Next Generation Fire Test Burner for Powerplant Fire Testing Applications

International Aircraft Systems Fire
Protection Working Group
Atlantic City, NJ
October 21 - 22, 2015

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http://www.fire.tc.faa.gov

Background

- **Currently specified oil burners are no longer commercially available**
- **Industry is left with the propane burner, however this burner has been shown to be less severe than an engine flammable fluid flame**
- **FAA Tech Center Fire Safety Branch has been tasked by Transport Airplane Directorate to develop burner performance standards for the next-generation fire test burner for powerplant fire testing**
  - New burner should be much easier to calibrate, provide more consistent results, and be readily available for industry use.

Current Status

Powerplants User Survey

Used to gain insight into current calibration/ operating conditions. Additionally, requested test data will help to initially set NextGen burner settings.

Round Robin Testing

This initial round robin testing, along with the test data requested in the survey will aid in the initial setting of operating parameters of NextGen Burner.

Setting of NextGen Burner Parameters

Utilizing the test data obtained from Oil/ Propane burner testing, NextGen burner parameters will be set. Testing will be conducted to compare NextGen with Oil/Propane burners.

Additional Round Robin/ NextGen Testing

Additional round robin testing with more advanced components will be conducted and compared with NextGen burner performance to help refine NextGen burner settings.

Report Publication

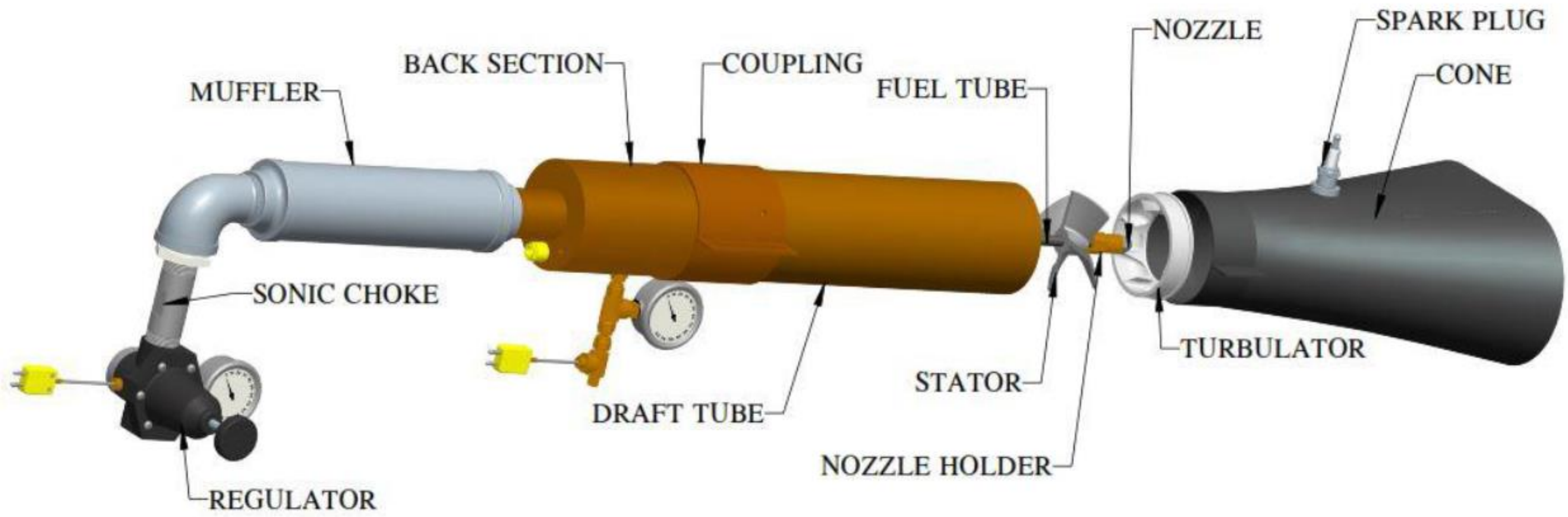
An FAA report will be published detailing the NextGen burner settings and performance characteristics. This report will also detail testing and calibration guidelines/procedures for the NextGen burner.

Revision of AC 20-135

Once a powerplants test method utilizing the NextGen burner has been defined and standardized, a revision of AC 20-135 and other regulatory material will be able to proceed.

