Experimental Investigation of the Park Burner, Comparisons to NexGen

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Project Overview

- Project Objective:
  - Demonstrate the 2000 F minimum average temperature requirement drives heat flux to upper bound
  - Draw comparisons between the calibration and burn-through of Park vs NexGen Burners
- Previous Work on NexGen burner development:
  - Effect of burner setup, assembly tolerances and calibration TC size
  - Effect of burner orientation on performance
  - Burner sensitivity to operating conditions
    - Air and fuel flowrate
    - Air and fuel temperature
  - Comparison of fire test results between NexGen and Gas burner

Liquid Burner

Gas Burner

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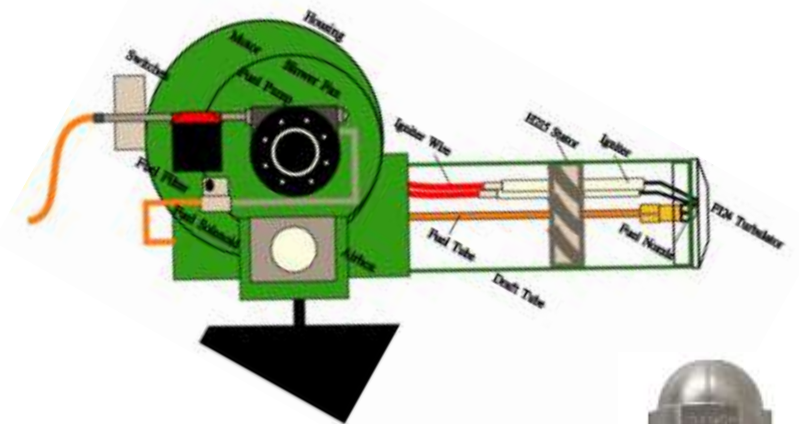
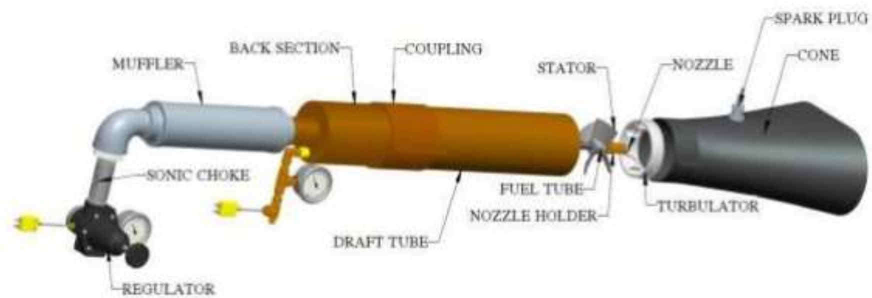
Liquid Burner Overview

Park Burner



Monarch 2.25 GPH, 80 Degree PLP

NexGen Burner



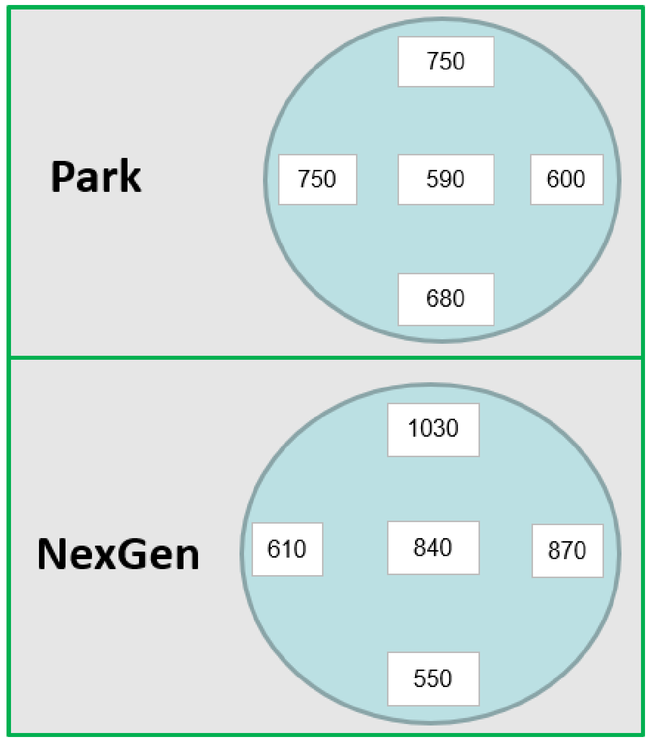
Delevan 2.5 GPH, 80 Degree Type W

- Same fuel (Jet-A) and burner cone
  - NexGen burner: both fuel and air flow rate are controlled and metered
  - Park burner: only fuel flow rate is controlled and metered

