

North American 4441 Tempest® High Velocity Gas Burner



Achieve Superior Temperature Uniformity

- Jet action burner offering outstanding recirculation
- Slotted tile produces exceptional temperature uniformity
- Extraordinary performance across various furnace applications in a wide spectrum of industries

The North American Tempest® High Velocity Gas Burner is one of the world's most widely used and respected burners

The Tempest® is acclaimed for its high velocity jet action and superior recirculation promoting capabilities. These two features bring both the quality benefit of close temperature uniformity and the productivity benefit of safe higher heating rates up to 3000°F (1650°C). Additionally, a variety of tile material and outlet shape choices provide flexibility in installation with a “flame fitting” to the shape of the combustion chamber.

TYPES OF APPLICATIONS

- Periodic kilns in the ceramics and refractory industries
- Tunnel kilns in the ceramics and refractory industries
- Forge furnaces
- Heat treat furnaces
- Galvanizing baths
- Scrap preheaters
- Carbon baking furnaces
- Cupolas
- Pipe coaters
- Portable refractory dry out
- Preheat equipment
- Variety of other applications

PERFORMANCE BENEFITS

- Low NOx emissions
- High excess air and excess fuel
- Direct spark ignition
- Integral air and gas meters
- Sturdy cast construction
- Wide operating limits
- Range of ignition and flame supervision capabilities
- Compatible with StepFire™ or other pulse fired control system.



4441 Tempest®. Shown with alumina/mullite tile "A" for fiber wall furnace installation.



4441 Tempest®. Shown with alumina/mullite slotted tile for narrow lane firing and better temperature uniformity.

North American Tempest® High Velocity Burner Operation

PRINCIPLES OF CONVENTIONAL 4441 OPERATION

On most 4441 burners the air enters the burner from the back and is distributed around the outside of the stabilizer cup. Fuel is also connected to the back of the burner, but on the centerline. The fuel enters the inside of the stabilizer cup, where the first small amounts of air is added to the fuel. An ignition spark starts the combustion process, and the base of the flame stabilizes inside the cup.

Additional air is added in multiple stages to the fuel and flame as it moves through the burner towards the tile exit. This air staging helps to keep the flames oxygen content low, and the air that flows around the stabilizer cup and flame helps to control the temperatures inside the burner. Because the flame burns in the stabilizer cup and inside the tile it can be monitored with a flame supervision system.

Before the flame leaves the burner, the tile tapers to a nozzle which increases the flames velocity as it exits the tile. The final fuel / air reaction happens in the furnace where the high velocity flame entrains furnace gases into the burning flame envelope.

4441 OPERATION INSTRUCTIONS

- **Combustion Air:** 00.3-41.6"w.c. (0.08-10.3 kPa) air pressure, max 350°F (177°C). Most sizes are available in a hot air version that can operate with 800°F (427°C) combustion air. Sizes -3 through -4-B are available as standards and special versions of the larger sizes are available but without complete flow documentation.
- **Fuel:** Natural gas for all burner sizes, propane gas versions are available in the -1 thru -4-B sizes. Gas pressure varies per size with 19"w.c. (4.7 kPa) is maximum required at design capacity, for 27.7"w.c. (6.9 KPa) combustion air pressure, at stoichiometric ratio.
- **Flame Supervision:** Flame rod or UV detector Consult National Safety Standards and insurance underwriters for specific flame supervision requirements. Flame supervisory components must be ordered separately. See the parts list table for correct flame rod part number.
- **Ignition:** Direct spark (no pilot) with 6000 V transformer. Lighting not recommended above 27.7"w.c. (6.9 kPa) main air pressure. Always energize the spark before the gas or with the gas as the flame lights most reliably in an excess air condition as the gas transitions from off to its set point.

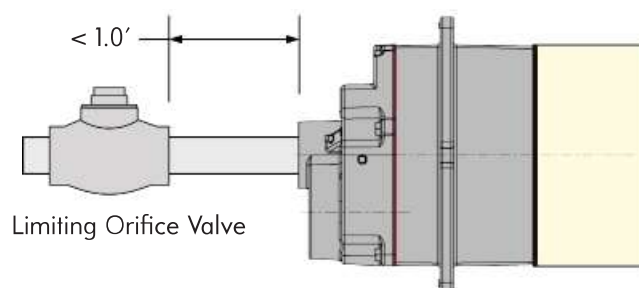
On systems that use UV flame supervision, UV radiation generated by the spark igniter can often be "seen" by the UV detector through reflection off the burner internals or the burner tile. Many flame relay controls turn off the spark when

a flame (UV) is detected. This can be a problem when the controller responds to the spark but there is no actual flame. For this reason, it is often necessary to use additional timers and relays to prevent premature shut down of the spark igniter.

