

Eclipse Blast Tips, Line Burners And Open Burners

WARNING

The burners covered in this Guide are designed to mix fuel with air and burn the resulting mixture. All fuel burning devices are capable of producing explosions and fires when improperly applied, installed, adjusted, controlled, or maintained. This Guide will provide information for using these burners for their limited design purpose. Do not deviate from any instructions or application limits in this Guide without written advice from the Engineering Department at the Eclipse factory in Rockford, Illinois. Read this entire Guide before attempting to light burners. If you do not understand any part of the information in this Guide, contact your local Eclipse representative or the Eclipse Engineering Department before proceeding further.

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IMPORTANT NOTICES RELATING TO SAFE BURNER OPERATION

1. Store the burner inside. Exposure to the elements can damage the burner.
2. Adjustment, maintenance, and troubleshooting of the mechanical parts of these units should be done by people with good mechanical aptitude and experience with combustion equipment.
3. Order replacement parts from Eclipse only. Any customer supplied valves or switches should carry UL, FM, CSA, and/or CGA approval where applicable.
4. The best safety precaution is an alert and competent operator. New operators must be thoroughly instructed and demonstrate an adequate understanding of the equipment and its operation. Regular retraining must be scheduled to maintain a high degree of proficiency. The operator must have easy access to this Information Guide at all times.

1.0 APPLICATIONS

These premix burners are used for a wide variety of low-to-medium temperature applications where combustion chambers operate at neutral to slightly negative pressure.

Extended Cage Open Blast Burners can be used to fire boilers, kilns, ovens, air heaters, heat treat furnaces and non-ferrous crucible and pot-type melting furnaces.

Line Burners are designed for applications where heat must be evenly distributed over a large area, such as ovens, kettles and air heaters.

Blast Tips also provide widely distributed heat input as required by underfired kettles, core box heaters and soldering machines.

Sticktite and Ferrofix Nozzles are well-suited to firing kilns, ovens, heat treat furnaces and air heaters.

2.0 OPERATING PARAMETERS AND REQUIREMENTS**2.1 Capacities and Supply Pressures**

Figure 1 lists capacities and mixture pressures for these burners.

2.2 Combustion Chamber Conditions

Chamber pressure: Neutral to slightly negative

Maximum chamber temperature:

Extended Cage Open Blast Burners: 2000°F

Line Burners: 800°F

No-Blow Series K Blast Tips (Standard): 750°F

No-Blow Series K Blast Tips (Stainless Steel): 1200°F

Standard Steel Blast Tips: 600°F

Lava Blast Tips: 1000°F

Sticktite & Ferrofix Nozzles (Cast Iron or Steel): 800°F*

Sticktite & Ferrofix Nozzles (Alloy): 1200°F*

*With secondary air around the tip and a suitable refractory tunnel to protect the tip from furnace radiation, these tips can be used to fire applications up to 2000°F. See Bulletin P-5 for refractory blocks and holders for these nozzles.

2.3 Burner Environment

Ambient temperature limits are dictated by monitoring and control equipment such as ultraviolet scanners, automatic fuel shutoff valves and electrical wiring.

Protect burners from the weather.

Combustion air must be clean and free of corrosive contaminants. Eclipse strongly recommends use of a combustion air filter to remove airborne particles. If corrosive fumes or materials are present in the air, provide the blower with a supply of fresh, uncontaminated air.

Room openings to admit fresh combustion air from outdoors must be at least one square inch for every 4000 BTU/hr of burner firing rate.

Provide access to the burner for inspection and maintenance.

FIGURE 1 - CAPACITIES AND SUPPLY PRESSURES

Extended Cage Open Blast Burners - H-12 Bulletin

BURNER CATALOG NUMBER	CAPACITY* — BTU/HR. — NATURAL GAS					
	BLOWER PRESSURE — O.S.I.					
	4	8	12	16	20	24
	MIXTURE PRESSURE AT BURNER — IN W.C.					
	2"	4"	6"	8"	10"	12"
503 ECB	35,000	49,000	60,000	69,000	77,000	84,000
504 ECB	57,000	81,000	100,000	115,000	129,000	141,000
505 ECB	104,000	146,000	180,000	206,000	232,000	254,000
506 ECB	164,000	232,000	285,000	328,000	368,000	402,000
508 ECB	260,000	366,000	450,000	518,000	580,000	635,000
510 ECB	438,000	618,000	760,000	875,000	980,000	1,070,000
512 ECB	750,000	1,050,000	1,300,000	1,500,000	1,650,000	1,850,000
516 ECB	1,200,000	1,750,000	2,150,000	2,450,000	2,750,000	3,000,000

*Capacities based on 80% of required air in mixture, balance as secondary air.

