Vertical Flame Propagation Test Method (VFP)

Presented to: IAMFTF, Atlantic City NJ

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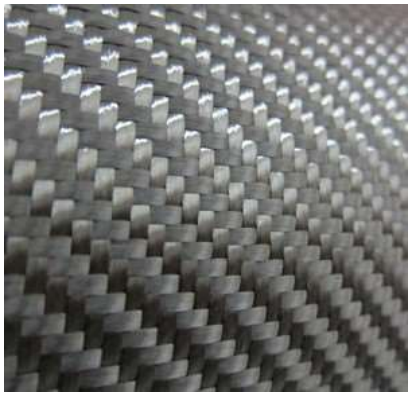
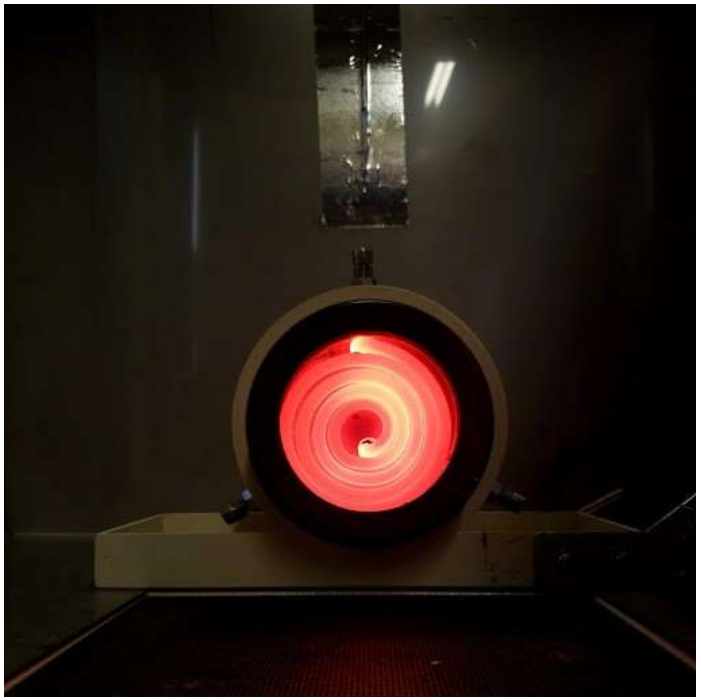
Background

- Planned method to test composite structure components and other non-metallic, extensively used parts in inaccessible areas.
  - Composite Fuselage
  - Wires
  - Ducting
  - Sleeving



Where Are We Now?

- Updates to the Marlin VFP
- New sample holder for wire
- Technical Document
- Test Method Document
- Furnace Issues
- Fuel/Air Flow Rates



Updates at the FAA

- Permanently installed MFC's
- Updated Software
- New Sample Holder
- Test Start Switch
- Hold-Open Mechanism
- Larger Control Enclosure
- Repositioned Exhaust Hood

Updates

- **New sample holder**
  - Deeper offset
  - Stronger hold
  - Hold-open Mechanism
- **Modular pins for sleeving**

Updates

- **Wire sample holder**
  - -Stainless rods
  - -Marinite backer
  - -3 wire config
  - -Pinned corners

VFP Furnace

- **Noticeable differences**
  - -Coil diameter
  - -Overall rod length
  - -Effective heated length
  - -Mass 
  - -Construction