Halfwave ignition transformers will prevent UV sensing of the spark during trial for ignition, but they supply lower amperage to the igniter with produces a cooler spark that may not reliably ignite burners over as wide a range of inputs or air/fuel ratios as a conventional transformer.

- **Relight:** Tempest® burners require spark for re-ignition. They will not relight reliably from a hot tile or furnace.
- **Control:** Excellent performance with all control systems; StepFire™, on-ratio and fuel-only turndown. A limiting orifice valve must be installed in gas supply line within 1 ft. (30 cm) of burner (generally the closer the better). A ratio regulator should ideally be within 4 ft. (122 cm) of burner.

Even in cases where a motorized valve is used for fuel control, a limiting orifice valve that takes at least 10"w.c. (6 osi) of pressure drop must be installed close to the burner. Failure to install the valve could cause stability problems as the gas flow is modulated.



- **Piping:** In cross-connected systems, the design, selection, and system installation must consider pressure drop through the components to avoid excessive pressure drop in the gas line between the ratio regulator and the burner. Consider the gas pressure required at the burner to achieve the desired heat release (i.e. gas flow). For more detailed information on cross-connected control systems, see Sheet 7218-2 Instructions, Bulletin 7216 and the Practical Pointers Book.
- **"A" tiles:** 4441 burners with the "A" style self-supporting tiles may be shipped with the tiles separate from the burner mounting to prevent tile damage. Attaching the tiles in field conditions is relatively easy. See Sheet 4441-2 which ships with "A" series burners for detailed instructions.

North American Tempest® High Velocity Gas Burner Performance Data

4441 NATURAL GAS PERFORMANCE DATA

(Performance for 27.7"w.c (16 osi) main air pressure operating at stoichiometric ratio unless stated otherwise)

Burner Size	-1	-2	-3	-4-A	-4-B	-5	-6	-7	-8-A	-8-B	-8-C
Air Flow, not burning (scfh)	1600	2700	4000	6100	8200	11000	19000	26000	36000	50000	63000
Air Flow, (scfh)	1250	2200	3300	5250	6900	9500	15000	22000	31000	42000	54000
Air Orifice ΔP, UA-DA, ("w.c.)	13.2	16.6	17.4	16.4	16.5	15.5	7.3	7.1	13.8	11.9	8.3
Gas Orifice ΔP, UG-DG ("w.c.)	3.9	6.7	8.5	7.9	8.5	2.9	2.6	3.8	2.5	4.6	7.3
Gas Pressure UG ("w.c.)	18.0	16.4	17.1	15.2	15.7	12.5	15.6	12.1	10.0	13.3	13.5
Gas Pressure UG ("w.c.), 30% XSF	20.8	24.2	23.4	20.6	22.0	13.8	17.1	13.3	13.0	16.4	17.5
Max. % XSA, (ignition and flame signal limit)	2000	3000	4000	6000	6000	6000	6000	6000	3000	3000	3000
Max. % XSF, (ignition and flame signal limit)	30	30	30	30	30	30	30	30	30	30	30
Flame Length (in.)	10	10	12	20	26	28	36	45	50	60	68
Flame Diameter (in.)	1	2	2	3	4	6	7	8	12	14	14

4441 PROPANE GAS PERFORMANCE DATA

(Performance for 27.7"w.c (16 osi) main air pressure operating at stoichiometric ratio unless stated otherwise)

Burner Size	-1	-2	-3	-4-A	-4-B
Air Flow, not burning (scfh)	1700	2700	3850	6200	8600
Air Flow, (scfh)	1350	2200	3450	5350	7600
Air Orifice ΔP, UA-DA, ("w.c.)	13.2	15.3	18.7	16.5	15.9
Gas Orifice ΔP, UG-DG ("w.c.)	1.9	3.2	8.3	3.2	4.5
Gas Pressure UG ("w.c.)	15.9	14.4	15.9	11.4	12.1
Gas Pressure UG ("w.c.), 30% XSF	16.6	15.1	24.2	13.5	15.1
Max. % XSA, (igniton and flame signal limit)	1000	2000	3300	1750	2800
Max. % XSF, (ignition and flame signal limit)	30	30	30	30	30
Flame Length (in.)	8	15	12	24	24

