

Updated Experimental Investigation of the NexGen and Propane Burner

Fire Test Center

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May 10th, 2017

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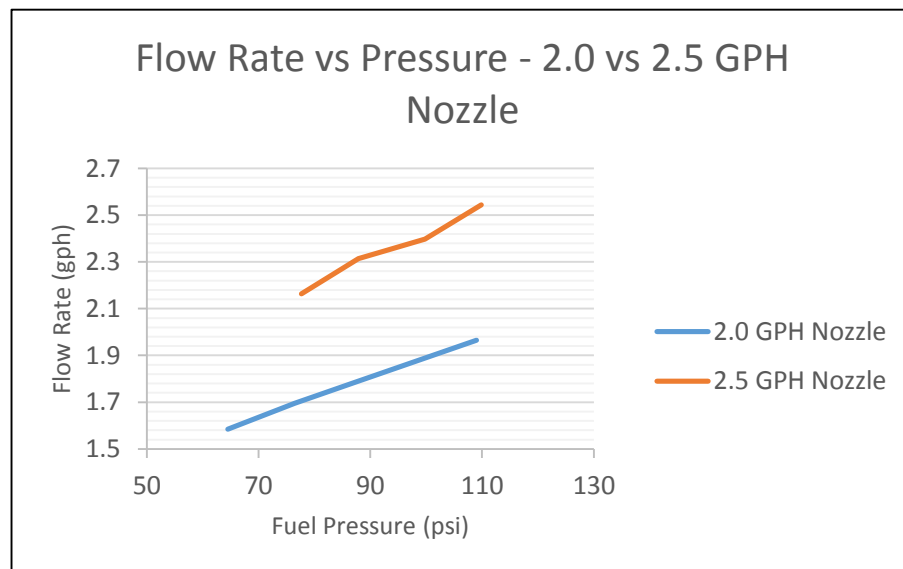
Project Overview

- Project Objective:
 - Quantify the effect of fuel flow rate on burn-through and back side temperature
 - Draw comparisons between the NexGen and Propane burner, for various test article sizes and test conditions.
- Previously Presented Work
 - Effect of Burner setup and calibration TC size
 - Sensitivity of Burner to air and fuel flow rates and temperatures
 - Effect of burner orientation on performance
 - Comparison of fire test results between NexGen and Gas burners
- Recent Developments
 - Study of Flame Retention Heads (FRH) and Delavan fuel nozzles
 - Burner sensitivity to operating conditions
 - Burner sensitivity to assembly tolerances
 - Sensitivity to inclination and test set-up
 - Study of ignitorless stator configuration, comparison with FRH configuration

Effect of Fuel Flow Rate on Burn-Through and Back Side Temperature

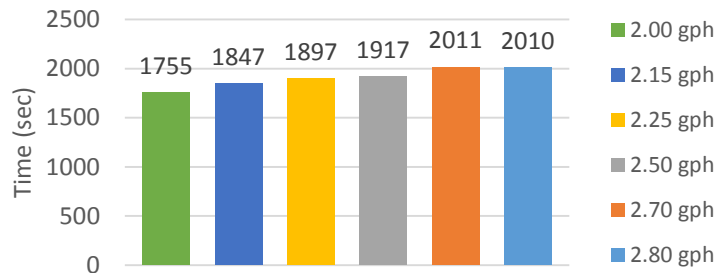
Overview

- Two fuel nozzles tested:
 - Delevan, 80 Degree, Type W, 2.5 GPH
 - Delevan, 80 Degree, Type W, 2.0 GPH
- Two nozzles were used to reach a larger range of fuel flow rates (1.75 – 2.8 gph) than is achievable from one nozzle alone.

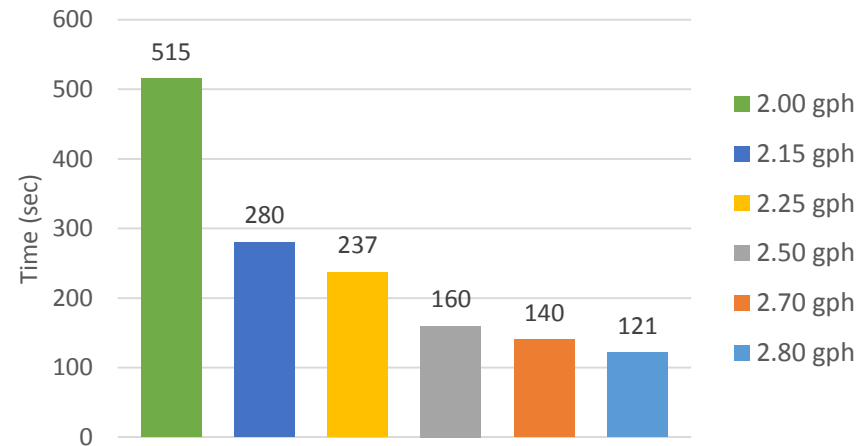


2.5 GPH Nozzle – Flow Rate Variation

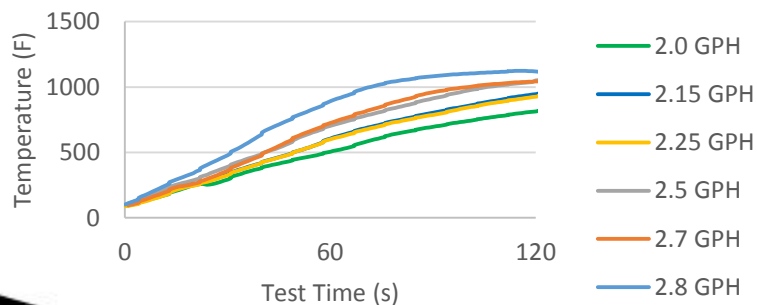
1" Temperature vs Fuel Flow Rate
- 2.5 GPH Nozzle



Burn Through Time vs Fuel Flow Rate -
2.5 GPH Nozzle



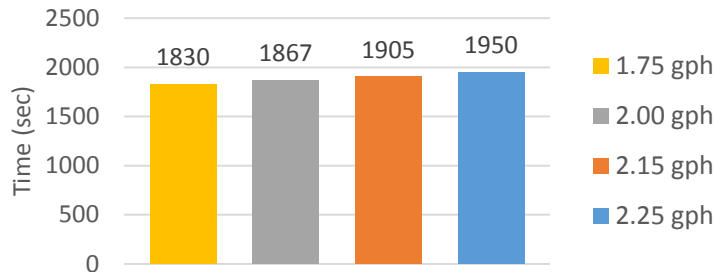
2.50 GPH Nozzle Comparison,
Various Flow Rates



