International Aircraft Systems Fire Protection Working Group Meeting

Effect of Setup and Test Cell Conditions on Burnthrough of Aluminum Panels

Fire Test Center
University of Cincinnati, Cincinnati, OH, USA
October 21, 2015

Ryan Hasselbeck, Samir Tambe, and San-Mou Jeng

UNIVERSITY OF Cincinnati

Project Overview

- Project Objective:
  - Demonstrate the effect of burner inclination, test fixture design, and use of ceramic insulation on burn through times
- Previous Work
  - Old Configuration (Turbulator & Stator):
    - Effect of burner setup and calibration TC size on burner
    - Sensitivity of burner to air and fuel flow rates and temperature
    - Effect of burner orientation on burner performance
    - Comparison of fire test results between NexGen and Gas burners
  - New Configuration (FRH):
    - Fuel spray and temperature maps for different FRHs and fuel nozzles
    - Burn through and temperature maps of varying fuel/air operating settings
    - Fuel nozzle spray characterization and comparison
    - Sensitivity of burner to assembly tolerance

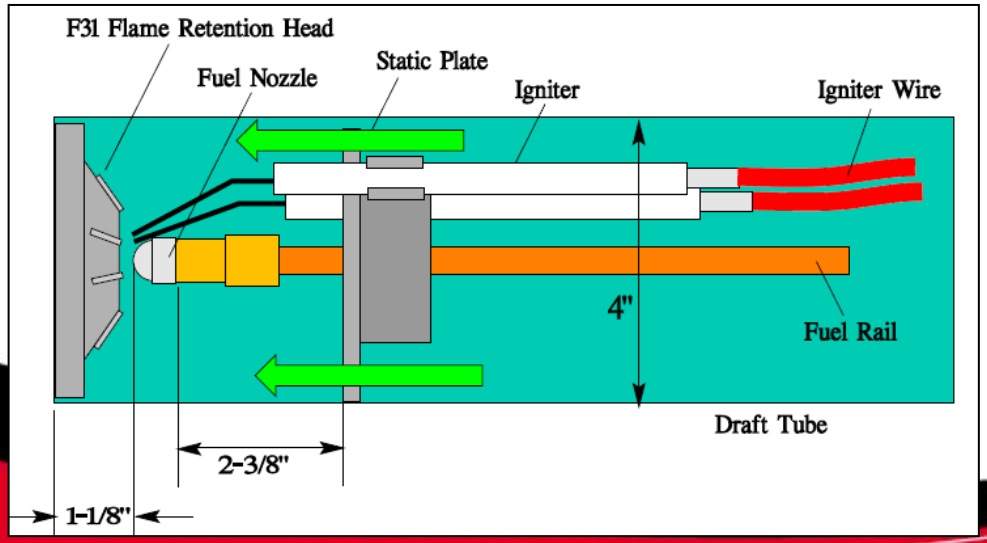
Current Approach

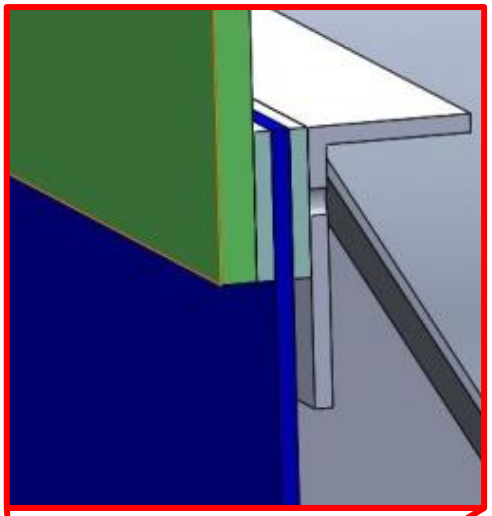
- Test Fixture Design
  - Two fixtures of different construction
  - Burn through tests
  - Back side temperature comparison
- Burner Inclination
  - 0˚ , 20˚ , 40˚ , 60˚
  - Burn through tests
  - Back Side Temperature Comparison
- Use of Ceramic Insulation on Panels
  - Burn through tests with/without insulation
  - Back side temperature comparison

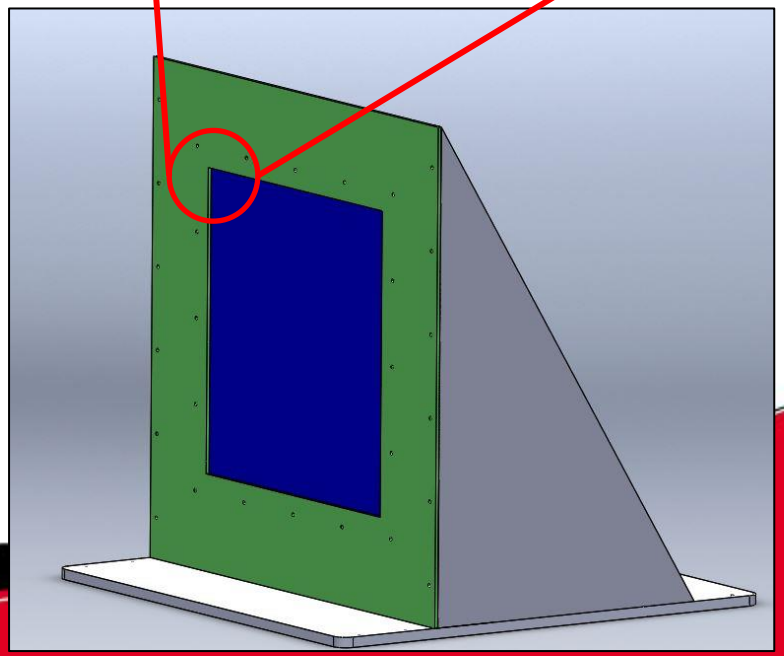
2024 Al Panel, 24x24x1/8”

Baseline Condition

- Air Flow Settings
  - 50 psig (265 PPH), 50 ºF
- Fuel Flow Settings
  - 109 psi (2.5 GPH), 42 ºF



