Eclipse Tube Firing Burners
ThermThief Series Version 1.00

Design Guide
No. 310, 7/99

Eclipse Combustion
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Any operation expressly prohibited in this Guide, any adjustment, or assembly procedures not recommended or authorized in these instructions shall void the warranty.
This manual has been written for people who are already familiar with all aspects of a nozzle-mix burner and its add-on components, also referred to as “the burner system.”

These aspects are:
• design/selection
• use
• maintenance.

Design Guide No. 310
• This document

Data Sheet No. 310-1 through 310-3
• Available for individual TFB models
• Required to complete design calculations in this guide

Installation Guide No. 310
• Used with Data Sheet to complete installation

Price List No. 310
• Used to order burners

EFE 825 (Combustion Engineering Guide)
• Eclipse bulletins and Info Guides: 610, 710, 720, 730, 742, 744, 760, 930, I-354.

Purpose
The purpose of this manual is to make sure that the design of a safe, effective and trouble-free combustion system is carried out.
There are several special symbols in this document. You must know their meaning and importance.

The explanation of these symbols follows below. Please read it thoroughly.

**Danger:**

Indicates hazards or unsafe practices which WILL result in severe personal injury or even death.

Only qualified and well trained personnel are allowed to carry out these instructions or procedures.

Act with great care and follow the instructions.

**Warning:**

Indicates hazards or unsafe practices which could result in severe personal injury or damage.

Act with great care and follow the instructions.

**Caution:**

Indicates hazards or unsafe practices which could result in damage to the machine or minor personal injury.

Act carefully.

**Note:**

Indicates an important part of the text. Read thoroughly.

If you need help, you can contact your local Eclipse Combustion representative. You can also contact Eclipse Combustion at any of the addresses listed on the back of this document.
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PRODUCT DESCRIPTION

The ThermThief is a nozzle-mix tube-firing burner that is designed to fire into radiant tubes or immersion tubes.

**Flame guidance**

An alloy air tube maintains the proper air velocity past the nozzle, regardless of the heater tube diameter. The flame heats the heater tube uniformly without hot spots that might reduce the life of the tube or overheat the process fluid.

**Recuperator**

The ThermThief can be used with or without an exhaust leg recuperator. An exhaust leg recuperator is a heat exchanger that transfers heat from the exhaust air to the combustion air. Preheating the combustion air can increase the fuel efficiency by as much as 20%. The ThermThief can handle combustion air temperatures up to 800°F. The recommended recuperators for the ThermThief are the Eclipse Bayonet (Data 317) and the Bayonet-Ultra (Spec. 318).
Important notices about safe burner operation will be found in this section.

⚠️ **Danger:**

The burners covered in this manual are designed to mix fuel with air and burn the resulting mixture. All fuel burning devices are capable of producing fires and explosions when improperly applied, installed, adjusted, controlled or maintained.

Do not bypass any safety feature. Fires and explosions can be caused.

Never try to light the burner if the burner shows signs of damage or malfunctioning.

⚠️ **Warning:**

The burner is likely to have HOT surfaces. Always wear protective clothing when approaching the burner.

💡 **Note:**

This manual gives information for the use of these burners for their specific design purpose. Do not deviate from any instructions or application limits in this manual without written advice from Eclipse Combustion.

Read this entire manual before attempting to start the system. If any part of the information in this manual is not understood, then contact your local Eclipse Combustion representative or Eclipse Combustion before continuing.
Adjustment, maintenance and troubleshooting of the mechanical and the electrical parts of this system should be done by qualified personnel with good mechanical aptitude and experience with combustion equipment.

The best safety precaution is an alert and competent operator. Thoroughly instruct new operators so they demonstrate an adequate understanding of the equipment and its operation. Regular retraining must be scheduled to maintain a high degree of proficiency.