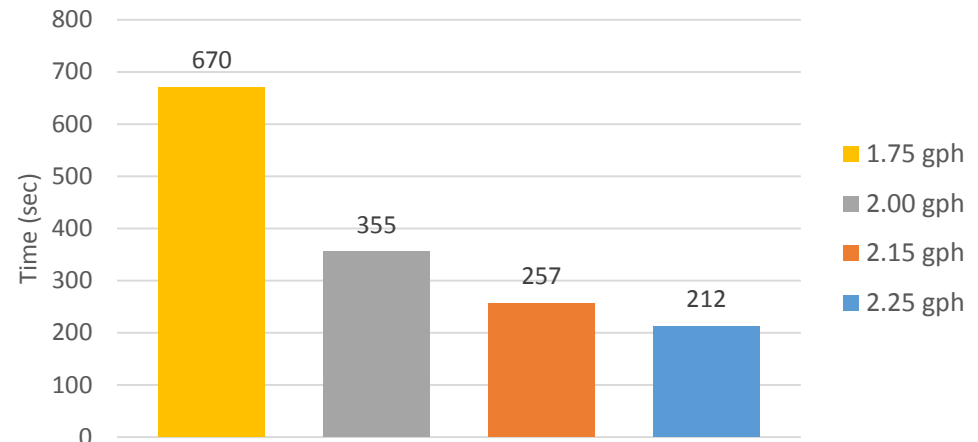
- Temperature decreases, as expected, with a decreasing fuel flow rate.
- Burn-Through time increases with a decreasing fuel flow rate, as expected. The trend is not linear.

2.0 GPH Nozzle – Flow Rate Variation

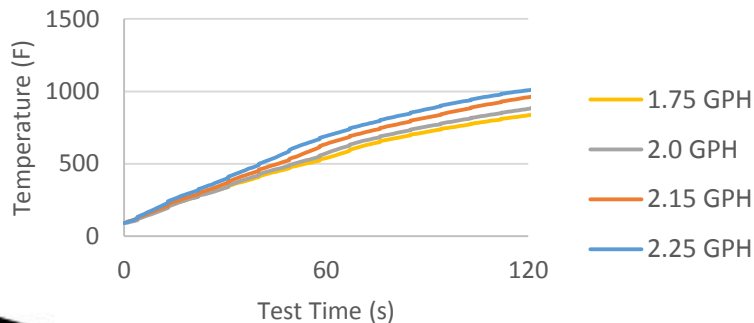
1" Temperature vs Fuel Flow Rate
- 2.0 GPH Nozzle



Burn Through Time vs Fuel Flow Rate - 2.0
GPH Nozzle



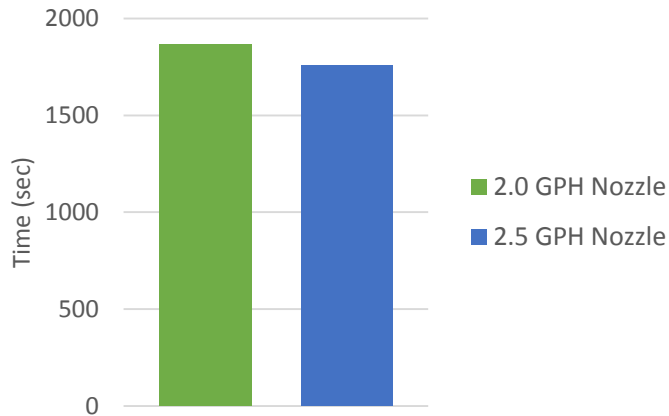
2.0 GPH Nozzle Comparison, Various
Flow Rates



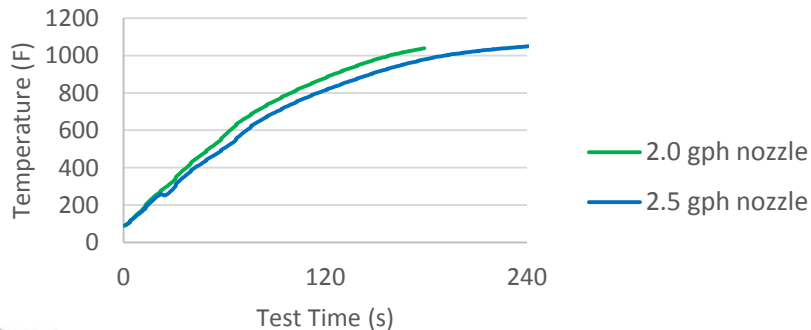
- Temperature decreases, as expected, with a decreasing fuel flow rate.
- Burn-Through time increases with a decreasing fuel flow rate, as expected. The trend is not linear.

