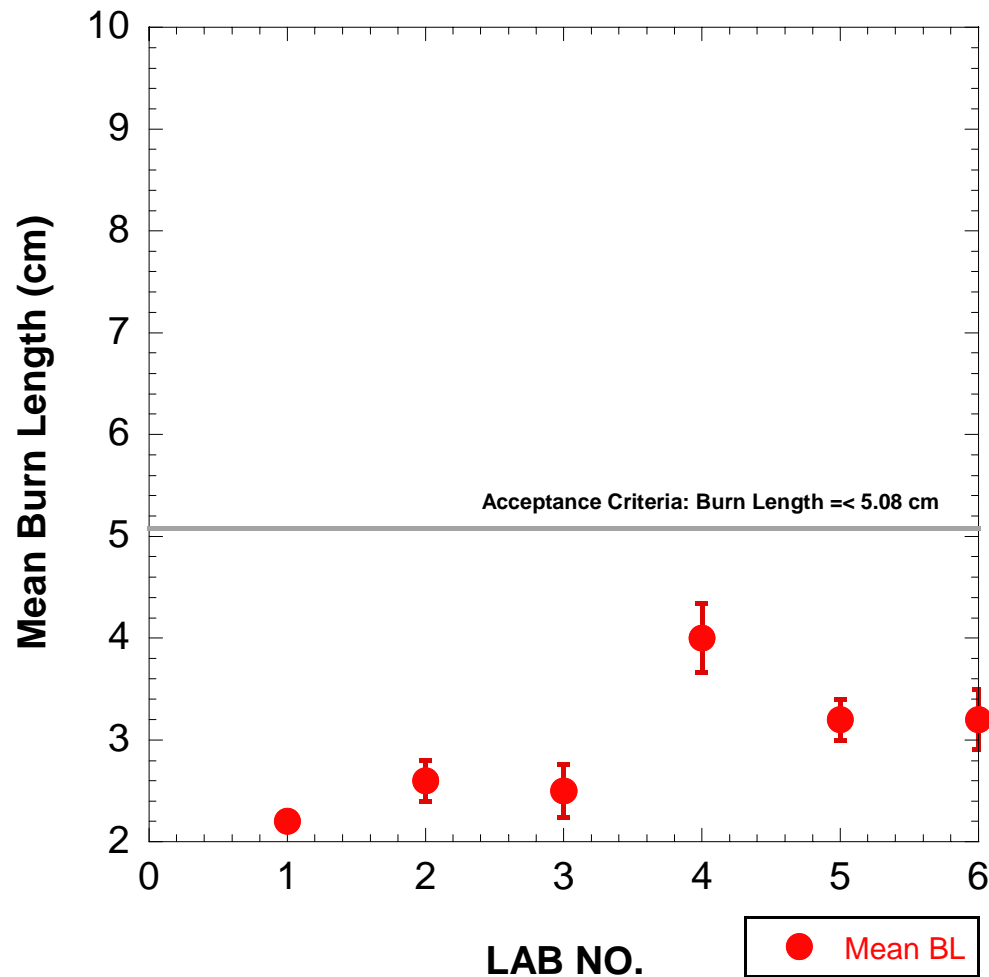
Sample A – All Passed



Sample A



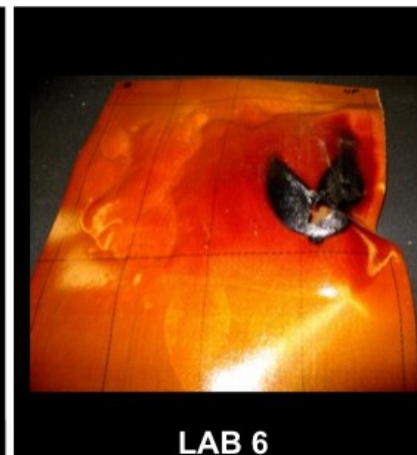
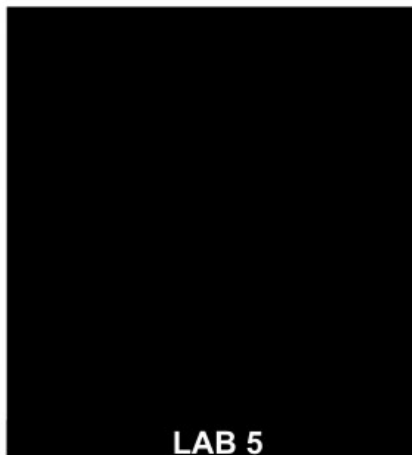
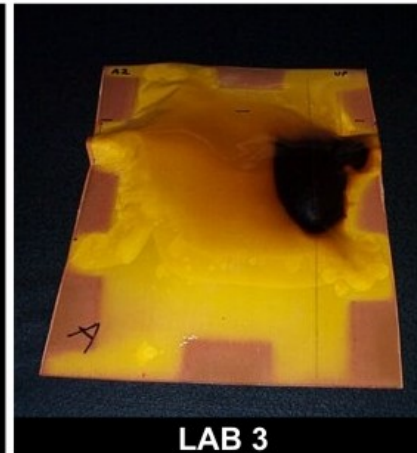
Sample A



