Ignition and Thickness Effects on ULOI/MOC Testing

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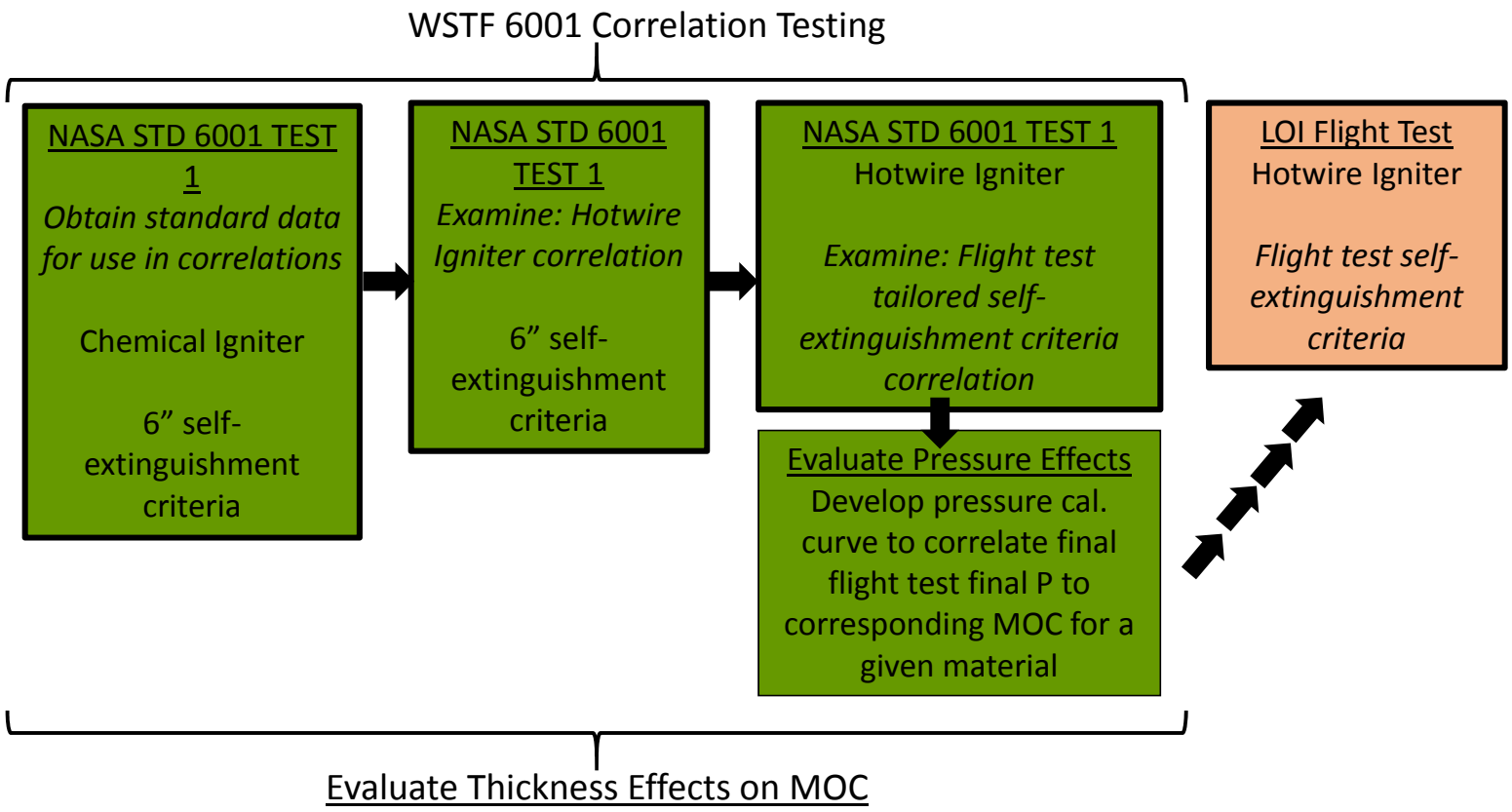
FLARE Project

