

# PAINT EFFECT ON HEAT RELEASE OF AIRCRAFT MATERIALS

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## Outline

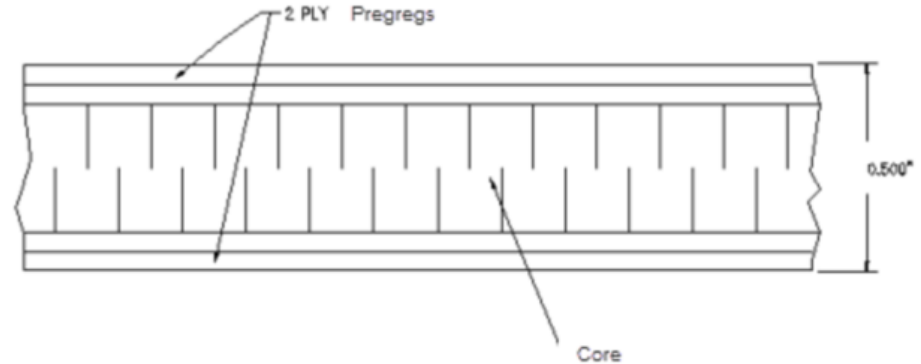
- Introduction
- Experimental
  - Materials
  - Test Methods
- Test Results
  - Multiple layer painting
  - Clear top coating
  - Paint thickness
  - Surface Preparation
  - Paint curing time
- Summary

## Introduction

- ❖ Paint has been often used on interior cabin furniture and deco panels.
- ❖ The impact of paint finishes on heat release has been recognized but limited amount of research work has been published in this area.
- ❖ The paint system, such as primer, base paint, top coating, and paint thickness, have been shown impact on the heat release.
- ❖ Multiple layer coatings were applied on some panels to test excessive amount paint effect on flammability of the painted panels.
- ❖ Painting process parameter's impact has also been discussed.

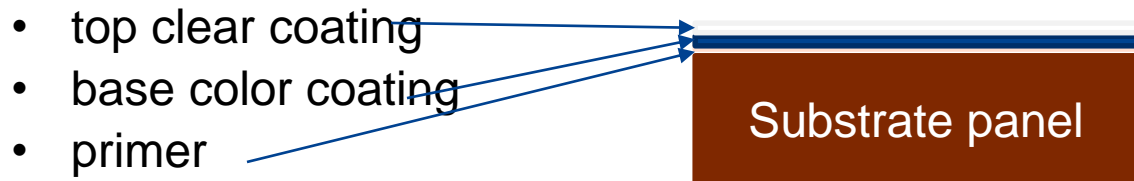
## Materials

- a. Clear coating A.
- b. Paint blue color B.
- c. Paint grey color C.
- d. Paint white color D .
- e. Panel CDPA437 (0.500" Thickness).
- f. Primer ivory color F.
- g. Primer grey color G.
- h. Panel CDM050-41 (0.500" Thickness)



Panel Structure

## Paint system



- ❖ All samples were coated and dried in accordance with approved process specification to minimize process variations.
- ❖ Spray gun was used to apply paint system with an even application of the paint following an approved internal process specification.
- ❖ The coating thickness on metal witness plate was measured with a PosiTest DFT coating thickness gauge with accuracy of +/- (2  $\mu\text{m}$ +3%).
- ❖ Three batches samples were made for this project.

Heat release is per FAR 25.853 (d) described in FAA's Aircraft Materials Fire Test Handbook.

### Two criteria data reported:

- Peak heat release rate (HRR)
  - HRR is a measure of the rate at which heat energy is evolved by a material when burned. It is expressed in terms of power per unit area (kilowatts per square meter--kW/m<sup>2</sup>).
- Total heat release within first 2 minutes (HR).
  - HR is a measure of the amount of heat energy evolved by a material when burned. It is expressed in terms of energy per unit area (kilowatt minutes per square meter--kW min/m<sup>2</sup>).

