Pre-Installation Application Guide

MFC II Series Boiler
Vent and Combustion Air Guide

Exhaust venting, combustion air and piping requirements for MFC II Series boilers

Other documents for this product include:

OMM-0180 MFC II Series Operation & Maintenance Manual

TAG-0116 MFC II Series Electrical Power Guide
TAG-0117 MFC II Series Gas and #2 Oil Supply Guide
TAG-0118 MFC II Series Boiler Application Guide

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1. GENERAL

The AERCO MFC II gas-fired or fuel oil-fired (backup) boiler is a high efficiency, forced draft, hydronic-heating unit with unique venting capabilities. All MFC II venting options (which include horizontal and vertical discharges, direct vent, and manifolded vent breeching), typically exceed the capabilities of competing combustion equipment. These and other features enable MFC II boilers to provide extremely high thermal efficiencies and optimum temperature control under widely varying conditions. It is therefore critical that the flue gas vent and combustion air system be designed to maintain these objectives.

MFC II boiler's high efficiency is achieved through air/fuel modulation and the release of energy from the moisture condensing in the combustion products. Because condensation can occur in the exhaust vent system, means must be provided to remove the moisture accumulation. Each model is fitted with a condensate removal trap, as indicated in Figure 1, which illustrates the vent connection and condensate removal connection for the MFC II 4000, MFC II 5000, MFC II 6000, MFC II 8000, MFC II 10000 and MFC II 12000 models.

The design guidelines in this bulletin provide broad latitude while meeting the objectives of safety, longevity and optimum performance.

IMPORTANT: This document is intended for informational purposes only and does not replace the official installation manual. Review the full installation and operation manual, including all safety information, before installation.

2. APPROVED VENT MATERIALS

The MFC II boiler is a Category II and IV appliance, which requires special attention to exhaust venting and combustion air details. The exhaust vent MUST be UL listed for use with Category II and IV appliances. The following materials are allowed:

The MFC II 4000, 5000, 6000, 8000, 10000 and 12000 boilers can only use Stainless Steel venting materials listed to UL1738. Polypropylene, PVC, and CPVC ***are NOT allowed***.

TABLE 1: Flue System Requirements – Minimum Thickness for AL29-4C

DIAMETER	WALL THICKNESS	DIAM.	WALL THICKNESS	DIAMETER	WALL THICKNESS
3"	0.015"	9"	0.020"	20"	0.024"
4"	0.015"	10"	0.020"	22"	0.024"
5"	0.015"	12"	0.020"	24"	0.024"
6"	0.015"	14"	0.020"	26"	0.034"
7"	0.015"	16"	0.020"	28"	0.034"
8"	0.015"	18"	0.024"	30"	0.034"

Proper clearances to combustibles must be maintained per UL and the vent manufacturer requirements. The UL, National Fuel Gas Code (ANSI Z223.1/ NFPA54)[1], NFPA 31 Standard for the Installation of Oil-Burning Equipment, and CSA B149.1-10 guidelines are often the basis for state and local codes. AERCO's recommendations follow the guidelines of these agencies, unless more stringent codes govern the installation site. The venting and combustion air systems must meet all applicable code requirements. AERCO will not be responsible for failure of the system design to meet code requirements.

All Canadian installations must comply with CSA B149.1 installation code.

MFC II Series boilers have the capability to condense #2 fuel oil if the oil has a low sulfur content (<15 ppm) and return temperatures are no less than 140 degrees Fahrenheit. For applications which shall take advantage of this capability, please be sure to utilize the appropriate venting specified above that has been approved for oil fired equipment and condensing on fuel oil.

3. REQUIRED VENT TERMINATIONS

These guidelines should comply with AERCO, UL, NFPA 54 (National Fuel Gas Code, ANSI Z223.1), NFPA 31, and in Canada: CSA B149.1-10 recommendations and regulations.

Vent terminations should be at least 4 feet below, 1 foot above or 4 feet removed horizontally from any window, door or gravity air inlet of a building. Such terminations should extend beyond the outside face of the wall by at least 6 inches.

