Heat Flux and Thermal Response Measurements for Designing a Propane Fuel Fast Cook Off Test Apparatus

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Agenda

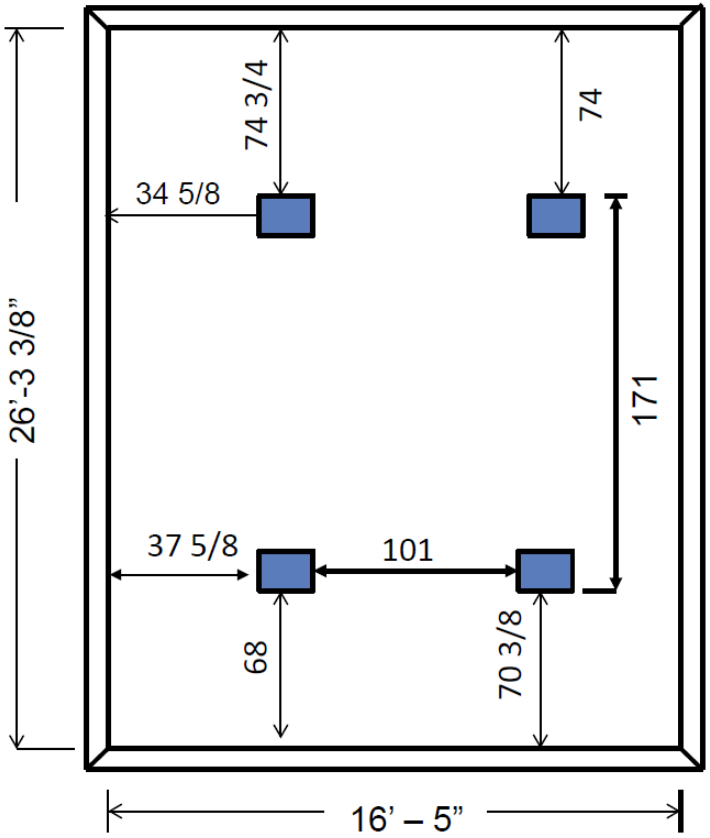
- Background
- Description of Propane Burner at W91 Laboratory
- Instrumentation Overview
- Test Layout
- Test Results
  - Temperature Measurements
  - Heat Flux Measurements
- Summary

Background

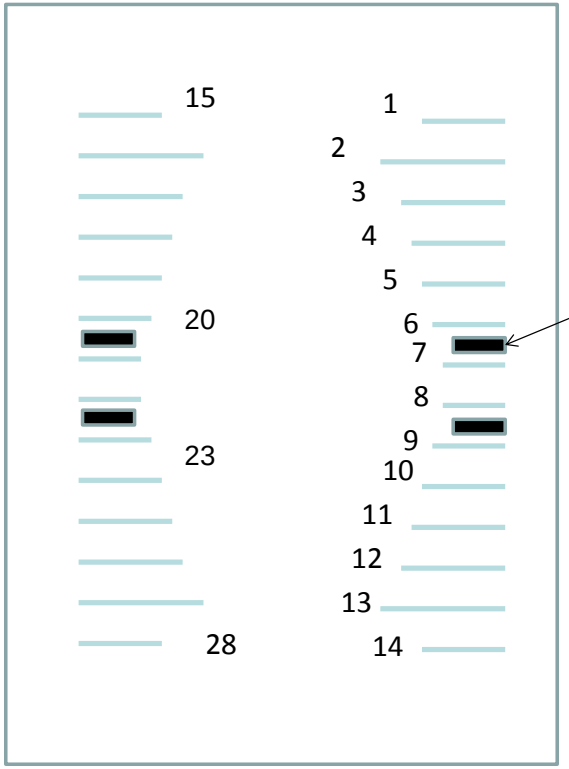
- Increased Environmental Regulation has limited the use of Liquid Fuel Fires due to soil, ground water contamination, air quality
- Several countries have already switched to propane as an cleaner burning alternative fuel
  - Canada
  - Sweden
  - Germany
- Current joint effort with China Lake focuses on measuring heat fluxes in liquid fuel fires and in propane fires using multiple instruments
- This presentation focuses on the results of recent testing at a propane fast cook off facility in Germany.