Figure 1: Park Burner Design. Adapted from "Burnthrough Test Method for Aircraft Thermal/Acoustic Insulation" by Ochs, 2005
Figure 2: Schematic of NexGen Burner. Adapted from "Next Generation Fire Test Burner Apparatus", 2016

Air Velocities – Park vs NexGen

- Park burner air mass flow can not adjustable/controlled.
- Park burner: 15-20% less air velocity (exit of tube)
- Measured with hot wire probe



Average Air Velocities (ft/min)	
	Exit of Tube
Park	674
NexGen	780

Fire Test Setup

- Temperature calibration: 1/8”, Type K exposed bead Thermocouples
- Heat Flux: copper pipe with water flows
- Burn-through tests: 24”x24”x0.125” panel (2024 Aluminum)

Figure 1: TC Rake

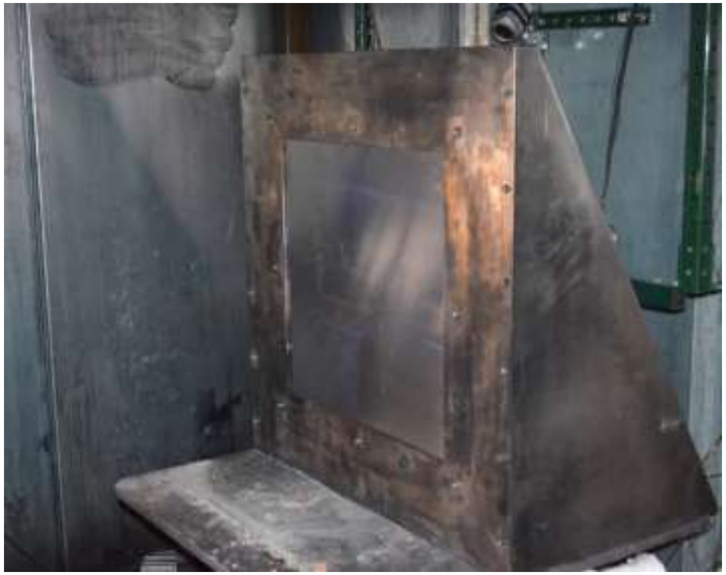


Figure 2: Al Panel

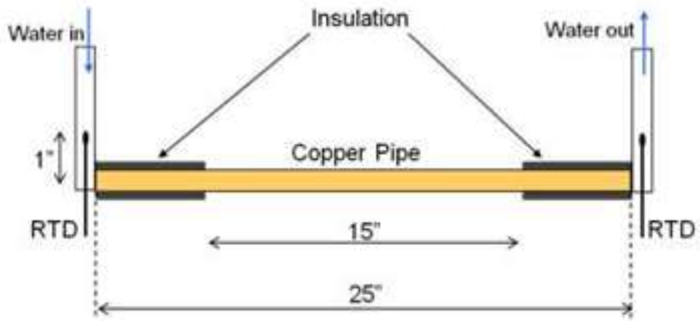
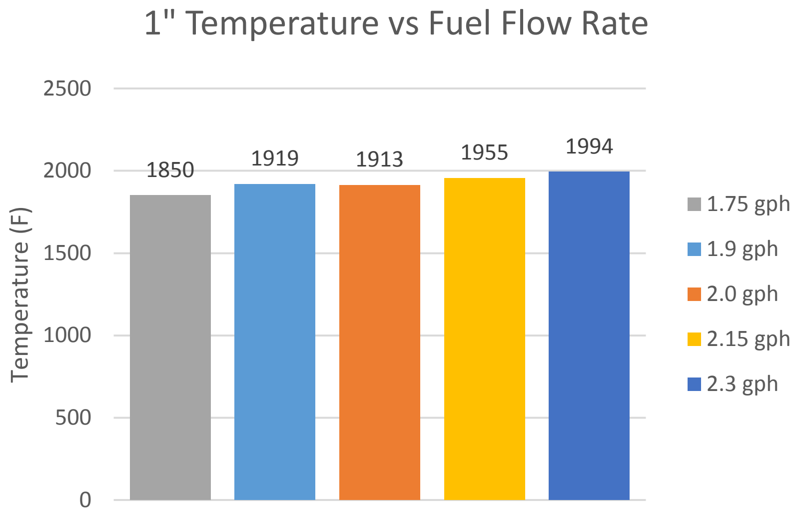
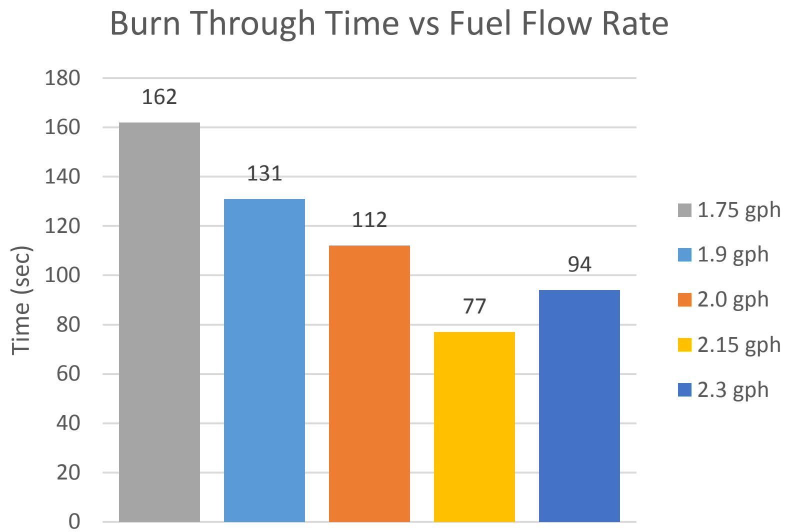
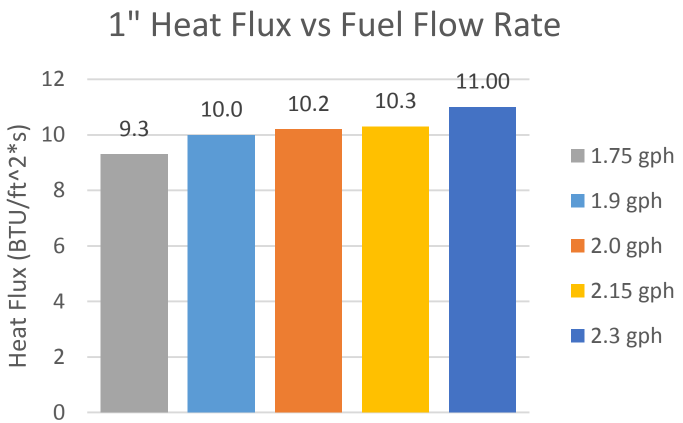