VFP Furnace

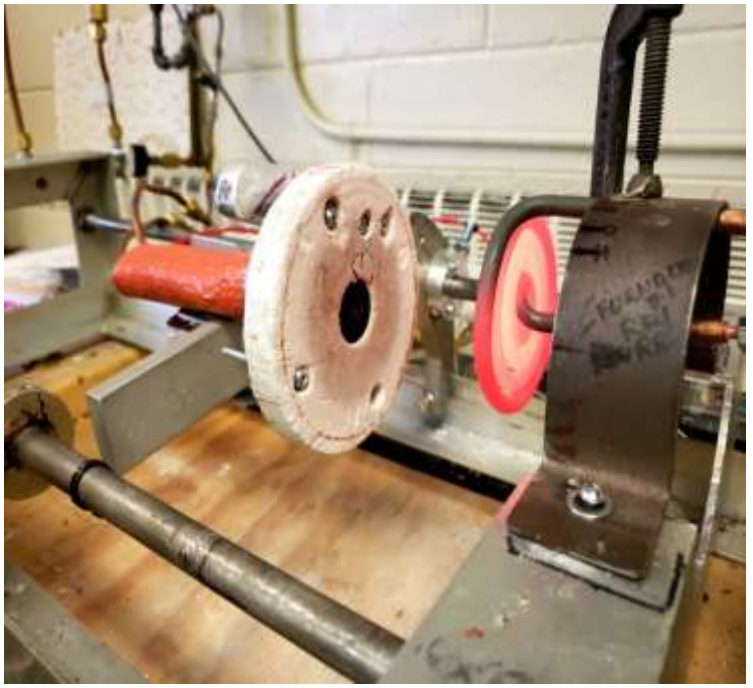
- **Is it the Coil?**

- Diameter of Inconel
- Length of Inconel
- Overall coil diameter
- Max. Wattage
- Effective Heating Length
- Resistance
- Watts/in^2
- Other

VFP Furnace

- **Chromalox (MVFP)**

- **Caloritech (VFP2)**



Furnace Assemblies

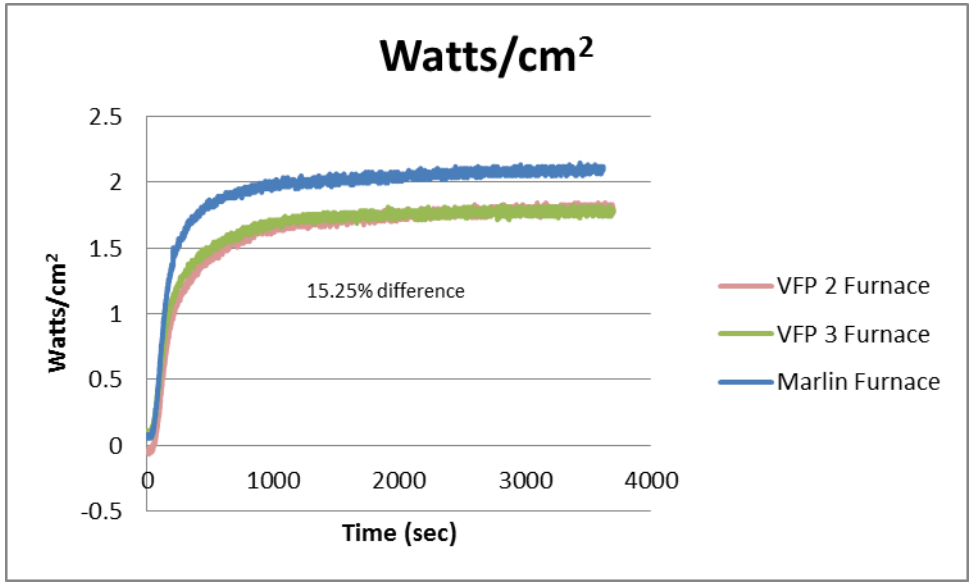
Differences in construction could play a major role

Front, Side by Side

VFP 2, Back

Marlin, Back

VFP Furnace



- Vatell s/n 8031 Heat Flux Gauge

- 706 Watts @ 3” distance

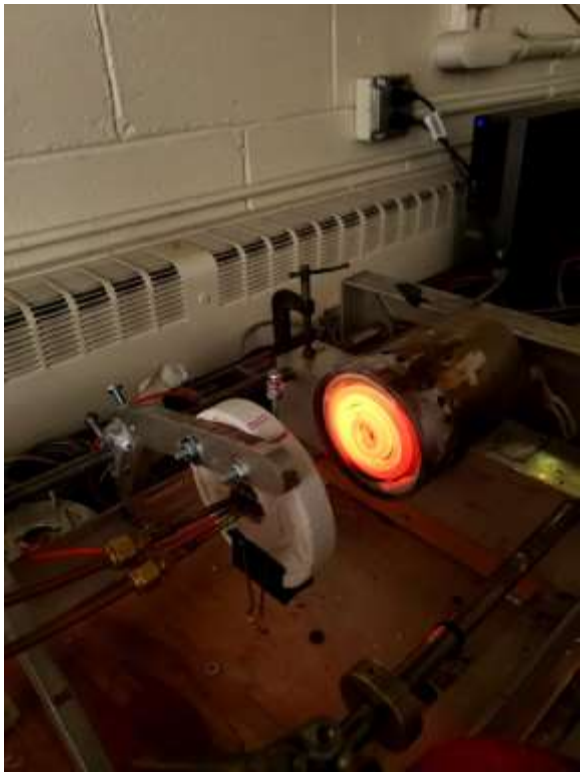
**Aligned with ribbon burner (impingement point)

