

# **HOTBATCH**

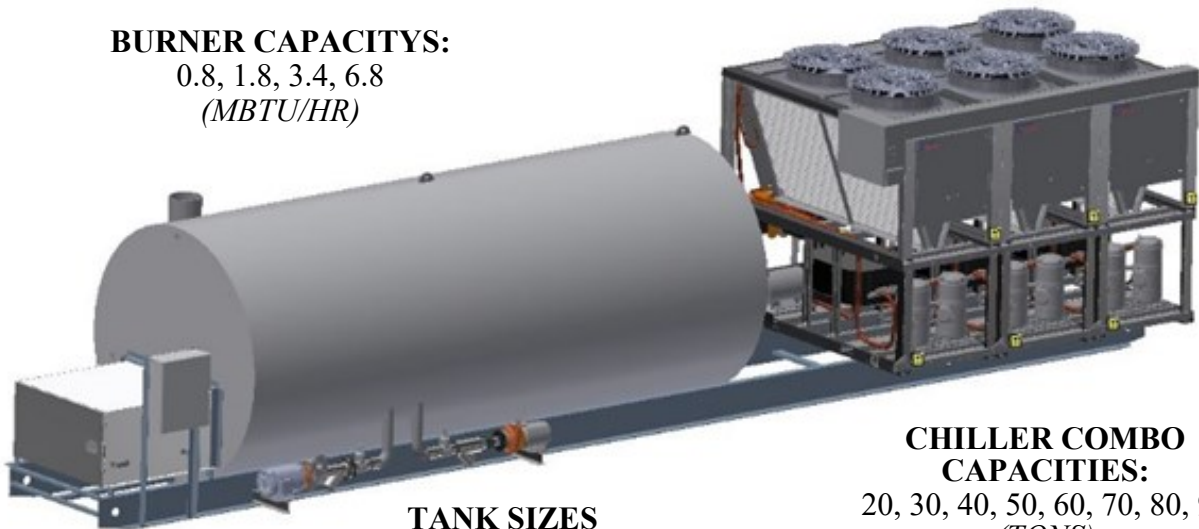
## **Batchwater Tank Heaters**

### **Installation, Operation, and Maintenance**

Standalone Heater and Chiller Combinations  
Single & Dual Blast Tube Configurations

#### **BURNER CAPACITIES:**

0.8, 1.8, 3.4, 6.8  
(*MBTU/HR*)



**TANK SIZES**  
3, 5, 10, 15, 20, 25, & 30  
(*thousands of gallons*)

**CHILLER COMBO  
CAPACITIES:**  
20, 30, 40, 50, 60, 70, 80, 90  
(*TONS*)

#### **WARNING**

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing chiller equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by and unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tabs, stickers, and labels that are attached to the equipment. Servicing should only be done with power supplies switched off and locked out.

APR. 2026



## Introduction, Warning, Cautions, and Notices

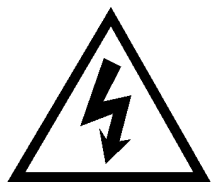
### SAFETY CONSIDERATIONS

Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause death, personal injury, or property damage. Consult a qualified installer, service agency, or your distributor or branch for information or assistance. The qualified installer or agency must use factory-authorized kits or accessories when modifying this product. Refer to the individual instructions packaged with the kits or accessories when installing.

Follow all safety codes. Wear safety glasses, protective clothing, and work gloves. Use quenching cloth for brazing operations. Have fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions included in literature and attached to the unit. Consult local building codes and current editions of the National Electrical Code (NEC) NFPA 70. In Canada, refer to current editions of the Canadian electrical code CSA 22.1.

### WARNING

#### ELECTRICAL SHOCK HAZARD



Failure to follow this warning could result in personal injury or death. Before installing, modifying, or servicing system, main electrical disconnect switch must be in the OFF position. There may be more than 1 disconnect switch. Lock out and tag switch with a suitable warning label

#### EQUIPMENT ELECTRICAL DISCONNECTS

When installing equipment, a service disconnect must be installed in the fixed wiring in accordance with local electrical code.

#### CLEARANCE REQUIREMENTS

When installing, allow sufficient space for airflow clearance, wiring, refrigerant piping, and service. Allow 36 in. clearance to service end of unit and 72in. above unit without any major air flow obstructions. For proper airflow, a 48in. clearance all remaining sides must be maintained. Position so water, snow, or ice from roof or eaves cannot fall directly on unit. Never install equipment indoors or in areas with improper venting to environment.

#### EQUIPMENT INSTALL

Equipment MUST be installed on a level and solid surface. Failure to do so can result in improper oil distribution in

compressors and will terminate factory warranty. Anchor bolts must be used in the provided locations on each of the mounting feet (*refer to fig. 1 for details*). For hurricane tie downs, contact a local distributor for details and PE (*professional Engineer*) certification, if required by local authorities.

### WARNING

#### PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIRED

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- Before installing/ servicing this unit, technicians MUST put on all PPE required for the work ( Examples; cut resistant gloves/ sleeves, safety glasses, hard hat/bump cap, fall protection, electrical PPE, and arc flash clothing) ALWAYS refer to appropriate Material Safety Data Sheets and OSHA guidelines for proper PPE.
- NEVER perform any switching, disconnect, or voltage testing without proper electrical PPE and arc flash clothing. Ensure electrical meters and equipment are properly rated for intended voltage.

On rooftop applications, mount on level platform or frame. Place unit above a load-bearing wall and isolate unit and piping set from structure. Arrange supporting members to adequately support unit and minimize transmission of vibration to building. Consult local codes governing rooftop applications.

#### COMPRESSOR CRANKCASE HEATER—CHILLER COMBO UNITS ONLY

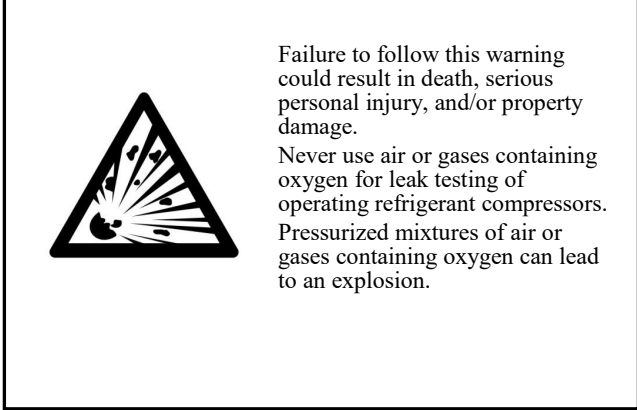
When equipped with a crankcase heater, furnish power to heater a minimum of 12 hrs. before starting unit. To apply power to the heater only, set low voltage breaker (CB6) to off and the compressor breakers (CB1 and CB2) to the on position. Close all cabinet covers during the waiting period to prevent burns or electrical shock.

#### 3 - PHASE MONITOR—CHILLER COMBO UNITS ONLY

In 3 - phase equipment, a small circuit board is factory installed to prevent incorrect rotation of motors. A small LED will flash if a phase problem exist. Depower the equipment by switching the appropriate disconnect and interchange two of the field wiring leads on the distribution block.

## WARNING

## EXPLOSION HAZARD



Never use air or gases containing oxygen for leak testing of operating refrigerant compressors. Pressurized mixtures of air or gases containing oxygen can lead to an explosion.

## RESPONSIBLE PRACTICES

Responsible chemical practices are important to the environment, our customers, and the industry. All technicians who handle refrigerants and or fuels, must be certified according to local rules. For the USA, the federal Clean Air Act (section 608) sets forth the requirement for handling, reclaiming, recovering and recycling certain refrigerants and the equipment that is used in the service procedures. In addition, some states or municipalities may have additional requirements must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

## WARNING

**QUALIFIED PERSONNEL ONLY**

**QUALIFIED PERSONNEL ONLY**

The equipment is not to be used by persons (including children) with reduced physical, sensory, or mental capabilities, or lack of experience and knowledge of the equipment.

## CAUTION

## INSTALLATION CONSIDERATIONS

- ## INSTALLATION CONSIDERATIONS
- Equipment must not be installed in altitudes greater than 6561.7 ft or 2000 meters.
  - Fluid circuit pressure must not exceed 300 psi.
  - Fluid circuit water temperature limitations; 32°F (0°C) minimum / 180°F (93.3°C)

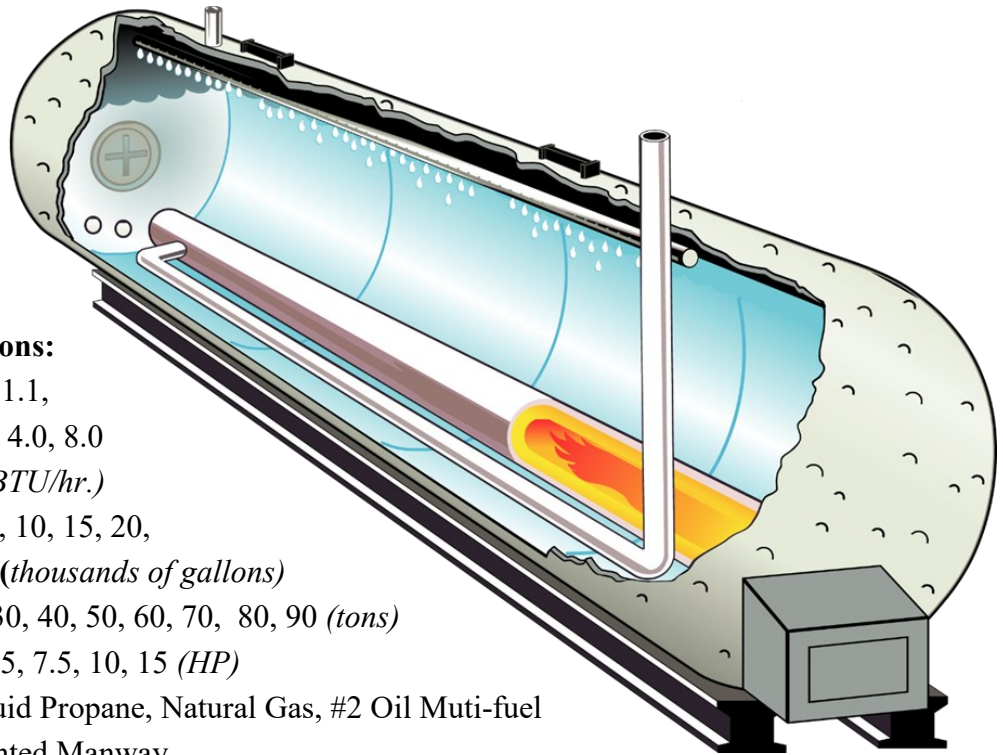
## INSTALLATION CHECK LIST

- ⇒ Equipment is installed on a level and solid surface. If installed on a roof top, all precautions have been taken when considering load bearing supports.
- ⇒ Equipment is properly grounded. Ground rods may be required depending on installation and application. **ALL MOBLIE EQUIPMENT MUST BE GROUNDED VIA GROUND ROD.**
- ⇒ Equipment is clear of obstructions in working spaces according to this manual.
- ⇒ Equipment has proper overcurrent protection, wire size, and means of electrical disconnect.
- ⇒ 3 Phase wiring is the correct phasing and motors are rotating in the correct location.
- ⇒ The appropriate plumbing connections been made with respect to the plumbing diagram in this manual.
- ⇒ Will your equipment be exposed to harsh environments such as, salty air, alcohols, petroleum, alkalies, or acids? If so, has the equipment been coated to protect against degradation?
- ⇒ The proper precautions have been taken before turning on the chiller.

### INSTALLATION NOTES:

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on its right side, suggesting it's resting on a surface.

## Product Information/ Introduction



### Equipment Specifications:

- **Burner Sizes** - 0.8, 1.1, 2.0, 4.0, 8.0 (MBTU/hr.)
- **Tank Sizes** - 3, 5, 8, 10, 15, 20, 25, 30 (thousands of gallons)
- **Chiller Sizes** - 20, 30, 40, 50, 60, 70, 80, 90 (tons)
- **Pump Options** - 3, 5, 7.5, 10, 15 (HP)
- **Fuel Options** - Liquid Propane, Natural Gas, #2 Oil Multi-fuel
- 24" Side Wall Mounted Manway
- Single & Split Input Voltage Options
- Multiple Blast Tube Configurations
- Configurable Additional Fittings for Chillers and Dual Tanks

|                                         |       |
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## Model Nomenclature

| <u>HBC</u>                                                                                                                                                                                                                                                                                                                            | <u>10K</u> | <u>3.4M</u> | <u>XXO</u> | <u>-</u> | <u>4</u> | <u>C</u> | <u>10</u> | <u>5</u> | <u>90</u> | <u>2</u> | <u>X</u> | <u>B</u> |                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|------------|----------|----------|----------|-----------|----------|-----------|----------|----------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>HBS - HotBatch Skid Mounted</b><br><b>HBC - HotBatch Chiller Combo</b><br><b>HBM - HotBatch Trailer Mounted</b>                                                                                                                                                                                                                    |            |             |            |          |          |          |           |          |           |          |          |          | <b>Series Revision ID</b><br>A<br>B<br>C<br>etc.                                                                                                                                                                                                    |
| <b>Tank Size</b><br><b>03K</b> - 3,000 Nominal Gallons<br><b>05K</b> - 5,000 Nominal Gallons<br><b>08K</b> - 8,000 Nominal Gallons<br><b>10K</b> - 10,000 Nominal Gallons<br><b>15K</b> - 15,000 Nominal Gallons<br><b>20K</b> - 20,000 Nominal Gallons<br><b>25K</b> - 25,000 Nominal Gallons<br><b>30K</b> - 30,000 Nominal Gallons |            |             |            |          |          |          |           |          |           |          |          |          | <b>Tank Sight Tube</b><br><b>X</b> - No Sight Tube<br><b>S</b> - Sight Tube Installed                                                                                                                                                               |
| <b>Nominal Heating Capacity</b><br><b>0.8M</b> - 800,000 BTU/hr (single blast tube)<br><b>1.8M</b> - 1,800,000 BTU/hr (single blast tube)<br><b>3.4M</b> - 3,400,000 BTU/hr (single blast tube)<br><b>6.8M</b> - 6,800,000 BTU/hr (dual blast tube)                                                                                   |            |             |            |          |          |          |           |          |           |          |          |          | <b>Tank Fitting Configuration</b><br><b>1</b> - Heating Only<br><b>2</b> - Heating and Cooling                                                                                                                                                      |
| <b>Fuel Designation</b><br><b>L</b> - Liquid Propane<br><b>N</b> - Natural Gas<br><b>O</b> - #2 Oil<br><b>X</b> - In place of the undesired fuel types                                                                                                                                                                                |            |             |            |          |          |          |           |          |           |          |          |          | <b>Chiller Capacity</b><br><b>20</b> - 20 Tons<br><b>30</b> - 30 Tons<br><b>40</b> - 40 Tons<br><b>50</b> - 50 Tons<br><b>60</b> - 60 Tons<br><b>70</b> - 70 Tons<br><b>80</b> - 80 Tons<br><b>90</b> - 90 Tons<br><b>XX</b> - No Chiller Installed |
| <b>Input Voltage</b><br><b>1</b> - 120v/1ph/60hz<br><b>2</b> - 230v/3ph/60hz<br><b>4</b> - 460v/3ph/60hz<br><b>5</b> - 575v/3ph/60hz                                                                                                                                                                                                  |            |             |            |          |          |          |           |          |           |          |          |          | <b>Process Pump 2 Size</b><br><b>03</b> - 3 HP<br><b>07</b> - 7.5 HP<br><b>10</b> - 10 HP<br><b>15</b> - 15 HP<br><b>XX</b> - No Pumps Installed                                                                                                    |
| <b>Electrical &amp; Pump Packages</b><br><b>X</b> - Standard Unit, Burner Only (dual voltage requirement)<br><b>A</b> - Single Voltage Input & Main Disconnect Switch Installed<br><b>B</b> - Process Pump w/ Controls + Main Disconnect Switch<br><b>C</b> - Second Process Pump w/ Controls + Main Disconnect Switch                |            |             |            |          |          |          |           |          |           |          |          |          | <b>Process Pump 1 Size</b><br><b>03</b> - 3 HP<br><b>07</b> - 7.5 HP<br><b>10</b> - 10 HP<br><b>15</b> - 15 HP<br><b>XX</b> - No Pumps Installed                                                                                                    |

**Figure 1, Models Nos. HBS(03K-30K)(0.8M-3.4M) Product Overview**

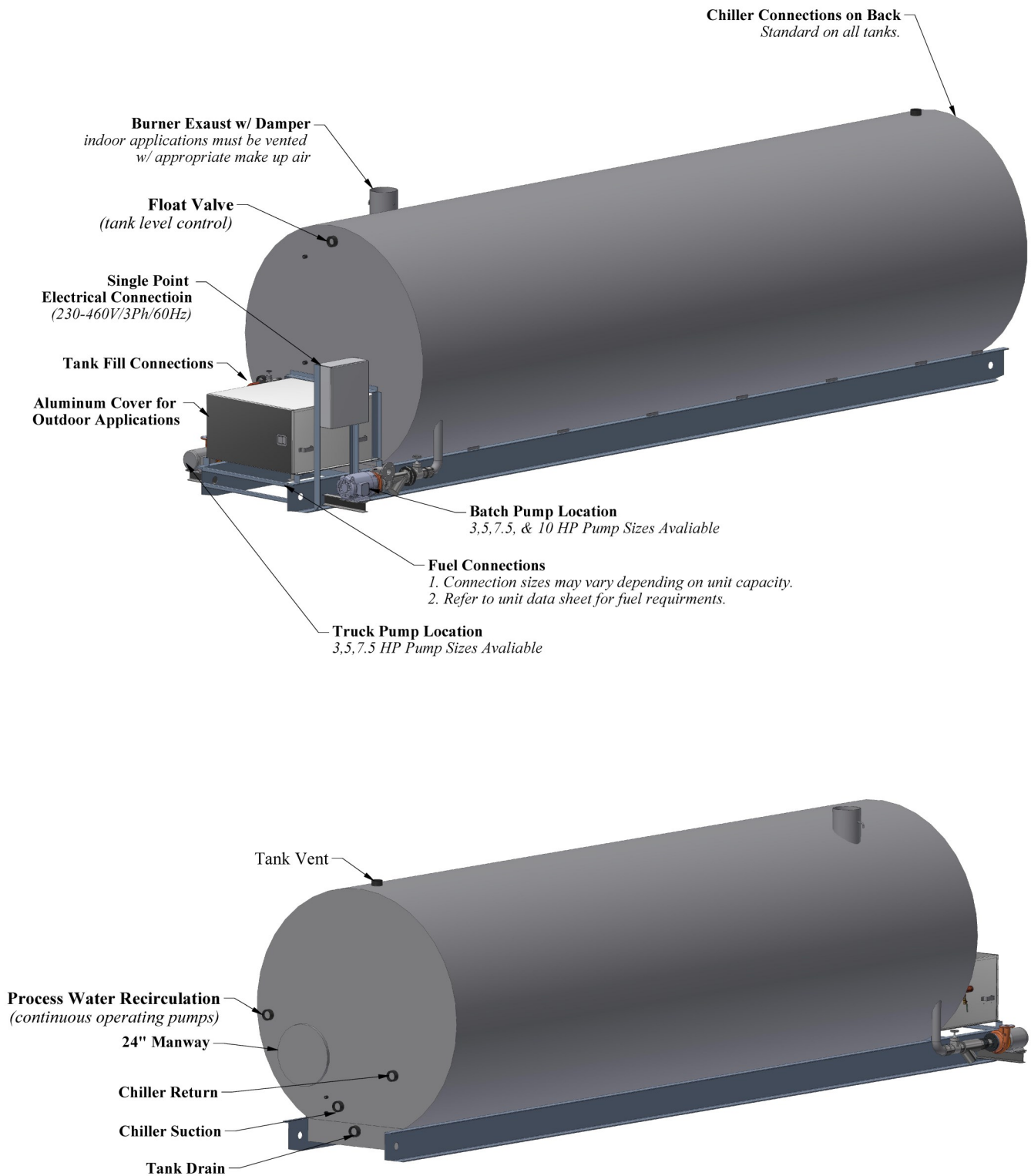


**Figure 2, Models Nos. HBS(03K-30K)(0.8M-3.4M) Physical Data**

| Unit Sizes vs Model Number |               |               |           |           |          |            |                  |
|----------------------------|---------------|---------------|-----------|-----------|----------|------------|------------------|
| Model #                    | Usable Volume | S, Skid Width | T, Length | X, Length | Y, Width | Z, Height  | W1, weight (lbs) |
| HBS03Kxxx                  |               | 51.875        | 168 in    | 19'       | 76 in    | 79 3/4 in  | 10,000           |
| HBS05Kxxx                  |               | 51.875        | 210 in    | 22'-6"    | 88 in    | 92 in      | 10,500           |
| HBS08Kxxx                  |               | 51.875        | 258 in    | 26'-6"    | 102 in   | 106 1/8 in | 13,500           |
| HBS10Kxxx                  |               | 51.875        | 324 in    | 32'       | 102 in   | 106 1/8 in | 14,500           |
| HBS15Kxxx                  |               | 82.625        | 312 in    | 31'       | 126 in   | 127 5/8 in | 18,000           |
| HBS20Kxxx                  |               | 82.625        | 408 in    | 39'       | 126 in   | 127 5/8 in | 22,700           |
| HBS25Kxxx                  |               | 82.625        | 468 in    | 44'       | 132 in   | 133 5/8 in | 28,400           |
| HBS30Kxxx                  |               | 82.625        | 564 in    | 52'       | 132 in   | 133 5/8 in | 31,000           |

| Total Usable Tank Capacity in Gallons (Various Size Burners) |                         |                     |                     |
|--------------------------------------------------------------|-------------------------|---------------------|---------------------|
| Model #                                                      | 0.8/1.1 MBTU/hr Burners | 1.8 MBTU/hr Burners | 3.4 MBTU/hr Burners |
| HBS03Kxxx                                                    | 2,383.3                 | -                   | -                   |
| HBS05Kxxx                                                    | 4,195.9                 | 4,043.3             | -                   |
| HBS08Kxxx                                                    | 6,981.5                 | 6,787.3             | -                   |
| HBS10Kxxx                                                    | 8,792.8                 | 8,559.8             | 8,116.8             |
| HBS15Kxxx                                                    | 13,768.8                | 13,535.5            | 13,079.0            |
| HBS20Kxxx                                                    | 18,404.6                | 18,095.6            | 17,511.1            |
| HBS25Kxxx                                                    | 23,398.5                | 23,090.6            | 22,501.7            |
| HBS30Kxxx                                                    | 28,398.5                | 28,090.6            | 27,501.7            |

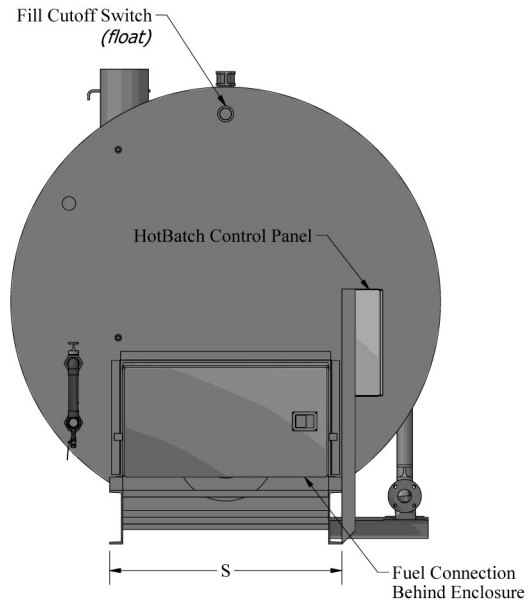
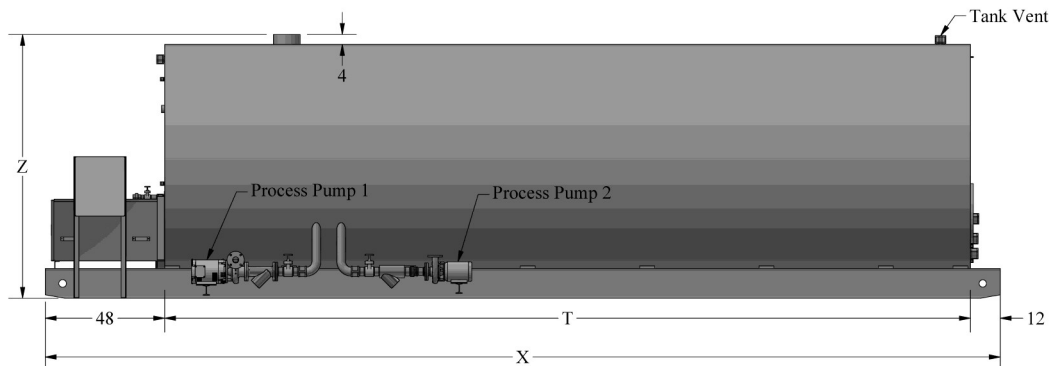