Figure 3: Heat Flux Tube

Park Burner Results

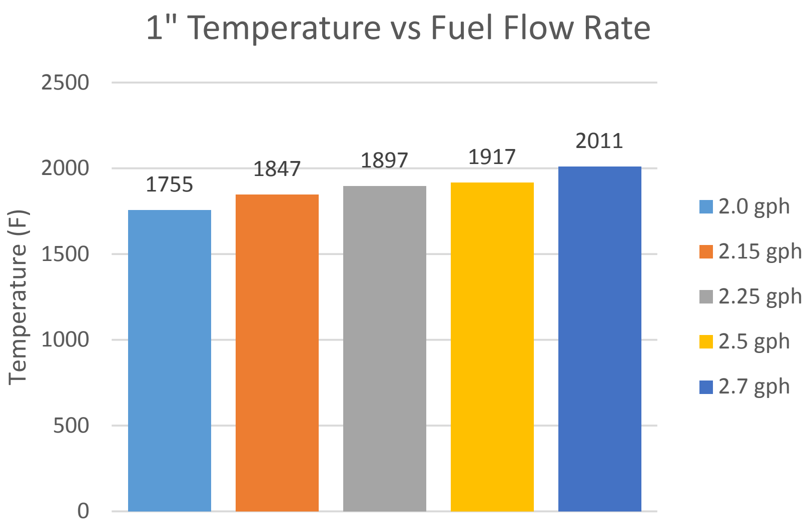


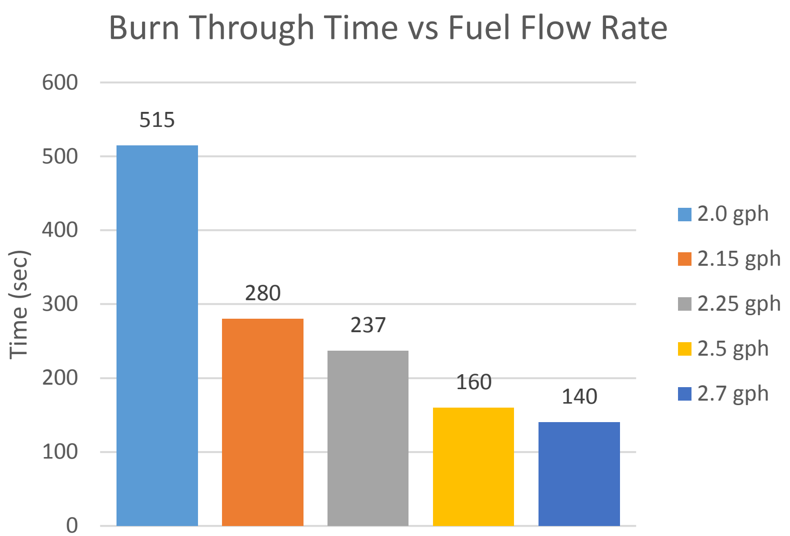


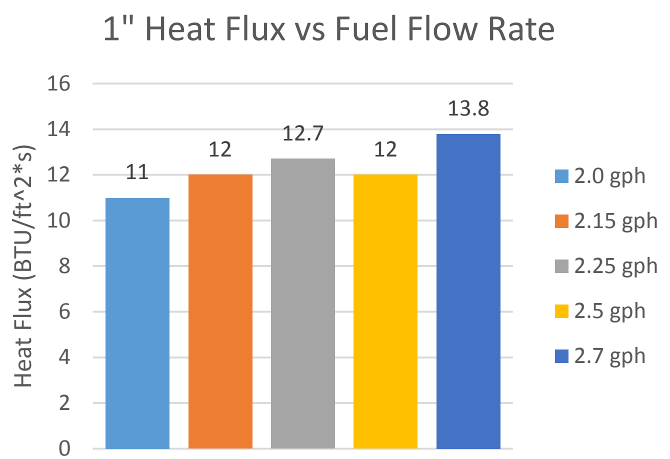


- 1.75-2.3 gph fuel flow rate
- More severe fire with higher fuel flow rate
- ~2000 degrees F, heat flux has reached the upper limit (per ISO 2685)
- Our experience – very difficult to satisfy calibration requirement

NexGen Burner Results







