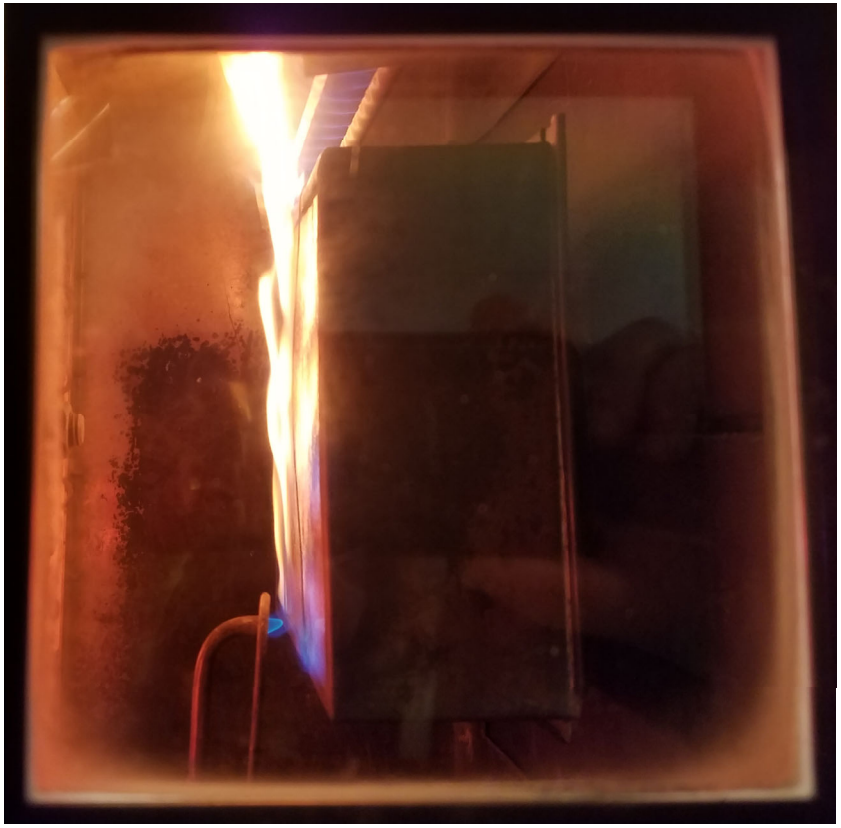
HR2 TRL 6 - Reproducibility Assessment

Test Plan



A look inside the HR2 burn chamber

Presented by: Brian Johnson, The Boeing Company

Prepared by: Yaw Agyei and Brian Johnson, both of The Boeing Company

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Introduction

- HR2 Goal: Define a robust method to determine peak and total heat release that improves repeatability and reproducibility when compared with OSU

Status

- NASA Technical Readiness Level (TRL) model adopted
- TRL 5 - Repeatability completed - CoV improvement demonstrated
  - Multiple changes to processes and equipment to reduce variation
  - Significant improvements demonstrated for both panel types
- HR2 is in **TRL Phase 6 -** Reproducibility

Note: Success criteria will be determined by the OSU / HR2 task group

HR2 Development TRLs & Gates

TRL 5 - *Repeatability* - variation in measurements taken on the same item under the same conditions. Homogenous coupon tested multiple times using one unit.

➡ Gate 5 / Enter **TRL 6**: Coefficient of Variation (CoV) improvement vs. OSU

TRL 6 - *Reproducibility* - variation in measurements taken on the same items under the same conditions using different machines.

➡ Gate 6 / Enter **TRL 7**: Individual coupon type CoV and ANOVA evaluation

TRL 7 - *Range* - Finalized prototype equipment demonstration on range of production configurations. HR2 pass/fail criteria (peak/total) established.

➡ Gate 7 / Enter **TRL 8**: Consistent results over a range of sample types

TRL 8 - *Guidance* - drawings release, equipment built to standards, 'qualified' through test and demonstration.

➡ Gate 8 / Enter **TRL9**: Qualification criteria and test guidance established

TRL 9 - *Round Robin* - Multiple production units verified by successful round robin testing.

