MODEL M5M
Watertube Boilers
2000-6000 MBTU
Boiler Book
07/2018
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PRODUCT OFFERING

The Model M5M Boiler is a compact carbon steel, extended fin, watertube boiler. Heat transfer design is configured in a 2-pass gas travel across the watertube surfaces. The pressure vessel is constructed to conform to the A.S.M.E. Code, either Section IV for low pressure steam @ 15 PSIG MAWP [maximum allowable working pressure] hydronic heating @ 140 PSIG or Section I for MAWP greater than 15 PSIG steam or hot water greater than 250 degrees F.

The vessel [boiler] consists of two rows on each side of the vessel, of formed seamless tubes with extended fin surfaces and downcomers connected to the steam drum and lower drum. To reduce standby losses, the vessel is insulated with a fiberglass blanket and removable steel jacket.

Complete with an integral burner for Natural Gas, the complete burner/boiler package is UL and cUL Approved, listed, and labeled.

Standard Equipment

The standard boiler/burner package is described below. Optional controls, trim, and devices may be added to meet project requirements, and some of those options are noted, following this standards list.

1. Boiler
   A. Designed, constructed, and hydrostatically tested in accordance with the A.S.M.E. Boiler and Pressure Vessel Code. The complete vessel is mounted on a structural steel frame.
   B. Upper drum includes a hand hole in the rear head for drum water side inspection.
   C. Connections on steam units are included for the following:
      • Feedwater Makeup w/internal dispersion tube.
      • Surface Blowoff.
      • Steam Supply.
      • Safety Relief Valve.
   D. Connections on hot water units are included for supply water and internal circulating pump.
   E. Lower Drum includes hand holes at each end for waterside inspection. A drain/blowoff tapping is provided at the front, bottom centerline.
   F. Refractory is limited to the furnace floor, lower drum, and burner throat tile. High temperature insulation is installed on the front water wall and furnace access door.
   G. Two lifting eyes are provided on the top centerline of the upper drum for ease of installation.
   H. Furnace inspection/access door is provided in the rear via a removable access plug.
   I. The exhaust gas vent is located at the top front centerline of the boiler. A stack thermometer is shipped loose for field installation by the installing contractor into the stack.
   J. The complete vessel is fully insulated [2” fiberglass blanket] under a preformed, sectional steel jacket.
   K. Factory painted using hard-finish enamel.

2. Forced Draft Burner
   A. The burner is of the forced draft design and provided with a UL/cUL fuel burning system in full accordance with the requirements of state, provincial and local codes, and other applicable regulatory bodies.
B. Burner shall be equipped to burn Natural Gas and shall be the high radiant surface combustion pre mix design.

C. To ensure proper air for pre purge and combustion is provided by the fan, a combustion air proving switch is provided.

D. Responding to system demand from the drum mounted sensor the burner operates in the full modulation firing mode. Ultra-violet [UV] flame scanner is provided for flame presence during firing.

E. An Ignition transformer is provided.

F. Pilot is spark ignited gas.

G. Gas Train consists of the following:
   • Primary gas shutoff valve with integral proof of closure switch.
   • A manual shutoff valve located ahead of the primary gas valve.
   • A plugged leakage test connection and a second manual shutoff valve for tightness checking of the primary shutoff valve.
   • Separate Gas Pressure Regulators for the pilot train and main gas train.
   • Low Gas Pressure and High Gas Pressure Switches.
   • A second motorized gas valve is provided in addition to the primary valve on size 6000 units.

The pilot gas train includes a manual shutoff valve and solenoid shutoff valve.

3. Boiler Trim and Controls
   A. A.S.M.E. safety relief valves relative to boiler design pressure.
   B. Pressure gauge with inspectors test cock and connection for steam boiler.
   C. Primary Water Column complete with gauge glass and column drain valve for steam boilers.
   D. Low Water cutoff switch and pump control switch, integrally mounted in the primary water column for steam boilers.
   E. Primary low water cutoff internal probe type with manual reset for hot water boilers.
   F. Auxiliary Low Water Cutoff, manual reset type, standard for steam boilers, optional for hot water boilers.
   G. Controls:
      • Operating Limit.
      • Excess Pressure [High Limit], manual reset for steam boiler.
      • Excess Temp [High Limit], manual reset for hot water boiler.
      • Burner firing rate.
   H. Boiler water circulating pump for hot water boilers.