Order replacement parts from Eclipse only. Any customer-supplied valves or switches should carry UL, FM, CSA, CGA and/or CE approval where applicable.
DESIGN

Design Structure

Designing a burner system is a straight-forward exercise of combining steps that add up to a reliable and safe system. These steps are:

1. Burner selection and tube design.
2. Control methodology.
3. Ignition System.
4. Flame monitoring system.
6. Main gas shut-off valve train.

Step 1: Burner selection

The design of a combustion system for radiant tubes and immersion tubes is significantly different. For this reason, we have divided the process for burner selection into two separate sections;

• "Step 1a: Radiant tube burner application" on page 9
• "Step 1b: Immersion tube burner application" on page 14.

All individual burner performance data including dimensions, capacities, operating parameters and emissions information can be found in the following Data Sheets:
• 310-1 Data 30 TFB • 310-2 Data 75 TFB • 310-3 Data 200 TFB

Fuel type

The usable fuel types are:
• natural gas
• propane
• butane.

For other fuels, contact Eclipse Combustion with an accurate breakdown of the fuel contents.

Air type

• ambient
• preheat.

Calculate the required heat release per tube

Given the net heat requirement of the furnace (Btu/hr), divide by the number of radiant tubes to determine the required heat release per tube.
Calculate the tube surface area
The burner radiates its heat to the process through the wall of the tube. To calculate the required burner input you must know the total area of the tube inside the furnace.

To calculate the tube surface area, use this formula:

\[ \text{Tube surface area} = OD \times \pi \times n \times L \]

- OD = the outside diameter of the tube in inches.
- \( \pi = 3.142 \)
- \( n = \) number of tube legs
  - 2 for a U-tube
  - 3 for a trident tube
  - 4 for a W-tube.
- L = the total length of each leg in inches.

Determine the maximum heat transfer rate
The maximum heat transfer rate is the maximum amount of heat that the tube can radiate to the process per time unit.

The maximum heat transfer rate of a tube depends on the temperature of the chamber and how the tube is mounted inside the furnace. A tube can be enclosed in the structure of the furnace or not enclosed.

An enclosed tube has a lower maximum heat transfer rate than a tube which is free to radiate in all directions.

**Table 3.1 Maximum heat transfer rate**

<table>
<thead>
<tr>
<th>CHAMBER TEMPERATURE (°F)</th>
<th>MAX. HEAT TRANSFER RATE (BTU/HR PER IN²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOT ENCLOSED TUBE</td>
</tr>
<tr>
<td>1000</td>
<td>90</td>
</tr>
<tr>
<td>1300</td>
<td>80</td>
</tr>
<tr>
<td>1550</td>
<td>70</td>
</tr>
<tr>
<td>1650</td>
<td>60</td>
</tr>
<tr>
<td>1750</td>
<td>50</td>
</tr>
<tr>
<td>1850</td>
<td>45</td>
</tr>
</tbody>
</table>

Calculate the maximum heat release
Multiply the previously calculated tube surface area by the maximum heat transfer rate:

\[ \text{Maximum heat release} = \text{tube surface area} \times \text{max heat transfer rate} \]
Compare the heat releases

Compare the required heat release with the maximum heat release.

If the required heat release is greater than the maximum heat release, then the number or the size of the radiant tubes must be increased.

⚠️ **Caution:**
Exceeding the maximum heat release will significantly shorten the tube life.

Determine efficiency

Decide whether or not you want to use a recuperator. A recuperator is a heat exchanger which uses heat from the exhaust to pre-heat the combustion air. The effect of a recuperator on the efficiency of the system can be significant, as shown in the table below.