2.5 vs 2.0 GPH Nozzle Comparison

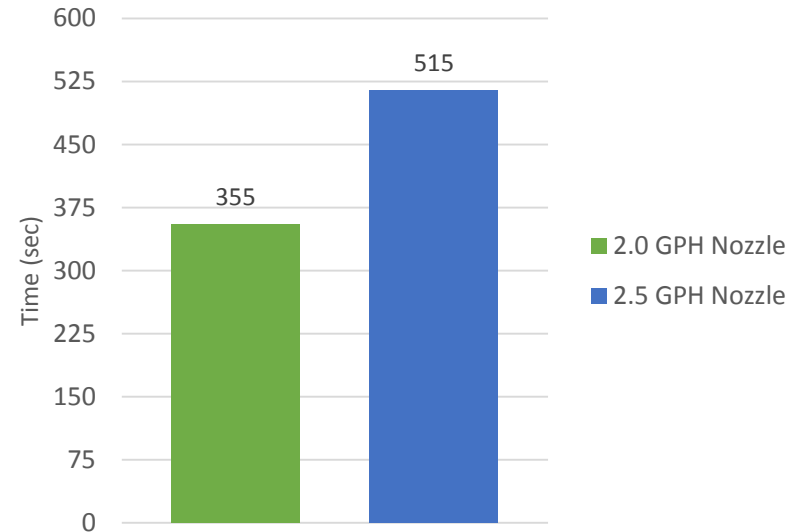
1" Temperature -- 2.0 GPH Flow



Backside Temperature -- 2.0 GPH Flow



Burn Through Time -- 2.0 GPH Flow

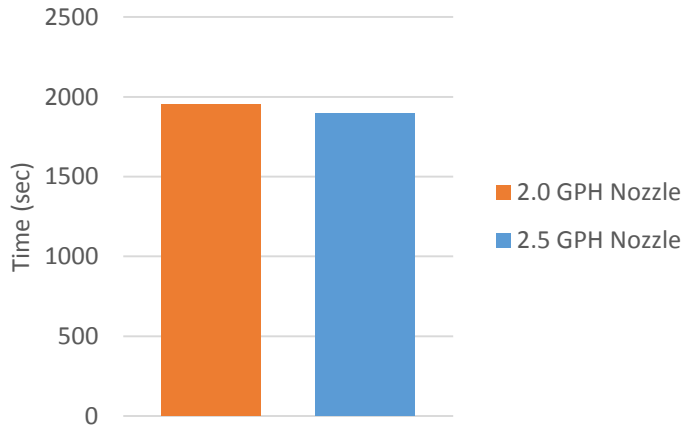


2.0 GPH nozzle operated at 116 psi
2.5 GPH nozzle operated at 65 psi

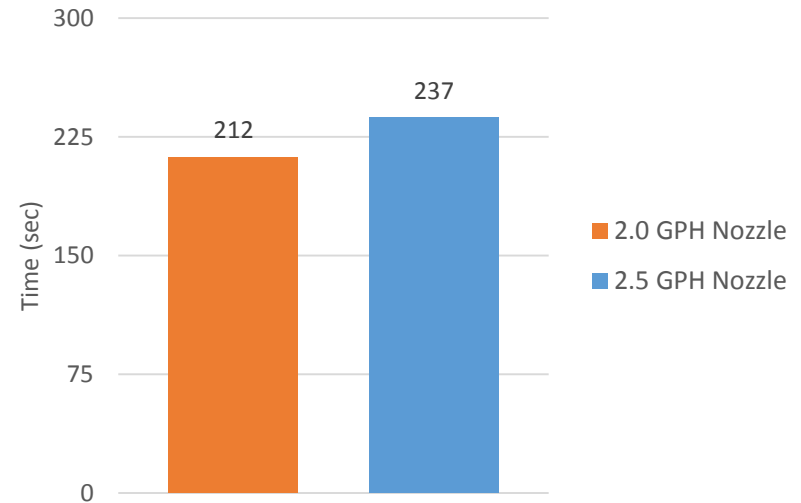
- Fuel pressure of different nozzles has an observable effect on performance, regardless if flow rates are equivalent.

2.5 vs 2.0 GPH Nozzle Comparison

1" Temperature -- 2.25 GPH Flow

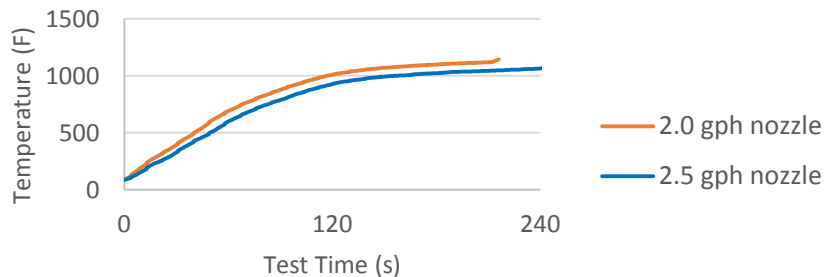


Burn Through Time -- 2.25 GPH Flow



2.0 GPH nozzle operated at 142 psi
2.5 GPH nozzle operated at 86 psi

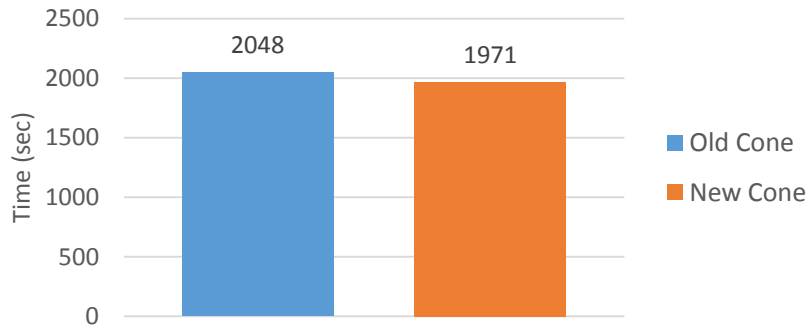
Backside Temperature -- 2.25 GPH Flow



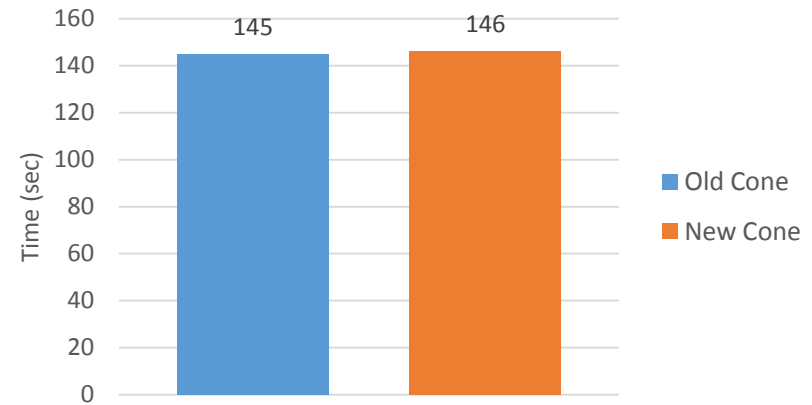
- This effect of fuel pressure is repeatable over a range of fuel flow rates.

