Eclipse Velocity Burners
ThermJet Series Version 1.00
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Audience

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.

The audience is expected to have had experience with this kind of equipment.

ThermJet Documents

Design Guide No. 205
- This document

Data Sheet No. 205-1 through 205-9
- Available for individual TJ models
- Required to complete design calculations in this guide

Installation Guide No. 205
- Used with Data Sheet to complete installation

Price List No. 205
- Used to order burners

Related Documents

- 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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The ThermJet is a nozzle-mix burner that is designed to fire an intense stream of hot gases through a combustor using combustion air temperatures up to 600° F.

The high velocity of the gases improves temperature uniformity, product quality and system efficiency.

The ThermJet burner comes in two types:
• High Velocity (HV)
• Medium Velocity (MV)

The gas velocity can be as high as 500 ft/s for the High Velocity burner, and 250 ft/s for the Medium Velocity burner.
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.
<table>
<thead>
<tr>
<th>CAPABILITIES</th>
<th>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.</th>
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<tbody>
<tr>
<td>OPERATOR TRAINING</td>
<td>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.</td>
</tr>
<tr>
<td>REPLACEMENT PARTS</td>
<td>Order replacement parts from Eclipse only. Any customer-supplied valves or switches should carry UL, FM, CSA, CGA and/or CE approval where applicable.</td>
</tr>
</tbody>
</table>
Design structure
Designing a burner system is a straight-forward exercise of combining modules that add up to a reliable and safe system. The design process is divided into the following steps:

1. Burner model selection:
   a. the burner size and quantity
   b. the flame velocity
   c. the fuel type and pressure
   d. the combustor type

2. Control methodology

3. Ignition system

4. Flame monitoring system

5. Combustion air system: blower and air pressure switch

6. Main gas shut-off valve train selection

7. Process temperature control system

Burner size and quantity
Select the size and number of burners based on the heat balance. For heat balance calculations, refer to the Combustion Engineering Guide (EFE 825).
All the sizes and the performances are in:
- ThermJet Selection Guide 205-0
- Data Sheets 205-1 through 205-9

Flame velocity
Each burner size comes in two versions, High or Medium Velocity. Select the version needed based on requirements for temperature uniformity, circulation, chamber size, air pressure and overall operating costs.
Flame velocity information is in:
• ThermJet Selection Guide 205-0
• Data Sheets 205-1 through 205-9

**Fuel type & fuel pressure**
The usable fuel types are:
• natural gas
• propane
• butane

For other fuels less than 800 Btu/ft (330 MJ/m³) contact Eclipse Combustion with an accurate breakdown of the fuel contents.

The gas pressure must be at the minimum level shown.
The required gas pressure at the burner can be found in:
• ThermJet Selection Guide 205-0
• ThermJet Data Sheets 205-1 through 205-9

**Combustor**
The combustor that you choose depends on the temperature and the construction of the furnace.
The furnace temperature limits of the combustors can be found in:
• ThermJet Selection Guide 205-0
• ThermJet Data Sheets 205-1 through 205-9

The control methodology is the basis for the rest of the design process. Once it is known what the system will look like, the components that are in it can be selected. The control methodology chosen depends on the type of process to be controlled.

**Note:**
The stated operational characteristics only apply if the described control circuits are followed. Use of different control methods will result in unknown operational performance characteristics. Use the control circuits contained within this section or contact Eclipse Combustion for written, approved alternatives.
Control methods

There are two main methods to control the input of a ThermJet system. Each of these methods also has two variants. These methods may be applied to single burner as well as multiple burner systems.

The methods and variants are:

1. Modulating control
   a. Modulating gas & air, on-ratio control or excess air @ low fire on page 3-4.
   b. Modulating gas with fixed-air control on page 3-5.

2. High/low control
   a. High/low air & gas control (pulse firing) on page 3-6.
   b. High/low gas with fixed-air control (Can also be used for pulse firing) on page 3-7.

   Note:
   Use of a ratio regulator in a fixed-air system is optional. However, eliminating the ratio regulator will adversely affect the ignition reliability at inputs greater than 40% of maximum.