## Test Results

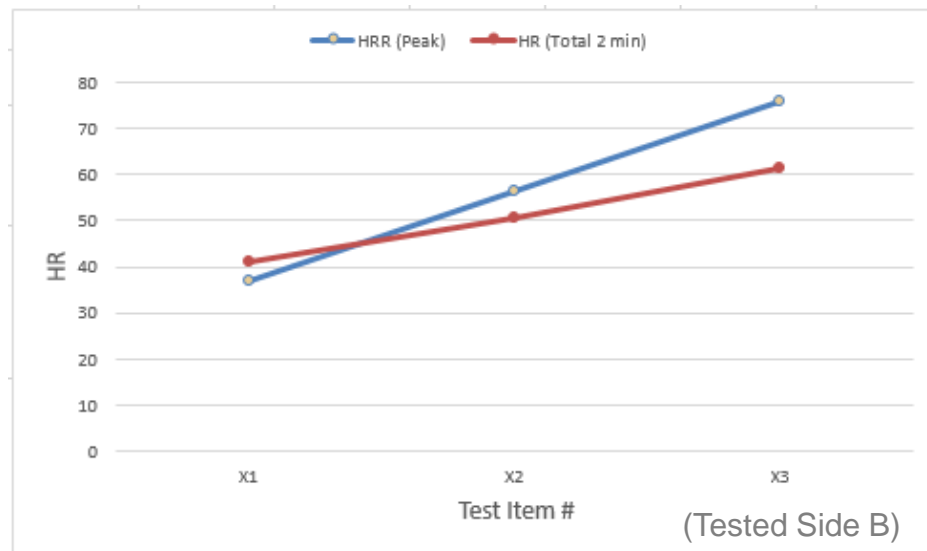
### Notes

1. Each batch panels were manufactured with same lot materials.
2. Paint thicknesses were measured with witness metal plate samples that were painted at same time as the samples.
3. All test side A is 1<sup>st</sup> top layer side of each configuration as listed in the table while side B is the last bottom layer side of each sample.

Item #	Configuration	Test side	HRR Peak	HR 2 min Total
X1	Panel CDPA437	B	36.9	41.2
X2	Panel CDPA437 Primer ivory color F Paint white color D	B	56.4	50.4
X3	Primer ivory color F Panel CDPA437 Primer ivory color F Paint white color D	B	76	61.3
X4	Paint grey color C Primer ivory color F Panel CDPA437 Primer ivory color F Paint white color D	A	70.1	47.4
X5	Paint blue color B Paint blue color B Paint grey color C Primer ivory color F Panel CDPA437 Primer ivory color F Paint white color D	A	76	59.2
		B	71	53.1
X6	Clear coating A Paint blue color B Paint blue color B Paint grey color C Primer ivory color F Panel CDPA437 Primer ivory color F Paint white color D	A	87.3	67.5
		B	67.8	45.9

## Test Results -Basic Paint Layers

Item #	Configuration
X1	<b>Panel CDPA437</b>
X2	<b>Panel CDPA437</b> Primer ivory color F Paint white color D
X3	Primer ivory color F <b>Panel CDPA437</b> Primer ivory color F Paint white color D

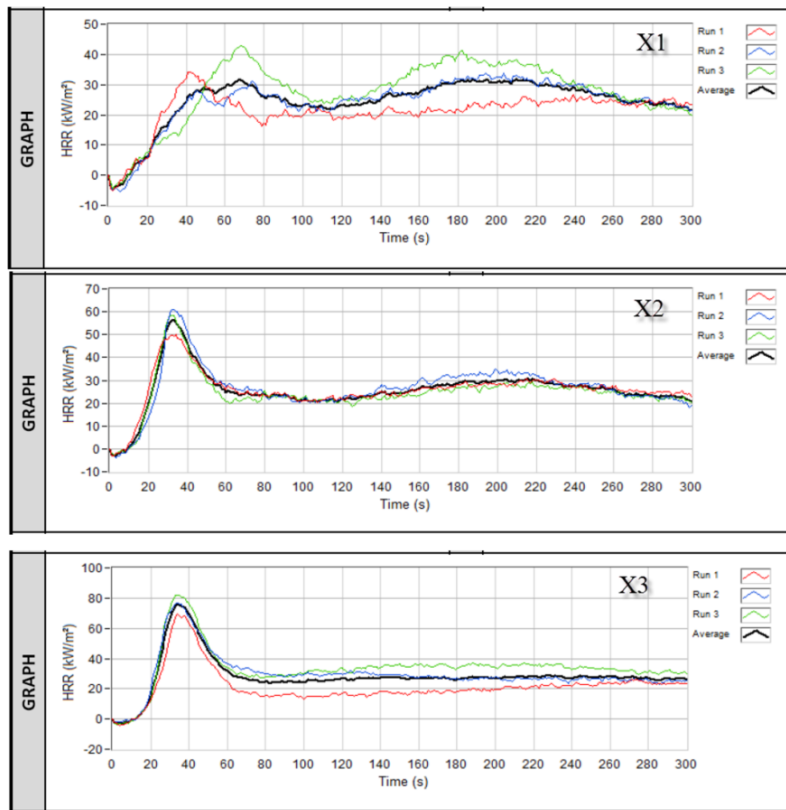


➤ Primer and paint additions increase the HR value.