Side Study: Burner Cone Age

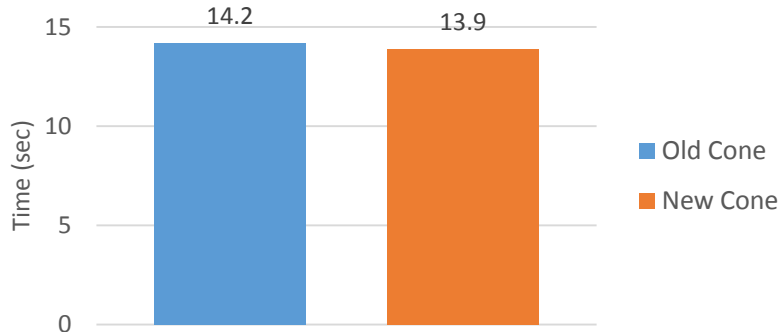
1" Temperature vs Burner Cone



Burn Through Time vs Burner Cone



1" Heat Flux vs Burner Cone



- Burner operated at same fuel pressure and flow rate.
- As a burner cone is 'broken in', the fuel flow required to reach 2000 degrees decreases some.

Summary

- Burner performance is highly dependent on fuel flow rate. Calibration temperature, back-side temperature rise, and burn-through time are all impacted by fuel flow rate, though the impact is not linear.
- Fuel nozzles of different flow ratings will not perform equivalently, when operated at equivalent fuel flow rates.
- Though burn-through times are not effected by the cone alone, the calibration of the burner (rather, the fuel input required to achieve 2000 F) will depend on the age of the cone.
- Note: A burn-through time of 5 minutes was achieved at fuel flow input of 2.15 GPH (2.5 GPH Nozzle).

NexGen and Propane Comparison Overview of Set-Up

NexGen Burner: Panel Set-Up



Propane Burner: Panel Set-Up

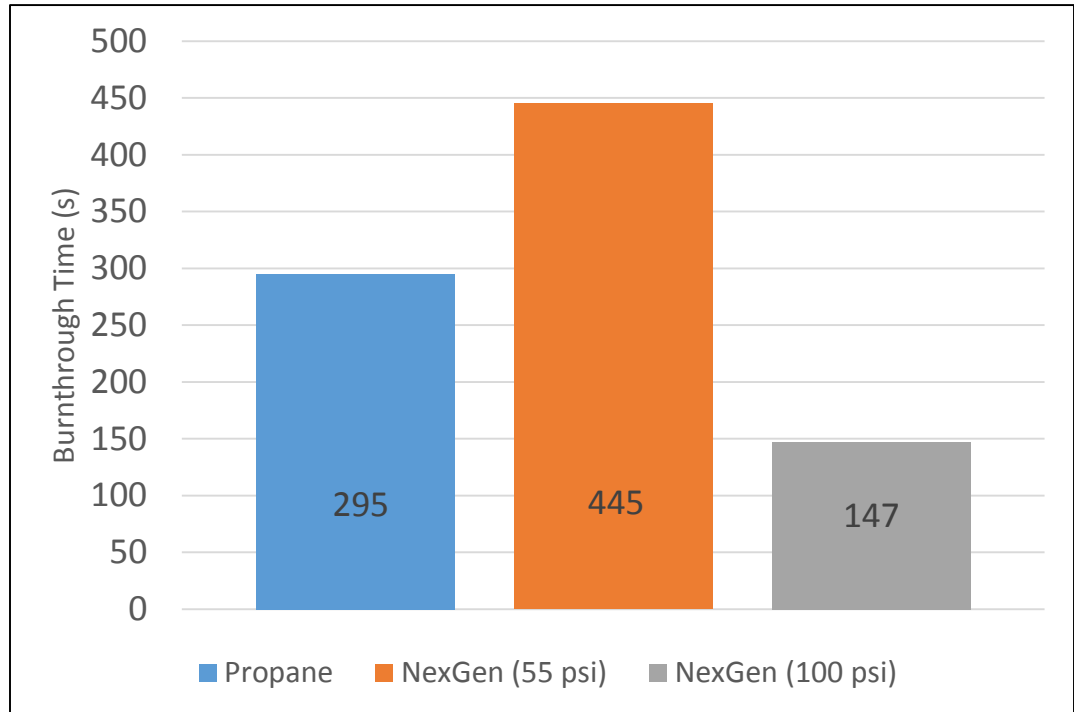


Burnthrough Results

8" Panels

- Flame is fully able to wrap around panel, for both the NexGen and Propane burners.
- When heat flux is matched, NexGen burner takes significantly longer for burnthrough. Likely an effect of gravity (panel is horizontal for vertical propane burner, vs vertical panel for horizontal NexGen).

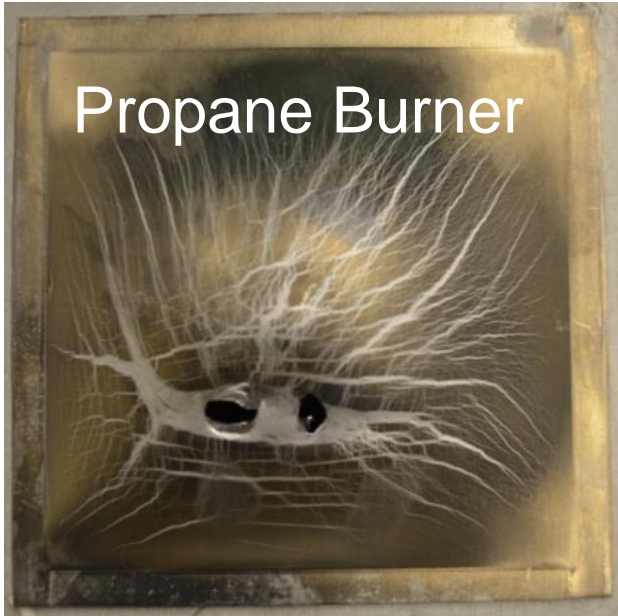
Burnthrough Comparison



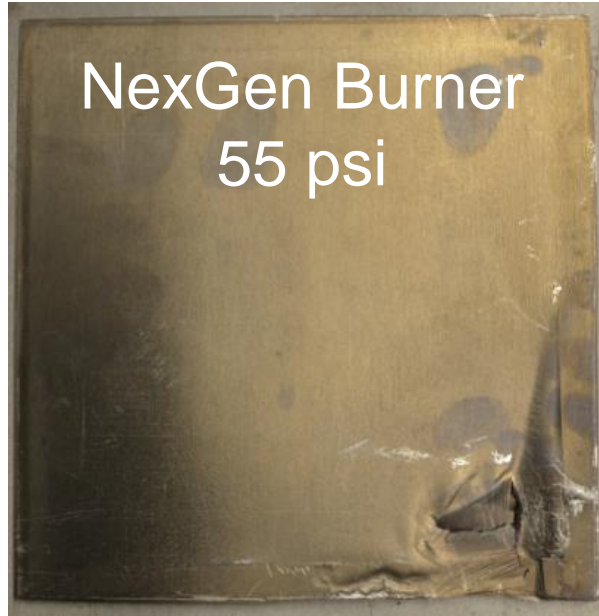
	Burner	Temperature (F)	Heat Flux (BTU/ft*s)	Burnthrough (s)
8" Panels	Propane	2067	9.8	295
	NexGen (55 psi)	1712	9.7	445
	NexGen (100 psi)	1910	13.4	147