**Figure 3, Models Nos. HBS(20K-30K)(6.8M) Product Overview**

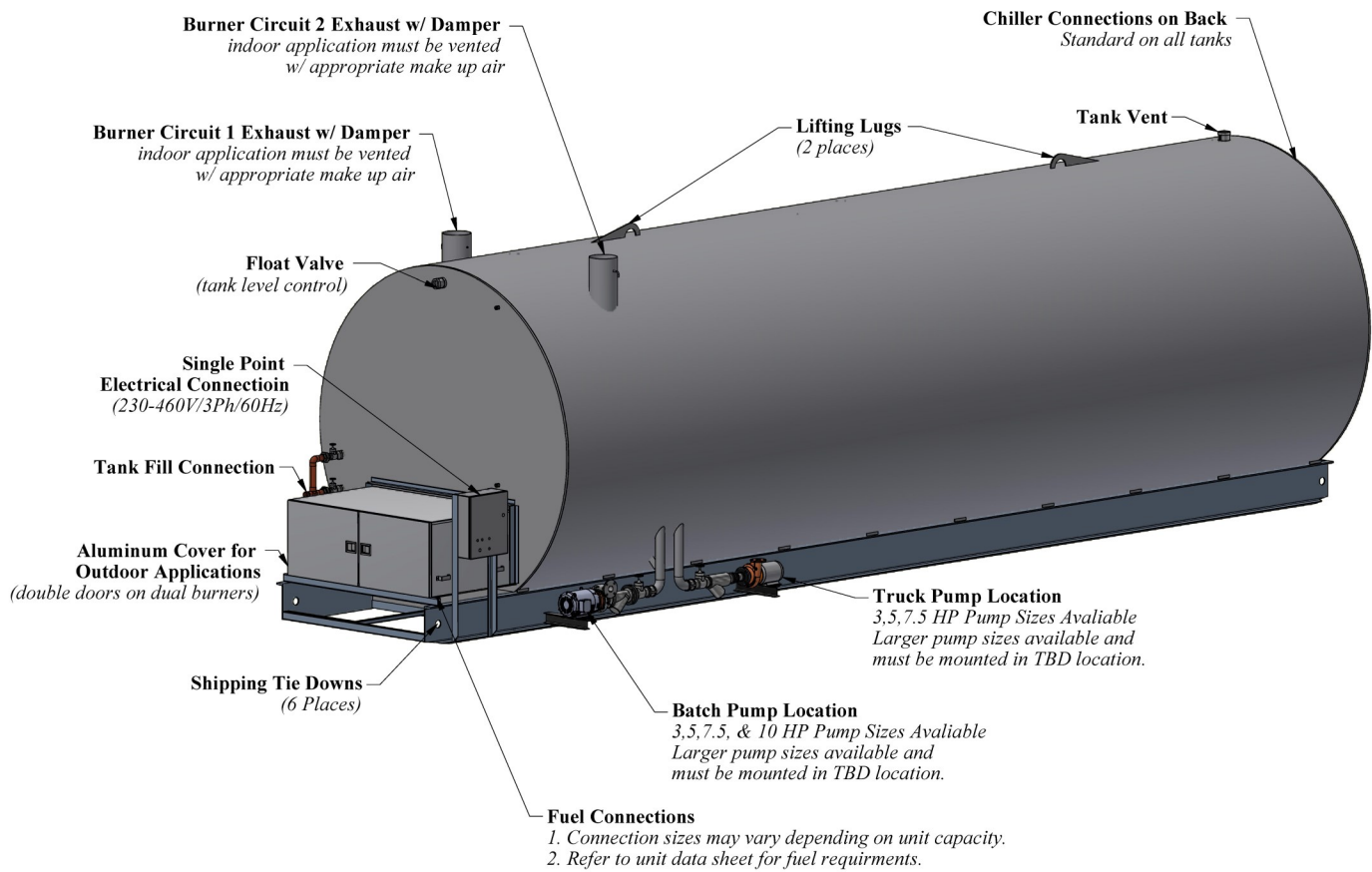
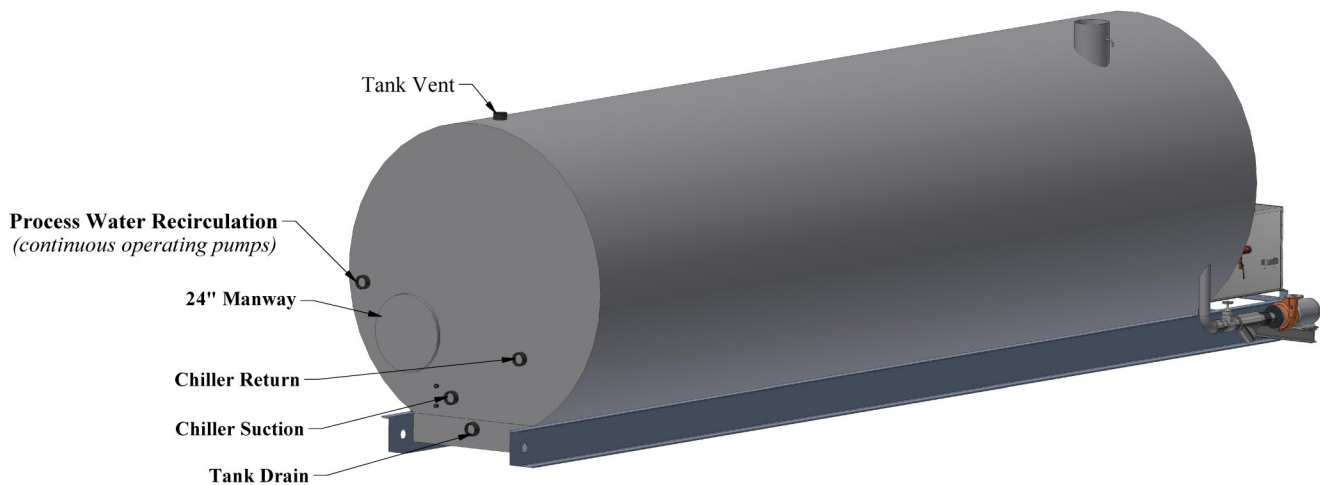


**Figure 4, Models Nos. HBS(20-30)(6.8M) Physical Data**

| Unit Sizes vs Model Number |           |           |          |            |                  |
|----------------------------|-----------|-----------|----------|------------|------------------|
| Model #                    | T, Length | X, Length | Y, Width | Z, Height  | W1, weight (lbs) |
| HBS15Kxxx                  | 312 in    | 31'       | 126 in   | 127 5/8 in | 23,500           |
| HBS20Kxxx                  | 408 in    | 39'       | 126 in   | 127 5/8 in | 27,000           |
| HBS25Kxxx                  | 468 in    | 44'       | 132 in   | 133 5/8 in | TBD              |
| HBS30Kxxx                  | 564 in    | 52'       | 132 in   | 133 5/8 in | TBD              |

| Total Usable Tank Capacity in Gallons (Various Size Burners) |                     |
|--------------------------------------------------------------|---------------------|
| Model #                                                      | 6.8 MBTU/hr Burners |
| HBS15Kxxx                                                    | 11,158.1            |
| HBS20Kxxx                                                    | 15,022.2            |
| HBS25Kxxx                                                    | 20,003.4            |
| HBS30Kxxx                                                    | 25,003.3            |

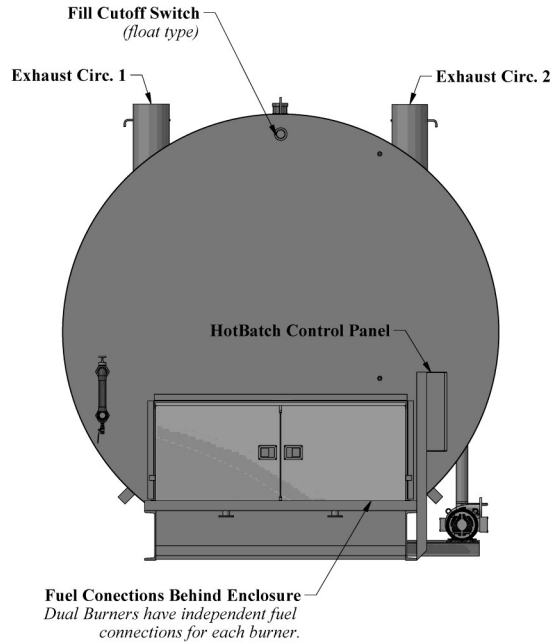
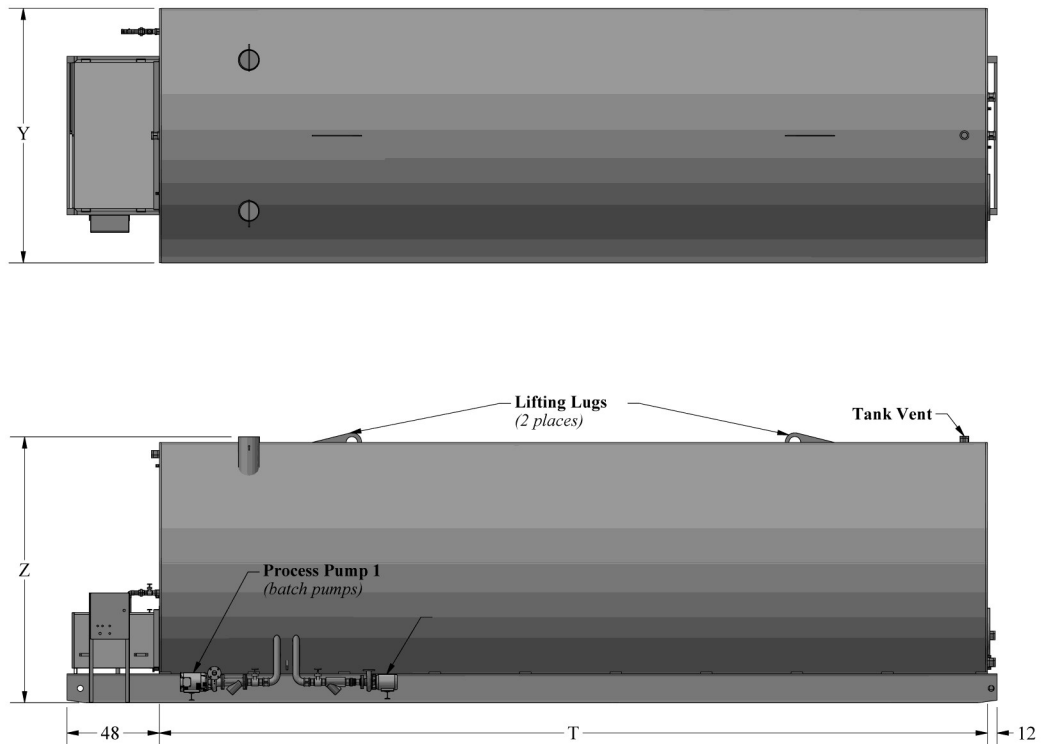


**Figure 5, Models Nos. HBC(5K-20K)(0.8M-3.4M) Product Overview**

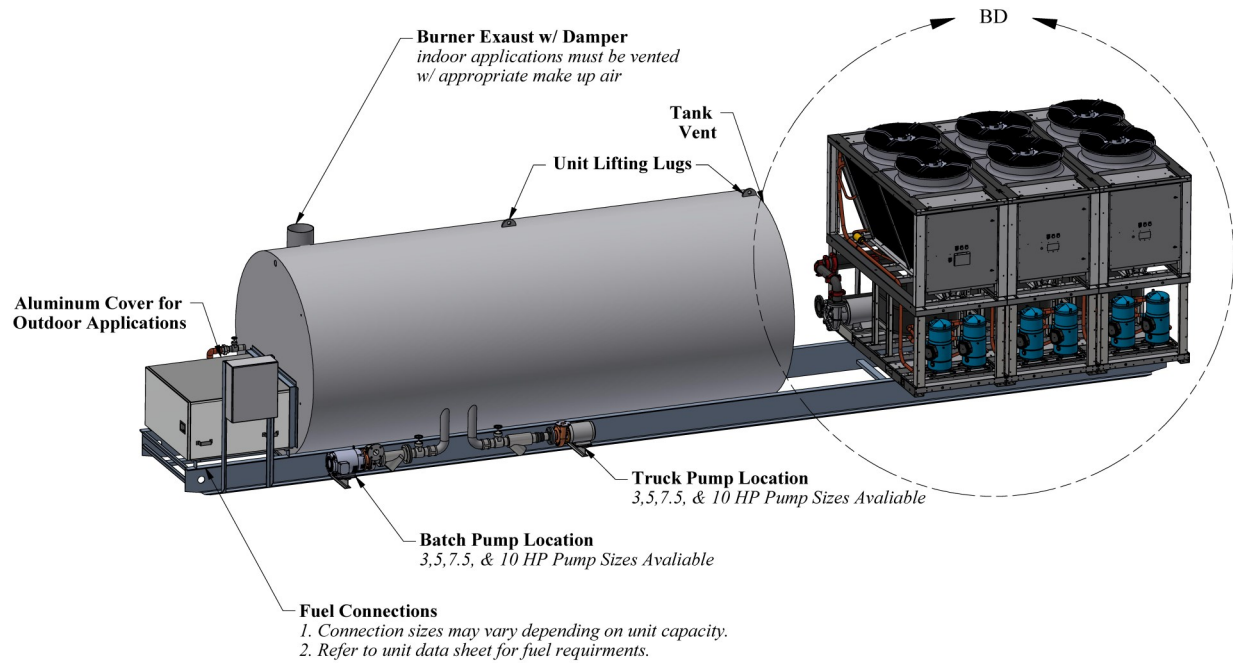
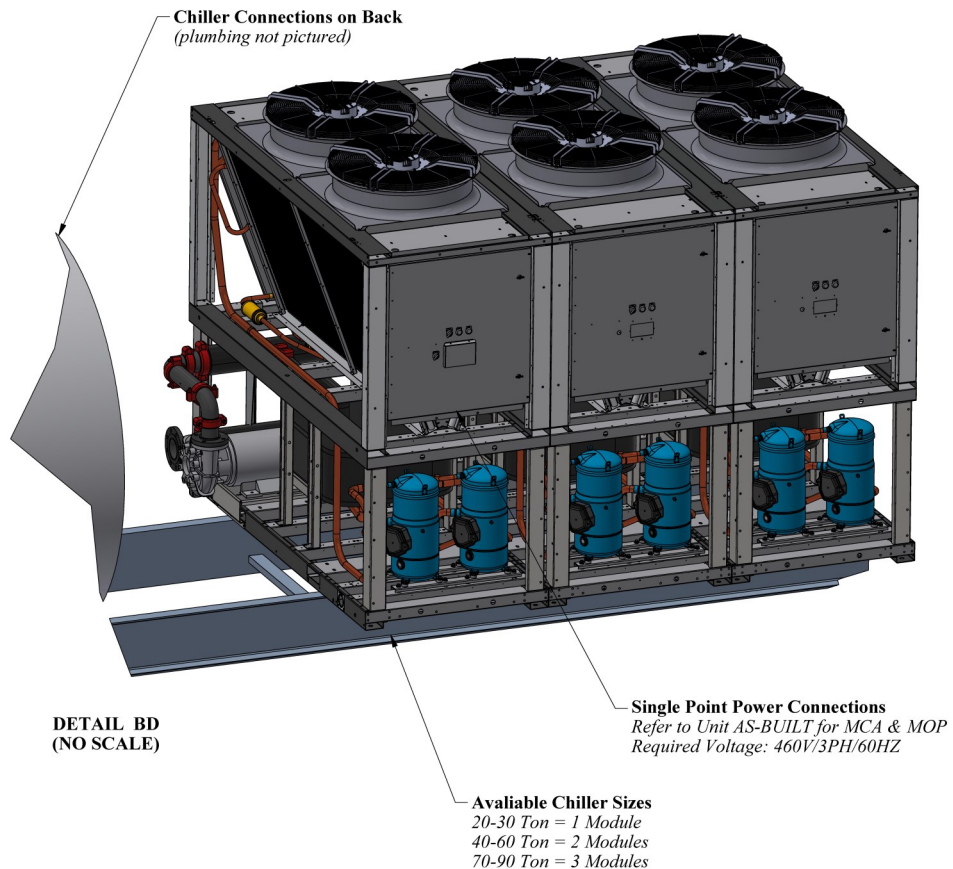


**Figure 6, Models Nos. HBC(5K-25K)(0.8M-3.4M) Product Overview**

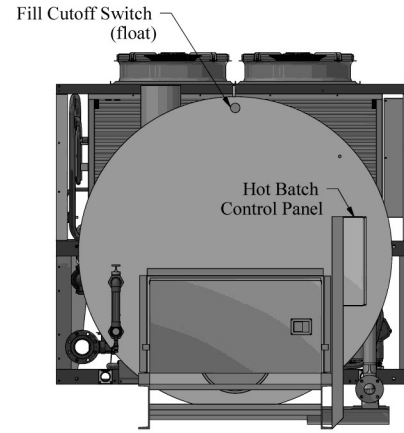
| EC, Equipment Centriod (Total Length) |                 |                 |                 |                 |
|---------------------------------------|-----------------|-----------------|-----------------|-----------------|
| Model #                               | AMC 20-30       | AMC 40-60       | AMC 70-90       | AMC 100-120     |
| HBC05Kxxx                             | 180 in (349 in) | N/A             | N/A             | N/A             |
| HBC10Kxxx                             | 237 in (466 in) | 268 in (506 in) | 301 in (546 in) | N/A             |
| HBC15Kxxx                             | 271 in (451 in) | 242 in (491 in) | 272 in (531 in) | N/A             |
| HBC20Kxxx                             | 276 in (547 in) | 308 in (587 in) | 339 in (627 in) | 368 in (667 in) |

| Unit Sizes vs Model Number |           |            |                 |                     |
|----------------------------|-----------|------------|-----------------|---------------------|
| Model #                    | T, Length | Z1, Height | Z2, Base Height | W1, HotBatch Weight |
| HBC05Kxxx                  | 210 in    | 92 in      | 12 in           | 10,500              |
| HBC08Kxxx                  | 264 in    | 106 1/8 in | 12 in           | 13,500              |
| HBC10Kxxx                  | 324 in    | 106 1/8 in | 12 in           | 14,500              |
| HBC15Kxxx                  | 312 in    | 127 5/8 in | 14 in           | 18,000              |
| HBC20Kxxx                  | 408 in    | 127 5/8 in | 14 in           | 22,700              |
| HBC25Kxxx                  | 468 in    | 133 5/8 in | 14 in           | 28,400              |

| Unit Sizes vs Model Number |           |                    |
|----------------------------|-----------|--------------------|
| Model #                    | C, Length | W2, Chiller Weight |
| 20 Ton Chiller             | 40 in     | 1860               |
| 30 Ton Chiller             | 40 in     | 2150               |
| 40 Ton Chiller             | 80 in     | 3720               |
| 50 Ton Chiller             | 80 in     | 4010               |
| 60 Ton Chiller             | 80 in     | 4300               |
| 70 Ton Chiller             | 120 in    | 5870               |
| 80 Ton Chiller             | 120 in    | 6161               |
| 90 Ton Chiller             | 120 in    | 6450               |

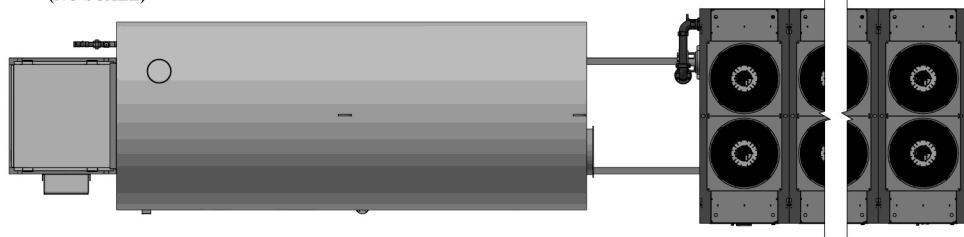
**NOTES:**

1. Drawing is not to scale, tank height may exceed chiller height depending on model.
2. Determine the maximum height by evaluating dimension Z<sub>1</sub>, Z<sub>2</sub>, & Z<sub>3</sub>. To determine the height of the chiller, dimensions Z<sub>2</sub>, & Z<sub>3</sub> 2. summed.
3. Determine the total weight by adding W<sub>1</sub> and W<sub>2</sub>.



**FRONT VIEW  
(NO SCALE)**

**TOP VIEW  
(NO SCALE)**



**RIGHT SIDE VIEW  
(NO SCALE)**

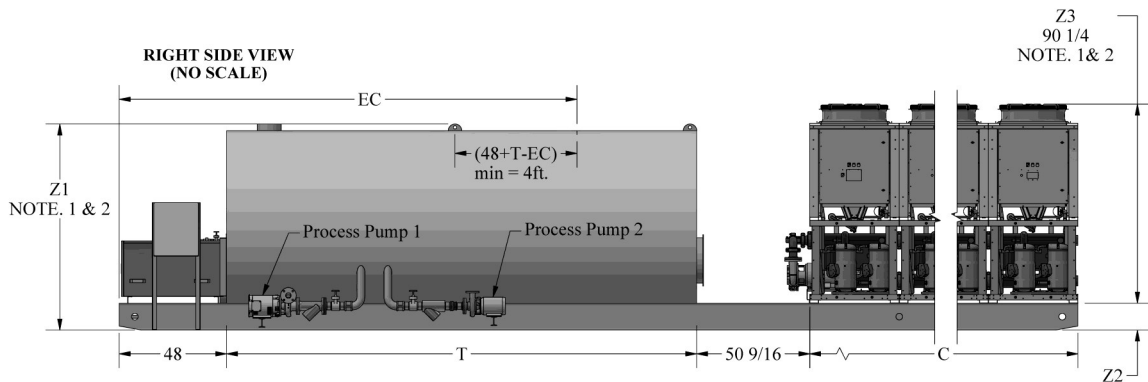


Figure 7, Equipment Installation and Maximum Grade Tolerance

| TABLE 1, Installation Angularity Tolerance (degrees) |       |     |
|------------------------------------------------------|-------|-----|
| Hot Batch Model #                                    | X     | Y   |
| HBx05K                                               | ± 2.5 | ± 2 |
| HBx08K                                               | ± 1.9 | ± 2 |
| HBx10K                                               | ± 1.5 | ± 2 |
| HBx15K                                               | ± 1.5 | ± 2 |
| HBx20K                                               | ± 1.2 | ± 2 |
| HBx25K                                               | ± 1   | ± 2 |
| HBx30K                                               | ± 0.8 | ± 2 |

**WARNING!!!**

If angularity tolerances are ignored upon installation, the tank containing 180° or higher could be discharged from the tank vent. In some cases, specifically trailer mounted equipment and or scenarios where installing cribs or leveling is impossible, an extension pipe may be added to the tank vent to prevent over flow. Always consult with the manufacture before proceeding.

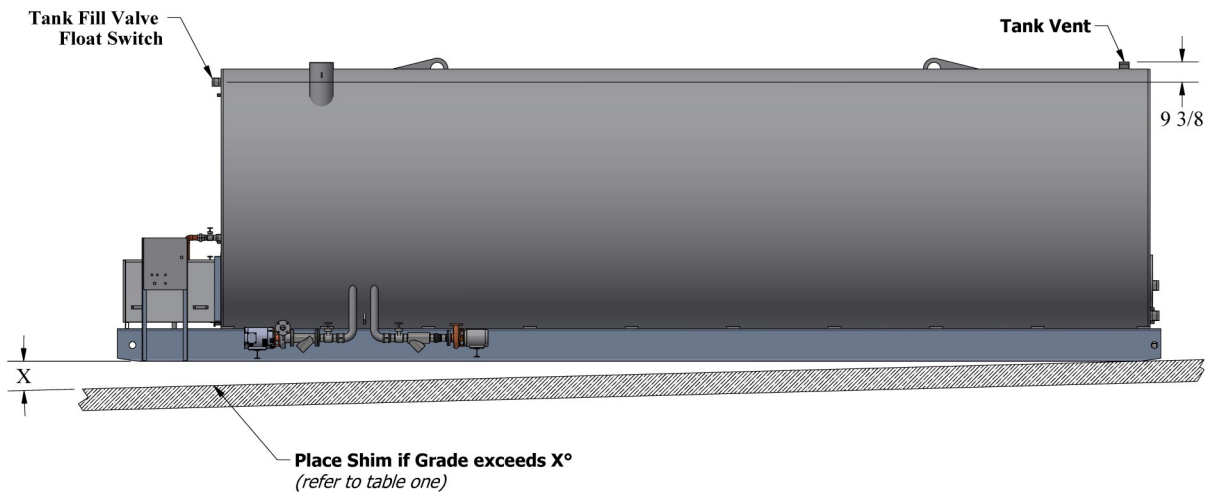
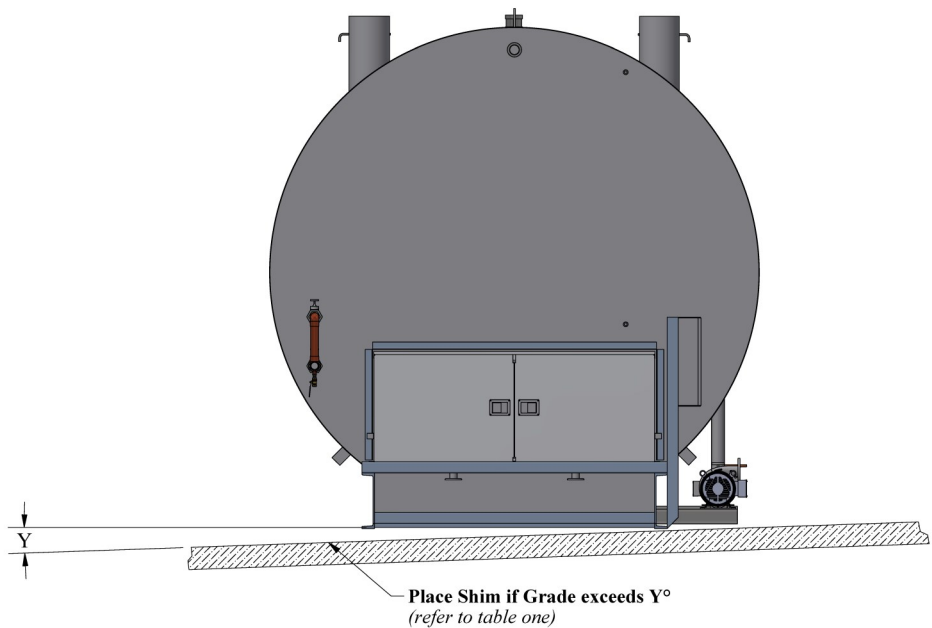




**Figure 8, Lifting Via. Crane**

**WARNING!!!**

The crane operator should always ensure proper lifting procedures, changes to the length of cables 1 & 2 may be required to ensure an even lift. Crane operators should always consult with a qualified engineer before changing cable lengths. Failing to ignore this warning could result in serious bodily harm or death.