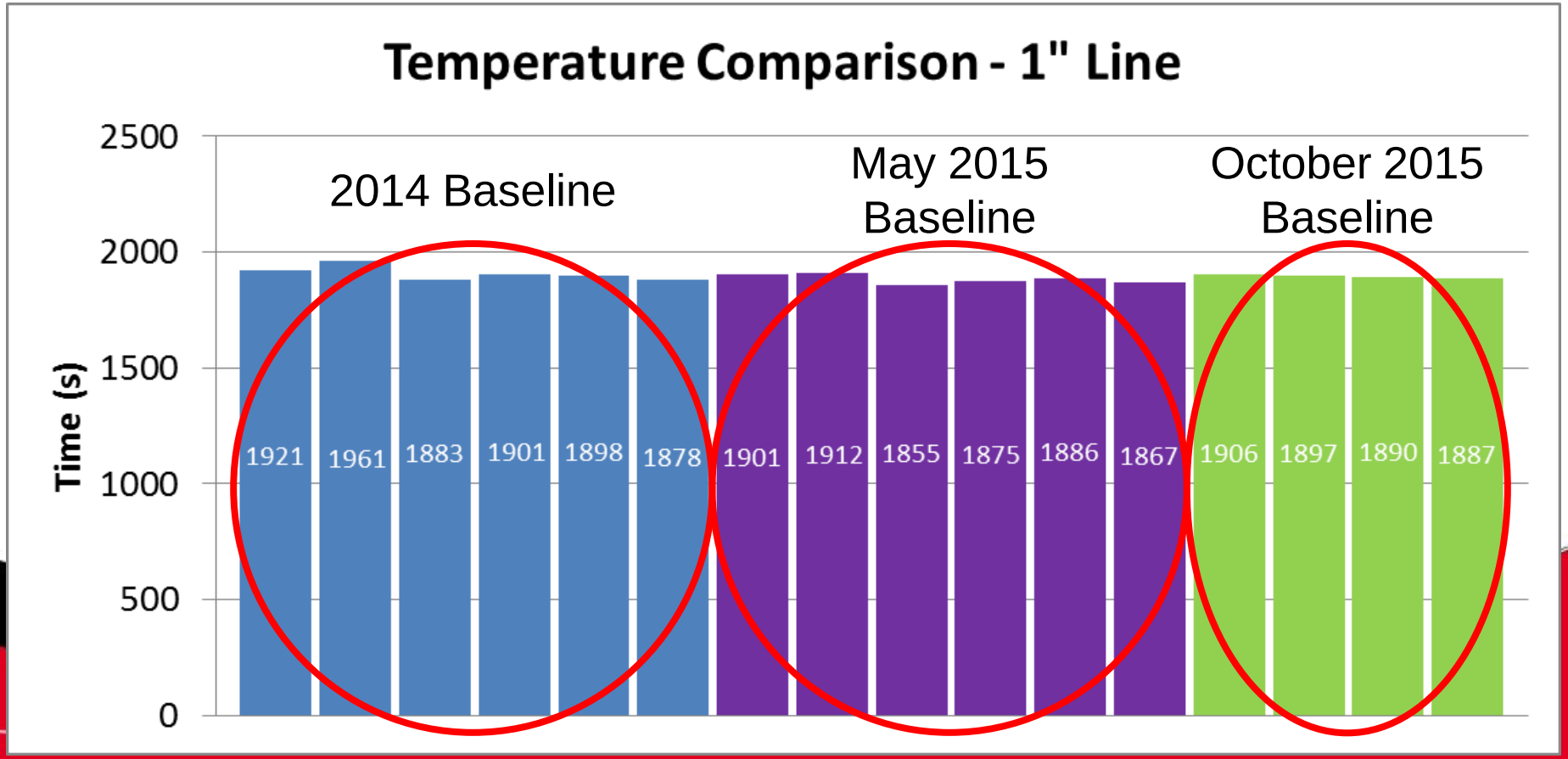




Baseline Condition – Repeatability

- Temperatures at 1” calibration line are very consistent from test to test & year to year.

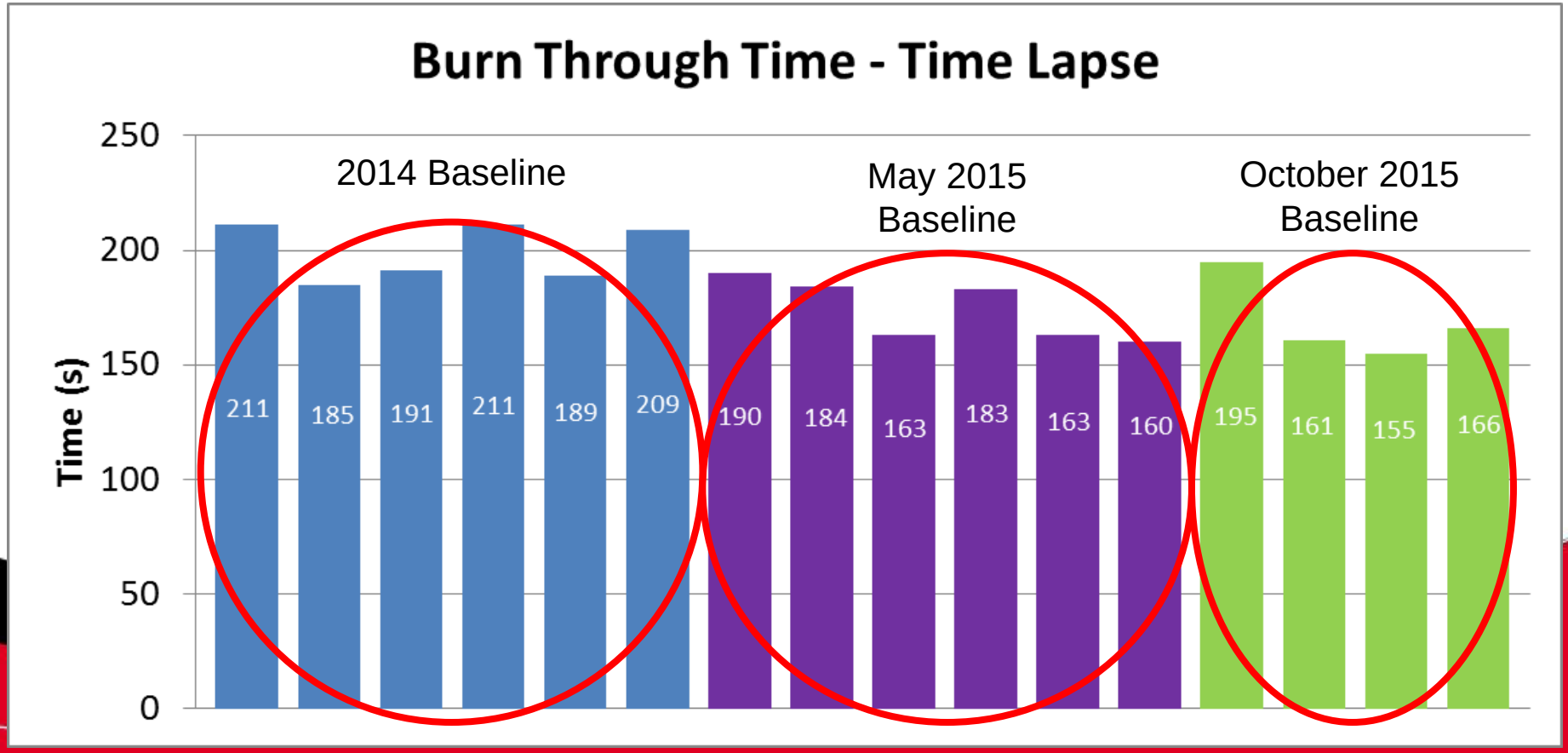
Standard Deviation = 30˚



Baseline Condition – Repeatability

- Good burn through repeatibility for Baseline test
  - In general, burn through is 185 ±30 sec
  - Some change in burn through times observed after burner reassembly