4. Burner Control Panel and Controls
   A. The control panel is a NEMA 1A Rated enclosure, mounted on the boiler above the burner at approximately eye level height. This panel may be located on the boiler side relative to additional electrical control options.
   B. Mounted within or on the control panel box are the controls noted in the Control Panel Figure:
Optional Equipment

For more detailed information on optional equipment, contact the local Cleaver-Brooks authorized representative. In summary, options could include the following:

- Larger pressure gauges or specific manufacturer type.
- Bottom Drain Valves for low pressure applications.
- Bottom Blowoff Valves for high pressure applications.
- Surface Blowoff Valve with internal collector pipe.
- TDS control.
- Feedwater Stop and Check Valves.
- Steam Stop Valve.
- ASME Hydro Test of Valves and Valve Piping.
- Design pressures above 150 PSIG to 600 PSIG.
- Lead/Lag Control.
- Alarm with silence switch.
- Additional Indicator Lights.
- Main Power Disconnect.
- Optional NEMA Enclosures.
- Stack economizer.
- Packaged skid systems available.
Insurance/ Codes

The boiler package can be equipped to meet various insurance or code requirements. Some of these insurance/code requirements are:

1. Factory Mutual [FM Global] - Recommended guidelines as described by FM pertain to boilers rated at greater than 2.5 MMBTU/hr input on gas and 2.8 MMBTU/hr input on oil. Boilers that are labeled and tested in accordance with an independent testing lab such as UL or CSA and are below these inputs are exempt from these recommendations.

   The Model M5M boiler is UL listed and labeled.

2. XL GAP [Formerly GE GAP/IRI] Recommended guidelines as described by XL GAP pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBTU/hr input. For these boilers, the requirements are the same as for A.S.M.E CSD-1 requirements. Above 12.0 MMBTU/hr input, the requirements defer to the NFPA 85 standards for single burner boilers.

3. A.S.M.E. CSD-1 - Recommended guidelines as described by this Code pertain to boilers rated at 400,000 Btu/hr input to 12.0 MMBTU/hr input. Above 12.0 MMBTU/hr input, the requirements defer to the NFPA 85 standards for single burner boilers.

DIMENSIONS AND RATINGS

For layout purposes, the nominal dimensions and connections for the Model M5M are shown in Figures 2 and 3 and Tables 1, 2, 4 and 5. Ratings of each boiler size are noted in Tables 3 and 6. Additional information is shown in the following tables:

- Tables 7 & 8 - Gas Line Capacity
- Table 9 - Hot Water Flow Rate and Pressure Drop
- Table 10 - Hot Water Maximum Circulating Rates
- Table 11 - Feedwater Make-up Rates
- Table 12 - Feedwater Quality
- Table 13 - Natural Gas Pressure Requirements, standard gas train size.
Figure 2: M5M Dimension Diagram - Steam
Table 1: M5M Steam Dimensions Inches

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For connection sizes (inches) see Table 1
### Table 3: M5M Ratings Steam

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Figure 3: M5M Dimension Diagram - Hot Water
Table 4: M5M Hot Water Dimensions Inches

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Table 5: M5M Hot Water Dimensions Millimeters

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<td>F Rear Casing to Supply Nozzle</td>
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<td>M Boiler Centerline to Base Centerline</td>
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<td>U Drum Centerline Spacing</td>
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For connection sizes (inches) see Table 4
Table 6: M5M Ratings Hot Water