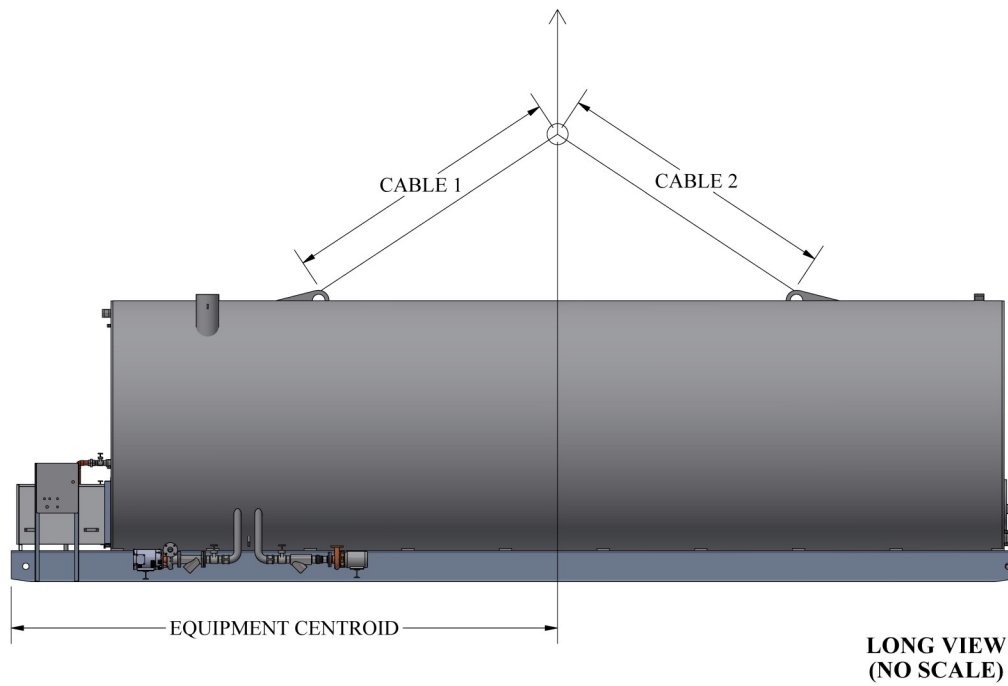
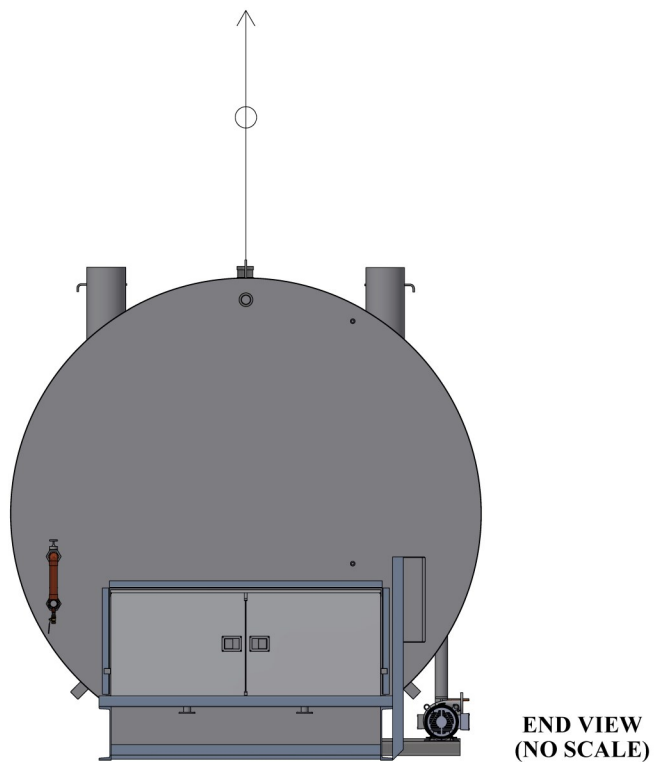
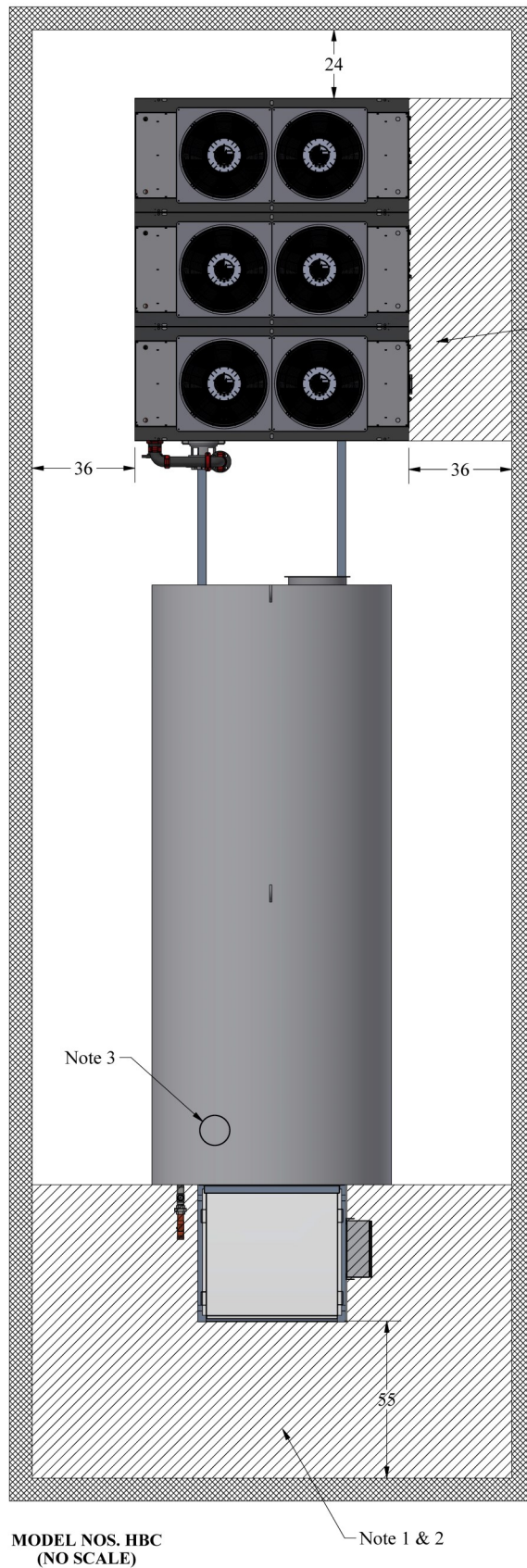
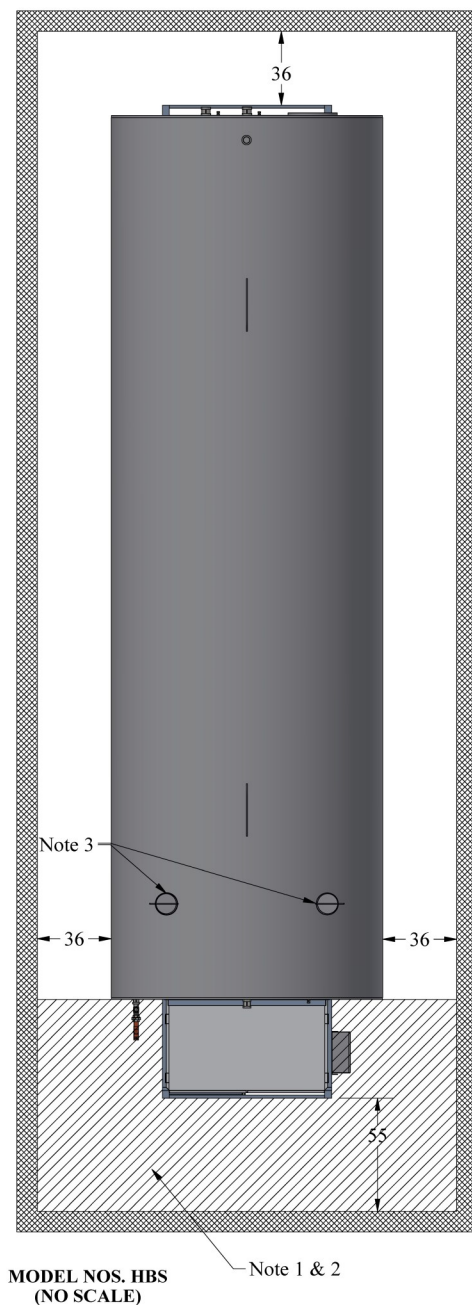


**Figure 9, HBS & HBC Working Space and Installation Clearances**



**System Clearance Note:**

1. Critical working spaces for service and local code restrictions.
2. If clearances are ignored, American GeoThermal reserves the right to refuse startup and or service for the safety of its staff.
3. This equipment is intended for outdoor use only. If the equipment must be installed indoor, contact the factory for additional information on make up air and proper exhaust venting methods.
4. Electrical Panel clearances may vary by state consult with the local codes office for additional detail.



# Buner Controls Panel Layout

## NOTE:

1. Models HBxxxxxxxxx\_(2-5)BxxxxxxxxA ONLY
2. Models HBxxxxxxxxx\_(2-5)(B&C)xxxxxxxxA ONLY



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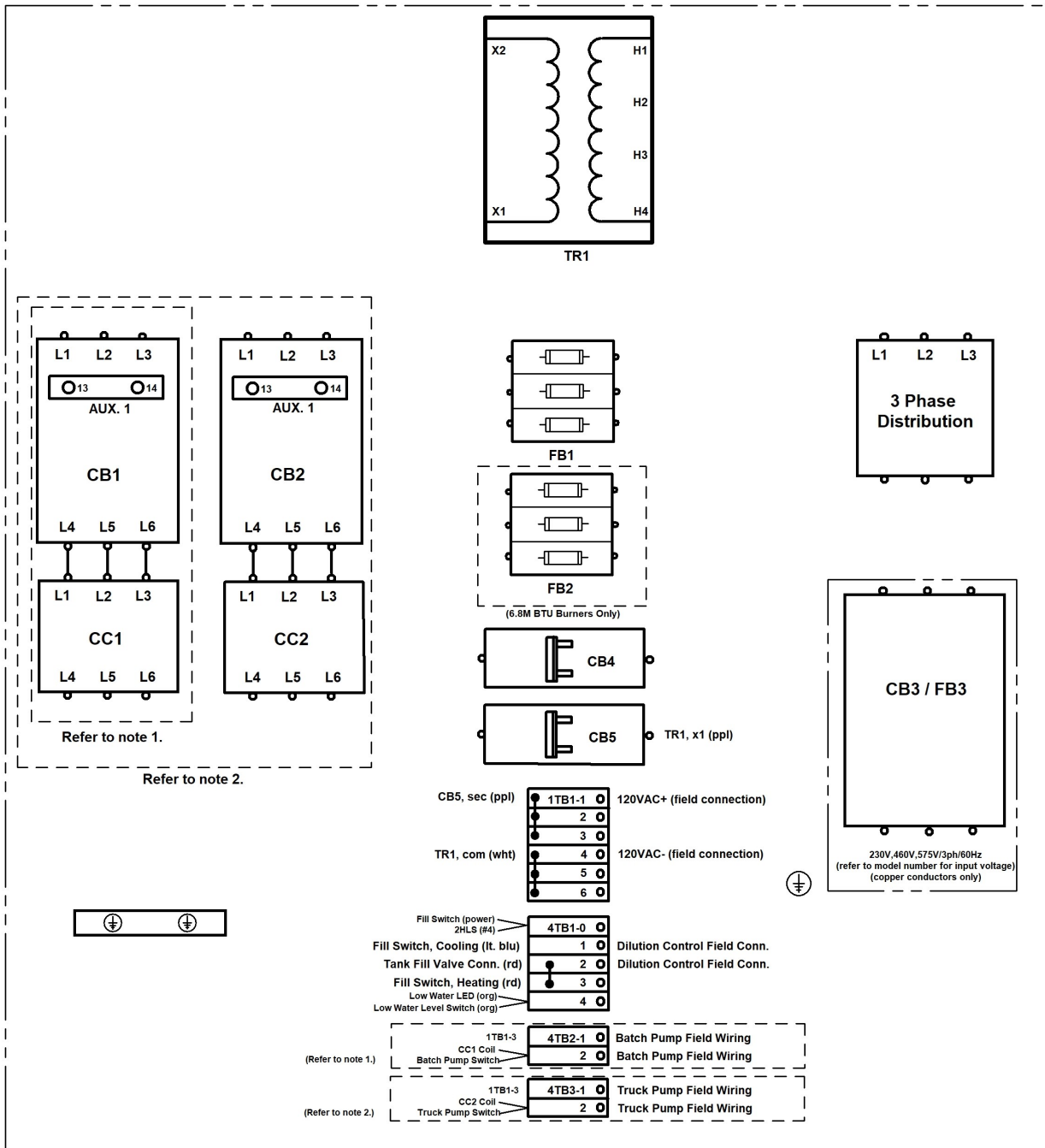
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UNIT SERIES  
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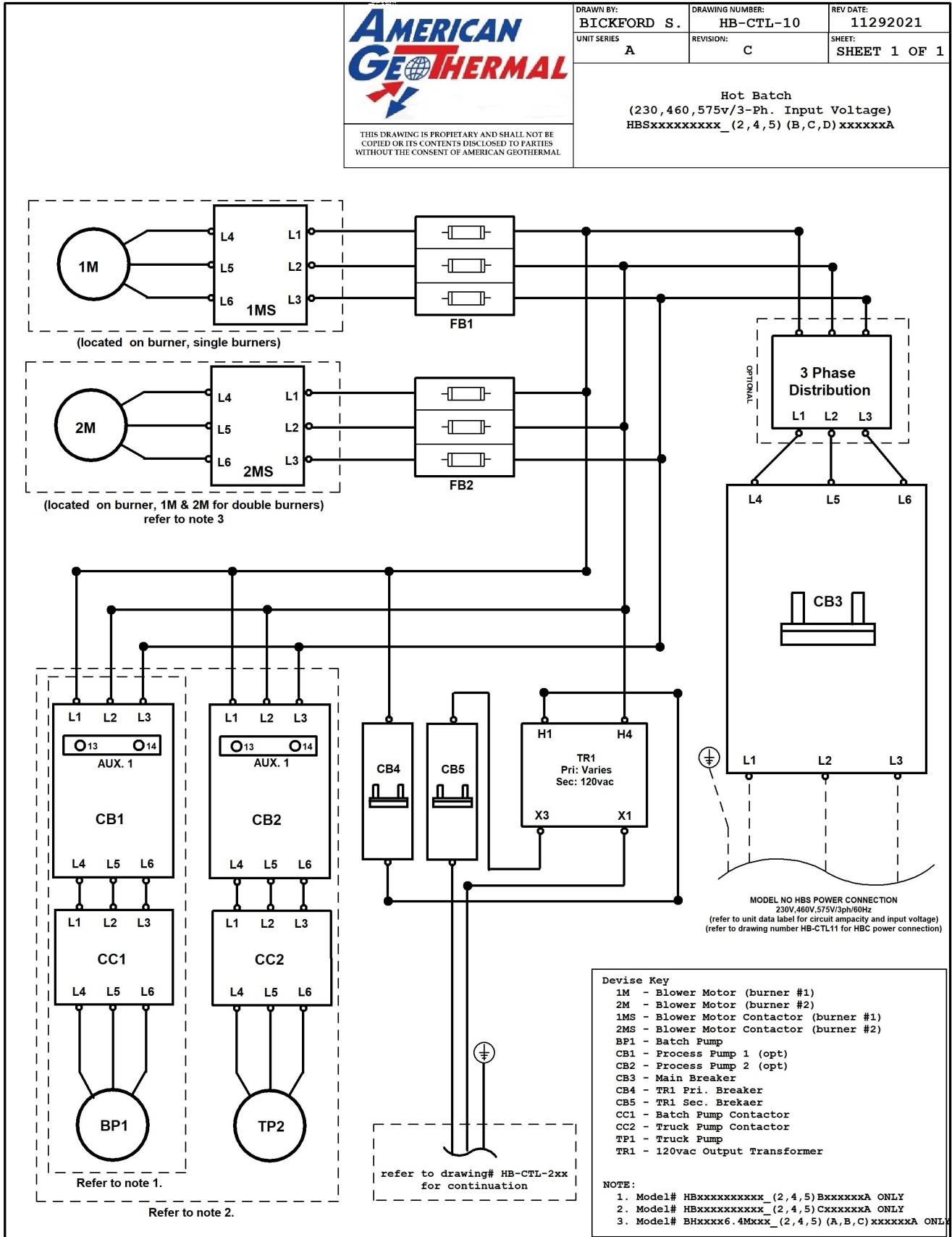
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SHEET 1 OF 1

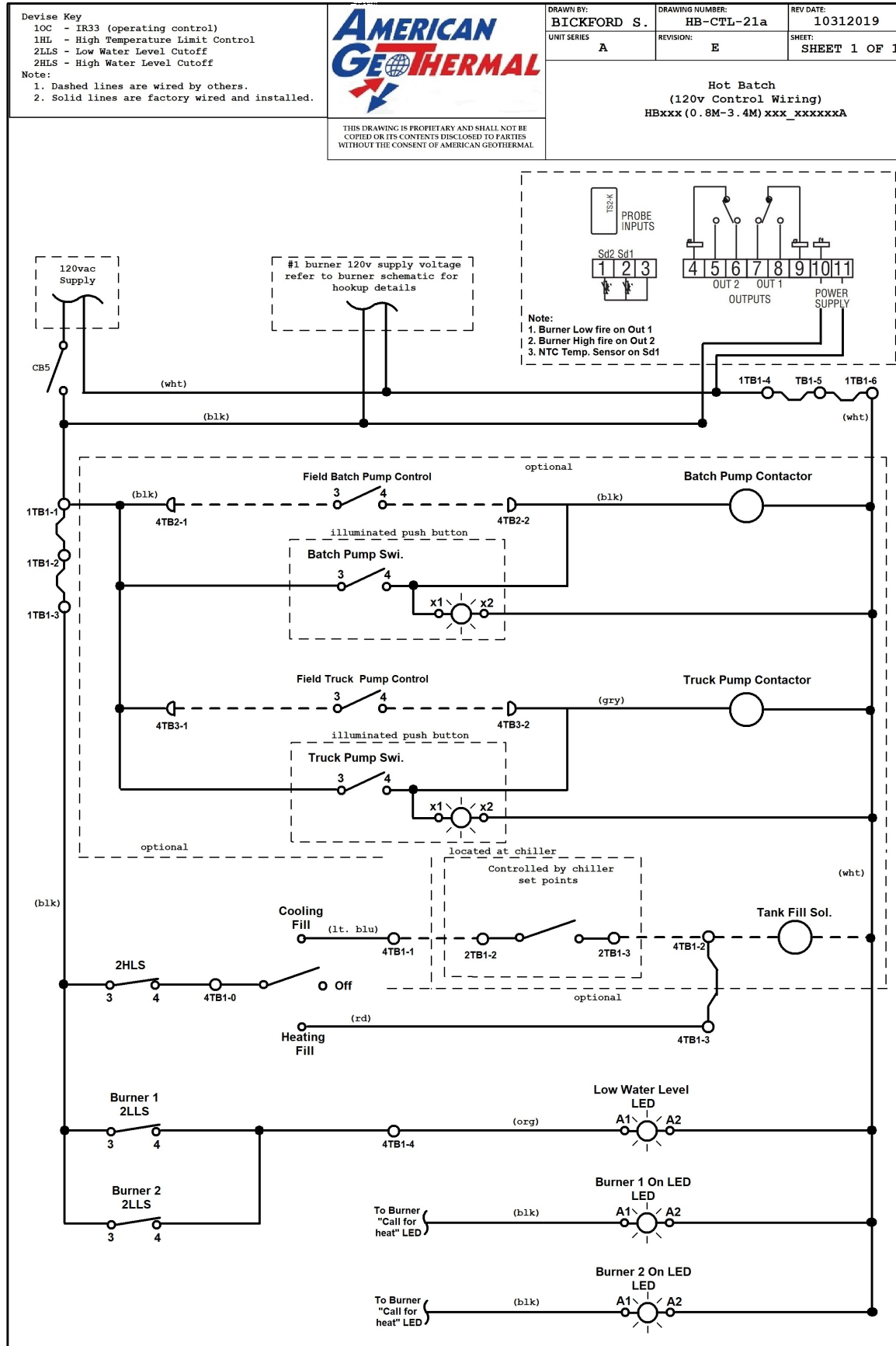
## Hot Batch 3 Phase Panel Layout



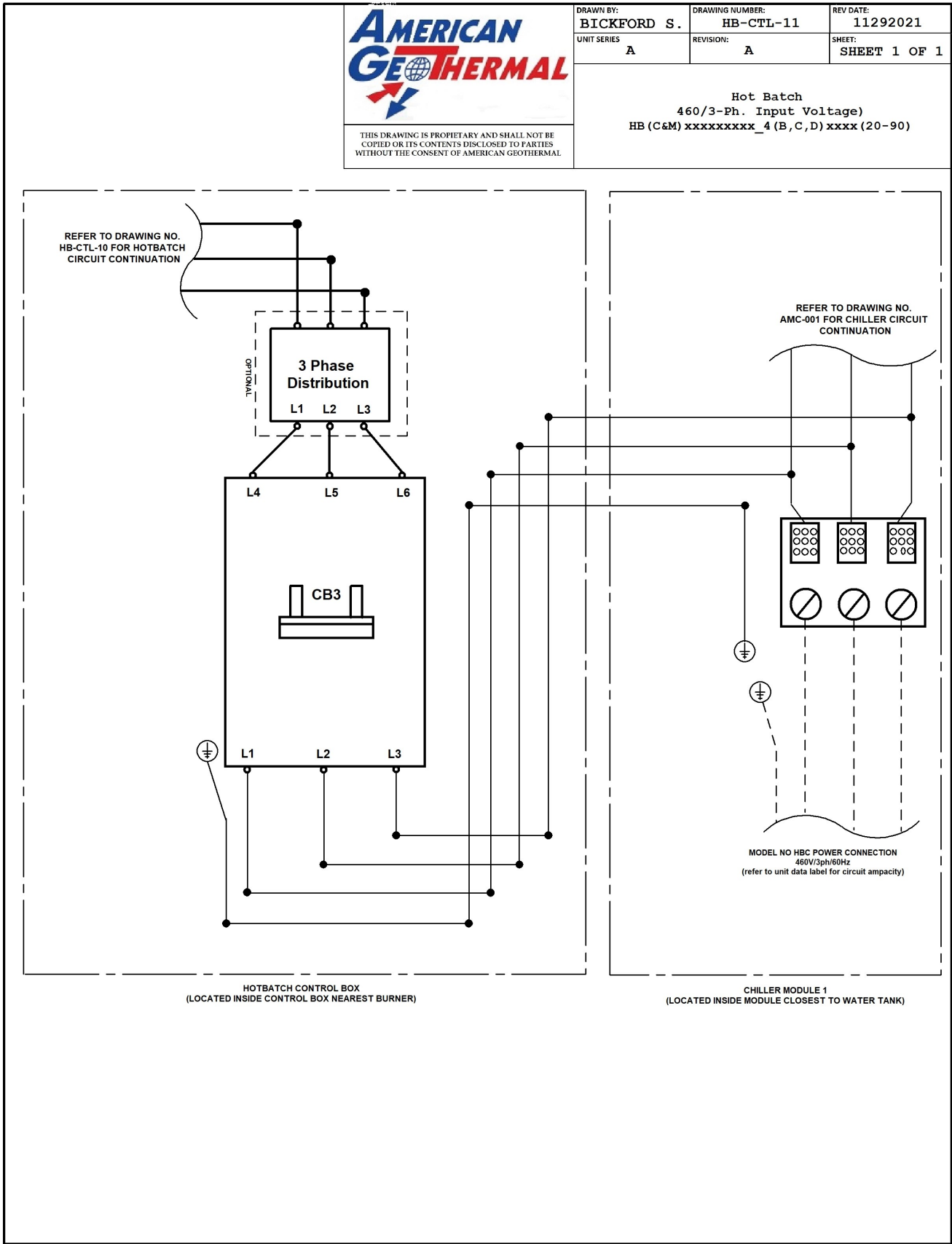
## Burner Controls, 3-Phase Schematic



# Burner Controls Low Voltage Schematic

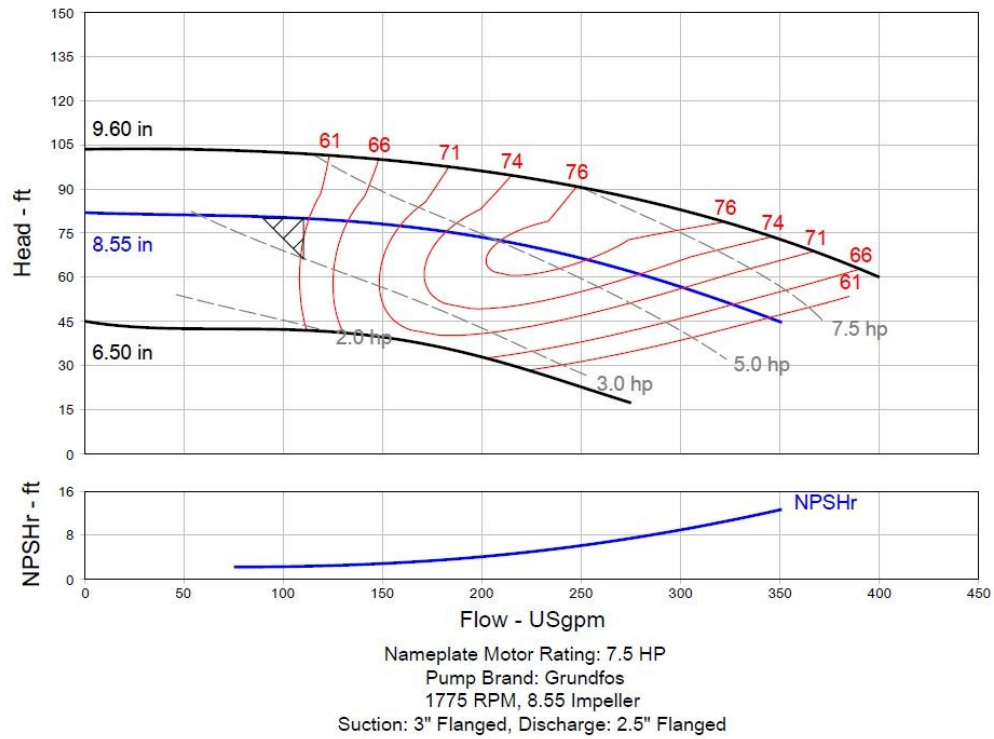
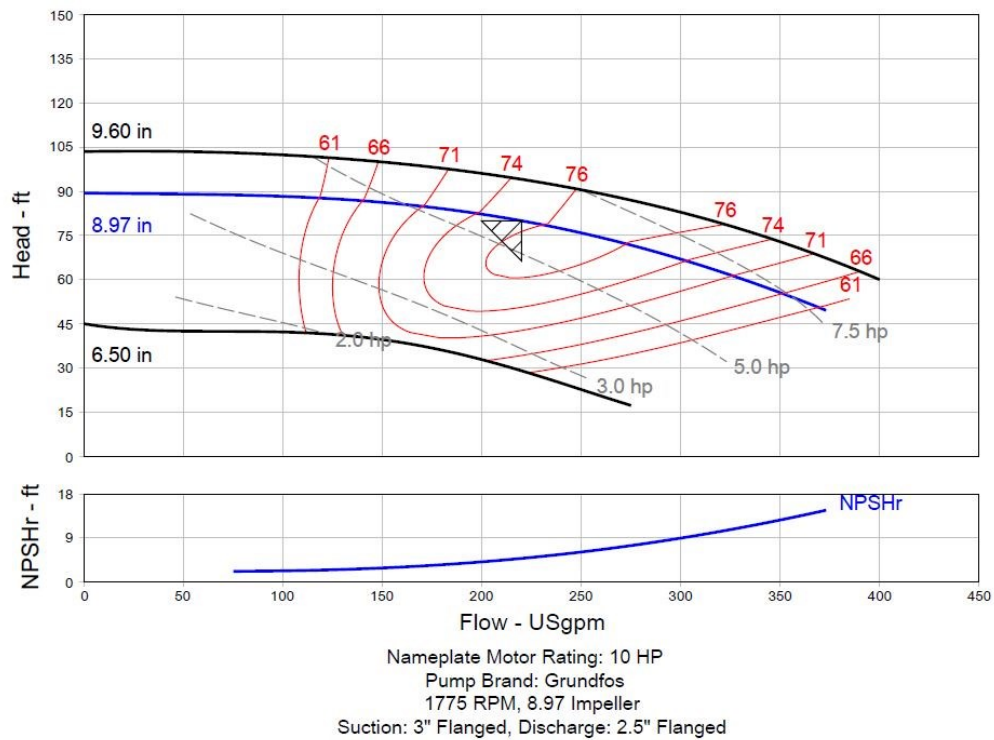


Model No. HBC Power Connection

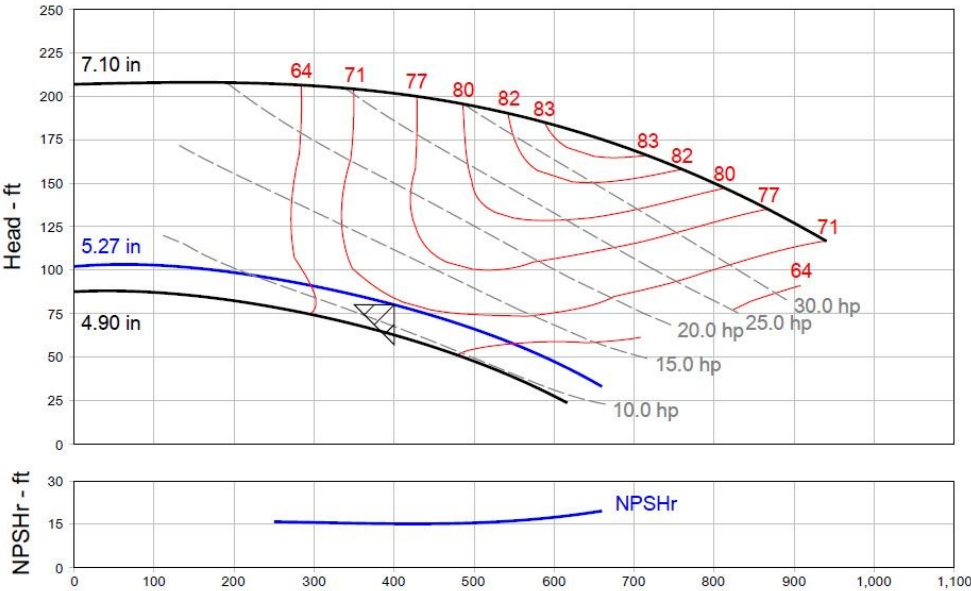




## Grundfos Brand Pump Curves



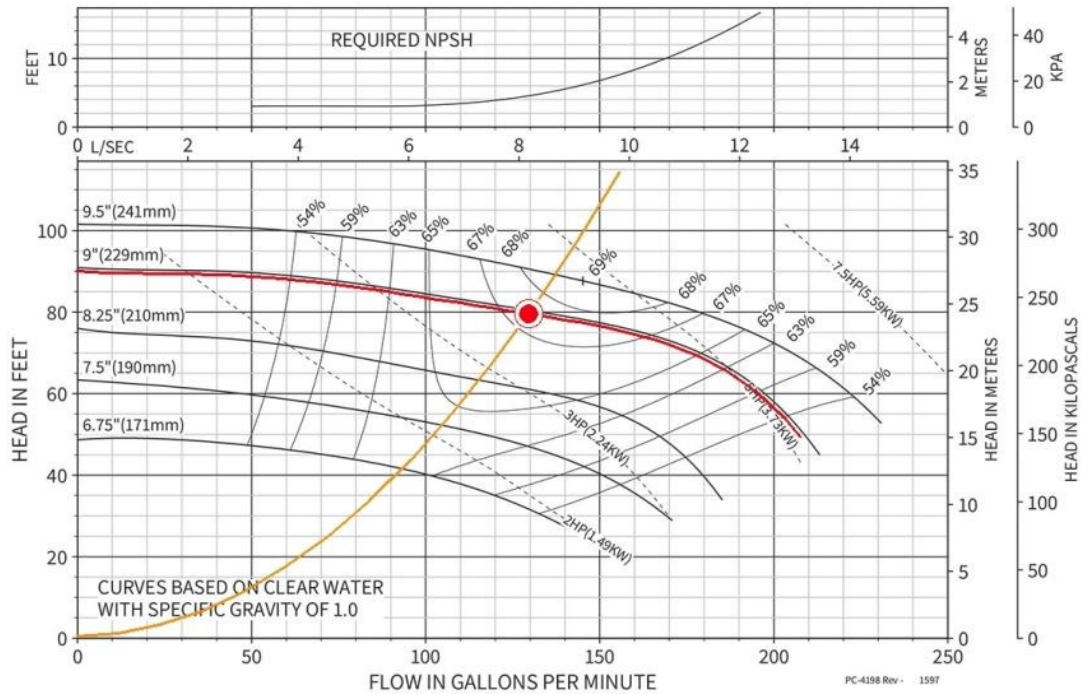
Grundfos Brand Pump Curves Cont.