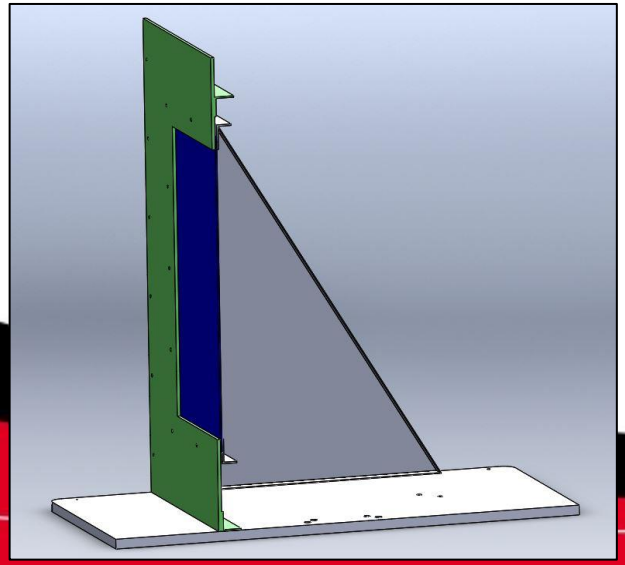
Standard Deviation = 28 s

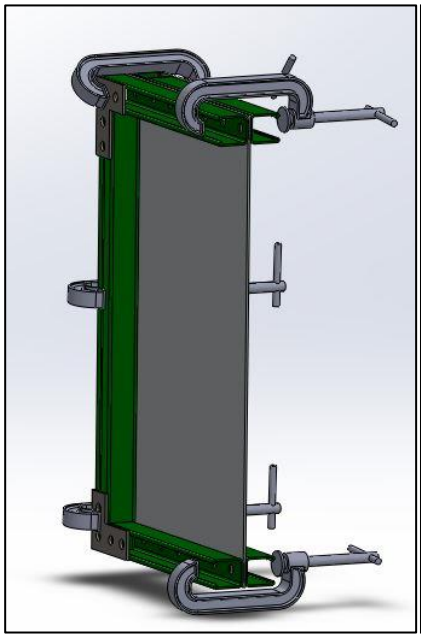


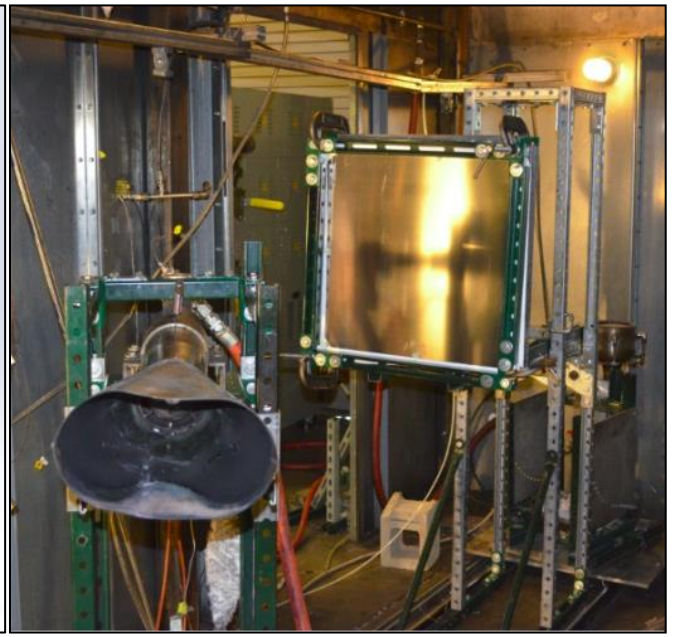
Test Fixture Design – Set Up

- UC has a custom made test article stand, other fire test houses may mount panels differently. Test UC's method vs simpler Unistrut design.