➡ Gate 9 / **Production Readiness**: Significant R&R improvements vs. OSU

TRL 6 Test Plan

Approach

- Phase 1 - Evaluate participating units to ensure parameters* fall within set ranges
- Phase 2 - Test 40 specimens and compare variation to reproducibility criteria

Instruments

Currently Online

- Marlin Engineering HR2 - FAA TC, Egg Harbor Township, New Jersey
- Deatac HR2 - FAA TC, Egg Harbor Township, New Jersey

Future Implementation

- Marlin Engineering HR2 - Airbus Fire Test Laboratory, Bremen, Germany
- Pending Purchase - Boeing Test Laboratory, Seattle, Washington

* Discussion of operating / response parameters and tolerance intervals is discussed in a following presentation by Y. Agyei

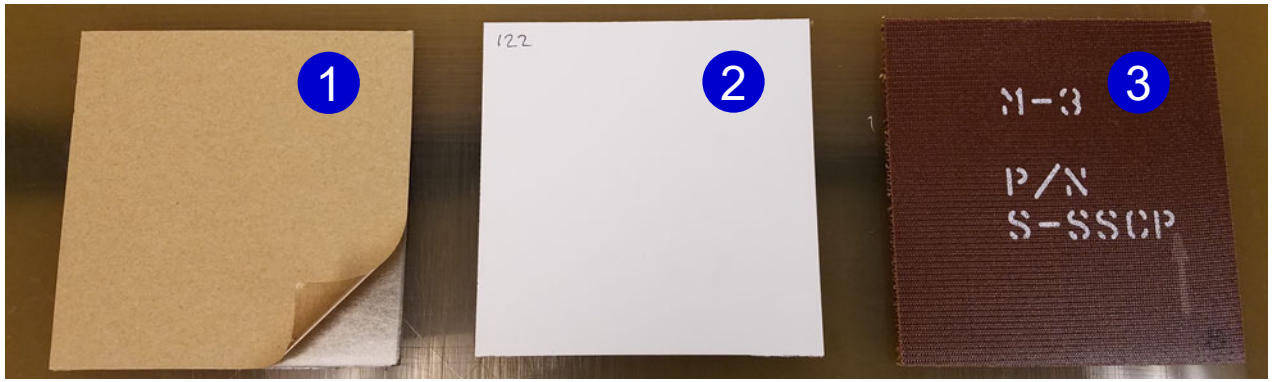
TRL 6 Test Plan

Test Coupons

- Fabricate all coupons to support initial unit testing schedule
- Ship panels to Boeing for randomization and distribution
- Store coupons reserved for late year testing in conditioning chamber (70°F, 50% RH)
- Develop plan to statistically evaluate variation due to storage effects*

40 randomized samples each of 3 homogenous coupon types per unit

1. Aluminum panel with transfer tape - provided by Airbus
2. Standard panel with decorative - provided by Boeing
3. Standard laminate panel - provided by the FAA / Schneller



* Boeing panels exhibit very little additional variation when similarly stored

Phase 2 - Specimen Test Measurements

Test Procedure

- Detailed cold and hot start procedures shall be followed prior to testing
- Test per A4 Test Method in Aircraft Materials Fire Test Handbook Rev 3
- All specimens will be continuously conditioned form receipt until the time tested
- Coupons shall be removed from conditioning in groups of threes and transferred into a sealed plastic bag
- Individual coupons shall be removed from the bag just prior to testing
- Coupons will be weighed after wrapping and prior to testing
- Sample holders will be marked and recorded prior to each run
- Same materials and processes will be used in sample preparation
- Thermopile must stabilize to within 1% of baseline prior to specimen loading*
- Ambient temperature and humidity will be recorded prior to each test
- Sample holders will be cleaned with a wire brush after each test
- Thermocouples shall be cleaned after three (3) runs

➢ Implementing variation-reducing techniques learned in TRL 5 testing

* Current procedure specifies 3%

Phase 2 - Machine Prep and Material Assessment Logs

Machine Preparations Log

Heat Flux Gauge Calibration Records		
	Center	Corner
HFG Identifier		
Heat Flux Gauge Type		
Manufacture		
Calibration Facility		
Calibration Date		
Calibration Method		
Calibration Responsivity		

Machine Preparation Records											
								Sacrificial Panel			
Run #	Center Heat Flux (W/cm^2)	Corner Heat Flux (W/cm^2)	Power Output (W)	Thermopile Output (w/o Flames)	Thermopile Output (B_0) (w/ Flames)	Lab Temperature (F)	Lab Relative Humidity (%)	Peak (kW/m^2)	Time at Peak (seconds)	Total ($kW*min/m^2$)	Baseline (mV)
1											
2											
3											
4											
5											

* Sacrificial panel burn may be reduced or eliminated in light of the characteristic measurements / range tightening; will be further discussed in the breakout sessions

