

Fundamental Processes and Design Considerations for the NexGen Fire Test Burner: Experiments and High-Fidelity Simulations

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Overview

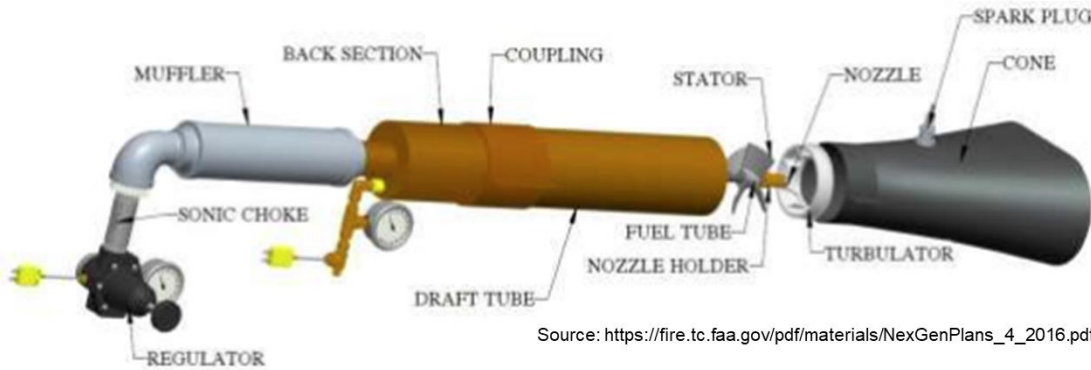
- Previous work:
 - Developed a modified burner configuration at the request of GE to bring Heat Flux of the NexGen burner down
- Current objective:
 - Continued experimentation with NexGen burner configurations to further optimize burner performance
 - Desire a heat flux more in line with the requirement (4500 BTU/hr)
 - Conduct burn-through (bolt-drop on 24x24" aluminum panel) testing to evaluate burner configurations beyond calibration performance only
 - Develop Temperature and Heat Flux map of burner configurations under consideration

Approach

- Obtain temperature and heat flux map of:
 - NexGen burner as configuration is currently defined (referred to here as 'FAA Configuration')
 - NexGen burner in the previously developed modified configuration
- Further experiment with different burner configurations
 - Types of components and the spacing of those components
 - Evaluated by their temperature and heat flux performance at typical calibration position
 - For all experimental configurations, inputs to the burner (fuel and air pressure) remain constant. The only variable should be the burner configuration itself.
 - Fuel: 115 psi, Air: 50 psig
- Promising candidates will be selected to move on to burner mapping and burn-through comparative testing

Current Configurations – Overview

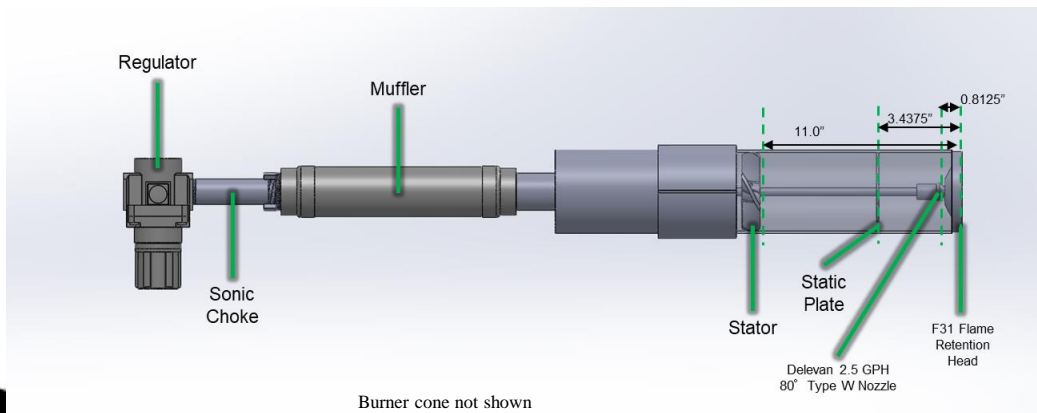
- FAA Configuration



At 1.5" above burner centerline:

Average Temperature (F)	Total Heat Flux (BTU/hr)	
	Average	Peak
2133	6323	6802

- Modified Configuration



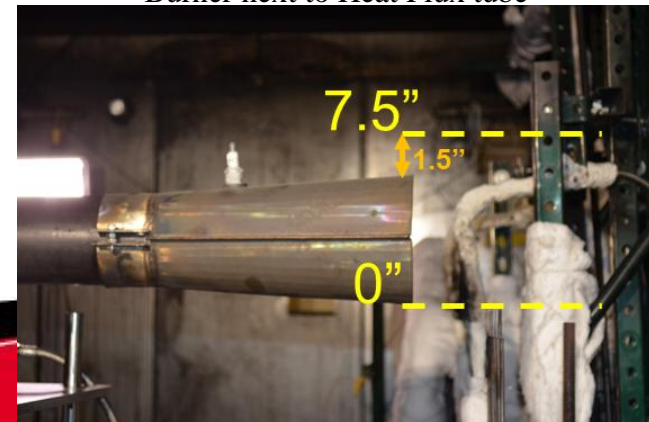
At 1.5" above burner centerline:

Average Temperature (F)	Total Heat Flux (BTU/hr)	
	Average	Peak
2058	5260	5902

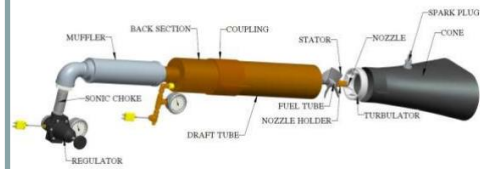
Burner Mapping – Overview

- Distance from burner cone to probes is maintained at 4"
- Measurement domain is ranging from the bottom of the burner cone (0") to 1.5" above the top of the cone (7.5")
- Temperature is recorded in 0.5" increments
 - Using 1/16" Type K Exposed Bead TCs
- Heat Flux is recorded in 1.5" increments
 - Heat Flux is allowed to rise for 30 seconds before recording starts
 - Heat Flux is time averaged over the full typical 3 minute calibration period
 - Peak Heat Flux is also reported
 - Using RTD for temperature measurement

Burner next to Heat Flux tube



Burner Map

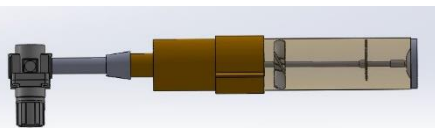


Baseline – FAA Configuration

TC #							
1	2	3	4	5	6	7	
690	677	685	909	1175	1409	1580	
1019	925	824	1011	1280	1558	1747	
1525	1332	1150	1234	1444	1721	1880	
1790	1609	1520	1645	1858	2012	2056	
2068	1919	1864	1961	2078	2125	2137	
2179	2075	2087	2107	2148	2135	2129	
2214	2113	2126	2123	2148	2115	2091	
2211	2097	2100	2093	2117	2067	2020	
2196	2075	2079	2076	2089	2030	1960	
2149	2045	2059	2061	2042	1929	1795	
2095	2011	2033	2014	1946	1801	1607	
1951	1912	1969	1930	1827	1643	1418	
1677	1705	1795	1750	1644	1435	1209	
1372	1483	1568	1521	1361	1149	955	
1082	1194	1287	1236	1145	954	755	
777	890	985	964	897	769	633	

Individual TC Averages (deg F)

Height (inches)	Average Temperature (F)	Heat Flux (BTU/ft ² s)		Total Heat Flux (BTU/hr)	
		Average	Peak	Average	Peak
7.5	1018	6.4	7.0	2764	2977
7	1195				
6.5	1469				
6	1785	11.7	12.4	5040	5336
5.5	2022				
5	2123				
<u>4.5</u>	<u>2133</u>	<u>14.7</u>	<u>15.8</u>	<u>6323</u>	<u>6802</u>
4	2101				
3.5	2072				
3	2011	12.9	13.8	5538	5930
2.5	1930				
2	1807				
1.5	1602	8.4	8.9	3614	3824
1	1344				
0.5	1093				
0	845	4.2	4.5	1764	1910