- Correlation Pathway of NASA-STD-6001 Data to flight LOI data

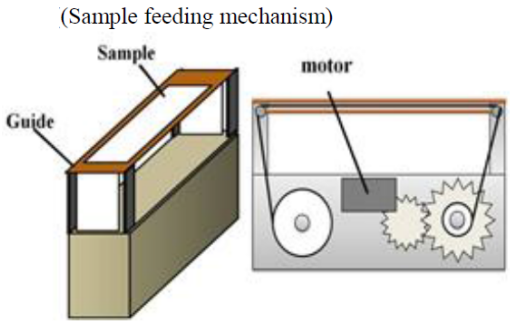


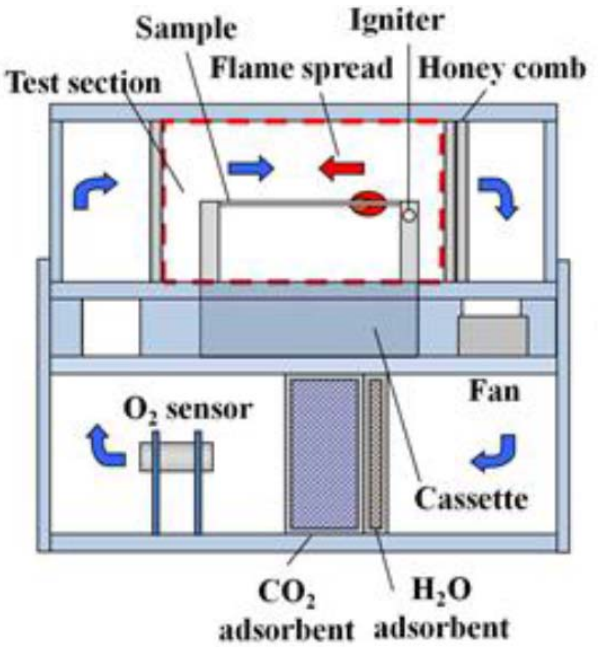
NASA/WSTF Involvement

- NASA STD-6001.B Test 1
- Standardized ULOI/MOC method utilizing Test 1 Criteria
  - 6” Burn Length Criteria
  - K-10 Paper Ignition acceptance criteria
  - 12” pretest sample length
- ULOI/MOC Tests
  - Oxygen Concentration Tolerance: +0.15% - 0%
  - If K-10 is driving failure criteria, perform Burn Length MOC to characterize material independent of NASA-STD-6001.B acceptance criteria

Hot Wire Igniter Investigation

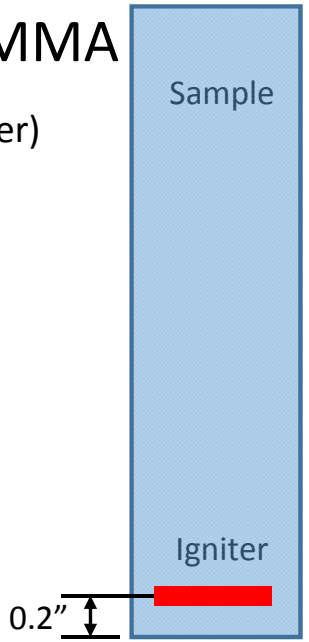
- Assumptions - Continuous Sample Feeding System
  - Reusable Hot Wire
  - Surface Ignition
  - Thin Materials (easily rolled up)
- Compare to Edge Ignition
  - Greater surface area to mass ratio
  - Less heat loss





Proposed Configurations

- All coils constructed with 20 ga wire
- Test performed on 0.0625” thick PMMA
- Proposed Geometry – (d=mandrel diameter)
  - Helical (a)
  - Elliptical (b)
  - Sinusoidal (c)
  - Single Bare conductor
- Igniter position
  - On surface
  - 0.2” from bottom leading edge



(a)

(b)

(c)