**Table 3.2 Efficiency**

<table>
<thead>
<tr>
<th>Furnace Chamber Temperature (°F)</th>
<th>% Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without recuperator (ambient air)</td>
</tr>
<tr>
<td>1000</td>
<td>57</td>
</tr>
<tr>
<td>1300</td>
<td>51</td>
</tr>
<tr>
<td>1550</td>
<td>47</td>
</tr>
<tr>
<td>1650</td>
<td>44</td>
</tr>
<tr>
<td>1750</td>
<td>41</td>
</tr>
<tr>
<td>1850</td>
<td>39</td>
</tr>
</tbody>
</table>

Calculate the gross burner input

Calculate the gross burner input (Btu/hr) with this formula:

\[
\text{Gross burner input} = \frac{\text{Required heat release}}{\text{Efficiency}}
\]
Compare the gross burner input

Compare the gross burner input with the maximum tube input. If the gross burner input is greater than the maximum tube input from the table below, then the size of the radiant tube must be increased.

**Table 3.3 Maximum tube input**

<table>
<thead>
<tr>
<th>TUBE I.D. (INCHES)</th>
<th>MAXIMUM INPUT (1000's BTU/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>600</td>
</tr>
<tr>
<td>6</td>
<td>900</td>
</tr>
<tr>
<td>8</td>
<td>1500</td>
</tr>
<tr>
<td>10</td>
<td>2500</td>
</tr>
<tr>
<td>12</td>
<td>3500</td>
</tr>
</tbody>
</table>

Exceeding these inputs may result in burner pulsation or other operational problems.

Sizing example

Application parameters
- 4 U-tubes - 4.5" OD x 75" effective length
- 500,000 Btu/hr total required heat release - recuperated
- 1650 °F chamber temperature
- open radiant angles (not enclosed tubes).

1. The required heat release per tube:

\[
\frac{\text{total required heat release}}{\text{number of tubes}} = \text{Required heat release per tube}
\]

- \( \frac{500,000}{4} = 125,000 \text{ Btu/hr} \)

2. Tube surface area for each tube:

\[
\text{OD} \times \pi \times n \times L = \text{Tube surface area}
\]

- \( 4.5 \times 3.142 \times 2 \times 75 = 2120.85 \text{ in}^2 \)

  (n=2 Because it is a U-tube which has two legs).

3. From Table 3.1 "Maximum heat transfer rate" on page 10, find the maximum heat transfer rate:

- 60 Btu/in²/hr.
4. The maximum permissible heat release (per tube) is:

\[ \text{tube surface area} \times \text{max heat transfer rate} = \text{Maximum heat release} \]

- \( 2120.85 \times 60 = 127,251 \text{ Btu/hr} \).

5. This is sufficient, because only 125,000 Btu/hr is required.

6. From Table 4.2 "Efficiency" on page 11, find the efficiency with a recuperator at 1650 °F:

- 64%.

7. The gross burner input (per tube) is:

\[ \frac{\text{Required heat release}}{\text{Efficiency}} \times 100 = \text{Gross burner input} \]

- \( \frac{125,000}{64} \times 100 = 195,312 \text{ Btu/hr} \).

Size the system for 200,000 Btu/hr per burner.

8. Compare the result from step 7 to the required maximum inputs in Table 4.3 on page 12. Gross input is less than 300,000 Btu/hr, therefore, the 4" I.D. tube can be used.
**Air tube length**

The air tube length varies based on the location of the hot face of the furnace relative to the mounting flange of the burner.

*Figure 3.1  Air tube length*

The end of the air tube 1 must be within $\pm \frac{1}{2}"$ of the face of the furnace wall 2.

You must choose the length closest to your requirements. You can find the air tube lengths (dimension B) that are available in the appropriate Data Sheet. 310-1 (30 TFB), 310-2 (75 TFB), 310-3 (200 TFB).

**Step 1b: Immersion tube burner application**

**Determine the net heat release required to the tank**

The net heat release to the tank is derived from heat balance calculations. These calculations are based on the heatup- and steady state-requirements of the process, and take into account surface losses, tank wall losses and tank heat storage. Detailed guidelines for heat balance calculations are in the Eclipse Combustion Engineering Guide (EFE 825).