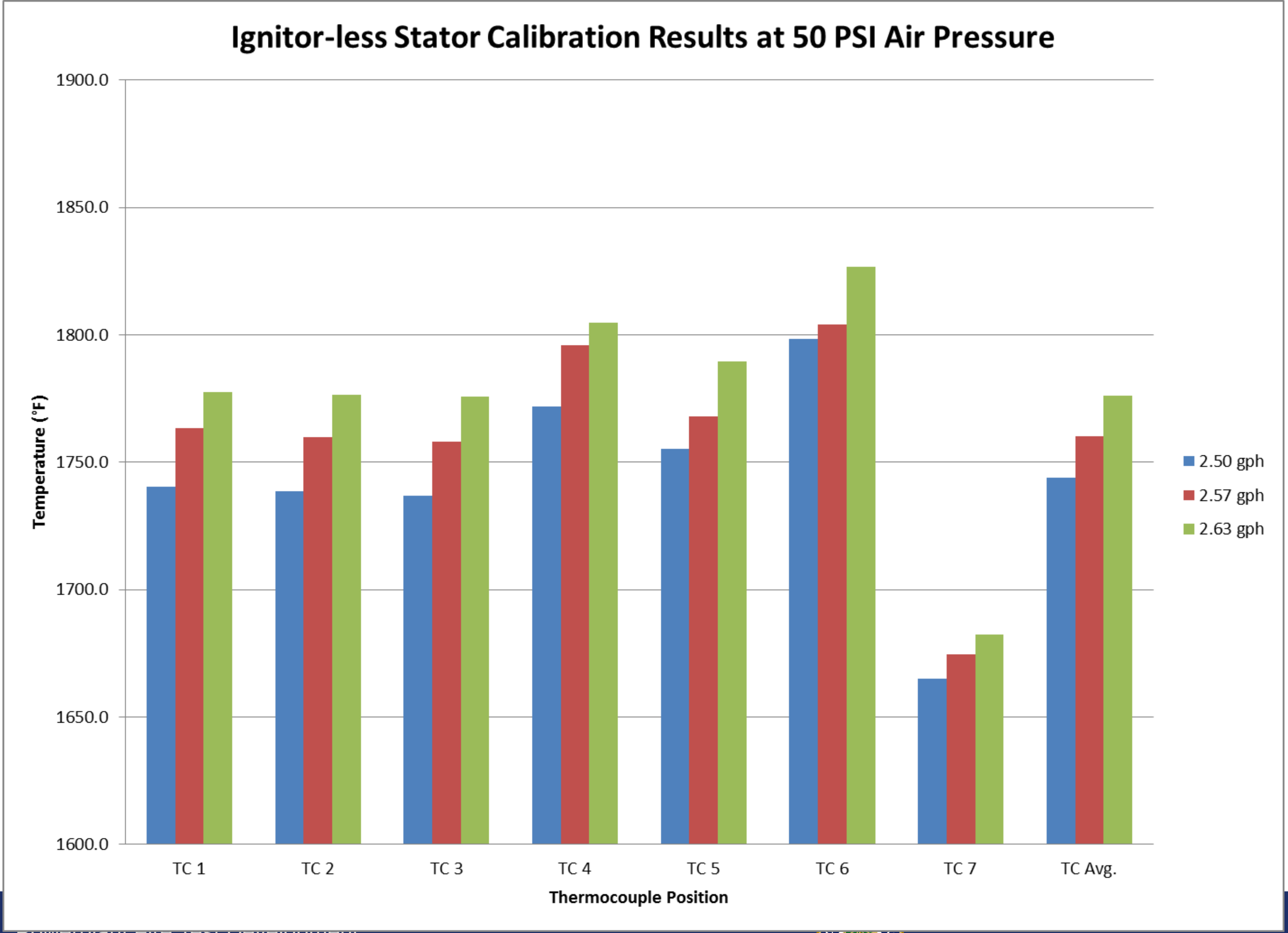
Current Status – Testing

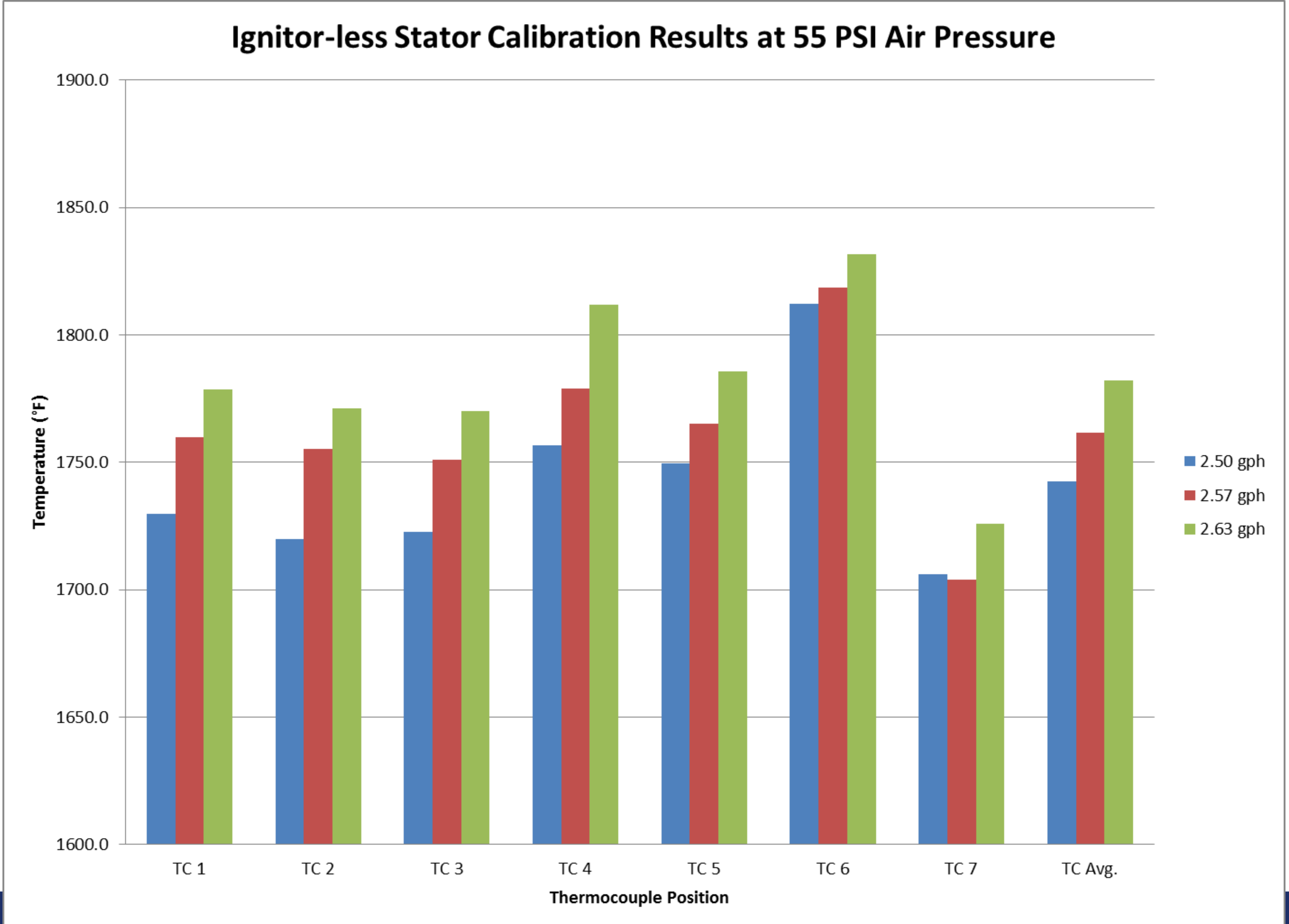
- **Reconfigured burner to current Materials configuration**
  - Replace flame retention head (FRH) with turbulator
  - Replace static plate with ignitor-less stator
  - Install spark plug in cone