8" Panels

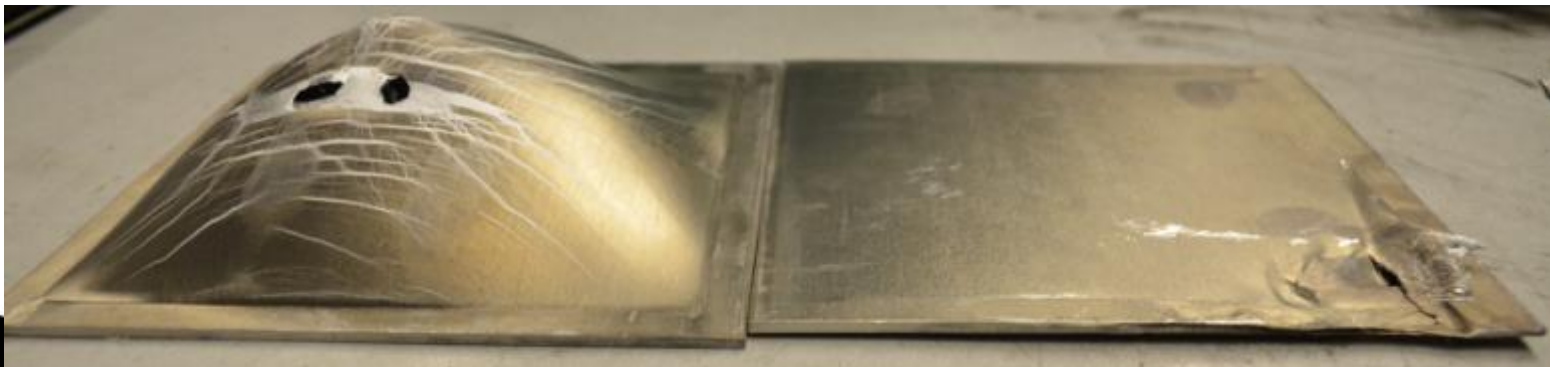
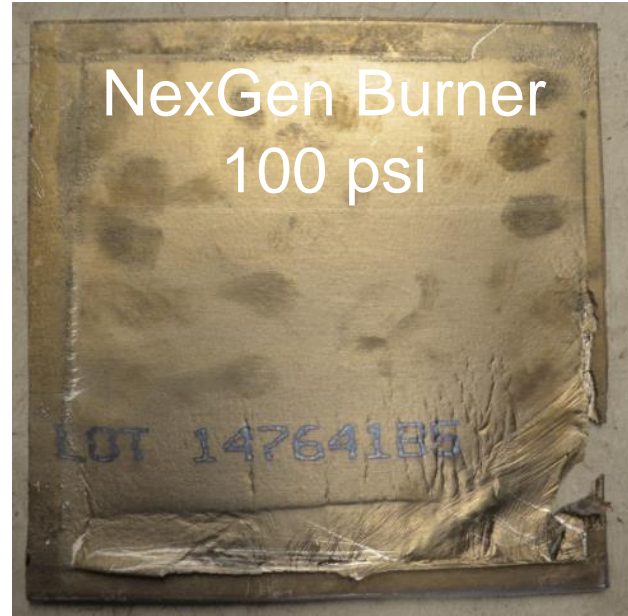
Propane Burner



NexGen Burner
55 psi



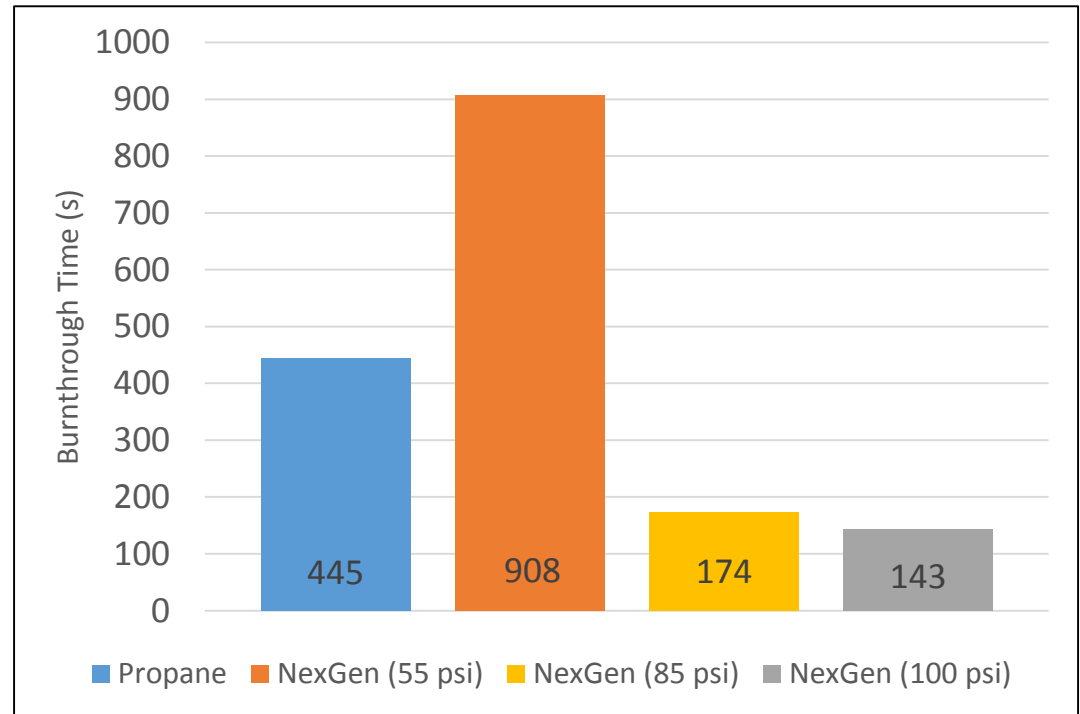
NexGen Burner
100 psi



12" Panels

Burnthrough Comparison

- Flame is unable to wrap around for either NexGen or Propane burner.
- When heat flux is matched, NexGen burner takes significantly longer for burnthrough, as with the 8" panels.
- Burnthrough time with the NexGen burner does not increase linearly with increasing fuel pressure.