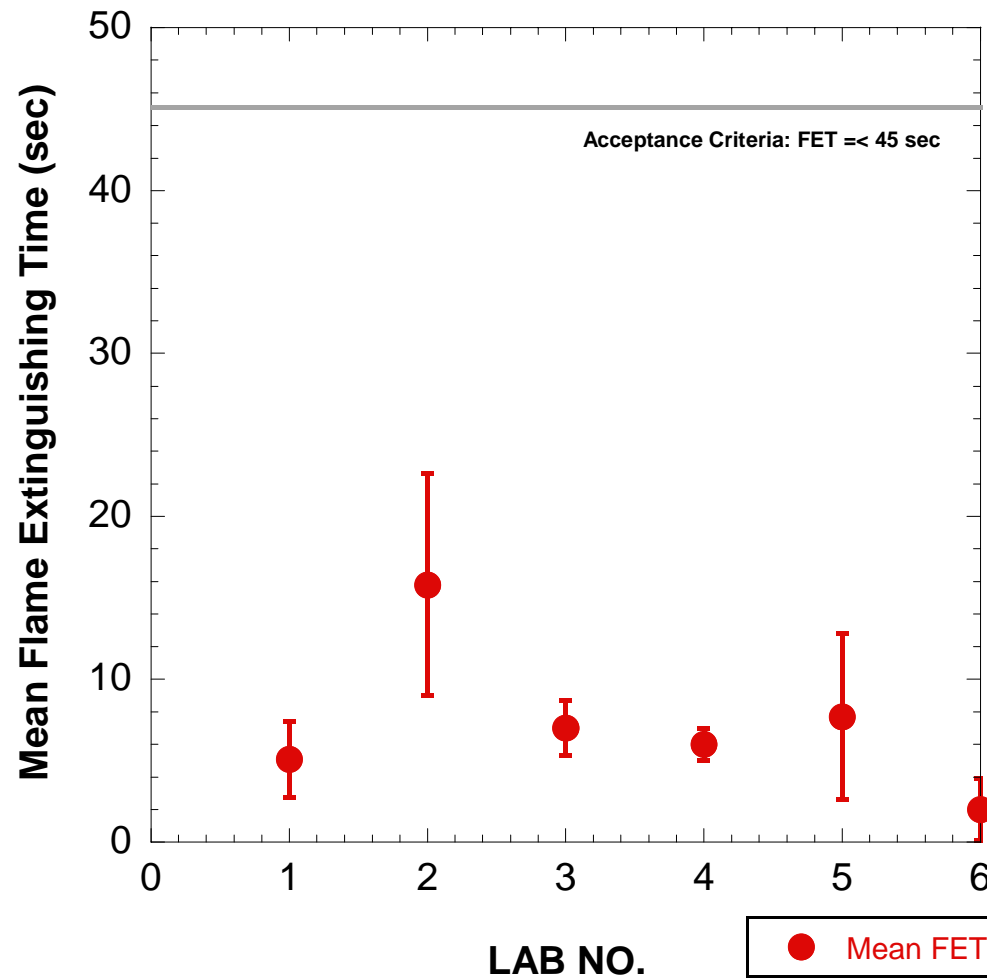
Preliminary Results



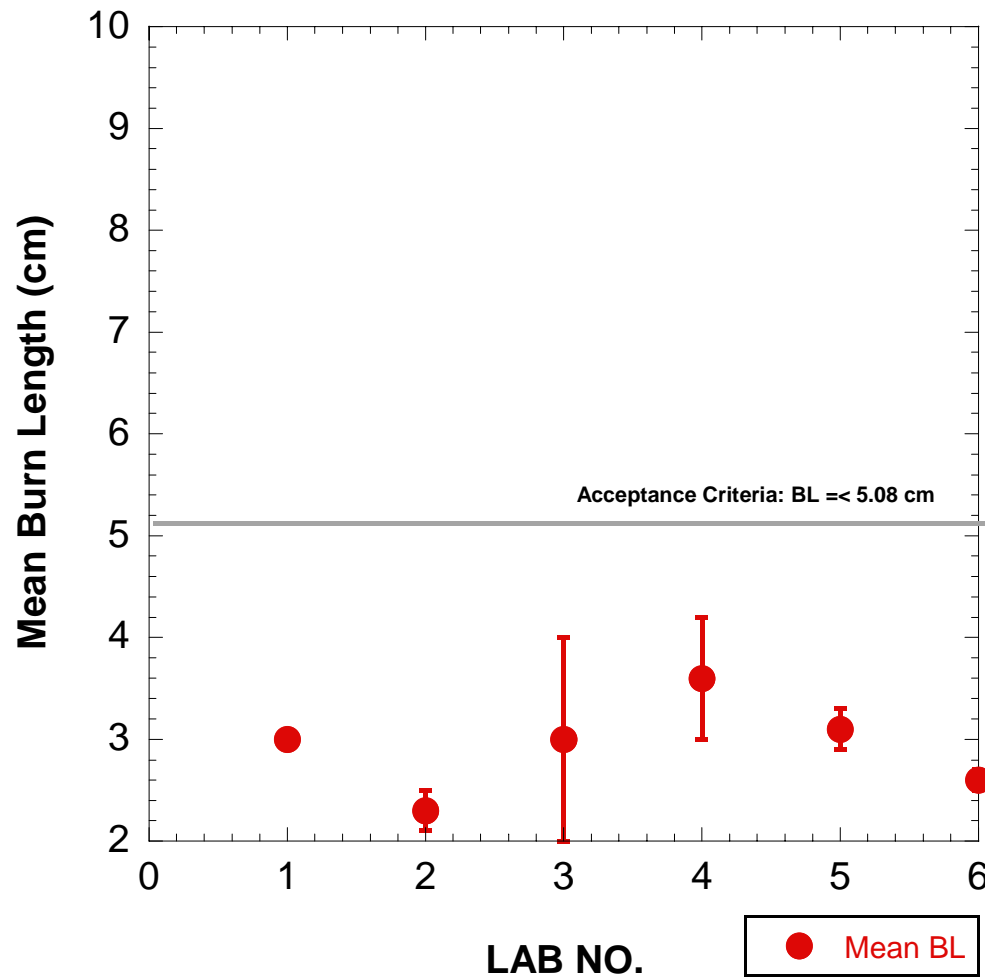
Sample B – All Passed



Sample B



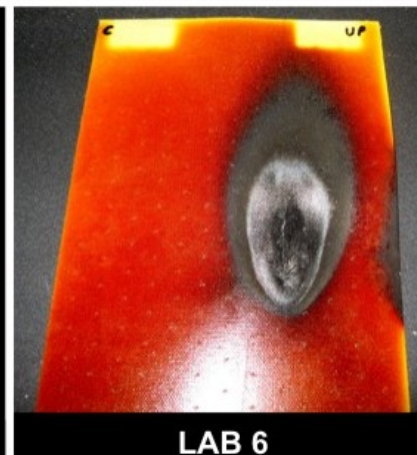
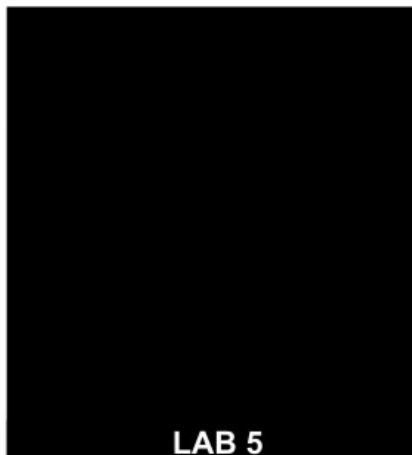
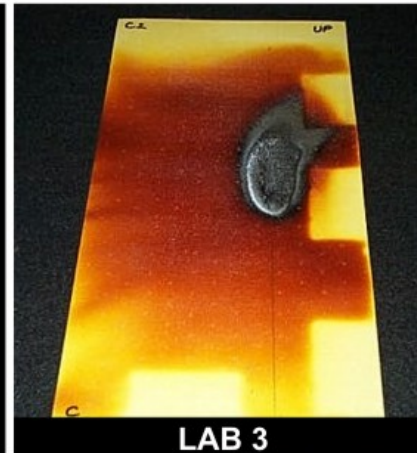
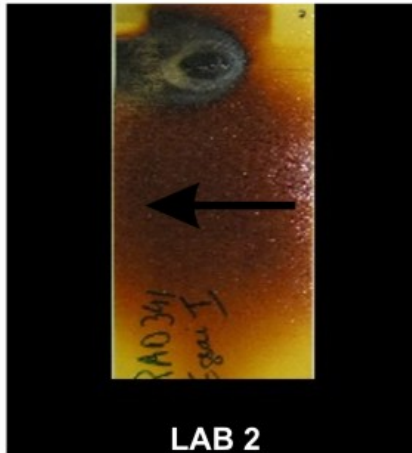
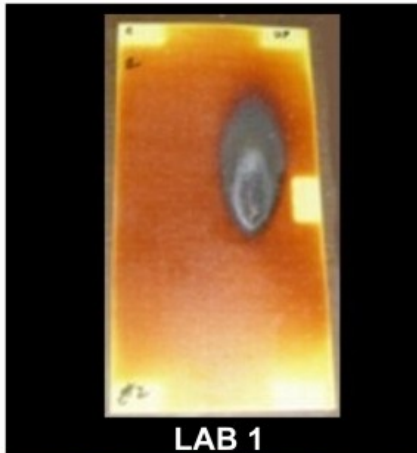
Sample B



Preliminary Results



Sample C – All Passed

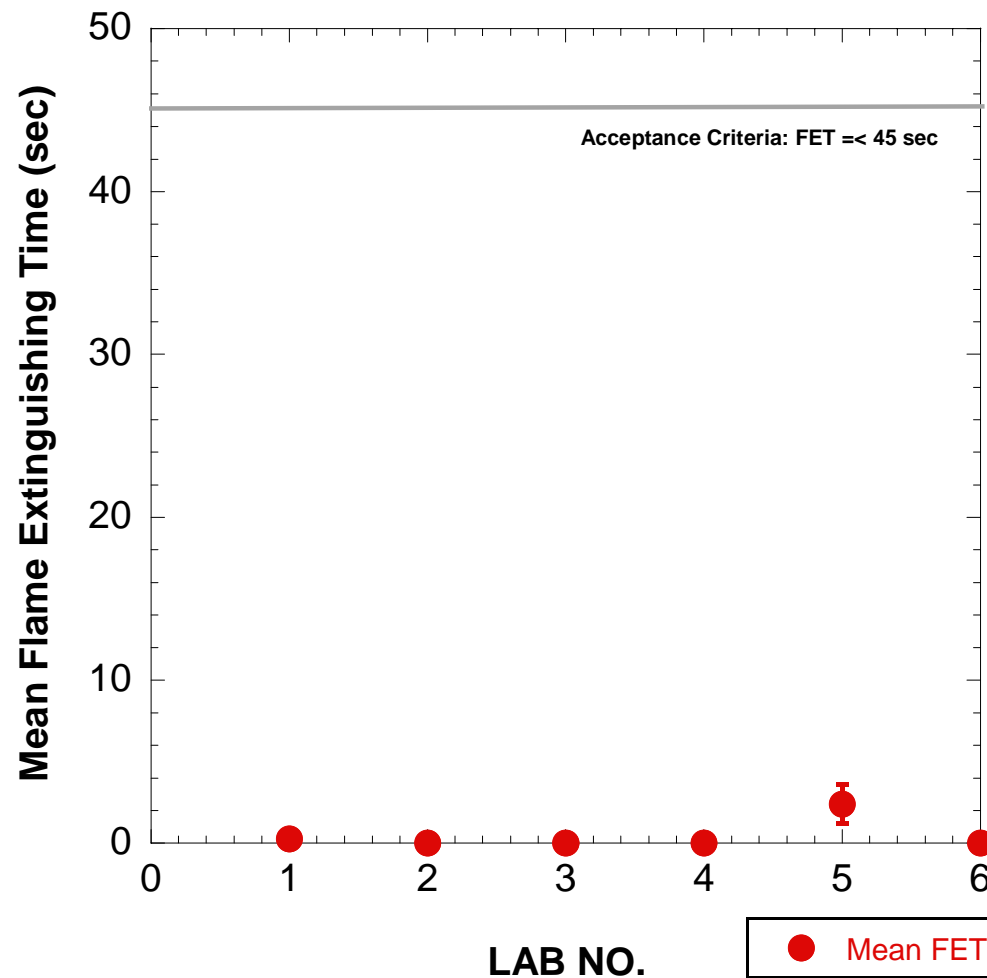




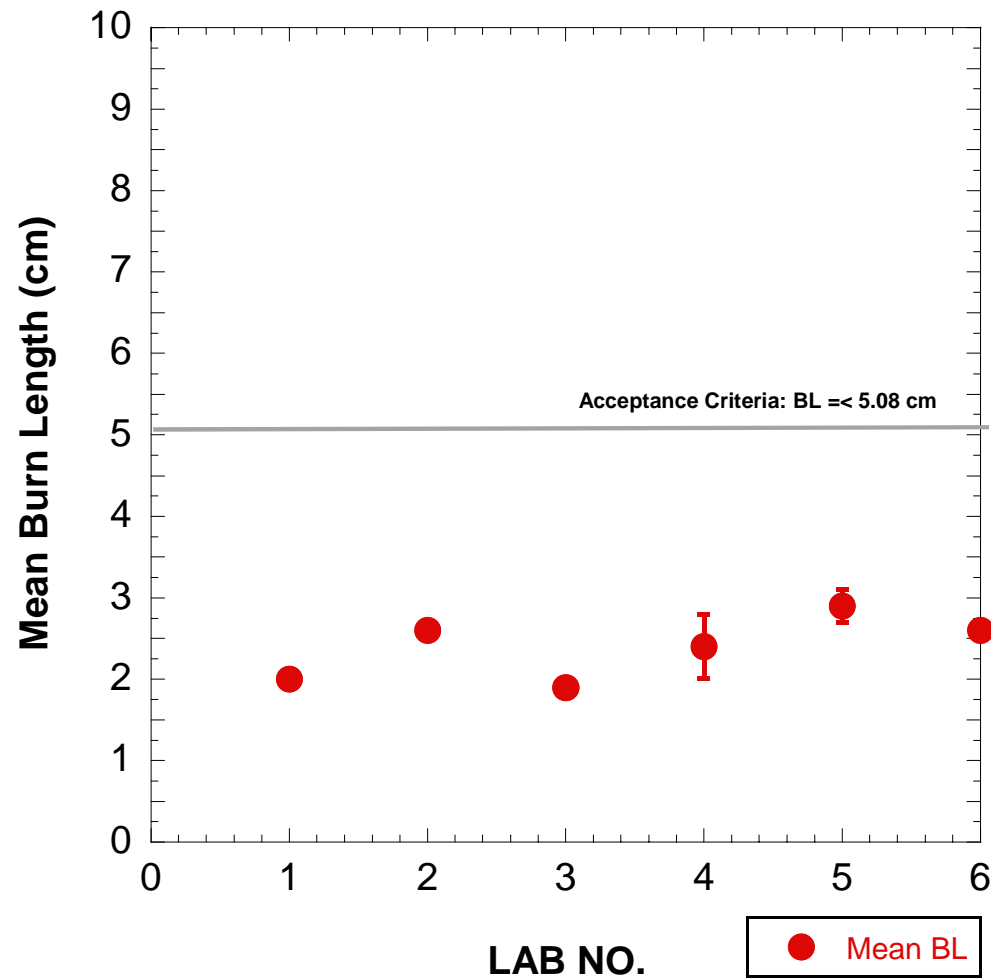
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Sample C



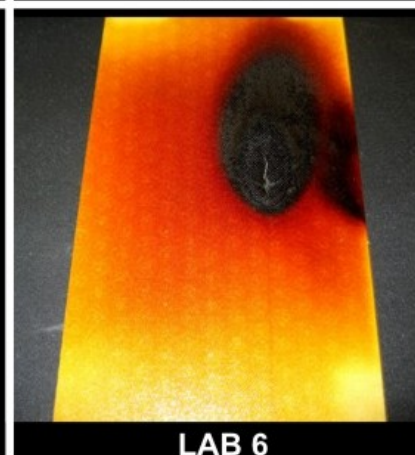
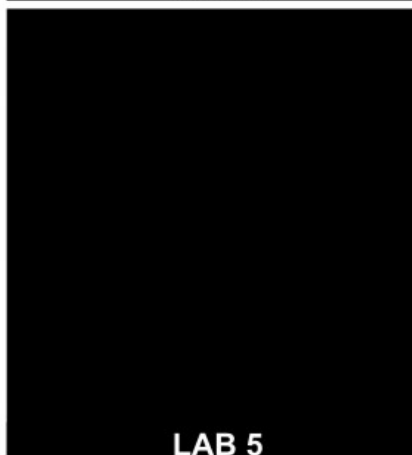
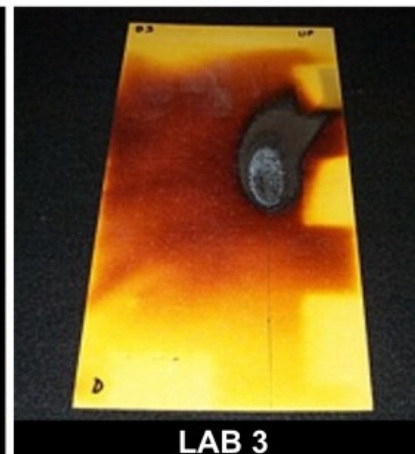
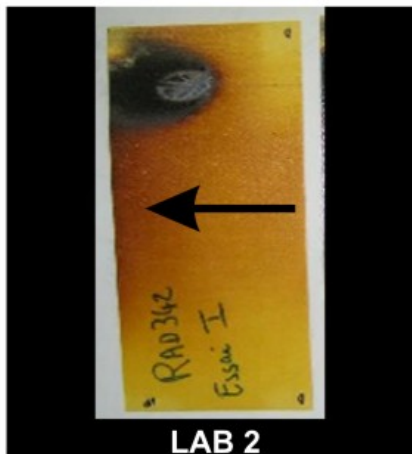
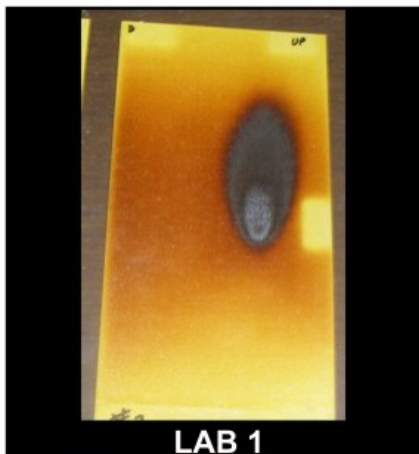
Sample C