   Use of a ratio regulator in a fixed-air system also provides automatic gas modulation if system air flow changes over time (such as a clogged air filter).

In the pages that follow you will find schematics of these control methods. The symbols in the schematics are explained in the “Key to System Schematics” (see Appendix).

Automatic gas shut-off by burner or shut-off by zone

The automatic gas shut-off valve can be installed in two operational modes:

1. Automatic gas shut-off by burner
   If the flame monitoring system detects a failure, the gas shut-off valves close the gas supply to the burner that caused the failure.

2. Automatic gas shut-off by zone
   If the flame monitoring system detects a failure, the gas shut-off valves close the gas supply to all the burners in the zone that caused the failure.

   Note:
   All ThermJet control schematics on the following pages reflect a single gas automatic shut-off valve. This may be changed to conform to local safety and/or insurance requirements (Refer to page 3-1 of ThermJet Installation Guide No. 205).
Modulating gas & air
On-ratio control or excess air @ low fire
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.

1. Air
The control valve 1 is in the air line. It can modulate air flow to any position between low and high fire air.

2. Gas
The ratio regulator 2 allows the on-ratio amount of gas to go to the burner. Low fire gas is limited by the ratio regulator 2. High fire gas is limited by the manual butterfly valve 3.

Note:
The ratio regulator can be biased to give excess air at low fire

Note:
Do not use an adjustable limiting orifice (ALO) as the high fire gas limiting valve 3. ALO’s require too much pressure drop for use in a proportional system.

Figure 3.1  Modulating gas & air.
On-ratio control or excess air @ low fire

Multiple burners
Automatic shut-off at the burner

Single burner

Optional IF flame monitoring system controls the main gas shut-off valve train AND ignition above 40% of maximum is NOT required.
Step 2: Control Methodology (continued)

Modulating gas with fixed-air 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.

1. Air
The amount of air to the burner is fixed.

2. Gas
The control valve is in the gas line. It can modulate to any position between low and high fire.

Note:
Use of a ratio regulator in a fixed-air system is optional on a single burner system only. However, eliminating the ratio regulator will adversely affect the ignition reliability at inputs greater than 40% of maximum.

Figure 3.2 Modulating gas with fixed-air control
High/low air & gas control (pulse firing)

A burner system with high/low control gives a high or low fire input to the process. No input between high and low fire is possible.

1. Air
   a. Low fire:
      A control input closes the solenoid valve 4. As a result the CRS valve 5 quickly moves to low fire.
   b. High fire:
      A control input opens the solenoid valve 4. As a result the CRS valve 5 quickly moves to high fire.

2. Gas
   a. Low fire:
      A control input closes the solenoid valve 1. Low fire gas passes through the butterfly valve 3.
   b. High fire:
      A control input opens the solenoid valve 1.

If fast high/low control is not necessary, then the CRS valve can be replaced with a two-position automatic butterfly valve.
**Step 2: Control Methodology (continued)**

**High/low gas with fixed-air control**  
*(Can also be used for pulse firing.)*

A burner system with high/low control gives a high or a low input to the process. NO input between high and low fire is possible.

1. **Air**  
The amount of air to the burner is fixed.

2. **Gas**  
   a. **Low fire:**  
      A control input closes the solenoid valve ①.  
      Low fire gas passes through the butterfly valve ③.
   b. **High fire:**  
      A control input opens the solenoid valve ①.  
      High fire gas passes through the open solenoid valve ①.

**Note:**  
Use of a ratio regulator ② in a fixed-air system is optional on a single burner system only. However, eliminating the ratio regulator will adversely affect the ignition reliability at inputs greater than 40% of maximum.

**Figure 3.4**  
*High/Low gas with fixed-air control*  
*(Can also be used for pulsefiring.)*
It is recommended that low fire start be used, however, ThermJet burners are capable of direct spark ignition anywhere within the operating range.

**Note:**

You must follow the control circuits described in the previous section, “Control Methodology,” to obtain reliable ignition.