	Burner	Temperature (F)	Heat Flux (BTU/ft*s)	Burnthrough (s)
12" Panels	Propane	2057	9.6	445
	NexGen (55 psi)	1696	9.7	908
	NexGen (100 psi)	1909	12.3	143
	NexGen (85 psi)	1850	11.5	174

12" Panels

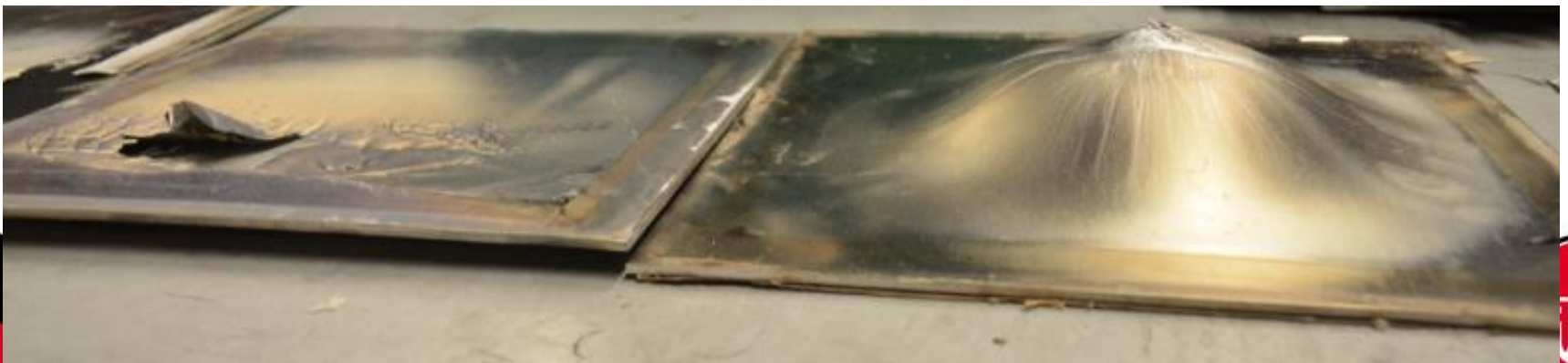
NexGen Burner
100 psi



NexGen Burner
55 psi



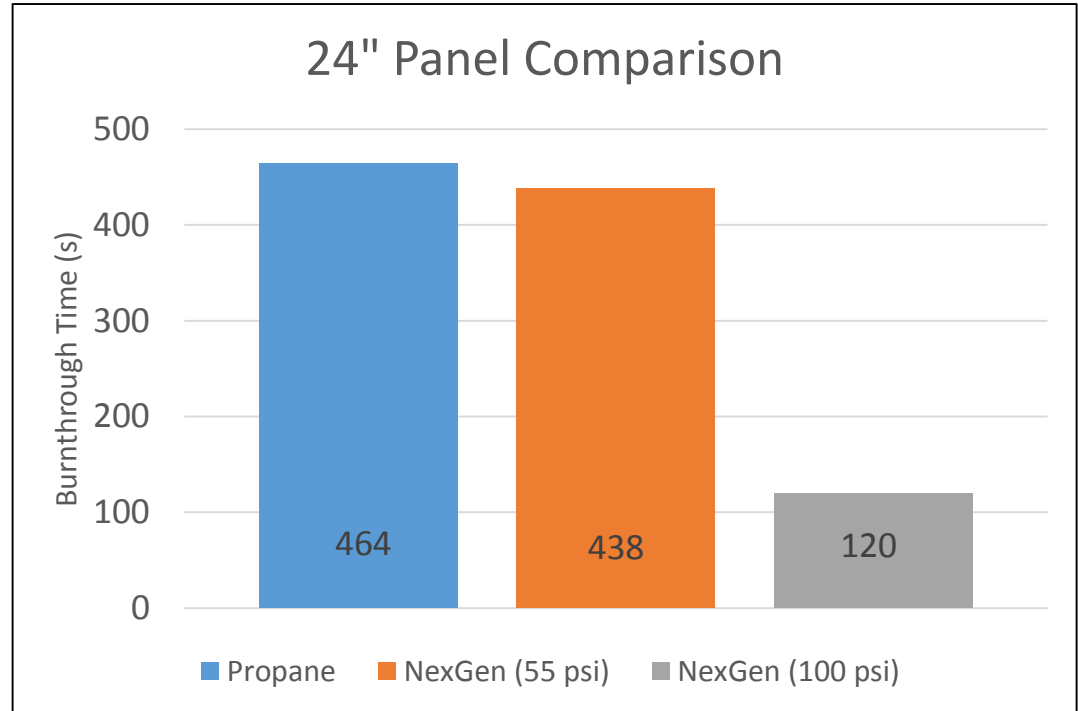
Propane Burner



24" Panels

Burnthrough Comparison

- Flame is unable to wrap around for either NexGen or Propane burner.
- When heat flux is matched, burn-through time with the NexGen burner closely matches that of the propane burner.