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<th>Description</th>
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<th>2000</th>
<th>2500</th>
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<td>Input Max.</td>
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<td>3,500,000</td>
<td>4,000,000</td>
<td>4,500,000</td>
<td>5,000,000</td>
<td>6,000,000</td>
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<tr>
<td></td>
<td>KCAL/Hr.</td>
<td>504,000</td>
<td>630,000</td>
<td>756,000</td>
<td>882,000</td>
<td>1,008,000</td>
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<td>Natural Gas (1000 Btu/ft³)</td>
<td>FT³/Hr</td>
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<td>2500</td>
<td>3000</td>
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<td>Natural Gas</td>
<td>M³/Hr</td>
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<td>71</td>
<td>85</td>
<td>99</td>
<td>113</td>
<td>127</td>
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<td>Output 100% Firing</td>
<td>BTU/Hr.</td>
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<td>2,852,500</td>
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<td>3,667,500</td>
<td>4,075,000</td>
<td>4,890,000</td>
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<td></td>
<td>KCAL/Hr.</td>
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<td>°C</td>
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<td>Water Content</td>
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<td>Gallons (Imp.)</td>
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<td>Kg</td>
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<td>Operating Weight</td>
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<td>Kg</td>
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<td>6,000</td>
<td>7,000</td>
<td>8,000</td>
<td>9,000</td>
<td>10,000</td>
<td>12,000</td>
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<td>Watts</td>
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<td>1758</td>
<td>2051</td>
<td>2344</td>
<td>2637</td>
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<td>3516</td>
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<td>Fan Motor Size</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>7.5</td>
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<tr>
<td>Operating Voltage, Fan</td>
<td>Volts/Ph/Hz</td>
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<td>460/3/60</td>
<td>460/3/60</td>
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<td>460/3/60</td>
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<tr>
<td>Control Circuit</td>
<td>Volts/Ph/Hz</td>
<td>115/1/60</td>
<td>115/1/60</td>
<td>115/1/60</td>
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<tr>
<td>Flue Gas Mass Flow @ 100% Firing (Natural Gas)</td>
<td>lb/hr</td>
<td>2266</td>
<td>2832.5</td>
<td>3399</td>
<td>3965.5</td>
<td>4532</td>
<td>5098.5</td>
<td>5665</td>
<td>6798</td>
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<tr>
<td></td>
<td>kg/h</td>
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<td>1285</td>
<td>1542</td>
<td>1799</td>
<td>2056</td>
<td>2313</td>
<td>2570</td>
<td>3084</td>
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</tbody>
</table>
APPLICATION DATA

The following information is provided for the Model M5M boiler. Additional information may be obtained from your local Cleaver-Brooks authorized representative.

Emissions

Controlled emissions shall be <20 PPM NOx and <50 PPM CO for natural gas fuel operation without the use of FGR [Flue Gas Recirculation].

Feedwater

Steam boilers require make-up water for steam production. This make-up can be a combination of condensate return and raw make-up, 100% condensate return or 100% raw make-up. Proper treatment of make-up water and boiler water is essential to the longevity and performance of the boiler. Table 9 depicts the rate of make-up required and Table 10 shows the recommended water quality guidelines.

As a minimum, raw make-up should be piped into a water softener and then to a feed tank, which also can be the container that receives the system condensate returns. Chemical feed is recommended to be fed via a quill into the water make-up line feeding the boiler.

Blowdown

As steam is produced; unwanted solids are left behind in the boiler water and become concentrated within the vessel. If these constituents are allowed to adhere to the heat transfer surfaces, they will impede the flow of energy into the water. Their removal requires proper blowdown that will include bottom and possibly surface blowoff. For proper TDS control, surface blowoff with a TDS monitoring device is recommended. Local codes will dictate the manner of treating the blowdown affluent.

Boiler Stacks

General - The Model M5M boiler operates with a positive vent pressure and a vent gas temperature that is non-condensing. Therefore, the stack must be a positive pressure design.

Proper design and installation of the flue gas venting is critical to efficient and safe operation of the burner. The vent should be designed with proper supports and clearances from combustible materials. Use insulated vent pipe spacers where the vent passes through walls and roofs.

The design of the stack and breeching must provide the required draft at each boiler stack connection. Although constant pressure at the flue gas outlet is not required, it is necessary to size the breeching and stack to limit flue gas pressure variations. Consideration of the draft must be given where lengthy runs of breeching are employed or unusually high stacks. Please note: the allowable pressure range for design of the stack and breeching is negative 0.25" w.c. (-62 Pa) to a positive 0.25" w.c. (+62 Pa) for proper light offs and combustion. NOTE: This pressure range does not pertain to the boiler room, that is, the boiler room must be neutral or slightly positive, never negative when using air from the boiler room for combustion.

When two or more Model M5M boilers are connected to a common breeching/stack, one should evaluate the affects of pressure variations that may occur during boiler sequencing while boilers are firing. It may be determined that some type of mechanical draft system be employed to ensure proper draft at each boiler is maintained.