W91 Laboratory Propane Burner

Chamber Overall Dimensions



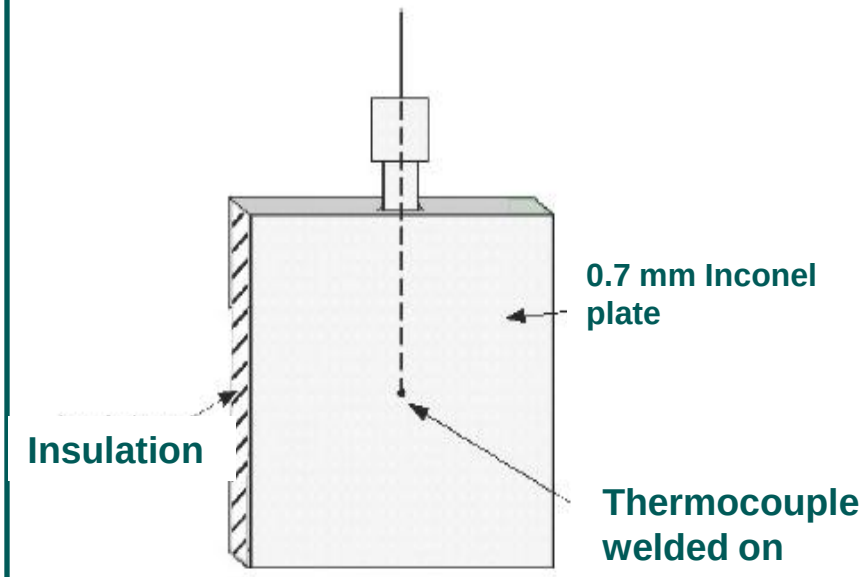
Burner Arrangement in Chamber



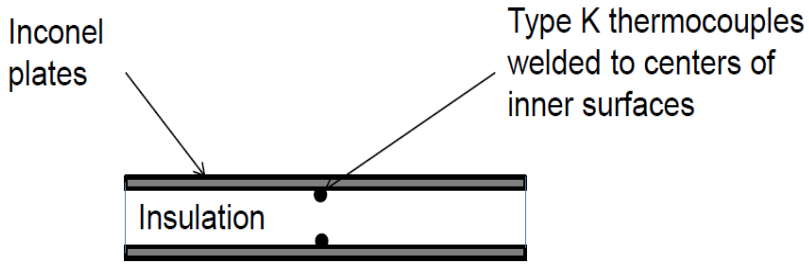
Test No. 2 Video

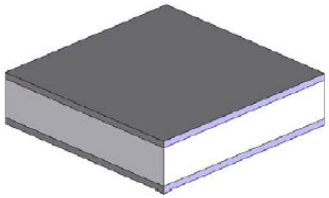
Instrumentation

Plate Thermometer - PT

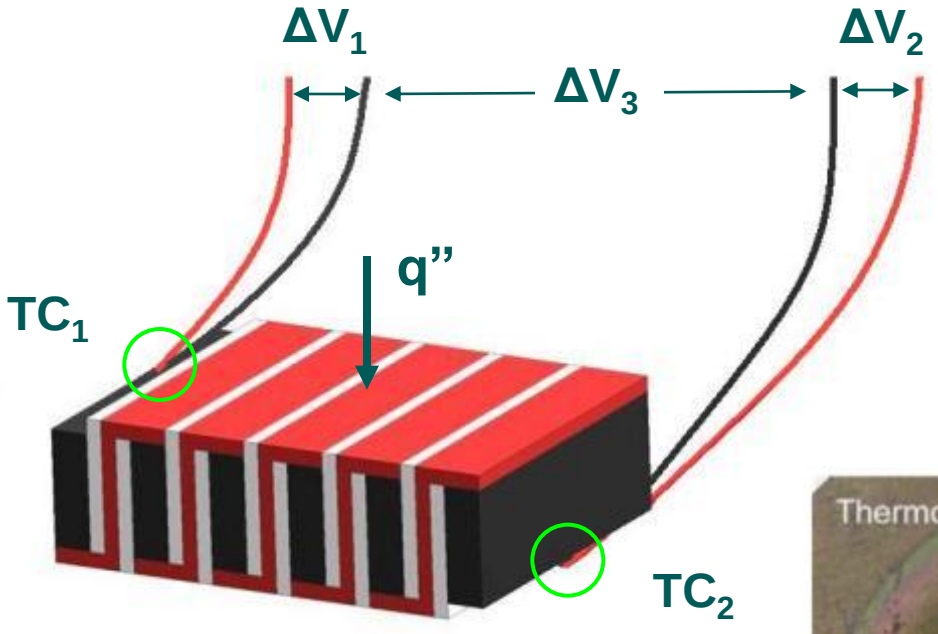


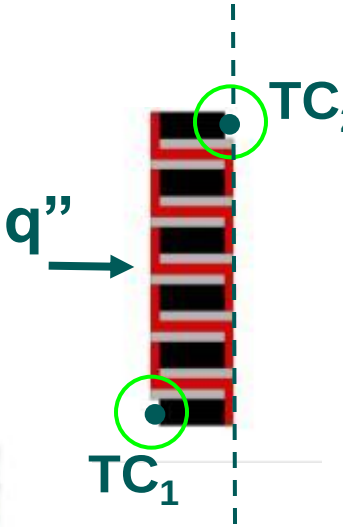