FIGURE 1 - CAPACITIES AND SUPPLY PRESSURES (Cont'd.)

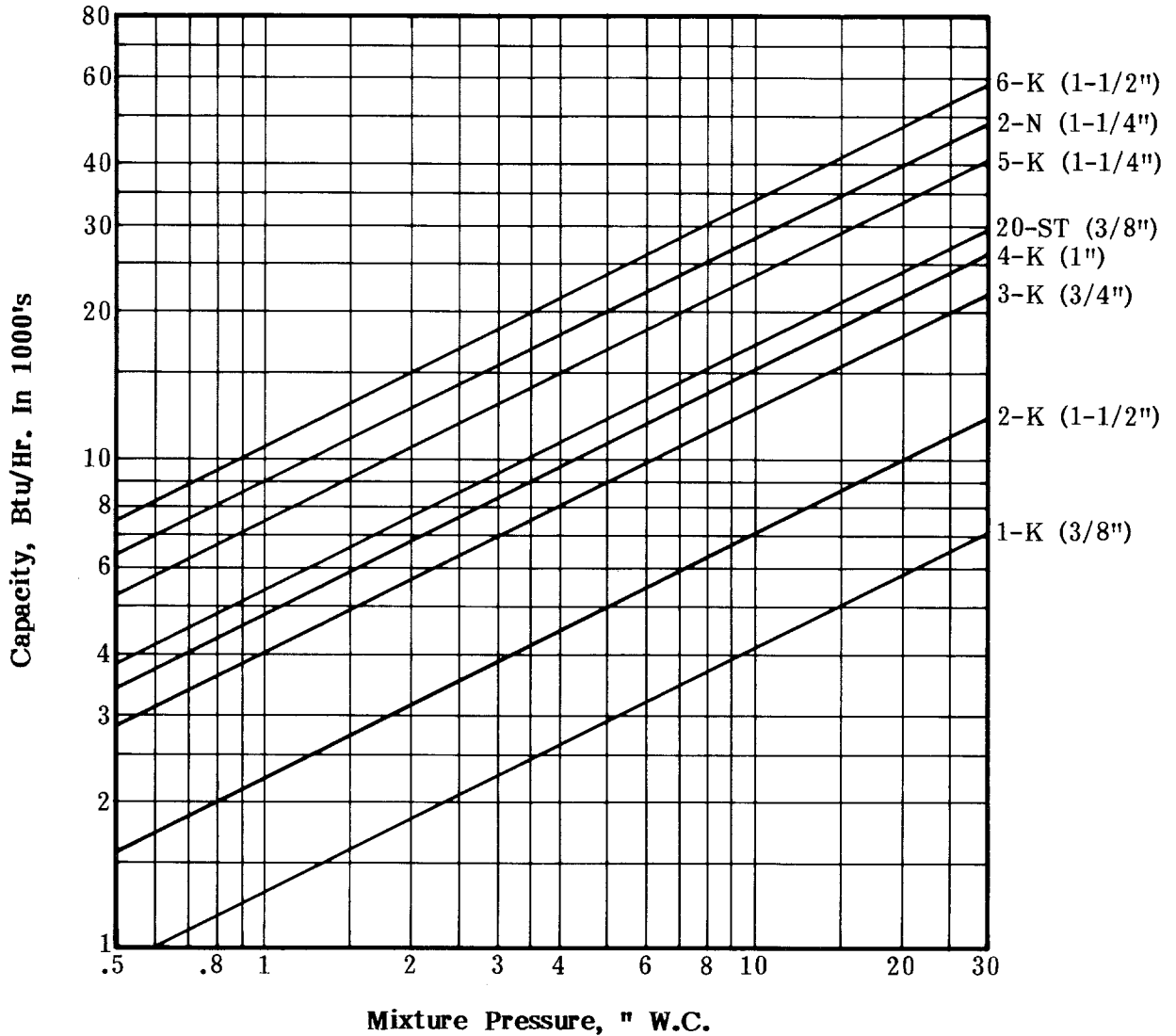
Line Burners - H-17 Bulletin

Capacity in 1000's of Btu/hr, with 70% total air in premix, at various mixture pressures