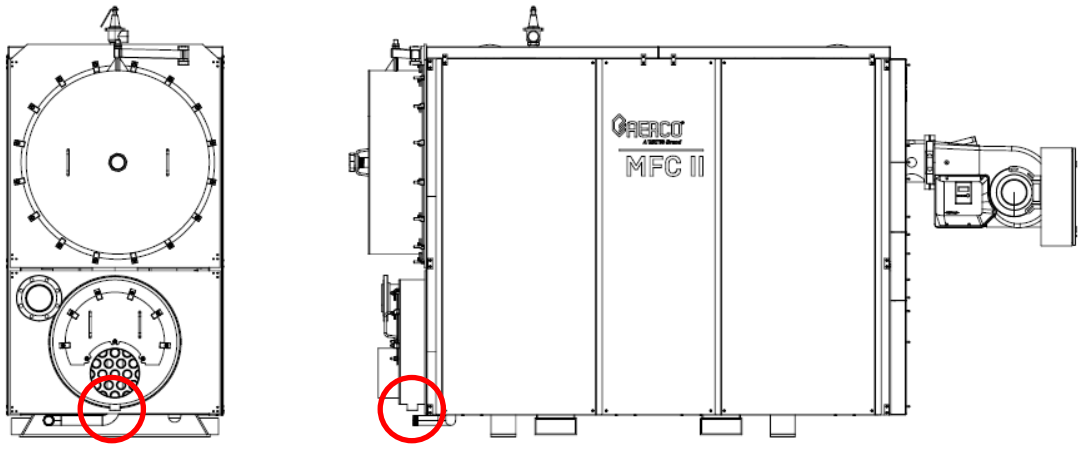

Figure 1: Location and Piping of Condensate Drain Port

The bottom of the vent termination should be at least 12 inches above both finished grade and any maximum snow accumulation level to avoid blocking the vent or air intake. The vent termination should be at least 3 feet above any forced-air building inlet within 10 feet. The design must prevent flue gases from recirculating through the boiler air intake.

Vents should not terminate over public walkways or areas where condensate or vapor could create a nuisance or be detrimental to the operation of regulators, meters or related equipment.

Discharges should not be located in high wind, wind-blocked areas or corners, or be located directly behind vegetation. Discharges in these locations may cause the flue pressures to fluctuate and result in flame instability. As a general rule, designs should minimize wind effects.

Wall and roof penetrations should follow all applicable codes and the vent manufacturer's instructions. Vents should never be installed at less than required clearances to combustible materials, as enumerated in UL, NFPA, CSA B149.1-10 or local codes "Double-wall" or “Thimble” assemblies are required when vents penetrate combustible walls or roofs.

Vertical discharges should extend at least 3 feet above the roof through properly flashed penetrations, and at least 2 feet above any object within a 10-foot horizontal distance.

Vertical and horizontal discharges should be designed to prevent rain from entering the vent. Large-mesh screens can be applied to protect against the entry of foreign objects, but the 'free area' should be at least equivalent to the flue cross-sectional area when unrestricted.

If the vent system is to be connected to an existing stack, the stack must be UL listed for Category II and IV appliances (capable of 350°F, positive pressure and condensing flue gas operation). Masonry stacks must be lined, and the vent penetration must terminate flush with, and be sealed to, this liner. Vents may enter the stack through the bottom or side. All side connections must enter at a 45-degree connection in the direction of flow and must enter at different elevations, with the smallest vent connection at the highest elevation. MFC II boiler vents must not be connected to other manufacturers’ equipment.

The exhaust vent must be pitched up towards the termination by a minimum of ¼ inch per foot of length. Condensate must flow back to the unit freely, without accumulating in the vent.

4. COMBUSTION AIR SUPPLY

TABLE 2: Required Combustion Air Volumes (at Full Capacity)	
UNIT	**VOLUME**
MFC II 4000	935 SCFM
MFC II 5000	1170 SCFM
MFC II 6000	1400 SCFM
MFC II 8000	1870 SCFM
MFC II 10000	2335 SCFM
MFC II 12000	2800 SCFM

These flows MUST be accommodated. Air supply is a direct requirement of NFPA, CSA B149.1-10 (Canada) and local codes that should be consulted for correct design implementation.

In equipment rooms containing other air-consuming equipment — including air compressors and other combustion equipment — the combustion air supply system must be designed to accommodate all such equipment when all are operating simultaneously at maximum capacity.

Combustion air intakes must be located in areas that will not induce excessive (>0.10" water column (W.C.) intake air pressure fluctuations. Designs should take into account equipment blowers and exhausts when using room air for combustion.

Intakes should be located to prevent infiltration of chlorides, halogens or any other chemicals that would be detrimental to the operation of combustion equipment. Common sources of these compounds are swimming pools, degreasing compounds, salts, plastic processing and refrigerants. When the environment contains these types of chemicals, the air MUST be supplied from the outdoors using direct-vent/ducted-combustion ductwork.

Air intakes must not be located in the proximity of garages, industrial and medical hood venting, loading docks or refrigerant vent lines. Boilers should not be installed in the proximity of activities that generate dust if that dust can enter the boiler intake. Boilers should be located to prevent moisture and precipitation from entering combustion air inlets.

When a boiler is used, temporarily, to provide heat during ongoing building construction or renovation, accumulated drywall dust, sawdust and similar particles can:

- Accumulate in the unit's combustion air intake and block combustion air flow.
- Accumulate over the burner surface and restrict flow of air/fuel mixture.

In these situations, AERCO recommends that a temporary air intake filter be installed above the boiler combustion air inlet. Air filters may be required year-round in instances in which dust or debris can enter the combustion air tube. Consult the boiler Operations and Maintenance Manual for details.