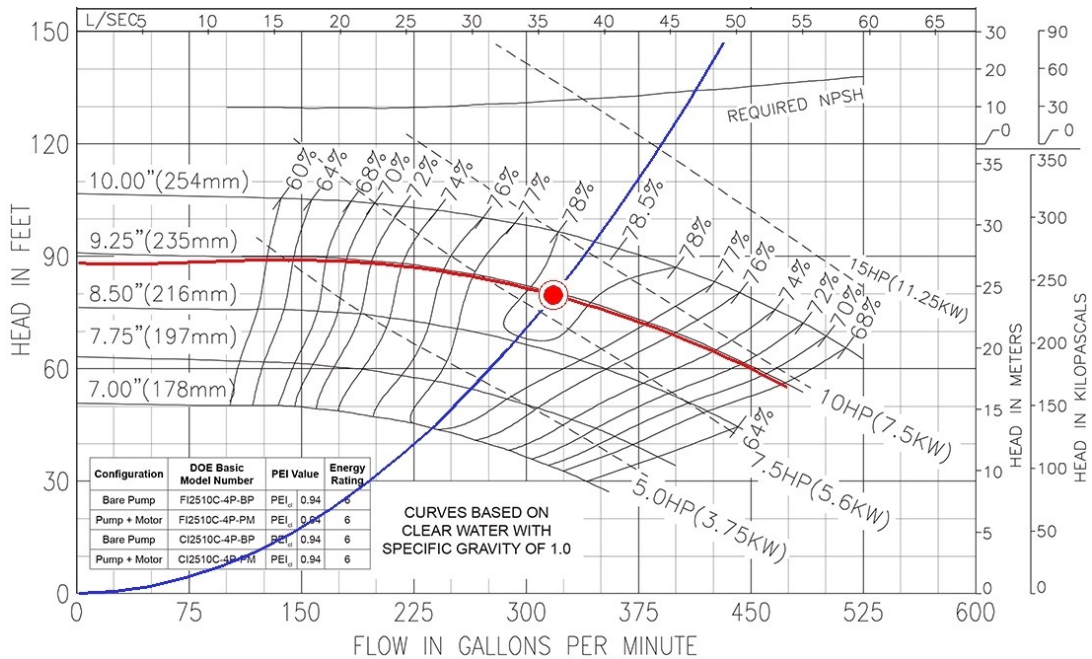
Nameplate Motor Rating: 15 HP  
Pump Brand: Grundfos  
3550 RPM, 5.27 Impeller  
Suction: 4" Flanged, Discharge: 3" Flanged



## Taco Brand Pump Curves

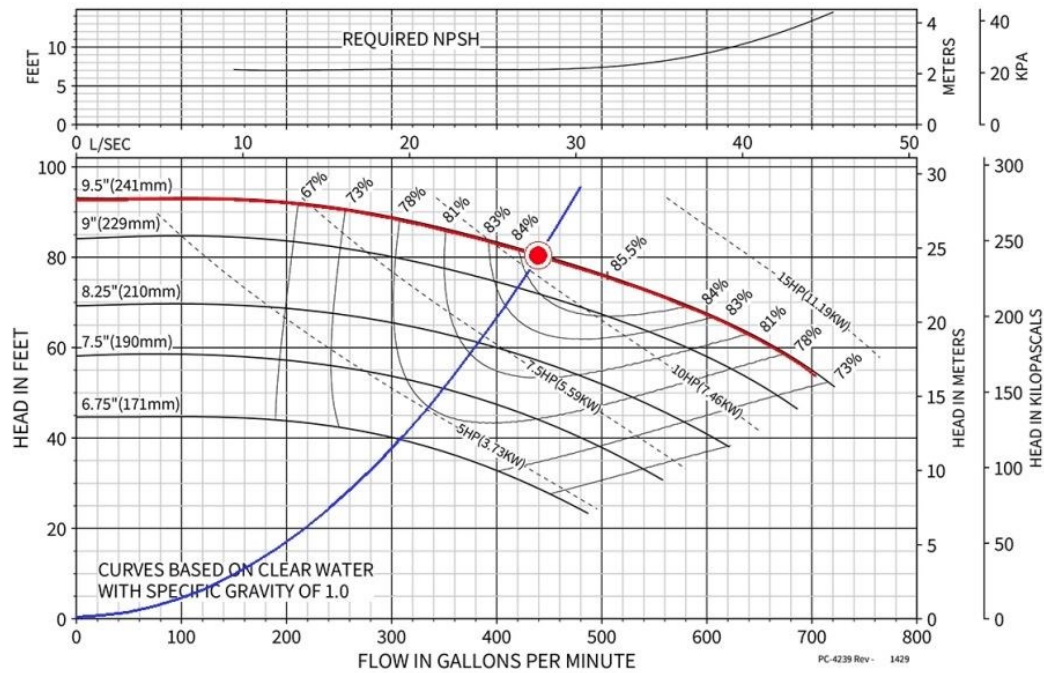


**Nameplate Motor Rating: 5 HP**  
 Pump Brand: Taco  
 Replacement Part No: WP:T0511  
 1760RPM, 9" Nominal Impeller  
 Suction: 2" Flanged, Discharge: 1-1/2"



**Nameplate Motor Rating: 10 HP**  
 Pump Brand: Taco  
 Replacement Part No: WP:T10318  
 1750RPM, 9.25" Nominal Impeller  
 Suction: 3" Flanged, Discharge: 2-1/2"

## Taco Brand Pump Curves Cont.



**Nameplate Motor Rating: 15 HP**

Pump Brand: Taco

Replacement Part No: WP:T15480

1750RPM, 9.5" Nominal Impeller

Suction: 4" Flanged, Discharge: 3

## Tank Insulation/Coating Ratings & General Information

| Temperature Losses of Various Size Tanks (Based on 160°F Tank Temperature) |                     |                                               |                                               |                                               |
|----------------------------------------------------------------------------|---------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Model No.                                                        | Tank Size (gallons) | 30°F Ambient Temp.<br>Q (BTU/hr.) [ΔT °F/hr.] | 50°F Ambient Temp.<br>Q (BTU/hr.) [ΔT °F/hr.] | 80°F Ambient Temp.<br>Q (BTU/hr.) [ΔT °F/hr.] |
| HBx03K                                                                     | 3,000               | 19,442 [0.77]                                 | 16,451 [0.66]                                 | 11,964 [0.48]                                 |
| HBx05K                                                                     | 5,000               | 27,834 [0.67]                                 | 23,552 [0.57]                                 | 17,129 [0.41]                                 |
| HBx08K                                                                     | 8,000               | 39,181 [0.59]                                 | 33,153 [0.50]                                 | 24,111 [0.361]                                |
| HBx10K                                                                     | 10,000              | 47,016 [0.56]                                 | 39,783 [0.48]                                 | 28,933 [0.35]                                 |
| HBx15K                                                                     | 15,000              | 58,068 [0.46]                                 | 49,135 [0.39]                                 | 35,734 [0.29]                                 |
| HBx20K                                                                     | 20,000              | 72,933 [0.44]                                 | 61,712 [0.37]                                 | 44,882 [0.27]                                 |
| HBx25K                                                                     | 25,000              | 86,755 [0.42]                                 | 73,408 [0.35]                                 | 53,387 [0.26]                                 |
| HBx30K                                                                     | 30,000              | 101,700 [0.41]                                | 86,054 [0.34]                                 | 62,585 [0.25]                                 |

**General Insulation Ratings** - NCFI 10-011 is a two component, HFC-245fa blown, all PMDI based spray polyurethane foam system designed for use as a self-adhering, seamless, high insulating, spray applied rigid polyurethane foam system. NCFI 10-011 has been formulated to spray at 2.8 pcf depending on lift thickness..

This product is classified to UL Standards and requirements by Underwriters Laboratories Inc. when used in accordance with UL's Roofing Materials and System Directory and/or UL's Fire Resistance Directory. Wind uplift resistance rated at 160-165 psf (depending on construction).



on

This product is Approved by Factory Mutual Research Corporation subject to the conditions of Approval as a spray foam roof insulation system for use in Class 1 roof construction as described in the current edition of the FMRC Approval Guide. Windstorm rated 1-60 to 1-180 (depending on construction).



**Insulation Coating Ratings** - In addition to the 2.8 pcf density foam insulation, an acrylic elastomeric coating must be applied to protect the insulation from UV degradation and other environmental conditions.

- Superior resistance to ultraviolet degradation
- Excellent adhesion to SPF
- Good low temperature flexibility down to -15°F
- Low toxicity and odor
- Retains high reflectivity because of excellent dirt pickup resistance, reduces substrate temperatures, prolongs

insulation life span, and reduces thermal losses.

- Meets the requirements of ASTM D6083
- Energy Star Certified Product

### Recoating Instructions (Post Insulation Repair)

1. All surfaces must be clean, dry, and free of dirt, grease, oil, and other contaminants that would interfere with proper adhesion.
2. Apply in two separate coats at the minimum rate of one gallon per 100 square feet.
3. Only apply at temperatures above 50°F. and when weather conditions will permit coating to dry before rain, dew, or freezing temperature occur.
4. May be applied by spray or heavy nap roller. However, airless spray is recommended for consistency.

Contact American Geothermal for assistance on insulation or coating repair.

| INSULATION PHYSICAL PROPERTIES |                         |
|--------------------------------|-------------------------|
| Core Density                   | 2.8 pcf.                |
| Compressive Strength           | 54 psi.                 |
| Tensile Strength               | 60 psi.                 |
| Moisture Vapor Transmission    | 0.92 perm. ·in.         |
| Closed Cell Content            | > 93%                   |
| R- Value                       | 13.4 @ 2"<br>27.4 @ 4"  |
| Maximum Service Temperature    | 180°F                   |
| Flammability, ASTM E-84        | 2 inch Flame Spread <75 |

Note: The above values are average values obtained from a laboratory and should serve only as a guide

## Determining Useable Tank Capacity

**Tank Capacity and How To Measure It** - There are many ways to measure internal tank volume. Standard on all tanks is **(1) Pressure Gauge** that reads psi. This can easily be converted to feet of water using the following equation. Of course this method can be used on any size tank with any orientation however, is limited to tanks with 100% water—no glycol mixtures. In addition, this method can only be applied once the gauge reading is greater than 0 because of the gauge location. If the gauge reading is = 0, there may still be ~ 1 feet of water in the bottom of the tank. Because the installed tank does not meet DOT specification 49 CFR § 173.32, always completely drain the tank before transporting on roadways.



In addition to the pressure gauge method, **(2) An Optional Sight Tubes** can be added during the time of manufacturing or, later during the installation of the equipment. Although the sight tubes can not be used to calculate the exact volume of the tank, they are however, great for estimating. All tanks come standard with sight tube fittings. If the operator wishes to purchase the sight tube kit they can simply reach out to the American Geothermal Service Department and order assembly no. HBx-006. Have your equipment Model and Serial No. available during the time of contact. Sight Tubes can become dirty after months of use and therefore, it is recommended to change out the plastic tubing once per year to ensure clear sight and accurate readings. Tubes should be UV resistive and have a minimum operating temperature of 200°F.

**Total Feet of Water = Gauge Reading × 0.433 + 1**

*Note: If gauge reading is equal to 0, ~1 feet of water may still be present inside the tank.*

**Tank Sight Tube**





## HotBatch Equipment Operation and Controls Overview

### SAFETEEY SWITCHES AND FILL VAVLES

**WARNING** - AT NO POINT SHOULD ANY OF THE FOLLOWING SWITCHES OR SENSORS BE JUMPERED, REMOVED, OR TAMPERED WITH IN ANY WAY. FAILING TO IGNORE THIS WARNING COULD RESULT IN EQUIPMENT DAMAGE, SERIOUS INJUSRY, AND/OR DEATH.

- a. **Tank High Level Float Switch** - The tank high level limit switch works in conjunction with the tank fill valve by acting as a cut off switch. As the water level approaches the float switch, the fill valve will then close and stop the flow of water into the tank. This switch prevents the tank from overflowing. If water is observed pouring out of the tank vent, check the installation angle in which the unit was placed. Each model has a different angularity tolerance that can be located on figure 7 in the installation section of this manual. In some cases, an extension pipe



may need to be attached to avoid overflowing - NEVER attach a soft flexible hose to the vent. Tank vents should always remain clear of obstructions and/or restrictions— tanks should

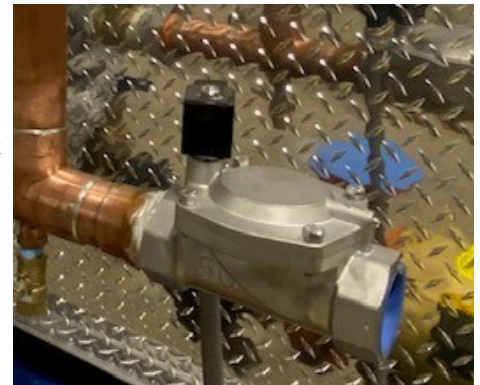
remain open to the atmosphere at all times. Always consult with the manufacture before modifying equipment.

- b. **Tank Low Level Float Switch** - Like the high level limit switch, the low level limit switch serves as a protection switch to prevent the water level from becoming to low while the burner is in normal operation. Because the tank has a minimum level for burner operation, as the tank level approaches the limit switch, the burner will shut down and an indicator (LED) will illuminate on the burner control box. In some cases, process pumps may batch water faster than the tank fill valve can recover it. If problems persist, proceed to the trouble shooting section of this manual.
- c. **Tank Fluid Fill Valve** - The fluid fill valve has two functionalities - heating and cooling modes. On the burner controls enclosure there is a switch labeled “Fill Valve Control Switch” this valve determines the wiring path of the control valve. In **heating mode**, the fill valve on operates only on the state of the high level float switch. However in **cooling**

**mode**, the fill valve operates both the high level float switch and the chiller “Total Fill Valve Control Setpoints.” The Total Fill Valve Control (TFVC) formerly Dilution Control, allows the operator complete control over tank temperature and volume. For example, when fluid is batched form the tank, the volume removed is replace by fluid warmer than the tanks contents. In turn, the tank temperature is affected in some way i.e. in cooling modes, tank temp increases. Due to this external heat load being introduced, the operator often has little control over the final temperature of the tank caused by the dilution . However in some instances, this mode of operation may not be acceptable and a different control method is required. American GeoThermal developed TFVC using state of the art temperature control software that allows the operator to set



operator to set desired minimum and maximum tank temperatures for cooling modes. Once the minimum and maximum temperatures are set and the



TFVC is activated, the fill solenoid valve will shut off regardless of the tank fill level to prevent dilution beyond desire. By using the chiller interface, the setpoint menu can be accessed by pressing the down key a few time until the “Fill Valve Controls” page is observed. The user can then adjust the maximum tank temperature setpoint.

- d. **Tank High Temperature Limit Switch** - The high temperature limit switch prevents the fluid within the tank from exceeding 180 degrees in the event of a control failure. If a fault occurs, the limit switch must be reset by pressing the tab in backward direction located on top of the devise.



## HotBatch Equipment Operation and Start Up

### e. Tank Temperature

**Thermostat-** The tank temperature thermostat serves as the primary tank temperature control. By using the up and down arrow keys and accessing the SP1 setpoint, the tank temperature setpoint can easily be changed by adjusting the SP1 value followed by pressing “set” to save the adjustment. Reference the picture to the right! SP1 should never exceed 160°F.



Utilization, and Nominal System Voltages can be found on the data label - **the below data label is an example only**. The installer should always consider the Minimum Circuit Ampacity (MCA) when sizing wire and over current protection. The All fuses being installed on 3 phase systems should comply UL-248-12 which indicates that all fuses should be class R, rated for either 250V, or 600V and current ratings under 600 Ampere. If the wire pull exceeds 100 ft. table 1 shall not be used to select wire. Proper voltage drop calculation should be considered and wire size must be adjusted per the adjusted ampere rating. Consult with a certified and licensed electrician to preform the proper adjustments to wire sizes.

### HOTBATCH START UP AND OPERATION

**WARNING—** The system start up should be performed by an certified individual whom contains the appropriate knowledge of gas and oil fired equipment. Damage to the equipment caused by negligent installation and/or, equipment operation will not be covered under the manufactures warranty. Contact American GeoThermal for assistance on start up and service.

- a. **Line Voltage Connection** - Always refer to the unit data label for line voltage and power requirements. As shown below, the System Rated,

AMERICAN GEOTHERMAL  
1037 OLD SALEM RD.  
MURFREESBORO, TN 37129  
(615) 890-6985

MODEL NUMBER HBC10K1.8MLNO4B10xx022xB  
SERIAL NUMBER 21H195  
BURNER JOB # J124386

#### FOR OUTDOOR INSTALLATION ONLY

Rated Voltage: 460v/3ph/60hz  
Utilization Voltage: 414-506  
Nominal System Voltage 440-460-480

Minimum Circuit Ampacity: 18.7  
Recommended Dual Element Fuse: 20.0  
Maximum Overcurrent Protection: 20.0

| VOLTAGE DROP FORMULAS – 1 $\phi$ , 3 $\phi$ |         |                                                              |                                                 |      |                                                                                                                                                             |
|---------------------------------------------|---------|--------------------------------------------------------------|-------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Phase                                       | To Find | Use Formula                                                  | Example                                         |      |                                                                                                                                                             |
|                                             |         |                                                              | Given                                           | Find | Solution                                                                                                                                                    |
| 1 $\phi$                                    | VD      | $VD = \frac{2 \times R \times L \times I}{1000}$             | 240 V, 40 A,<br>60' L, .764 R                   | VD   | $VD = \frac{2 \times R \times L \times I}{1000}$<br>$VD = \frac{2 \times .764 \times 60 \times 40}{1000}$<br>$VD = 3.67 \text{ V}$                          |
| 3 $\phi$                                    | VD      | $VD = \frac{2 \times R \times L \times I}{1000} \times .866$ | 208 V, 110 A, 75' L,<br>.194 R, .866 multiplier | VD   | $VD = \frac{2 \times R \times L \times I}{1000} \times .866$<br>$VD = \frac{2 \times .194 \times 75 \times 110}{1000} \times .866$<br>$VD = 2.77 \text{ V}$ |

| VOLTAGE DROP VARIABLES                                                             |                                                                                                            |                                                                                                                         |                                                                                                     |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| V = Voltage (in V)<br>V <sub>s</sub> = Supply voltage (in V)<br>I = Current (in A) | VD = Voltage drop (in V)<br>K = Resistivity of conductor (in $\Omega$ )<br>L = Length of conductor (in ft) | %VD = Percent voltage drop (in V)<br>R = Resistance of conductor (in $\Omega$ /ft)<br>1000 = 1000' or less of conductor | V <sub>l</sub> = Voltage loss (in V)<br>CM = Circular mils (in area)<br>$.866 = \frac{\sqrt{3}}{2}$ |

## HotBatch Fuel Connections and Line Sizing

**Table 1- Wiring Sizing Specifications**

*Applicable codes may require different wire sizing*

| MCA | 3 Conductors<br>(1 raceway) | 6 Conductors<br>(1 raceway) |
|-----|-----------------------------|-----------------------------|
| 10  | 16                          |                             |
| 18  | 14                          |                             |
| 25  | 6                           |                             |
| 40  | 8                           | -                           |
| 65  | 6                           | -                           |
| 100 | 3                           | -                           |
| 115 | 2                           | -                           |
| 130 | 1                           | -                           |
| 150 | 1/0                         | -                           |
| 175 | 2/0                         | -                           |
| 200 | 3/0                         | -                           |
| 230 | 4/0                         | -                           |
| 255 | 250 MCM                     | -                           |
| 285 | 300 MCM                     | 1/0                         |
| 300 | -                           | 2/0                         |

- b. **Fluid Connections and Pump Control** - Depending on equipment model number, a variety of fluid connections may be required. The minimum fluid requirement are both the tank fill valve connection (2 inch FNPT) and some method of water dispatch (typically a pump.) In most cases, the factory has installed process pump for batch water processes. Refer to the equipment AS\_BUILT for plumbing connection types and sizes. Pump connections types can be FNPT or ANSI flanges ranging from 1-1/2" to 4" nominal pipe sizes. Pumps can be controlled in variety of ways.. All HotBatch systems that contain factory pumps and controls will come standard with an illuminated push button to turn the pump off and on. In addition, the control panel contains terminal blocks for a remote switch to be wired in (refer to drawing no. HB-CTL-21a and reference the "field batch and truck control." Alternatively, some systems will be equip with bladder tanks that will be outfitted with a pressure switch and a check valve. When the remote solenoid valve opens pressure drops and in turn, the pump starts. Once the remote valve closes, the pressure builds and the pump turns off. For **continuous pump operation** one of the two methods can be utilized to prevent deadheading the pump.

**Table 2- Fuel Connections & Data**

| Table 2– Fuel Connections & Data               |                |                   |                |
|------------------------------------------------|----------------|-------------------|----------------|
|                                                | #2 Oil         | Natural Gas       | Liquid Propane |
| Model No. HBxxx0.8M - (800,000 BTU/hr.)        |                |                   |                |
| Connection Size                                | 1/4” FNPT      | 1” MNPT           | 1” MNPT        |
| Fuel Consumption (high fire)                   | 6.1 gal./hr    | 748 Cu.ft./Hr     | 8.7 Gal./ Hr   |
| Required Fuel Pressure                         | -              | 14” W.C           | 14” W.C        |
| Time Required to Raise 1000 Gal. by 100°F      | 1.49 Hours     |                   |                |
| Model No. HBx1.1M - (1,100,000 BTU/hr.)        |                |                   |                |
| Connection Size                                | 1/4” FNPT      | 1” MNPT           | 1” MNPT        |
| Fuel Consumption (high fire)                   | 8.4 Gal./Hr.   | 1029 Cu.ft./Hr    | 12.1 Gal./ Hr. |
| Required Fuel Pressure                         |                | 14” W.C           | 14” W.C        |
| Time Required to Raise 10K Gal. by 100°F       | 1.08 Hours     |                   |                |
| Model No. HBx1.8M - (1,800,000 BTU/hr.)        |                |                   |                |
| Connection Size                                | 1/4” FNPT      | 1” MNPT           | 1” MNPT        |
| Fuel Consumption (high fire)                   | 13.9 Gal./Hr.  | 1683 Cu.ft./hr    | 19.8 Gal./ Hr. |
| Required Fuel Pressure                         | -              | 14” W.C           | 14” W.C        |
| Time Required to Raise 1000 Gal. by 100°F      | 0.662 Hours    |                   |                |
| Model No. HBx3.4M - (3,400,000 BTU/hr.)        |                |                   |                |
| Connection Size                                | 1/4” FNPT      | 1-1/2” MNPT       | 1-1/2” MNPT    |
| Fuel Consumption (high fire)                   | 26.3 Gal./Hr.  | 3180.5 Cu.ft./Hr. | 37.4 Gal./ Hr. |
| Required Fuel Pressure                         | -              | 14” W.C           | 14” W.C        |
| Time Required to Raise 1000 Gal. by 100°F      | 0.350 Hours    |                   |                |
| Model No. HBx6.8M - (Dual - 3,400,000 BTU/hr.) |                |                   |                |
| Connection Size (x2)                           | 1/4” FNPT      | 1-1/2” MNPT       | 1-1/2” MNPT    |
| Fuel Consumption (high fire)                   | 52.5 Gal./ Hr. | 6361.1 Cu.ft./Hr. | 74.8 Gal./ Hr. |
| Required Fuel Pressure                         | -              | 14” W.C           | 14” W.C        |
| Time Required to Raise 1000 Gal. by 100°F      | 0.175 Hours    |                   |                |



## HotBatch Fuel Connections & Line Sizing

1. **Process Recirculation** - when batch water flow requirements are low and a small amount of water can be sacrificed, a tee may be installed on the head of the pump and a small line can be plumbed from the tee back to the tank. Consult with an engineer before proceeding as installing the incorrect line size can result in damage to the pump.
2. **Process Bypass** - in this method, typically a 3 way valve either a signal driven actuating valve or pressure sustaining valve is used in conjunction with a water solenoid valve.

