The Power of Flight

Fire Test Burner Evaluation

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Problem / Background:

Both fuel and propane burners are acceptable to run fire tests for both EASA and FAA

AC20-135

ISO2685

Airbus/ Boeing Internal Specs, …

Fuel burner is typically used in the horizontal position

Propane burner can be used in any position from vertical to horizontal- Vertical preferred by CFMI

CEAT tests demonstrated that the horizontal propane burner was less damaging than the horizontal fuel burner

CFMI Tests (University of Cincinnati):

Test Duration:

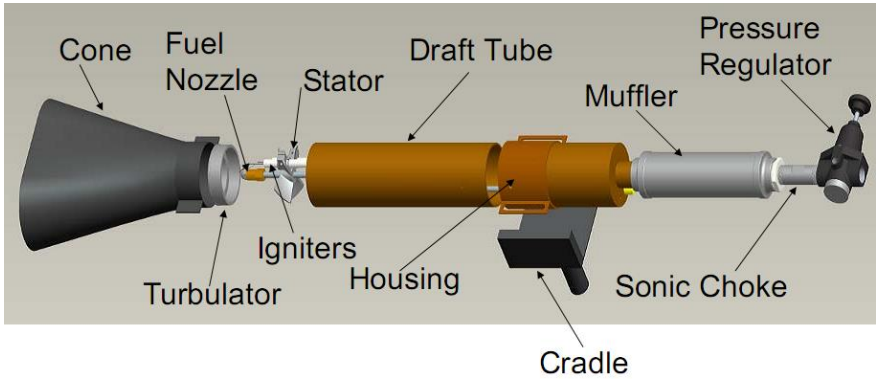
- 15 minutes or until burn-through, if shorter

Temperature Calibration (**per Regulation**)

- Rake of 7 TCs, individual TC temperatures: 2000 ± 150 °F
- Average of all 7 TCs: ≥ 2000 °F (**interpretation of AC33-17-1A**)

Heat Flux Calibration (**per Regulation**)

- Minimum 9.3 BTU/ft^2-s (106 kW/m^2)
- Maximum 11.1 BTU/ft^2-s (126 kW/m^2) (ISO2685)



Fuel Burner (NexGen) (**Horizontal**) Gas Burner (**Vertical**)

Burner Comparison

The type and number of burners shall be chosen such that, during the fire test, the critical parts of the components or items of equipment are enveloped in the test flame(s) from the appropriate direction(s).

For that, the following conditions shall be fulfilled:

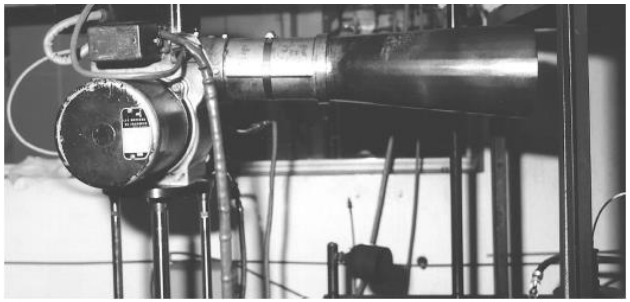
$A \leq 2B$

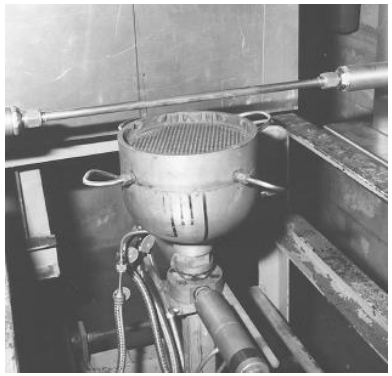
where

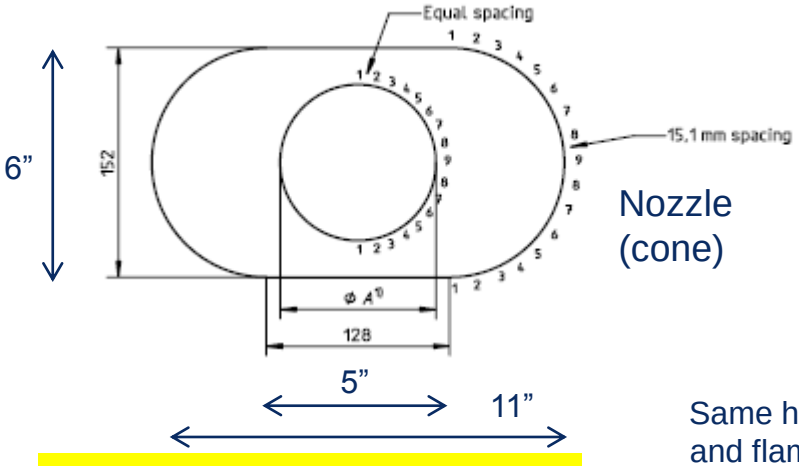
A is the major cross-section of the equipment or specimen, in square metres;

B is the area of the flame at the nozzle of the burner, in square metres.