- 2.0-2.7 gph fuel flow rate (10-15% higher than Park)
- Fixed air flow rate (~15% higher than Park roughly)
- NexGen and Park at similar air/fuel ratio
- NexGen burner higher heat release
- At 2000 degrees F, heat flux is 30% above upper bound (ISO 2685)

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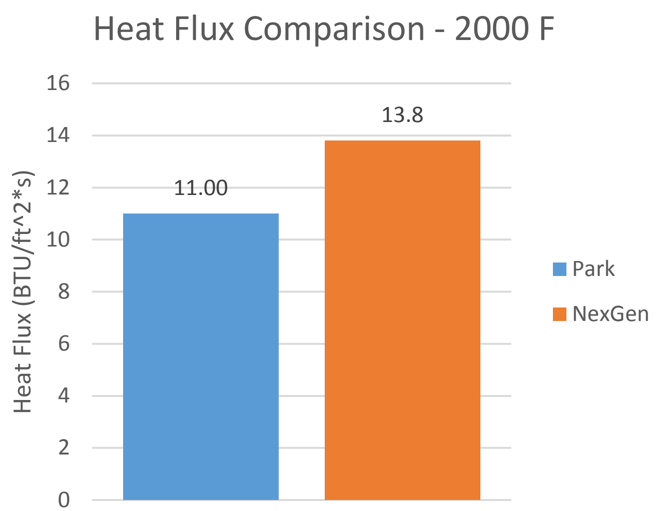
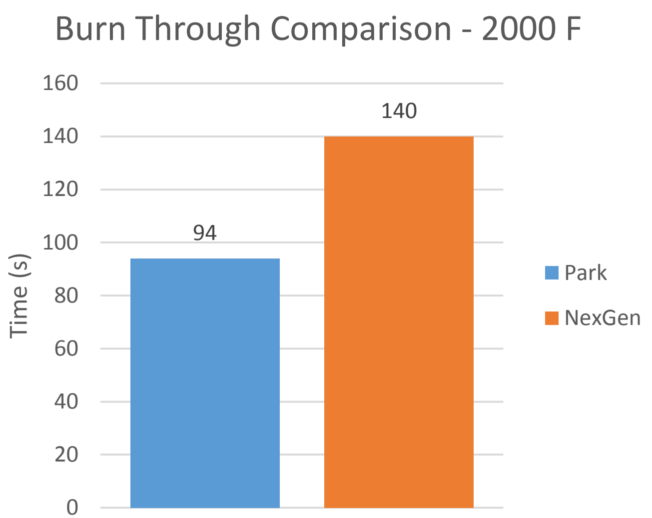
Burner Comparison – At 2000 F