Catalog Numbers	Total Port Area, Sq. In.	Capacity in 1000's of Btu/hr, with 70% total air in premix, at various mixture pressures						
		2"wc	3"wc	4"wc	5"wc	6"wc	7"wc	8"wc
0L6S	.0502	10	12	14	16	17	19	20
1L6S	.1008	20	24	28	32	35	37	40
2L6S	.1344	25	31	38	40	43	47	50
3L6S	.2565	46	56	66	73	81	86	92
4L6S	.3444	67	82	91	106	118	125	134
5L6S	.4320	84	103	121	133	148	157	168
0LS, 0LSB, 0LSS, 0LE	.1008	19	23	28	30	34	36	40
1LS, 1LSB, 1LSS, 1LSBS, 1LE	.2016	39	48	56	62	69	73	78
2LS, 2LSB, 2LSS, 2LSBS, 2LE	.2688	52	64	75	82	92	97	104
3LS, 3LSB, 3LSS, 3LSBS, 3LE	.5136	92	113	132	145	162	172	184
4LS, 4LSB, 4LSS, 4LSBS, 4LE	.6888	134	164	192	212	236	251	268
5LS, 5LSB, 5LSS, 5LSBS, 5LE	.8640	168	206	241	266	296	314	336
0LC	.2079	37	45	53	59	64	69	75
1LC	.4158	74	91	106	117	129	138	148
2LC	.5446	106	130	152	168	186	198	212
3LC	1.0138	196	240	281	310	345	367	392
4LC	1.3496	263	322	377	416	463	492	526
5LC	1.6854	330	404	472	522	580	617	660
0LFT	.1491	29	36	41	46	51	54	57
1LFT	.2982	58	71	83	92	102	109	116
2LFT	.3962	77	94	110	122	135	144	154
3LFT	.7532	147	180	210	232	258	275	294
4LFT	1.0087	196	240	280	310	345	367	392
5LFT	1.2642	247	303	353	391	434	462	494
1L3E	.182	36	44	51	57	62	67	72
2L3E	.2156	42	51	59	66	73	79	84
3L3E	.3380	66	81	93	104	114	123	132
4L3E	.4256	83	102	117	131	144	155	166
5L3E	.5132	100	122	141	158	173	187	201

FIGURE 1 - CAPACITIES AND SUPPLY PRESSURES (Cont'd.)

Blast Tips - H-21 Bulletin



Capacities are based on 0.6 sp gr natural gas at 10:1 air/gas ratio. Blast tips can be operated with less than full combustion air in the premix provided adequate secondary air is available.

For air/gas ratios other than 10:1, apply the multifactor below to the capacity in the graph.

Air/Gas Ratio:	8:1	9:1	10:1	11:1
Multifactor:	1.22	1.1	1.0	.92

FIGURE 1 - CAPACITIES AND SUPPLY PRESSURES (Cont'd.)

Nozzles - H-22 Bulletin

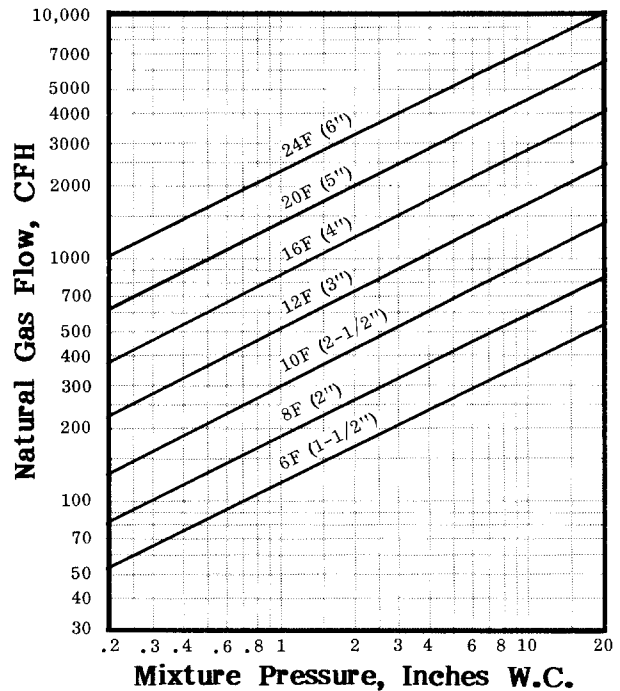
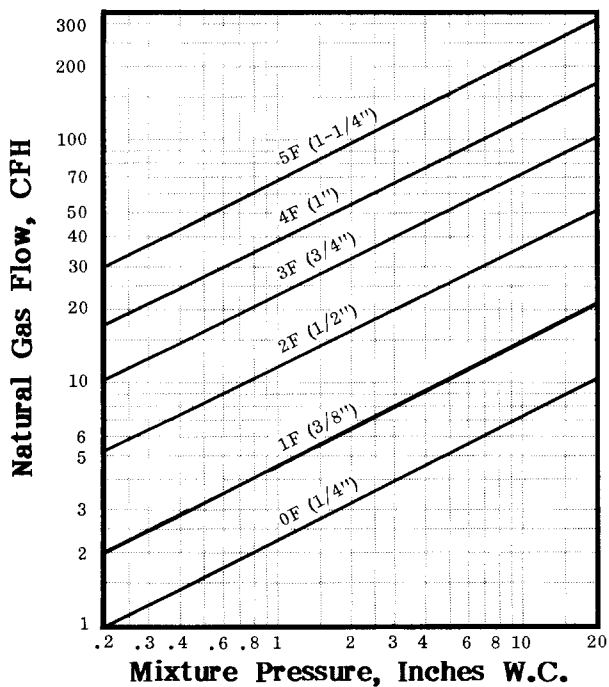
Sticktite, Steel Natural Gas Flow, CFH