Modified Configuration

Burner Map

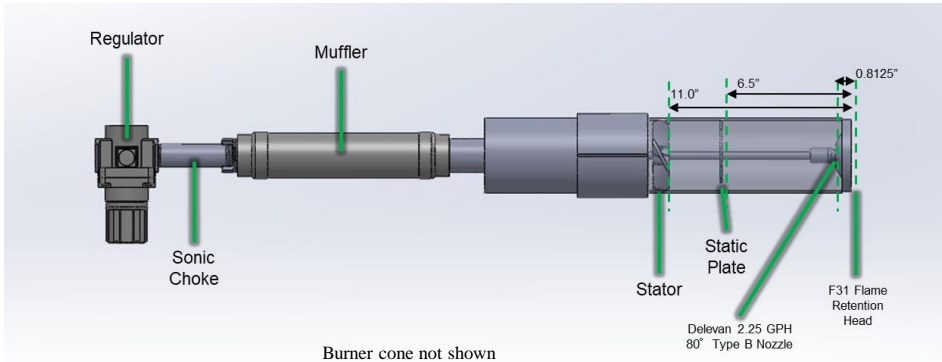
TC #								
1	2	3	4	5	6	7		
676	674	611	656	717	891	967		
1079	1006	867	853	829	991	1171		
1442	1285	1113	1086	1116	1303	1478		
1854	1631	1470	1435	1454	1622	1758		
2130	1957	1816	1780	1756	1836	1881		
2155	2124	2088	2024	1959	1909	1950		
2070	2038	2182	2123	2068	1967	1960		
2044	1964	2161	2210	2140	2018	1989		
2026	1999	2131	2262	2200	2060	2015		
1970	2065	2161	2277	2223	2082	2034		
1805	2067	2200	2183	2178	2084	2048		
1623	1926	2038	1980	2047	2002	1974		
1296	1607	1711	1644	1697	1743	1734		
1101	1327	1420	1369	1430	1471	1447		
876	1007	1064	1019	1081	1135	1117		
691	753	782	723	771	798	767		

Individual TC Averages (deg F)

Height (inches)	Average Temperature (F)	Heat Flux (BTU/ft ² s)		Total Heat Flux (BTU/hr)	
		Average	Peak	Average	Peak
7.5	742	4.9	5.2	2089	2197
7	971				
6.5	1260				
6	1603	10.7	11.3	4576	4850
5.5	1879				
5	2030				
<u>4.5</u>	<u>2058</u>	<u>12.3</u>	<u>13.8</u>	<u>5260</u>	<u>5902</u>
4	2075				
3.5	2099				
3	2116	11.5	12.5	4903	5352
2.5	2081				
2	1941				
1.5	1633	8.3	8.8	3570	3761
1	1366				
0.5	1043				
0	755	3.6	4.1	1575	1711

Alternative Modified Configuration

- Static Plate depth increased to 6.5”
- Nozzle (2.5 GPH 80° Type W) replaced with 2.25 GPH 80° Type B



Height (inches)	Average Temperature (F)	Heat Flux (BTU/ft ² s)		Total Heat Flux (BTU/hr)	
		Average	Peak	Average	Peak
7.5	720	4.6	4.8	2013	2135
7	960				
6.5	1260				
6	1600	9.8	10.0	4301	4392
5.5	1867				
5	1963				
<u>4.5</u>	<u>1975</u>	<u>11.6</u>	<u>12.8</u>	<u>5118</u>	<u>5546</u>
4	1972				
3.5	1972				
3	1955	10.8	11.7	4726	4980
2.5	1885				
2	1758				
1.5	1520	7.8	8.1	3408	3541
1	1237				
0.5	965				
0	711	3.4	3.6	1420	1534