Combustion Air - An adequate volume of uncontaminated air to support proper combustion and equipment ventilation must be supplied. Air shall be free of chlorides, halogens, fluorocarbons, construction dust or other
contaminants that are detrimental to the burner or boiler heating surfaces. Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler [boiler room is neutral or slightly positive pressure]. All installations must comply with NFPA 54 (National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B149/.1 and B149.2 for Canadian installations.

**Engineered Design** - When determining boiler room air requirements for the boiler, the “Engineered Design” method may be used. Following this method, consideration must be given to the size of the boiler room, airflow, and air velocity as follows:

1. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler.
2. Air supply openings can be louvered for weather protection, but they should not be covered with a fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.
3. A vent fan in the boiler room is not recommended as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.
4. It is forbidden to have the total area of the air supply openings at less than one square foot.
5. Size the openings by using the formula (Area in ft² = cfma/fpma), where cfma = cubic feet per minute of air; fpma = feet per minute of air.
6. Amount of air required (cfm):
   - A. Combustion Air = Maximum boiler horsepower (bhp) times 8 cfm.
   - B. Ventilation Air = Maximum boiler horsepower (bhp) times 2 cfm.
   - C. Total Air = 10 cfm per bhp (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).
7. Acceptable air velocity in the boiler room (fpm):
   - A. From floor to 7 feet high = 250 fpm.
   - B. Above 7 feet from boiler room floor = 500 fpm.

**Example of required air openings (Engineered Method):**

Determine the area of the boiler room air supply openings for [2] size 4500 Model M5M boilers at 750 feet elevation; each have a rating of 107 boiler horsepower. The air openings will be 5 feet above the floor level.

The total boiler horsepower (bhp): 107 x 2 = 214 bhp.

From (6.C.) above, total air required = 214 bhp x 10 = 2140 cfm.

Air Velocity: From (7.A.) above = 250 fpm.

Area required: From the formula in (5) above, 2140 cfm/250 fpm = 8.56 square feet total.

Area opening: 8.56 divided by 2 = 4.28 ft² per opening (2 required).

**Consult local codes, which may supersede these requirements.**

**Gas Piping**

**General** - The Model M5M boiler requires appropriate gas supply pressure and volume for proper operation and long burner life. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation must follow these guidelines and of the local authorities that have installation jurisdiction.

**Gas Train Components** - Model M5M boilers are equipped with a gas train that meets the requirements of UL as standard. These components also comply with the recommendations of FM, XL GAP [formerly IRI/GE GAP] and ASME CSD-1. The gas train and its components have been designed and tested to operate for the highest combustion efficiency.

**Gas Pressure Requirements** - For proper and safe operation, each Model M5M boiler requires a stable gas pressure supply. The pressure requirements are listed in the gas pressure table.
**Gas Piping** - Model M5M units are standardly equipped with a gas pressure regulator. If upstream pressure to the standard regulator will be greater than 3 psig, an additional upstream regulator should be provided with a pressure relief valve.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c., a “full lockup” type regulator is recommended along with proper overpressure protection. In addition to the regulator, a plug type or “butterball” type gas shutoff cock should be provided upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the boiler gas train during gas piping tests.

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 block iron pipe and fittings.

**Gas Supply Pipe Sizing** - For proper operation of a single unit or multiple units, we recommend that the gas pipe be sized to allow no more than 0.3" w.c. pressure drop from the source [gas header or utility meter] to the final unit location. The gas supplier [utility] should be consulted to confirm that sufficient volume and normal pressure are provided to the building at the discharge side of the gas meter or supply pipe. [For installations of new boilers into an existing building, gas pressure should be measured with a manometer to ensure sufficient pressure is available].