Refer to the "Pump Curves" section of this manual

for maximum rated head pressure and flow rates. For service and pump disassembly/reassembly, please contact American GeoThermal for assistance.

- c. **Burner Fuel Supply**- Always refer to the equipment data label for the fuel compatibility. The data label shown on the next page is for visual representation only and does not reflect the actual system requirements. If the equipment data label can not be accessed at the time of installation, please contact

### Equivalent Length of Fittings in Feet

| Pipe Size (IPS)       | 1   | 1.25 | 1.5 | 2    | 2.5  | 3    | 4    |
|-----------------------|-----|------|-----|------|------|------|------|
| Std. Tee through Side | 5.5 | 7.5  | 9.0 | 12.0 | 14.0 | 17.0 | 22.0 |
| Std. E11              | 2.7 | 3.7  | 4.3 | 5.5  | 6.5  | 8.0  | 12.0 |
| 45° E11               | 1.2 | 1.6  | 2.0 | 2.5  | 3.0  | 3.7  | 5.0  |
| Plug Cock             | 3.0 | 4.0  | 5.5 | 7.5  | 9.0  | 12.0 | 16.0 |

### Capacity of Pipe - Natural Gas (CFH)

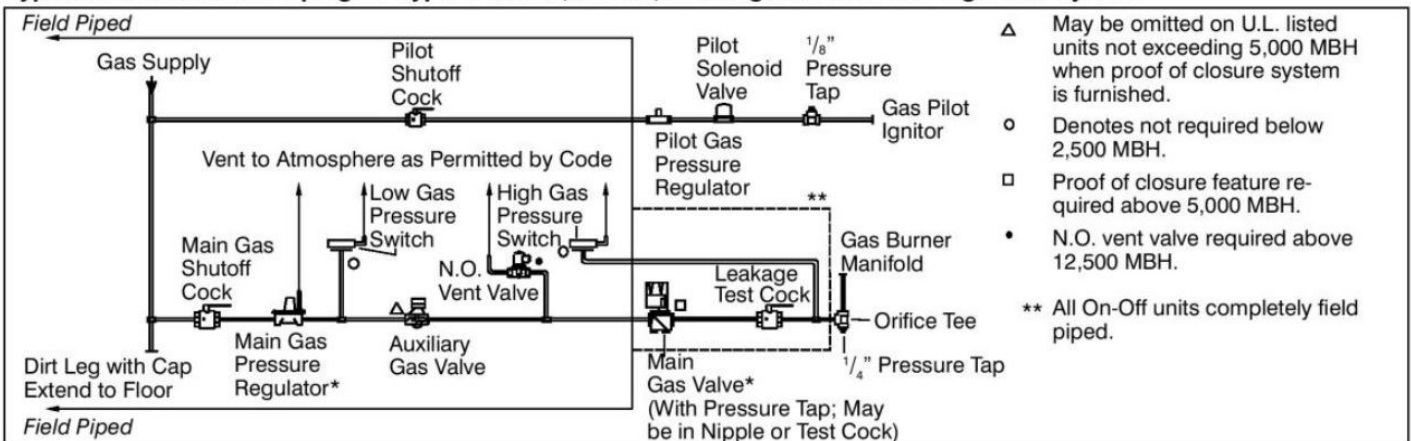
With Pressure Drop of 0.3" w.c. and Specific Gravity of 0.60

| Pipe Length<br>In Feet | Pipe Size - Inches (IPS) |       |       |      |       |      |       |
|------------------------|--------------------------|-------|-------|------|-------|------|-------|
|                        | 1                        | 1 1/4 | 1 1/2 | 2    | 2 1/2 | 3    | 4     |
| 10                     | 520                      | 1050  | 1600  | 3050 | 4800  | 8500 | 17500 |
| 20                     | 350                      | 730   | 1100  | 2100 | 3300  | 5900 | 12000 |
| 30                     | 285                      | 590   | 890   | 1650 | 2700  | 4700 | 9700  |
| 40                     | 245                      | 500   | 760   | 1450 | 2300  | 4100 | 8300  |
| 50                     | 215                      | 440   | 670   | 1270 | 2000  | 3600 | 7400  |
| 60                     | 195                      | 400   | 610   | 1150 | 1850  | 3250 | 6800  |
| 70                     | 180                      | 370   | 560   | 1050 | 1700  | 3000 | 6200  |
| 80                     | 170                      | 350   | 530   | 990  | 1600  | 2800 | 5800  |
| 90                     | 160                      | 320   | 490   | 930  | 1500  | 2600 | 5400  |
| 100                    | 150                      | 305   | 460   | 870  | 1400  | 2500 | 5100  |
| 125                    | 130                      | 275   | 410   | 780  | 1250  | 2200 | 4500  |
| 150                    | 120                      | 250   | 380   | 710  | 1130  | 2000 | 4100  |
| 175                    | 110                      | 225   | 350   | 650  | 1050  | 1850 | 3800  |
| 200                    | 100                      | 210   | 320   | 610  | 980   | 1700 | 3500  |

### Correction Factors

| Specific Gravity<br>Other Than 0.60 |            | Specific Drop<br>Than 0.3 |            |
|-------------------------------------|------------|---------------------------|------------|
| Specific Gravity                    | Multiplier | Pressure Drop             | Multiplier |
| 0.50                                | 1.10       | 0.1                       | 0.577      |
| 0.60                                | 1.00       | 0.2                       | 0.815      |
| 0.70                                | 0.926      | 0.3                       | 1.00       |
| 0.80                                | 0.867      | 0.4                       | 1.16       |
| 0.90                                | 0.817      | 0.6                       | 1.42       |
| 1.00                                | 0.775      | 0.8                       | 1.64       |
| Propane - Air                       |            | 1.0                       | 1.83       |
| 1.10                                | 0.740      | 2.0                       | 2.58       |
| Propane                             |            | 3.0                       | 3.16       |
| 1.55                                | 0.662      | 4.0                       | 3.65       |
| Butane                              |            | 6.0                       | 4.47       |
| 2.00                                | 0.547      | 8.0                       | 5.15       |

### Typical Schematic Gas Piping for Type C Burner, On-Off, Low-High-Off and Low-High-Low System



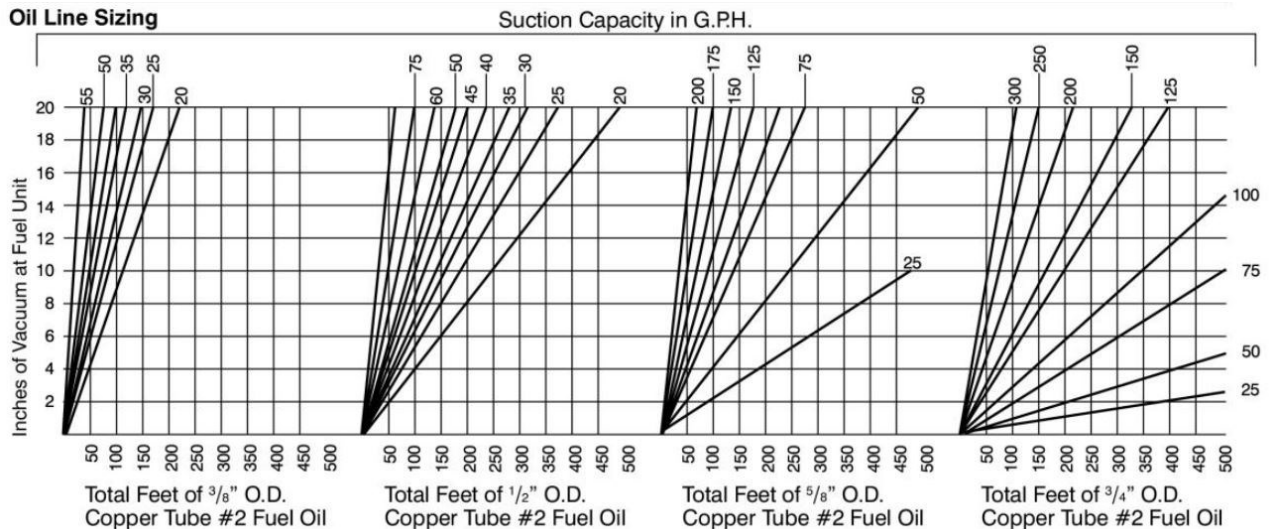
## HotBatch Fuel Connections & Line Sizing

|                                                                                                                  |        |     |     |
|------------------------------------------------------------------------------------------------------------------|--------|-----|-----|
| Burner:                                                                                                          | Qty. 1 | 460 | 60  |
| Batch Pump:                                                                                                      | 1      | 460 | 60  |
| Truck Pump:                                                                                                      | 0      | N-A | N-A |
| Operating Fuel Types: Liquid Propane<br>Natural Gas<br>#2 Oil                                                    |        |     |     |
| Drawing Numbers: GO-J124386 HB-CTL-10 (rev-c)<br>PDG-J124386 HB-CTL-14 (rev-c)<br>PDO-J124386 HB-CTL-21a (rev-c) |        |     |     |
| For Nonresidential Installation Only                                                                             |        |     |     |
| MANUFACTURED IN USA                                                                                              |        |     |     |

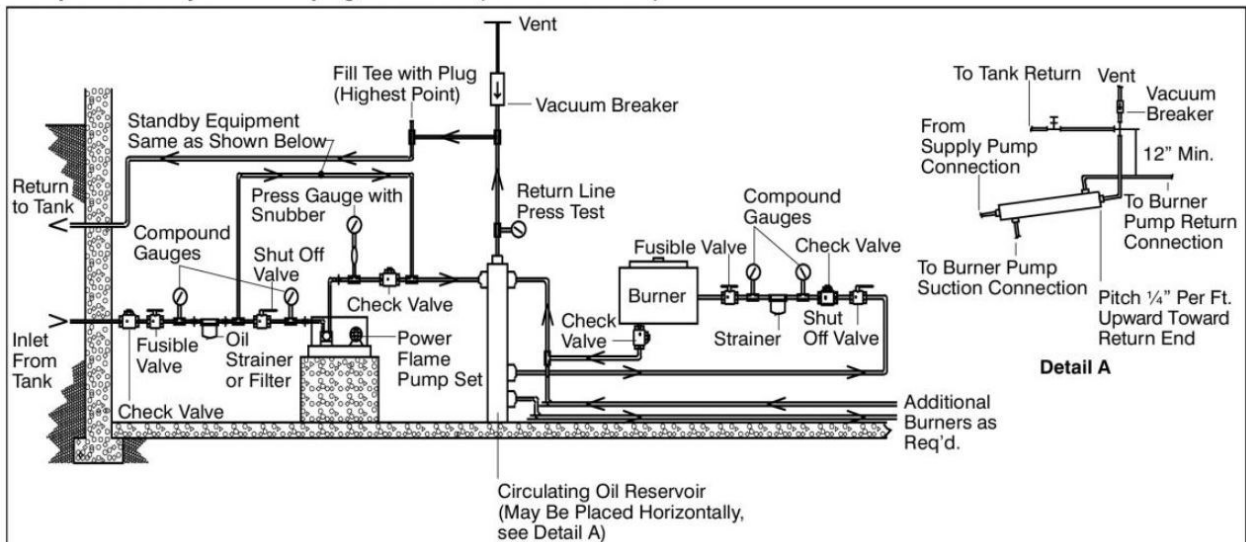
American GeoThermal for assistance. The manufacture will not be responsible for negligent fuel connections and or installation.

- d. **Gas Supply Piping-** Gas piping should be sized to provide required pressure at the burner train inlet manual shutoff cock, when operating at the maximum desired fuel input. All gas piping should be appropriately pressure tested to ensure leak free operation. It is recommended that a dirt pocket or trap be piped into the gas supply system just ahead of the burner train inlet manual shutoff cock. When testing with pressures higher than the maximum pressure rating of the gas train components, be sure to isolate these components and test their piping for gas leaks with correct pressures only. On some burners, the maximum main gas train and/ or pilot gas train components pressure is 1/2" psig. (14

### Oil Line Sizing



### Multiple Burner System Oil Piping Schematic (Flooded Suction)



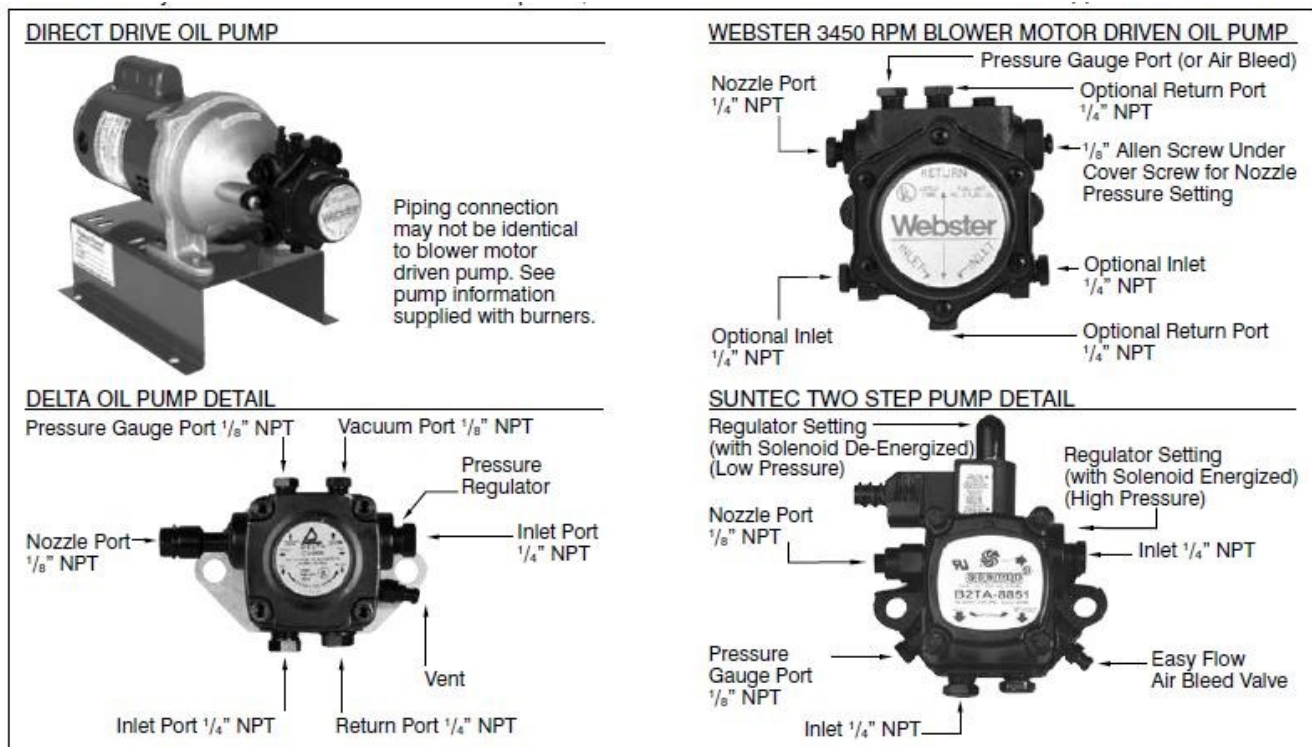
## HotBatch Fuel Connections and Line Sizing

| Oil Pump Suction Capacity and Filter Selection Chart |                  |                      |
|------------------------------------------------------|------------------|----------------------|
| Gas/Oil Model                                        | Oil Model        | GPH Suction Capacity |
| C1-GO-10                                             |                  | 70(1)                |
| C1-GO-12                                             | C1-O and C1-OS   | 70(1)                |
| C2-GO-15                                             | C2-OA and C2-OAS | 70(2)                |
| C2-GO-20A                                            | C2-OB and C2-OBS | 40                   |
| C2-GO-20B                                            | C2-OB and C2-OBS | 40                   |
| C3-GO-20                                             | C3-O             | 105                  |
| C3-GO-25                                             | C3-O             | 105                  |
| C3-GO-25B                                            | C3-O(B)          | 135                  |
| C4-GO-25                                             | C4-OA            | 135                  |
| C4-GO-30                                             | C4-OB            | 135                  |
| C5-GO-30(B)                                          | C5-O(B)          | 250                  |
| C6-GO-30                                             | C6-O             | 250                  |
| C7-GO-30(B)                                          | C7-O(B)          | 265                  |
| C8-GO-30                                             | C8-O             | 265                  |

in.W.C). Refer to the table below for information relating to the sizing of gas supply piping. These charts are based on the general flow characteristics of commercially produced black wrought iron pipe. If in doubt regarding flow capabilities of a chosen line size, the next largest size is recommended. Refer to the schematic below for typical gas piping schematics to meet U.L. requirements in the C burner firing ranges.

- e. **Burner Oil Supply Piping** - The C burner is designed for use with light grade fuel oil- commercial standard grades #2 or #1. It is recommended that prior to installation all national, local, and applicable codes be

reviewed to ensure total compliance. Do not install manual valves in the return line between the pump and tank unless required by a specific code. If a manual valve is required, an automatic relief valve must be installed across the manual valve to ensure that oil will bypass directly back to the tank in the event the manual valve is inadvertently left in the closed position. Use copper tubing with flare fitting or iron pipe on all installations. All units must utilize the proper size and type of suction line oil filters. Refer to the table below for recommended oil filters. If the oil storage system has been used with fuel heavier than #2 fuel oil, the entire system should be thoroughly cleaned and flushed before starting up the new system. Utilize fusible link and/or overhead anti-siphon valves as appropriate. If iron pipe oil lines are used on underground tanks, swing joint utilizing nipples and elbow must be used and joined together, making certain the piping connections are tightened as the tank settles. Keep swing joints in the suction and return lines as close to the tank as possible. Underground tanks should be pitched away from the suction line end of the tank to prevent sediment from accumulating at the suction line entrance. The suction line should be a minimum of 3" from the tank bottom. Make certain that all tanks contain an atmospheric vent and is free of any blockages and/or restrictions. It is very important





## Buner Start Up

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to properly size the oil suction line and oil filter, to provide fuel flow to the burner without exceeding 10" suction (vacuum) at the oil pump suction port.

### f. Oil Line Sizing Procedure:

1. Check oil pump GPH Suction Capacity shown in Table 6.
2. Measure total tube length (horizontal and vertical) from the end of the line in the tank, to the connection at the oil pump.
3. Choose the appropriate graph above based on the tubing size. Read up from horizontal line Total Feet of Copper Tube to Suction Capacity in GPH.
4. Read left to the vertical line Inches of Vacuum at Fuel-Unit.(This is the vacuum required to draw oil through the length of tubing selected.)
5. If installation has lift (Lift is defined as the vertical distance the fuel unit is above the top of the tank,) add 1" of vacuum for every foot of lift.
6. Add the vacuum determined from items 4 and 5 together to determine total inches of vacuum.
7. If total is over 10", move to next larger tubing size chart and re-calculate total inches of vacuum.
8. The instructions above do not allow for any added restrictions, such as line filter, elbows, sharp bends, check valves, etc. Suction line vacuum values for such components vary by manufacture. A rule of Thumb to determine total vacuum for suction line sizing is to add 10% vacuum determined from the Oil line sizing chart on the previous page.

9. It is always safe to size the return line from the pump to tank at the same size as the selected suction line.

- g. **Combustion Air Requirements** - Fresh air required to support combustion, as well as to provide adequate location ventilation, must be supplied. All types of fuel require approximately 12 cubic feet of standard air (sea level at 60 F°) per 1000 BTUs firing rate, for theoretical perfect combustion. In actual practice, a certain amount of excess air is required to ensure complete combustion, but this can vary substantially with specific job conditions. Additional air is lost from the boiler room through barometric dampers, draft diverters and similar venting devices. It is generally accepted that ½ square inch of free air opening (for each gas or oil burner in the room) per 1000 BTU/hr. firing rate will be adequate. Under no circumstances should a boiler room be under negative pressure. Jurisdictional authority relating to combustion air and boiler room ventilation requirements vary widely. In order to make certain of compliance, review NFPA-54 and the controlling authorities should be consulted.
- h. **General Start Up Procedure (MULTI-FUEL BURNERS)** - A thoroughly qualified burner technician should be employed to provide the initial burner start up, as well as any subsequent servicing. A representative of the owner and/or the person or persons responsible for operating and maintaining the unit should be present during the initial start up. A service representative may also be required by the local utility

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### Required Burner Start up and Service Test Equipment

The following test equipment is required to ensure proper start up and adjustment of the burner equipment to obtain maximum efficiency and reliability of operation.

#### For All Fuel Options

CO2 indicator or O2 analyzer Stack thermometer  
Draft gauge or inclined manometer  
Combination volt/ammeter  
D.C. microammeter or D.C. voltmeter, as required by Flame Safeguard programmer selection

#### For Gas

CO indicator  
U-Tube manometer or calibrated 0-10" and 0-35" W.C. pressure gauges  
(Higher pressure ranges may be necessary depending upon gas inlet supply pressure.)

#### For Oil

Compound vacuum/pressure gauge - 0-30" vacuum/0-30 PSIG  
0-400# oil pressure gauge (two required for internal bypass type oil nozzles)  
Smoke tester

## Burner Start Up

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on gas fired equipment. Instructions regarding the proper care and maintenance of the unit should be outlined with these people present. Before beginning start up, the start up technician should thoroughly study and become completely familiar with the exact sequence of operation and all other details of the specific flame safeguard control system being used. This information will be found in bulletins printed and supplied by Honeywell or Fireye. A copy of this bulletin was supplied with the burner. After the burner is mounted and all wiring and piping has been completed, tested and determined to be correct, the following procedures are recommended: For combination gas/oil units; the gas side operation should be set up first to clock the gas meter, allowing precise gas inputs to be determined. Once the gas operation is complete, the oil side can be set up easily by correlating the CO<sub>2</sub> values of the two fuels. See the next page, CO<sub>2</sub>-O<sub>2</sub> Ratio Curves for Fuel Oils and Gases. If it is anticipated that the Gas/Oil burner will rarely run on oil; it is recommended that the blower motor driven oil pump drive coupling be removed - and replaced only when required for oil firing. If, however, the pump coupling is left connected to the blower motor, it is essential to ensure that the pump has a good oil supply, when the burner is operating on the gas cycle, so that it will not run dry. Be certain on initial start up that the pump is adequately primed to prevent against mechanical seizure caused by lack of oil. The pump warranty will be voided if the pump is run without adequate oil supply.

1. Make a general inspection tour of the equipment room to ensure that the installation is complete. Check piping, controls, and wiring. When using the Alpha System™ Circuit Board, check wiring connections before powering the unit. See page 7 & 8 for connection diagram. NOTE: L1 Main 115 volt hot incoming power terminal is located on the lower set of terminals at the bottom of the main circuit board. The L1 Fused terminal located on the lower set of terminals is for factory use only and should not be used for incoming power connections.
2. Close main and checking gas cocks. Open suction line manual oil valves and others as appropriate.
3. Tighten all screws on terminal blocks in control cabinet in case some may have loosened in shipment.
4. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
5. Check fuses in main panel and in burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. Determine that voltage supply is correct to motor

starter line connections and to control circuit line connections. If a control circuit transformer is supplied, make certain its primary voltage matches the line voltage being supplied. (A 230 volt transformer does not produce proper control voltage when supplied with 208 volts.)

6. Check breaching and stack to ensure that they are open and unobstructed.
7. Check blower (and oil pump motor, as applicable) rotation by momentarily making contact of the motor starters. Proper rotation is imprinted on the fan housing and (if supplied) the remote oil pump set assembly.
8. Check operating controls, limit controls, low water cut-off, flame safeguard control reset, high and low gas pressure switches (if used) and low fire interlock switch (if used) and all other applicable interlocks. All contacts should be closed (an exception will be found on jobs using the low gas pressure switch; this switch should be open until the main gas cock is opened). If a low oil pressure switch is used, its contacts will remain open until the oil pump is running and the low oil pressure cut-in point is reached.
9. Do not repeatedly recycle the burner, so as to allow any unburned fuel in the combustion chamber.
10. Specific instructions relative to component sequencing are provided in the flame safeguard manufacturer's bulletin which is included with the documentation shipped with the burner. Refer to Honeywell and Fireye literature regarding the clipping of jumpers or setting of DIP switches in connection with the pilot establishing period, flame failure action, and air flow switch failure features.
11. Proper test equipment must be used in order to achieve maximum system operational reliability and fuel efficiencies. All fuel/air adjustments should be made to achieve required input rate, satisfactory combustion test values, flame stability and appearance.
12. Every new burner start up should employ the use of the Burner Start Up Information and Test Data sheets on pages at the back of this manual.

### i. General Start Up Procedure (GAS BURNERS) -

## Buner Start Up

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Some applications may require the burner to function at the low end of its rated capacity. As a result, the two combustion air inlets may supply more air than is required for efficient combustion. In such instances, it may be desirable to operate the system using only one combustion air inlet and one combustion air inlet damper. This may be accomplished by removing cross connecting linkage between dampers and locking the unused damper in a fixed, closed position. One way of locking the damper is to use a 10-24 machine screw through the hole in the linkage arm, and drill and tap the air inlet housing, or use two nuts on the screw and let the screw bear against the air inlet housing. Air diffuser movement (fore and aft) may be necessary to produce the best flame pattern or smoothest operation. Gas and Gas/Oil burners for Scotch marine and other selected applications incorporate a gas/air premix adjustment. This adjustment is identified by diametrically opposed adjustment knobs on the blast tube.

1. Prior to burner start up - contact the local gas company to determine if any correction factors have to be applied to their indicated meter flow rates. This information is important as relates to achieving specific heat exchanger BTU/HR inputs.
2. Refer to the gas piping diagram furnished with the burner. Check gas piping, controls and valves for leaks and compliance with codes.
3. Check all linkages. If the system is a packaged burner/heat exchanger system, the linkage was probably set when the system was test fired at the heat exchanger manufacturer's factory. It should, however, be checked to ensure that it was not damaged in shipment. On conversion units (where the burner and heat exchanger are mated in the field), the linkage will have to be set to suit the particular operating conditions.
4. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
5. Remove the pilot assembly and check for proper settings of the spark gap, tightness of electrode in its bracket and firm connections of the electrode cable.
6. Close main, checking and pilot gas cocks. Install one gas pressure gauge to read burner firing head pressure (use a 0-10" W.C. gauge or a manometer). See Section 3 for pressure sensing locations. Install a second gas pressure gauge to read gas supply pressure between the main gas cock and the inlet to the main gas pressure regulator (use a 0-35" W.C. gauge or as appropriate). If there is no tapping in this location, install a tee at the point where the pilot gas supply is connected to the main gas line. Slowly open the main gas cock in order

to determine that the incoming gas pressure is within the specified limits of the main and pilot gas pressure regulators, automatic fuel valves and gas pressure switches. Many systems are rated for a maximum gas supply pressure of 14" W.C. If pressure exceeds this value, consult the first page of the Burner Specification Sheet and/or gas component product bulletins supplied with the burner to ensure that the supplied system can operate properly at the elevated supply pressure.