TC #							
1	2	3	4	5	6	7	
833	762	688	765	674	585	741	
1120	989	899	990	913	834	986	
1493	1313	1177	1254	1207	1158	1231	
1853	1636	1487	1565	1543	1524	1582	
2005	1921	1806	1837	1844	1828	1840	
2026	2000	1946	1939	1962	1942	1926	
1979	1955	1970	1966	2000	1990	1969	
1944	1925	1993	1997	2022	2000	1920	
1946	1925	2003	1996	2017	1997	1921	
1909	1987	2008	1943	1946	1947	1944	
1856	2029	1963	1819	1805	1845	1881	
1669	1992	1854	1676	1625	1700	1801	
1467	1722	1565	1416	1377	1466	1634	
1150	1351	1289	1210	1147	1181	1349	
847	1018	1045	1008	929	912	1011	
592	672	810	803	721	672	710	

Calibration Result Comparisons

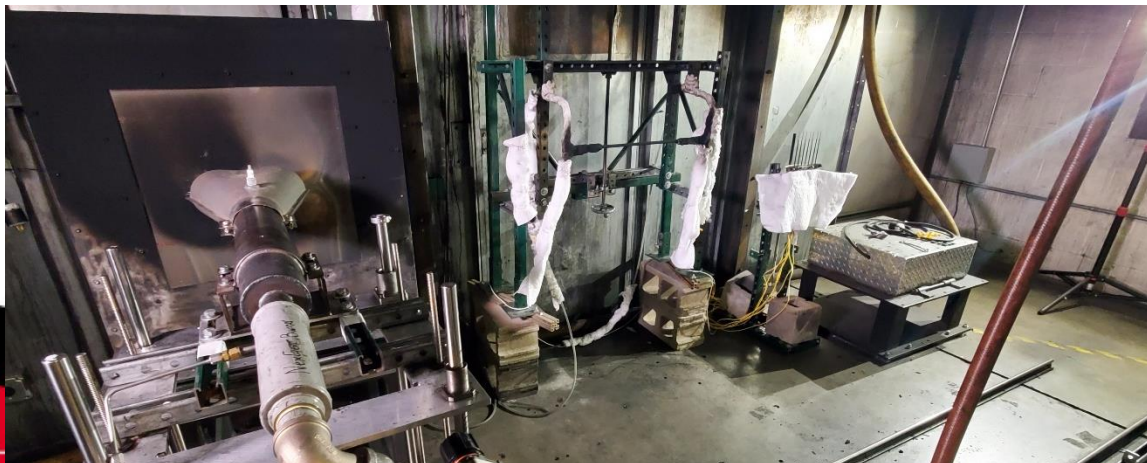
Burner performance at typical calibration height:

	Temperature (F)	Heat Flux (avg) (BTU/hr)	Heat Flux (peak) (BTU/hr)
FAA Config	2133	6323	6802
Modified	2058	5260	5902
Alt Modified	1975*	5118	5546

Burn Through Testing

- Material: 24x24" aluminum panel with screw and nut located at panel centerline
- Orientation: horizontal burner, vertical panel
- Horizontal distance: panel 4" from burner cone
- Vertical distance: cone centerline located 1.5" below panel centerline

	Temperature (F)	Heat Flux (avg) (BTU/hr)	Heat Flux (peak) (BTU/hr)	Bolt Drop Time
FAA Config	2120	6100	6623	1m39s
Modified	2105	5604	6282	1m34s
Alt Modified	2021	5061	5450	1m53s



Future Work

- Set all configurations under consideration to equivalent temperature and compare heat flux and burn-through performance
- Continue burn-through testing on additional materials to further investigate difference in performance of various burner configurations
- Conduct temperature and heat flux mapping of all configs with the burner positioned in a vertical orientation
- Utilize results of CFD to inform design considerations of burner configuration

Thank You

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