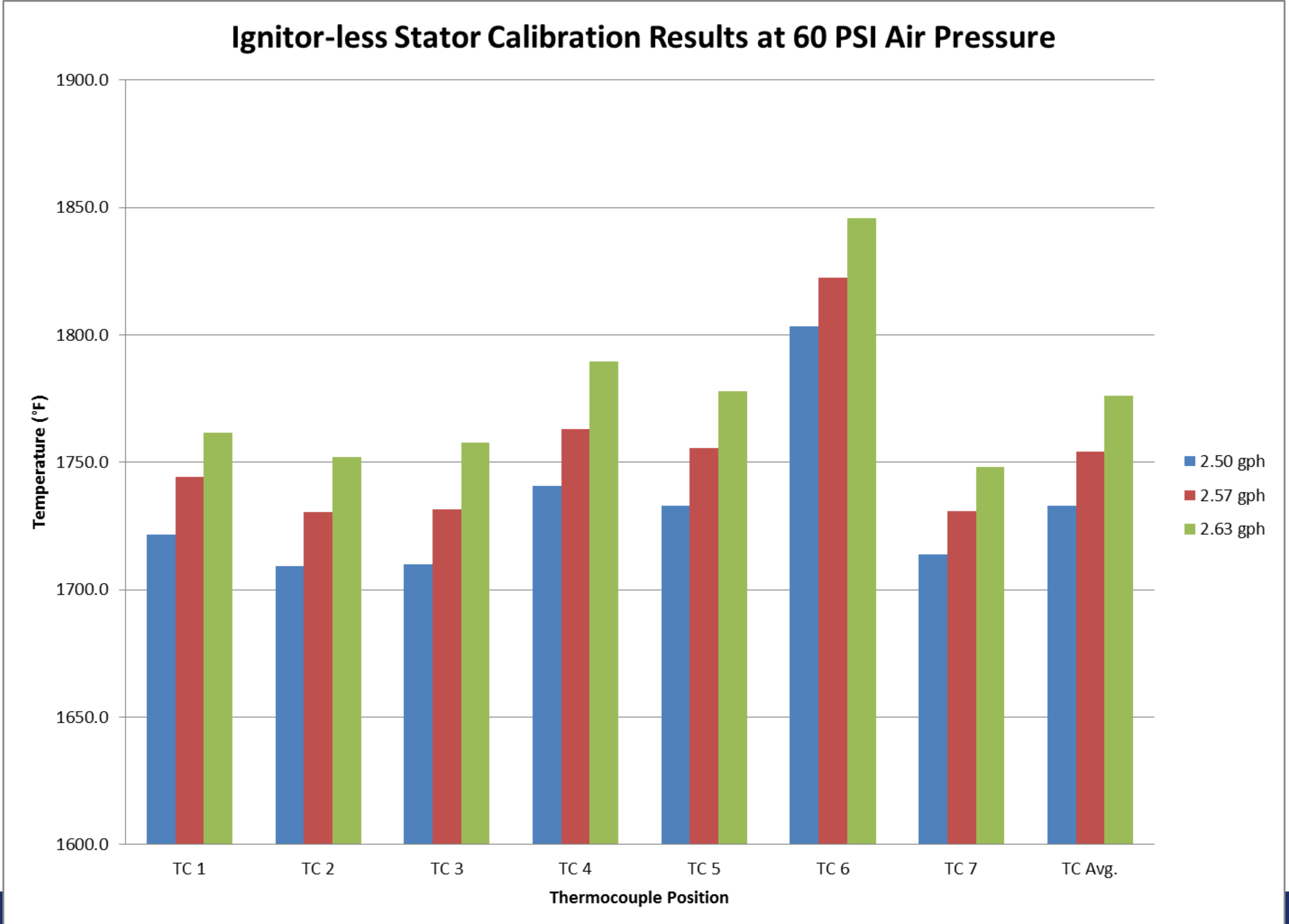


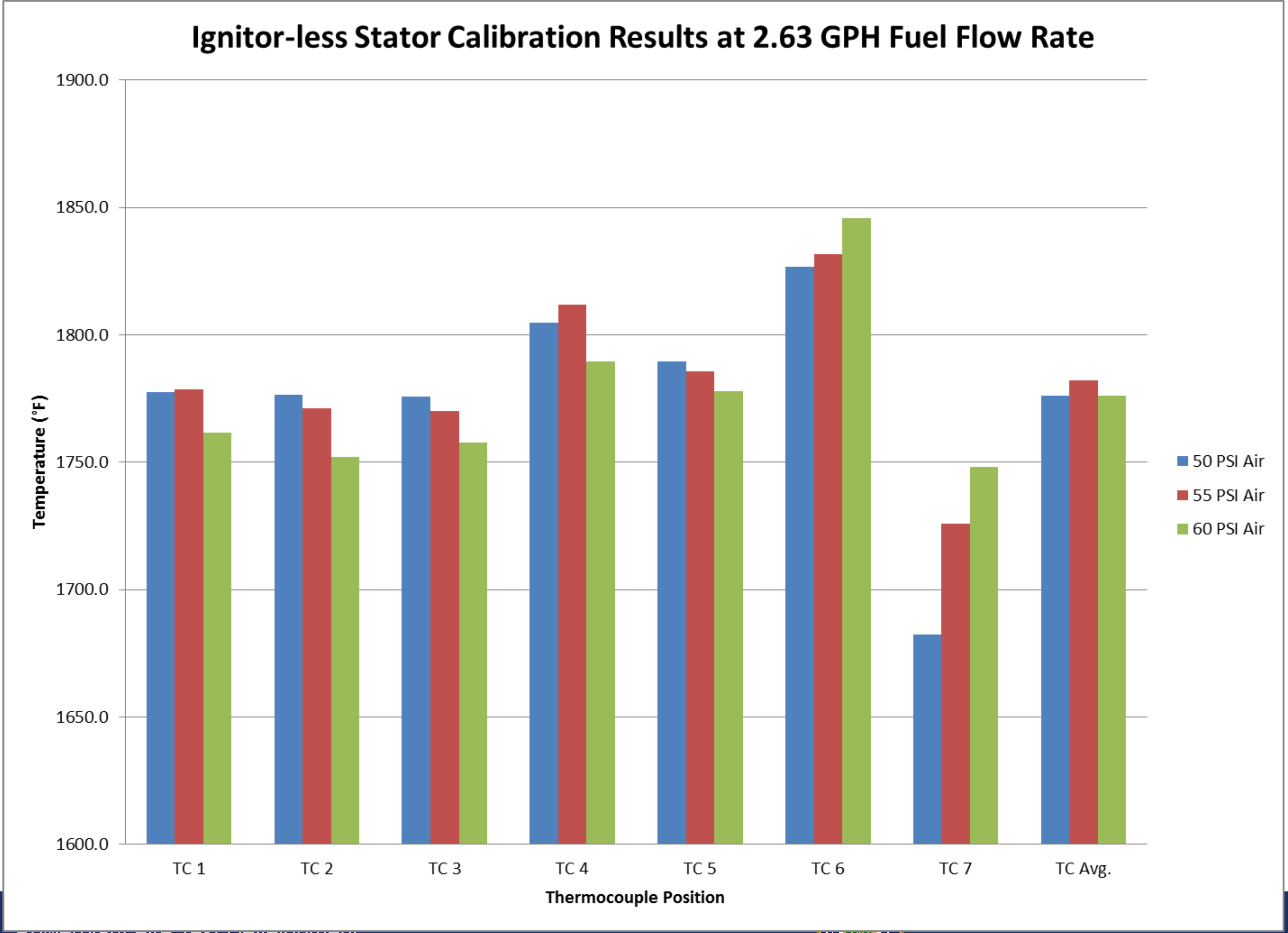
Current Status – Testing

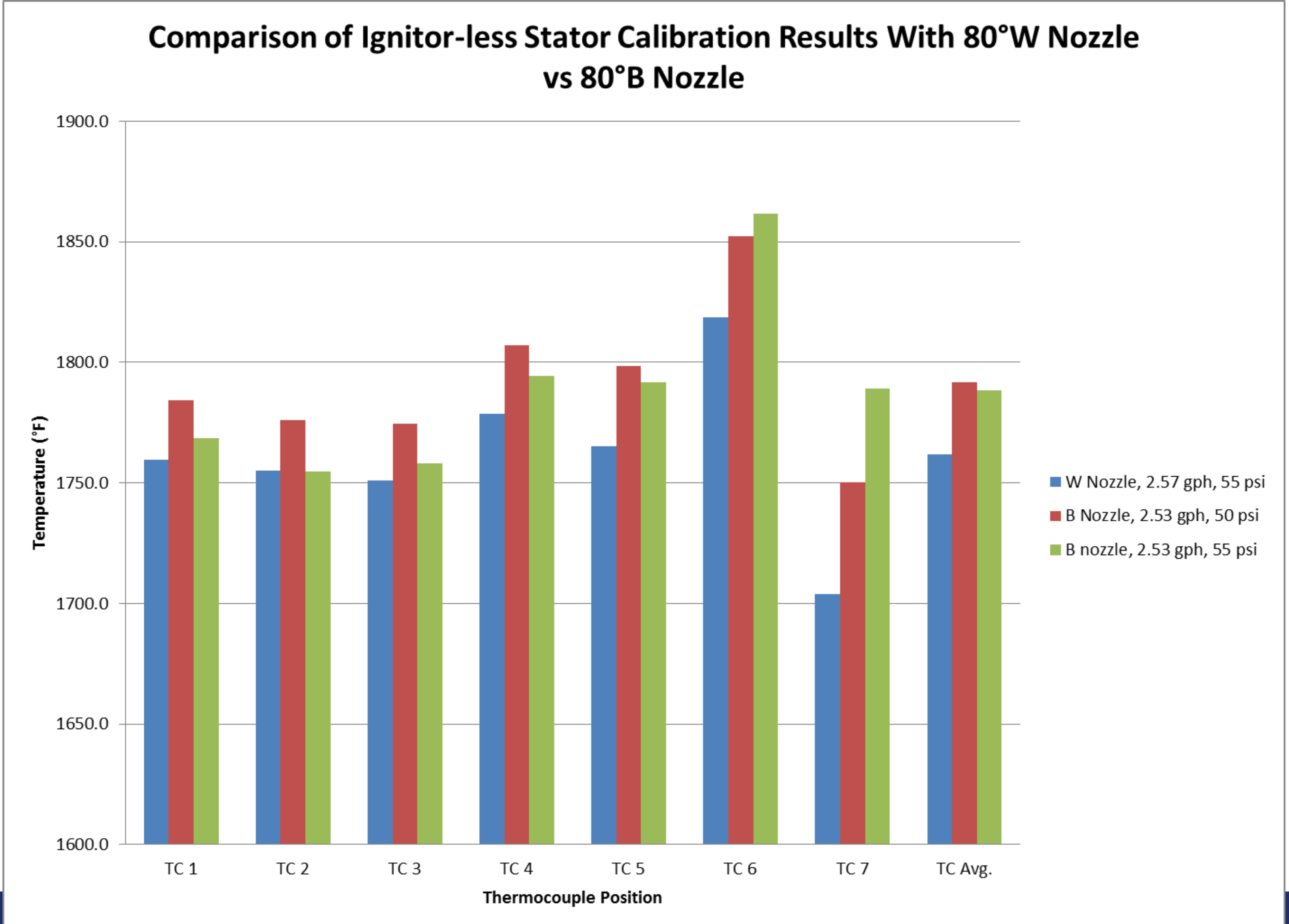
- **Conducted tests to compare calibration results with the FRH setup under a variety of conditions**
  - Air pressure = 50, 55 & 60 psi
  - Fuel flow = 2.50, 2.57, 2.63 gph
  - Delavan 80°W vs Delavan 80°B Nozzle
- **Tested limited amount of panels remaining from the comparative testing conducted previously (slug calorimeter, aluminum, & Textech**