Igniter Configuration – Results

Ignition Times Using Standard Power Supply – 6V

Shape	Round												Elliptical		
Size	0.25			0.135			0.085			0.064			0.079		
Wraps	R (Ω)	Red (s)	Ignition (s)	R (Ω)	Red (s)	Ignition (s)	R (Ω)	Red (s)	Ignition (s)	R (Ω)	Red (s)	Ignition (s)	R (Ω)	Red (s)	Ignition (s)
3.5	--	--	--	--	--	--	0.3	3	6.7	--	--	--	--	--	--
4.5	0.3	6.6	21.8	0.3	4.1	12	0.3	2.5	5.8	0.2	3.1	6.5	0.3	4.4	12
5.5	--	--	--	--	--	--	0.3	4.1	10.1	--	--	--	--	--	--
8.5	--	--	--	--	--	--	0.3	6	17.8	--	--	--	--	--	--
12.5	0.4	24.7	33	0.4	8.9	31.5	0.4	7.4	53.7	--	--	--	--	--	--
16.5	--	--	--	--	--	--	0.5	10.1	73.4	--	--	--	--	--	--
20.5	1	155.3	209.4	0.6	25.2	68.8	0.6	11.1	69.7	--	--	--	--	--	--

Igniter Configuration - Results

Ignition Times Using Standard Power Supply – 6V

	Sinusoidal					
	0.145			0.109		
Period	R (Ω)	Red (s)	Ignition (s)	R (Ω)	Red (s)	Ignition (s)
3.5	0.3	8.3	125.6			
4.5				0.3	8.3	61.1
4.5 Edge				0.3	7.5	53.1
3.5, 10V	0.3	2.6	7.5			

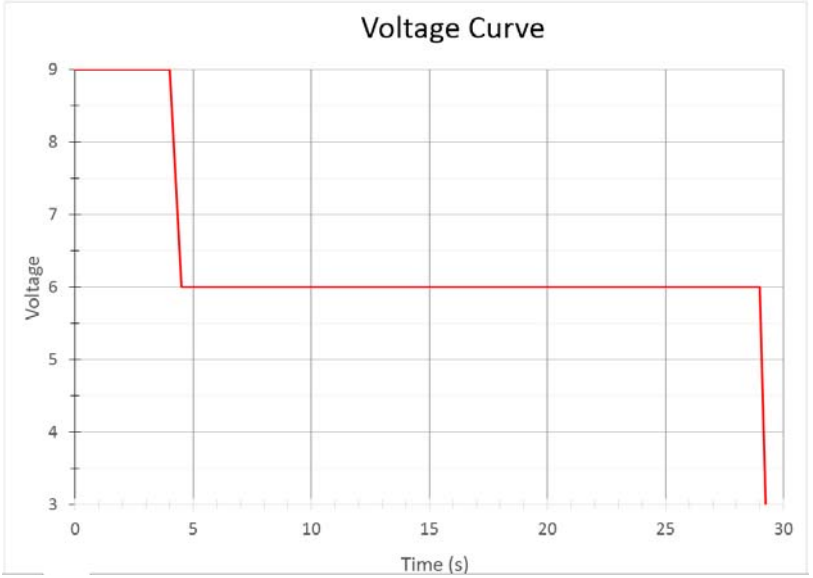
Straight				
Voltage (V)	Width (in.)	R (Ω)	Red (s)	Ignition (s)
6	1.375	0.2	2.7	6
6	1.375	0.2	2.9	7
6	0.75	0.2	2.9	7.5
6	0.75	0.2	2.7	5.6
6	1	0.2	2.3	4.7
6	1	0.2	3.2	8