7. Disconnect pilot line at inlet to the pilot gas pressure regulator and purge air from the pilot gas line. Purging of gas lines must be done in accordance with NFPA 54 of the National Fire Protection Association's National Fuel Gas Code. After the air is purged from the gas supply system, close the pilot cock and reconnect the pilot line. Leave the pilot cock closed.
8. Install required system measuring devices: a) appropriate flame signal meter to the flame safeguard control; b) manometer (or 0-10" W.C. gauge) in the pilot test tee port; c) stack thermometer and CO<sub>2</sub> or O<sub>2</sub> sample line to the breaching; and d) draft gauge to the combustion chamber test point.
9. It is strongly recommended that an automatic gas valve bubble leak test be performed in accordance with the gas valve manufacturer's instructions on every new installation and periodically afterwards in order to ensure that the valve is functioning according to the manufacturer's specifications. It is also suggested that the test be conducted during a normal prepurge burner operation. This test will reveal any problems that relate to incorrect wiring of the automatic gas valve that could cause premature energization of the valve.
10. Set the air dampers approximately 1/4" open, and with both pilot and leak test gas cocks closed, open the main gas cock (to allow the low gas pressure switch, if supplied, to make its circuit). With the control switch in the Off position, apply power to the burner through the main burner disconnect switch. Switch the burner panel On/Off switch to the On position momentarily to determine that the blower rotation is correct.
11. Restart the burner. Perform an initial spark pick-up test. With the pilot gas cock closed, the burner will go through a blower prepurge period, after which the gas pilot ignition transformer will be energized,



## Buner Start Up

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- although no pilot will be established. (At no time should there be any flame signal reading, nor the main gas valve attempt to open.) At the end of the pilot trial for ignition and blower purge period, the flame safeguard control should shut the system down in a safety lock-out mode, requiring manual reset of the flame safeguard control to restart the burner. If a flame signal is detected, verify the flame retention tab and ignition electrode are properly positioned,
12. Wait three minutes, reset the flame safeguard control safety switch (restarting the burner) and open the pilot gas cock. When the blower prepurge period ends and the burner is energized--if the flame safeguard control has a stop/run switch-- stop the timer while the pilot is on, visually check the pilot flame size and stability and make adjustments as required. If the burner has automatic air damper operation (dampers moved by the automatic gas valve or modulating motor) and the Flame Safeguard control does not have a timer stop/run switch, it will be necessary to keep the air dampers in the pilot light off (low air flow) position by temporarily electrically disconnecting the motorized gas valve or modulating motor to complete pilot adjustments. Recycle the burner several times to make certain pilot operation is reliable.
  13. With pilot adjustments completed, reset the timer switch to the Run position, which will allow the sequence to proceed to the automatic gas valve energizing position. If the motorized gas valve or modulating motor wires have been disconnected, shut the burner off and reconnect electrically to allow normal automatic air damper operation.
  14. When the main automatic gas valve begins to open, slowly open the checking gas cock to light off the main flame. The main flame should light immediately. If not, it may be necessary to eliminate air from the main gas line and/or adjust main gas pressure regulator flow rates.
  15. Adjust the burner as necessary to provide smooth ignition of the main flame. If the flame signal drops significantly when the main automatic gas valve opens, slightly increase the pilot gas pressure to attain a stable flame signal value.
  16. For On/Off burners - adjust the main gas pressure regulator to achieve the proper main flame gas input. Set and lock the air dampers to provide 8 1/2 to 10% CO<sub>2</sub> (Carbon Dioxide) and little or no\* CO (Carbon Monoxide). Make certain the gas pilot operates reliably at the final fuel/air settings.
  17. For Low/High/Off burners - adjust the main gas pressure regulator in combination with the air damper linkage operation to achieve 8 1/2 to 10% CO<sub>2</sub> (Carbon Dioxide) and little or no\* CO (Carbon Monoxide) at the full high fire input rate position. Make certain the linkage operates smoothly and without binding or overtravel of the air damper stops.
  18. For Low/High/Low burners - adjust the main gas pressure regulator in combination with the air damper linkage operation to achieve 8 1/2 to 10% CO<sub>2</sub> (Carbon Dioxide) and little or no\* CO (Carbon Monoxide) at the full high fire input rate position. Make certain the linkage operates smoothly and without binding or overtravel of the air damper stops. Run burner to the low fire position and lock motorized gas valve internal low fire adjustment to a setting that will attain 7 to 9%CO<sub>2</sub> at the desired low fire input rate.
  19. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.
- j. **General Start Up Procedure (OIL BURNERS) -** Power Flame Type C oil burners are of the pressure atomizing forced draft type, using a single simplex or bypass type nozzle system. On/Off burners use a simplex nozzle. Fixed air low fire start burners use a simplex nozzle with a bypass valve to allow reduced oil nozzle pressures at light off. Low/High/Off and Low/High/Low burners have movable air dampers and may use a single simplex or bypass type oil nozzle with a bypass valve to allow reduced oil pressures at light off and at low fire. Modulating burners have movable air dampers and use a single simplex or bypass type oil nozzle with a proportioning metering valve in the nozzle return line to allow modulated fuel inputs from low to high fire. Some applications may require the burner to function at the low end of its rated capacity. As a result, the two combustion air inlets may supply more air than is required for efficient combustion. It may therefore be desirable to operate the system using only one combustion air inlet and one combustion air inlet damper. This may be accomplished by removing cross connect-ing linkage between dampers and locking the unused damper in a fixed position. One way of locking the damper is to use a 10-24 machine screw through the hole in the linkage arm, and drill and tap the air inlet housing or use two nuts on the screw and let the screw

## Buner Start Up

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bear against the air inlet housing. Air diffuser movement (fore and aft) may be necessary to produce the best flame pattern or smoothest operation. Gas and Gas/Oil burners for Scotch marine and other selected applications incorporate a gas/air premix adjustment. This adjustment is identified by diametrically opposed adjustment knobs on the blast tube. Check oil and gas piping (if applicable) for leaks, and check all controls for compliance with codes and insurance requirements.

k. Check all linkages. If the system is a packaged burner/heat exchanger system, the linkage was probably set when the system was fire tested at the heat exchanger manufacturing factory. It should, however, be checked to ensure that it was not damaged in shipment. If the system is a conversion unit (burner and heat exchanger are mated in the field), the linkage will have to be set to suit the particular operating conditions.

l. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.

m. Install oil pressure and vacuum gauges. Check suction line to be sure manual valve is open and that check valves are opening in the proper direction of oil flow. Check oil filter for tightness. There should be no manual valve in the return line from pump to tank.

n. Direct Spark Oil Ignition. Remove oil nozzle gun and check electrode settings and ensure that oil nozzle size is correct. Electrode gap should be approximately 1/8" and set forward to correspond with the nozzle spray angle. Do not set electrodes so that oil can impinge on them.

o. Gas Pilot Oil Ignition. Remove the pilot assembly and check for the proper setting of the ignition electrode spark gap. Install a manometer or 0-10" W.C. gas pressure gauge in the pilot gas pressure test port. See page 39 for details on gas pilot adjustments. Disconnect the pilot gas line at the inlet to the pilot gas pressure regulator and bleed air out of the pilot line. Make certain that the gas pressure to the pilot regulator does not exceed the regulator or pilot solenoid valve rating. When bleeding air from the pilot line system, do not allow the venting of gas into the room.

p. Install required systems measuring devices: A) Appropriate flame signal meter to the flame safeguard control B) Stack thermometer, CO<sub>2</sub> and Smoke Test sample line in the breaching C) Draft gauge to the combustion chamber test point

q. With the burner panel control switch in the Off position, apply power to the burner through the main

burner disconnect switch. Switch the burner panel On/Off switch to the On position momentarily to determine that the blower motor (and separate oil pump set motor, if supplied) is running in the right rotation.

r. Appropriate steps must be taken to transfer the oil from the tank to the burner. It is imperative that the system be primed prior to operation. The system priming may be achieved by closing the manual valve in the oil suction line and priming the oil pump through the pump gauge pressure port. Priming can also be accomplished through the oil filter on the suction line, if it is of the removable top type. When replacing the oil filter cap, be sure to attain a vacuum tight seal. Start the burner with the suction line manual valve closed. Let the burner run until the vacuum gauge indicates a high vacuum, then quickly open the manual valve in the suction line. This combination of priming and high suction should pull the oil from the tank to the burner, provided that there are no leaks and the line is properly sized.

s. Refer to the burner wiring diagram and flame safeguard control information supplied with the burner to determine the specific firing sequence relating to limit and interlock circuits.

t. Set the air damper approximately 1/4" open and start the burner. The ignition circuit will be energized after the blower prepurge period (if supplied) has been completed and all limit and other interlock circuits have been closed. If the unit has a gas pilot, allow it to come on and adjust it for proper ignition and flame signal. For flame safeguard controls having a timer Stop/Run test switch, place the switch in the Stop position, causing the ignition timing sequence to stop while air and gas pressure adjustments are being made. Cycle the burner several times to make certain the pilot is operating reliably. Shut the pilot gas cock and cycle the burner through prepurge. With the gas shut off, the pilot valve and ignition transformer will energize, but there will be no pilot and the unit will shut down on safety lockout.

There should be no evidence of a flame signal reading or should the main oil solenoid valve attempt to open.

u. When a Gas Pilot is used to ignite the main oil, there will be a period of time when only the pilot will be on. The flame scanner must first detect the

## Buner Start Up

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pilot Then, in a given number of seconds, the main oil solenoid valve will be energized. For direct spark ignited oil units, the ignition spark and main oil solenoid valve will be energized at the same time. As soon as the oil flame is detected by the flame scanner, the ignition spark will be de-energized (interrupted ignition), unless the burner is equipped with intermittent spark operation, which keeps the spark on during the burning cycle.

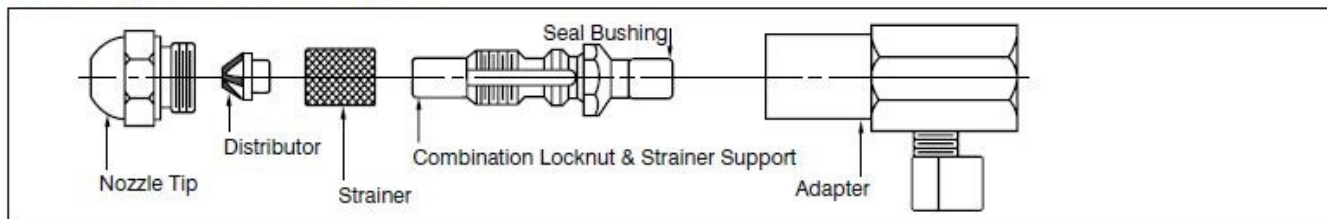
- v. For burners equipped with gas pilots, perform an initial Spark Pickup Test. With the pilot gas cock closed, the burner will go through a blower prepurge period, after which the gas pilot ignition transformer will be energized, although no pilot will be established. (At no time should there be any flame signal reading, nor should the main gas valve attempt to open.) At the end of the pilot trial for ignition and blower purge period, the flame safeguard control should shut the system down in a safety lockout mode, requiring manual reset of the flame safeguard control to restart burner. If a flame signal is detected, verify the flame retention tab and ignition electrode are properly positioned.
  - w. If the burner is direct spark ignited, either remove the flame scanner from its sight pipe or electrically disconnect the main oil solenoid valve and start the burner. In either of the above tests, the flame safeguard control will not detect any flame and should go into a safety lockout mode requiring manual reset of the flame safeguard safety lockout switch.
  - x. There must be no indication of oil pressure at the nozzle until the main oil valve is programmed to open. Should a pressure reading be obtained prior to that time, it is an indication that the main oil valve has been mis-wired or is leaking.
  - y. Restart the burner and allow normal sequencing to bring on gas pilot ignition or the direct spark ignition. Once the main solenoid oil valve is energized, the oil flame should be established immediately. If not, shut the system down and make corrections as required. Do not repeatedly recycle the burner, such as to allow any accumulation of unburned fuel in the combustion chamber.
  - z. For small On/Off burners with a simplex nozzle, adjustments consist primarily of attaining correct fuel/air ratios. Adjustments should be set to obtain 11-121/2% CO<sub>2</sub> and no more than a #2 smoke (Bachrach). The burner can usually be set to burn at a 0 smoke reading. Oil pump pressures will be set anywhere from 200 to 300 psig
  - aa. Fixed Air Low Fire Start burners with simplex nozzles require correct fuel/air ratios for high fire and should be set with no more than a #2 smoke at high fire with 11 - 121/2% CO<sub>2</sub>. 0 smoke should be attainable. Low fire nozzle pressures are set to achieve smooth light off with the air dampers fixed in the operating (high fire) position. See page 34, Table 9 for additional information. High fire nozzle pressures will be from 200 to 300 psig.
  - bb. Gas On/Off System with Oil Reduced Air, Low Fire Start RALFS.
  - cc. Low/High/Off or Low/High/Low modes of operation (both having automatic air dampers) should have initial adjustments made at the light off position. See Section 3 for mechanical operation of the specific system. After the light off fuel/air adjustments are made (which on a Low/High/Low oil burner is the same as the Low Fire position), run the burner to the high fire position and make adjustments as required for good operation. Adjustments should provide 11 - 121/2% CO<sub>2</sub> with no more than a #2 smoke (0 smoke is usually attainable) at high fire and 8 - 10% CO<sub>2</sub> with no more than a #2 smoke on low fire (0 smoke is usually attainable) for Low/High/Low systems. For systems with two-step pumps using simplex nozzles or internal bypass nozzles, the oil pressures at the nozzle supply pump gauge port will generally be from 100 to 125 psig at low fire and 200 to 300 psig at high fire. For systems with pumps that do not have the two-step operation and employ the internal bypass nozzle, the nozzle supply pump gauge port will generally be from 270 to 300 psig at both low and high fires. The nozzle bypass line pressure at low fire will generally be from 60 to 125 psig and 180 to 225 psig at high fire. Tighten all linkages and permanently mark all settings.
  - dd. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.
- k. Servicing and Component Adjustments -**
- 1. The system is designed to use 300 PSI pressure at the nozzle inlet at low and high fire (and throughout the range on modulating systems). The

## Servicing

firing rate is changed by an adjustable bypass arrangement that allows more or less oil to bypass the nozzle and flow to the return line. Low fire pressures at the bypass pressure test tee will generally be from 60 to 100 PSI, with high fire bypass pressures from 180 to 225 PSI. These pressures will vary depending upon the nozzle size selection and specific job firing conditions. See this page, Table 8 for flow rates, sizing and pressure information.

2. Smoky fires with apparent large droplet size in the spray pattern are generally caused by low nozzle or return flow pressures. To properly check the system, it is necessary to verify both nozzle supply and return pressures. Also check to make certain that the nozzle adapter and strainer are not partially plugged.
3. Careless cleaning or handling of the nozzle may damage the orifice, causing heavy streaks in the oil spray. This will also show up as large droplets or sparks in the flame.
4. Off center fires, low bypass line pressures and safety lockouts (due to poor spray pattern and ignition failure) may result from plugged slots in the nozzle distributor head. When such situations are observed, the nozzle should be removed, disassembled and cleaned.
5. Excessive after squirt of oil is caused by air in the system. Be sure air is not trapped in pressure gauges, overhead oil lines or fittings. A leaking check valve on the bypass return line from the nozzle can create the same effect.
6. The Teflon seal should stay on the nozzle when servicing. On some sizes of burners using Delavan 30630 and 30637 Series nozzles, the Teflon seal

### Internal Bypass Oil Nozzle Components



### Internal Bypass (Return Flow) Nozzle Data

#### HAGO

| Nozzle Size<br>100 PSIG<br>Nominal<br>Rating GPH<br>#2 Fuel Oil<br>By-Pass<br>(Return)<br>Closed | Supply Pressure to Nozzle 300 PSIG at All Rates*                    |                                                                                         |                                                    |                               |                                                    |                               |                                                    |                               |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|
|                                                                                                  | Approx. High Fire Rate                                              |                                                                                         |                                                    |                               | Reduced Firing Rates                               |                               |                                                    |                               |
|                                                                                                  | Approx. High Fire Rate<br>300 PSIG<br>By-Pass<br>(Return)<br>Closed | Approx. High Fire By-Pass<br>(Return)<br>Pressure<br>PSIG By-Pass<br>(Return)<br>Closed | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH |
| 4.5                                                                                              | 7.3                                                                 | 207                                                                                     | 180                                                | 5.5                           | 150                                                | 4.4                           | 120                                                | 3.1                           |
| 5.0                                                                                              | 8.5                                                                 | 196                                                                                     | 150                                                | 5.9                           | 120                                                | 4.4                           | 90                                                 | 2.8                           |
| 5.5                                                                                              | 9.0                                                                 | 209                                                                                     | 180                                                | 7.0                           | 150                                                | 5.2                           | 120                                                | 3.8                           |
| 6.0                                                                                              | 10.2                                                                | 190                                                                                     | 150                                                | 7.0                           | 120                                                | 5.1                           | 90                                                 | 3.1                           |
| 6.5                                                                                              | 10.8                                                                | 195                                                                                     | 150                                                | 7.6                           | 120                                                | 5.2                           | 90                                                 | 3.4                           |
| 7.0                                                                                              | 11.5                                                                | 202                                                                                     | 150                                                | 7.1                           | 120                                                | 5.1                           | 90                                                 | 3.5                           |
| 7.5                                                                                              | 12.6                                                                | 181                                                                                     | 150                                                | 10.0                          | 120                                                | 7.1                           | 90                                                 | 4.8                           |
| 8.0                                                                                              | 13.3                                                                | 197                                                                                     | 180                                                | 11.6                          | 150                                                | 8.2                           | 120                                                | 5.5                           |
| 9.0                                                                                              | 15.2                                                                | 200                                                                                     | 180                                                | 12.5                          | 150                                                | 8.9                           | 120                                                | 6.0                           |
| 9.5                                                                                              | 15.9                                                                | 178                                                                                     | 150                                                | 12.0                          | 120                                                | 8.0                           | 90                                                 | 5.1                           |
| 10.0                                                                                             | 17.2                                                                | 202                                                                                     | 180                                                | 13.8                          | 150                                                | 9.6                           | 120                                                | 6.3                           |



**HAGO**

| Nozzle Size<br>100 PSIG<br>Nominal<br>Rating GPH<br>#2 Fuel Oil<br>By-Pass<br>(Return)<br>Closed | Supply Pressure to Nozzle 300 PSIG at All Rates*                              |                                                                                            |                                                    |                               |                                                    |                               |                                                    |                               |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|
|                                                                                                  | Approx. High<br>Fire Rate<br>GPH<br>300 PSIG<br>By-Pass<br>(Return)<br>Closed | Approx. High<br>Fire By-Pass<br>(Return)<br>Pressure<br>PSIG By-Pass<br>(Return)<br>Closed | Reduced Firing Rates                               |                               |                                                    |                               |                                                    |                               |
|                                                                                                  |                                                                               |                                                                                            | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH |
| 10.5                                                                                             | 17.5                                                                          | 202                                                                                        | 150                                                | 11.4                          | 120                                                | 8.0                           | 90                                                 | 5.4                           |
| 11.0                                                                                             | 19.3                                                                          | 203                                                                                        | 150                                                | 11.4                          | 150                                                | 11.4                          | 120                                                | 7.9                           |
| 11.5                                                                                             | 20.0                                                                          | 192                                                                                        | 180                                                | 17.8                          | 150                                                | 12.8                          | 120                                                | 8.5                           |
| 12.0                                                                                             | 20.1                                                                          | 194                                                                                        | 180                                                | 18.1                          | 150                                                | 13.0                          | 120                                                | 9.1                           |
| 12.5                                                                                             | 21.6                                                                          | 196                                                                                        | 180                                                | 18.6                          | 150                                                | 13.4                          | 120                                                | 8.9                           |
| 13.0                                                                                             | 22.2                                                                          | 205                                                                                        | 180                                                | 17.8                          | 150                                                | 12.9                          | 120                                                | 8.8                           |
| 13.5                                                                                             | 23.2                                                                          | 192                                                                                        | 180                                                | 21.0                          | 150                                                | 14.8                          | 120                                                | 10.5                          |
| 14.0                                                                                             | 24.0                                                                          | 208                                                                                        | 180                                                | 18.9                          | 150                                                | 13.3                          | 120                                                | 8.5                           |
| 14.5                                                                                             | 24.6                                                                          | 207                                                                                        | 180                                                | 18.6                          | 150                                                | 14.1                          | 120                                                | 9.2                           |
| 15.0                                                                                             | 26.0                                                                          | 199                                                                                        | 180                                                | 21.8                          | 150                                                | 15.6                          | 120                                                | 10.4                          |
| 16.0                                                                                             | 26.8                                                                          | 190                                                                                        | 180                                                | 24.9                          | 150                                                | 18.2                          | 120                                                | 11.9                          |
| 17.0                                                                                             | 29.0                                                                          | 206                                                                                        | 180                                                | 23.4                          | 150                                                | 16.9                          | 120                                                | 11.5                          |
| 17.5                                                                                             | 29.2                                                                          | 204                                                                                        | 180                                                | 24.4                          | 150                                                | 18.1                          | 120                                                | 12.2                          |
| 18.0                                                                                             | 29.8                                                                          | 206                                                                                        | 150                                                | 20.0                          | 120                                                | 15.3                          | 90                                                 | 11.1                          |
| 19.0                                                                                             | 32.4                                                                          | 202                                                                                        | 180                                                | 27.8                          | 150                                                | 20.2                          | 120                                                | 14.1                          |
| 19.5                                                                                             | 33.4                                                                          | 185                                                                                        | 150                                                | 24.3                          | 120                                                | 17.1                          | 90                                                 | 11.3                          |
| 20.0                                                                                             | 35.2                                                                          | 185                                                                                        | 150                                                | 26.5                          | 120                                                | 18.3                          | 90                                                 | 12.1                          |
| 21.0                                                                                             | 36.4                                                                          | 190                                                                                        | 150                                                | 26.2                          | 120                                                | 18.8                          | 90                                                 | 13.1                          |
| 21.5                                                                                             | 37.0                                                                          | 192                                                                                        | 150                                                | 26.8                          | 120                                                | 18.4                          | 90                                                 | 12.8                          |
| 22.0                                                                                             | 37.3                                                                          | 192                                                                                        | 150                                                | 26.0                          | 120                                                | 19.6                          | 90                                                 | 13.6                          |
| 24.0                                                                                             | 41.6                                                                          | 190                                                                                        | 150                                                | 29.7                          | 120                                                | 21.7                          | 90                                                 | 15.1                          |
| 26.0                                                                                             | 42.4                                                                          | 198                                                                                        | 150                                                | 29.5                          | 120                                                | 22.1                          | 90                                                 | 15.8                          |
| 28.0                                                                                             | 46.0                                                                          | 198                                                                                        | 150                                                | 31.6                          | 120                                                | 23.8                          | 90                                                 | 17.9                          |
| 30.0                                                                                             | 49.3                                                                          | 196                                                                                        | 150                                                | 35.9                          | 120                                                | 28.3                          | 90                                                 | 21.6                          |
| 32.0                                                                                             | 53.0                                                                          | 192                                                                                        | 150                                                | 40.3                          | 120                                                | 31.2                          | 90                                                 | 23.9                          |
| 35.0                                                                                             | 57.1                                                                          | 205                                                                                        | 150                                                | 40.1                          | 90                                                 | 26.1                          | 70                                                 | 22.5                          |
| 40.0                                                                                             | 65.3                                                                          | 198                                                                                        | 150                                                | 49.3                          | 90                                                 | 31.9                          | 70                                                 | 27.8                          |
| 45.0                                                                                             | 74.6                                                                          | 188                                                                                        | 150                                                | 61.9                          | 90                                                 | 43.8                          | 70                                                 | 39.7                          |
| 50.0                                                                                             | 83.0                                                                          | 175                                                                                        | 150                                                | 73.7                          | 90                                                 | 51.2                          | 70                                                 | 46.1                          |

**MONARCH**

| Nozzle Size<br>100 PSIG<br>Nominal<br>Rating GPH<br>#2 Fuel Oil<br>By-Pass<br>(Return)<br>Closed | Supply Pressure to Nozzle 300 PSIG at All Rates*                              |                                                                                            |                                                    |                               |                                                    |                               |                                                    |                               |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|
|                                                                                                  | Approx. High<br>Fire Rate<br>GPH<br>300 PSIG<br>By-Pass<br>(Return)<br>Closed | Approx. High<br>Fire By-Pass<br>(Return)<br>Pressure<br>PSIG By-Pass<br>(Return)<br>Closed | Reduced Firing Rates                               |                               |                                                    |                               |                                                    |                               |
|                                                                                                  |                                                                               |                                                                                            | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH |
| 4.5                                                                                              | 7.8                                                                           | 205                                                                                        | 180                                                | 7.7                           | 60                                                 | 3.4                           | -                                                  | -                             |
| 5.0                                                                                              | 8.2                                                                           | 195                                                                                        | 180                                                | 7.6                           | 120                                                | 4.9                           | 60                                                 | 3.6                           |
| 5.5                                                                                              | 9.3                                                                           | 180                                                                                        | 120                                                | 4.6                           | 60                                                 | 3.5                           | -                                                  | -                             |
| 6.0                                                                                              | 10.4                                                                          | 215                                                                                        | 180                                                | 5.9                           | 120                                                | 4.4                           | 60                                                 | 3.1                           |
| 6.5                                                                                              | 11.5                                                                          | 225                                                                                        | 180                                                | 6.3                           | 120                                                | 4.8                           | 60                                                 | 3.6                           |
| 7.0                                                                                              | 10.6                                                                          | 220                                                                                        | 180                                                | 7.9                           | 120                                                | 5.4                           | 60                                                 | 3.6                           |
| 7.5                                                                                              | 12.3                                                                          | 205                                                                                        | 180                                                | 7.6                           | 120                                                | 5.4                           | 60                                                 | 4.1                           |
| 8.0                                                                                              | 12.5                                                                          | 200                                                                                        | 180                                                | 7.7                           | 120                                                | 5.0                           | 60                                                 | 3.5                           |
| 9.0                                                                                              | 14.4                                                                          | 200                                                                                        | 180                                                | 9.1                           | 120                                                | 5.9                           | 60                                                 | 3.9                           |
| 9.5                                                                                              | 15.4                                                                          | 210                                                                                        | 180                                                | 9.4                           | 120                                                | 6.2                           | 60                                                 | 4.3                           |
| 10.5                                                                                             | 16.0                                                                          | 220                                                                                        | 180                                                | 9.8                           | 120                                                | 6.5                           | 60                                                 | 4.3                           |
| 12.0                                                                                             | 19.4                                                                          | 210                                                                                        | 180                                                | 12.5                          | 120                                                | 8.1                           | 60                                                 | 4.9                           |
| 13.5                                                                                             | 23.3                                                                          | 210                                                                                        | 180                                                | 18.5                          | 120                                                | 10.8                          | 60                                                 | 6.6                           |
| 15.5                                                                                             | 25.5                                                                          | 220                                                                                        | 180                                                | 13.9                          | 120                                                | 9.0                           | 60                                                 | 6.8                           |
| 17.5                                                                                             | 28.2                                                                          | 225                                                                                        | 220                                                | 22.4                          | 180                                                | 17.0                          | 120                                                | 10.9                          |
| 19.5                                                                                             | 30.6                                                                          | 235                                                                                        | 220                                                | 23.6                          | 180                                                | 17.4                          | 120                                                | 10.3                          |
| 21.5                                                                                             | 33.5                                                                          | 240                                                                                        | 220                                                | 26.4                          | 180                                                | 19.4                          | 120                                                | 11.9                          |
| 24.0                                                                                             | 35.1                                                                          | 230                                                                                        | 220                                                | 33.4                          | 180                                                | 24.3                          | 120                                                | 14.4                          |
| 28.0                                                                                             | 48.7                                                                          | 215                                                                                        | 180                                                | 40.2                          | 120                                                | 21.1                          | 60                                                 | 11.1                          |
| 30.0                                                                                             | 51.6                                                                          | 225                                                                                        | 220                                                | 50.6                          | 180                                                | 38.0                          | 120                                                | 23.2                          |
| 35.0                                                                                             | 58.5                                                                          | 200                                                                                        | 180                                                | 38.0                          | 120                                                | 32.6                          | 60                                                 | 15.7                          |
| 40.0                                                                                             | 68.3                                                                          | 190                                                                                        | 180                                                | 54.3                          | 120                                                | 40.5                          | 60                                                 | 22.2                          |
| 45.0                                                                                             | 76.2                                                                          | 180                                                                                        | 180                                                | 66.0                          | 120                                                | 49.6                          | 60                                                 | 29.4                          |
| 50.0                                                                                             | 83.9                                                                          | 165                                                                                        | 120                                                | 61.9                          | -                                                  | -                             | -                                                  | -                             |