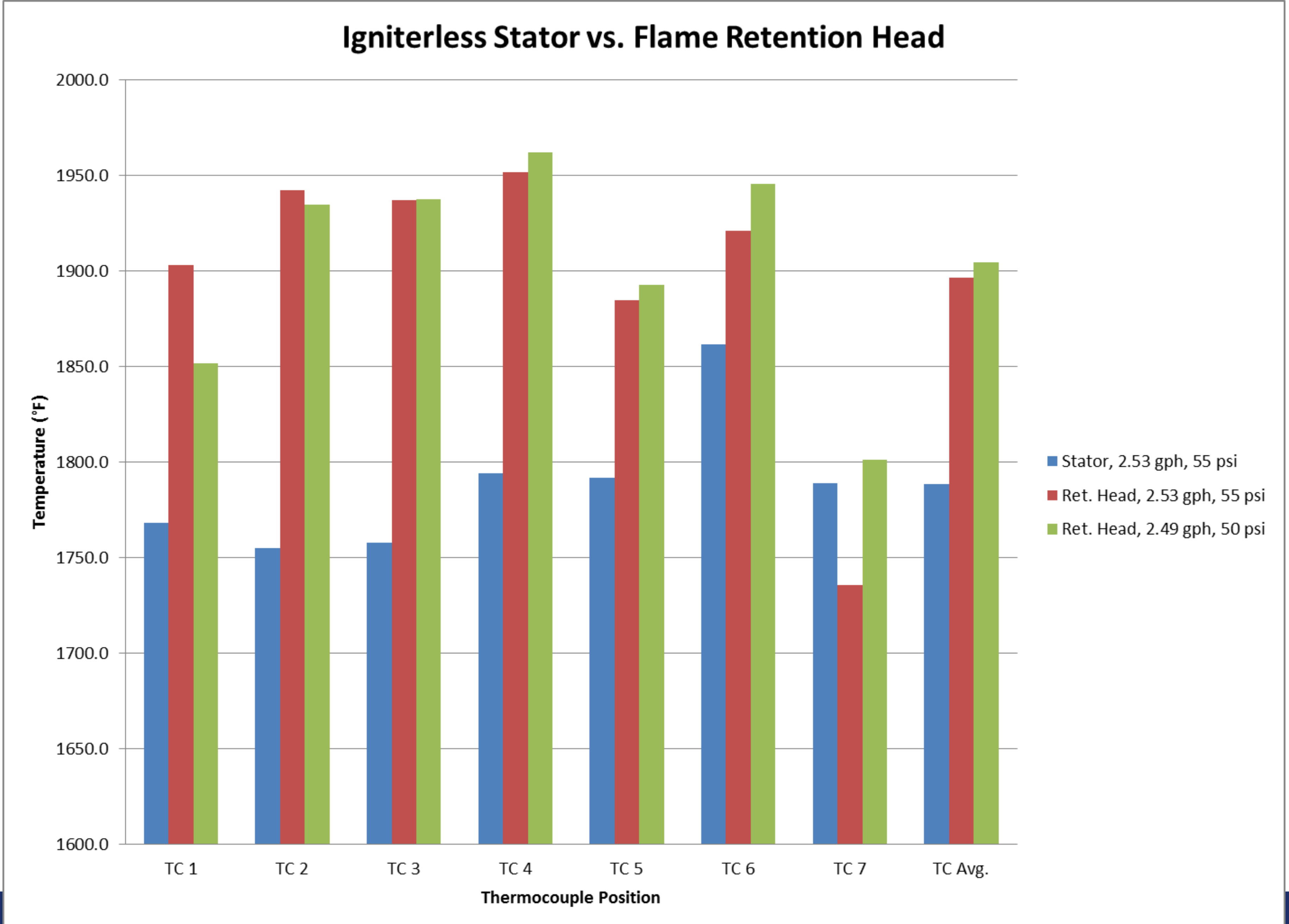

Ignitor-less Stator Calibration Results at 50 PSI Air Pressure
1900.0
1850.0
1800.0
1750.0
1700.0
1650.0
1600.0
Temperature (°F)
TC 1
TC 2
TC 3
TC 4
TC 5
TC 6
TC 7
TC Avg.
Thermocouple Position
2.50 gph
2.57 gph
2.63 gph