**Determine the efficiency**

The efficiency of the tube is directly linked to the effective tube length. The diameter of the tube has no influence on the efficiency. The efficiency of the tube is the factor between the burner input to the tube and net output to the tank. At a given burner input, the net output to the tank is higher for a longer tube than for a relatively short tube.
Note:
A commonly used efficiency is 70%. Efficiencies greater than 85% will produce condensation in the tube which may shorten tube life or disrupt the system.

Figure 3.2 below shows the relationship between the tube length and the efficiency.

**Figure 3.2 Effective tube length**

The effective tube length required is a function of the efficiency chosen.

The effective length of a tube is the total length of straight tube covered by liquid. Add 13" for each 90° bend.

**Calculate the gross burner input**

Calculate the gross burner input in (Btu/hr) with this formula:

\[
\text{Gross Burner input} = \frac{\text{Net heat release to the tank}}{\text{Tube efficiency}}
\]
Compare the gross burner input

Compare the gross burner input with the maximum tube input. If the gross burner input is greater than the maximum tube input from the table below, then the size of the immersion tube must be increased.

Table 3.4 Maximum tube input

<table>
<thead>
<tr>
<th>TUBE I.D. (INCHES)</th>
<th>MAXIMUM INPUT (1000's BTU/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>600</td>
</tr>
<tr>
<td>6</td>
<td>900</td>
</tr>
<tr>
<td>8</td>
<td>1500</td>
</tr>
<tr>
<td>10</td>
<td>2500</td>
</tr>
<tr>
<td>12</td>
<td>3500</td>
</tr>
</tbody>
</table>

Exceeding these inputs may result in burner pulsation or other operational problems.

Sizing example

Application parameters

- Net heat release required to tank: 1,000,000 Btu/hr
- Efficiency: 70%
- Effective tube length: (Fig. 3.2) 37'
- Gross Burner Input: \( \frac{1,000,000}{0.70} = 1,428,571 \) Btu/hr
- 200TFB Burner: 2,000,000 Btu/hr maximum capacity
- Minimum Tube I.D.: (Table 3.4) = 8"
- Tube Surface Area/sq. in. = \( O.D. \times \pi \times L \)
  
  \[ O.D. = 8.625 \]
  
  \[ \pi = 3.142 \]
  
  \[ L = \text{Total effective tube length in inches} = (37 \times 12) = 444" \]
  
  \[ 8.625 \times 3.142 \times 444 = 12,032.3 \text{ sq. in.} \]
- Btu/hr/sq.in = Net heat release to tank / sq.in. surface area
  
  \[ \frac{1,000,000}{12,032.3} = 83.1 \text{ Btu/sq.in./hr} \]

Note:

If the medium to be heated in the above example was cooking oil, it would be necessary to increase tube length or select a larger tube. It is recommended that you not exceed 50 Btu/hr/sq.in. for cooking oil.
Air tube length

The air tube length should be as short as possible to maximize the exposure of the immersion tube to the flame.

Caution:
Any section of immersion tube that extends beyond the nozzle, must be submerged in the liquid. Dimension B must be greater than Dimension A.

Figure 3.3 Air tube length

Choose the shortest tube length (Dimension B) that is greater than Dimension A. You can find the air tube lengths (dim. B) that are available in the appropriate Data Sheet. 310-1 (30TFB), 310-2 (75TFB), 310-3 (200TFB).

Tube design

1. Elbows
   a. We recommend the use of standard and sweep elbows only.
   b. The first elbow should be at least eight tube diameters from the face of the burner.

2. Stack
   a. Make sure that the stack is large enough to handle the exhaust flow plus the dilution air.
   b. The stack must be at least one pipe size larger than the tube exhaust.

Note:
3. **Draft breaking hood**

A draft breaking hood is an open connection between the heater tube exhaust and the exhaust stack. It allows fresh dilution air to pass into the exhaust and mix with the exhaust gases.

The advantages of a draft hood are:

- the burner operation is less sensitive to atmospheric conditions
- the temperature of the exhaust gases is lower when they pass through the roof.

**Note:**

Make sure that it is possible to get access between the draft hood and the tube exhaust. Then you can install a damper plate if acoustic feedback occurs in the tube.