Baseline Stand





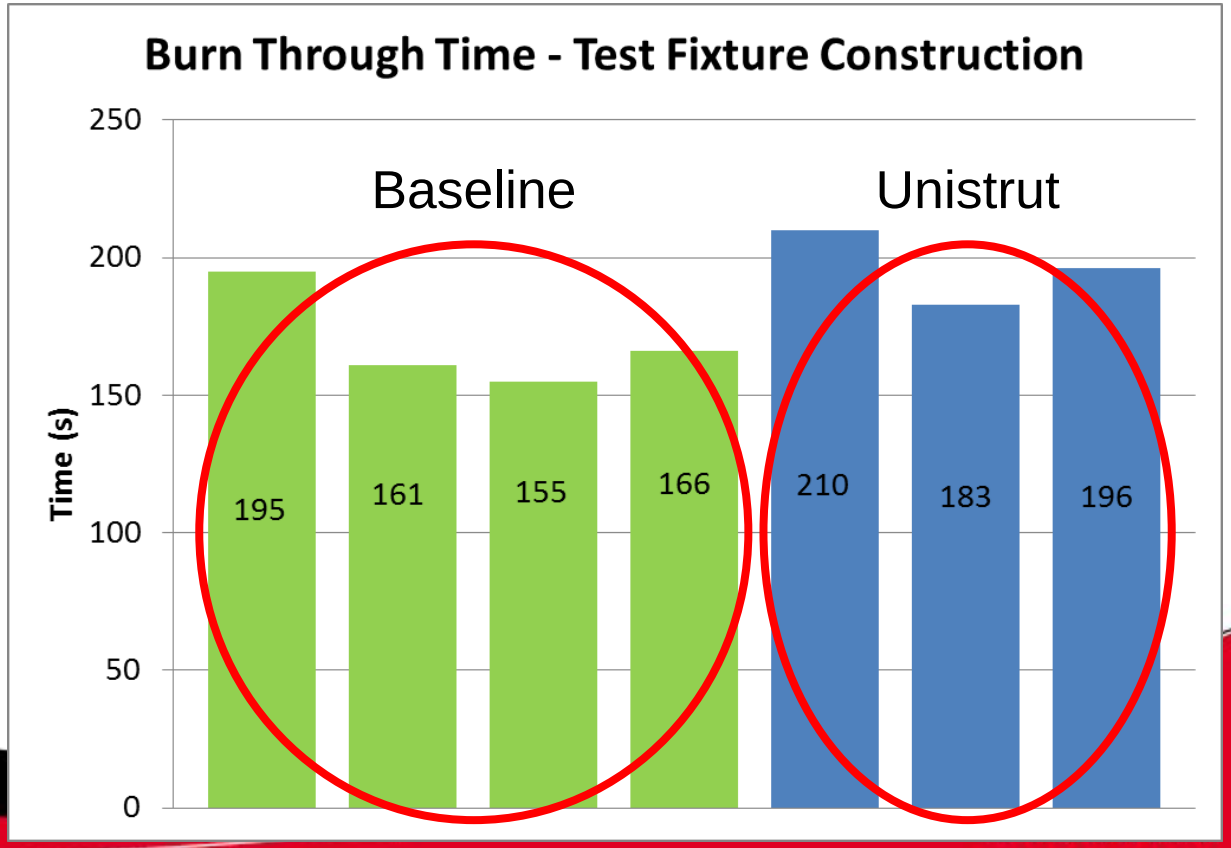


Unistrut Stand

Test Fixture Design – Burn Through Times

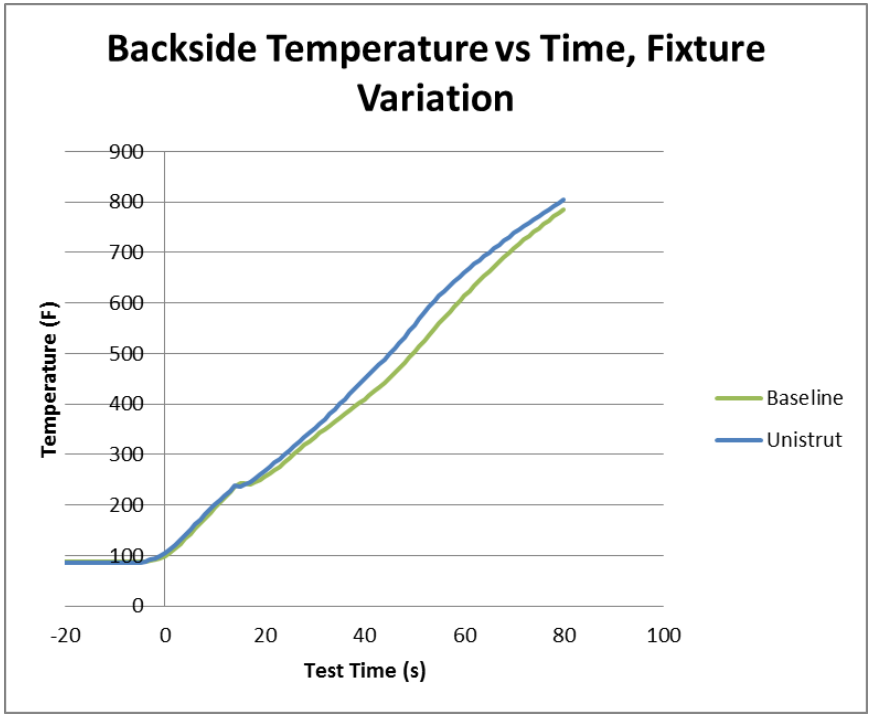
- Unistrut frame has an average 25 seconds longer burn through time compared to baseline
  - Within normal variance, though close to limit

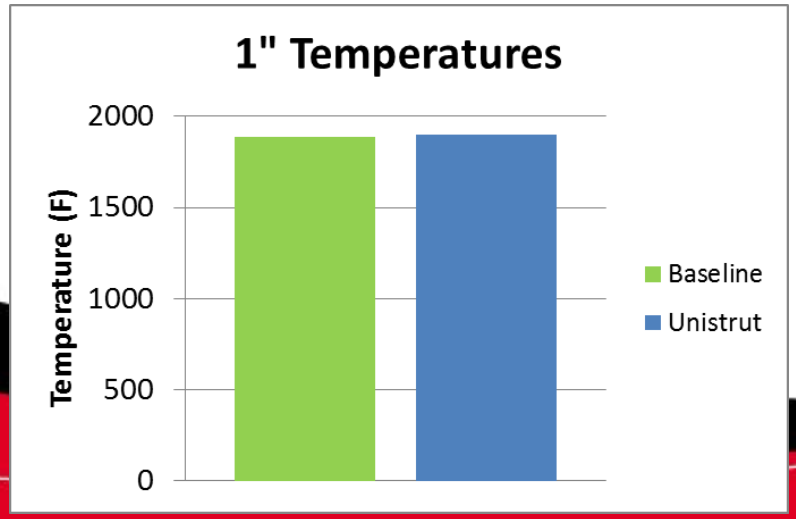
Fixture	Burnthrough (min:sec)
Baseline	2:51
Unistrut	3:16

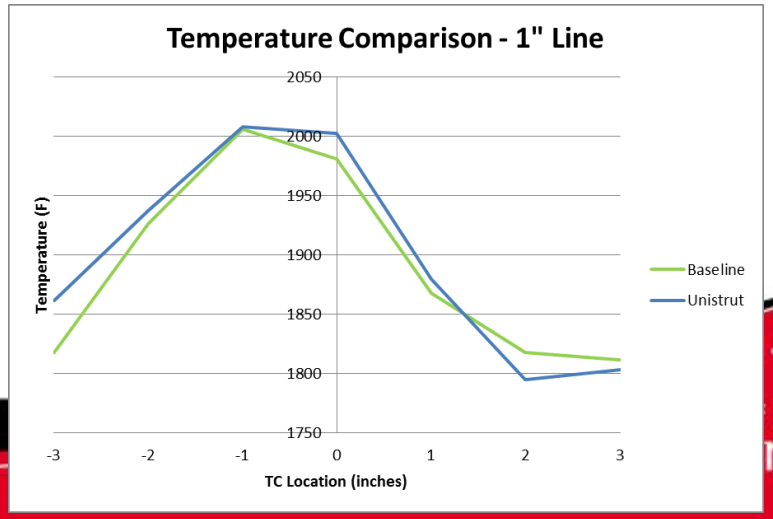


Test Fixture Design – Burn Through Times

Fixture	Avg 1" T (°F)	Burnthrough (min:sec)
Baseline	1887	2:51
Unistrut	1898	3:16