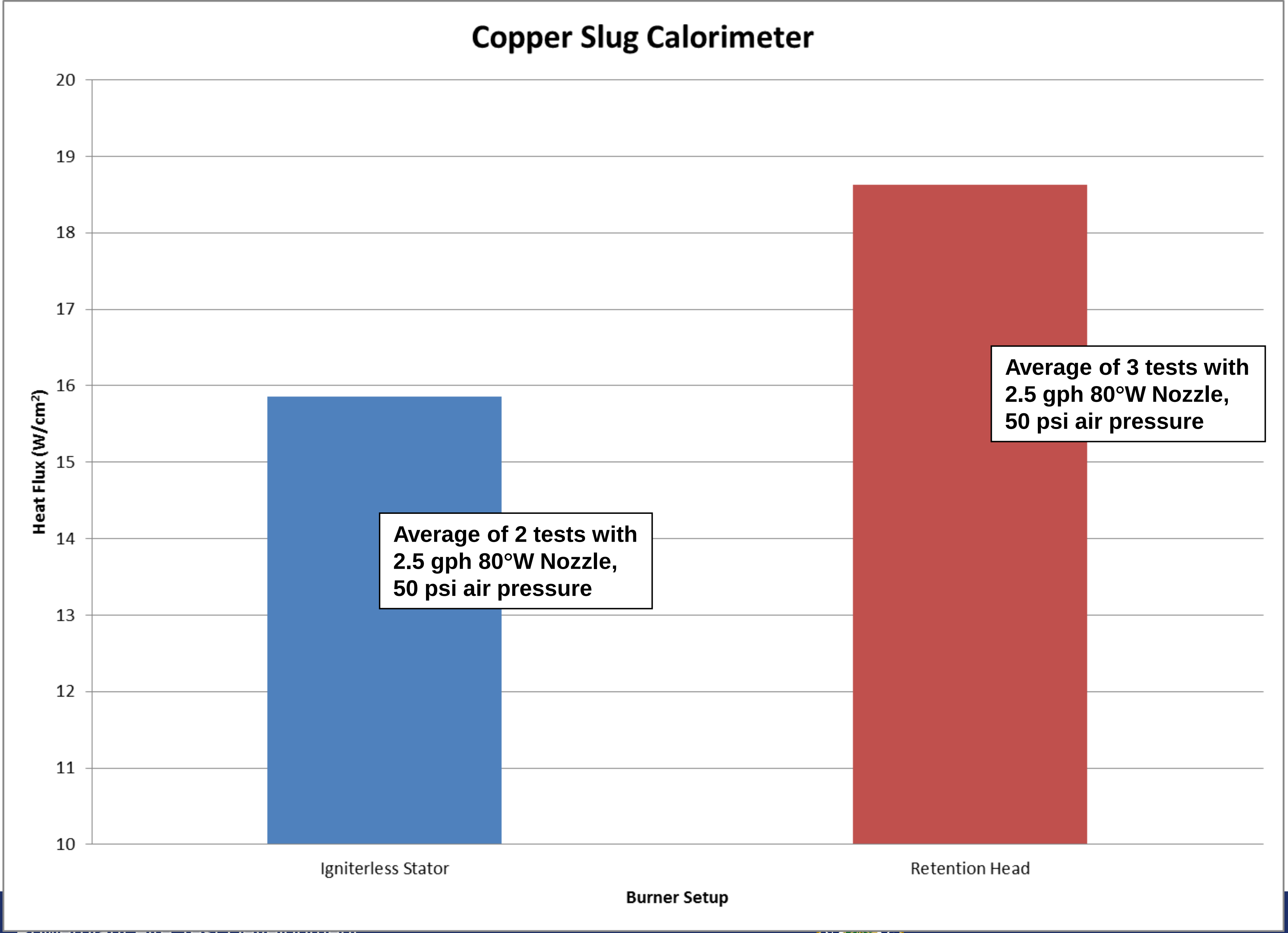

Ignitor-less Stator Calibration Results at 55 PSI Air Pressure
1900.0
1850.0
1800.0
1750.0
1700.0
1650.0
1600.0
Temperature (°F)
TC 1
TC 2
TC 3
TC 4
TC 5
TC 6
TC 7
TC Avg.
Thermocouple Position
2.50 gph
2.57 gph
2.63 gph

