

Design and Application Details

Maxon TUBE-O-THERM® Burners are nozzle-mixing, gas fired, refractory-less burners specifically designed for firing into a small bore tube. Typical applications are industrial solution heating jobs such as dip tanks, spray washers, pickling or quench tanks, salt baths, indirect air heaters and bakery ovens.

TUBE-O-THERM® Burners are available in two basic versions: 1) packaged with integral low horsepower combustion air blower in your choice of the voltages listed below, or 2) EB (external blower) for use with an external combustion air source.

TUBE-O-THERM® Burner Model	3" Pkd.	4" Pkg.	6" Pkg.	8" Pkg.
Horsepower	1/2 HP	1/2 HP	2 HP	3 HP
208-230/460/3/60 (std.)	X	X	X	X
115/230/1/60	X	X	X	NA
190-380/3/50*	X	X	X	X
575-3-60	X	X	X	X

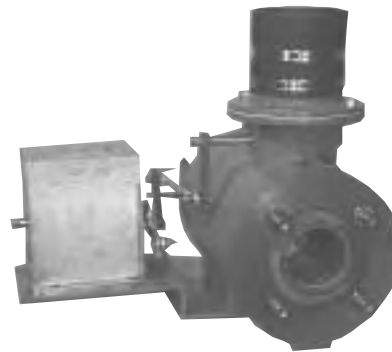
*50 hertz motor option at extra charge

Standard TUBE-O-THERM® Burner package (shown below) includes a combustion air blower with a non-sparking aluminum impeller. A built-in pilot and spark ignitor is included in the cast iron burner body, as well as the air and gas control valves, gas nozzle, pilot adjustable orifice and provisions for your flame scanner. Burner design permits blower to be rotated at 90° intervals around centerline for application flexibility.



3" TUBE-O-THERM® Gas Burner with customer's control motor and UV scanner mounted

Model EB (external blower) TUBE-O-THERM® Burners (shown below), like all TUBE-O-THERM® Burner assemblies, are designed to deliver heat efficiently into your fired tube application.

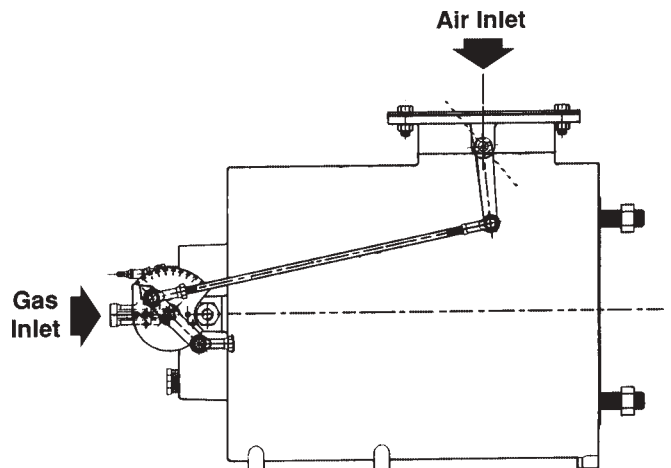


3" EB TUBE-O-THERM® Burner with control motor

Wall or tube stub mounting options simplify installation on your application. Mounting dimensions for tube stub option correspond to standard ANSI 150# flange sizes.

Low torque requirements permit use of virtually any electric operator. Maxon supplies connecting base and linkage assemblies for mounting most temperature control operators.

Principle of operation (illustrated below)



Both versions incorporate a gas and air valve linked together to control the gas-air ratio over the full throttling range of the burner. Gas flows out through the gas nozzle where it mixes with the combustion air. Natural gas, propane or butane can be used.

Design and Application Details (continued)

Horizontal mounting of the burner is preferred, but it may be mounted in any position suitable for automatic control motor and UV scanner. Do not directly insulate tube length outside of tank or overheating and deterioration of tube may occur. The installer should take precautions to prevent personnel from coming into contact with the hot section of the tube. See restrictions in the "Wall Mounting Option" section on page 2755.

NOTICE: Burner performance can be affected by tube configuration. (See page 2755.)

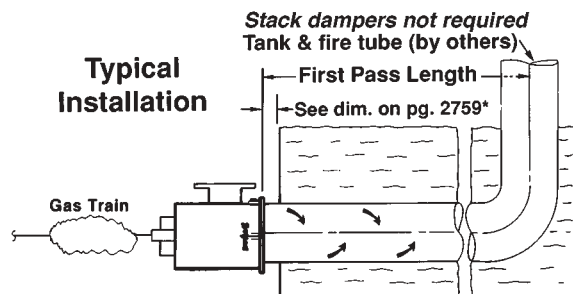
Tube length and configuration

Tube design should consist of a specified length of Schedule #40 pipe or lighter (see note below) in the same size as burner. It is possible to fire TUBE-O-THERM® Burners into tube diameters larger than the size designation. Contact your Maxon representative for further information.

Maxon suggests that the first straight pass of tube consist of the minimum length shown below for each tube size and not end in a single-miter elbow turn. Burner capacity may be reduced if tube layout has multiple single-miter turns.

Firing tube length and resulting wetted tube surface area determines combustion transfer efficiency. Refer to efficiency vs. tube length chart on page 2756 for proper length.

Many factors affect overall system efficiency. Typical installations run in the 70% to 80% range. Space considerations (including tube displacement) may limit possible tube lengths and reduce efficiency. Above 80% efficiency, there is a risk of condensation-caused tube damage.