CATALOG NUMBER	MIXTURE PRESSURE - INCHES W. C.																	
	.2	.3	.4	.5	.6	.7	.8	.9	1	2	3	4	5	6	7	8	9	10
ST-102-10	---	---	---	10.5	11.5	12.5	13.3	14.2	15	21.2	26	30	33.8	37	40	43	45	48
ST-103-14	10.7	13	15	17	18.5	20	21.5	22.8	24	34	42	48	54	59	64	68	72	76
ST-204-18	23.5	28.8	33.2	37	41	44	47	50	52.5	75	91	105	118	130	140	150	160	168
ST-205-28	51	62.5	72	80	88	95	102	108	114	162	198	230	255	280	302	325	345	362
ST-206-36	81	100	115	130	142	153	164	174	184	260	320	370	410	450	488	520	550	580
ST-208-42	109	132	154	172	188	203	218	230	243	345	420	490	545	600	645	690	735	770
ST-208-46	130	160	182	205	225	243	260	275	290	410	502	580	655	718	770	830	875	920
ST-210-56	192	235	272	305	332	360	385	410	430	610	750	865	965	1,050	1,130	1,220	1,300	1,350
ST-212-68	280	340	395	440	482	525	560	595	625	890	1,080	1,250	1,400	1,540	1,670	1,780	1,890	2,000
ST-216-84	422	520	600	670	740	795	850	900	950	1,350	1,650	1,900	2,120	2,330	2,520	2,700	2,850	3,000
ST-224-128	960	1,180	1,350	1,510	1,680	1,800	1,910	2,030	2,150	3,050	3,700	4,300	4,800	5,250	5,700	6,100	6,400	6,800

Sticktite, Alloy Natural Gas Flow, CFH

CATALOG NUMBER	MIXTURE PRESSURE - INCHES W. C.																	
	.2	.3	.4	.5	.6	.7	.8	.9	1	2	3	4	5	6	7	8	9	10
ST-102-A18-8-7	4	5	5.7	6.4	7	7.6	8.1	8.6	9	12.8	15.8	18	20	22	24	25.5	27	28
ST-102-A18-8-10	5.8	7.1	8.2	9.2	10	10.9	11.7	12.4	13	18.3	22.5	26	29	32	34	36.5	39	41
ST-102-A18-8-12	7.6	9.3	10.8	12	13	14.2	15.2	16	17	24	29.5	34	38	42	45	48	51	54
ST-103-A18-8-12	8.5	10.3	12	13.4	14.8	16	17	18	19	27	33	38	42	46	50	54	57	60
ST-103-A18-8-14	10.2	12.5	14.5	16	17.8	19	20.5	21.8	23	32.3	39.5	46	51	56	60	64.5	68	72
ST-104-A18-8-18	19	23	26.5	30	32.5	35	37.5	40	42	59.5	73	84	94	102	110	120	125	132
ST-105-A18-8-22	27	33	38	42	46	50	53.8	57	60	84	104	120	134	146	160	170	180	190
ST-105-A18-8-28	44.2	54	63	70	77	84	90	95	100	140	172	200	222	245	263	280	300	310
ST-106-A18-8-36	73	89	102	115	125	135	146	155	162	230	280	322	360	395	430	455	485	505
ST-108-A18-8-46	125	153	178	198	218	235	250	267	280	390	480	558	620	680	730	775	830	870

Ferrofix



Capacities are based on 0.6 sp. gr. natural gas at 8:1 air/gas ratio. For air/gas ratios other than 8:1, apply the multifactor below to the capacity in the table.