---

**Step 2: Control methodology**

**The control methodology is the basis for the rest of the design process.** Once you know what your system will look like, you can select the individual components. **Which control methodology you choose depends on the type of process that you want to control.**

**Control methods**

There are two main methods to control the input of a ThermThief system:

1. **Modulating control**

   A burner system with modulating control gives an input that is in proportion with the demands of the process. Any input between high and low fire is possible. The burner operates at 15% excess air at high fire, and 100% excess air (min.) at low fire.

2. **High/low control**

   A system with high/low control gives a high or low fire input to the process. No input between high and low fire is possible. The burner operates at 15% excess air at high fire, and 100% excess air (min.) at low fire.

The only difference in the components is the type of actuator on the automatic butterfly valve (control valve 1, page 19).

On the next page you will find schematics of these control methods. The symbols in the schematics are explained in the Appendix on page 28.
Automatic gas shut-off by burner (optional)
As an option, an automatic gas shut-off valve can be installed.
If the flame monitoring system detects a failure, the gas shut-off valve closes, interrupting the gas supply to the burner that caused the failure.

System schematics

1. Air
   The control valve is in the air line. It sets the air flow to the required value.

2. Gas
   The ratio regulator allows the required amount of gas to go to the burner. Low fire gas is limited by ratio regulator . High fire gas is limited by the manual butterfly valve .

Figure 3.4  System schematics
(Modulating or High/Low control)

Combustion air at ambient temperature
(Radiant & Immersion applications)

Pre-heated combustion air
(Radiant applications)
Step 3: Ignition System

For the ignition system use:
- 6000 VAC transformers
- full wave spark transformers
- one transformer per burner.

Do NOT use:
- 10,000 VAC transformers
- twin outlet transformers
- distributor type transformers
- half wave spark transformers.

ThermThief burners are capable of direct spark ignition anywhere within the listed operating range. However, it is recommended that low fire start be used. Local safety and insurance requirements demand that you limit the maximum time that a burner takes to ignite. These time limits vary from country to country. For the USA the time limit is 15 seconds, for Europe it is 3 seconds.

The time that a burner takes to ignite depends on:
- the distance between the gas shut-off valve and the burner
- the air/gas ratio
- the gas flow at start conditions.

In the USA, with a time of 15 seconds to ignition, there should be sufficient time to ignite the burners. It is possible, however, to have the low fire too low to ignite within the time limit. Under these circumstances you must consider the following options:
- start at higher input levels
- resize and/or relocate the gas controls

Step 4: Flame monitoring system

A flame monitoring system consists of two main parts:
- a flame sensor
- flame monitoring control.

Note:
A flame monitoring system may not be required. Check your local standards to verify.

Flame sensor

You can find information in:
- Info Guide 852; 90° U.V. scanner
- Info Guide 854; straight U.V. scanner

Note:
When using the U.V. scanner it is necessary to use mounting adaptor part #10033 to ensure that the U.V. scanner will not detect the ignition spark.
Step 5: Combustion Air System: Blower and air pressure switch

Flame monitoring control
The flame monitoring control is the equipment that processes the signal from the U.V. scanner.

For flame monitoring control selection there are several options:
- flame monitoring control for each burner: if one burner goes down, only that burner will be shut-off.
- multiple burner flame monitoring control: if one burner goes down, all burners will be shut-off.

There are three flame monitoring controls that are recommended:
- Bi-flame series; see Bulletin/Info guide 826
- Multi-flame series 6000; see Bulletin/Info guide 820
- Veri-flame; see Bulletin/Info guide 818.

The effects of atmospheric conditions
Blower data is based on the International Standard Atmosphere (ISA) at Mean Sea Level (MSL), which means that it is valid for:
- sea level
- 29.92” Hg
- 70ºF.

If you are above sea level or in a hot area, the properties of the air are different. As the density of the air decreases, the outlet pressure and the flow of the blower decreases.