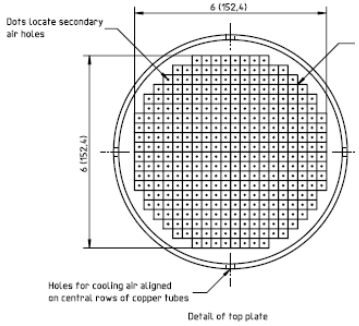
1950's burners have a blower. Replaced by calibrated orifice in NexGen burner used here







Nozzle (cone)



6” dia

Fuel Burner (N)
Fuel Flow ~ 13.5- 18.7 pph
~ 74 kW – 104 KW as measured
Surface Area at Exit of Cone ~ 58 in²

Same heat flux density and flame temperature calibration requirement

Designed to deliver 2000+/-150 ºF

Gas Burner (P)
Gas Flow ~ not specified
~ 21-38 KW as measured
Surface Area ~ 28 in²

Stainless Steel Panels (Comparison)

Test articles:

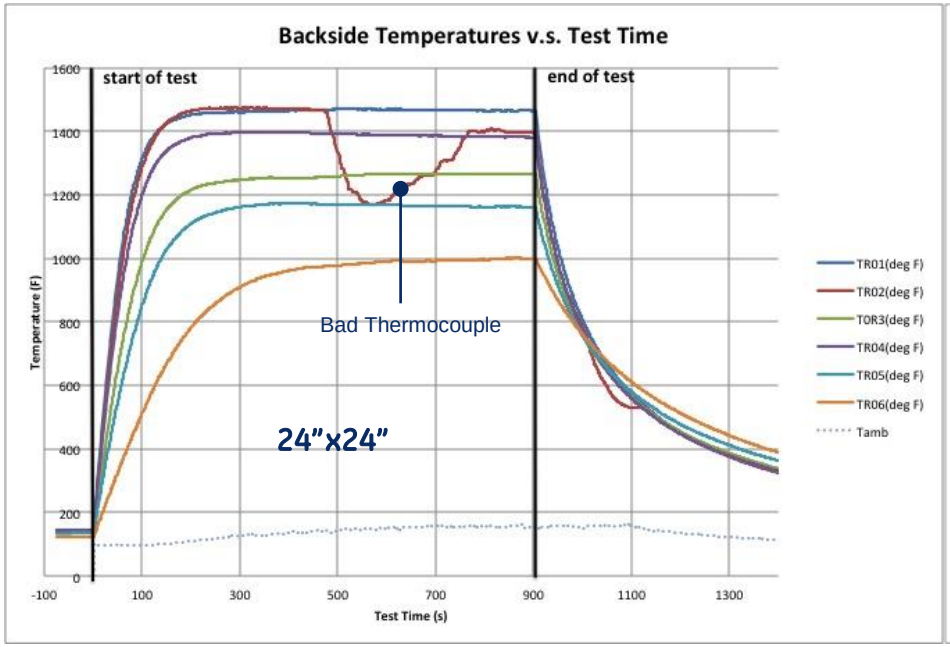
Stainless Steel Plates, 0.12" thick, 24x24" or 12x12" size.

Objectives:

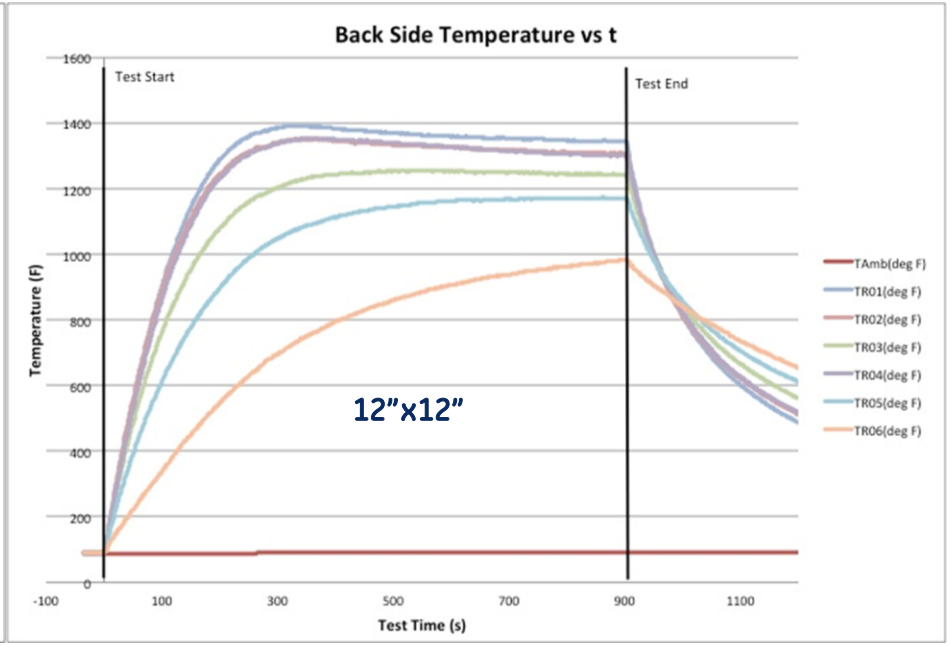
Characterization of burner flame (each burner)