Air/Gas Ratio:	7:1	8:1	9:1	10:1	11:1
Multifactor:	1.12	1.0	.91	.82	.75

3.0 SUPPLY AND CONTROL SYSTEM REQUIREMENTS

These burners operate on gas/air premixtures containing from 70% to over 100% of the required combustion air. If the premix contains less than 100% of the combustion air, the balance must be provided by secondary air.

3.1 Mixture Pressures

Maximum and minimum recommended mixture pressures are shown on the tables and graphs of Figure 1. Operating at mixture pressures below the listed minimums may cause flashback.

3.2 Gas/Air Mixing Devices

These burners require separate gas/air mixing equipment. For descriptions of various types of gas/air mixers and their operation, refer to the following bulletins:

- L-150, Atmospheric Injectors
- L-300, LP Low Pressure Proportional Mixers
- L-310, VS Vari-Set Proportional Mixers
- L-400, VB Variport Mixers
- L-500, CM Consta-Mix Valves

3.3 Firing Rate Control

These burners can be operated with on-off, high-low, proportioning or fixed rate control systems within the capacity limits listed in Figure 1. Be sure that the gas/air mixer you select is compatible with the desired control mode. Atmospheric Injectors, for example, are difficult to adapt to anything other than manually adjusted, fixed rate control.

3.4 Piloting

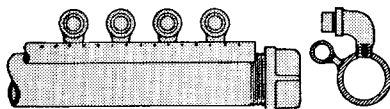
Extended Cage Open Blast Burners have a mounting location for a blast pilot.

Line Burners are available with pilot sections or pilot mounting brackets for blast pilots.

Blast Tips do not have piloting provisions. They can be lighted with hand torches. Where the tips are mounted on long pipe manifolds, they can be ignited with a raw gas lighter pipe as shown in Figure 2.

Sticktite and Ferrofix Nozzles do not have provision for piloting, but they can be installed in Mounting Cages that have openings for installing pilots. See Bulletin P-10.

FIGURE 2 - LIGHTER PIPE FOR BLAST TIPS



Pipe burner showing tips mounted in street ells with raw gas lighter pipe in place. This is generally the best construction for large capacity and long pipe burners, especially in ovens.

3.5 Flame Supervision

Extended Cage Open Blast Burners can be fitted with flame sensing thermocouples, flame rods or scanners. Current NFPA 86 regulations do not permit thermocouple flame monitoring devices on furnaces with a total connected input greater than 150,000 BTU/hr. See Figure 3 for recommended flame rods and thermocouples.

Line Burner Pilot Sections and Pilot Mounting Brackets include or have provision for a flame rod. See Figure 3.

Blast Tips do not have provision for flame monitoring.

Sticktite and Ferrofix nozzles do not have provisions for flame monitors, but can be installed in Mounting Cages that accept flame rods or scanners. Recommended flame rods are listed in Figure 3. See Bulletin P-10 for details of the Mounting Cages.

Any flame sensing equipment supplied by the customer should be UL, FM, or CSA approved. **Caution: Failure to use suitable flame sensing devices and automatic fuel shutoff valves can cause explosions and fires.**

FIGURE 3 - FLAME RODS & THERMOCOUPLES

<u>Burner</u>	<u>Type Of Flame Monitor</u>	<u>Monitor Part No.</u>	<u>Electrode Length</u>
503 ECB through 516 ECB	Thermocouple	11753	—
	Flame Rod	12392	6"*
Line Burner Pilot Section No. 2L6SP	Flame Rod (included)	13093-3	3-1/4"
Line Burner Inlet Flange with Bracket Ass'y. 180016 or 180017	Flame Rod	12392	6", cut to 3"
Sticktite & Ferrofix Nozzles with BAH, CAH, or DAH Mounting Cage	Flame Rod	12392	6"*

*Cut rod to required length in field. Length will depend on length of adapter used to install 3/4" electrode in 1 1/4" cage connection.

3.6 Main Gas Valve Train

Gas must be supplied to the gas/air mixer inlet through a valve train which complies with NFPA Standards and all applicable local codes. Eclipse offers gas control valves and packaged gas trains suitable for this purpose.

3.7 Limit Controls

Limit Controls and Safety equipment should comply with current NFPA Standard 86 and all applicable local codes and/or standards. NFPA Standards are available from:

National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269

4.0 INSTALLATION

4.1 Burner Mounting

Extended Cage Open Blast Burners with blocks & holders: Install the block per guidelines in Sheet P-5 Installation Suggestions. An optional Combustion Block Slip Fit Adapter (201 CB) is available for adjusting the length of the block and holder assembly to various wall thicknesses. This adapter can be bolted to the exterior furnace shell. See Bulletin H-12 for details.