Recommended first pass length:

3" & 4" burners – 15 pipe diameters minimum
6" & 8" burners – 10 pipe diameters minimum

*CAUTION: If recommended length outside of tank is exceeded, overheating & deterioration of tube may occur

Small bore immersion tubes can be sized for efficiencies lower than 80% if tank space is limited or if complete freedom from tube condensation is desired.

NOTE: Schedule 40 pipe should be used for at least the first 2 feet of tube length.

Temperature limitations

Blower motor manufacturers recommend maximum ambient temperature of +140°F (+40°C). Temperature limits can vary with the type of motor and insulation used. Such special motors are available at net extra charge and with extended deliveries. Check blower motor nameplate for temperature limits on **EB TUBE-O-THERM® Burners**.

Control motor manufacturers normally establish a maximum ambient temperature for their operators at +125°F (+52°C).

TUBE-O-THERM® Burner internal components include Rulon bearings which have a maximum temperature limit of +500°F (+260°C).

Automatic control

Regardless of the type of automatic control (high-low or modulating), TUBE-O-THERM® Burners should be at or very near the low firing position for pilot ignition and main flame light-off.

The built-in air and gas flow control valves are mechanically linked together. At low, the air valve is cracked open but the gas valve is practically closed.

If some higher firing rate is selected for low fire on high-low installations, both valves will be opened wider. The increased combustion air will necessitate more gas for pilot ignition. If carried too far, this increase can cause the main flame to be too rich.

Two position control, then, results in what essentially is high-low control, down to minimum capacity.

With either high-low or modulating control, high fire can be set at any desired point within burner range. (See notes on instruction page 2750-S-1 for set up of high-fire points less than rated high fire).

The TUBE-O-THERM® Burner was designed to accept the following electric control motors: Barber-Colman (EA51-58; also with prefix MC, MP, or MF), Honeywell Modutrol (M644, M744, M941, M944, M640A, or M940A), and Penn/Johnson (M80 or M81). The motor mounting bracket and linkage included with TUBE-O-THERM® Burners will accept any of these motors; additional CB & L parts are not required.

Flame safeguard

The TUBE-O-THERM® Burner will operate with a variety of UV scanners for all burner sizes.

Design and Application Details (continued)

Wall mounting option

The TUBE-O-THERM® Burner was designed to transfer heat to your process as efficiently as possible. As a result, your process tube, which bolts to the outlet of the TUBE-O-THERM® Burner, can become hot during the burner's operation. The inlet portion of this tube will overheat if it extends too far outside the tank. The maximum recommended length for the inlet portion of your process tube outside the tank is shown as Dimension C in the drawings labeled "Stub mounted versions" on pages 2759-2761.

For most applications, the wall mounting option is recommended. Use of the wall mounting option will support the burner off of the tank, instead of supporting the burner with the tube. Maxon also suggests using a burner support independent of the flange, which will allow for some expansion during firing. Consult your Maxon representative for more information.

Tube exhaust requirements

WARNING: Failure to follow the recommended exhaust considerations could result in poor burner performance and/or corrosion of the fired tube due to condensation.

Historically, conventional immersion tube burners were sized for 70% efficiency, since this percentage provided a compromise between operating fuel economy and tube length.

Small-bore tubes require less space than conventional tubes. Therefore, small-bore tubes can be made longer to provide efficiencies of 80% or more.

Tubes sized for 80% efficiency will have low exhaust temperatures, causing condensation to form in them during start-up or during long idling periods. This condensation will normally evaporate after the burner has run at high fire for a brief period of time. If extended idling periods are expected, a condensate drain should be provided at the low point nearest the exhaust and the immersion tube should be pitched towards the exhaust.

If the immersion tube will operate at efficiencies of 75% or lower, the exhaust leg can exit through the liquid surface in the tank without designing for condensation. However, the length of the exhaust tube must also be considered in the design as explained below.

These considerations also extend to the exhaust lengths after the tube exits the liquid surface. An exhaust tube exiting the tank will continue to transfer heat and cool the products of combustion to their condensation point. Therefore, an atmospheric break or dilution tee (shown at right) should be used. By doing

so, the diluting atmospheric air will depress the dewpoint temperature of the combustion products so that they may exhaust out of the plant without undue condensation.

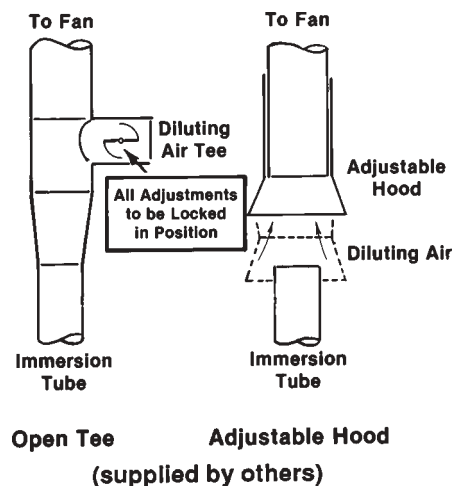
If the dilution tee option is chosen, there must be safeguards to ensure that the diluting air is not restricted or blocked. If this were to occur, condensation inside the stack could result, with condensate flowing downward to the low point in the tube, possibly blocking the tube and causing burner instability.

Because of the high firing rates possible with this burner and the low cross-sectional area of the tubes, no draft or chimney effect should be designed for, or expected, if the exhaust stack diameter is equal to the fired tube diameter.

Immersion tubes are usually vented to the outdoors, except for those in highly ventilated areas such as a plating room with continuous high-volume exhaust. An exhaust fan may be required if the building is under negative pressure. Exhaust is normally diluted to avoid the need for high-temperature fans, but adequate make-up air must be available.

This diluting can be done with an open tee installed in a vertical run (or in a horizontal run with the open end down), but such a system mixes slowly.