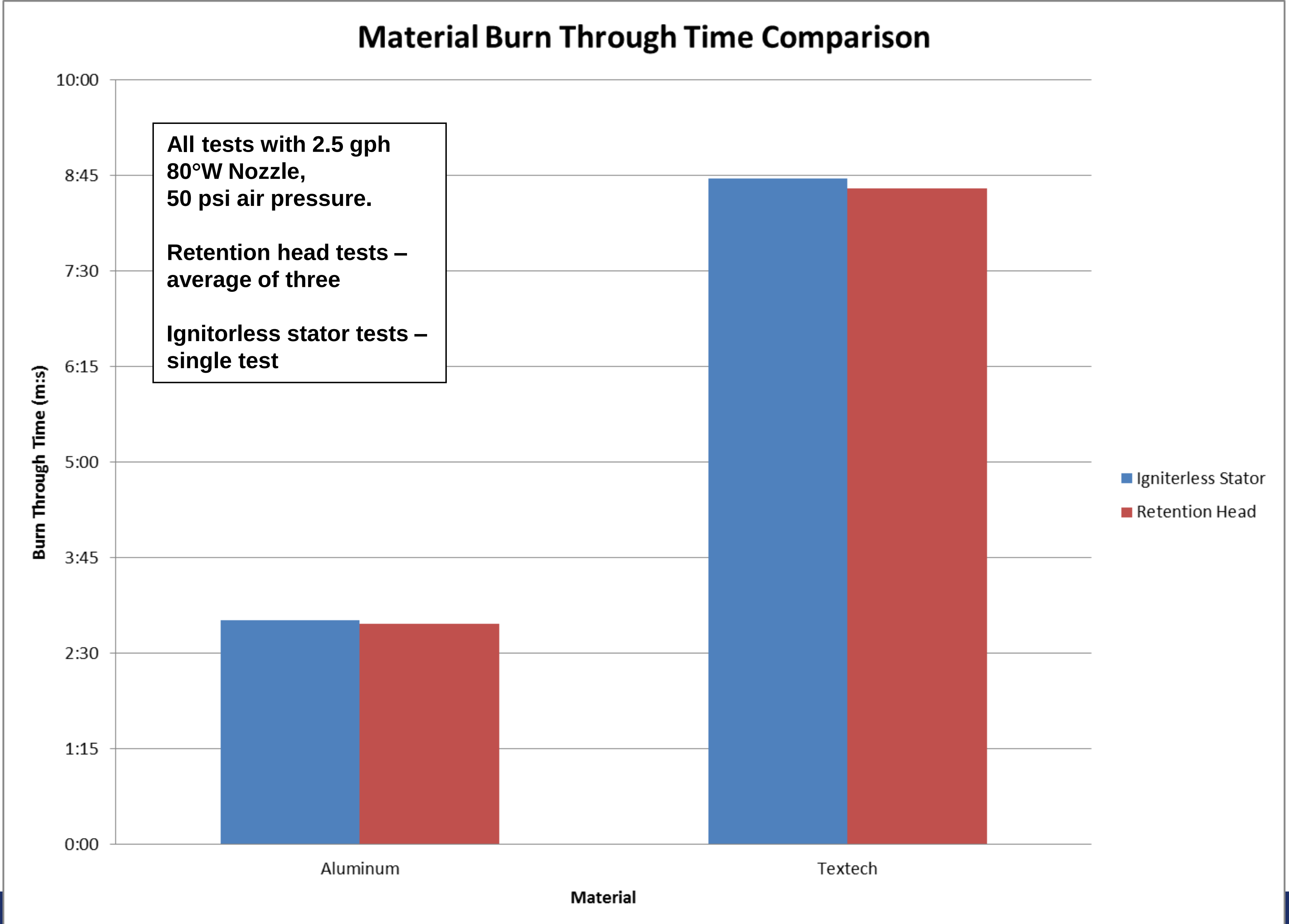

Ignitor-less Stator Calibration Results at 60 PSI Air Pressure
1900.0
1850.0
1800.0
1750.0
1700.0
1650.0
1600.0
Temperature (°F)
TC 1
TC 2
TC 3
TC 4
TC 5
TC 6
TC 7
TC Avg.
Thermocouple Position
2.50 gph
2.57 gph
2.63 gph


Ignitor-less Stator Calibration Results at 2.63 GPH Fuel Flow Rate
1900.0
1850.0
1800.0
1750.0
1700.0
1650.0
1600.0
Temperature (°F)
TC 1
TC 2
TC 3
TC 4
TC 5
TC 6
TC 7
TC Avg.
Thermocouple Position
50 PSI Air
55 PSI Air
60 PSI Air


Comparison of Ignitor-less Stator Calibration Results With 80°W Nozzle vs 80°B Nozzle
1900.0
1850.0
1800.0
1750.0
1700.0
1650.0
1600.0
Temperature (°F)
TC 1
TC 2
TC 3
TC 4
TC 5
TC 6
TC 7
TC Avg.
Thermocouple Position
W Nozzle, 2.57 gph, 55 psi
B Nozzle, 2.53 gph, 50 psi
B nozzle, 2.53 gph, 55 psi


Igniterless Stator vs. Flame Retention Head
2000.0
1950.0
1900.0
1850.0
1800.0
1750.0
1700.0
1650.0
1600.0
Temperature (°F)
TC 1
TC 2
TC 3
TC 4
TC 5
TC 6
TC 7
TC Avg.
Thermocouple Position
Stator, 2.53 gph, 55 psi
Ret. Head, 2.53 gph, 55 psi
Ret. Head, 2.49 gph, 50 psi


Copper Slug Calorimeter
20
19
18
17
16
15
14
13
12
11
10
Heat Flux (W/cm²)
Average of 2 tests with
2.5 gph 80°W Nozzle,
50 psi air pressure
Average of 3 tests with
2.5 gph 80°W Nozzle,
50 psi air pressure
Igniterless Stator
Retention Head
Burner Setup


Material Burn Through Time Comparison
All tests with 2.5 gph
80°W Nozzle,
50 psi air pressure.
Retention head tests – average of three
Ignitorless stator tests – single test
10:00
8:45
7:30
6:15
5:00
3:45
2:30
1:15
0:00
Burn Through Time (m:s)
Aluminum
Textech
Material
Igniterless Stator
Retention Head

Testing Summary

- **Under all conditions tested, calibration with the ignitor-less stator resulted in significantly lower temperature readings than with the FRH.**
- **Additionally, heat flux when measured/calculated with the copper slug calorimeter was significantly lower**