Extended Cage Open Blast Burners less blocks & holders: In applications where a combustion block is not required, such as ovens, the mounting cage may be bolted directly to the appliance wall. See Figure 4 for oven wall cutout and bolt location dimensions.

Sticktite and Ferrofix Nozzles: Figure 5 shows how Sticktite and Ferrofix Nozzles should be installed to fire through refractory walls. If furnace radiation tends to overheat the nozzles, use alloy nozzles. Depending on furnace draft and the amount of secondary air required for complete combustion, the optimum gap between the nozzle and furnace wall should be between 1/4" and 1". If in doubt, make the piping adjustable so the nozzle position can be changed.

4.2 Mixture Piping and Manifolds

General Recommendations

Gas/Air mixture piping and manifolds must be properly sized so burners can achieve rated capacity and produce uniform flame lengths. Figure 6 lists the maximum mixture volumes that can be carried by various sizes of pipes.

If mixture piping is extremely long (15 feet or more) or has a large number of resistances or fittings, pressure drops may be higher than expected. Compensate for this by using piping one size larger than shown in Figure 6.

Unless extreme care is taken in system design and operation, mixture lines larger than 4" pipe are highly susceptible to flashback. Unless the burner nozzle or mixer has a 5" or 6" connection, avoid using these sizes of pipe. If the total mixture capacity of several burners exceeds the capacity of a 4" manifold, consider dividing the burners among multiple manifolds.

Allow at least 9 pipe diameters of pipe run downstream of a mixer before installing an ell or tee. Use as few ells and tees between the mixer and burner as possible.

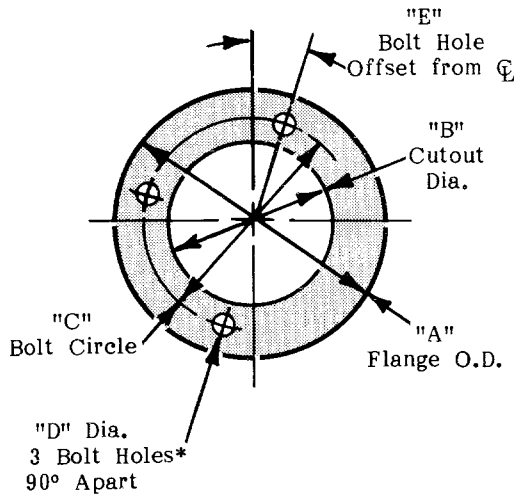
Do **not** install control valves in gas/air mixture lines.

If a steel flexible hose with convolutions is used between the mixer and burner with a 2-1/2" or less mixture line, the flexible hose should be at least two pipe diameter sizes larger, i.e. 1-1/2", use 2-1/2"; 2", use 3". Should the mixture line be 3" or larger, then flexible hose should be at least one pipe diameter size larger, i.e. 3", use 4"; 4", use 5".

Install mixture piping so that it is protected from heat from the combustion chamber. If this piping is allowed to get too hot, flashback may occur.

(Step 4.2 is continued on page 11.)

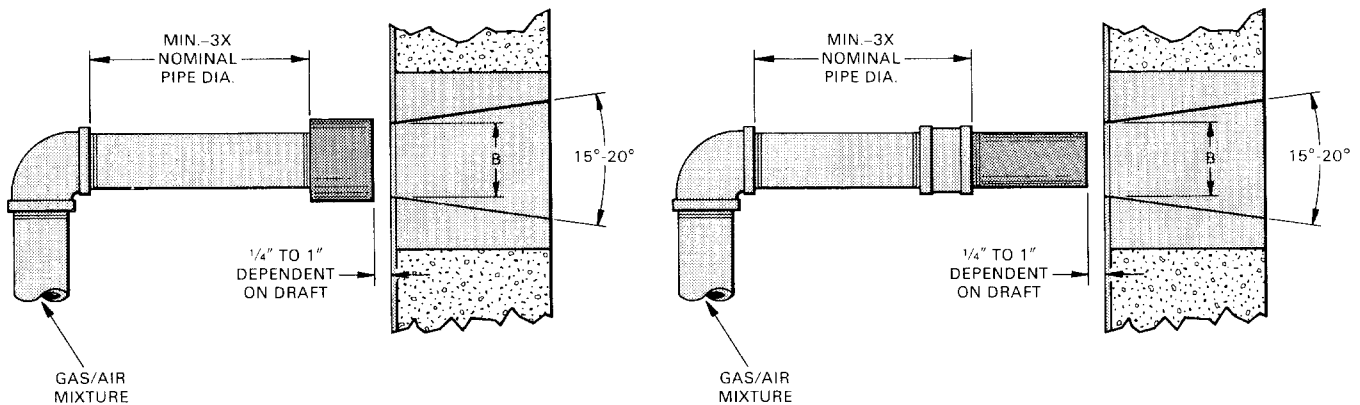
**FIGURE 4 - OVEN WALL CUTOUT & BOLT DIMENSIONS
FOR OPEN BLAST BURNER CAGE INSTALLATION**