- >15% Difference in heat flux between 3 furnaces

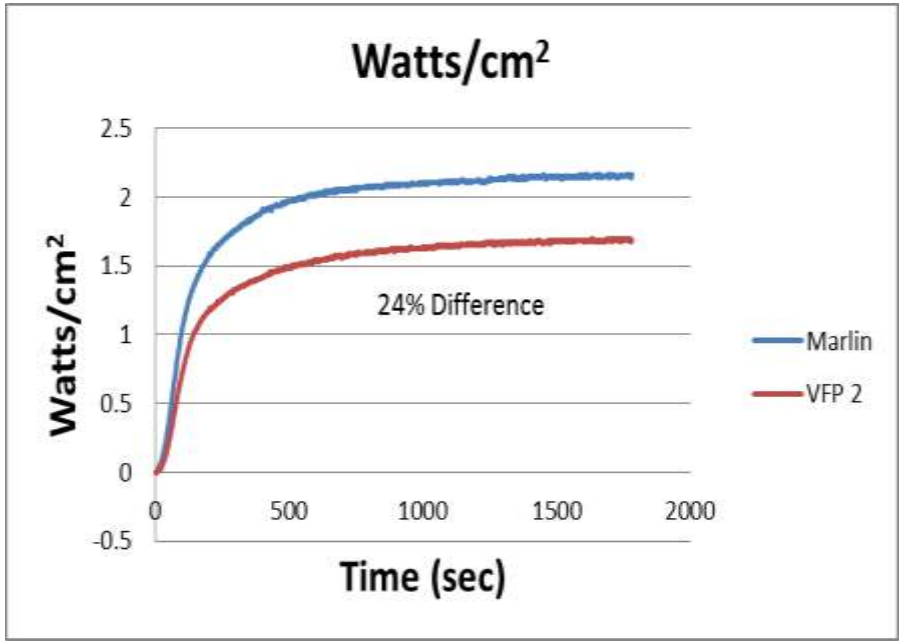
VFP Furnace

MVFP

VFP 2



VFP Furnaces

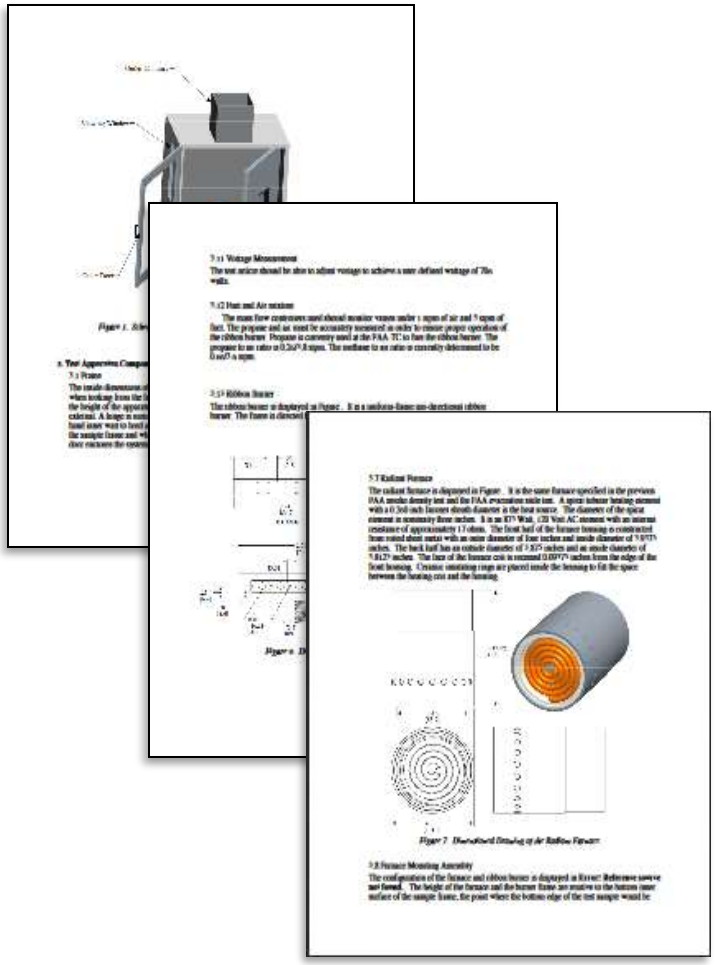


- Evac Slide Test Fixture
- 706 Watts @ 3”
- * Replaced Backer Plate w/.0625” SS

Furnaces Conclusion