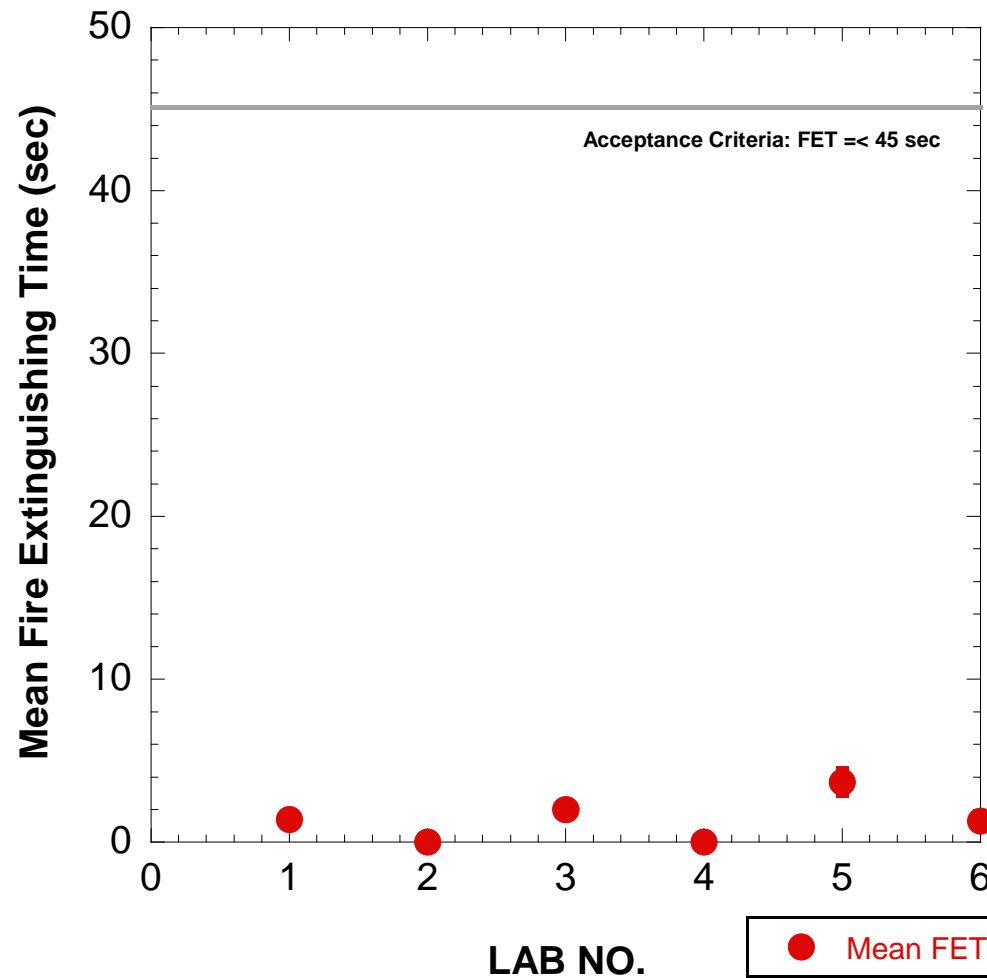
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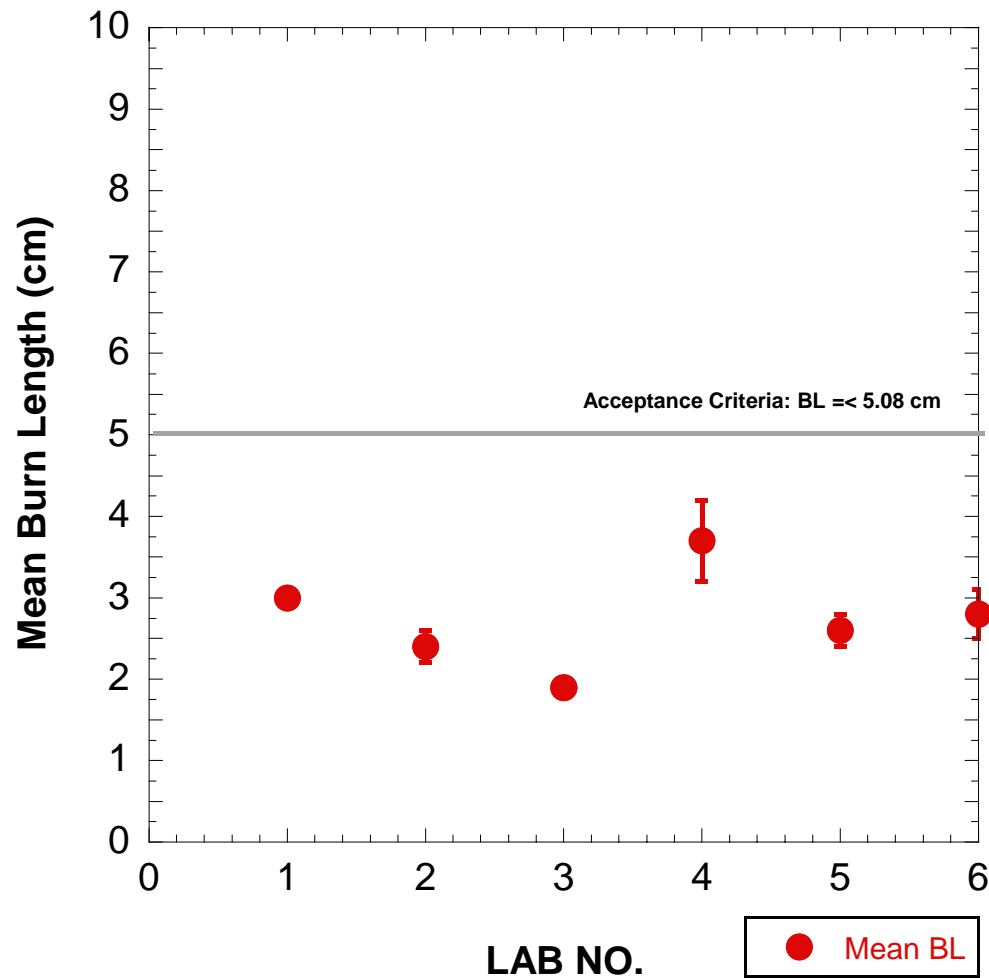
Sample D – All Passed



Sample D



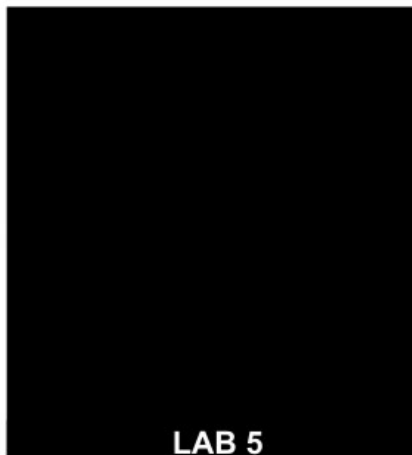
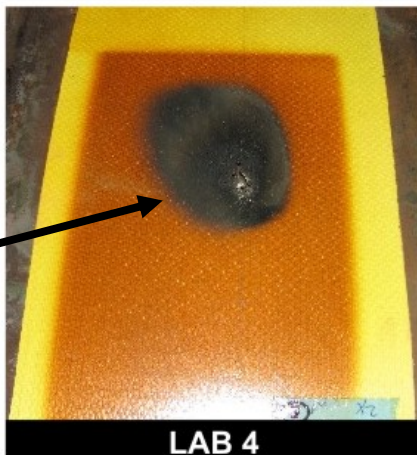
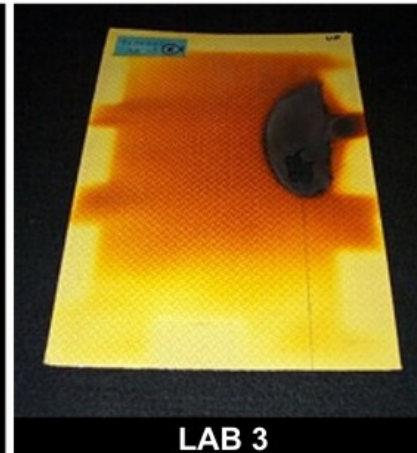
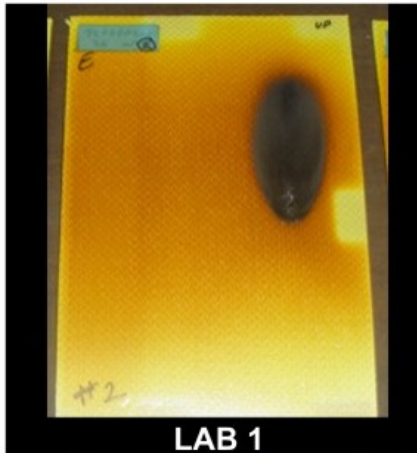
Sample D