Directional Flame Thermometer - DFT

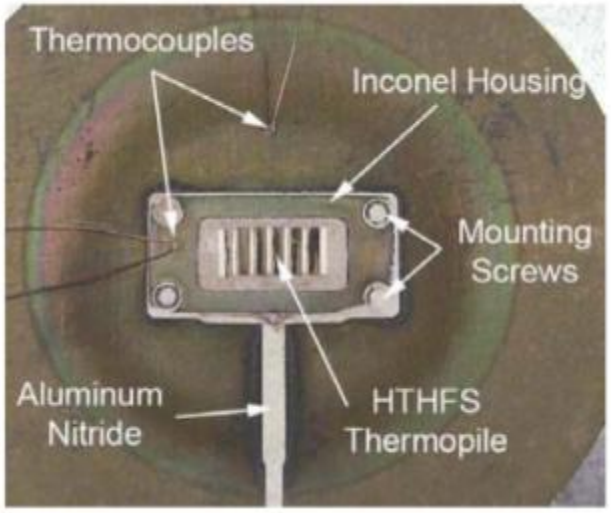




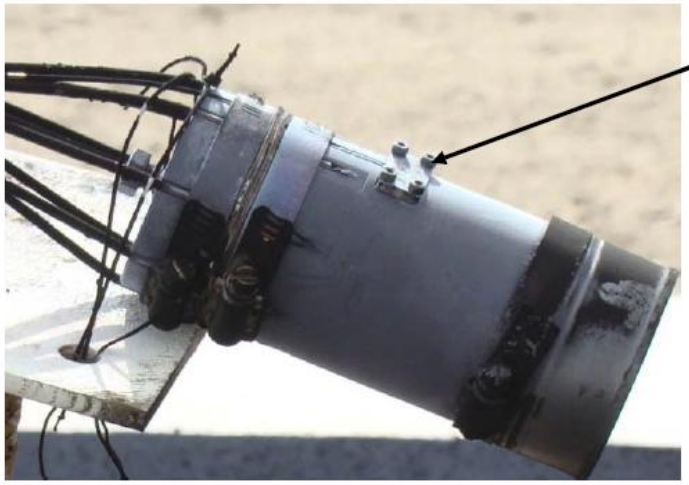
High Temperature Heat Flux Gage - VT



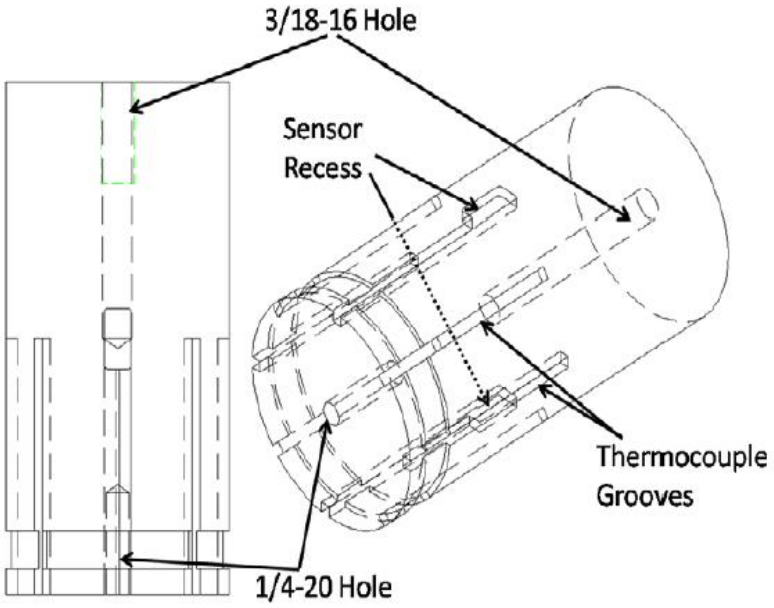


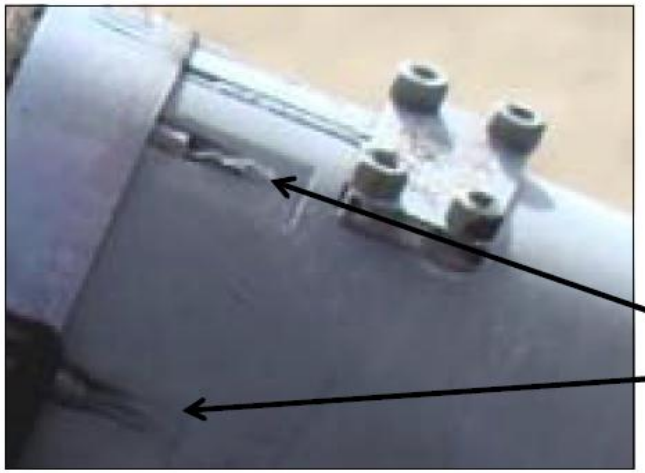


Generic Test Item



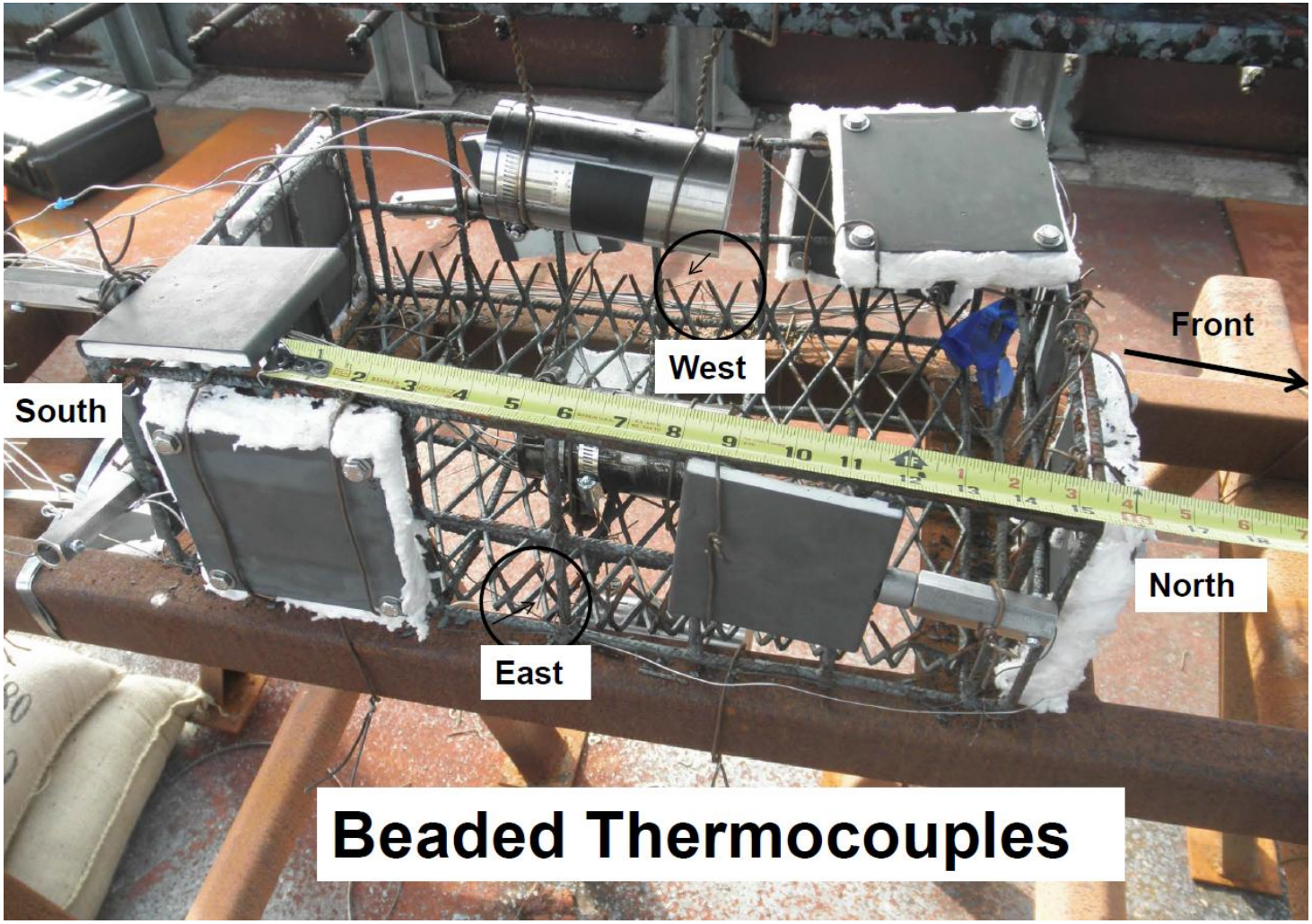
HTHFG - VT