Material Test Assessment Log

Unit	Day	Set	Order	Specimen Type	Specimen ID	File Name	Sample Holder #	Test Start Time	Room Temp (°F	Room Humidity (% RH)	Supply Air Temp (°	Supply Air Pressure (mmHg	Supply Air Humidity (%RH)	Tpile Baseline (mV/°	Peak (kW/m	Peak Time (sec)	2-Min Total HR (kW-min/m2
FAA-ME	1	1	1	SP	21	FAA-ME-Day1-Set1	1										
FAA-ME	1	1	2	SP	15	FAA-ME-Day1-Set1	2										
FAA-ME	1	1	3	SP	94	FAA-ME-Day1-Set1	3										
FAA-ME	1	1	4	AT	68	FAA-ME-Day1-Set1	4										
FAA-ME	1	1	5	BPD	140	FAA-ME-Day1-Set1	1										
FAA-ME	1	1	6	AT	82	FAA-ME-Day1-Set1	2										
FAA-ME	1	1	7	BPD	33	FAA-ME-Day1-Set1	3										
FAA-ME	1	1	8	SP	56	FAA-ME-Day1-Set1	4										
FAA-ME	1	1	9	AT	99	FAA-ME-Day1-Set1	1										
FAA-ME	1	1	10	AT	90	FAA-ME-Day1-Set1	2										
FAA-ME	1	2	11	SP	162	FAA-ME-Day1-Set2	3										
FAA-ME	1	2	12	BPD	52	FAA-ME-Day1-Set2	4										
FAA-ME	1	2	13	SP	24	FAA-ME-Day1-Set2	1										
FAA-ME	1	2	14	AT	146	FAA-ME-Day1-Set2	2										
FAA-ME	1	2	15	BPD	46	FAA-ME-Day1-Set2	3										
FAA-ME	1	2	16	AT	33	FAA-ME-Day1-Set2	4										
FAA-ME	1	2	17	SP	14	FAA-ME-Day1-Set2	1										
FAA-ME	1	2	18	AT	105	FAA-ME-Day1-Set2	2										
FAA-ME	1	2	19	AT	42	FAA-ME-Day1-Set2	3										
FAA-ME	1	2	20	SP	9	FAA-ME-Day1-Set2	4										
FAA-ME	1	3	21	SP	165	FAA-ME-Day1-Set3	1										
FAA-ME	1	3	22	BPD	106	FAA-ME-Day1-Set3	2										
FAA-ME	1	3	23	SP	107	FAA-ME-Day1-Set3	3										
FAA-ME	1	3	24	SP	25	FAA-ME-Day1-Set3	4										
FAA-ME	1	3	25	AT	119	FAA-ME-Day1-Set3	1										
FAA-ME	1	3	26	AT	93	FAA-ME-Day1-Set3	2										
FAA-ME	1	3	27	SP	57	FAA-ME-Day1-Set3	3										
FAA-ME	1	3	28	AT	12	FAA-ME-Day1-Set3	4										
FAA-ME	1	3	29	SP	151	FAA-ME-Day1-Set3	1										
FAA-ME	1	3	30	AT	58	FAA-ME-Day1-Set3	2										
FAA-ME	2	1	31	SP	99	FAA-ME-Day2-Set1	3										
FAA-ME	2	1	32	BPD	67	FAA-ME-Day2-Set1	4										
FAA-ME	2	1	33	BPD	104	FAA-ME-Day2-Set1	1										
FAA-ME	2	1	34	BPD	147	FAA-ME-Day2-Set1	2										
FAA-ME	2	1	35	SP	30	FAA-ME-Day2-Set1	3										
FAA-ME	2	1	36	SP	158	FAA-ME-Day2-Set1	4										
FAA-ME	2	1	37	BPD	51	FAA-ME-Day2-Set1	1										
FAA-ME	2	1	38	BPD	113	FAA-ME-Day2-Set1	2										
FAA-ME	2	1	39	SP	50	FAA-ME-Day2-Set1	3										
FAA-ME	2	1	40	SP	146	FAA-ME-Day2-Set1	4										

Next Steps

Anticipated Schedule

FAA TC HR2 operating parameter evaluation	Complete
All coupons fabricated, randomized, shipped	Mar 2020
FAA TC HR2 specimen testing start	Apr 2020
FAA TC data analysis complete	Apr 2020
Airbus HR2 operating parameter evaluation	Jul 2020*
Airbus TC HR2 specimen testing start	Aug 2020*
Airbus data analysis complete	Aug 2020*
Boeing HR2 operating parameter evaluation	Sep 2020+
Boeing TC HR2 specimen testing start	Sep 2020+
Boeing data analysis complete	Oct 2020+

* Contingent upon unit installation and setup timing
+ Contingent upon unit purchase, installation and setup timing

Questions?