An accurate description of these effects is in the Eclipse Combustion Engineering Guide (EFE 825). The Guide contains tables for the effect of pressure, altitude and temperature on air.

Blower
The rating of the blower must match the system requirements. You can find all the blower data in:

Follow these steps:

1. Calculate the outlet pressure.
   When you calculate the outlet pressure of the blower, you must calculate the total of these pressures:
   - the static air pressure required at the burner
   - the total pressure drops in the piping
   - the total of the pressure drops across the valves
   - the pressure in the radiant or immersion tube (suction or pressurized)
   - recommend safety margin of 10%.
Step 5: Combustion Air System: Blower and air pressure switch (continued)

2. Calculate the required flow

The blower output is the air flow delivered under standard atmospheric conditions. It must be enough to feed all the burners in the system at high fire. Combustion air blowers are normally rated in terms of standard cubic feet per hour (scfh) of air.

An example calculation follows the information tables below:

**Table 3.5 Required calculation information**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>UNIT OF MEASURE</th>
<th>FORMULA SYMBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total system heat input</td>
<td>Btu/hr</td>
<td>Q</td>
</tr>
<tr>
<td>Number of burners</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Type of fuel</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gross heating value of fuel</td>
<td>Btu/ft³</td>
<td>q</td>
</tr>
<tr>
<td>Desired excess air percentage</td>
<td>percent</td>
<td>%</td>
</tr>
<tr>
<td>(Typical excess air percentage @ high fire is 15%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air/Gas ratio (Fuel specific, see table below)</td>
<td>-</td>
<td>( \alpha )</td>
</tr>
<tr>
<td>Air flow</td>
<td>scfh</td>
<td>( V_{air} )</td>
</tr>
<tr>
<td>Gas flow</td>
<td>scfh</td>
<td>( V_{gas} )</td>
</tr>
</tbody>
</table>

**Table 3.6 Fuel gas heating values**

<table>
<thead>
<tr>
<th>FUEL GAS</th>
<th>STOICHIOMETRIC* AIR/GAS RATIO ( \alpha ) (ft³ ( \text{air} )/ft³ ( \text{gas} ))</th>
<th>GROSS HEATING VALUE ( q ) (Btu/ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas (Birmingham, AL)</td>
<td>9.41</td>
<td>1,002</td>
</tr>
<tr>
<td>Propane</td>
<td>23.82</td>
<td>2,572</td>
</tr>
<tr>
<td>Butane</td>
<td>30.47</td>
<td>3,225</td>
</tr>
</tbody>
</table>

\* Stoichiometric: No excess air. The precise amount of air and gas are present for complete combustion.
**Application example:**

“A batch furnace has been designed and requires a heat input of 2,900,000 btu/hr. It has been decided to provide the required heat input with four burners operating on natural gas using 15% excess air.”

**Calculation example:**

a. Decide which ThermThief burner model is appropriate:

\[
Q \text{ (total heat input)} = \frac{2,900,000 \text{ btu/hr}}{4 \text{ burners}} = 725,000 \text{ Btu/hr/burner}
\]

- Select 4 Model TFB075 ThermThief burners based on the required heat input of 725,000 Btu/hr for each burner.

b. Calculate required gas flow:

\[
V_{\text{gas}} = \frac{Q}{q} = \frac{2,900,000 \text{ btu/hr}}{1,002 \text{ Btu/ft}^3} = 2,894 \text{ ft}^3/\text{hr}
\]

- Gas flow of 2,894 ft³/hr is required

c. Calculate required stoichiometric air flow:

\[
V_{\text{air-Stoichiometric}} = \alpha \times V_{\text{gas}} = 9.41 \times 2,894 \text{ ft}^3/\text{hr} = 27,235 \text{ ft}^3/\text{hr}
\]

- Stoichiometric air flow of 27,235 scfh required

d. Calculate final blower air flow requirement based on the desired amount of excess air:

\[
V_{\text{air}} = (1 + \text{excess air \%}) \times V_{\text{air-Stoichiometric}}
\]

\[
= (1 + 0.15) \times 27,235 \text{ ft}^3/\text{hr} = 31,320 \text{ ft}^3/\text{hr}
\]

- For this example, final blower air flow requirement is 31,320 scfh at 15% excess air.