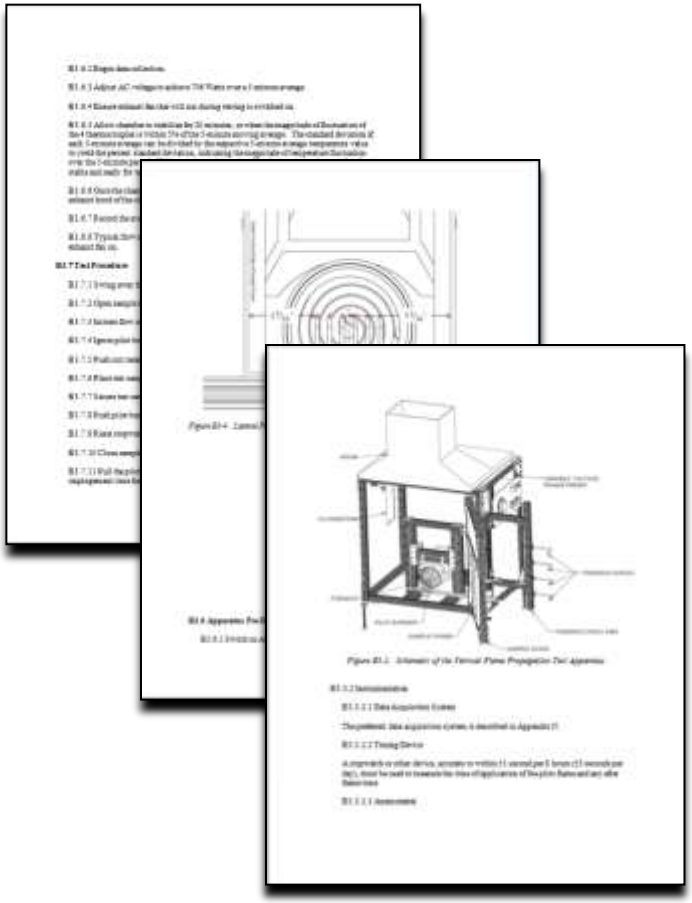
- **Define furnace construction for all VFP's.**
- **Mitigate temperature differences that could result, even at prescribed 706 watts.**

Technical Document



- Revisions to accommodate necessary details
- Critical Dim’s
- Will include new furnace spec’s