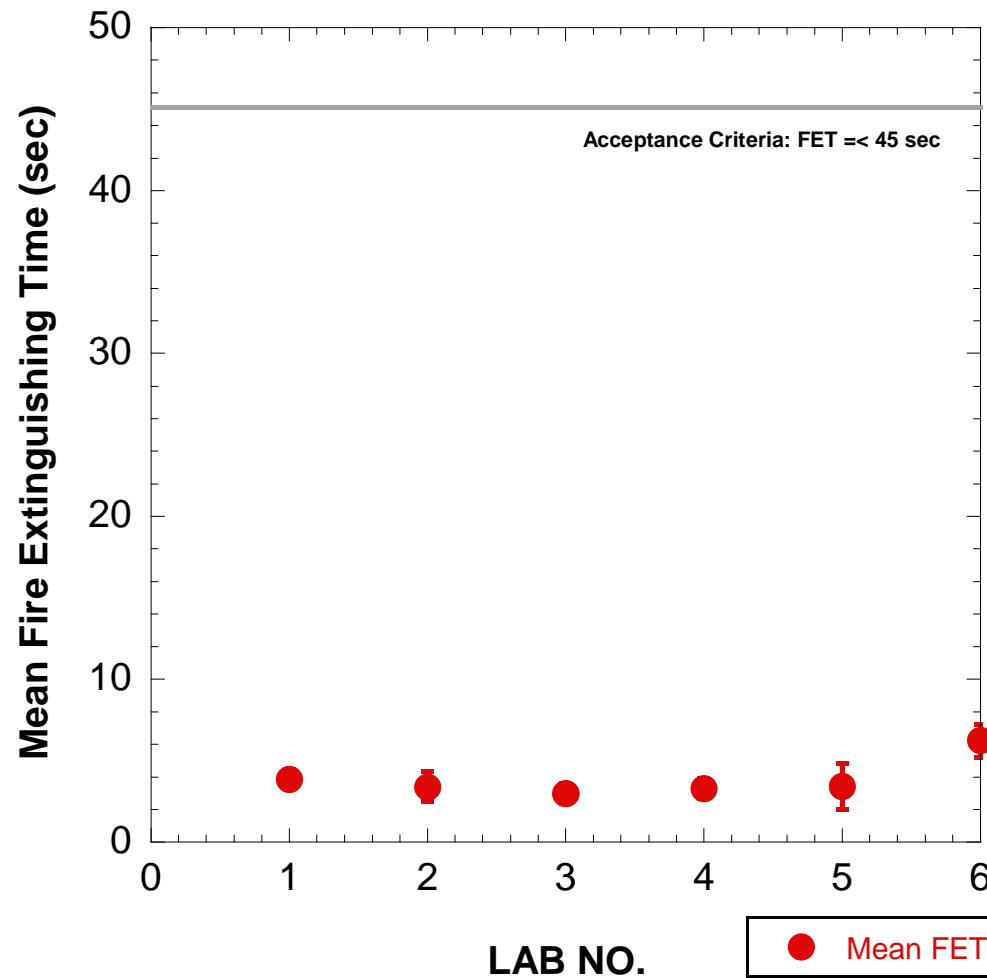
Preliminary Results



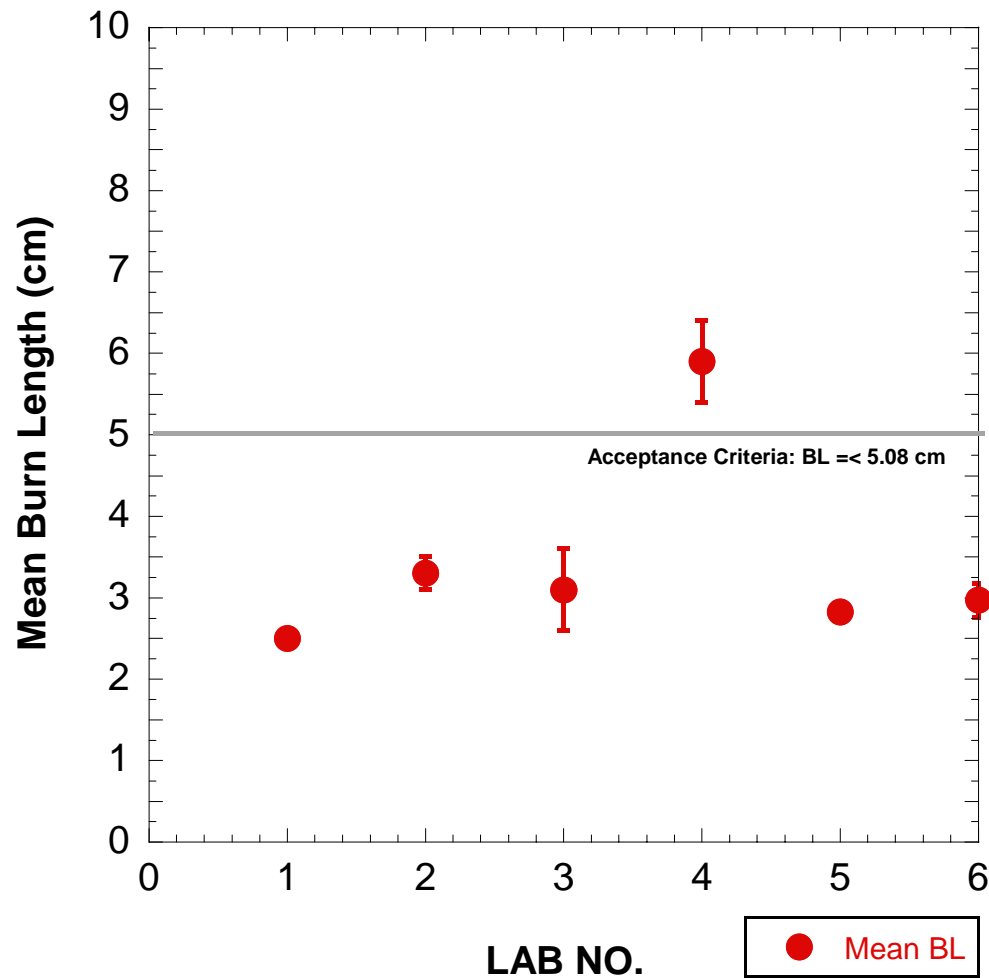
Sample E – 5 Passed, 1 Failed



Sample E



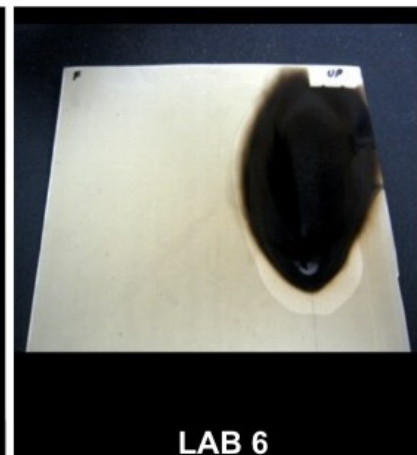
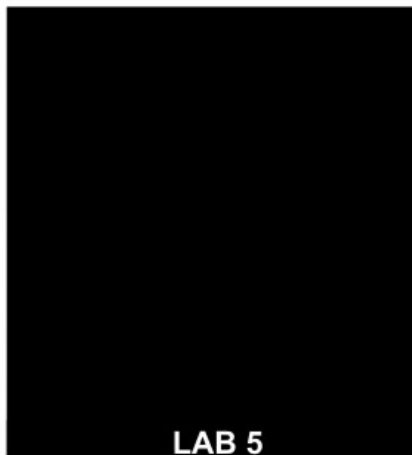
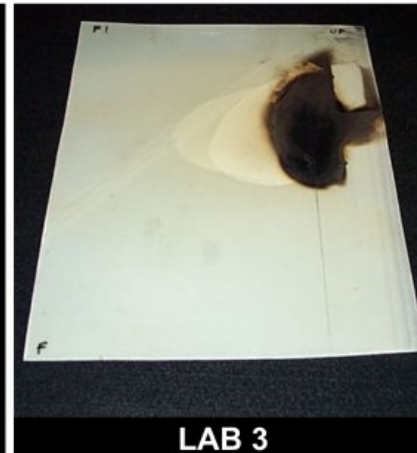
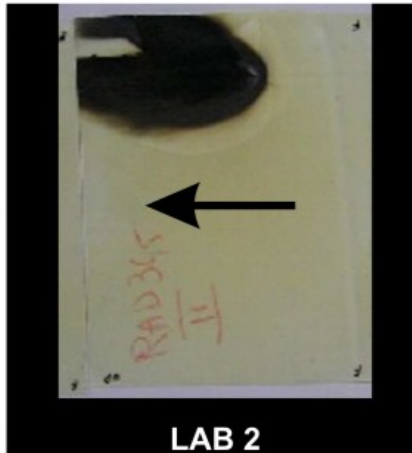
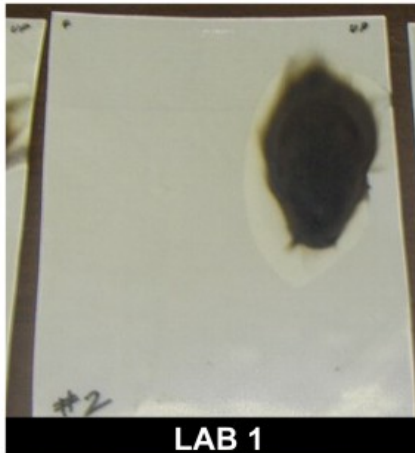
Sample E