**DELAVAN VARI-FLO 33769**

| Nozzle Size<br>100 PSIG<br>Nominal<br>Rating GPH<br>#2 Fuel Oil<br>By-Pass<br>(Return)<br>Closed | Supply Pressure to Nozzle 300 PSIG at All Rates*                              |                                                                                            |                                                    |                               |                                                    |                               |                                                    |                               |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|
|                                                                                                  | Approx. High<br>Fire Rate<br>GPH<br>300 PSIG<br>By-Pass<br>(Return)<br>Closed | Approx. High<br>Fire By-Pass<br>(Return)<br>Pressure<br>PSIG By-Pass<br>(Return)<br>Closed | Reduced Firing Rates                               |                               |                                                    |                               |                                                    |                               |
|                                                                                                  |                                                                               |                                                                                            | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH |
| 4.5                                                                                              | 7.5                                                                           | 162                                                                                        | 120                                                | 5.0                           | 100                                                | 4.0                           | 70                                                 | 3.0                           |
| 5.0                                                                                              | 8.5                                                                           | 136                                                                                        | 120                                                | 7.0                           | 105                                                | 6.0                           | 75                                                 | 4.0                           |
| 5.5                                                                                              | 9.2                                                                           | 150                                                                                        | 130                                                | 8.0                           | 120                                                | 7.0                           | 80                                                 | 4.0                           |
| 6.0                                                                                              | -                                                                             | -                                                                                          | -                                                  | -                             | -                                                  | -                             | -                                                  | -                             |
| 6.5                                                                                              | 10.8                                                                          | 160                                                                                        | 160                                                | 9.0                           | 120                                                | 7.0                           | 80                                                 | 4.0                           |
| 7.0                                                                                              | 12.0                                                                          | 141                                                                                        | 125                                                | 10.0                          | 110                                                | 8.0                           | 67                                                 | 4.0                           |
| 8.0                                                                                              | 13.0                                                                          | 158                                                                                        | 130                                                | 10.0                          | 120                                                | 8.0                           | 85                                                 | 5.0                           |
| 9.0                                                                                              | 15.0                                                                          | 132                                                                                        | 100                                                | 10.0                          | 90                                                 | 7.5                           | 60                                                 | 5.0                           |
| 9.5                                                                                              | 15.0                                                                          | 158                                                                                        | 120                                                | 10.0                          | 110                                                | 7.5                           | 80                                                 | 5.0                           |
| 10.0                                                                                             | 16.0                                                                          | 150                                                                                        | -                                                  | -                             | -                                                  | -                             | -                                                  | -                             |
| 12.0                                                                                             | 20.0                                                                          | 154                                                                                        | 118                                                | 16.0                          | 94                                                 | 12.0                          | 70                                                 | 8.0                           |
| 14.0                                                                                             | 23.0                                                                          | 160                                                                                        | 120                                                | 17.0                          | 100                                                | 11.0                          | 85                                                 | 8.0                           |
| 16.0                                                                                             | 26.0                                                                          | 144                                                                                        | 115                                                | 17.0                          | 100                                                | 15.0                          | 75                                                 | 10.0                          |
| 18.0                                                                                             | 30.0                                                                          | 165                                                                                        | 135                                                | 22.0                          | 110                                                | 15.0                          | 80                                                 | 10.0                          |
| 20.0                                                                                             | 32.0                                                                          | 160                                                                                        | 120                                                | 24.0                          | 100                                                | 18.0                          | 80                                                 | 14.0                          |
| 22.0                                                                                             | 36.0                                                                          | 155                                                                                        | 120                                                | 27.0                          | 100                                                | 20.0                          | 82                                                 | 15.0                          |
| 24.0                                                                                             | 41.0                                                                          | 144                                                                                        | 120                                                | 30.0                          | 100                                                | 25.0                          | 72                                                 | 15.0                          |
| 26.0                                                                                             | 43.0                                                                          | 150                                                                                        | 100                                                | 35.0                          | 100                                                | 27.0                          | 65                                                 | 15.0                          |
| 28.0                                                                                             | 47.5                                                                          | 148                                                                                        | 120                                                | 40.0                          | 100                                                | 30.0                          | 65                                                 | 16.0                          |
| 30.0                                                                                             | 51.0                                                                          | 138                                                                                        | 85                                                 | 40.0                          | 75                                                 | 30.0                          | 50                                                 | 17.0                          |
| 35.0                                                                                             | 60.0                                                                          | 175                                                                                        | 115                                                | 40.0                          | 90                                                 | 30.0                          | 60                                                 | 20.0                          |
| 40.0                                                                                             | 68.0                                                                          | 115                                                                                        | 70                                                 | 45.0                          | 50                                                 | 35.0                          | 20                                                 | 23.0                          |
| 45.0                                                                                             | 76.0                                                                          | 166                                                                                        | 120                                                | 60.0                          | 85                                                 | 40.0                          | 50                                                 | 25.0                          |
| 50.0                                                                                             | 85.5                                                                          | -                                                                                          | -                                                  | -                             | -                                                  | -                             | -                                                  | -                             |

\* When Supply Pressure to Nozzle is Lower Than 300 PSIG the By-Pass (Return) and Firing Rates Will be Reduced Somewhat.  
Consult Factory for Further Information.

**DELAVAN VARI-FLO 30630 and 30637**

| Nozzle Data                                                                                      |                 | Supply Pressure to Nozzle 300 PSIG at All Rates Except Alternate Firing*         |                                                                                               |                                                    |                |                                                    |                               |                                                    |                               |
|--------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------|----------------|----------------------------------------------------|-------------------------------|----------------------------------------------------|-------------------------------|
| Nozzle Size<br>300 PSIG<br>Nominal<br>Rating GPH<br>#2 Fuel Oil<br>By-Pass<br>(Return)<br>Closed | Model<br>Number | Approx.<br>High Fire<br>Rate<br>GPH 300<br>PSIG<br>By-Pass<br>(Return)<br>Closed | Approx. High<br>Fire By-Pass<br>(Return)<br>Pressure<br>PSIG<br>By-Pass<br>(Return)<br>Closed | Alternate Firing                                   |                | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH | Approx.<br>By-Pass<br>(Return)<br>Pressure<br>PSIG | Approx.<br>Firing Rate<br>GPH |
|                                                                                                  |                 |                                                                                  |                                                                                               | Approx.<br>Alternate<br>Nozzle<br>Pressure<br>PSIG | Approx.<br>GPH |                                                    |                               |                                                    |                               |
| 35.0                                                                                             | #30630          | 35.0                                                                             | 157                                                                                           | -                                                  | -              | 140                                                | 32.0                          | 100                                                | 18.7                          |
| 37.5                                                                                             | #30630          | 37.5                                                                             | 180                                                                                           | -                                                  | -              | 140                                                | 28.6                          | 100                                                | 13.8                          |
| 40.0                                                                                             | #30630          | 40.0                                                                             | 191                                                                                           | -                                                  | -              | 140                                                | 25.4                          | 100                                                | 16.7                          |
| 45.0                                                                                             | #30630          | 45.0                                                                             | 192                                                                                           | -                                                  | -              | 140                                                | 30.6                          | 100                                                | 16.5                          |
| 50.0                                                                                             | #30630          | 50.0                                                                             | 185                                                                                           | -                                                  | -              | -                                                  | -                             | 86                                                 | 16.7                          |
| 55.0                                                                                             | #30630          | 55.0                                                                             | 182                                                                                           | -                                                  | -              | 91                                                 | 18.3                          | -                                                  | -                             |
| 60.0                                                                                             | #30630          | 60.0                                                                             | 178                                                                                           | -                                                  | -              | 94                                                 | 20.0                          | -                                                  | -                             |
| 65.0                                                                                             | #30630          | 65.0                                                                             | 165                                                                                           | -                                                  | -              | 85                                                 | 21.7                          | -                                                  | -                             |
| 70.0                                                                                             | #30630          | 70.0                                                                             | 174                                                                                           | -                                                  | -              | 88                                                 | 23.3                          | -                                                  | -                             |
| 80.0                                                                                             | #30630          | -                                                                                | 154                                                                                           | 265                                                | 75             | 78                                                 | 25.0                          | -                                                  | -                             |
| 80.0                                                                                             | #30637          | -                                                                                | -                                                                                             | 260                                                | 74             | 85                                                 | 24.7                          | -                                                  | -                             |
| 80.0                                                                                             | #30637          | -                                                                                | -                                                                                             | 280                                                | 78             | 90                                                 | 26.0                          | -                                                  | -                             |
| 80.0                                                                                             | #30637          | 80.0                                                                             | 157                                                                                           | -                                                  | -              | 65                                                 | 27.0                          | -                                                  | -                             |
| 90.0                                                                                             | #30637          | -                                                                                | -                                                                                             | 260                                                | 83             | 90                                                 | 27.7                          | -                                                  | -                             |
| 90.0                                                                                             | #30637          | -                                                                                | -                                                                                             | 280                                                | 86             | 85                                                 | 28.7                          | -                                                  | -                             |
| 90.0                                                                                             | #30637          | 90.0                                                                             | 165                                                                                           | -                                                  | -              | 80                                                 | 30.0                          | -                                                  | -                             |
| 100.0                                                                                            | #30637          | -                                                                                | 136                                                                                           | 260                                                | 93             | 90                                                 | 31.0                          | -                                                  | -                             |
| 100.0                                                                                            | #30637          | -                                                                                | 151                                                                                           | 280                                                | 97             | 90                                                 | 32.0                          | -                                                  | -                             |
| 100.0                                                                                            | #30637          | 100.0                                                                            | 165                                                                                           | -                                                  | -              | 90                                                 | 32.3                          | -                                                  | -                             |
| 125.0                                                                                            | #30637          | -                                                                                | 161                                                                                           | 260                                                | 115.0          | 90                                                 | 38.0                          | -                                                  | -                             |
| 125.0                                                                                            | #30637          | -                                                                                | 163                                                                                           | 280                                                | 120.0          | 90                                                 | 39.0                          | -                                                  | -                             |
| 125.0                                                                                            | #30637          | 125.0                                                                            | 175                                                                                           | -                                                  | -              | 90                                                 | 41.0                          | -                                                  | -                             |
| 150.0                                                                                            | #30637          | -                                                                                | 161                                                                                           | 260                                                | 140.0          | 90                                                 | 45.0                          | -                                                  | -                             |
| 150.0                                                                                            | #30637          | -                                                                                | 163                                                                                           | 280                                                | 145.0          | 90                                                 | 50.0                          | -                                                  | -                             |
| 150.0                                                                                            | #30637          | 150.0                                                                            | 175                                                                                           | -                                                  | -              | 90                                                 | 56.0                          | -                                                  | -                             |

\* When Supply Pressure to Nozzle is Lower Than 300 PSIG the By-Pass(Return) and Firing Rates Will be Reduced Somewhat.  
Consult Factory for Further Information.



## OIL NOZZLE FLOW RATES

Simplex Nozzle System (Monarch PLP or Equivalent Solid or Semi Solid)  
Flow Rate vs Pressure

Capacity in GPH #2 Oil

| 100#<br>Nominal<br>Rating | 120# | 140# | 160# | 180# | 200# | 220# | 240# | 260# | 280# | 300# |
|---------------------------|------|------|------|------|------|------|------|------|------|------|
| 2                         | 2.1  | 2.3  | 2.4  | 2.6  | 2.7  | 2.9  | 3.0  | 3.1  | 3.2  | 3.3  |
| 2.5                       | 2.6  | 2.8  | 3.0  | 3.2  | 3.4  | 3.6  | 3.7  | 3.8  | 4.0  | 4.1  |
| 3                         | 3.2  | 3.4  | 3.6  | 3.8  | 4.0  | 4.2  | 4.4  | 4.7  | 4.8  | 5.0  |
| 3.5                       | 3.7  | 3.9  | 4.2  | 4.5  | 4.7  | 4.9  | 4.2  | 5.4  | 5.8  | 5.9  |
| 4                         | 4.2  | 4.5  | 4.8  | 5.1  | 5.4  | 5.6  | 5.9  | 6.2  | 6.4  | 6.7  |
| 4.5                       | 4.7  | 5.0  | 5.4  | 5.7  | 6.1  | 6.3  | 6.6  | 7.0  | 7.2  | 7.4  |
| 5                         | 5.3  | 5.6  | 6.0  | 6.4  | 6.8  | 7.1  | 7.3  | 7.7  | 7.9  | 8.2  |
| 5.5                       | 5.7  | 6.1  | 6.5  | 7.0  | 7.3  | 7.7  | 8.0  | 8.4  | 8.6  | 9.1  |
| 6                         | 6.3  | 6.7  | 7.2  | 7.7  | 8.1  | 8.5  | 8.8  | 9.2  | 9.5  | 9.9  |
| 6.5                       | 6.8  | 7.2  | 7.9  | 8.3  | 8.8  | 9.2  | 9.5  | 10.0 | 10.3 | 10.7 |
| 7                         | 7.3  | 7.9  | 8.3  | 9.0  | 9.4  | 9.9  | 10.3 | 10.7 | 11.2 | 11.4 |
| 7.5                       | 7.8  | 8.5  | 8.9  | 9.6  | 10.0 | 10.5 | 11.0 | 11.5 | 11.9 | 12.2 |
| 8                         | 8.3  | 9.1  | 9.5  | 10.3 | 10.8 | 11.3 | 11.8 | 12.3 | 12.8 | 13.0 |
| 9                         | 9.4  | 10.1 | 10.8 | 11.5 | 12.0 | 12.8 | 13.2 | 13.9 | 14.4 | 14.8 |
| 10                        | 10.4 | 11.2 | 12.0 | 12.8 | 13.4 | 14.2 | 14.7 | 15.4 | 16.0 | 16.6 |
| 11                        | 11.5 | 12.5 | 13.3 | 14.2 | 15.0 | 15.6 | 16.2 | 17.0 | 17.7 | 18.2 |
| 12                        | 12.5 | 13.6 | 14.5 | 15.3 | 16.2 | 17.0 | 17.7 | 18.5 | 19.2 | 19.8 |

stays in the nozzle adapter. If it is damaged through careless handling, the resulting leak will cause an increase in the burning rate, when the bypass line is closed at high fire.

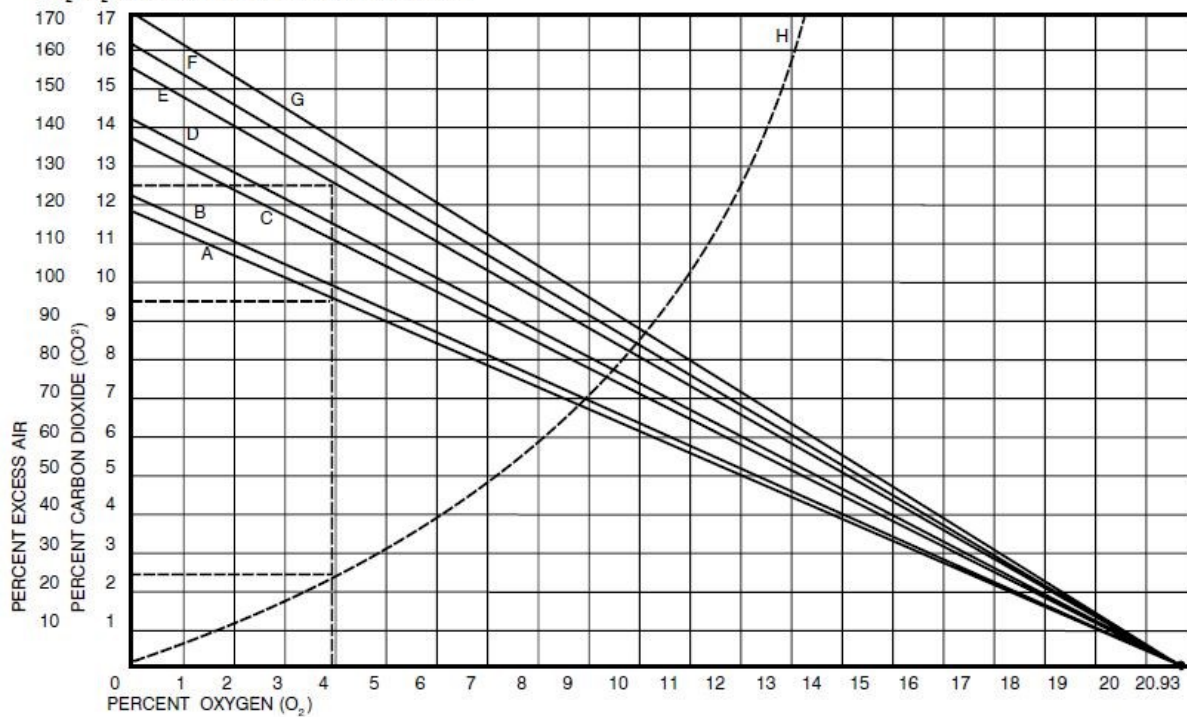
- High turn down ratios are a distinct advantage of internal bypass systems. It is possible, however, to adjust for a low fire so small that the flame is being chilled. The fire will look excellent and appear bright and uniform, but a combustion efficiency test will reveal high smoke content and low CO<sub>2</sub>. To correct this situation, increase the oil flow or decrease the air, or both. Be sure to test with proper instruments to ensure good, clean efficient combustion throughout the firing range.

### 1. Oil Nozzle Servicing

- Nozzles used on Power Flame Type C burners are of two types: simplex and internal bypass. The simplex nozzle is normally used on smaller burners in the three to eight gallons per hour range. The bypass nozzle is used for larger inputs requiring higher turndown or more sophisticated air/fuel control. Both types of nozzles have GPH ratings stamped on the side. Stamped ratings are based on 100 psig except models 30630 and 30637 which are based on 300 psig. The burners operate in the 300 psig range.
- When removing or replacing the oil nozzle and electrode assembly, take care to prevent damage to the ignition wire.

- The nozzles should be removed from the nozzle adapter by use of the proper wrench. They should be disassembled and thoroughly cleaned with a liquid solvent (preferably non-flammable) and a brush.
- Do not use a screwdriver, wire brush or similar metallic objects to clean nozzles. Damage to orifices or spray slots result in off-center or sparky fires.
- The nozzle should be seated firmly in the nozzle adapter to prevent leaks.
- If a nozzle is damaged or burned, replace it.
- The entire oil tube and nozzle assembly (the oil drawer assembly) may be removed for ease of service.
- When cleaning and taking the nozzle apart, do not force it.
- For additional information on bypass nozzles, see page 30. Note that the Teflon seal in the Monarch F80BPS and Delavan 33769 nozzles is an integral part of the nozzles and that if the seal is removed accidentally, the nozzle must be replaced. On the Delavan 30630 and 30637 nozzles, the seal normally remains in the nozzle adapter. When the nozzle is removed from the adapter, the seal should also be removed and replaced with a new seal.

CO<sub>2</sub>-O<sub>2</sub> Ratio Curves for Fuel Oils and Gases



| CURVE | FUEL        | MAXIMUM CO <sub>2</sub> % |
|-------|-------------|---------------------------|
| A     | Natural Gas | 11.7                      |
| B     | Natural Gas | 12.1                      |
| C     | Propane     | 12.1                      |
| D     | Butane      | 14.0                      |

| CURVE | FUEL                          | MAXIMUM CO <sub>2</sub> % |
|-------|-------------------------------|---------------------------|
| E     | #2 Fuel Oil                   | 15.2                      |
| F     | #5 Fuel Oil                   | 16.0                      |
| G     | #6 Fuel Oil                   | 16.9                      |
| H     | Excess Air vs. O <sub>2</sub> |                           |

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# TROUBLE SHOOTING SUGGESTIONS GAS, OIL OR GAS/OIL BURNER

## GENERAL

### 1. Burner Fails to Start

- A. Defective On/Off or fuel transfer switch. Replace.
- B. Control circuit has an open control contact. Check limits, low water cutoff, proof of closure switch and others as applicable.
- C. Bad fuse or switch open on in-coming power source. Correct as required.
- D. Motor overloads tripped. Reset and correct cause for trip out.
- E. Flame safeguard control safety switch tripped out. Reset and determine cause for apparent flame failure.
- F. Loose connections or faulty wiring. Tighten all terminal screws and consult wiring diagram furnished with the burner.
- G. Frozen oil pump shaft preventing blower motor operation. Replace oil pump.
- H. Flame safeguard control starting circuit blocked due to flame relay being energized. Possible defective scanner--replace. Possible defective amplifier--replace. Scanner actually sighting flame due to leaking fuel valve--correct unwanted flame cause. Defective flame safeguard control--replace.
- I. Defective blower motor. Repair or replace.

### 2. Occasional Lockouts for No Apparent Reason

- A. Gas pilot ignition failure. Refer to pilot adjustment section and readjust to make certain

that ignition is instant and that flame signal readings are stable and above minimum values. Use a manometer or 0 to 10" W.C. gas pressure gauge on pilot test tee to make certain that pressure is as recommended.

- B. Check for proper settings on direct spark oil ignition electrodes. Make certain that gap is not too wide and that *light-off* oil pressure is as recommended.
- C. Gas pilot ignition and direct spark oil ignition. Verify that there are no cracks in the porcelain and that transformer end and electrode end plug in connections are tight.
- D. Loose or broken wires. Check all wire nut connections and tighten all terminal screw connections in panel and elsewhere as appropriate.
- E. With flame safeguard controls that incorporate the air flow switch in the non-recycling circuit, ensure that when main flame lights, the air flow switch is not so critically set as to allow occasional momentary opening of the air switch contacts.
- F. Occasional low voltage supply. Have local utility correct. Make certain that the burner control circuit transformer (if supplied) is correct for the voltage being supplied.
- G. Occasional low gas supply pressure. Have local utility correct.
- H. Air leak in oil suction line or check valve not holding. Correct as required.

## GAS OPERATION

### 1. Burner Motor Runs, but Pilot Does Not Light

- A. Gas supply to burner shut off--make sure all manual gas supply valves are open. Automatic high pressure valve at meter such as *Sentry* type tripped shut due to high gas pressure--reset valve and correct cause for trip out.
- B. Pilot solenoid valve not opening--listen and feel for valve actuation. Solenoid valve not being powered--check electrical circuitry. Replace coil or entire valve if coil is burned out.
- C. Defective gas pilot regulator--replace.
- D. Gas pressure too high or too low at pilot orifice. Check orifice size in gas pilot assembly. Replace if incorrect. Refer to gas pilot adjustments for correct settings. Readjust as required.
- E. Defective ignition transformer--replace. Incorrect ignition electrode settings--refer to gas pilot adjustments for correct settings.
- F. Defective flame safeguard control or plug in purge timing card. Replace as required.
- G. Air flow switch not making circuit--check out electrically and correct pressure adjustment on switch if required. Defective air flow switch--replace. Air switch negative pressure sensing tube out of position--reposition as necessary.

### 2. Burner Motor Runs and Pilot Lights, but Main Gas Flame is Not Established

- A. Main shut off or test cock closed. Check to make certain fully open.

- B. Pilot flame signal reading too low to pull in flame safeguard relay. Refer to gas pilot settings section and readjust as required.
- C. Defective automatic main or auxiliary gas shut off valves. Check electrical circuitry to valves. Replace valves or correct circuitry as required.
- D. Main diaphragm shut off valve opening too slowly. Adjust bleed on valve.
- E. Defective flame safeguard control or plug in amplifier. Check and replace as required.
- F. Butterfly valve set incorrectly on modulating burner. Readjust as required.
- G. Main gas pressure regulator atmospheric vent line obstructed. Correct.
- H. Defective main gas pressure regulator--replace. Misadjusted main gas pressure regulator--readjust to meet required operational values.

### 3. Carbon Monoxide Readings on Gas Firing

- A. Flame impingement on *cold* heat transfer surfaces caused by excessive firing rate. Reduce firing rate to correct input volume.
- B. Flame impingement on cold combustion chamber surfaces due to undersized combustion chamber. Refer to chamber size charts, contact factory for additional information.
- C. Incorrect gas/air ratios. Readjust burner to correct CO<sub>2</sub>/O<sub>2</sub> levels, reducing CO formation to appropriate level. See NOTE on CO<sub>2</sub>—O<sub>2</sub> Ratio Curves Chart for additional information.

#### 4. Gas High Fire Input Cannot Be Achieved

- A. Gas company pressure regulator or meter operating incorrectly, not allowing required gas pressure at burner train inlet. Have gas company correct.
- B. Gas cock upstream of train inlet not fully open. Check and correct.
- C. Gas line obstructed. Check and correct.
- D. Gas train main and/or leak test cocks not fully open. Check and correct.
- E. Gas supply line between gas company regulator and burner inlet too small. Check supply pressure at meter, determine pressure drop and increase line size as required, or raise supply pressure to compensate for small line. Do not raise pressure so high that under static (no flow) conditions the pressure exceeds the maximum allowable pressure to the gas train components on the burner.

- F. Burner gas train components sized too small for supply pressure. Increase component size as appropriate.
- G. Automatic gas valve not opening fully due to defective operation. Replace gas valve.
- H. Side tee (limiting) orifice (if supplied) too small. Replace with correct size.
- I. On modulating burner, butterfly valve not fully opened. Readjust.
- J. Defective main gas pressure regulator. Replace.
- K. Incorrect spring in main gas pressure regulator. Replace as required.
- L. Main gas pressure regulator vent line obstructed. Check and correct.
- M. Normally open vent valve (if supplied) not closing when automatic gas valves open. Check to see if valve is fully closed when automatic valves are open. Replace vent valve, if not closing fully.