A survey of all connected gas using devices should be made. If appliances other than the boiler are connected to the gas supply line, then a determination should be made of how much flow volume [cfh = cubic feet per hour] will be demanded at one time and the pressure drop requirements when all appliances are operating.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final connection. As a minimum guideline, gas piping Tables 7 and 8 should be used. The data in these tables is from the NFPA source book, 2006 edition.
Table 7: Gas line capacity - Schedule 40 metallic pipe

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<th>Pipe Size</th>
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<th>1-1/4&quot;</th>
<th>1-1/2&quot;</th>
<th>2&quot;</th>
<th>2-1/2&quot;</th>
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<th>4&quot;</th>
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<td>Actual I.D.</td>
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<td>1.380&quot;</td>
<td>1.610&quot;</td>
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<td>2.469&quot;</td>
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<td>4.026&quot;</td>
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<tr>
<td>Length in feet</td>
<td><strong>Maximum Capacity in Cubic Feet of Gas per Hour (cfh)</strong></td>
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<td>343</td>
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<td>157</td>
<td>322</td>
<td>482</td>
<td>928</td>
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<td>2,610</td>
<td>5,330</td>
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<td>148</td>
<td>304</td>
<td>455</td>
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<td>131</td>
<td>269</td>
<td>403</td>
<td>777</td>
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<td>2,190</td>
<td>4,460</td>
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</tr>
<tr>
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<td>119</td>
<td>244</td>
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<td>4,050</td>
<td></td>
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<td>175</td>
<td>109</td>
<td>209</td>
<td>336</td>
<td>648</td>
<td>1,030</td>
<td>1,820</td>
<td>3,720</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>102</td>
<td>185</td>
<td>313</td>
<td>602</td>
<td>960</td>
<td>1,700</td>
<td>3,460</td>
<td></td>
</tr>
</tbody>
</table>

**Fuel: Natural Gas**
**Inlet Pressure: Less than 2.0 psi**
**Pressure Drop: 0.30" w.c.**
**Specific Gravity: 0.60**

Table 8: Gas line capacity - Schedule 40 metallic pipe

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Nominal</th>
<th>1&quot;</th>
<th>1-1/4&quot;</th>
<th>1-1/2&quot;</th>
<th>2&quot;</th>
<th>2-1/2&quot;</th>
<th>3&quot;</th>
<th>4&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual I.D.</td>
<td>1.049&quot;</td>
<td>1.380&quot;</td>
<td>1.610&quot;</td>
<td>2.067&quot;</td>
<td>2.469&quot;</td>
<td>3.068&quot;</td>
<td>4.026&quot;</td>
</tr>
<tr>
<td>Length in feet</td>
<td><strong>Maximum Capacity in Cubic Feet of Gas per Hour (cfh)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>678</td>
<td>1,390</td>
<td>2,090</td>
<td>4,020</td>
<td>6,400</td>
<td>11,300</td>
<td>23,100</td>
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<tr>
<td>20</td>
<td>466</td>
<td>957</td>
<td>1,430</td>
<td>2,760</td>
<td>4,400</td>
<td>7,880</td>
<td>15,900</td>
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<tr>
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<td>374</td>
<td>768</td>
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<td>2,220</td>
<td>3,530</td>
<td>6,250</td>
<td>12,700</td>
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</tr>
<tr>
<td>40</td>
<td>320</td>
<td>657</td>
<td>985</td>
<td>1,900</td>
<td>3,020</td>
<td>5,350</td>
<td>10,900</td>
<td></td>
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<td>50</td>
<td>284</td>
<td>583</td>
<td>873</td>
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<td>2,680</td>
<td>4,740</td>
<td>9,600</td>
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<td>257</td>
<td>528</td>
<td>791</td>
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<td>2,430</td>
<td>4,290</td>
<td>8,760</td>
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</tr>
<tr>
<td>70</td>
<td>237</td>
<td>486</td>
<td>728</td>
<td>1,400</td>
<td>2,230</td>
<td>3,950</td>
<td>8,050</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>220</td>
<td>452</td>
<td>677</td>
<td>1,300</td>
<td>2,080</td>
<td>3,670</td>
<td>7,490</td>
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</tr>
<tr>
<td>90</td>
<td>207</td>
<td>424</td>
<td>635</td>
<td>1,220</td>
<td>1,950</td>
<td>3,450</td>
<td>7,030</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>195</td>
<td>400</td>
<td>600</td>
<td>1,160</td>
<td>1,840</td>
<td>3,260</td>
<td>6,640</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>173</td>
<td>355</td>
<td>532</td>
<td>1,020</td>
<td>1,630</td>
<td>2,890</td>
<td>5,890</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>157</td>
<td>322</td>
<td>482</td>
<td>928</td>
<td>1,480</td>
<td>2,610</td>
<td>5,330</td>
<td></td>
</tr>
<tr>
<td>175</td>
<td>144</td>
<td>296</td>
<td>443</td>
<td>854</td>
<td>1,360</td>
<td>2,410</td>
<td>4,910</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>134</td>
<td>275</td>
<td>412</td>
<td>794</td>
<td>1,270</td>
<td>2,240</td>
<td>4,560</td>
<td></td>
</tr>
</tbody>
</table>