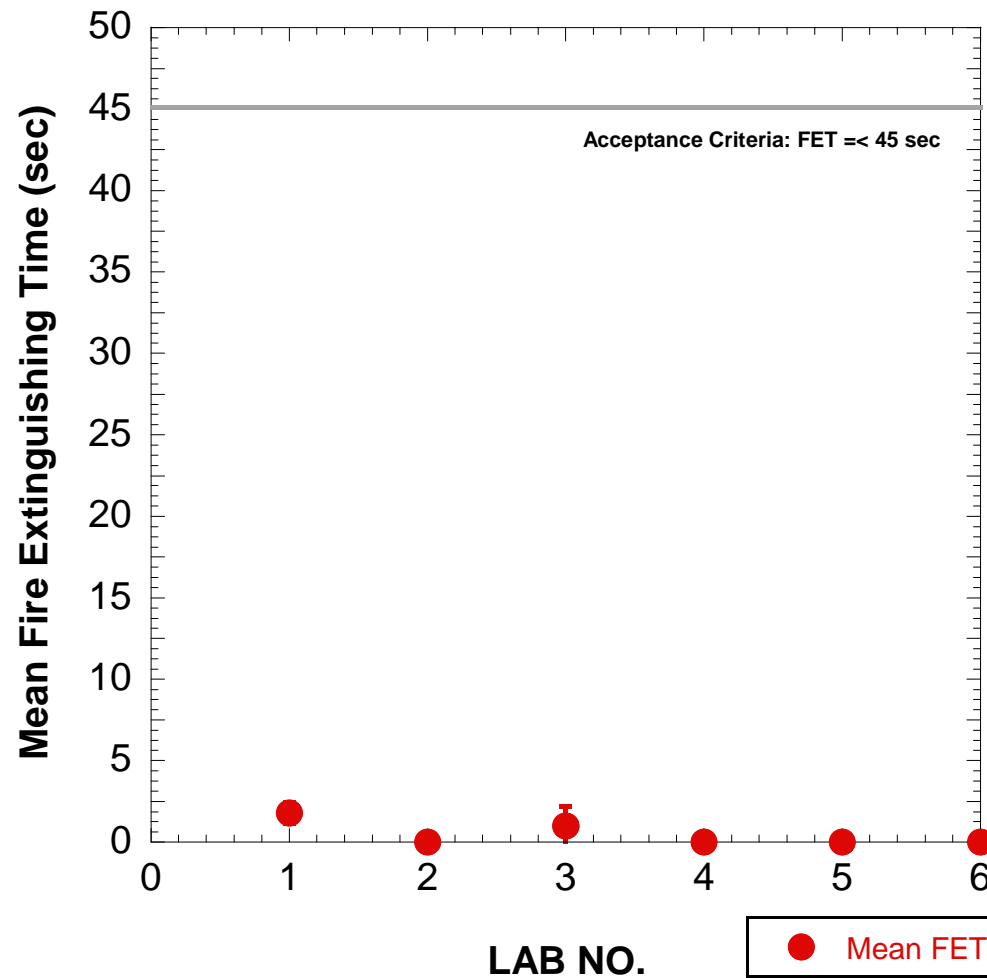
Preliminary Results



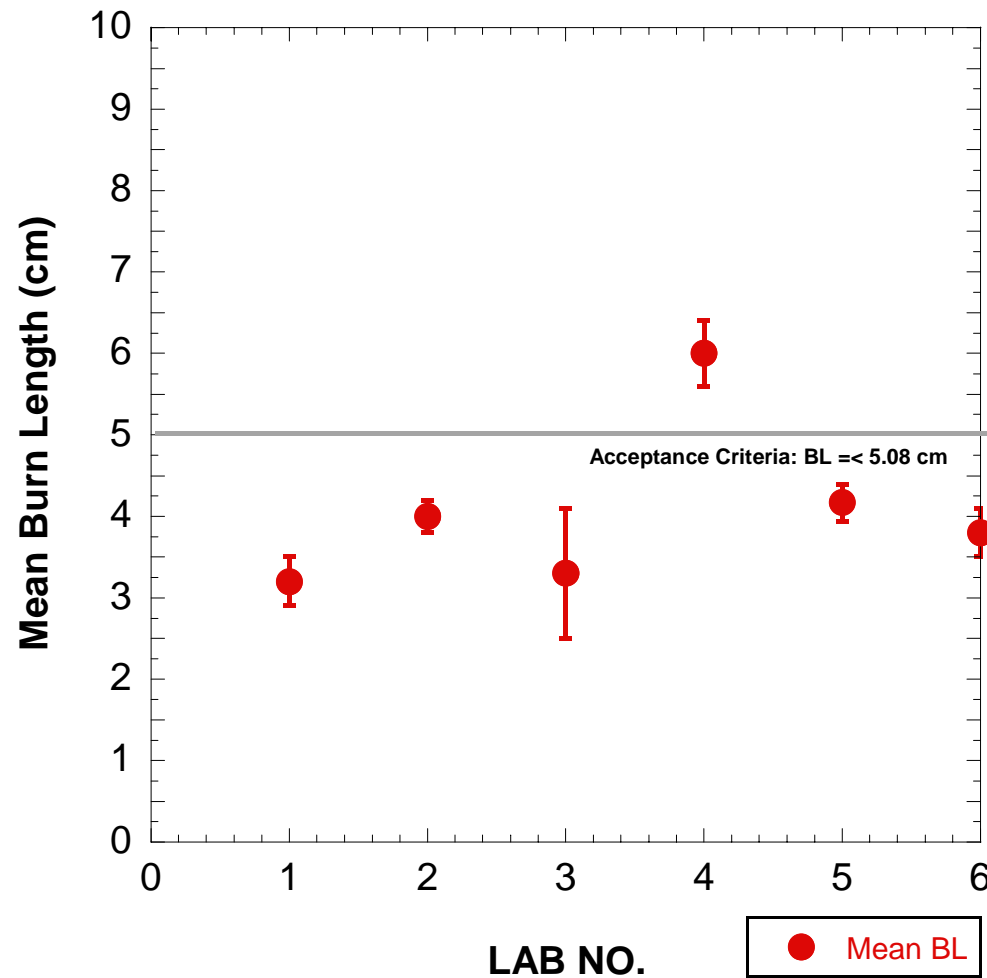
Sample F – 5 Passed, 1 Failed



Sample F



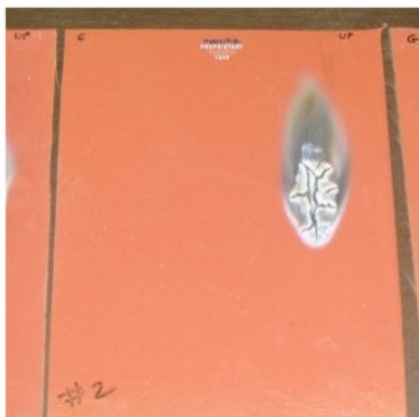
Sample F



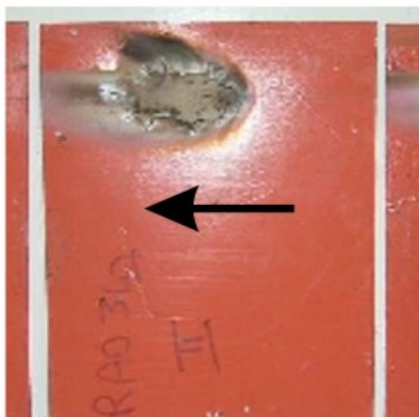
Preliminary Results



Sample G – All Passed



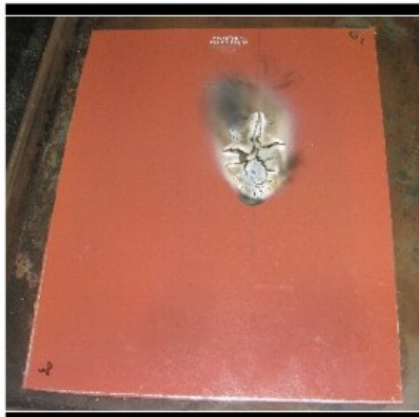
LAB 1



LAB 2



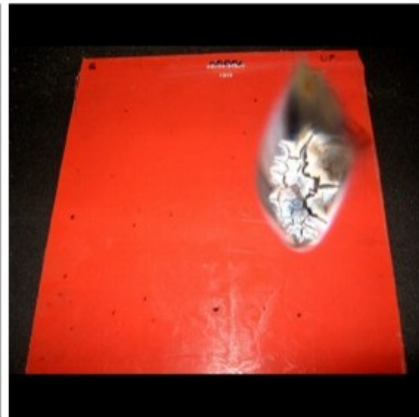
LAB 3



LAB 4

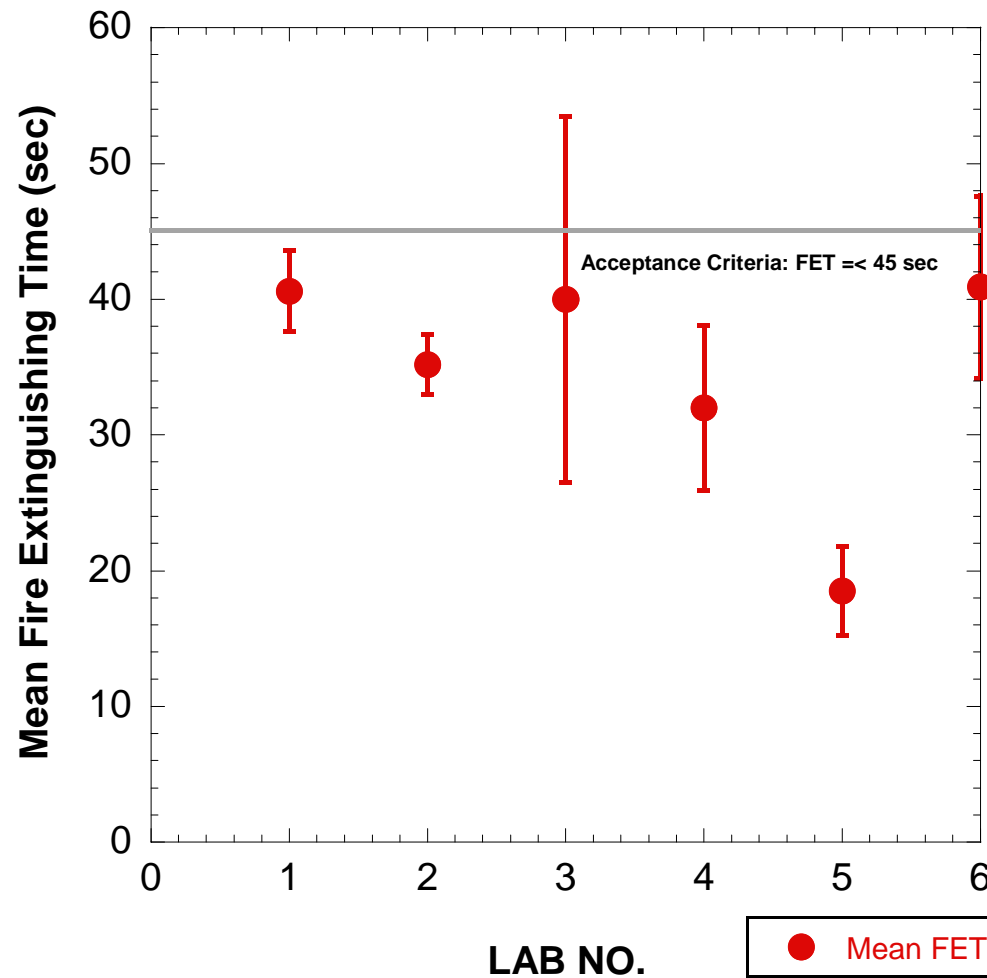


LAB 5

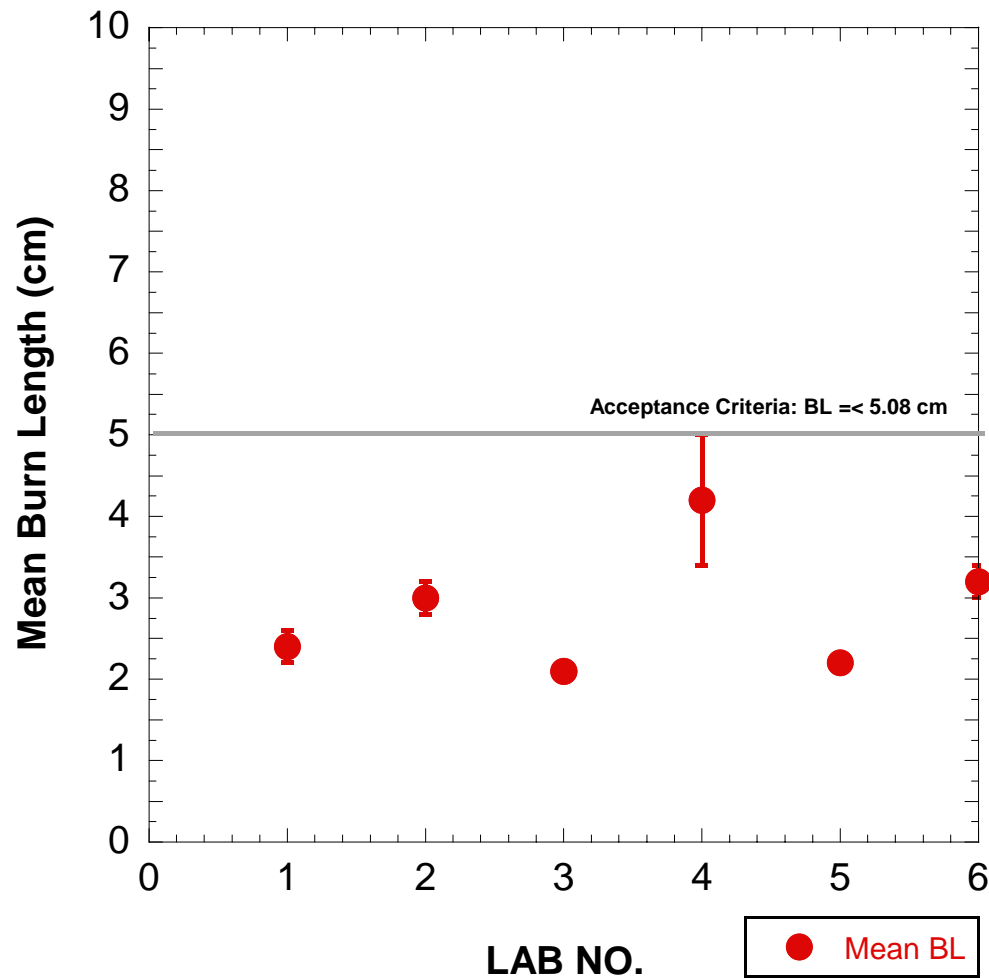


LAB 6

Sample G



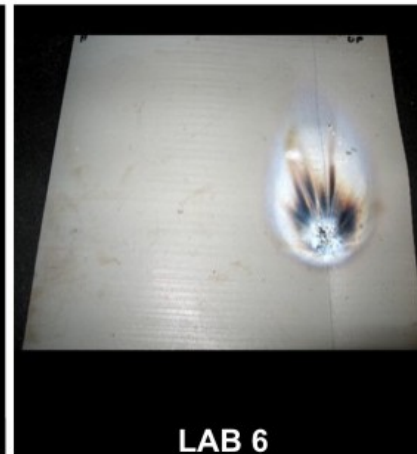
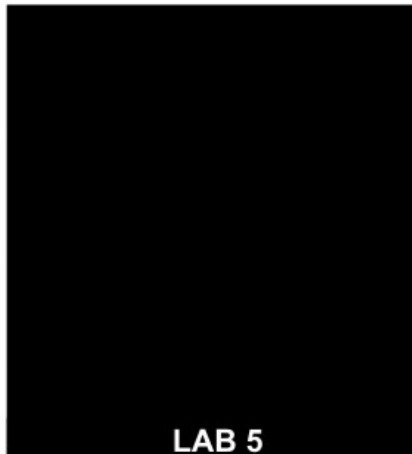
Sample G