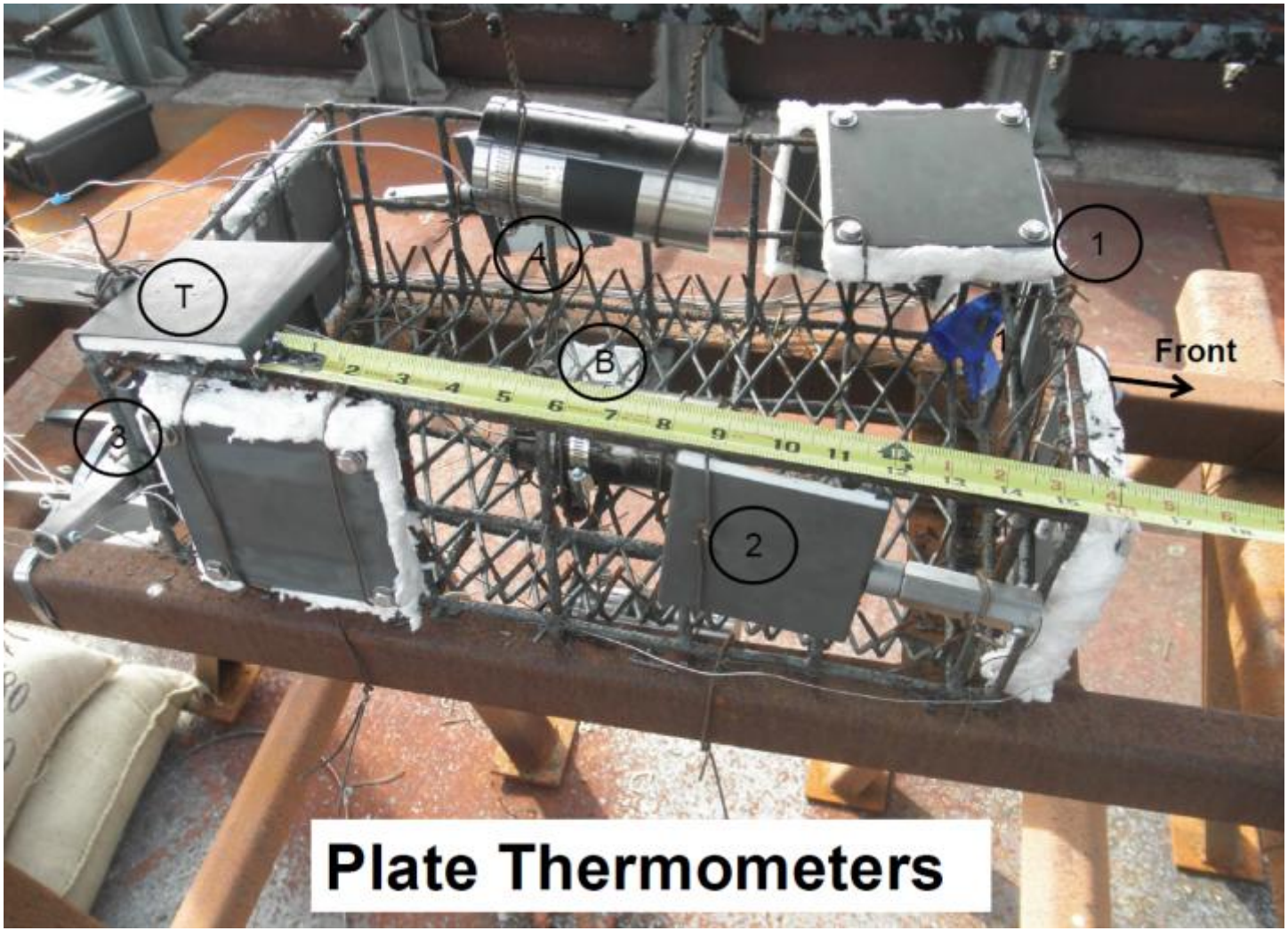


Type K thermocouples
welded to surface

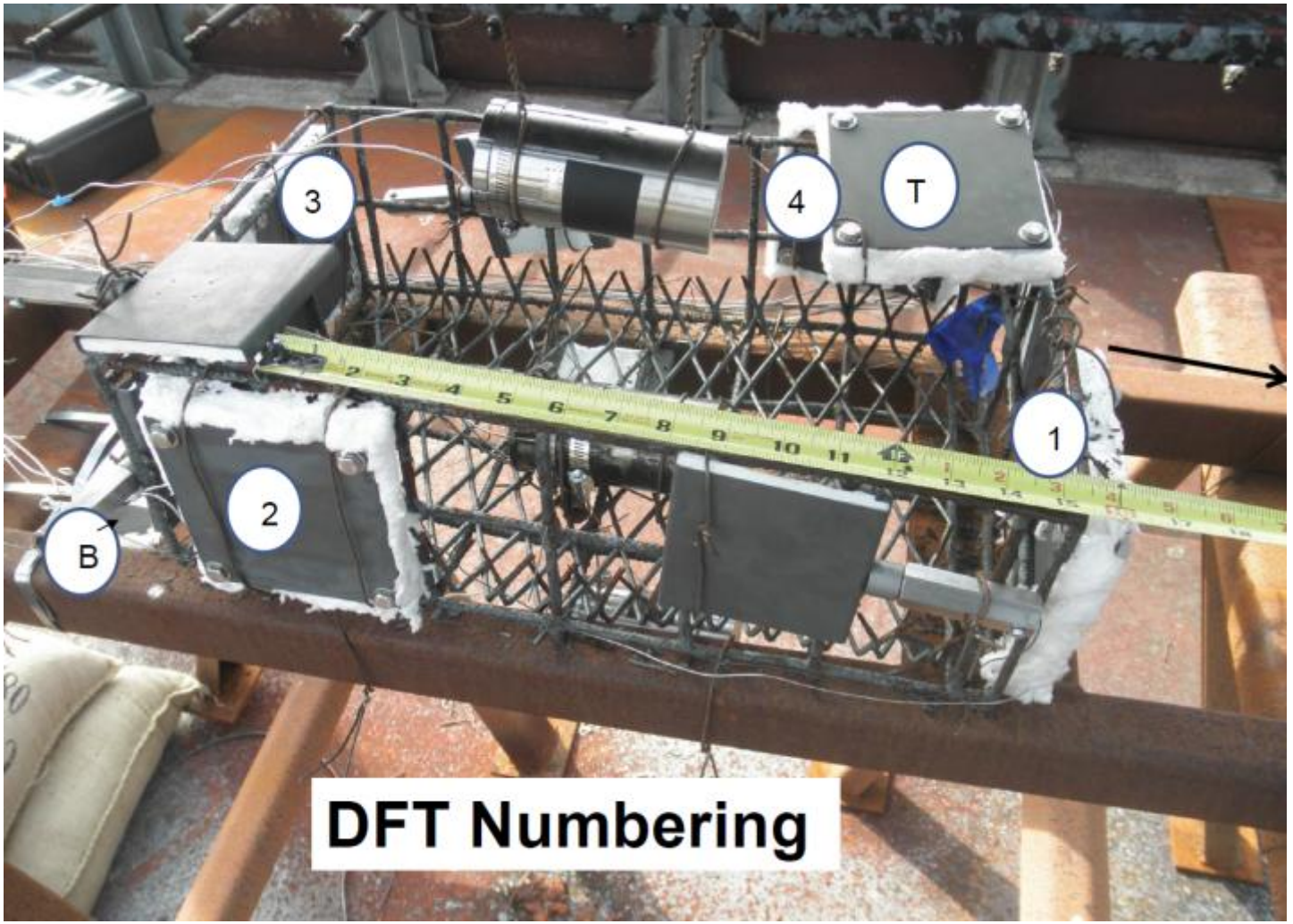
Test Layout – Instrumentation Basket



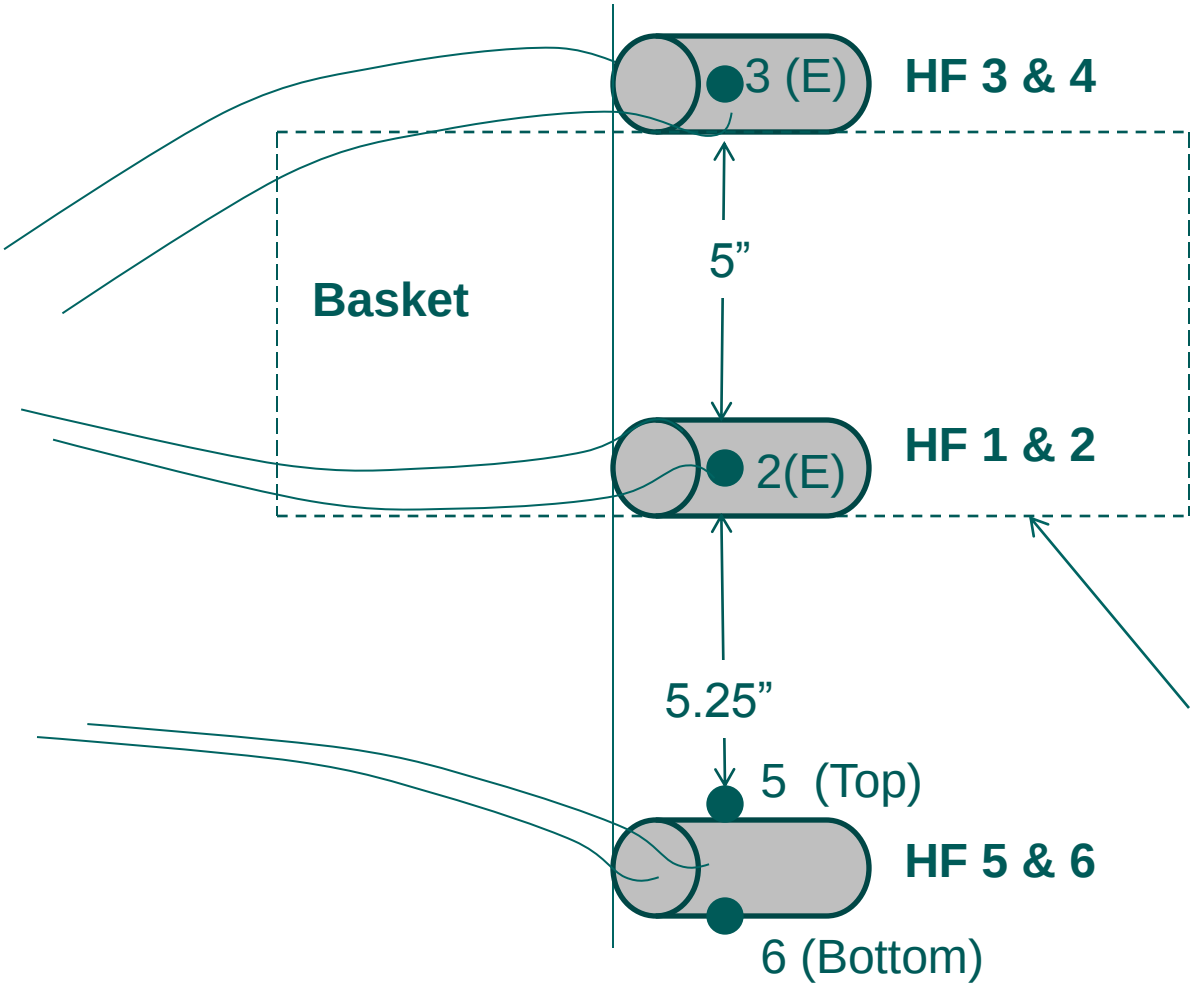
Test Layout – Instrumentation Basket

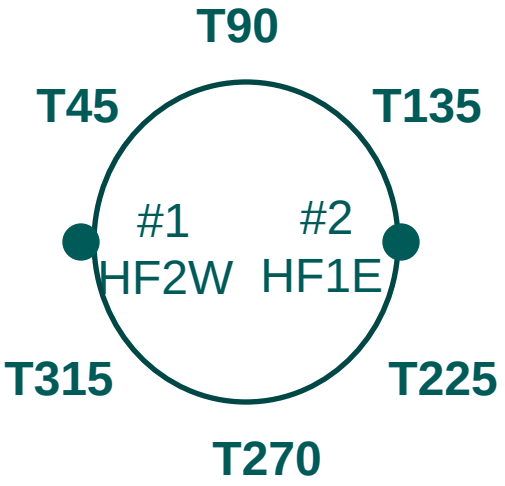


Test Layout – Instrumentation Basket

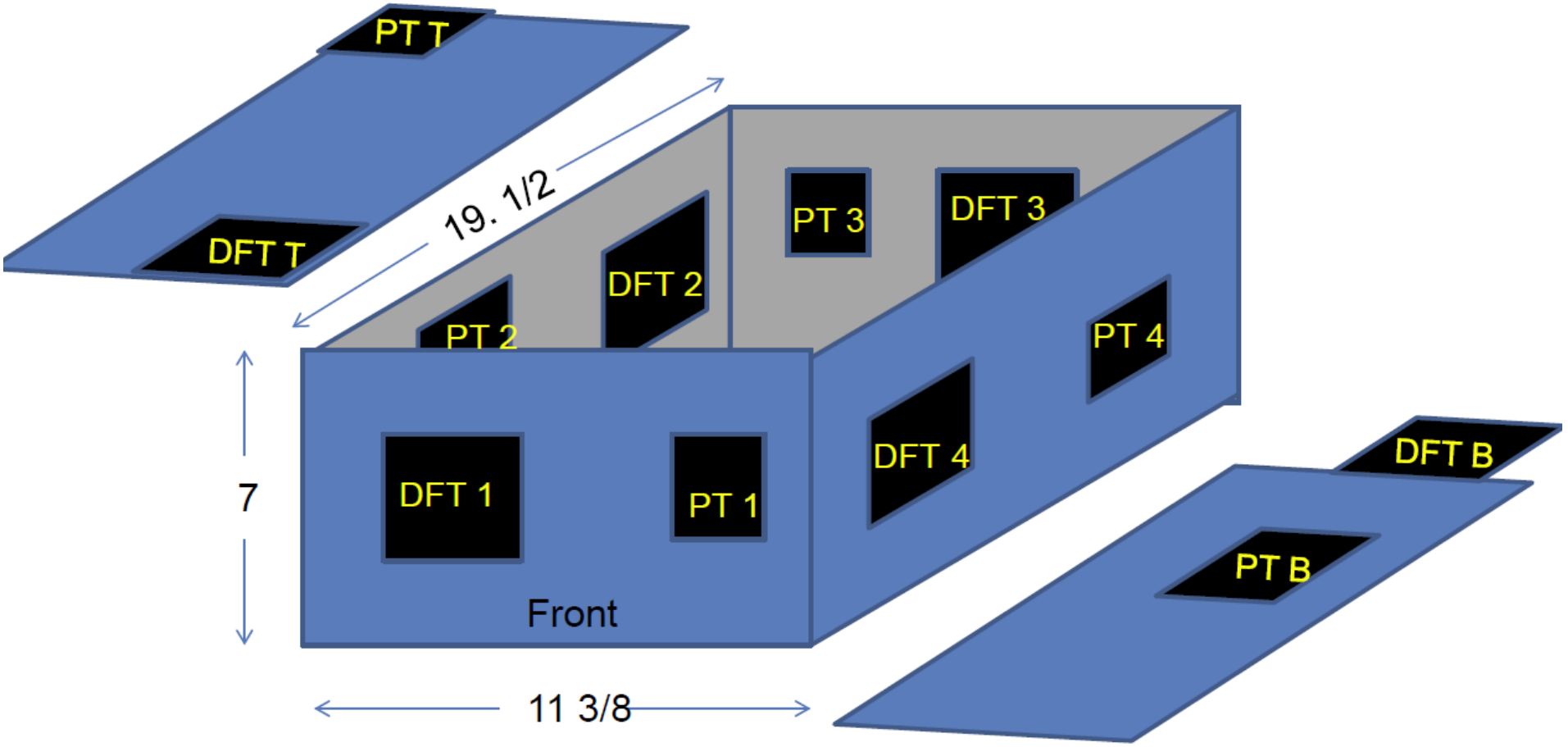