**Note:**

*It is common practice to add an additional 10% to the final blower air flow requirement as a safety margin.*

3. Find the blower model number and motor horsepower (hp).

With the output pressure and the specific flow, you can find the blower catalog number and the motor hp in Bulletin / Info Guide 610.

4. Eclipse Combustion recommends that you select a Totally Enclosed Fan Cooled (TEFC) motor.

5. Select the other parameters:

- inlet filter or inlet grille
- inlet size (frame size)
- voltage, number of phases, frequency
- blower outlet location, and rotation direction Clockwise (CW) or Counter Clockwise (CCW).
Step 5: Combustion Air System: Blower and air pressure switch (continued)

Note:
The use of an inlet air filter is strongly recommended. The system will perform longer and the settings will be more stable.

Note:
When selecting a 60 Hz Blower for use on 50 Hz, a pressure and capacity calculation is required. See Eclipse Combustion Engineering Guide (EFE 825)

The total selection information you should now have:
• blower model number
• motor hp
• motor enclosure (TEFC)
• voltage, number of phases, frequency
• rotation direction (CW or CCW).

Air pressure switch
The air pressure switch gives a signal to the monitoring system when there is not enough air pressure from the blower. You can find more information on pressure switches in:
• Blower Bulletin 610

Warning:
Eclipse Combustion supports NFPA regulations, which require the use of an air pressure switch in conjunction with other safety components, as a minimum standard for main gas safety shut-off systems.

Consult Eclipse
Eclipse can help you design and obtain a main gas shut-off valve train that complies with the current safety standards. The shut-off valve train must comply with all the local safety standards set by the authorities that have jurisdiction. For details, please contact your local Eclipse Combustion representative or Eclipse Combustion.

Note
Eclipse Combustion supports NFPA regulations (two shut-off valves) as a minimum standard for main gas safety shut-off systems.

Consult Eclipse
The process temperature control system is used to control and monitor the temperature of the system. There is a wide variety of control and measuring equipment available. For details, please contact your local Eclipse Combustion representative or Eclipse Combustion.
## Conversion Factors

### Metric to English
This table also contains a few Metric to Metric conversions.

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MULTIPLY BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg</td>
<td>lb</td>
<td>2.205</td>
</tr>
<tr>
<td>kPa</td>
<td>mbar</td>
<td>10</td>
</tr>
<tr>
<td>kW</td>
<td>Btu/hr</td>
<td>3414</td>
</tr>
<tr>
<td>m</td>
<td>ft</td>
<td>3.28</td>
</tr>
<tr>
<td>m³</td>
<td>ft³</td>
<td>35.31</td>
</tr>
<tr>
<td>m³/h</td>
<td>cfh</td>
<td>35.31</td>
</tr>
<tr>
<td>mbar</td>
<td>In wc</td>
<td>0.401</td>
</tr>
<tr>
<td>mbar</td>
<td>kPa</td>
<td>0.1</td>
</tr>
<tr>
<td>mbar</td>
<td>Psi</td>
<td>14.5 x 10⁻³</td>
</tr>
<tr>
<td>mm</td>
<td>ln</td>
<td>3.94 x 10⁻²</td>
</tr>
</tbody>
</table>