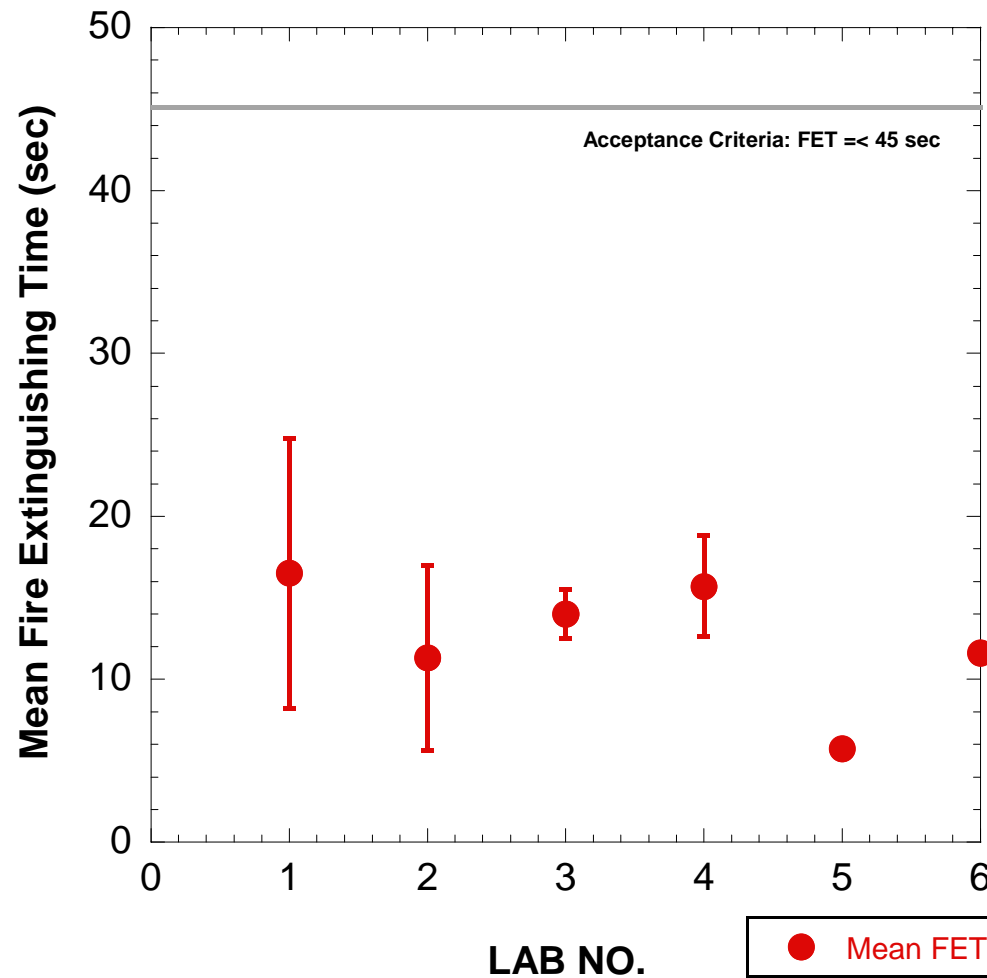
Preliminary Results



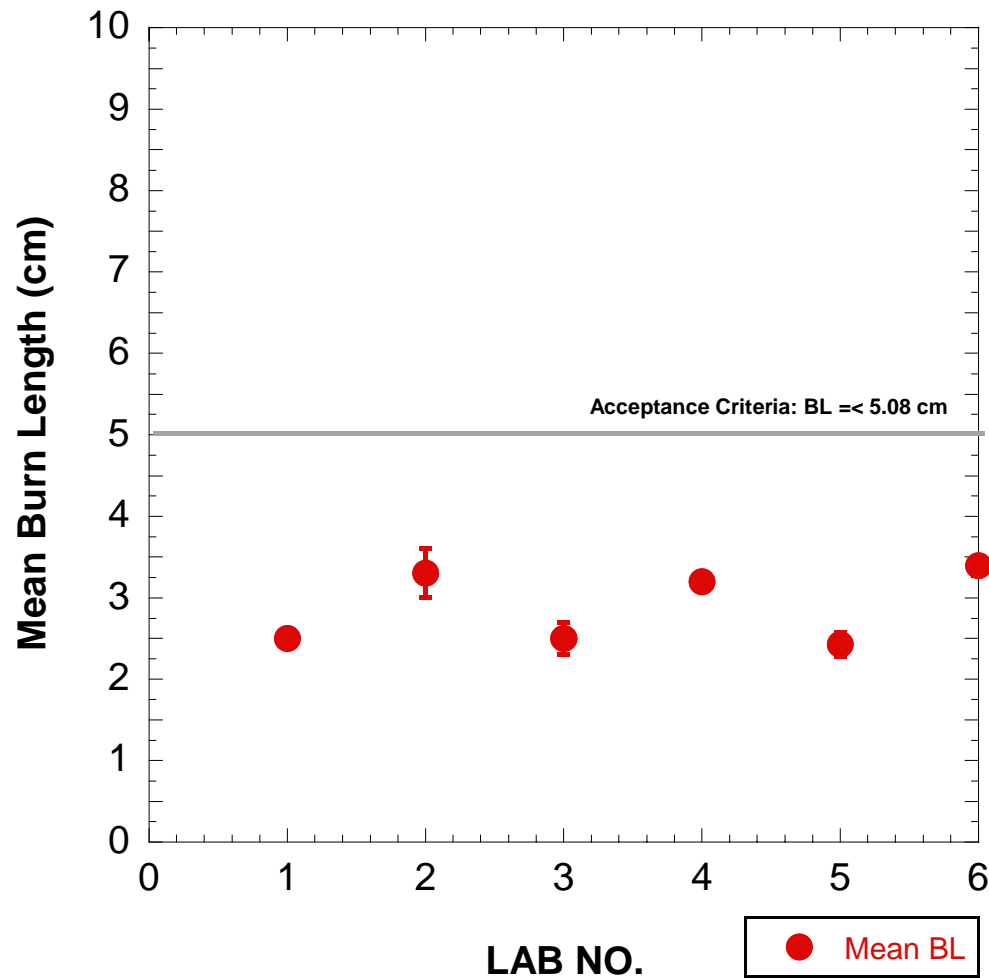
Sample H – All Passed



Sample H



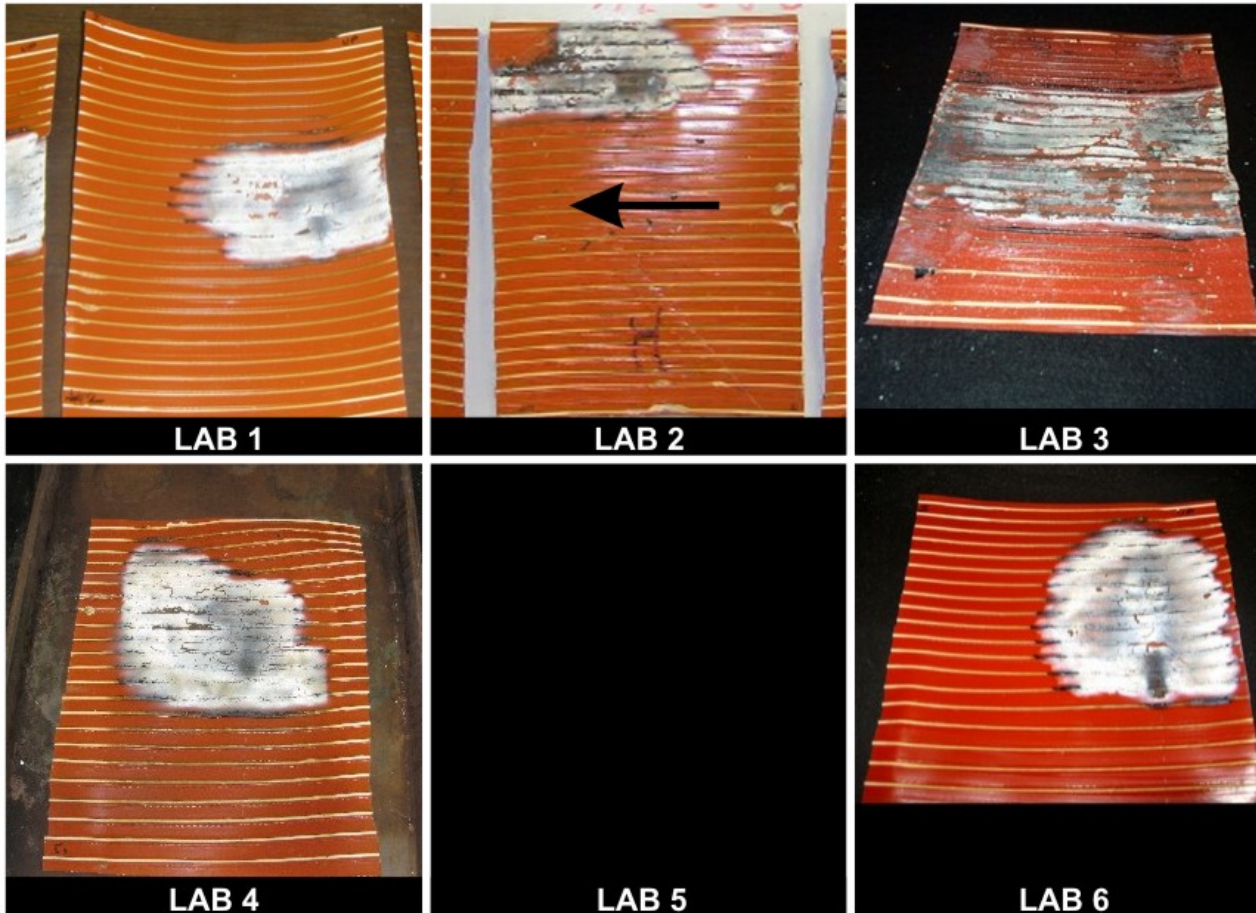
Sample H



Preliminary Results



Sample I – All Failed



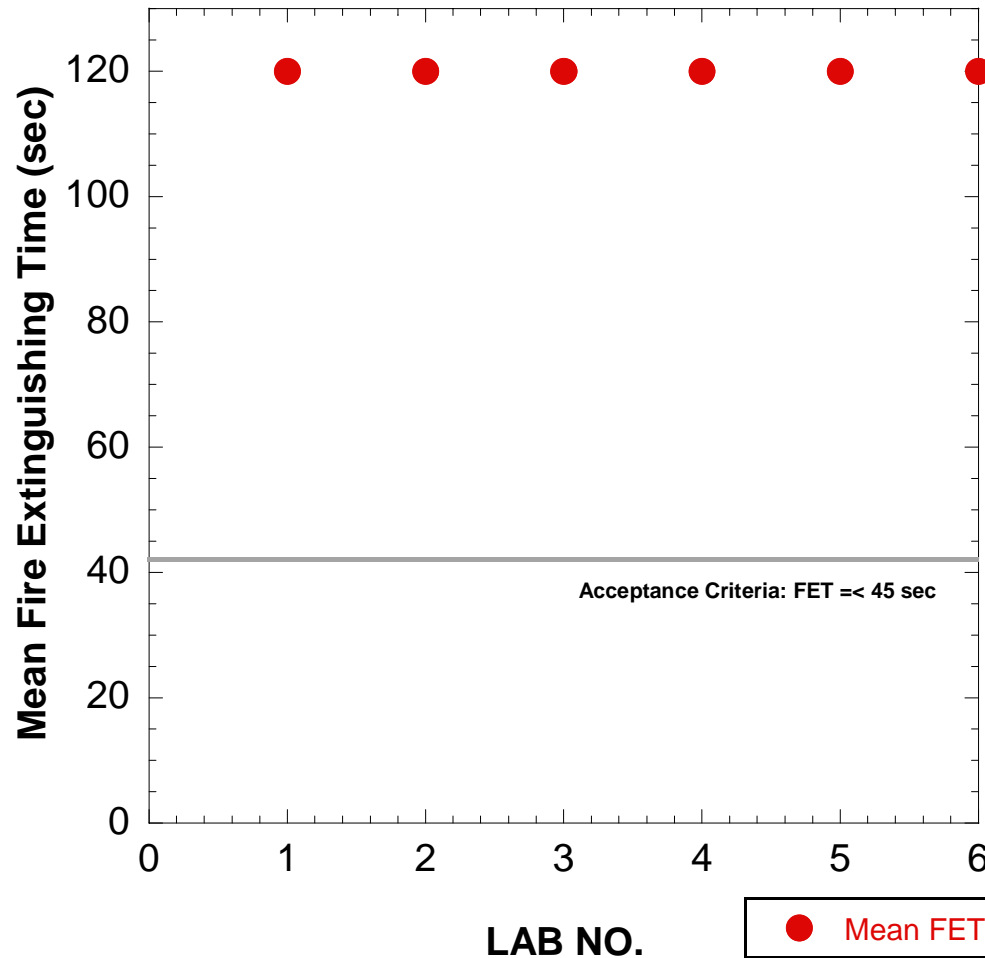
Labs 1,2, 4, 5, and 6 stopped the test after 120 seconds. Lab 3 ran the test until the fire extinguished.