- ❖ 1 layer primer and 1 layer white paint make the HRR increased by 19.5 (or 53%) by comparing X1 and X2 test results. 1 layer primer added on back side of the panel make the HRR increased by another 19.6 (or 35%) as shown testing data from X2 to X3. HR 2 minutes total values have been increased by about same 22% on both cases (X1 to X2 and X2 to X3) respectively.



## Test Results

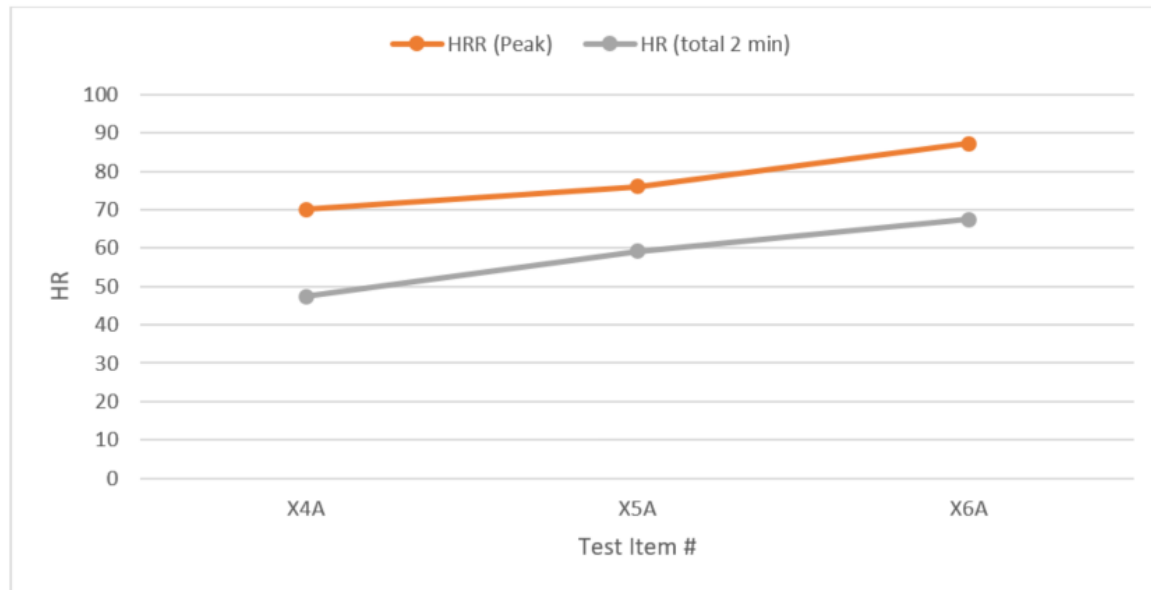


Average time to peak HRR:  
66 sec for panel alone (X1),  
33 sec for panel painted on one side (X2),  
34.3 sec for panel painted on one side and primer on the back side (X3).

- This indicates the painted panel burns much quicker than unpainted panel, which is most likely due to the quicker ignition with paint applied.
- The painted panel has also shown bigger heat released than the unpainted panel because of extra paint burned with the composite panel.

## Test Results -Multiple Paint Layers

X4	Paint grey color C Primer ivory color F <b>Panel CDPA437</b> Primer ivory color F Paint white color D
X5	Paint blue color B Paint blue color B Paint grey color C Primer ivory color F <b>Panel CDPA437</b> Primer ivory color F Paint white color D
X6	Clear coat A Paint blue color B Paint blue color B Paint grey color C Primer ivory color F <b>Panel CDPA437</b> Primer ivory color F Paint white color D



Samples X4, X5 and X6 has different paints on side A and have same paint applied on other side B.

The side A test results are shown.

## Test Results

**2<sup>nd</sup> batch samples** were made to investigate the clear coating and different color primer effects on the heat release of painted panels.

### Clear coating

➤ Clear coating addition increases heat release.