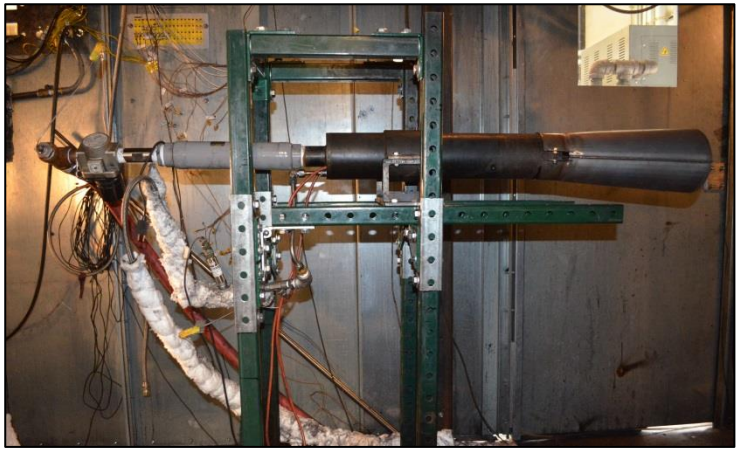






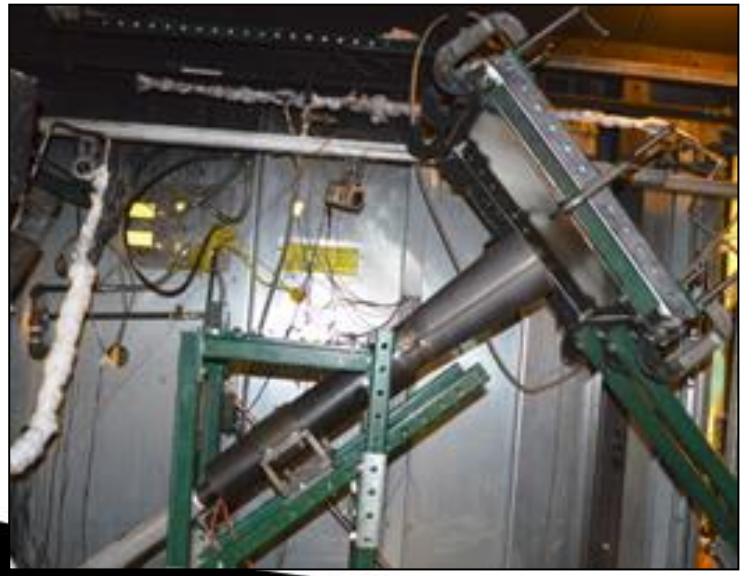
Burner Inclination – Set Up

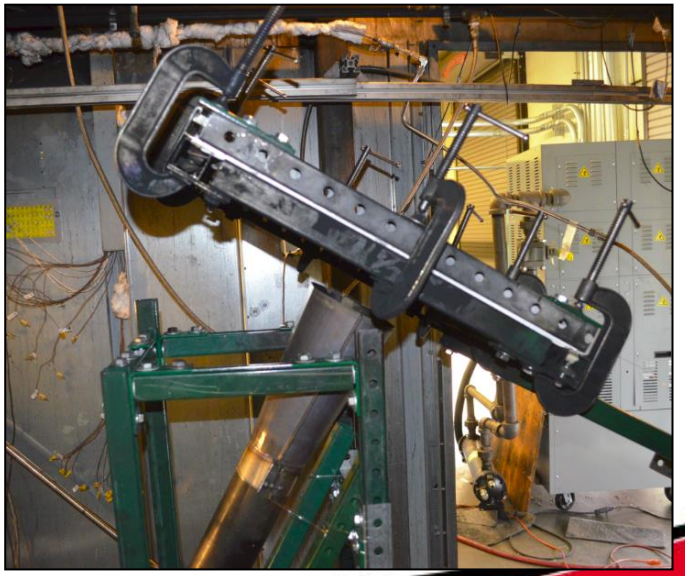
0°



20°

40°





60°

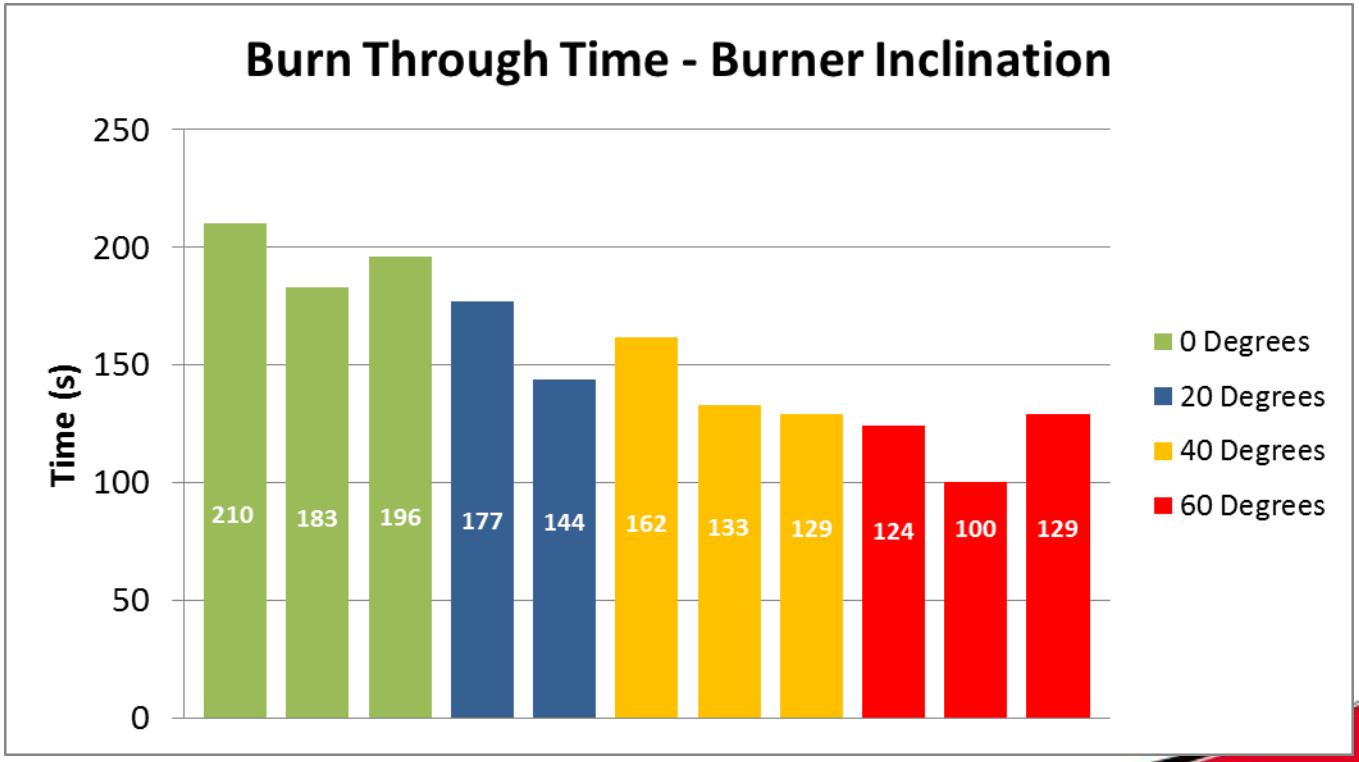
UNIVERSITY OF Cincinnati

Burner Inclination – Burn Through Times

- Very clear trend. Positive correlation between burner inclination and flame severity, resulting in lower burn through times.