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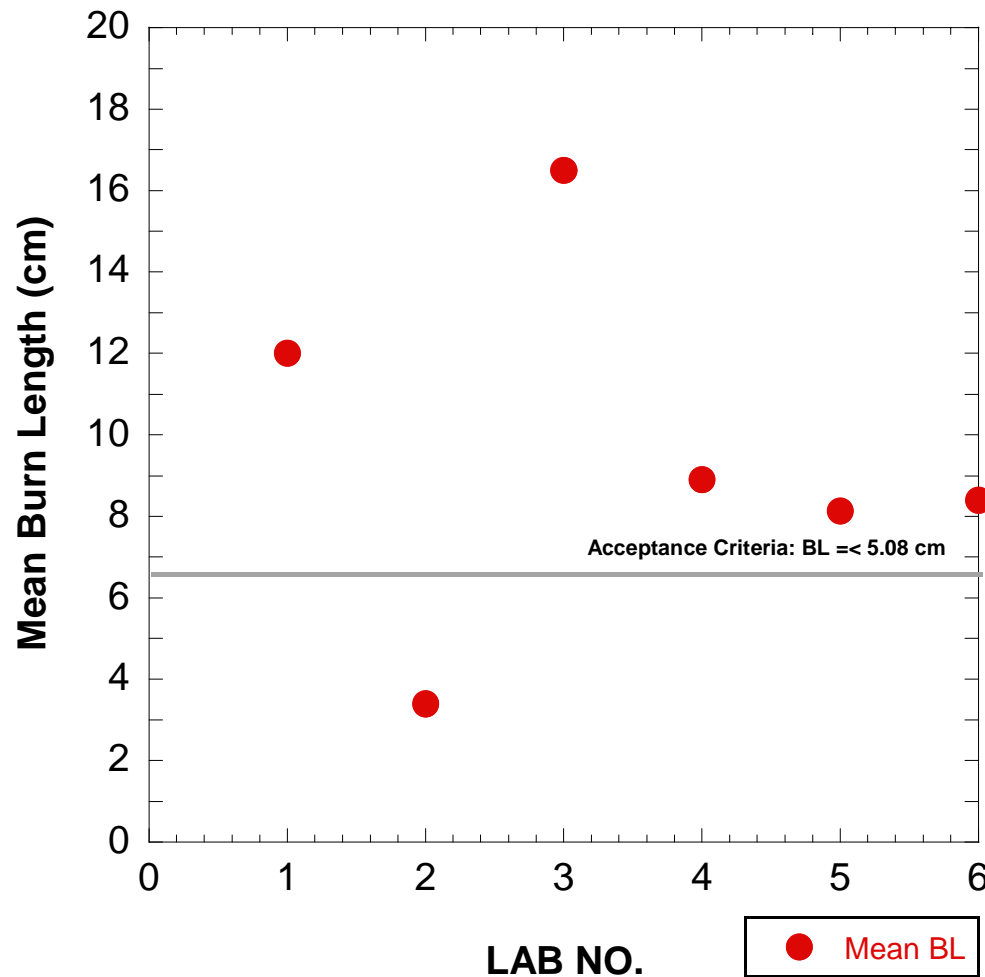


Sample I



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Sample I

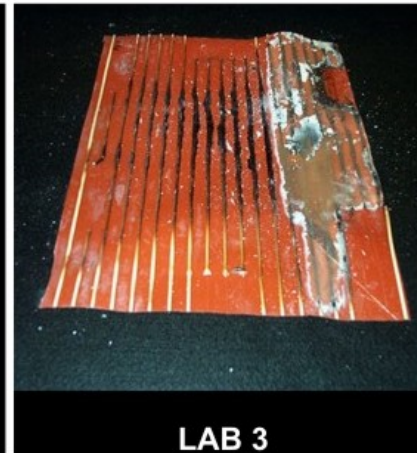


Labs 1, 2, 4, 5, and 6 stopped the test after 120 seconds. Lab 3 ran the test until the fire extinguished. Not all labs stopped at the same time, therefore the reported burn lengths are significantly different.

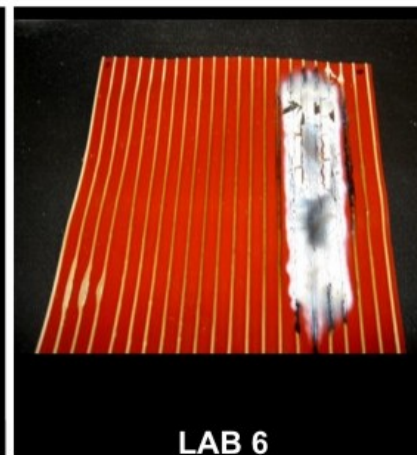
Preliminary Results



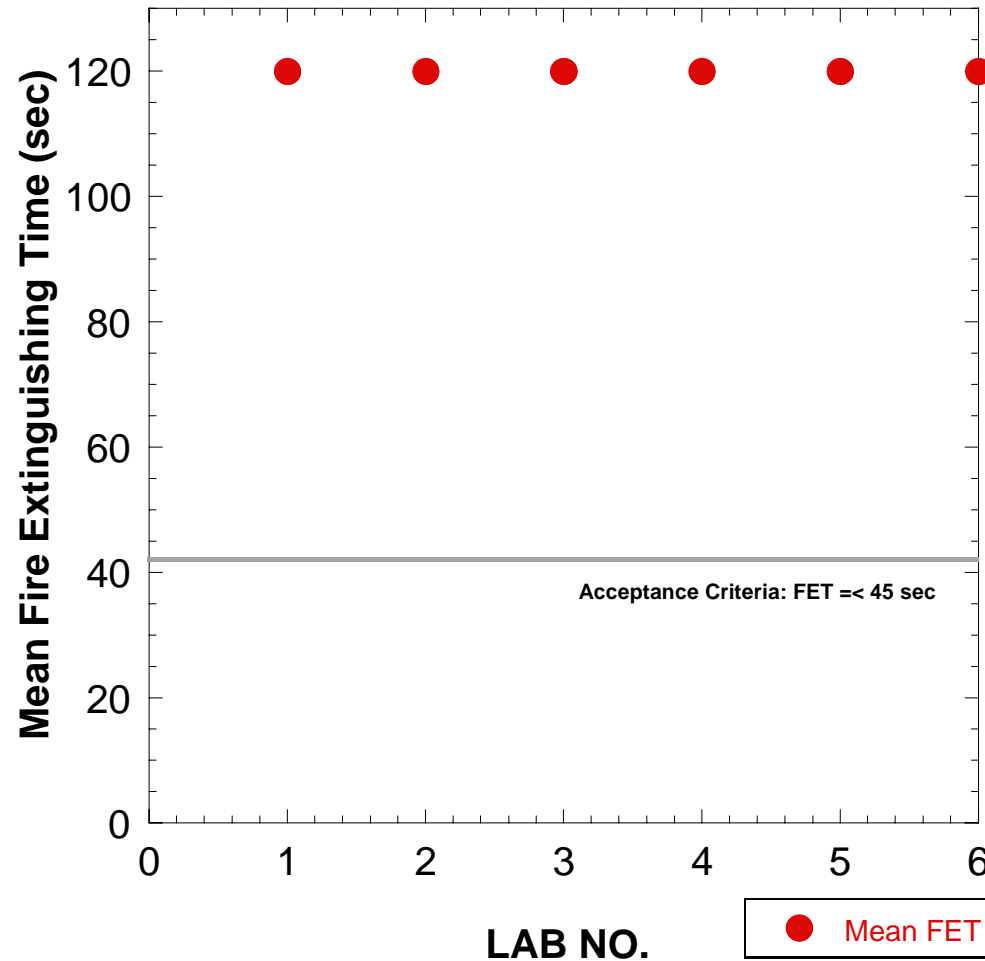
Sample J – All Failed



Labs 1,2, 4, 5, and 6 stopped the test after 120 seconds. Lab 3 ran the test until the fire extinguished.