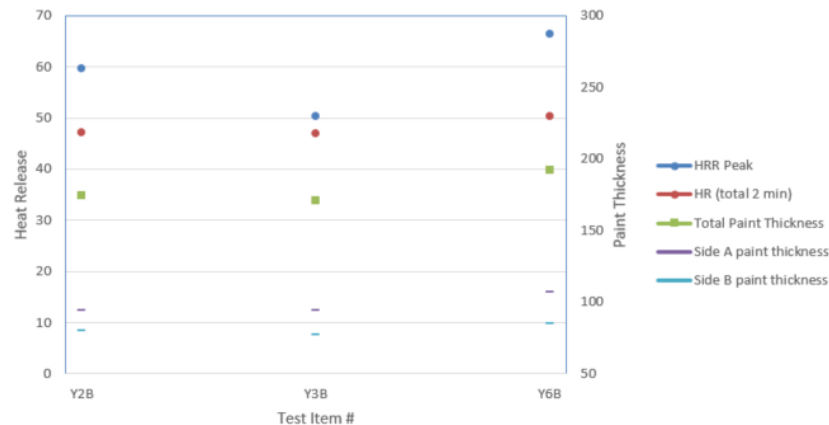
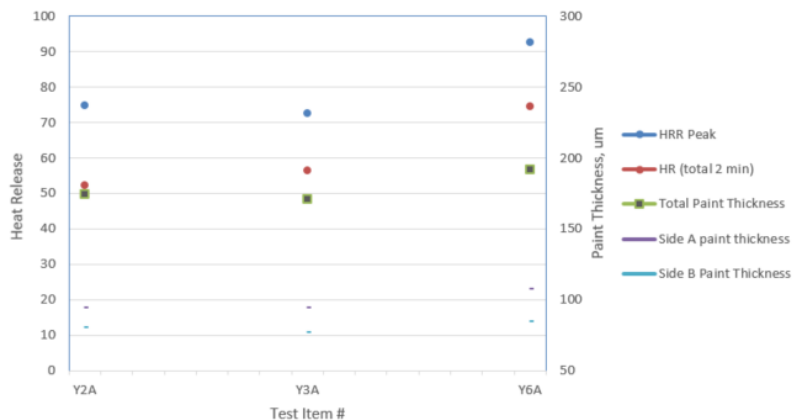
- From above table it can easy to see that clear coating addition increases heat release by comparing Y2 and Y3 to Y4 side A data. Y2 and Y3 have similar # of paint layers with clear top coating while Y4 has no layer of clear top coating.
- Similar impact of clear top coating ca also seen by comparing Y7 (without clear coating) and Y6 (with clear coating). They have similar primer and paint layers with similar paint thickness. Clear coating addition of sample Y6 makes it's heat release increased by 46% (from 63.4 to 92.6) for Peak heat release rate and 44% (from 51.5 to 74.4) for Total 2 min heat release.

Item #	Configuration	Test side	HRR Peak	HR 2 min Total
Y2	Clear coating A Paint blue color B Paint blue color B Primer ivory color F Panel CDPA437 Primer ivory color F Paint white color D	A	74.7	52.1
		B	59.7	47.1
Y3	Clear coating A Paint blue color B Paint blue color B Primer grey color G Panel CDPA437 Primer ivory color F Paint white color D	A	72.5	56.5
		B	50.3	47
Y4	Paint blue color B Paint blue color B Primer grey color G Panel CDPA437 Primer ivory color F Paint white color D	A	58.3	54.8
		B	59.1	42.8
Y6	Clear coating A Paint blue color B Paint blue color B Primer grey color G Panel CDPA437 Primer grey color G Paint white color D	A	92.6	74.4
		B	66.4	50.3
Y7	Paint blue color B Paint blue color B Primer grey color G Panel CDPA437 Primer grey color G Paint white color D	A	63.4	51.5

## Test Results -Total paint thickness

- Total paint thickness increase will have higher HR values

From below figure of side A test data, it can be seen that Y2 and Y3 have relative similar heat release data while Y6 has higher heat release, which may be contributed by total paint thickness that Y6 has thicker total paint thickness than the other two samples (Y2 and Y3) as shown in graphs below. Similar trend is also seen from Side B test data below.



## Test Results – clear top coating

Item #	Configuration	Paint thickness (μm)	Test side	HRR Peak	HR 2 min Total
C1	Paint blue color B Primer ivory color F Panel CDM050-41 (0.500" thk)	17 41 (31)*	A	53.8	40.1
T1	1 <sup>st</sup> layer clear top coating A Paint blue color B Primer ivory color F Panel CDM050-41 (0.500" thk)	10 17 41 (23)*	A	56.4	48.1
T2	2 <sup>nd</sup> layer clear top coating A 1 <sup>st</sup> layer clear top coating A Paint blue color B Primer ivory color F Panel CDM050-41 (0.500" thk)	13 10 17 41 (24)*	A	70.4	45.2

\* The value in the bracket ( ) is estimated average thickness based on witness panel measured thickness and weight measurement.

**A 3rd batch samples** with different clear coating thickness on a standard 0.500" flat composite panel substrate have similar results as shown in table.