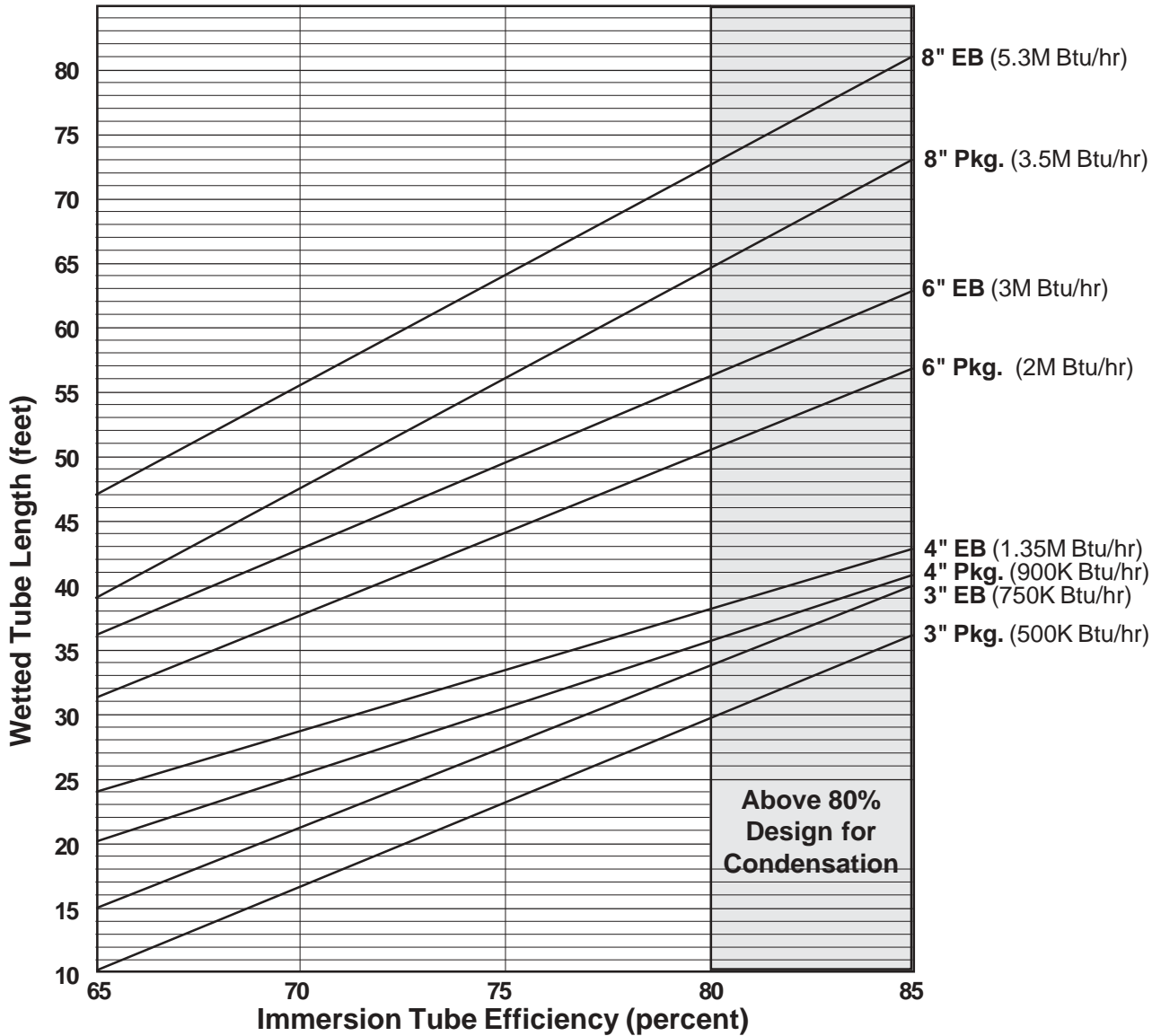
An adjustable hood (shown in sketch below) offers much better performance. In all cases, care must be taken that all products of combustion are exhausted from the building.



Cross-sectional area of the exhaust hood should be a minimum of 1.5 times the fired tube cross-sectional area.

Design and Application Details (continued)

Immersion Tube Sizing – 60 Hz



Design Notes

1. Systems sized for 80% efficiencies or higher need to account for condensation during extended idling periods. Refer to Design and Application Details on page 2755.
2. Curves shown are for 60 Hz applications only.
3. Curves above are not parallel due to small differences in excess combustion air at maximum design rate. All TUBE-O-THERM® Burners operate in a range of 2% to 4% excess oxygen at maximum firing rate.
4. Use the centerline lengths of elbows when computing total tube length.
5. Note that longer tube lengths are required to achieve the same efficiency on external blower (EB) versions. This is

due to increased maximum firing rate.

Indirect Firing

Tube sizing chart above is applicable only to liquid-backed immersion tubes. Indirect-fired applications (non-liquid backed fired tubes) could require additional length depending on the specific application. **For indirect firing in moving air streams, use the above chart and multiply the specified tube length by 1.75 to obtain the same efficiency.**

Recommended air stream velocity across fired tubes is 1500+ FPM.

Capacities and Specifications

60 Hz capacity and specification information for both standard burners (including blower) and EB burners (requiring separate air supply) are given in the table on page 2758. Measured sound levels and motor information apply only to standard burners.

For operation on 50 Hz power, reduce capacities to 83% of those shown. Refer to 50Hz capacities and specifications on Product Information Sheet 2750-2 for proper operating pressures.

Air pressure readings at test connection reflect those that may be expected during high fire operation and may vary as a result of tube and exhaust configurations.