Burner	A	B	C	D	E
503 thru 508 ECB	6-1/2"	3-1/2"	5-1/2"	5/16"	15°
510 thru 512 ECB	8-3/4"	4-7/8"	7-3/8"	9/16"	5°
516 ECB	12"	7-3/4"	10-3/4"	11/16"	70°

*4 Holes 90° apart for 516 ECB

**FIGURE 5 - INSTALLATION OF STICKTITE AND FERROFIX NOZZLES
FOR FIRING THROUGH REFRACTORY WALLS**



STICKTITE NOZZLES

PIPE SIZE	CATALOG NUMBER		DIA. B APPROX. RANGE
	CAST IRON	ALLOY	
1/2	ST-102	ST-102-A	1-1/8 - 1-5/8
		ST-102.5A	
3/4	ST-103	ST-103-A	1-3/8 - 1-5/8
		ST-103.5A	
1	ST-204	ST-104-A	1-7/8 - 2-3/8
1-1/4	ST-205	ST-105-A	1-7/8 - 2-1/2
		ST-105.5A	
1-1/2	ST-206	ST-106-BA	2-1/2 - 3
2	ST-208	ST-108-BA	2-7/8 - 3-1/2
		ST-208.5	
2-1/2	ST-210	---	3-3/4 - 5

3	ST-212	---	4 - 5-1/2
4	ST-216	---	4-1/2 - 6
6	ST-224	---	6 - 7-1/2

FERROFIX NOZZLES

PIPE SIZE	CATALOG NUMBER		DIA. B APPROX. RANGE
	STEEL	ALLOY*	
1/4	0F-1	NA	9/16 - 1
3/8	1F-1	1F-A	3/4 - 1-1/16
1/2	2F-1	2F-A	1 - 1-1/4
		3F-1,2	3F-A
1	4F-1,2	4F-A	1-1/2 - 1-7/8
1-1/4	5F-1,2	5F-A	2 - 2-3/8
1-1/2	6F-1,2	6F-A	2-1/4 - 2-5/8
2	8F-1,2	8F-A	2-3/4 - 3-1/4
2-1/2	10F-1,2	10F-A	3-1/4 - 3-3/4
3	12F-1,2	12F-A	3-3/4 - 4-1/2
4	16F-1,2	NA	5 - 6-1/4
5	20F-1,2	NA	6 - 7-1/2
6	24F-1,2	24F-A	7-1/4 - 9

*Alloy nozzles are available in Type 1 only.

NOTE: All dimensions are in inches.

FIGURE 6 - GAS/AIR MIXTURE CAPACITIES OF STANDARD PIPE

Pipe Size, Inches:	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6
Max. CFH in 1000's:	.3	.55	.9	1.5	2	3.5	5.5	8	13	26	37

FIGURE 7 - TYPICAL INSTALLATION OF BLAST TIPS IN PIPE MANIFOLDS



Pipe burner showing tips screwed directly into pipe. Suitable for small capacities and short lengths.

Pipe burner showing tips mounted in extension fittings. Reducing fittings may also be used where large tips of small capacity are used.

4.2 Mixture Piping and Manifolds (Cont'd)

Line Burner assemblies should be provided with enough mixture inlets to keep mixture velocities at reasonable levels. The table below lists the maximum firing rate permitted per each burner inlet connection.

% Primary Air in Premix	Max Btu/hr Per Each		
	1-1/2" inlet	2" inlet	3" inlet
70	235,000	385,000	850,000
80	205,000	340,000	755,000
90	190,000	310,000	680,000
100	170,000	280,000	620,000

Follow the guidelines in Figure 6 for sizing mixture piping to feed these connections.

Provide at least three pipe diameters of straight pipe run into **Extended Cage Open Blast Burners, Sticktite, Ferrofix and Unitite Nozzles**. Failure to do so will cause lopsided flames, less flexibility in gas/air ratios, and an increased susceptibility to flashback. See Figure 6. **Never** install an elbow or tee immediately ahead of the nozzle. Blast Tips are less sensitive to piping practice and can be screwed directly into mixture manifolds or couplings or elbows mounted on those manifolds. See Figures 2 and 8.