**Fuel: Natural Gas**
**Inlet Pressure: Less than 2.0 psi**
**Pressure Drop: 0.50" w.c.**
**Specific Gravity: 0.60**
**Hot Water**

For hydronic heating, maximum circulating rates are shown in Table 9 & 10 relative to system temperature drop. To prevent the heated water from flashing to steam, minimum overpressure is noted in Table 10A below. As a recommendation, a low boiler water pressure control can be provided to alert the boiler room attendant that overpressure of the boiler has decreased below the minimum setting.

### Table 9: Model M5M Hot Water – Pressure Drop and Maximum Flow Rate

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>Delta T = 20°F</th>
<th>Delta T = 30°F</th>
<th>Delta T = 40°F</th>
<th>Delta T = 50°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>∆P</td>
<td>GPM</td>
<td>∆P</td>
<td>GPM</td>
</tr>
<tr>
<td>2000</td>
<td>0.96</td>
<td>165.2</td>
<td>0.43</td>
<td>110</td>
</tr>
<tr>
<td>2500</td>
<td>1.49</td>
<td>206.5</td>
<td>0.67</td>
<td>138</td>
</tr>
<tr>
<td>3000</td>
<td>2.13</td>
<td>247.6</td>
<td>0.95</td>
<td>165</td>
</tr>
<tr>
<td>3500</td>
<td>1.32</td>
<td>289</td>
<td>0.59</td>
<td>193</td>
</tr>
<tr>
<td>4000</td>
<td>1.72</td>
<td>330.8</td>
<td>0.77</td>
<td>220</td>
</tr>
<tr>
<td>4500</td>
<td>2.18</td>
<td>372.1</td>
<td>0.97</td>
<td>248</td>
</tr>
<tr>
<td>5000</td>
<td>2.68</td>
<td>413.4</td>
<td>1.20</td>
<td>276</td>
</tr>
<tr>
<td>6000</td>
<td>3.86</td>
<td>496</td>
<td>1.72</td>
<td>331</td>
</tr>
</tbody>
</table>

NOTE: Return water temperature must be >140°F.

### Table 10: Model M5M Hot Water – Maximum Circulating Rate/Temperature Drop

<table>
<thead>
<tr>
<th>MODEL NO. (HP)</th>
<th>SYSTEM TEMPERATURE DROP (0°F)</th>
<th>MAXIMUM CIRCULATING RATE - GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 (47)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>2500 (59)</td>
<td>413</td>
<td>165</td>
</tr>
<tr>
<td>3000 (71)</td>
<td>494</td>
<td>248</td>
</tr>
<tr>
<td>3500 (83)</td>
<td>578</td>
<td>289</td>
</tr>
<tr>
<td>4000 (95)</td>
<td>661</td>
<td>331</td>
</tr>
<tr>
<td>4500 (107)</td>
<td>740</td>
<td>372</td>
</tr>
<tr>
<td>5000 (119)</td>
<td>826</td>
<td>413</td>
</tr>
<tr>
<td>6000 (143)</td>
<td>992</td>
<td>496</td>
</tr>
</tbody>
</table>

NOTE: Return water temperature must be >140°F.