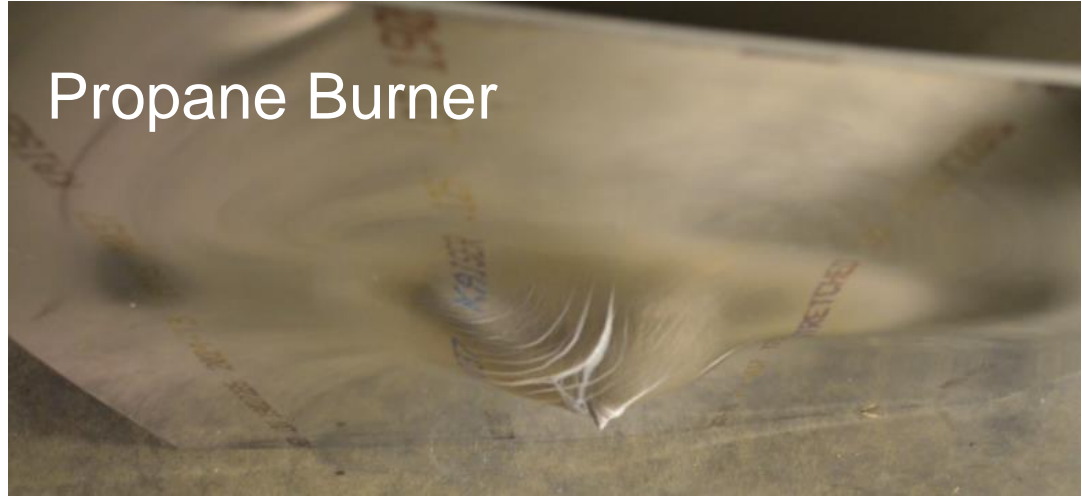


	Burner	Temperature (F)	Heat Flux (BTU/ft*s)	Burnthrough (s)
24" Panels	Propane	2069	9.8	464
	NexGen (55 psi)	1717	9.2	438
	NexGen (100 psi)	1934	12.7	120

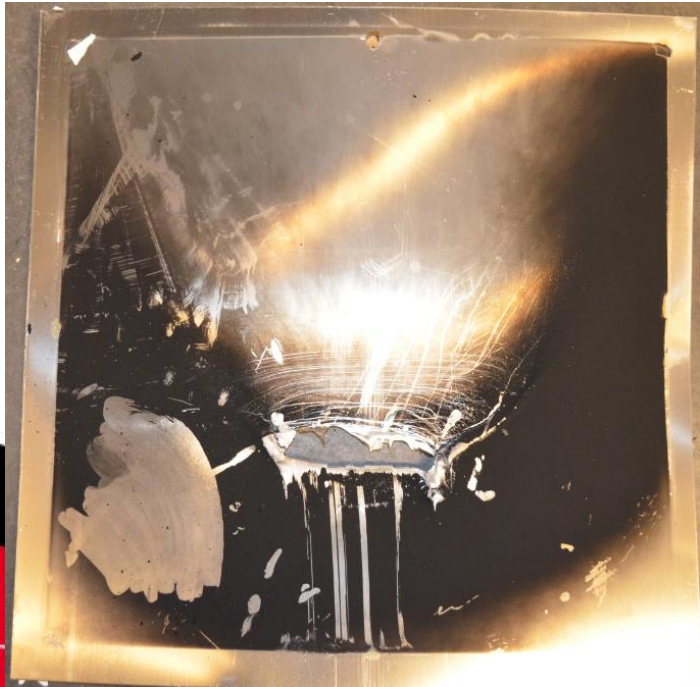
24" Panels



Propane Burner

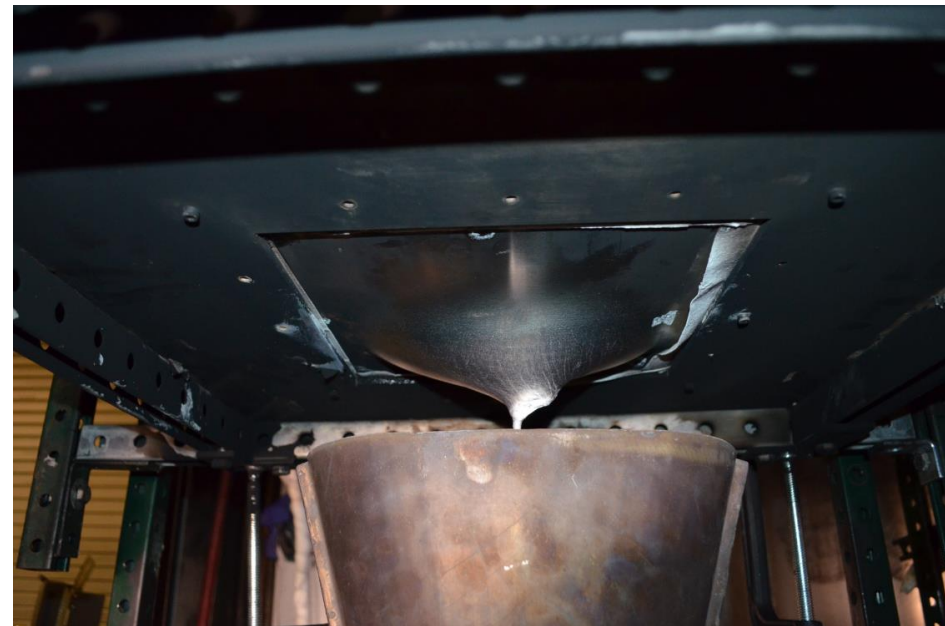


NexGen Burner



Vertical NexGen vs Propane Burner Comparison

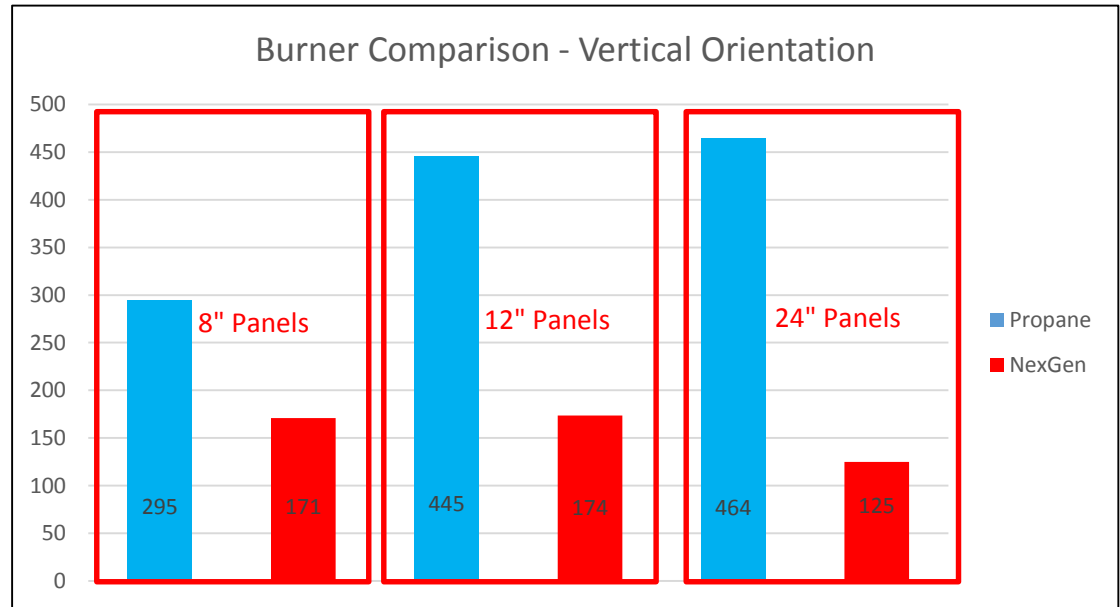
Vertical NexGen Burner Set-Up



Panels were suspended 4" above the burner cone and sandwiched around the edges, exactly as they were using the propane burner.