Generic Test Item Layout

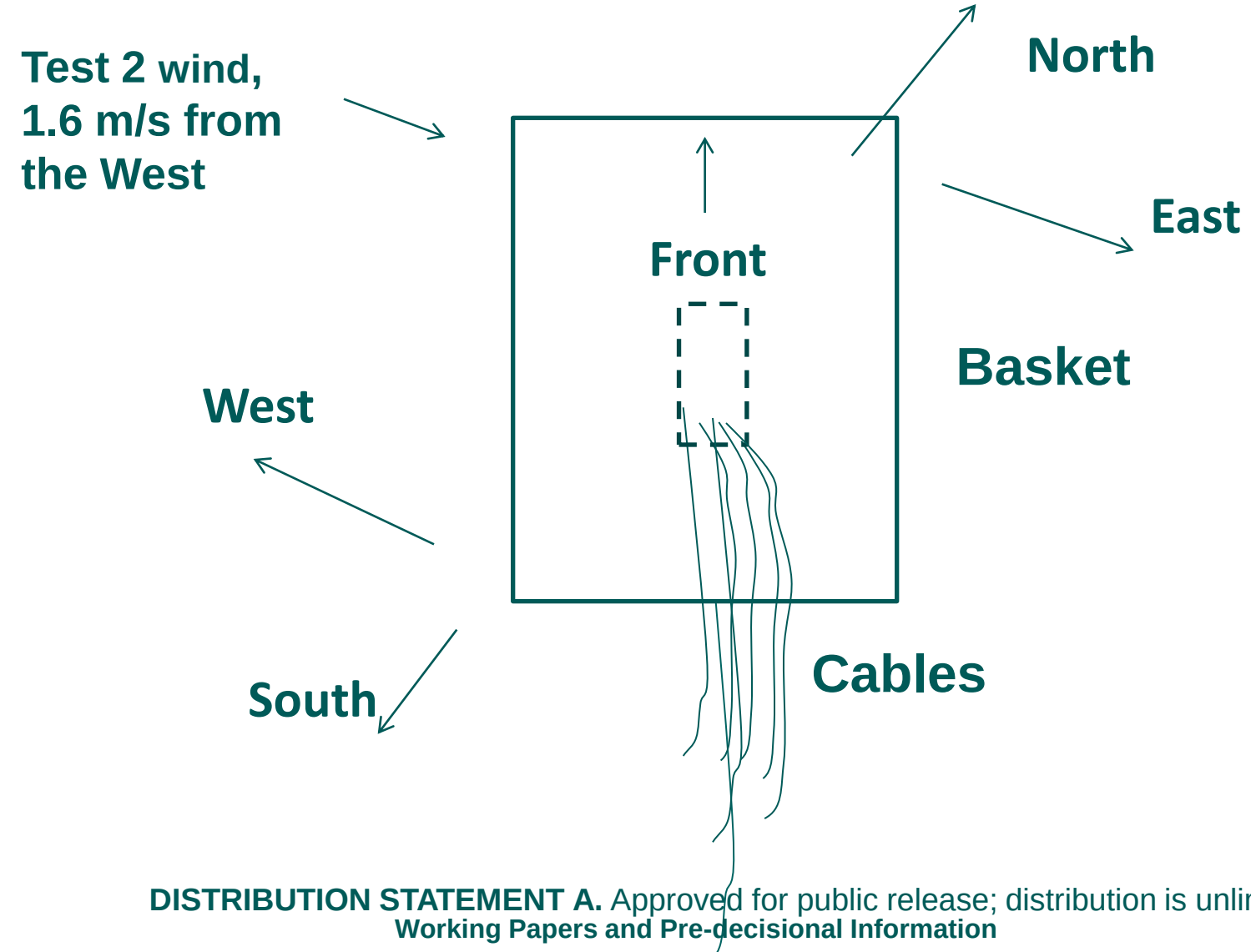




PT and DFT Positions



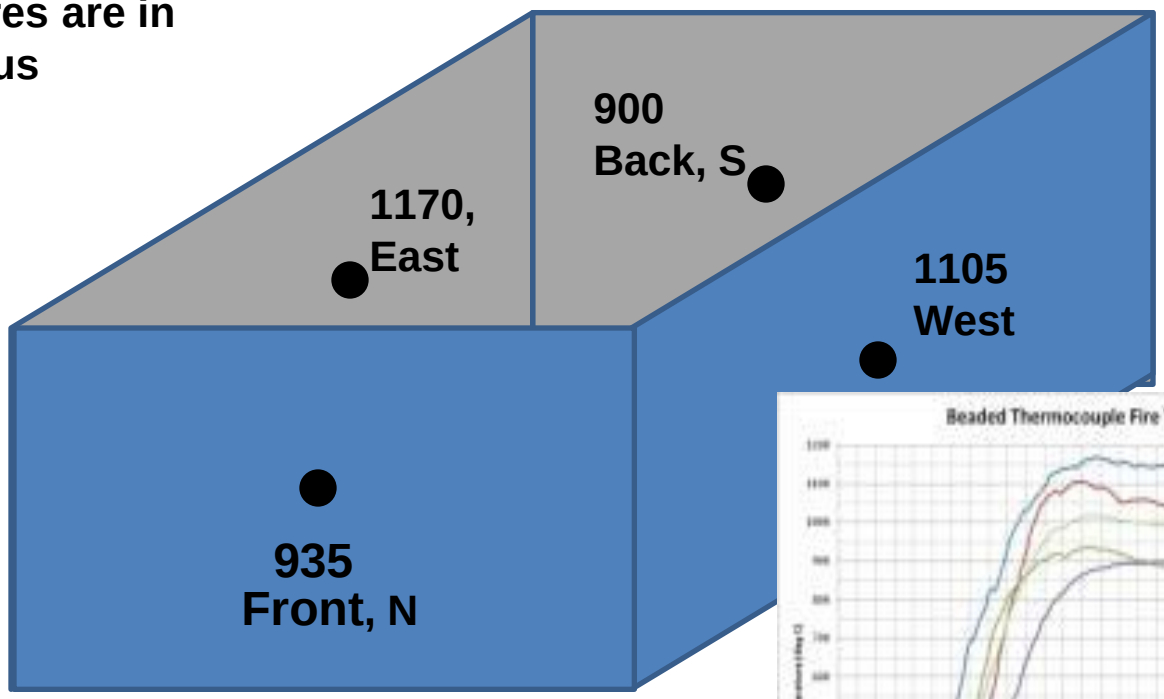
Coordinates, Directions, and Wind

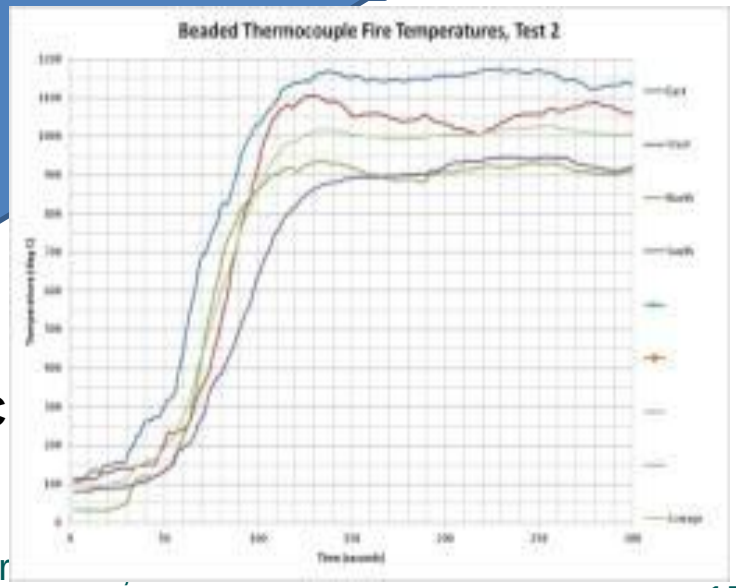


Temperature Data

Beaded Thermocouples

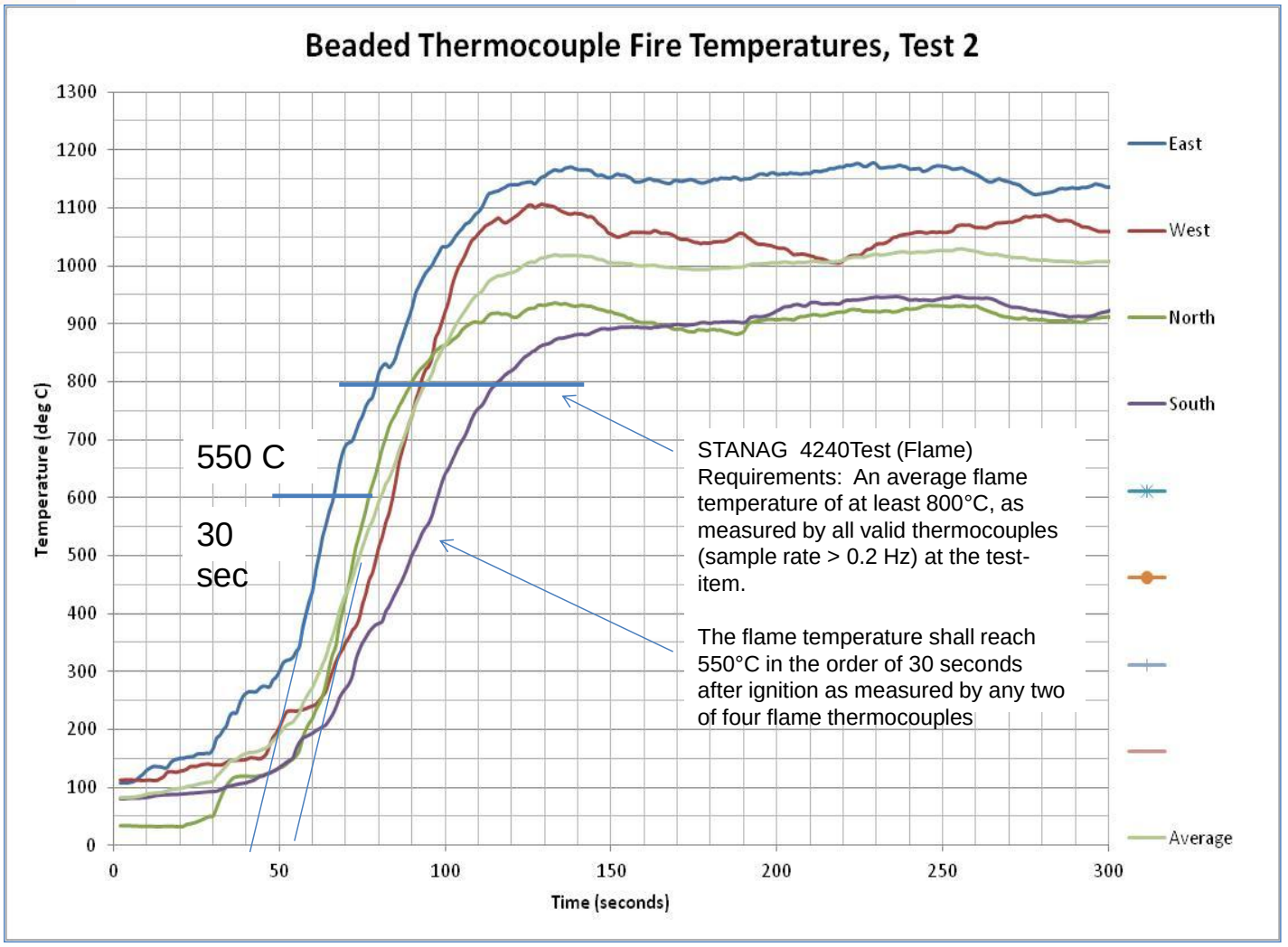
All temperatures are in degrees Celsius