❖ *This batch samples have same coating thickness on same type paint layers.*

➤ Top clear coatings increase heat release especially the Peak heat release value. And the thicker the clear coating, the larger the peak heat release.

## Test Results

### Base paint thickness

- ❖ *This batch samples have same coating thickness on same type paint layers.*

Item #	Configuration	Paint thickness (µm)	Test side	HRR Peak	HR 2 min Total
B1	1 <sup>st</sup> layer paint blue color B Primer ivory color F Panel CDM050-41 (0.500" thk) Primer ivory color F	11 41 (28)* 48 (37)*	A	53.5	41.2
B11	2 <sup>nd</sup> layer paint blue color B 1 <sup>st</sup> layer paint blue color B Primer ivory color F Panel CDM050-41 (0.500" thk) Primer ivory color F	17 11 41 (28)* 48 (38)*	A	58.5	42.4

\* The value in the bracket ( ) is estimated average thickness based on witness panel measured thickness and weight measurement.

- Addition of one layer same base paint will increase the heat release, i.e., the thicker the paint, the bigger heat release.

## Test Results

### Surface Preparation

Painting substrate surface preparation with filling & Fair and primer have been investigated shown in table.

❖ *This batch samples have same coating thickness on same type paint layers.*

- Primer will increase the heat release.
- Filler will increase the heat release.

Item #	Configuration	Paint thickness (μm)	Test side	HRR Peak	HR 2 min Total
P0	Panel CDM050-41 (0.500" thk)		A	31.6	29.6
P1	Primer ivory color F Panel CDM050-41 (0.500" thk)	41 (39)*	A	40.8	35
P2	Primer ivory color F Filling & Fair Panel CDM050-41 (0.500" thk)	41 (28)* 2.3 **	A	54.6	41.8

\* The value in the bracket ( ) is estimated average thickness based on witness panel measured thickness and weight measurement.

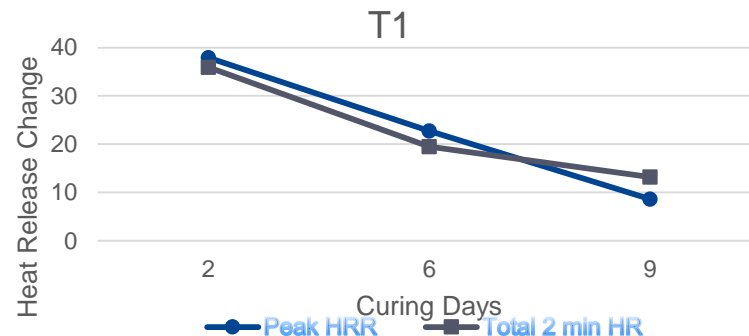
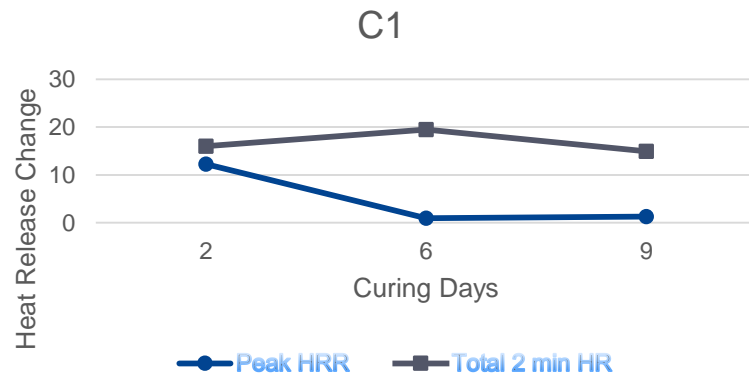
\*\* Filler weight in grams added on 14"x14" panel.

## Test Results

### Paint Curing Time

Paint curing (drying) time effects on heat release has been shown in these graphs with heat release delta changed comparison to raw bare panel as baseline.

- C1 is the painted sample without clear top coating
  - T1 has clear top coating
- 
- Peak heat release decreases with curing time.
  - With clear coating, it takes longer time to level off the decrease. This suggest it is better to test clear coated samples cured long enough.





## Summary

1. Primer, surface filler, base color paint and top clear coating all contribute the HR increase.
2. The thicker the paint (the more layer of paint), the higher the heat release.
3. Painted panels reach their peak HRR quicker than unpainted panel.
4. Heat release decreases with paint curing time before paint is fully cured.



## **ACKNOWLEDGMENT:**

Many thanks to Scott Campbell for his comments and suggestion about process impact tests.



***Thank You !  
&  
Questions ?***