Local safety and insurance require limits on the maximum trial for ignition time. These time limits vary from country to country. The time it takes for a burner 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

It is possible to have the low fire too low to ignite within the trial for ignition period. Under these circumstances you must consider the following options:

- start at higher input levels.
- resize and/or relocate the gas controls.
- use bypass start gas. (See the circuit schematics on the following page.)

---

**For the ignition system use:**

- 6,000 VAC transformer
- full-wave spark transformer
- one transformer per burner

**DO NOT USE:**

- 10,000 VAC transformer
- twin outlet transformer
- distributor type transformer
- half-wave transformer

Step 3: Ignition System

For the ignition system use:

- 6,000 VAC transformer
- full-wave spark transformer
- one transformer per burner

**DO NOT USE:**

- 10,000 VAC transformer
- twin outlet transformer
- distributor type transformer
- half-wave transformer
**Bypass start gas (optional)**

A bypass start gas circuit provides gas flow around zone gas control valves during the trial for ignition period. This should only be used if excess air (proportional or fixed air control) is being used on low fire; it should NOT be used with on-ratio low fire systems. During the trial for ignition period, the solenoid valve in the bypass line plus the automatic gas shut-off valve (either at each burner or each zone) are opened. If a flame is established, the bypass solenoid valve closes at the end of the trial for ignition period. If a flame is not established, then the bypass solenoid valve and the automatic gas shut-off valve close.

**Figure 3.5**  Bypass start gas circuit schematics

- **Modulating gas with fixed air control**
- **High/Low air & gas control**
- **High/Low gas with fixed-air control**
A flame monitoring system consists of two main parts:
- a flame sensor
- flame monitoring control

### Flame Sensor

There are two types that you can use for a ThermJet burner:
- U.V. scanner
- flame rod

A U.V. scanner can be used with all combustor types.

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

**Note:**
A flame rod will not work for burners with refractory block. The flame rod option is available for alloy and SIC firing tube versions of the TJ015 through TJ150. Flame rod option is not available for the TJ200 and larger.

You can find information in:
- Bulletin / Info Guide 832

### Flame Monitoring Control

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

For flame monitoring control you may select 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 recommended flame monitoring controls:
- Bi-flame series; see instruction manual 826
- Multi-flame series 6000; see Instruction Manual 820
- Veri-flame; see Bulletin/Info guide 610, 620, 630

Eclipse recommends the use of flame monitoring control systems which maintain spark for the entire trial for ignition period with U.V. scanners. Some of these flame monitoring models are:
- Landis & Gyr
- Kromschroder
- Honeywell RM7895 series (except RM7895A1048 & RM7895C1020)
- PCI manual ignition

**DO NOT** use:
- PCI automatic
- Honeywell RM7890 series
Effects of atmospheric conditions

The 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 (1,013 mbar)
- 70ºF (21ºC)

The make-up of the air is different above sea level or in a hot area. The density of the air decreases, and as a result, the outlet pressure and the flow of the blower decrease. An accurate description of these effects is in the Eclipse Combustion Engineering Guide (EFE 825). The Guide contains tables to calculate 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:

- Bulletin / Info Guide 610

Follow these steps:

1. Calculate the outlet pressure.

When calculating the outlet pressure of the blower, the total of these pressures must be calculated.

- the static air pressure required at the burner
- the total pressure drop in the piping
- the total of the pressure drops across the valves
- the pressure in the chamber (suction or pressurized)
- recommend a minimum safety margin of 10%
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>
<thead>
<tr>
<th>Table 3.1 Required calculation information</th>
</tr>
</thead>
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<tr>
<td><strong>DESCRIPTION</strong></td>
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<tr>
<td>Total system heat input</td>
</tr>
<tr>
<td>Number of burners</td>
</tr>
<tr>
<td>Type of fuel</td>
</tr>
<tr>
<td>Gross heating value of fuel</td>
</tr>
<tr>
<td>Desired excess air percentage (Typical excess air percentage @ high fire is 15%)</td>
</tr>
<tr>
<td>Air/Gas ratio (Fuel specific, see table below)</td>
</tr>
<tr>
<td>Air flow</td>
</tr>
<tr>
<td>Gas flow</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Table 3.2 Fuel gas heating values</th>
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</thead>
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<td><strong>FUEL GAS</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Natural gas (Birmingham, AL)</td>
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<tr>
<td>Propane</td>
</tr>
<tr>
<td>Butane</td>
</tr>
</tbody>
</table>