Inlet air pressures and flows must not exceed those given in table. **DO NOT OVERSIZE** blowers feeding EB Burners. If a blast gate or similar device is used to limit air pressure at an EB Burner, air pressure at the burner will rise as firing rate is reduced until the blower's rated pressure is reached. This will result in increased pilot and minimum capacities, as well as increased excess air at lower firing rates.

For optimum performance, the use of Maxon FG Blowers is recommended.

NOTE: The **required combustion air blower** for each individual EB-style burner is given below:

3" Burner	C-1450-12 (1-1/2 HP)
4" Burner	C-1450-12 (1-1/2 HP)
6" Burner	C-3480-12 (3 HP)
8" Burner	C-7020-16 (7-1/2 HP)

Blower curves for these burners are shown on Product Information Sheet 2750-3.

The TUBE-O-THERM® Burner combustion air and fuel gas controls are linked and characterized to provide proper air/fuel ratios at specific supply pressures. Use of blowers which do not match the Maxon FG Blower performance curves shown on Product Information Sheet 2750-3 could result in burner instability, excessive rumbling and unsatisfactory overall performance.

Main gas train should be sized to give no more than 6" wc pressure drop to obtain catalog minimums. It is recommended to size the regulator for at least 120% of the full system capacity at the required pressure, carefully considering pipe train losses.

Pilot piping and regulator should be sized carefully for the full pilot and capacity shown on Page 2758. Pilot regulator pressure range should match the pressure range used for the main gas regulator. This will eliminate the possibility of chattering in the pilot regulator when the main gas (higher pressure) is at high fire and the burner operates with continuous pilot. If burner controls are set to operate with interrupted pilot, chattering would not be a concern.

NOTE: Most regulator manufacturers include an internal relief valve in their standard regulators. These relief valves will begin to vent when the downstream pressure is somewhere around 7 inches w.c. greater than the regulator set pressure. Regulators can be ordered without an internal vent. The best option is to run the pilot interrupted. If the pilot is not interrupted, catalog minimums cannot be obtained.

Refer to Page 2758 for the proper pilot gas pressure as measured at the burner gas test port. The adjustable orifice inside the pilot can be used to establish the required pressure (5/32" hex wrench required). Pilot solenoid should be located within 5 feet of burner to allow gas to reach burner before flame safeguard "times-out".

Self-piloting feature of burner allows pilot gas to bypass internal gas control valve and issue from main gas nozzle ports. Most insurance authorities agree that an interrupted pilot is a more reliable method of monitoring an industrial combustion system.

Low-fire start: Main flame light-off is possible above minimum fire position, but larger pilot will be required and turndown will be sacrificed.

Transfer Efficiencies

Transfer Efficiency % (based on tube length)	Btu/hr, ft ² (avg.) wetted tube surface							
	3" Pkg.	3" EB	4" Pkg.	4" EB	6" Pkg.	6" EB	8" Pkg.	8" EB
65	35,480	35,480	24,830	31,040	23,810	31,240	26,514	32,461
70	23,160	27,290	21,220	28,150	21,530	28,500	23,086	29,340
75	17,800	22,330	18,790	25,810	19,660	26,210	21,137	27,506
80	14,800	19,440	17,220	24,120	18,270	24,720	19,683	25,723
85	12,890	17,400	15,840	22,650	17,200	23,340	18,048	24,631

Capacities and Specifications – 60 Hertz

TUBE-O-THERM® Burner		Size	3"		4"		6"		8"	
		Description	Pkgd.	External Blower	Pkgd.	External Blower	Pkgd.	External Blower	Pkgd.	External Blower
Capacities (Btu/hr)	Maximum		500,000	750,000	900,000	1,350,000	2,000,000	3,000,000	3,500,000	5,300,000
	Pilot Only		50,000	75,000	90,000	135,000	130,000	200,000	350,000	530,000
	Minimum(main only)		50,000	75,000	90,000	135,000	160,000	240,000	350,000	470,000
Natural Gas Requirements	Gas pressure required for main burner (at maximum capacities)	To burner gas inlet	35.3" wc	66.0" wc	29.5" wc	65.3" wc	36.5" wc	76.4" wc	37.0" wc	76" wc
		To burner gas test port	32.1" wc	59.0" wc	25.8" wc	56.9" wc	29.2" wc	62.1" wc	33.0" wc	72" wc
	Pilot gas pressure required	To burner gas test port	0.6" wc	1.2" wc	0.5" wc	1.0" wc	0.3" wc	0.6" wc	0.6" wc	1.3" wc
	Combustion air pressure required	At burner air inlet	6.1" wc	18.3" wc	7.2" wc	16.7" wc	9.8" wc	18.6" wc	10.0" wc	24.8" wc
		Differential air pressure [1]	1.5" wc	2.8" wc	1.3" wc	2.8" wc	2.1" wc	3.9" wc	1.4" wc	2.7" wc
Propane Gas Requirements	Gas pressure required for main burner (at maximum capacities)	To burner gas inlet	15.0" wc	32.0" wc	14.5" wc	31.7" wc	18.0" wc	41.0" wc	18.2" wc	44" wc
		To burner gas test port	13.6" wc	29.0" wc	12.9" wc	28.4" wc	15.4" wc	33.7" wc	16.5" wc	37" wc
	Pilot gas pressure required	To burner gas test port	0.5" wc	1.1" wc	0.3" wc	0.8" wc	0.4" wc	0.8" wc	0.6" wc	1.3" wc
	Combustion air pressure required (at high fire position with no fire)	At burner air inlet	6.1" wc	18.3" wc	7.2" wc	17.0" wc	9.8" wc	18.6" wc	10.0" wc	24.8" wc
		Differential air pressure [1]	1.5" wc	2.8" wc	1.3" wc	2.8" wc	2.1" wc	3.9" wc	1.4" wc	2.7" wc
Maximum combustion air volume required			100 SCFM	155 SCFM	180 SCFM	270 SCFM	415 SCFM	600 SCFM	675 SCFM	1015 SCFM
Tube length (in feet, sized for 80% efficiency) and diameter (Schedule #40 pipe or lighter)			30 ft. of 3" dia.	34 ft. of 3" dia.	36 ft. of 4" dia.	38 ft. of 4" dia.	50 ft. of 6" dia.	56 ft. of 6" dia.	64 ft. of 8" dia.	73 ft. of 8" dia.
Packaged burner and/or combustion air blower horsepower required			1/2 HP	[2]	1/2 HP	[2]	2 HP	[2]	3 HP	[3]
Packaged burner sound levels dB(A) at 3 feet (no silencer)			85	N/A	86	N/A	88	N/A	89	N/A