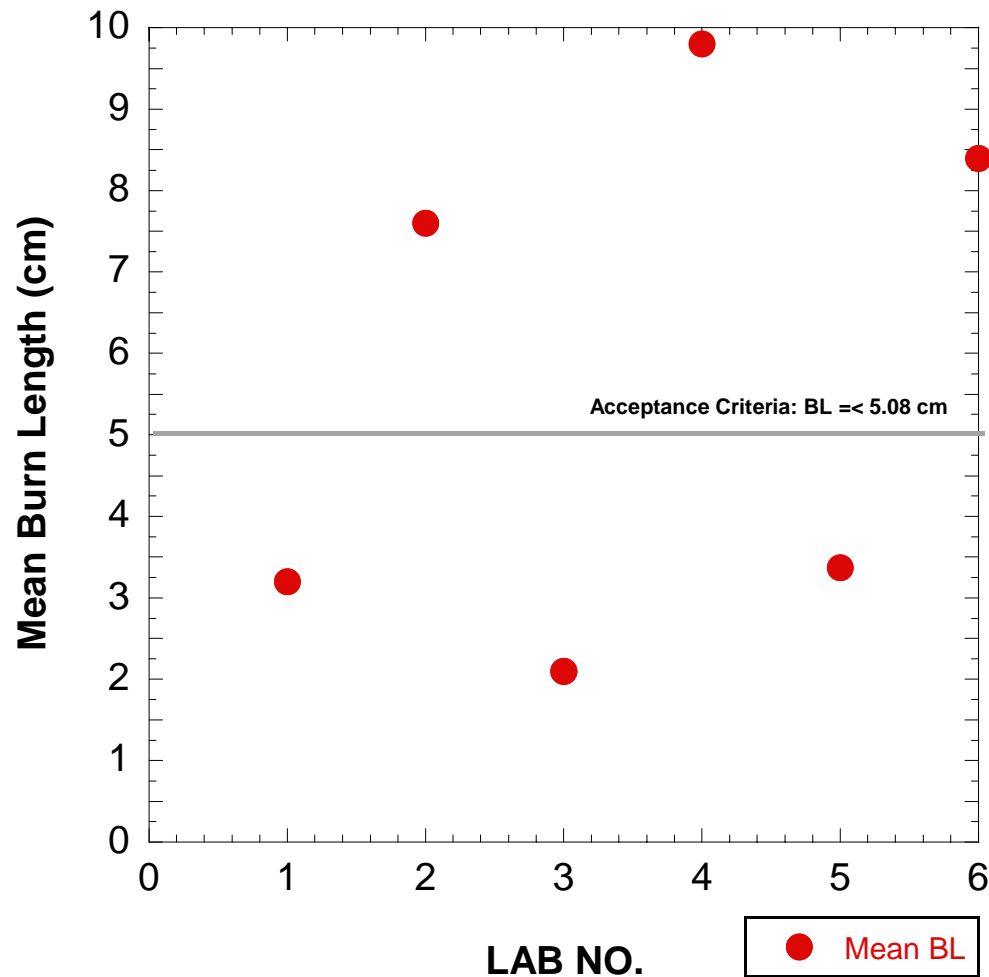


Sample J



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Sample J

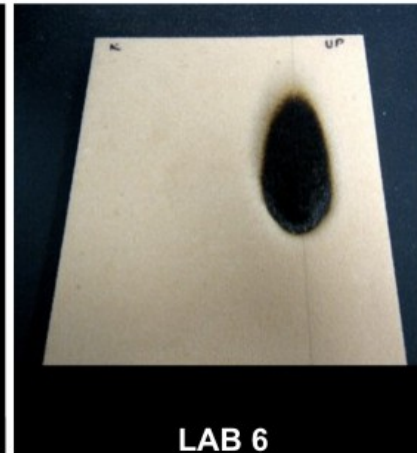
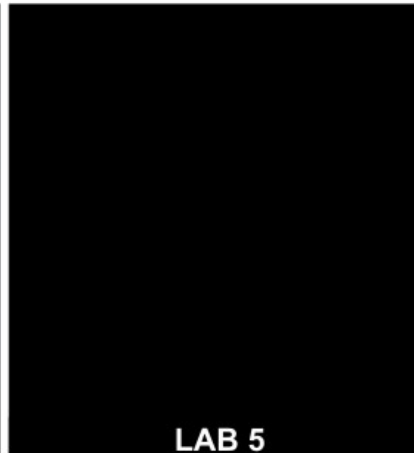
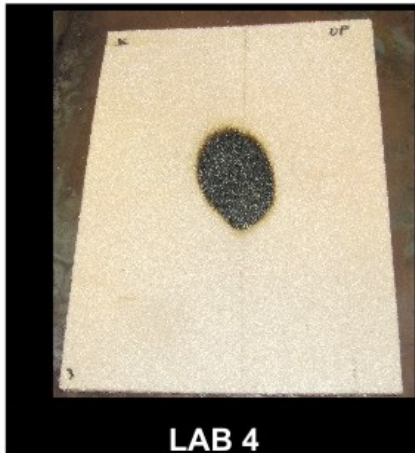
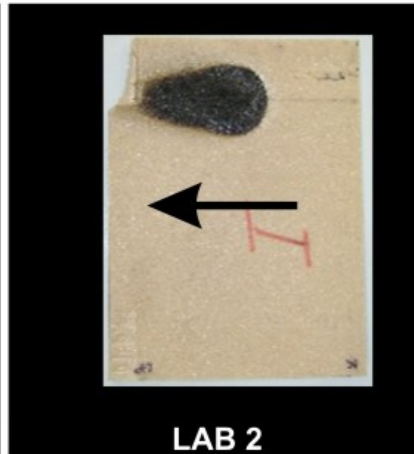
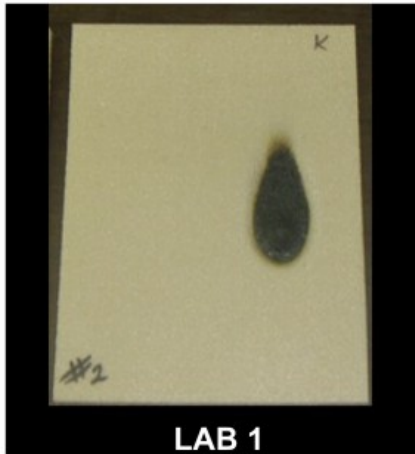


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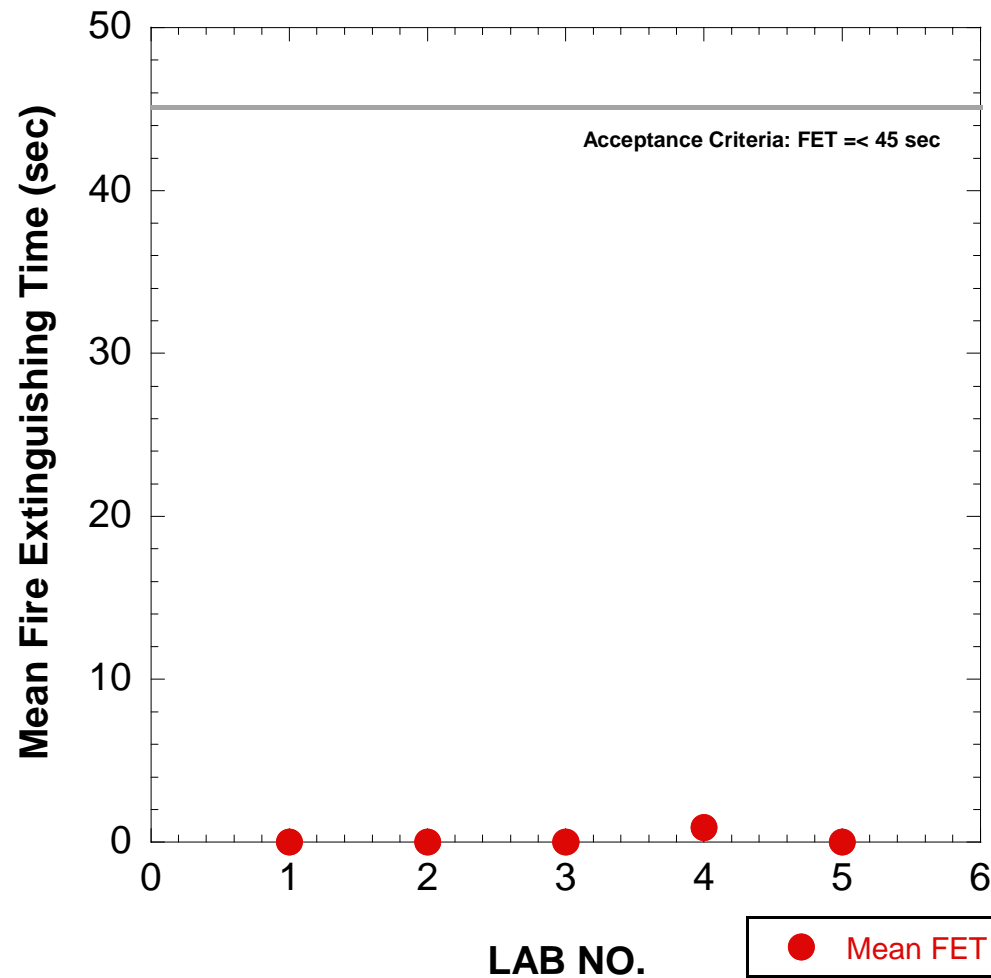
Preliminary Results



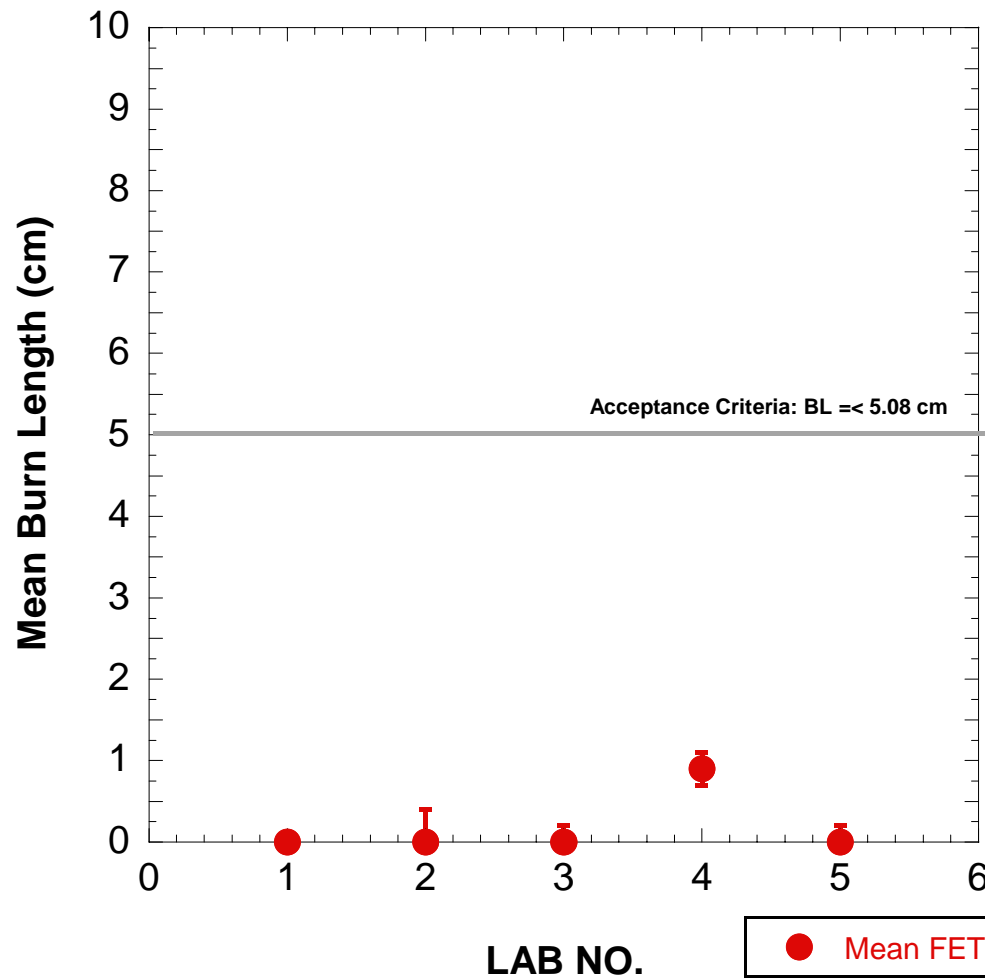
Sample K – All Passed



Sample K



Sample K



Preliminary Results



Individual Lab Acceptance Criteria Results

Lab ID	Ducting Material Sample										
	A	B	C	D	E	F	G	H	I	J	K
1	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Failed	Failed	Passed
2	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Failed	Failed	Not reported
3	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Failed	Failed	Passed
4	Passed	Passed	Passed	Passed	Failed	Failed	Passed	Passed	Failed	Failed	Passed
5	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Failed	Failed	Passed
6	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Passed	Failed	Failed	Passed
Predicted by MSCC	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass



Preliminary Results



Individual Lab Sample Setup

Lab No.	Actual Lab RHP-Sample Vertical Distance (cm)*	Standard Distance (cm)	Standard Tolerance Range (cm)	Is the distance within tolerance?
1	19.05	19.05 +/-0.32 cm	18.73 - 19.37	Yes
2*	19.4	19.05 +/-0.32 cm	18.73 - 19.37	Yes
3	19.37	19.05 +/-0.32 cm	18.73 - 19.37	Yes
4	20.95	19.05 +/-0.32 cm	18.73 - 19.37	No
5	19.1	19.05 +/-0.32 cm	18.73 - 19.37	Yes
6	19.05	19.05 +/-0.32 cm	18.73 - 19.37	Yes

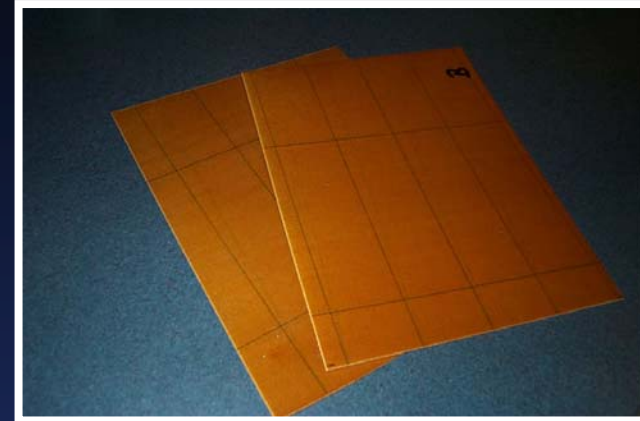
*Note: This lab's position of the panel is at 19 cm from the zero point to the chord of the concavity

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- ✓ Future Work
- ✓ Final Comments





Precision of Test Method:

- ✓ Will analyze (statistically) recently collected data using ASTM E 691-08 standard to determine the precision of the developed test method for aircraft ducting.
- ✓ ASTM E 691-08 - “Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method”



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Final Comments



Preliminary Conclusions:

- ✓ The average results of the labs matched the MSCC results. 9 materials passed, 2 failed.
- ✓ There is a possibility that the difference in results of Lab #4, with samples E & F, could be attributed to sample placement inside RHP. It will be investigated & re-tested
- ✓ Repeatability standard deviation (within a lab), for the most part, was very good; especially the burn length ones.
- ✓ Marginal materials (E, F, and G) exhibited wider standard deviations.
- ✓ ASTM E 691-08 will be used to analyze Interlaboratory reproducibility.



Final Comments



Questions?