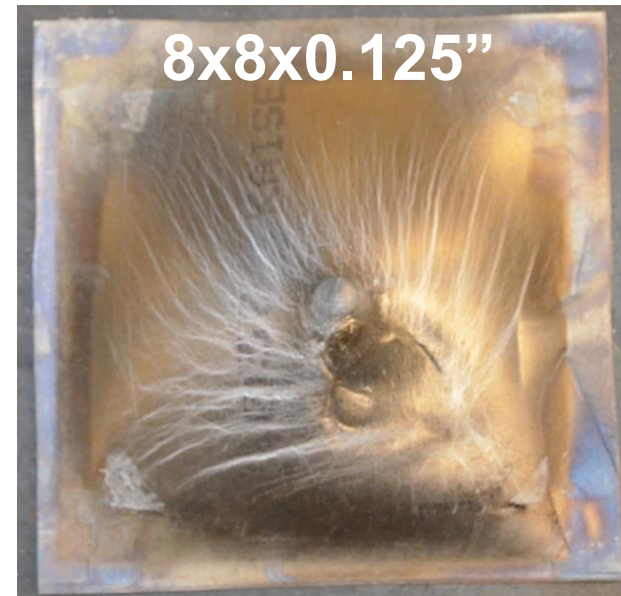
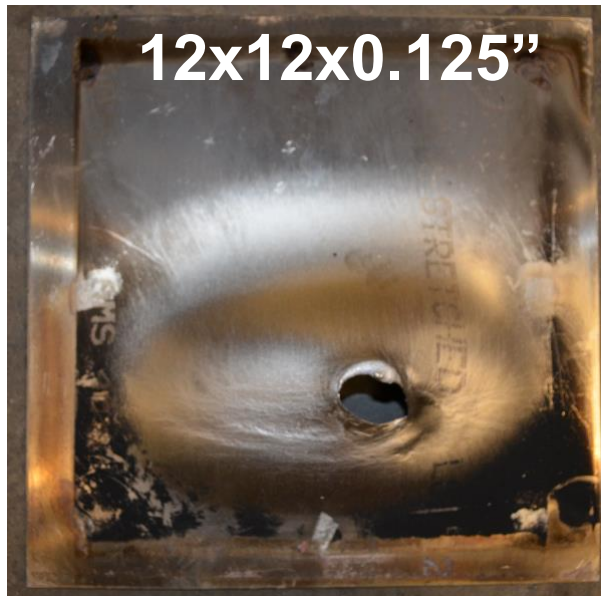
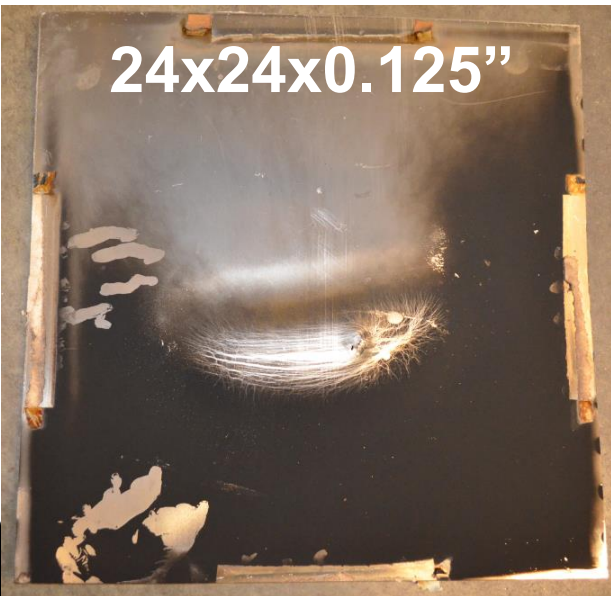
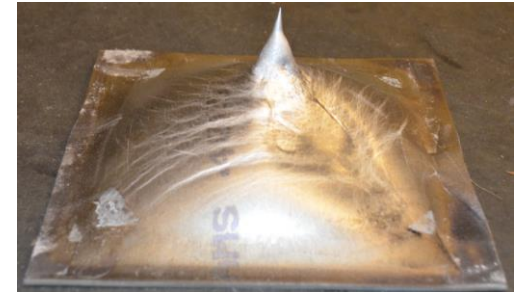
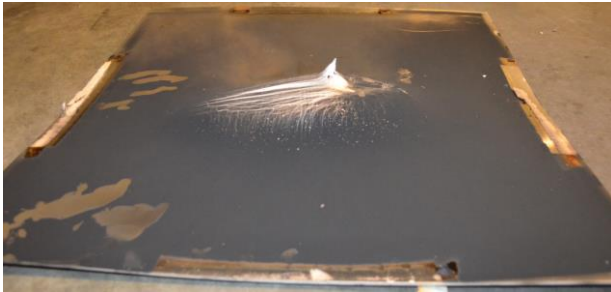
Burn-Through Results

- Temperature and Heat Flux were matched between both burners as closely as was possible.
- For all test article sizes, the NexGen burner yielded significantly lower burn-through times.
- Note: for both burners, the flame was able to wrap around the 8" panels.



	Burner (Vertical)	Temperature (F)	Heat Flux (BTU/ft*s)	Burn-Through (s)
8" Panels	Propane	2067	9.8	295
	NexGen	1981	10.8	171
12" Panels	Propane	2057	9.6	445
	NexGen	2014	10.7	174
24" Panels	Propane	2069	9.8	464
	NexGen	1993	10.8	125

Post Test Pictures



Summary

- With the larger 24x24" panels, when the heat flux is closely matched, the burn-through performance of both burners is nearly equivalent.
- With both burners operated vertically, and at similar calibration results, the NexGen burner is more severe than the propane burner.