Test Method



- Documenting test method to correspond with latest developments & hardware

Methane vs Propane

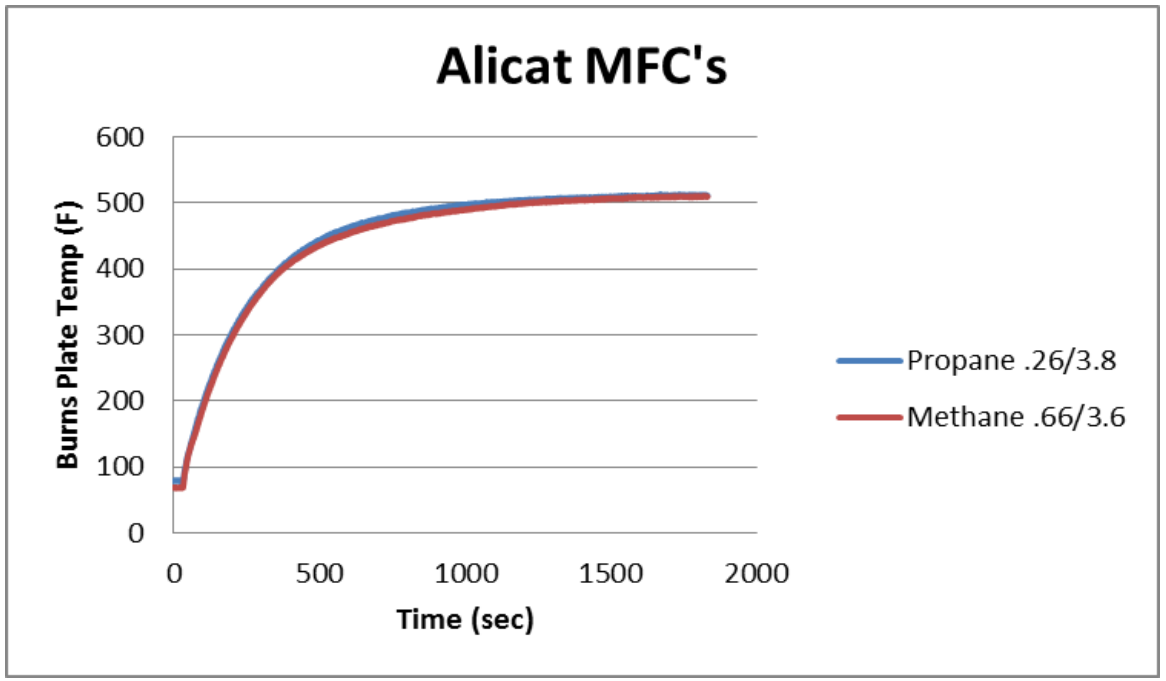
- **FAA tasked to make final decision (July 2018, France IAMFTF meeting)**
- **Background**
  - Propane
  - NBS flamelet ignitor
  - Rotometer/proportioner
  - Ribbon burner
  - Methane
  - MFC’s

Methane vs Propane cont.