[1] Setting differential air pressure is described in Service Tips on pages 2750-S-5 and 2750-S-6.

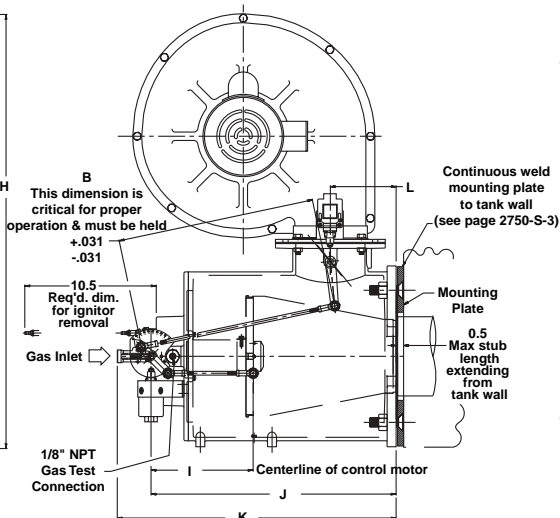
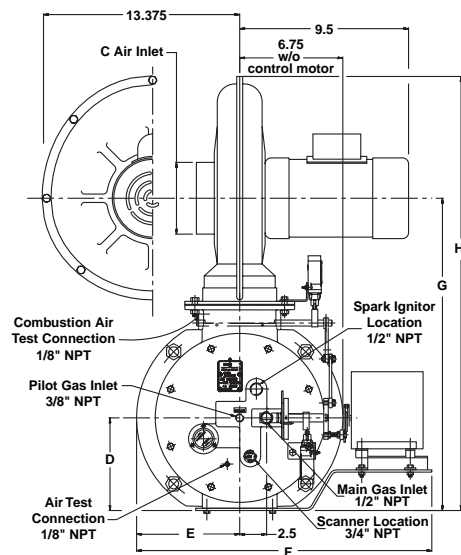
[2] 12 osi blower required [3] 16 osi blower required (See suggested blower selection on page 2757.)

Blower curves are shown on Product Information Sheet 2750-3.

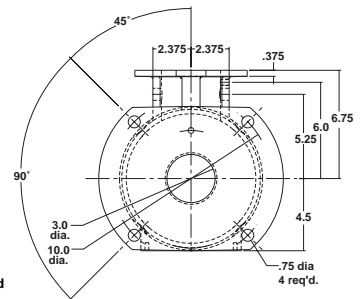
50 Hz performance data shown on Product Information Sheet 2750-1

Dimensions (in inches)

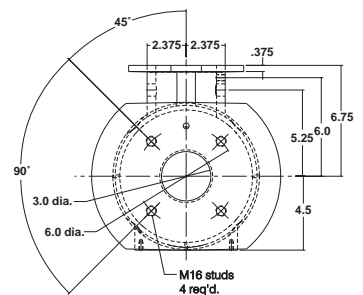
3" Packaged TUBE-O-THERM® Burners



3" flange mount



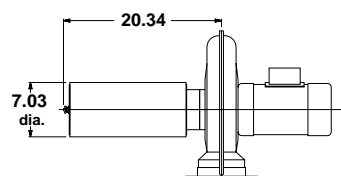
3" stub mount



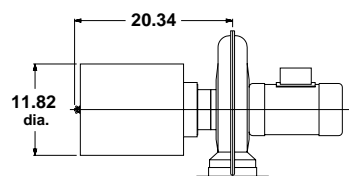
Burner Size	B*	C	D	E	F	G	H	I	J	K	L
3" Pkg.	13.113	4.0	4.875	5.75	19.62	19.0	26.5	6.5	15.75	18.75	4.188
3" EB	13.59										

*This dimension is factory-set

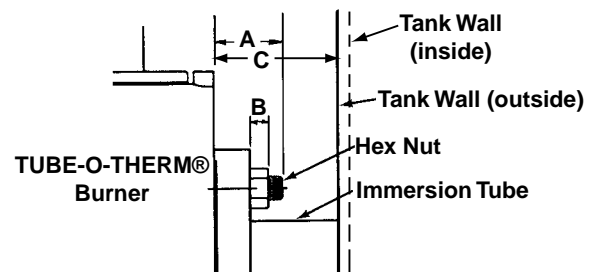
Foam Filter



Foam Filter/Silencer



Stub mounted versions (optional)



EB (external blower) TUBE-O-THERM® Burners

Dimensions for the EB version are the same as those shown above for the Packaged version with the exception of a dimension for the air inlet required for an external blower.