- Heat flux of the NexGen burner is 30% higher than Park
- Park burner is observed to be more severe from a burn-through perspective





- Park burner 1994 degrees F (@ 2.3 gph fuel)
- NexGen burner 2011 degrees F (@2.7 gph fuel)

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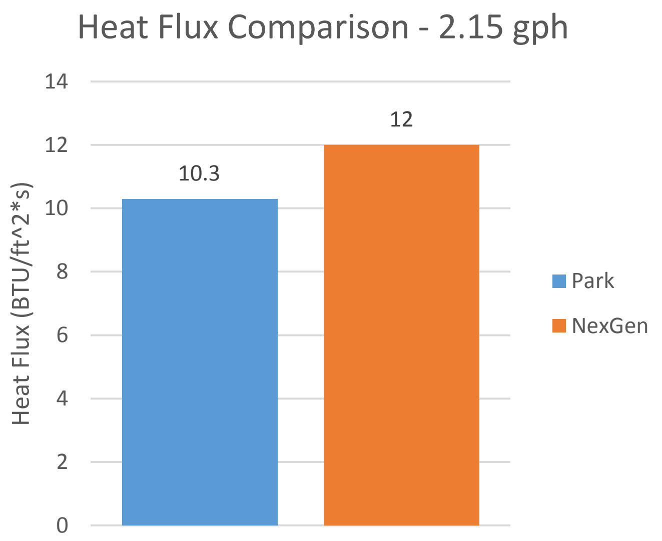
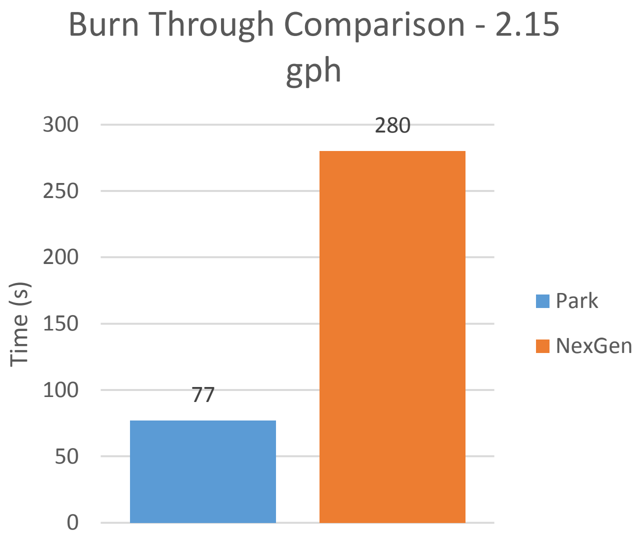
Burner Comparison – At 2.15 gph

- Heat flux between both burners is similar (Park 15% higher than NexGen)
- Park burn-through is observed to be significantly more severe at similar fuel flow rate





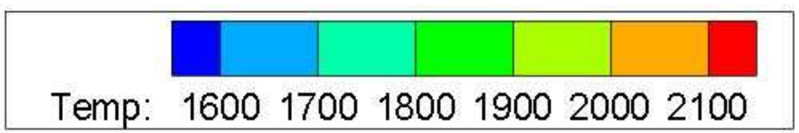
- Park burner 1955 degrees F
- NexGen burner 1847 degrees F