Ignition Times Using Auxiliary Power Supply

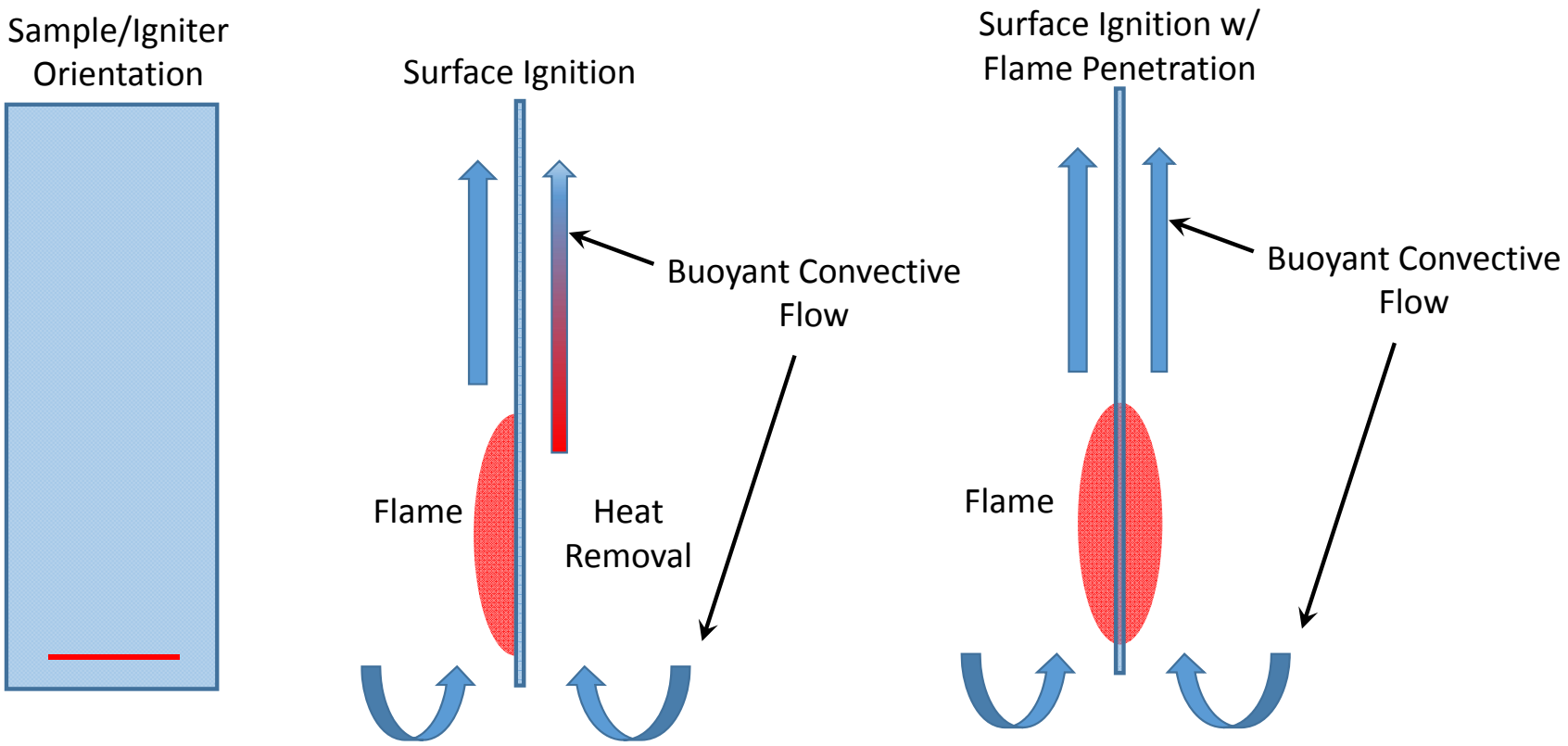
Straight				
Voltage (V)	Width width	R (Ω)	Red (s)	Ignition (s)
8V	1	0.2	2.2	5.7
10V	1	0.2	1.6	2.8
10V	1	0.2		
9V	1	0.2	1.8	3.4
9V	1	0.2	2	3.6

Power Supply Configuration

- Constant power supply
  - Standard 6V requires time to ignite
  - Oxidation of heating element
- Auxiliary power supply
  - Increased voltage
    - Quick ignition
    - Short life
    - Too high – inability to maintain combustion
  - Programmable curve
    - Ignite sample quickly
    - Lower voltage extends life
    - Correlation to the time standard igniter is on
    - Volatilizes to aid in sustaining combustion



Surface Ignition Variability



ULOI/MOC Results

- All tests performed using PMMA as fuel
- No failures attributed to the K-10 ignition failure criteria
- Four test series
  - Surface Ignition
    - 0.0625” – ULOI = 17.53%, MOC = 17.08%
    - 0.125” – ULOI = ~17.5%, MOC = ~17%
  - Edge Ignition
    - 0.0625” – ULOI = 15.62%, MOC = 15.11%
    - 0.125” – ULOI = 16.23%, MOC = 15.06%

Conclusions

- Surface ignition variability
  - Back face cools flame
  - Flammability results dependent on burn through
- Edge ignition
  - Provides configuration independent evaluation
  - Finer resolution of test data

Future ULOI/MOC Work

- Thinner samples (films)
- Other materials
  - LDPE
  - Polycarbonate
  - Nomex
- 1:1 with Standard test configuration