Air inlet sizes for EB versions are as follows:

3" EB – 4" dia.

Air inlet adapter flange assemblies are provided by Maxon.

Dim. A
Burner
flange to
end of stud

Dim. B
Thickness
of
hex nut

Dim. C
Burner Flange
to inside of tank
wall (max.)

3" Burner

1.807"

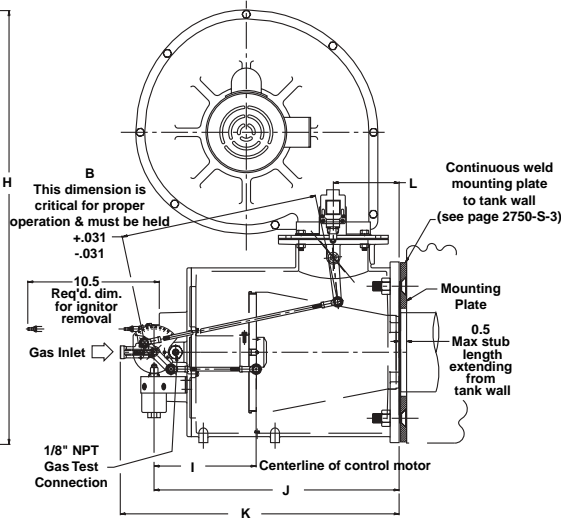
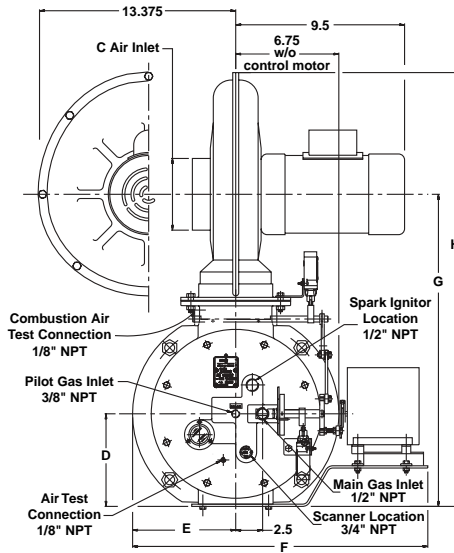
0.512"

2.5"

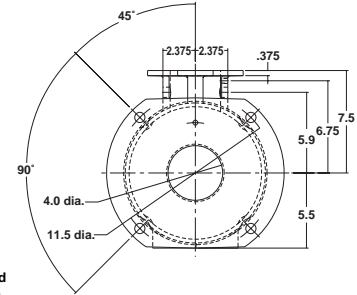
NOTE: Do not exceed Dimension C. The inlet portion of the tube will overheat if it extends too far outside the tank.

Dimensions (in inches)

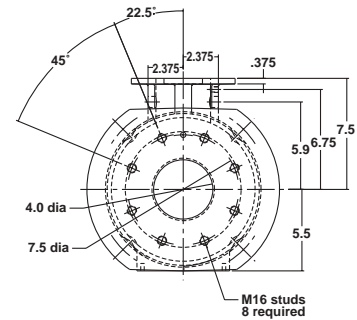
4" Packaged TUBE-O-THERM® Burners



4" flange mount



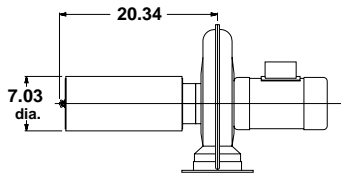
4" stub mount



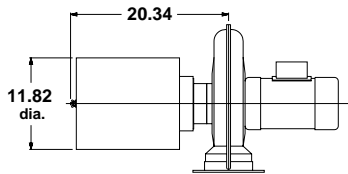
Burner Size	B*	C	D	E	F	G	H	I	J	K	L
4" Pkg. & EB	14.5	5.0	6.0	6.5	20.38	21.0	29.5	8.0	17.5	23.0	4.062

*This dimension is factory-set

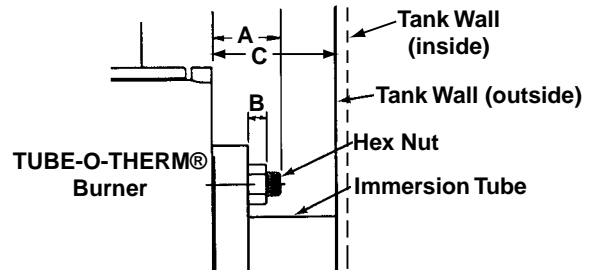
Foam Filter



Foam Filter/Silencer



Stub mounted versions (optional)



EB (external blower) TUBE-O-THERM® Burners

Dimensions for the EB version are the same as those shown above for the Packaged version with the exception of a dimension for the air inlet required for an external blower.

Air inlet sizes for EB versions are as follows:

4" EB – 4" dia.

Air inlet adapter flange assemblies are provided by Maxon.

Dim. A
Burner
flange to
end of stud

Dim. B
Thickness
of
hex nut

Dim. C
Burner Flange
to inside of tank
wall (max.)