4441 800°F (427°C) COMBUSTION AIR WITH NATURAL GAS DATA

Performance for 27.7"w.c (16 osi) main air pressure operating at 10% excess air

Burner Size	-3	-4-A	-4-B	-5	-6	-7
Air Flow, not burning (scfh)	2465	3760	5050	6775	11710	16025
Air Flow, (scfh)	2126	3375	4250	6100	9600	14000
Air Orifice ΔP, UA-DA, ("w.c.)		17.9	16.4			
Gas Orifice ΔP, UG-DG ("w.c.)		3.1	3.0			
Gas Pressure UG (osig)		8.7	6.8			
Flame Length (in)		24	24			
Flame Diameter (in)		5	6			

Natural Gas Operation | Tempest®

All Data:.....is based on firing with ambient combustion air.

UA-DA:.....Published data is reasonably accurate between 6.9 and 34.6" w.c. (1.7 and 8.6 kPa) main air pressure (UA) if piped with >5 diameters of straight pipe into burner. Square rooting the UA-DA pressure drops using the published 27.7" w.c. (6.9 kPa) data is reasonably accurate between 6.9-34.6" w.c. (1.7-8.6 kPa) air pressure. Below 6.9" w.c. (1.7 kPa) the UA-DA data is suspect and should not be used for accurate air metering. Square rooting will over-estimate air flow below 6.9" w.c. (1.7 kPa) and underestimate above 34.6" w.c. (8.6 kPa).

UG-DG:.....UG-DG information can be used to approximate fuel gas flow. External gas orifices or O₂ analysis should be used for precise determination of fuel metering and air/fuel ratio.

Max % XSAir, fs
 Max % XSAir, UV
 Max % XSAir, flame rod
 Max % XSFuel, fs

fs - indicates the maximum flame supervisory XSAir or XSFuel using either a UV detector or the specified flame rod listed on the 4441 parts list.

Max % XSAir, ignition
 Max % XSFuel, ignition

ignition - indicates the maximum XSAir or XSFuel at which the integral igniter will light the burner.

DG:.....Tile pressures are average values and are subject to considerable variation (±10%)

NOTE: The capacity of the burners has not changed but static pressure has been transitioned to measuring static pressure in imperial units by inches of water column. Previous versions of the bulletin measured static air pressure in ounces per square inch. Conversion: 1 osi = 1.73" w.c.

NATURAL GAS OPERATION

Main Air Pressure, (UA pressure tap), "w.c

4441-1	0.9	1.7	6.9	15.6	20.8	27.7	34.6	41.6
Air Flow, not burning (scfh)						1600		
Air Flow, (scfh)	200	280	600	900	1025	1250	1400	1550
Air Orifice ΔP, UA-DA, ("w.c.)	0.4	0.7	2.9	7.1	9.7	13.2	15.8	19.5
Gas Orifice ΔP, UG-DG, ("w.c.)	0.1	0.2	1	2.2	2.5	3.9	5	6
Tile Pressure, DG ("w.c.)	0.55	0.9	3.7	8.1	10.8	14.1	17.7	21
Max. % XSAir, fs, ignition	400	600	900	2000	2000	2000	2000	2000
Max. % XSFuel, fs	30	30	30	30	30	30	30	30
Max. % XSFuel, ignition	30	30	30	30	30	30	30	30
Flame Length (in.)	6	7	7	8	9	10	10	10
Flame Diameter (in.)	0.75	0.75	0.75	1	1	1	1	1

4441-2	0.3	1.7	6.9	15.6	20.8	27.7	34.6	41.6
Air Flow, not burning (scfh)						2700		
Air Flow, (scfh)	200	450	1040	1650	1890	2200	2500	2700
Air Orifice ΔP, UA-DA, ("w.c.)	0.15	1.23	3.7	9	11.4	16.6	20.9	25.3
Gas Orifice ΔP, UG-DG, ("w.c.)	0.05	0.3	1.3	3	4.4	6.7	8.5	8.6
Tile Pressure, DG ("w.c.)	0.2	0.8	2.9	5.9	7.7	9.8	12	14.3
Max. % XSAir, fs, ignition	400	1500	2000	3000	3000	3000	3000	3000
Max. % XSFuel, fs	30	30	30	30	30	30	30	30
Max. % XSFuel, ignition	30	30	30	30	30	30	30	30
Flame Length (in.)	6	8	10	10	10	10	11	10
Flame Diameter (in.)	1	2	1.5	1.5	2	2	2	2