- 6”x6”x1/8” Steel Plate
- Type K tc, embedded

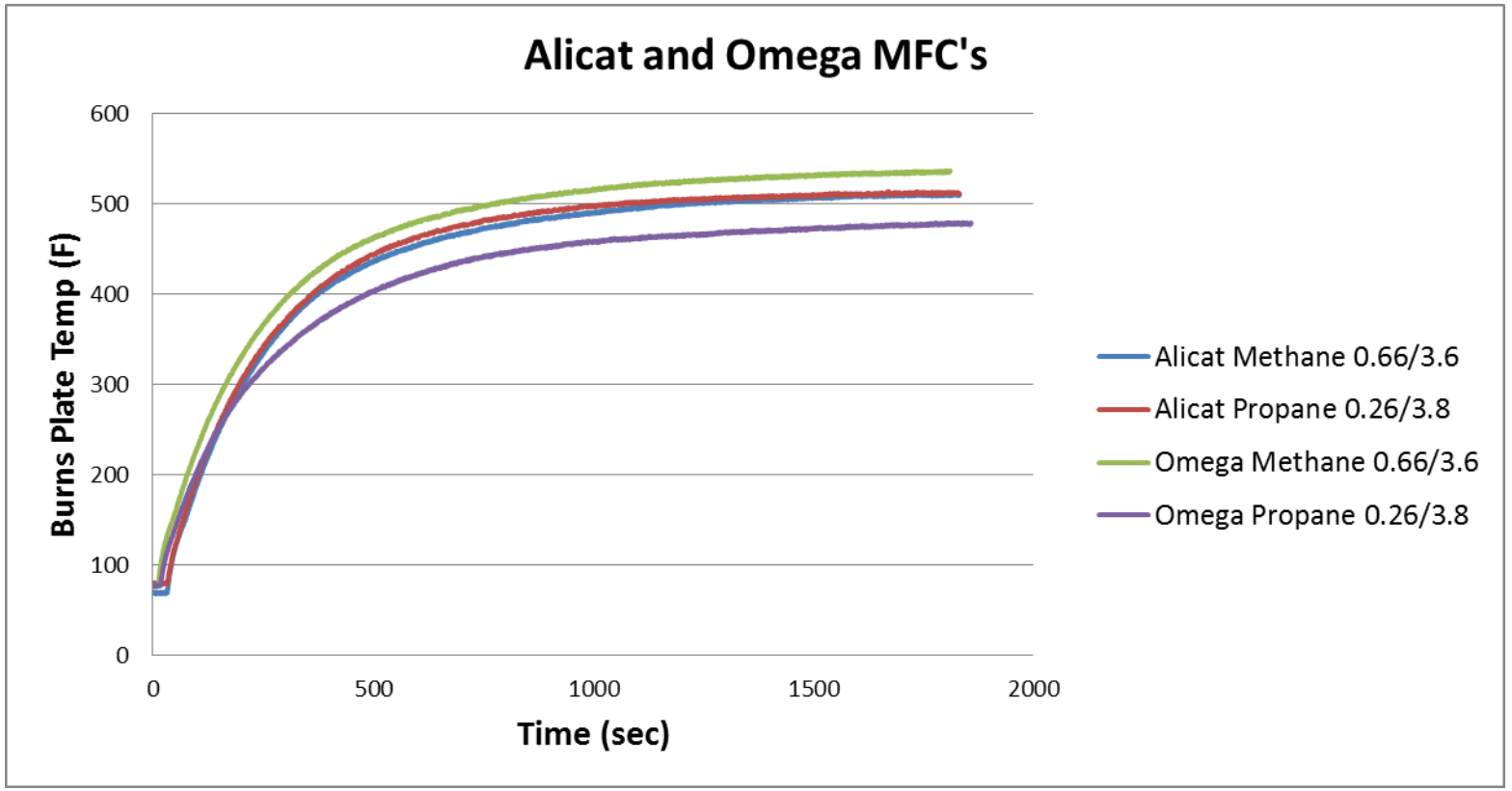
The Burns Plate

Methane vs Propane cont.



Propane and Methane compared at prescribed flow rates

Methane vs Propane cont.



Same flow rates using MFC's calibrated to different reference conditions

Methane vs Propane cont.

To correct for varying reference conditions of calibration

$$Q_2 = \frac{P_1}{P_2}\frac{T_2}{T_1}Q_1$$

Where:

$( )_1$ = Refers to absolute pressure and temperature of ‘standard’ reference conditions

$( )_2$ = Refers to absolute pressure and temperature of ‘other’ reference conditions

Q_1 = Mass flow rate of standard reference conditions (SLPM)

Q_2 = Corrected mass flow rate

Methane

Q_1 = 0.66 SLPM, T_1 = 25^0c, P_1 = 14.6959 psia

Air

Q_1 = 3.6 SLPM, T_1 = 25^0c, P_1 = 14.6959 psia

Methane vs Propane cont.

- **Methane**

$$Q_2 = \left(\frac{14.6959\ psia}{14.6959\ psia}\right)\left(\frac{294.1\ K}{298\ K}\right) 0.66\ SLPM$$