HP = Horsepower

### Table 10A: Boiler Operating temperature and minimum overpressure

<table>
<thead>
<tr>
<th>Outlet Water Temperature Degrees F (C)</th>
<th>Minimum System Operating Pressure</th>
<th>Boiler Design Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 – 180 (71 – 82)</td>
<td>12 (0.83)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>181 – 185 (83 – 85)</td>
<td>15 (1.03)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>186 – 195 (86 – 91)</td>
<td>18 (1.24)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>196 – 210 (92 – 99)</td>
<td>20 (1.38)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>211 – 220 (100 – 104)</td>
<td>22 (1.52)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>221 – 230 (105 – 110)</td>
<td>25 (1.72)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>231 – 240 (111 – 115)</td>
<td>30 (2.07)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>241 – 250 (116 – 121)</td>
<td>43 (2.96)</td>
<td>160 (11.03)*</td>
</tr>
<tr>
<td>251 – 260 (122 – 126)</td>
<td>55 (3.79)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>261 – 270 (127 – 132)</td>
<td>70 (4.83)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>271 – 280 (133 – 137)</td>
<td>82 (5.65)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>281 – 290 (138 – 143)</td>
<td>100 (6.9)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>291 – 300 (144 – 149)</td>
<td>112 (7.72)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>301 – 310 (150 – 154)</td>
<td>124 (8.55)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>311 – 320 (155 – 160)</td>
<td>140 (9.65)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>321 – 330 (161 – 165)</td>
<td>160 (11.03)</td>
<td>200 (13.79)**</td>
</tr>
<tr>
<td>331 – 340 (166 – 171)</td>
<td>170 (11.72)</td>
<td>250 (17.24)**</td>
</tr>
<tr>
<td>341 – 350 (172 – 176)</td>
<td>180 (12.41)</td>
<td>250 (17.24)**</td>
</tr>
<tr>
<td>355 (179)</td>
<td>190 (13.10)</td>
<td>250 (17.24)**</td>
</tr>
</tbody>
</table>

*Boiler built per ASME Code Section IV For Heating Boilers bearing the “H” Stamp

**Boiler built per ASME Code Section I For Power Boilers bearing the “S” Stamp.
### Table 11: Model M5M Steam Boiler Water Make-up Rates

<table>
<thead>
<tr>
<th>Boiler Model (HP)</th>
<th>Gallons per Minute [GPM] at full steaming capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 (47)</td>
<td>3.3</td>
</tr>
<tr>
<td>2500 (59)</td>
<td>4.1</td>
</tr>
<tr>
<td>3000 (71)</td>
<td>5.0</td>
</tr>
<tr>
<td>3500 (83)</td>
<td>5.8</td>
</tr>
<tr>
<td>4000 (95)</td>
<td>6.6</td>
</tr>
<tr>
<td>4500 (107)</td>
<td>7.5</td>
</tr>
<tr>
<td>5000 (119)</td>
<td>8.3</td>
</tr>
<tr>
<td>6000 (143)</td>
<td>9.9</td>
</tr>
</tbody>
</table>

### Table 12: Model M5M Boiler Water Quality Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Boiler Water Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.5 - 10.5</td>
</tr>
<tr>
<td>Iron</td>
<td>0.1 ppm</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.007 mg/liter</td>
</tr>
<tr>
<td>Silica</td>
<td>&lt; 200 ppm</td>
</tr>
<tr>
<td>Specific Conductivity</td>
<td>3500 umho/cm</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>2500</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>15 ppm</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>300 ppm as CaCO3</td>
</tr>
</tbody>
</table>

### Table 13: Model M5M required Natural Gas pressure*

<table>
<thead>
<tr>
<th>BOILER SIZE</th>
<th>Customer connection pipe size</th>
<th>PRESSURE REQUIRED</th>
<th>Firing Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min. (“W.C.”)</td>
<td>Max. (“W.C.”)</td>
</tr>
<tr>
<td>2000</td>
<td>1.5</td>
<td>17</td>
<td>**</td>
</tr>
<tr>
<td>2500</td>
<td>1.5</td>
<td>17</td>
<td>**</td>
</tr>
<tr>
<td>3000</td>
<td>1.5</td>
<td>17</td>
<td>**</td>
</tr>
<tr>
<td>3500</td>
<td>1.5</td>
<td>21</td>
<td>**</td>
</tr>
<tr>
<td>4000</td>
<td>1.5</td>
<td>21</td>
<td>**</td>
</tr>
<tr>
<td>4500</td>
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</tr>
<tr>
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<td>**</td>
</tr>
<tr>
<td>6000</td>
<td>1.5</td>
<td>28</td>
<td>**</td>
</tr>
</tbody>
</table>

*At entrance to the standard UL, cUL, FM & XL GAP gas trains (upstream of gas pressure regulator).

**Gas train components are rated for maximum of 3 psig with the gas pressure regulator capable of 10 psig inlet pressure. However, when the incoming pressure is greater than 3 psig, an upstream pressure relief device must be installed.

**Note:** For altitude above 2000 Feet, contact your local Cleaver-Brooks representative.