Observations

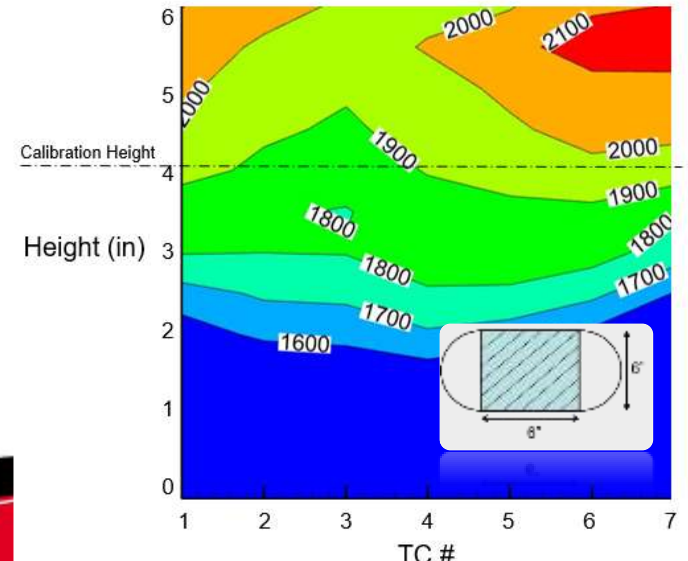
- Park flame less uniform than NexGen
- NexGen flame hottest on outer edges; Park burner intensity peaks in the center

$$\frac{T_{max} - T_{min}}{T_{mean}} = 18\% \text{ (Park)}, 7\% \text{ (NexGen)}$$

	TC1 (F)	TC2 (F)	TC3 (F)	TC4 (F)	TC5 (F)	TC6 (F)	TC7 (F)	Average T (F)
Park:	1799	1938	2120	2167	2117	2006	1809	1994
Normalized Park:	90	97	106	109	106	101	91	
NexGen:	2056	1984	1948	1948	1992	2085	2093	2015
Normalized NexGen:	102	98	97	97	99	103	104	

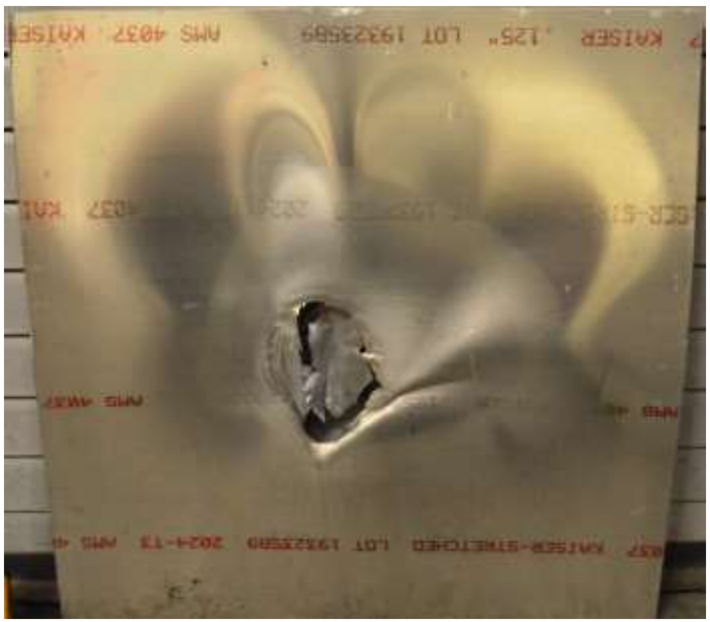


Typical NexGen Temp. Map



Burn Through

- Temperature distribution is reflected in burn-through results
- Park burns through in the center where peak flame intensity resides
- NexGen burn through more uniform



Park Burner

NexGen Burner

Conclusions

- 2000 degree F min. average requirement, calibrated by 1/8" TC, drives heat flux up to and above ISO 2685 upper bound
  - Use 1/16" TCs to calibrate, or
  - Re-assess 'minimum average' temperature requirement
- Park vs NexGen Burners
  - Park burner is operated at lower BTU (lower air and fuel rate)
  - More non-uniform temperature distribution of Park burner; high center temperature
  - Burn through patterns are different
  - Park burner has shorter burn through time
- High non-uniform and high center temperature profile of Park burner may be the root cause for shorter burn through time