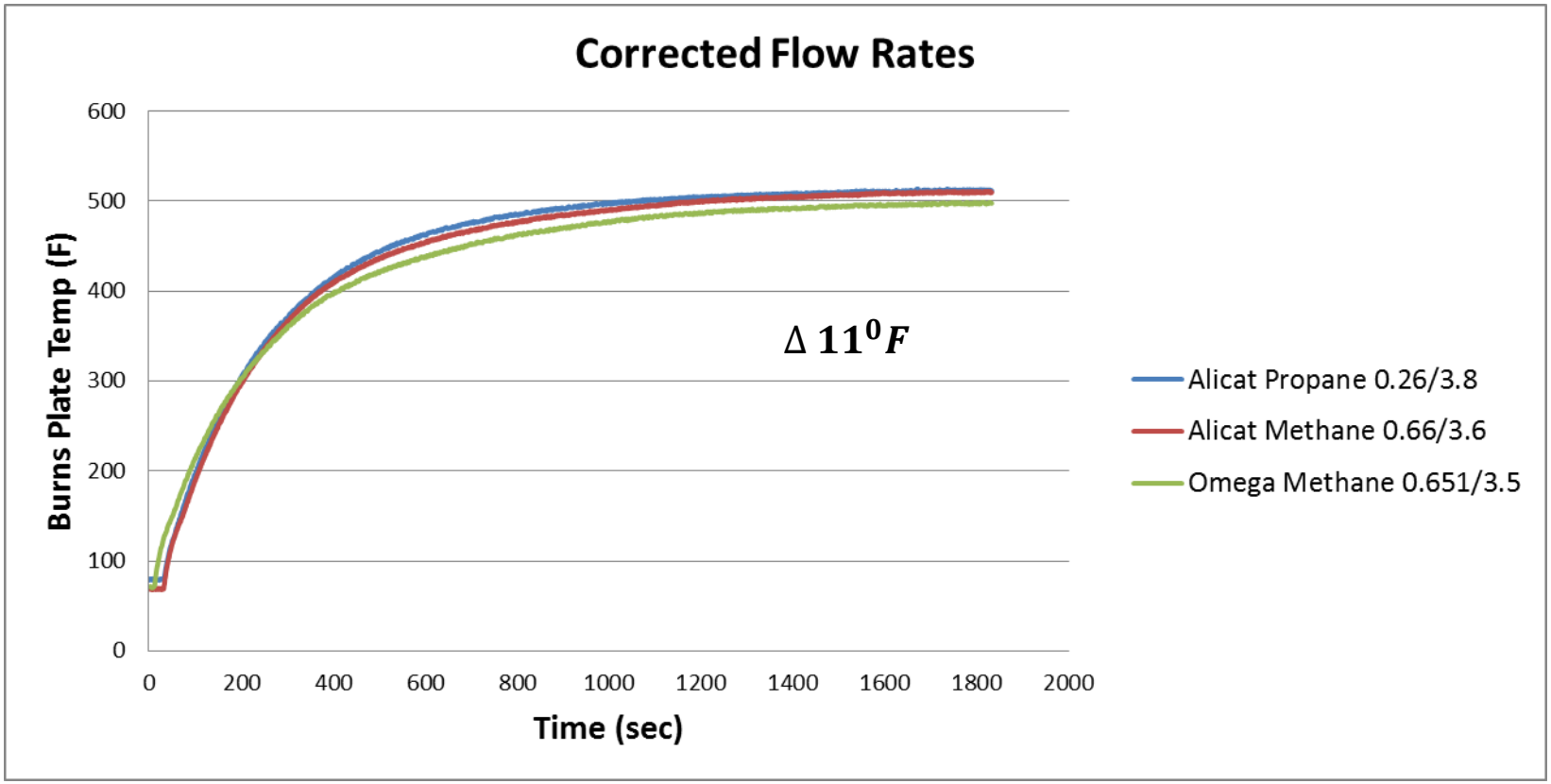
$Q_{2\ \boldsymbol{Methane}} = 0.651$ SLPM

- **Air**

$$Q_2 = \left(\frac{14.6959\ psia}{14.6959\ psia}\right)\left(\frac{294.1\ K}{298\ K}\right) 3.6\ SLPM$$

$Q_{2\ \boldsymbol{Air}}$ = 3.5 SLPM

Methane vs Propane cont.



Methane vs Propane Conclusion

- **Short-term:**
  - Correct for reference conditions if different than 14.6959 psia / 298 K (25^0C)

- **Long-term:**
  - FAA will specify reference conditions for calibration of MFC's in the Technical Spec
  - Acquire a larger data set to evaluate the relationship of methane to various sample

Future Work

- Evaluate the relationship between Methane and various materials
- Evaluate the effects of varying degrees of curvature
- Define furnace construction parameters
- Begin Round Robin I
- Continue updating Technical doc and Test Method doc, as needed

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