Burner Inclination	Burnthrough (min:sec)
0°	3:16
20°	2:41
40°	2:21
60°	1:57

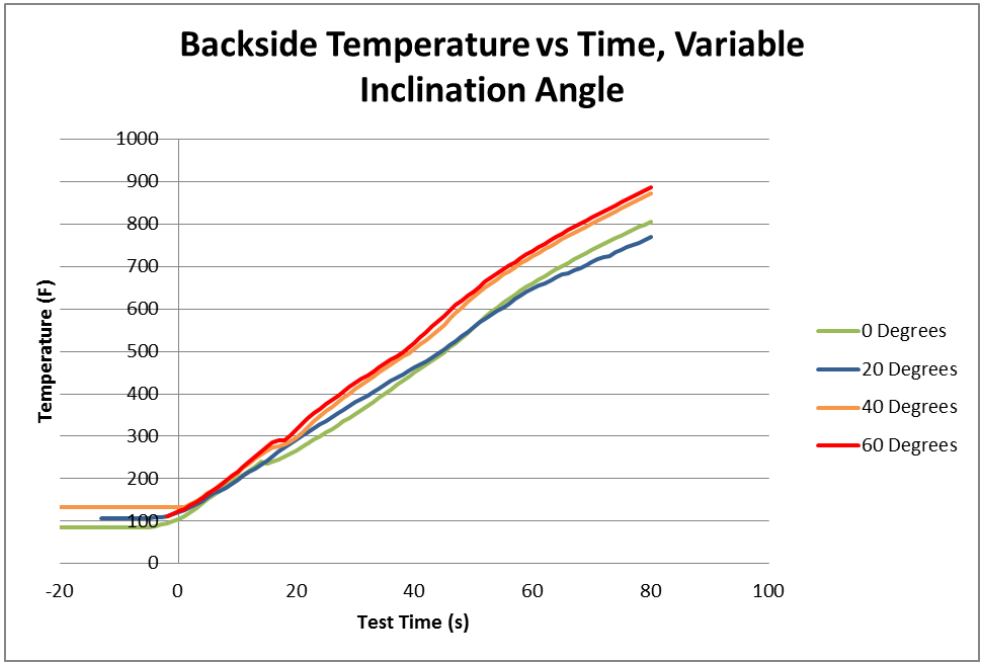
RMSE	3.85
Condition	% Deviation
0	2.0
20	2.4
40	2.7
60	3.3

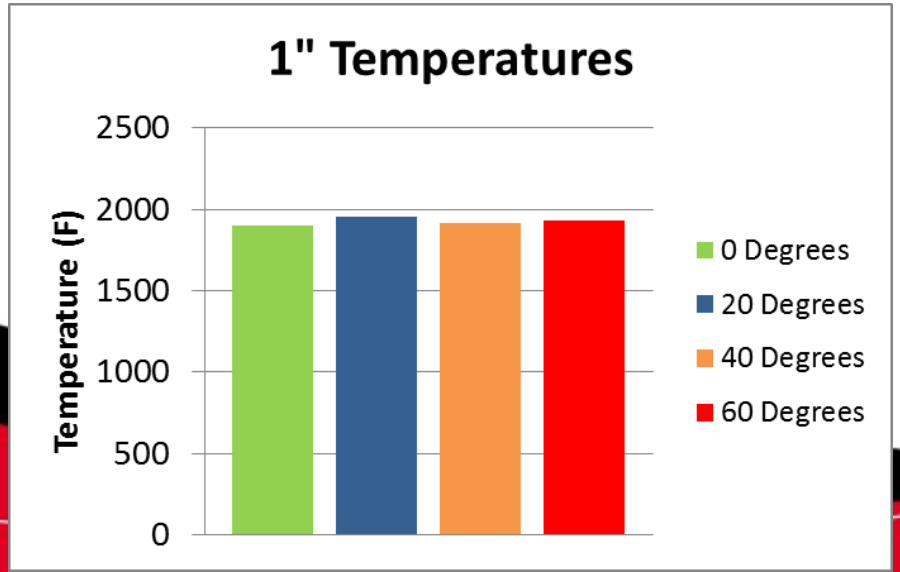


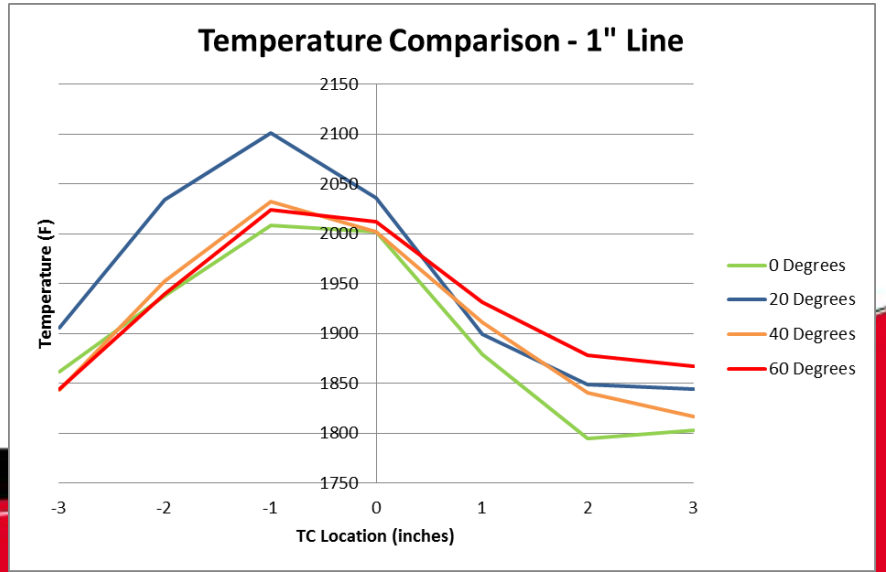
Burner Inclination – Burn Through Times

Burner Inclination	Avg 1" T (°F)	Burnthrough (min:sec)
0°	1898	3:16
20°	1953	2:41
40°	1914	2:21
60°	1928	1:57