°F = 9/5°C + 32

### English to Metric
This table also contains a few English to English conversions.

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
<th>MULTIPLY BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/hr</td>
<td>kW</td>
<td>0.293 x 10⁻³</td>
</tr>
<tr>
<td>cfh</td>
<td>m³/h</td>
<td>2.832 x 10⁻²</td>
</tr>
<tr>
<td>ft</td>
<td>m</td>
<td>0.3048</td>
</tr>
<tr>
<td>ft</td>
<td>ln</td>
<td>12</td>
</tr>
<tr>
<td>ft³</td>
<td>m³</td>
<td>2.832 x 10⁻²</td>
</tr>
<tr>
<td>ln</td>
<td>ft</td>
<td>8.333 x 10⁻²</td>
</tr>
<tr>
<td>ln</td>
<td>mm</td>
<td>25.4</td>
</tr>
<tr>
<td>ln wc</td>
<td>mbar</td>
<td>2.49</td>
</tr>
<tr>
<td>lb</td>
<td>kg</td>
<td>0.454</td>
</tr>
<tr>
<td>Psi</td>
<td>mbar</td>
<td>68.95</td>
</tr>
</tbody>
</table>

°C = 5/9 (°F - 32)
# Key to the System Schematics

Symbols used in the schematics on page 19.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Appearance</th>
<th>Name</th>
<th>Remarks</th>
<th>Bulletin/Info Guide</th>
</tr>
</thead>
</table>
| ![ThermThief burner symbol](image) | ![ThermThief burner image] | ThermThief burner | Available sizes:  
• 30 TFB  
• 75 TFB  
• 200 TFB. |  |
| ![Recuperator symbol](image) | ![Recuperator image] | Recuperator | A recuperator is a heat exchanger. It transfers heat from the exhaust gases to the combustion air. Doing that can improve the thermal efficiency of the burner by as much as 20%. | 318 |
| ![Safety valve train symbol](image) | ![Safety valve train image] | Safety valve train | Eclipse Combustion strongly endorses NFPA as a minimum. | 756 |
| ![Combustion air blower symbol](image) | ![Combustion air blower image] | Combustion air blower | The combustion air blower provides the combustion air to the burner(s). | 610 |
| ![Air pressure switch symbol](image) | ![Air pressure switch image] | Air pressure switch | The air pressure switch gives a signal to the safety system when there is not enough air pressure from the blower. | 610 I-354 |
| ![Gas cock symbol](image) | ![Gas cock image] | Gas cock | Gas cocks are used to manually shut off the gas supply on both sides of the main gas shut-off valve train. | 710 |
| ![Solenoid valve symbol](image) | ![Solenoid valve image] | Solenoid valve | Solenoid valves are used to automatically shut off the gas supply on small capacity burner systems. | 760 |
| ![Manual butterfly valve symbol](image) | ![Manual butterfly valve image] | Manual butterfly valve | Manual butterfly valves are used to balance the air flow at each burner, and/or to control the zone flow. | 720 |
### Automatic Butterfly Valve

Automatic butterfly valves are typically used to set the output of the system.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>APPEARANCE</th>
<th>NAME</th>
<th>REMARKS</th>
<th>BULLETIN/INFO GUIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Symbol" /></td>
<td><img src="image2.png" alt="Appearance" /></td>
<td>Automatic butterfly valve</td>
<td>Automatic butterfly valves are typically used to set the output of the system.</td>
<td>720</td>
</tr>
</tbody>
</table>

### Ratio Regulator

A ratio regulator is used to control the air/gas ratio. The ratio regulator is a sealed unit that adjusts the gas flow in ratio with the air flow. To do this, it measures the air pressure with a pressure sensing line, the impulse line. This impulse line is connected between the ratio regulator and the air supply line.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>APPEARANCE</th>
<th>NAME</th>
<th>REMARKS</th>
<th>BULLETIN/INFO GUIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Symbol" /></td>
<td><img src="image4.png" alt="Appearance" /></td>
<td>Ratio regulator</td>
<td>A ratio regulator is used to control the air/gas ratio. The ratio regulator is a sealed unit that adjusts the gas flow in ratio with the air flow. To do this, it measures the air pressure with a pressure sensing line, the impulse line. This impulse line is connected between the ratio regulator and the air supply line.</td>
<td>742</td>
</tr>
</tbody>
</table>