4" Burner

1.829"

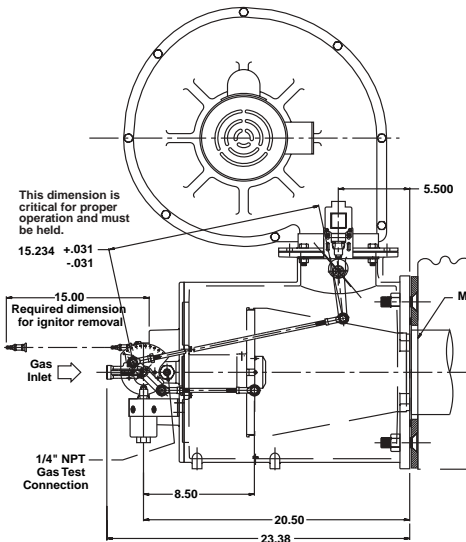
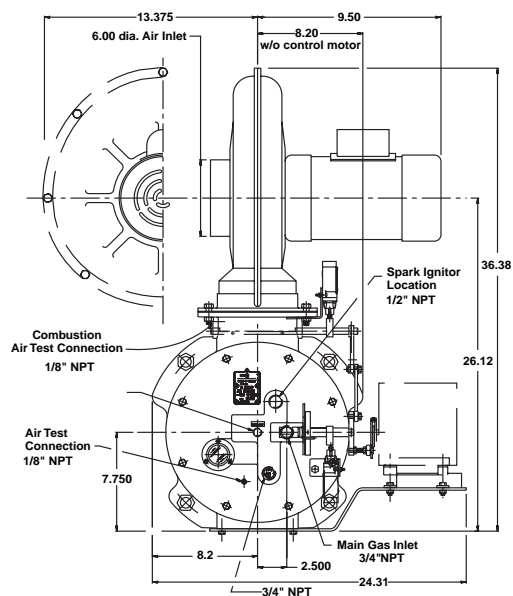
0.512"

2.5"

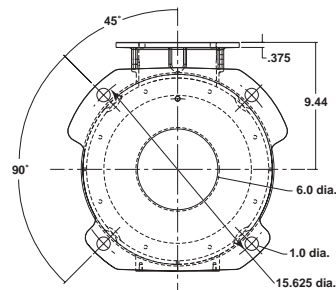
NOTE: Do not exceed Dimension C. The inlet portion of the tube will overheat if it extends too far outside the tank.

Dimensions (in inches)

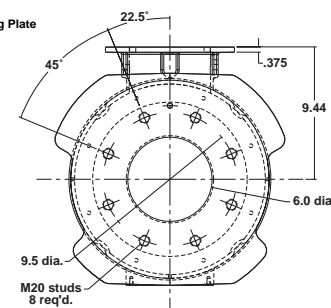
6" Packaged TUBE-O-THERM® Burners



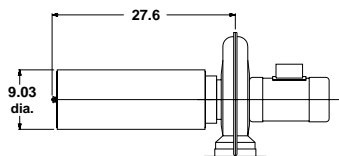
6" flange mount



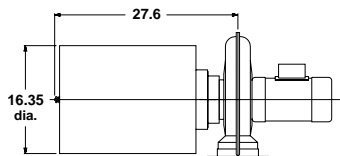
6" stub mount



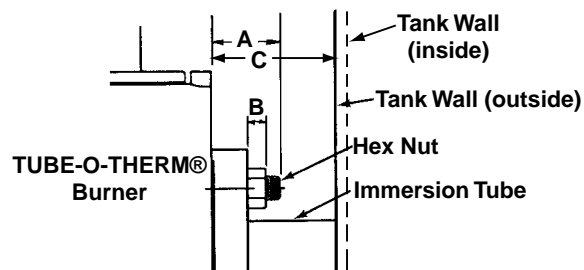
Foam Filter



Foam Filter/Silencer



Stub mounted versions (optional)



EB (external blower) TUBE-O-THERM® Burners

Dimensions for the EB version are the same as those shown above for the Packaged version with the exception of a dimension for the air inlet required for an external blower.

Air inlet sizes for EB versions are as follows:

6" EB – 6" dia.

Air inlet adapter flange assemblies are provided by Maxon. (See page 2763.)

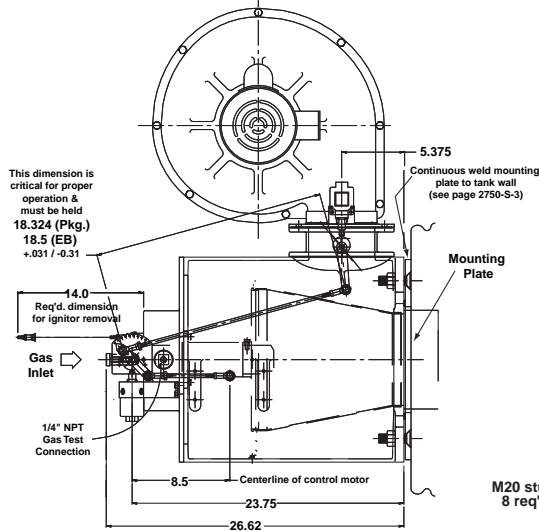
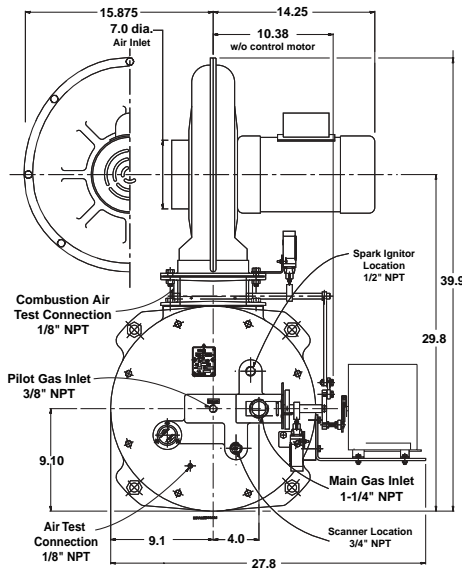
Dim. A Burner flange to end of stud	Dim. B Thickness of hex nut	Dim. C Burner Flange to inside of tank wall (max.)
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6" Burner	2.180"	0.63"	2.5"
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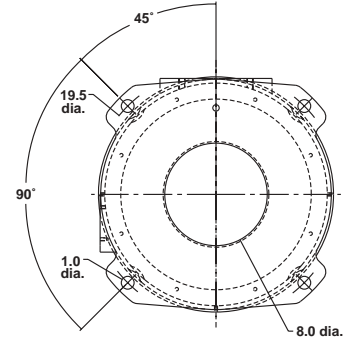
NOTE: Do not exceed Dimension C. The inlet portion of the tube will overheat if it extends too far outside the tank.