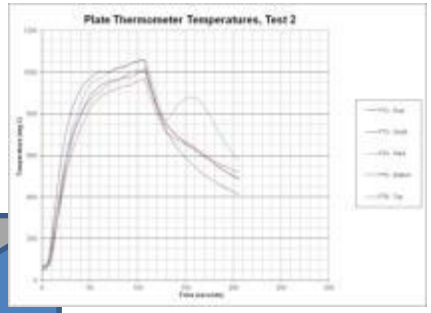


Average = 1125 C

Temperature Data



Max Temperatures PTs Test #2

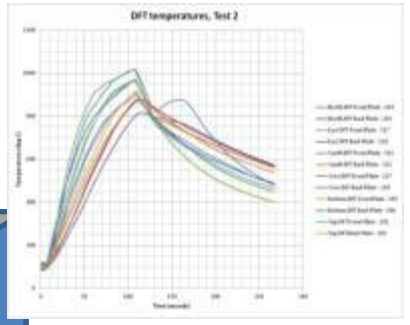


degrees C

Ave =	1022
Std Dev =	38

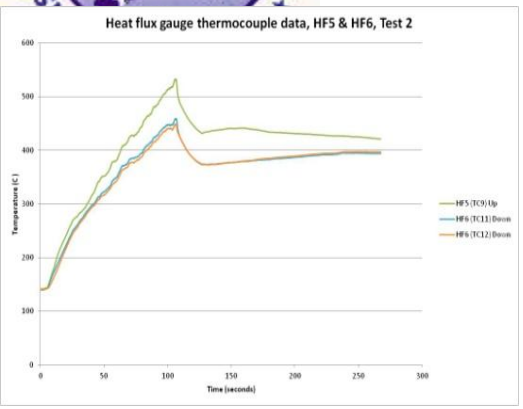
Max Temperatures DFTs Test #2

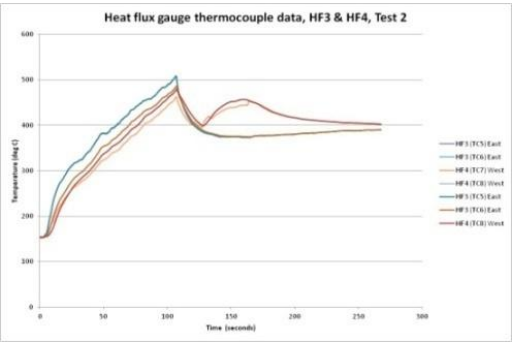
Note: Temperatures were still rising when flame was shut off