Note: Burner settings maintained constant

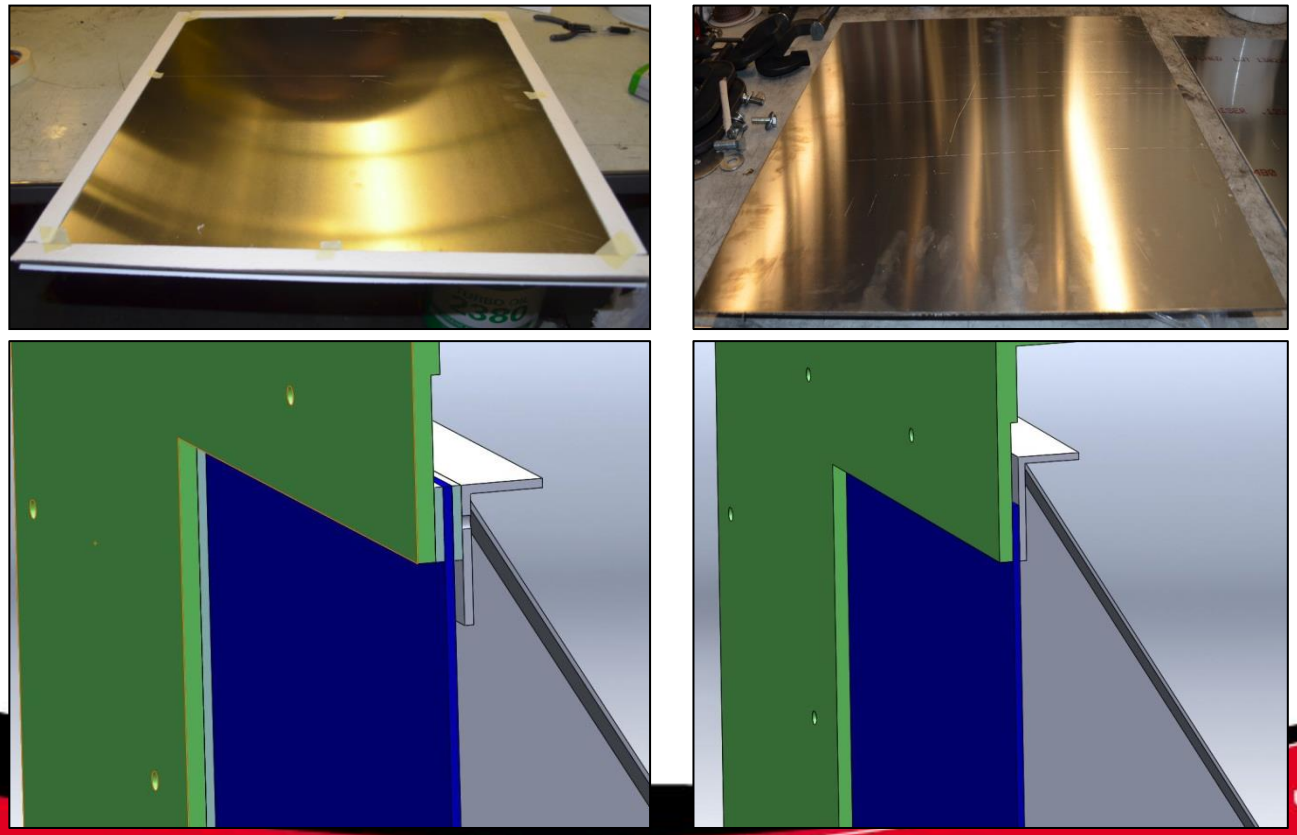






Ceramic Insulation – Set Up

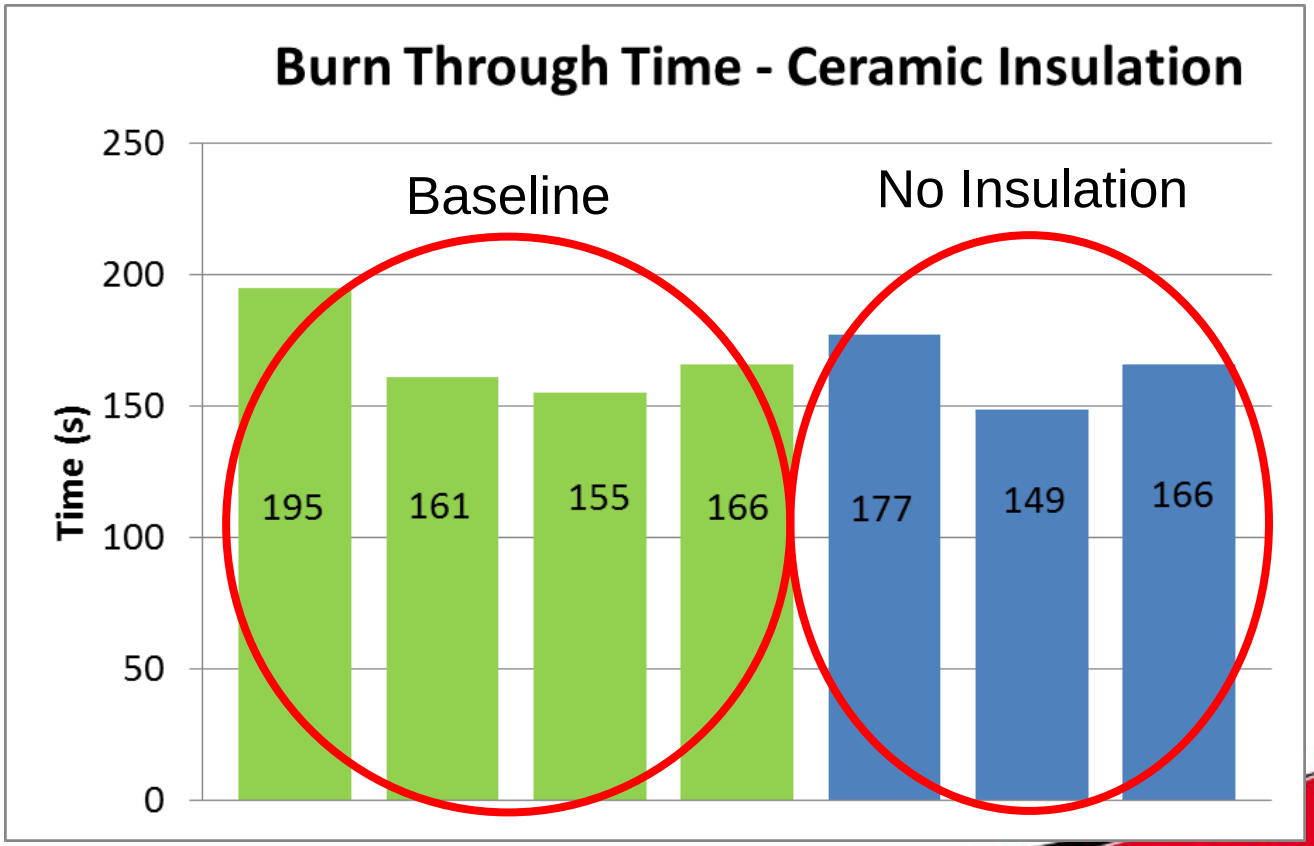
- UC typically uses a 0.125” ceramic insulation tape between the test panel and fixture to prevent conduction heat transfer. Test to determine any affect on burn-through.