- **However, burnthrough times for a limited number of aluminum and TexTech panels showed excellent agreement with FRH test data**

Testing – Next Steps

- **Lab modifications underway to be able to conduct composite (and other) testing under vibration**
- **Additional materials acquired for continued testing of ignitor-less stator configuration**
- **Next round of round robin/comparative testing to be initiated in coming months**
  - Need to discuss in task group meeting recommended test materials, configurations, etc.

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Current Status – AC 20-135

- **A sub-group had been formed with the goal of developing proposed rewording of AC20-135 in a parallel effort with NexGen burner development.**
  - Testing requirements (i.e. when/how to vibrate sample, orientation of sample, etc) and testing equipment (i.e. thermocouple type, heat transfer calibration device, etc) will be addressed.
  - Actual burner operation and calibration will be left open subject to burner development.
- **After initial sub-group meetings, it became evident that a more formal involvement from FAA was required and it was suggested that a proposal be submitted to the FAA from industry with the request that a formal group chartered for this task.**

Current Status – AC 20-135 (cont.)

- **Dirk Kearsley (BAE Systems) had drafted this request and submitted to FAA (6/2014).**
- **Internal FAA group of experts (Headquarters, Directorates, ACOs, etc) has been formed to initiate an evaluation of AC**
- **Work to be completed in two phases**
  1. Incorporate NexGen burner as an acceptable burner for powerplant testing
  2. Address longer term, more complete revision of AC to further address/clarify testing specifics

Questions

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