4.3 Flame Supervision Equipment

Install flame rods, scanners and cables so that ambient temperatures or furnace radiation will not overheat them. Heat block seals or cooling air connections may be necessary for UV Scanners.

Flame sensor wire must not be run in the same conduit as power or ignition wires.

4.4 Spark Ignition Plugs

Power supplied to ignition plugs must be 6000 VAC minimum at 120 VA. Do not use pipe dope on ignition plug threads. Run ignition cables in a separate conduit. Do not mix them with any other wiring.

4.5 General Piping Suggestions

All valves must be installed so that the arrow on the side of the valve body points in the direction of flow. If the handle of a manual plug type gas cock is removable, be sure that the handle is properly installed. When the valve is in the "off" position, the handle must be 90° or at a right angle to the line of flow through the valve.

Gas piping must comply with American National Standard "National Fuel Gas Code"* (NFPA No. 54 or ANSI Z223.1), or must be acceptable to the authority having jurisdiction.

4.6 General Wiring Suggestions

Electrical wiring must comply with the National Electric Code*, (NFPA Std. 70 or ANSI-CI 1981), or must be acceptable to the authority having jurisdiction.

*Available from:

National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269

American National Standard Institute
1430 Broadway
New York, New York 10018

5.0 STARTUP AND ADJUSTMENT

5.1 Close Gas Valves

Close all manual and automatic gas valves, including the main gas butterfly and the pilot gas cock.

5.2 Start Combustion Air Blower

Check the impeller for correct rotation. If it's running backward, have a qualified electrician change the motor wiring.

5.3 Start Duct or Circulating Fan

If the burner is to fire into a duct or chamber with a circulating fan, start the fan to produce full process air flow past the burner.

5.4 Set High and Low Fire Air and Gas Flows

The method for doing this will depend on the type of air/gas mixer used. Refer to the mixer instruction sheets for the correct procedure.

5.5 Check High and Low Fire

Cycle the burner from high to low several times to check repeatability of settings.

If combustion chamber or duct pressure is likely to change as the oven comes up to operating temperature, re-check burner settings hot and re-adjust them if necessary.

5.6 Shutdown

The blower must not be turned off until the chamber temperature is below 250°F. This will prevent hot gases from flowing back over the burner and damaging it.

6.0 TROUBLE-SHOOTING

Caution: Trouble-shooting of panels and electrical circuits should be done by qualified plant electricians, technicians, or engineers experienced in all facets of this type of combustion equipment.

6.1 Burner Fails to Light

- a) On initial start-up, gas line may be filled with air. Repeat ignition trial several times to purge.
- b) No power to ignition transformer or gas solenoid valve.
- c) Open circuit between ignition transformer and spark plug.
- d) Spark plug needs cleaning.
- e) Spark plug center electrode grounded against burner.
- f) Spark plug improperly grounded. Do not use pipe dope on ignition plug threads.

6.2 Flame Too Long and Yellow on High Fire

- a) Gas flow is too high. Adjust ratio at mixer.

6.3 Flame Too Short on High Fire

- a) Gas flow is too low. Adjust ratio at mixer.

6.4 Flame Too Long and Yellow on Low Fire

- a) Gas flow is too high. Adjust low fire ratio per mixer instructions.
- b) Air flow is too low. Adjust low fire ratio per mixer instructions.

6.5 Burner Backfires

- a) Low fire mixture pressure is below recommended minimum. Adjust upward.
- b) Nozzle or mixture piping is overheated. Provide protection from excessive ambient or furnace temperatures.
- c) Improper mixture piping design. Refer to Section 4.2.

7.0 MAINTENANCE

7.1 Maintenance Program

A sound preventative maintenance program, carried out by qualified individuals, will greatly increase equipment reliability and productivity. Frequency of maintenance checks should reflect the duty cycle of the heating equipment and conditions such as dirt and temperature. Any maintenance program should include at least the following steps:

- a) Check burner high and low fire air and gas settings.
- b) Examine and, if necessary, clean or replace air and gas filter elements.
- c) Check all piping connections for leaks.
- d) Check the ability of the flame supervision system to function properly by simulating system failures:
 1. Simulate burner flame-out by manually shutting off the gas.
 2. Trip out pressure switches and other limit interlocks.
 3. Try to light the burner before the purge and other timers have finished their cycles.

7.1 Maintenance Program (Cont'd.)

If simulated limit or flame failures do not shut down the fuel system within an acceptably short period of time, immediately take the equipment out of service and correct the problem.

- e) Leak test automatic and manual reset fuel valves per insurance company procedures.
- f) Check all bolts and screws for tightness.