* Stoichiometric: No excess air. The precise amount of air and gas are present for complete combustion.
**Example Blower Calculation**

**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 ThermJet burner model is appropriate:
   \[
   \frac{Q}{4} \text{ (total heat input)} = \frac{2,900,000 \text{ Btu/hr}}{4 \text{ burners}} = 725,000 \text{ Btu/hr/burner} 
   \]
   - Select 4 Model TJ075 ThermJet 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:
   \[
   V_{\text{air-Stoichiometric}} = \alpha (\text{air/gas ratio}) \times V_{\text{gas}} = 9.41 \times 2,894 \text{ ft}^3/\text{hr} = 27,235 \text{ ft}^3/\text{hr}
   \]
   - 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.
### Metric to English.

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<th>FROM</th>
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### Metric to Metric.

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### English to Metric.

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**KEY TO SYSTEM SCHEMATICS**

These are the symbols used in the schematics.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>APPEARANCE</th>
<th>NAME</th>
<th>REMARKS</th>
<th>BULLETIN/INFO GUIDE</th>
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<td><img src="image2" alt="appearance" /></td>
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<td></td>
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<td><img src="image3" alt="symbol" /></td>
<td><img src="image4" alt="appearance" /></td>
<td>Main gas shutoff valve train</td>
<td>Eclipse Combustion, Inc. strongly endorses NFPA as a minimum</td>
<td>756</td>
</tr>
<tr>
<td><img src="image5" alt="symbol" /></td>
<td><img src="image6" alt="appearance" /></td>
<td>Combustion air blower</td>
<td>The combustion air blower provides the combustion air pressure to the burner(s).</td>
<td>610</td>
</tr>
<tr>
<td><img src="image7" alt="symbol" /></td>
<td><img src="image8" alt="appearance" /></td>
<td>Air pressure switch</td>
<td>The air pressure switch gives a signal to the safety system when there is not enough air pressure from the blower.</td>
<td>610 I-354</td>
</tr>
<tr>
<td><img src="image9" alt="symbol" /></td>
<td><img src="image10" alt="appearance" /></td>
<td>Gas cock</td>
<td>Gas cocks are used to manually shut off the gas supply on both sides of the main gas shut-off valve train.</td>
<td>710</td>
</tr>
<tr>
<td><img src="image11" alt="symbol" /></td>
<td><img src="image12" alt="appearance" /></td>
<td>Solenoid valve (normally closed)</td>
<td>Solenoid valves are used to automatically shut off the gas supply on a bypass gas system or on small capacity burner systems.</td>
<td>760</td>
</tr>
<tr>
<td><img src="image13" alt="symbol" /></td>
<td><img src="image14" alt="appearance" /></td>
<td>Manual butterfly valve</td>
<td>Manual butterfly valves are used to balance the air or gas flow at each burner, and/or to control the zone flow.</td>
<td>720</td>
</tr>
<tr>
<td><img src="image15" alt="symbol" /></td>
<td><img src="image16" 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>
<tr>
<td>SYMBOL</td>
<td>APPEARANCE</td>
<td>NAME</td>
<td>REMARKS</td>
<td>BULLETIN/INFO GUIDE</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>![Ratio regulator symbol]</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 top of the ratio regulator and the air supply line. The cap must stay on the ratio regulator after adjustment.</td>
<td>742</td>
<td></td>
</tr>
<tr>
<td>![CRS valve symbol]</td>
<td>CRS valve</td>
<td>A CRS valve is used in a high/low time-proportional control system to quickly open and close the air supply.</td>
<td>744</td>
<td></td>
</tr>
<tr>
<td>![Pressure taps symbol]</td>
<td>Pressure taps</td>
<td>The schematics show the advised positions of the pressure taps.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>![Impulse line symbol]</td>
<td>Impulse line</td>
<td>The impulse line connects the ratio regulator to the air supply line.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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