Dimensions (in inches)

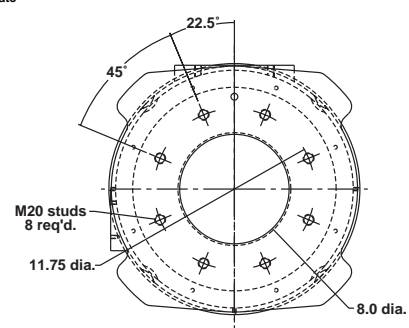
8" Packaged TUBE-O-THERM® Burners



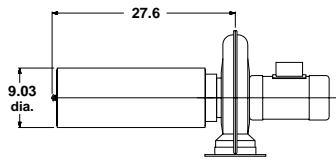
8" flange mount



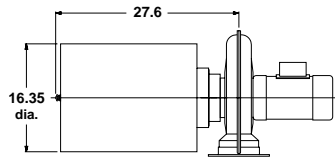
8" stub mount



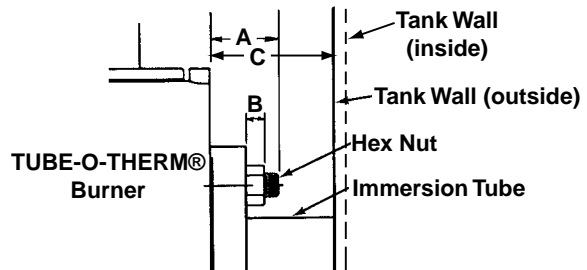
Foam Filter



Foam Filter/Silencer



Stub mounted versions (optional)



EB (external blower) TUBE-O-THERM® Burners

Dimensions for the EB version are the same as those shown above for the Packaged version with the exception of a dimension for the air inlet required for an external blower.

Air inlet sizes for EB versions are as follows:
8" EB – 6" dia.

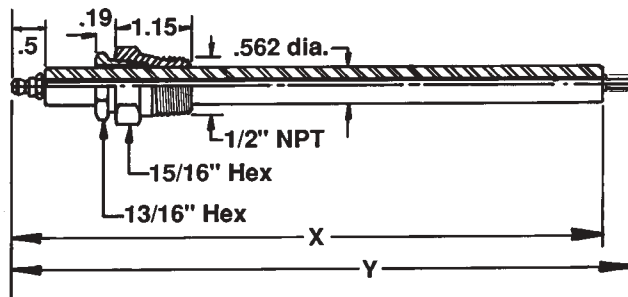
Air inlet adapter flange assemblies are provided by Maxon.

	Dim. A Burner flange to end of stud	Dim. B Thickness of hex nut	Dim. C Burner Flange to inside of tank wall (max.)
8" Burner	2.272"	0.63"	3"

NOTE: Do not exceed Dimension C. The inlet portion of the tube will overheat if it extends too far outside the tank.

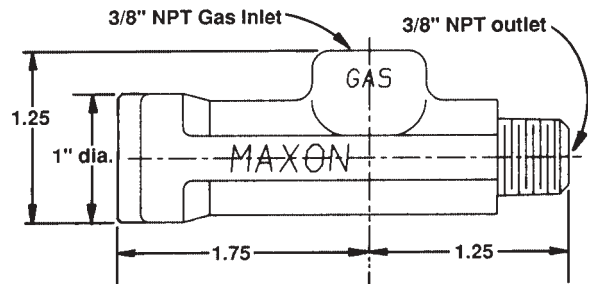
Dimensions (in inches)

Replacement Spark Ignitor

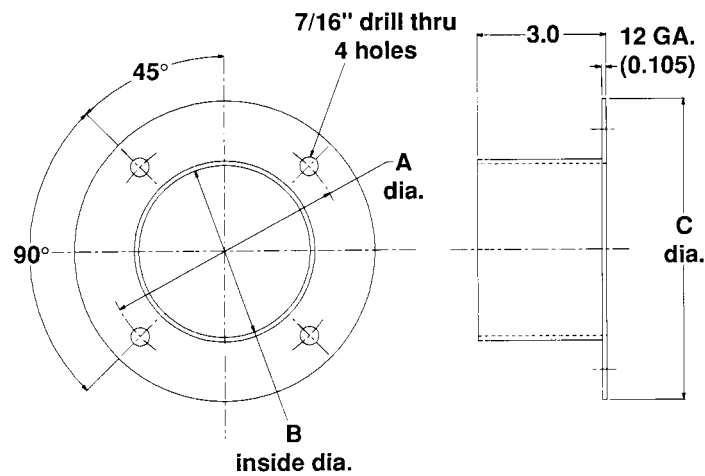


Burner Size	X	Y
3" & 4"	8.75	9.0
6" & 8"	12.25	12.5

Replacement Pilot Gas Adjustable Orifice



EB Adapter Flange



Burner Size	A	B	C
3" & 4"	5.58	4.0	7.0
6" & 8"	7.5	5.79	9.19

Suggested Spare Parts:

- Spark ignitor and protective cover
- Pilot gas adjustable orifice

Notes