Ceramic Insulation – Burn Through Times

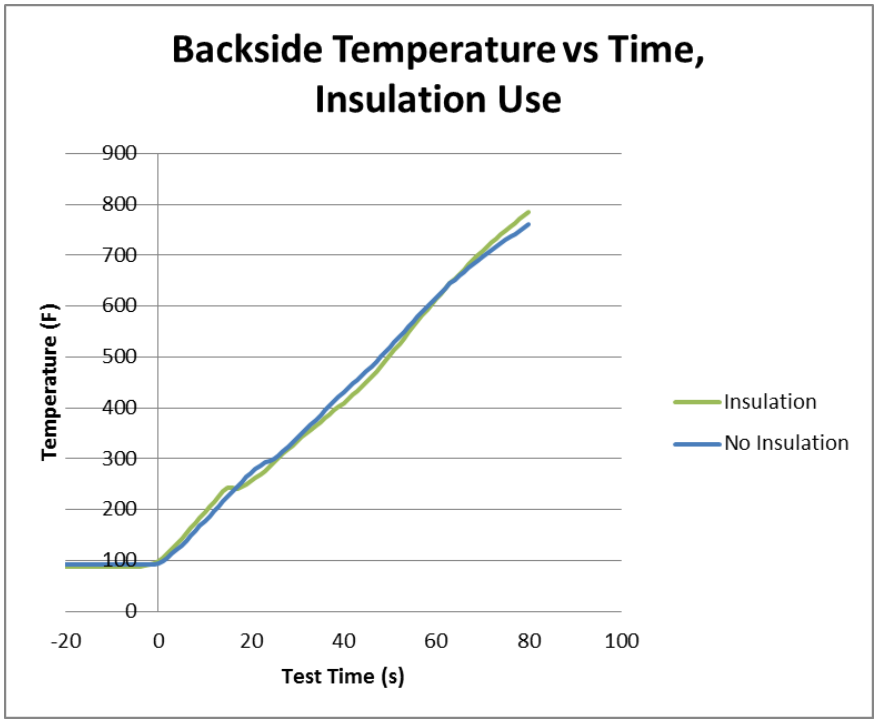
- No observable difference in burn through times with and without insulation (for 24” x 24” panels).

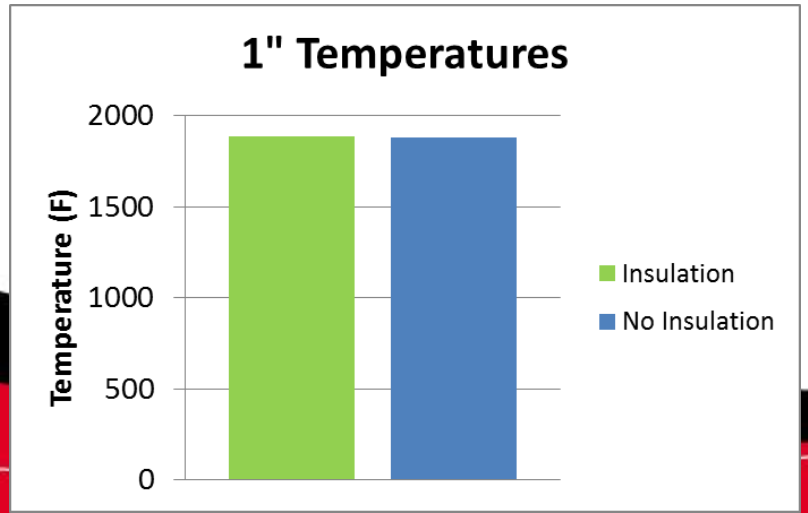
Test Case	Burnthrough (min:sec)
Insulation	2:51
No Insulation	2:44

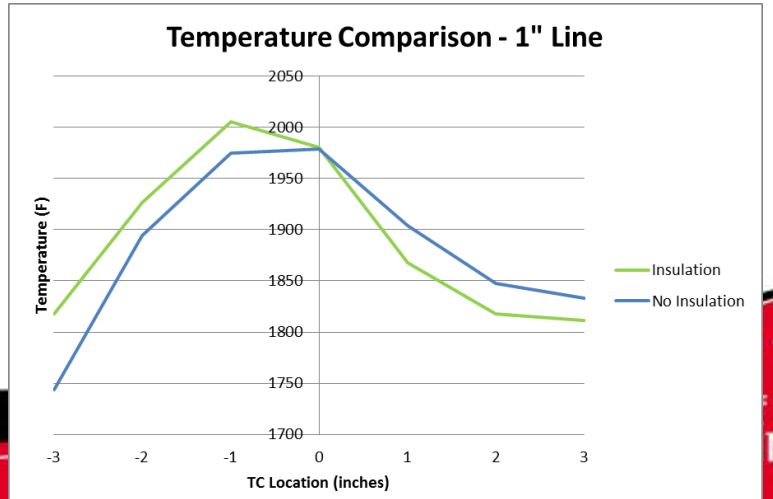


Ceramic Insulation – Burn Through Times

Test Case	Avg 1" T (°F)	Burnthrough (min:sec)
Insulation	1887	2:51
No Insulation	1882	2:44







Conclusions and Recommendations

- Summary
  - Test fixture design shown to have minimal impact on burn-through results
  - Test severity shown to increase with increased burner inclination angle
  - Insulation to prevent heat transfer between test panel and fixture demonstrated to have no affect on burn-through

- Recommendations
  - Burner operation settings need to be defined for each inclination angle