Measure panel surface temperature

SS-N-2



SS-P-3



Similar behavior

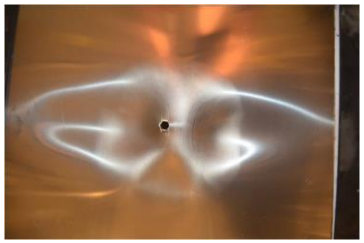
Aluminum Panel Tests (Damage Assessment)

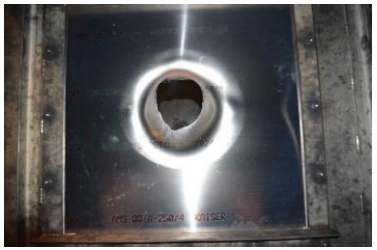
Aluminum Plate, 24x24" sheet of 2024 aluminum (standard factory finish), 1/8" thick, with an 8x20mm screw, nut and counter-nut at the center of sample

Test	Burn Through Time (seconds)	Fuel	Potential Energy	Average Flame Temp (ºF)	Heat Flux BTU/ft^2-s
AL-N-1	**154**	Jet A 17.7 pph	93 KW	1922	11.1
AL-N-2	**174**	Jet A 18.4 pph	96 KW	1947	11.5
AL-N-3	**130**	Jet A 19.2 pph	101 KW	1995	12.0
AL-N-4	**125**	Jet A 19.9 pph	104 KW	2007	12.1
AL-P-1	**156**	Propane 6.7 pph	38 KW	2012	10.5
AL-P-2	**175**	Propane 6.8 pph	38 KW	2004	11.3

Fuel Burner

Gas Burner Data





The propane burner operated vertically was found to produce comparable bolt-drop times to the kerosene burner operated horizontally.

N= NexGen, P= Propane

Reqt = 9.3- 11.1

Burner Heat Flux and Average Flame Temperature

Heat Flux Requirements (ISO2685), BTU/ft^2-s: 9.3 MIN, 11.1 MAX

Burner	Fuel Flow (gallons/hour)	Heat Flux (Btu/ft^2/s)	Flame Temperature (^{o}F)	Source
Lennox OB-32	2.04	9.8 – 10.8	2000 +/- 150	Engineering Report No 3A, 1978
Carlin 200 CRD	2.04	9.3 – 11.2	2000 +/- 150	Engineering Report No 3A, 1978
Stewart Warner HP-250	2.04	9.3 – 10.1	2000 +/- 150	Engineering Report No 3A, 1978
Stewart Warner FR-600	2.03	9.9 – 10.9	2000 +/- 150	Engineering Report No 3A, 1978
NexGen	2.25	9.4 – 9.5	2000 +/- 150	UC report to FAA, 2012
NexGen	2.75 (~18.7 pph)	11.1 – 12.3	Min. Average of 2000	This Presentation
Gas Burner	6.2 pph	9.7 – 11.3	Min. Average of 2000	This Presentation

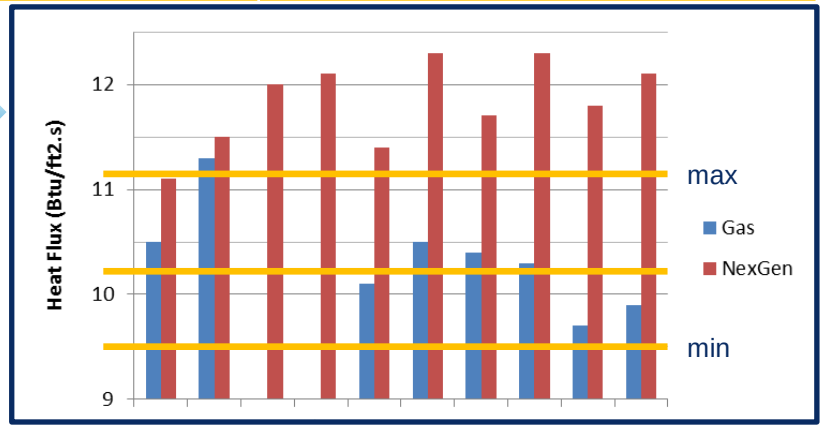
Heat Flux needed to meet 2000^{o}F average temperature (AC33-17-1A interpretation):

NexGen burner consistently delivers heat fluxes in excess of requirements.

Total energy in excess of 20 KW

(same behavior observed with vintage fuel burners)

Gas burner within spec. even with min. average reqt



Summary

Assessment:

- Burners have different power outputs (Choice of burner dependent on size of tested article per ISO2685)
- Min. temperature of 2000^{o}F per AC33-17-1A interpretation is forcing heat fluxes in excess of regulation with the NexGen burner. This has been observed as well with vintage fuel burners. Gas burner meets flux requirements even at average temperature requirement (and is therefore preferred)
- Similar results are obtained with gas and fuel burners, when gas burner is used in the vertical direction

Note: the FAA Technical Center is developing the NexGen burner to get 2000^{o}F +/-150^{o}F (no average requirement) . The NexGen burner is within spec. in terms of heat flux at these conditions (per University of Cincinnati findings)