### OIL OPERATION

#### 1. Burner Motor Runs, but Direct Spark Ignited Oil Flame is Not Established

- A. Defective or incorrect size oil nozzle. Remove and clean or replace.
- B. Low oil pressure. Check with gauge for correct *light-off* pressure.
- C. Defective oil pump. Replace.
- D. Defective oil solenoid valve. Replace.
- E. Oil pump coupling loose or defective. Replace or tighten as required.
- F. Low oil pressure switch (if supplied) defective or incorrectly set. Adjust or replace switch.
- G. Ignition transformer defective. Replace.
- H. Ignition electrode set incorrectly. Remove electrodes and reset.
- I. Ignition electrodes cracked and grounding out spark. Replace electrodes.
- J. Ignition leadwire defective and grounding spark out. Replace.
- K. Ignition plug in connections at transformer or electrodes loose. Tighten.
- L. Air flow switch (if provided) not making. Reset pressure or replace.
- M. Defective flame safeguard control or plug in purge timer card. Replace.
- N. Air dampers held in high fire position due to mechanical binding of linkage. Readjust linkage.
- O. Loose wiring connections. Check and tighten all connections.

#### 2. Oil Flame Ignites, but then Flame Safeguard Control Locks Out on Safety

- A. Flame scanner lens dirty. Remove and clean.
- B. Scanner sight tube blocked or dirty. Check and clean.
- C. Flame scanner defective. Replace.
- D. Defective oil nozzle causing unstable flame and scanning problems. Replace oil nozzle.
- E. Fuel/air ratios incorrect, resulting in unstable or smoky flame causing scanner flame sighting problem. Readjust ratios for clean stable flame.
- F. Defective flame safeguard amplifier or control. Replace as appropriate.

#### 3. Oil Flame Extremely Smoky at Light Off or in Low Fire Position

- A. Defective or incorrect size oil nozzle. Replace.
- B. Fuel/air ratio incorrect. Readjust.

- C. N.C. oil solenoid valve in oil nozzle return line not opening. Check electrical circuitry and replace valve if defective.
- D. On two-step pump - N.O. pump mounted solenoid valve malfunctioning. Replace valve or pump.

#### 4. Light Off Oil Flame Is Established and Proven, but Burner Will Not Attempt to Go to the High Fire Position

- A. Low/High/Low or Modulating burner high fire temperature or pressure control could be defective or not set to call for high fire. Readjust or replace control.
- B. Loose wires or incorrectly wired. Verify wiring and tighten all connections.
- C. Flame safeguard control or high fire panel switching relay (if supplied) defective. Verify and correct as required.
- D. High fire 3 way solenoid valve defective. Replace.
- E. Hydraulic oil cylinder defective. Replace.
- F. On two-step pump - N.O. solenoid valve defective (not closing). Replace pump or valve.
- G. Linkage mechanically binding. Readjust linkage.
- H. On modulating system - defective modulating motor. Replace.

#### 5. Low Oil Flame Is Established and Proven, but Flame Out Occurs in Transition from Low Fire to High Fire

- A. On Low/High/Off or Low/High/Low system - N.C. oil solenoid valve in nozzle return line not closing (or leaking). Check valve operation and replace if necessary.
- B. On two-step oil pump - N.O. solenoid valve defective (not closing). Replace valve or pump.
- C. Defective or incorrect size oil nozzle. Replace.
- D. High fire oil pressure too low. Readjust.
- E. Air dampers set too far open at low fire, which causes flame to blow out in starting to high fire. Readjust dampers.
- F. Oil pump coupling loose or defective. Tighten or replace.
- G. Defective oil pump. Replace.
- H. Linkage mechanically binding. Readjust.
- I. Make certain the #72 orifice into the N.C. side of the 3 way valve has not been removed.
- J. On modulating systems - fuel/air ratios set incorrectly, causing flame to blow out when going to high fire. Readjust linkage.



# PERIODIC CHECK LIST

| Item                                                                               | Frequency                          | Checked By                                           | Remarks                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------|------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gages, monitors, and indicators                                                    | Daily                              | Operator                                             | Make visual inspection and record readings in log                                                                                                                                                                    |
| Instrument and equipment settings                                                  | Daily                              | Operator                                             | Make visual check against heat exchanger manufacturer's recommended specifications                                                                                                                                   |
| Firing rate control                                                                | Weekly<br>Semiannually<br>Annually | Operator<br>Service Technician<br>Service Technician | Verify heat exchanger manufacturer's settings<br>Verify heat exchanger manufacturer's settings<br>Check with combustion test                                                                                         |
| Flue, vent, stack, or outlet damper                                                | Monthly                            | Operator                                             | Make visual inspection of linkage, check for proper operation                                                                                                                                                        |
| Combustion air                                                                     | Monthly                            | Operator                                             | All sources remain clean and open                                                                                                                                                                                    |
| Ignition System                                                                    | Weekly                             | Operator                                             | Make visual inspection, check flame signal strength if meter-fitted<br>(see <i>Combustion safety controls</i> )                                                                                                      |
| Fuel Valves<br>Pilot and main                                                      | Weekly                             | Operator                                             | Open limit switch-make aural and visual check-check valve position indicators and check fuel meters if so fitted                                                                                                     |
| Pilot and main gas or main oil                                                     | Annually                           | Service Technician                                   | Perform leakage tests-refer to valve manufacturer's instructions                                                                                                                                                     |
| Combustion safety controls<br>Flame failure                                        | Weekly                             | Operator                                             | Close manual fuel supply for (1) pilot, (2) main fuel cock, and/or valves(s): check safety shutdown timing; log                                                                                                      |
| Flame signal strength                                                              | Weekly                             | Operator                                             | If flame signal meter installed, read and log; for both pilot and main flames, notify service organization if readings are very high, very low, or fluctuating; refer to flame safeguard manufacturer's instructions |
| Pilot turndown tests                                                               | As required/annually               | Service Technician                                   | Required after any adjustments to flame scanner mount or pilot burner; verify annually-refer to flame safeguard manufacturer's instructions                                                                          |
| Refractory hold in                                                                 | As required/annually               | Service Technician                                   | See <i>Pilot turndown tests</i>                                                                                                                                                                                      |
| High limit safety control                                                          | Annually                           | Service Technician                                   | Refer to heat exchanger manufacturer's instructions                                                                                                                                                                  |
| Operating control                                                                  | Annually                           | Service Technician                                   | Refer to heat exchanger manufacturer's instructions                                                                                                                                                                  |
| Low draft, fan, air pressure, and damper                                           | Monthly                            | Operator                                             | Refer to this manual and control manufacturer's instructions                                                                                                                                                         |
| High and low gas pressure interlocks                                               | Monthly                            | Operator                                             | Refer to instructions in this manual                                                                                                                                                                                 |
| Low oil pressure interlocks                                                        | Monthly                            | Operator                                             | Refer to instructions in this manual                                                                                                                                                                                 |
| Fuel valve interlock switch                                                        | Annually                           | Service Technician                                   | Refer to valve manufacturer's instructions                                                                                                                                                                           |
| Purge switch                                                                       | Annually                           | Service Technician                                   | Refer to fuel/air control motor manufacturer's instructions                                                                                                                                                          |
| Low fire start interlock                                                           | Annually                           | Service Technician                                   | Refer to fuel/air control motor manufacturer's instructions                                                                                                                                                          |
| Automatic changeover control (dual fuel)                                           | At least annually                  | Service Technician                                   | Under supervision of gas utility                                                                                                                                                                                     |
| Inspect burner components                                                          |                                    | Service Technician                                   | Refer to this manual and control component manufacturer's instructions                                                                                                                                               |
| Remove oil drawer assembly                                                         | Annually                           | Service Technician                                   | Remove and clean                                                                                                                                                                                                     |
| Check blower motor and blower wheel for cleanliness. Remove and clean as necessary | Annually                           | Service Technician                                   | Remove and clean                                                                                                                                                                                                     |
| Remove, inspect and clean gas pilot assembly                                       | Annually                           | Service Technician                                   | Remove and clean                                                                                                                                                                                                     |

Refer to heat exchanger manufacturer's instructions for general inspection procedures and for specific testing and inspection of all liquid level controls, pressure/temperature relief and other applicable items.

If you have any questions about the procedures listed above-or questions relating to components or devices on your unit not specifically covered in the above-contact our Service Department at (620)421-0480 for assistance.



# START UP INFORMATION & TEST DATA

The following information shall be recorded for each burner start up:

Power Flame Model No. \_\_\_\_\_ Invoice No. \_\_\_\_\_ Serial No. \_\_\_\_\_  
Installation Name \_\_\_\_\_ Start Up Date \_\_\_\_\_  
Start Up Contractors Name \_\_\_\_\_ Phone \_\_\_\_\_  
Name of Technician Performing Start Up \_\_\_\_\_  
Type of Gas Natural ☐ LP ☐ Other \_\_\_\_\_ Fuel Oil Grade No. \_\_\_\_\_

## Gas Firing

### Gas Pressure at Train Inlet

Burner in Off Position \_\_\_\_\_ "W.C.

### Gas Pressure at Train Inlet

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Gas Pressure at Firing Head

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Gas Pressure at Pilot Test Tee

### Power Supply

Volts \_\_\_\_\_ Ph \_\_\_\_\_ Hz \_\_\_\_\_

Control Circuit Volts \_\_\_\_\_

Blower Motor amps at high fire \_\_\_\_\_

### Flame Signal Readings

Pilot \_\_\_\_\_

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### CO<sub>2</sub> or O<sub>2</sub> (Specify)

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### CO

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Input Rate BTU/HR

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Over Fire Draft

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Stack Outlet Test Point Draft

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Net Stack Temperature

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Combustion Efficiency

Low Fire \_\_\_\_\_ %

High Fire \_\_\_\_\_ %

### NOx Measured

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

## Oil Firing

### High Fire Vacuum Reading at Oil Pump Inlet \_\_\_\_\_ "H.G.

### Gas Pressure at Pilot Train Inlet (If applicable) \_\_\_\_\_

### Gas Pressure at Pilot Test Tee (If applicable) \_\_\_\_\_

### Oil Nozzle Supply Pressure

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Oil Nozzle Bypass Pressure

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Power Supply

Volts \_\_\_\_\_ Ph \_\_\_\_\_ Hz \_\_\_\_\_

Control Circuit Volts \_\_\_\_\_

Blower Motor amps at high fire \_\_\_\_\_

Remote Oil Pump Motor amps at high fire \_\_\_\_\_

### Flame Signal Reading

Pilot (If applicable) \_\_\_\_\_

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### GPH Firing Rate

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### CO<sub>2</sub> or O<sub>2</sub> (Specify)

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Bachrach Scale Smoke Number

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Over Fire Draft

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Stack Outlet Test Point Draft

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Net Stack Temperature

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

### Combustion Efficiency

Low Fire \_\_\_\_\_ %

High Fire \_\_\_\_\_ %

### NOx Measured

Low Fire \_\_\_\_\_

High Fire \_\_\_\_\_

| General                                 | Gas                                | Oil                                 |
|-----------------------------------------|------------------------------------|-------------------------------------|
| Operating control cut out setting _____ | Low gas pressure switch _____ in.  | Low oil pressure switch _____ lbs.  |
| Operating control cut in setting _____  | High gas pressure switch _____ in. | High oil pressure switch _____ lbs. |
| Limit control cut out setting _____     |                                    |                                     |
| Limit control cut in setting _____      |                                    |                                     |

| Checked For Proper Operation of:                       | Yes | No  |                                                               | Yes | No  |
|--------------------------------------------------------|-----|-----|---------------------------------------------------------------|-----|-----|
| Low water cut off                                      | ( ) | ( ) | Barometric damper                                             | ( ) | ( ) |
| High water cut off                                     | ( ) | ( ) | Boiler room combustion air and ventilation provisions correct | ( ) | ( ) |
| Flame safeguard control ignition failure               | ( ) | ( ) |                                                               |     |     |
| Flame safeguard control main flame failure             | ( ) | ( ) | Oil tank vent system checked                                  | ( ) | ( ) |
| Burner air flow switch                                 | ( ) | ( ) | All oil lines checked for leaks                               | ( ) | ( ) |
| Induced draft fan controls                             | ( ) | ( ) | All gas lines checked for leaks                               | ( ) | ( ) |
| Over fire draft controls                               | ( ) | ( ) | Gas lines and controls properly vented                        | ( ) | ( ) |
| Fresh air damper end switch                            | ( ) | ( ) | Other system components (specify)                             | ( ) | ( ) |
| Notified _____ of following system deficiencies: _____ |     |     |                                                               |     |     |

## This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

# POWER FLAME INCORPORATED



## OWNER OPERATING INSTRUCTIONS

### FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Do not touch electrical switches.
3. Extinguish any open flame.
4. Call your gas supplier immediately.

Do not store or use gasoline or other flammable liquids and vapors in the vicinity of this or any other appliance.

### WARNING

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to the burner manual. For assistance or additional information consult a qualified installer, service agency or the gas supplier.

## IMPORTANT PRECAUTIONS

1. Never attempt to light burner with paper or other materials.
2. Never experiment with the burner.
3. Never change the fuel or air adjustments without consulting with the burner service company.
4. Never attempt to light the burner if combustion chamber contains any unburned fuel or gases.
5. Never throw waste paper, rags, garbage, or other waste materials into the combustion chamber.
6. Never wash out heating equipment room without first covering the burner with waterproof material.

## START UP

### Preparation for Start Up - All Fuels

1. Ensure that the system is in working order. If heat exchanger is a boiler, ensure that proper water level is available.  
Oil burner - make sure that the oil tank has an adequate fuel level and that the fuel is the proper grade.
2. Set the burner control panel switch to the *OFF* position.

### Start Up - Gas Burner

1. Manually open and close the main gas shut off cock, leak test cock and pilot cock to determine that they operate freely. Open all three cocks. (Reset low gas pressure switch if supplied.)
2. Set the main power switch and burner panel control switch to the *ON* position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.
3. The burner blower motor will start and after a suitable prepurge period (this will vary with the type of flame

Combination Gas/Oil burner - Set the fuel selector switch to the fuel to be burned.

3. Turn the thermostat or operating control down to its lowest setting.
4. Check fuses and replace as necessary.
5. Depress the flame safeguard programming control reset button.

safeguard control supplied - but will usually be a minimum of 30 seconds to a maximum of 90 seconds) the burner pilot will light, after which the main flame will be established.

4. If the system does not respond properly, contact your qualified burner service company.
5. When burning gas on a Combination Gas/Oil unit that has a blower motor driven oil pump, open all oil line valves. Oil must circulate through the oil pump, even when burning gas.

### Start Up - Oil Burner

1. Open all valves in oil lines.
2. If pilot gas ignition system is supplied - open and close the pilot gas cock to determine that it is operating freely. Open the pilot gas cock.
3. Set the main power switch and burner panel control switch to the *ON* position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.

4. The burner blower motor will start. Depending upon the type of flame safeguard control supplied, the fuel ignition system may energize within 1 or 2 seconds after the blower motor starts or could be as long as 90 seconds.
5. If the system does not respond properly, contact your qualified burner service company.

## EXTENDED SHUT DOWN MAINTENANCE

1. Place main power switch and burner control panel switch to the *OFF* position.
2. Close all valves in gas and oil lines.
3. Cover burner to protect it from dust and dampness.

1. See *Maintenance* section in burner manual for suggestions on periodic maintenance and service.

Burner Service Company

Date of Installation

Address

Telephone

## Summer/Winterization of Equipment

### WINTERIZATION PROCEDURE, HEATING SEASON:

1. On the burner end of the tank, there is a chrome toggle switch located underneath the diamond plate aluminum cover. Place that switch into WINTER MODE.
2. On the burner end of the tank, locate the “fill valve operation” switch and place it into heating mode.
3. Remove the cap from the burner exhaust (if necessary)
4. Close the burner drain located underneath the Powerflame burner.
5. Close (clockwise) the lower cooling hand valve & open (counter clockwise) the upper heating hand valve located near the tank fill valve (refer to the picture on the next page). If the equipment only contains one hand valve, it must remain open at all times.

### CHILLER/ HEATER COMBO UNITS

6. Isolate the chiller from the tank using the gate valves shown in the plumbing diagram on the previous page and completely drain the fluid plumbing by removing the factory installed plugs. There are a total of 4 plugs, plug 1 is located on the head of the pump and plugs 2 & 3 are located on the opposite end of the chiller within the header caps. Plug 4 is located on the circulation pump y-strainer—some units are equip with valves in place of this plug.
7. Place a submersible pump into a container and fill with an appropriate blend of antifreeze and water to protect against the desired ambient temperature. Connect the submersible pump to the bottom header drain (plug 3 location) and a second line extending from the container to the top header drain (plug 2 location.) *Replace the plug on the pump head before circulating the fluid mixture.*
8. When the pump begins displacing the fluid from the container, continue to refill until the antifreeze mixture circulates back to the container or until the pump can run with out gulping air. Allow the mixture to circulate for 5 to 10 mins.
9. Test the newly circulated mixture with an antifreeze hydrometer to ensure protection. Add antifreeze if needed and continue circulating to hit the desired protection level.
10. Once the proper concentration is achieved, allow the mixture to drain back into a storage tank (save this mixture for later use) and place caps on the chiller connections.
11. Turn OFF all control switches located on the outside of the chiller.
12. Turn OFF all CBO Breakers in each chiller module, the large breaker furthest to the right.

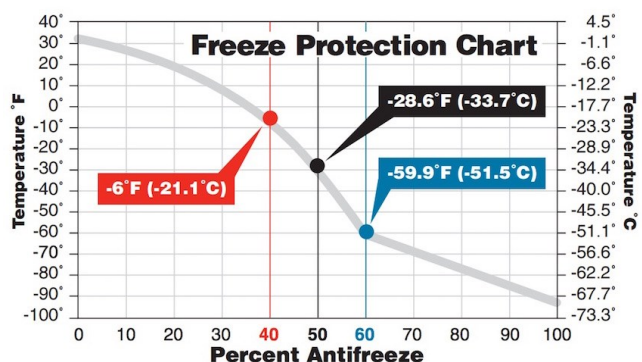
### SUMMERIZATION PROCEDURE, COOLING SEASON:

1. On the burner end of the tank, there is a chrome toggle switch located underneath the diamond plate aluminum cover. Place that switch into to the SUMMER MODE.
2. On the burner end of the tank, locate the “fill valve operation” switch and place it into cooling mode.
3. Replace the cap from the burner exhaust. This will prevent moisture from entering the blast tube and furthering the oxidation of the heat exchanger.
4. Open the burner drain located underneath the Powerflame burner. CAUTION, an excess liquified carbon build could coming flowing out. If necessary, place a bucket underneath or screw on a hose and drain to a remote location.
5. Open (counter clockwise) the lower cooling hand valve & close (clockwise) the upper heating hand valve located near the tank fill valve (refer to the picture on the next page). If the equipment only contains one hand valve, it must remain open at all times.

### CHILLER/ HEATER COMBO UNITS

6. Open all chiller isolation valves between the tank and the chiller. Ensure that all drain plugs have been placed back in their appropriate locations from the previous winterization—there are a total of 4 plugs.
7. Turn ON all CBO Breakers in each chiller module, the large breaker furthest to the right. Each controller should begin its start up sequence otherwise, check all other breakers inside panel (all breakers should be the in on position).
8. Turn the three way switch located on the outside of each module into the AUTO mode.
9. To prime the fluid circuit, place the three way switch located next to the screen into the PUMP ONLY mode.

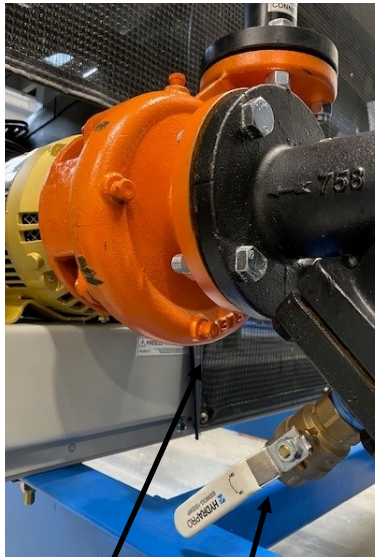
**Note: Refer to the AMC chiller installation/user manual for the start up procedure.**



**Note: Located on the next page is pictorial representations of each critical component of the summer/winterization process.**



## Summer/Winterization Component Locations



Plug No. 2  
Top Header

Plug No. 1  
Pump

Plug No. 4,  
Y-Strainer

Plug No. 3,  
Bottom Header

**Chiller Plug Locations**



Chiller Isolation  
Valves

J6 Switch  
(optional)

Auxiliary Fill Valve  
(optional)

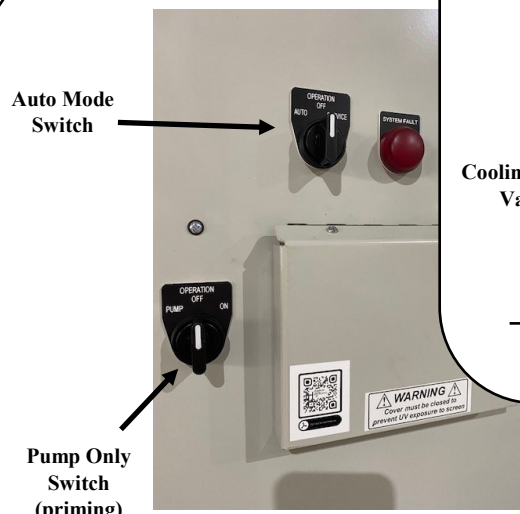
**Chiller Plumbing**



**CB0, Main Chiller  
Breaker**



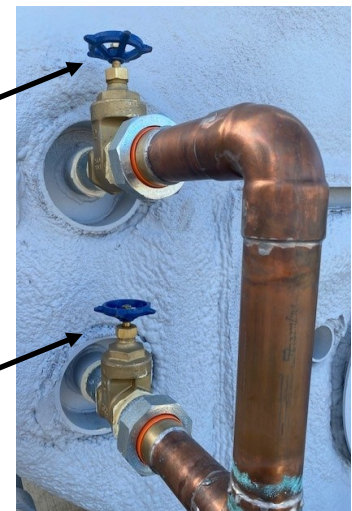
**Summer/Winter Mode**



Auto Mode  
Switch

Pump Only  
Switch  
(priming)

**Chiller Control Switches**



Heating Hand  
Valve

Cooling Hand  
Valve

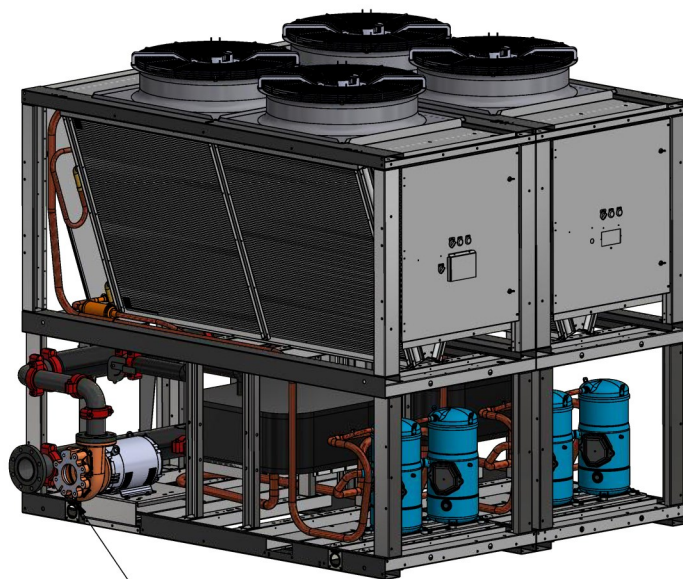
**Heating & Cooling Fill  
Valve Locations**



## Chiller Drain Plug Locations

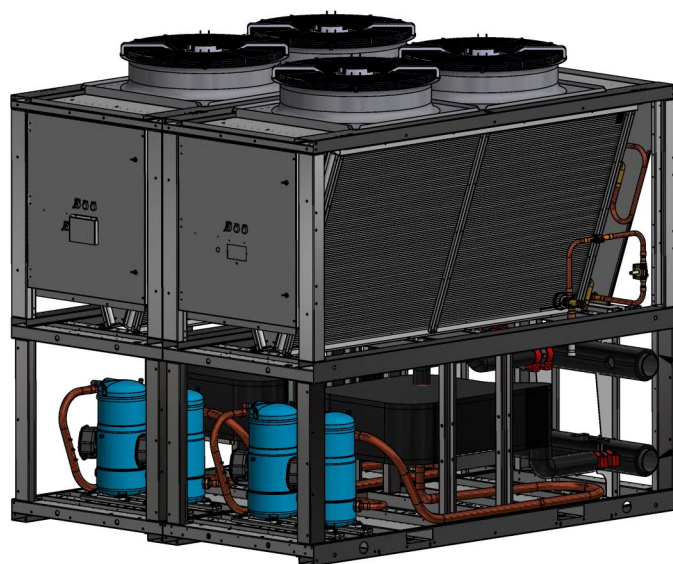
### CAUTION

ALL UNIT SIZES (20-120 TONS) ARE COMPLETELY DRAINABLE. A TOTAL OF THREE PLUG MUST BE REMOVED TO ALLOW THE FLUID CIRCUIT TO FULLY DRAIN. FOR ADDITIONAL INFORMATION AND A COMPLETE WINTERIZING PROCEDURE, REFER TO THE WINTERIZING SECTION OF THIS EQUIPMENT MANUAL. (FAILING TO FOLLOW THIS CAUTION CAN RESULT DAMAGE TO THE EVAPORATOR COIL OR FLUID PIPING AND WILL NOT BE COVERED BY THE FACTORY WARRANTY.)



**PLUG NO. 1**  
*Located on the bottom of  
the fluid circulation pump.*

TOP LEFT ISO.VIEW  
SCALE 1:30



**PLUG NO. 2 & 3**  
*Located at the end of  
each main header pipe.*

TOP RIGHT ISO.VIEW  
SCALE 1:30

## **Warranty and Liability Clause**

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The warranty is extended by American Geothermal Inc. and applies to all commercial equipment and related accessories unless otherwise stated.

The Company warrants for a period of 12 months from initial start-up or 15 months from date of shipment, whichever is less, that the Company products covered by this order (1) are free from defects in material and workmanship and (2) have the capacities and ratings set forth in the Company's catalogs and bulletins, provided that no warranty is made against corrosion, erosion, or deterioration. The Company's obligations and liabilities under this warranty are limited to furnishing f.o.b. factory or warehouse at Company designated shipping point, freight allowed to Buyer's city (or port of export for shipment outside the conterminous United States) replacement equipment (or at the option of the Company parts therefore) for all Company products not conforming to this warranty and which have been returned to the manufacturer. The Company shall not be obligated to pay for the cost of lost refrigerant. No liability whatever shall attach to the Company until said products have been paid for and then said liability shall be limited to the purchase price of the equipment shown to be defective.

The Company make certain further warranty protection available on an optional extra-cost basis. Any further warranty must be in writing, signed by an officer of the Company.

The warranty and liability set forth herein are in lieu of all other warranties and liabilities, whether in contract or in negligence, express or implied, in law or in fact, including implied warranties of merchantability and fitness for particular use. In no event shall the Company be liable for any incidental or consequential damages.

THE WARRANTY AND LIABILITY SET FORTH HEREIN ARE IN LIEU OF ALL OTHER WARRANTIES AND LIABILITIES, WHETHER IN CONTRACT OR IN NEGLIGENCE, EXPRESS OR IMPLIED, IN LAW OR IN FACT, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR USE, IN NO EVENT SHALL WARRANTOR BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.





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