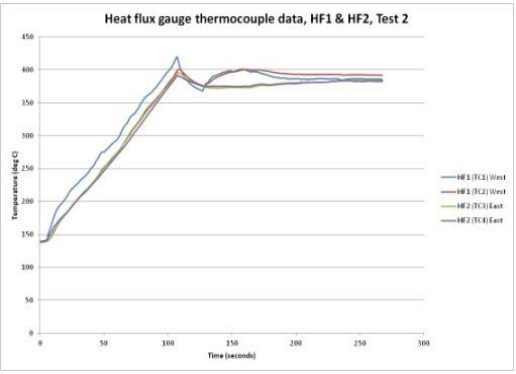


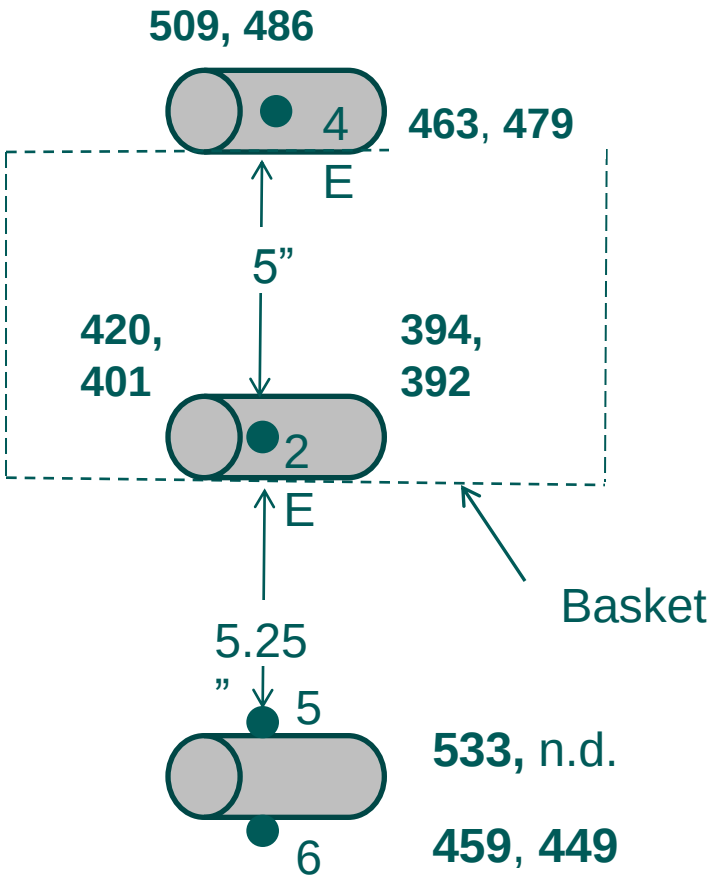
f = front plate of DFT
b = back plate

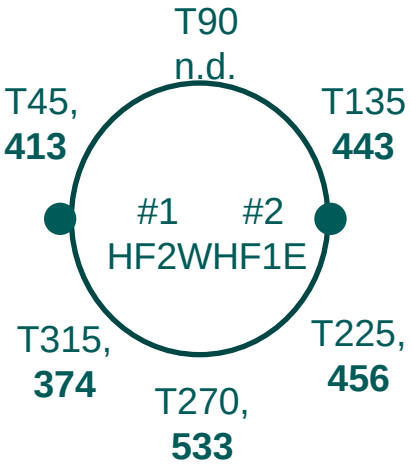
Generic Test Item Surface Temp Data







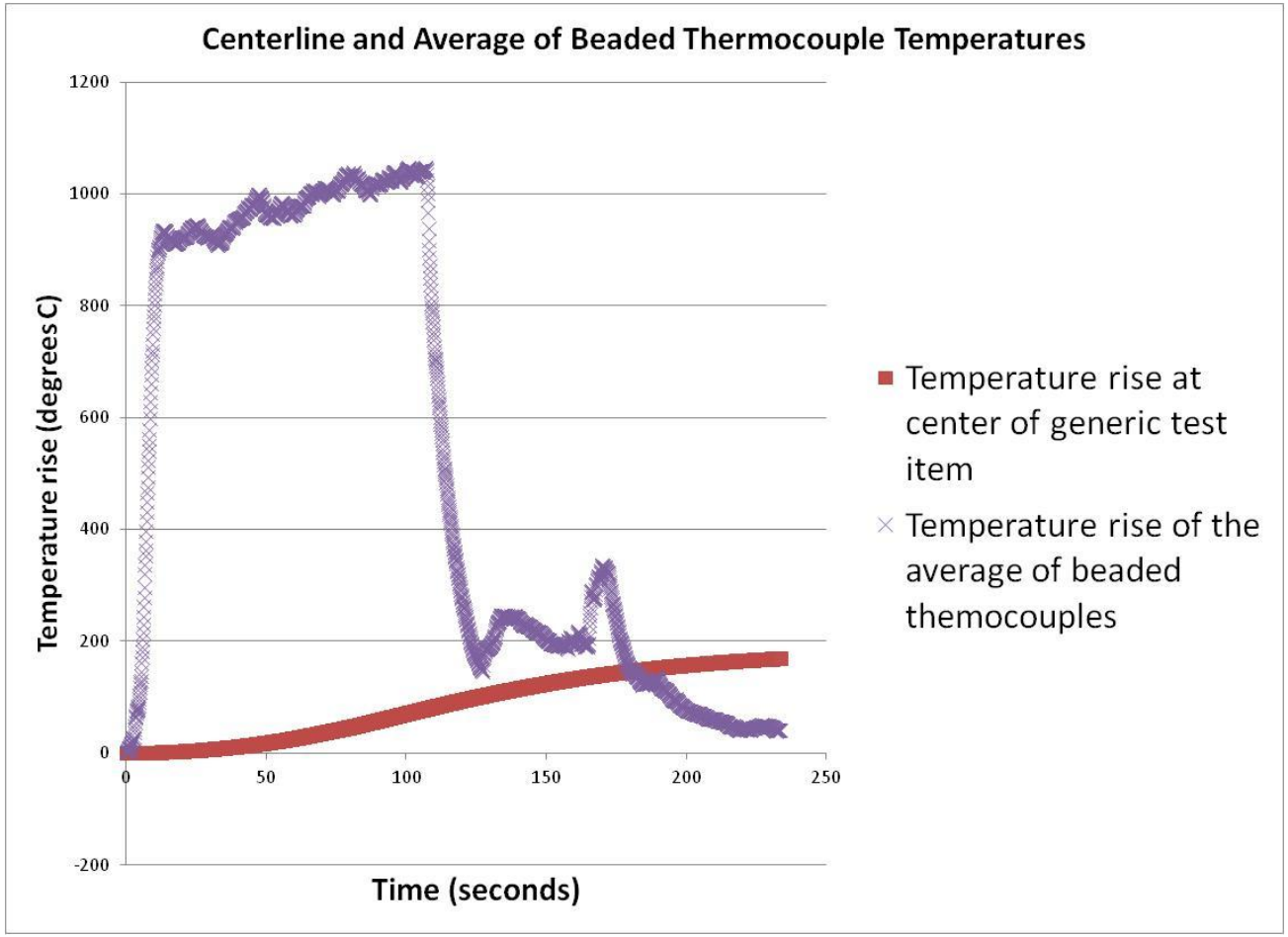




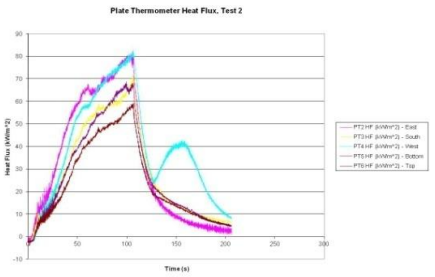
Ave =462
S.D. = 49

degrees C

Centerline and Average of Beaded Thermocouple Temperatures

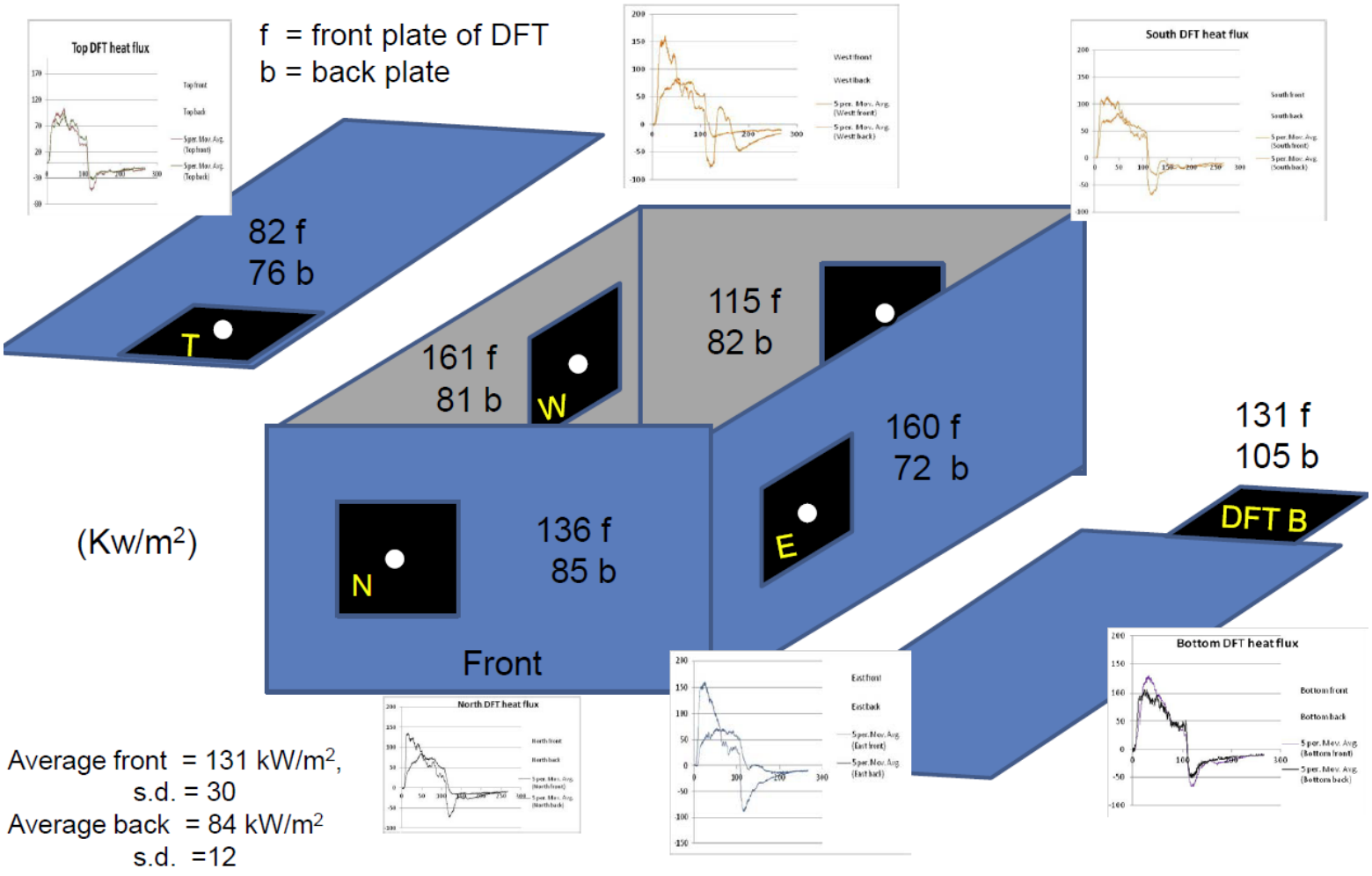


Heat Flux Data PTs Test #2



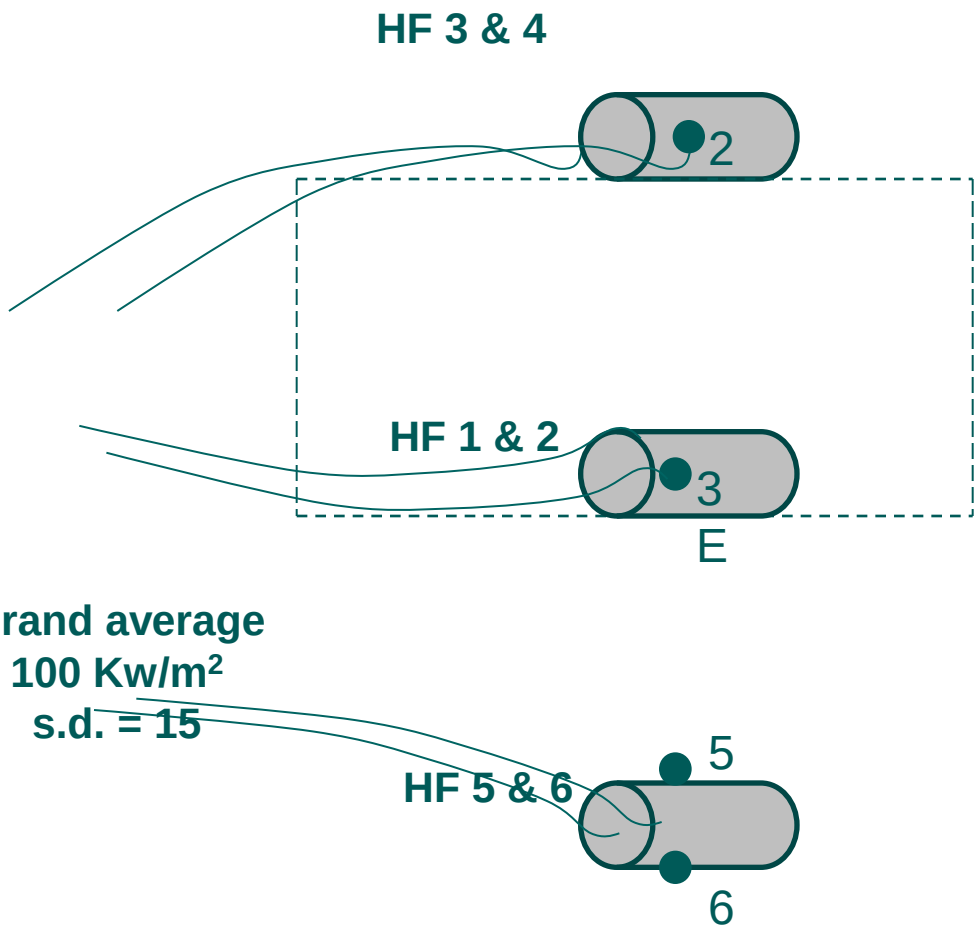
Average	63.1
SD	9.4

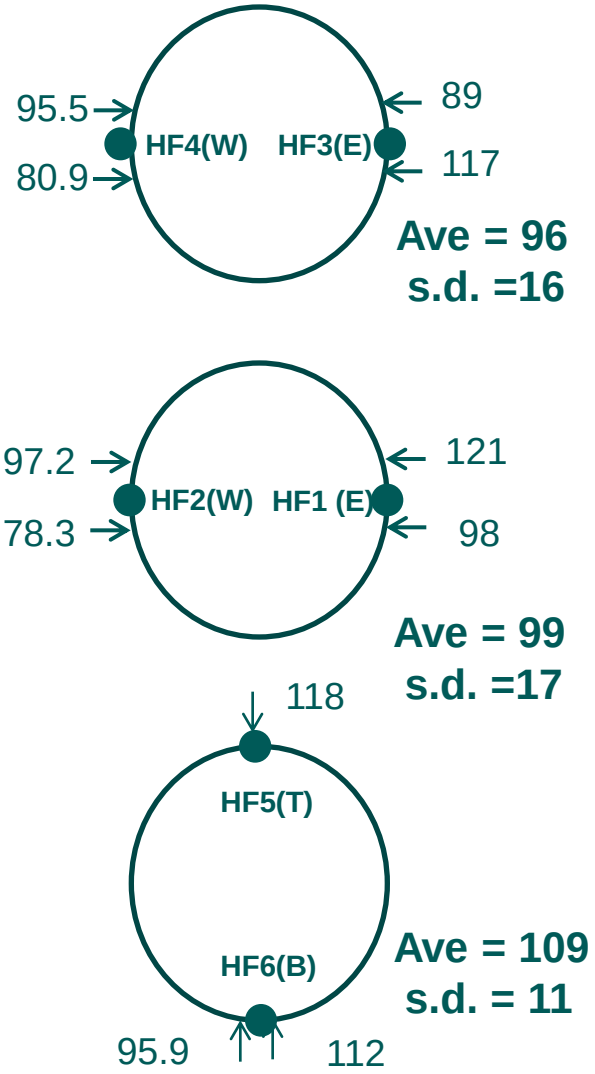
Heat Flux Data DFTs Test #2



Average front = 131 kW/m², s.d. = 30
Average back = 84 kW/m² s.d. =12

Generic Test Item
Heat Flux Data, Test #2





Summary

- Extensive data on the test item thermal environment in a propane fuel fast cook off fire have been collected
- The data from each sensor type are self consistent, but there are significant differences between the data sets from the various types of sensors
- There are gradients in the temperature and heat flux as one travels from below the basket to above the basket.

Acknowledgements

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