4.1 Combustion Air from WITHIN the Building

Where combustion air will originate from within the building, air must be provided to the equipment room from two permanent openings to an interior room (or rooms). Openings connecting indoor spaces shall be sized and located in accordance with the following:

- Each opening shall have a minimum free area of 1 inch^2 per 1,000 BTU/hr (2,200 mm^2/kW) of total input rating of all appliances in the space, but not less than 100 inch^2 (0.06 m^2).
- One opening shall commence within 12 inches (300 mm) of the top of the enclosure, and one opening shall commence within 12 inches (300 mm) of the bottom. (See Figure 2).
- The minimum dimension of air openings shall be not less than 3 inches (80 mm).

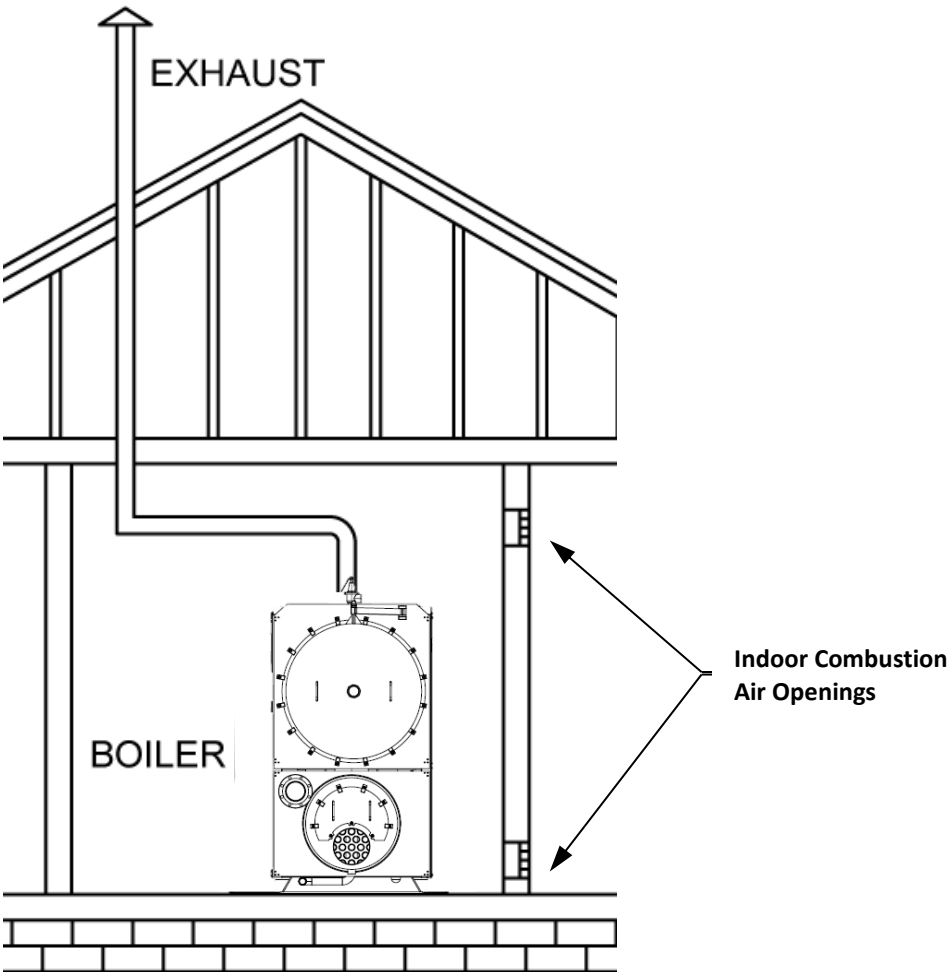

Figure 2: All Combustion Air from Adjacent Indoor Spaces through Indoor Combustion Air Openings

4.2 Combustion Air from OUTSIDE the Building

Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with the methods described below. The minimum dimension of air openings shall not be less than 3 inches (80 mm). The required size of the openings for combustion air shall be based upon the net free area of each opening. When the free area through a louver, grille, or screen is known, it shall be used to calculate the opening size required to provide the free area specified. For additional details, consult NFPA 54, or in Canada, CSA B149.1-10, paragraphs 8.4.1 and 8.4.3.

4.3 Two-Permanent-Openings Method (USA Only)

Two permanent openings shall be provided; one commencing within 12 inches (300 mm) of the top of the enclosure and one commencing within 12 inches (300 mm) of the bottom. The openings shall communicate directly — or by ducts — with the outdoors, or spaces that freely communicate with the outdoors, as show on the following pages:

- When communicating directly with the outdoors or to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 inch^2 per 4,000 BTU/hr (550 mm^2/kW) of total input rating of all appliances in the space (see Figures 3 and 4).

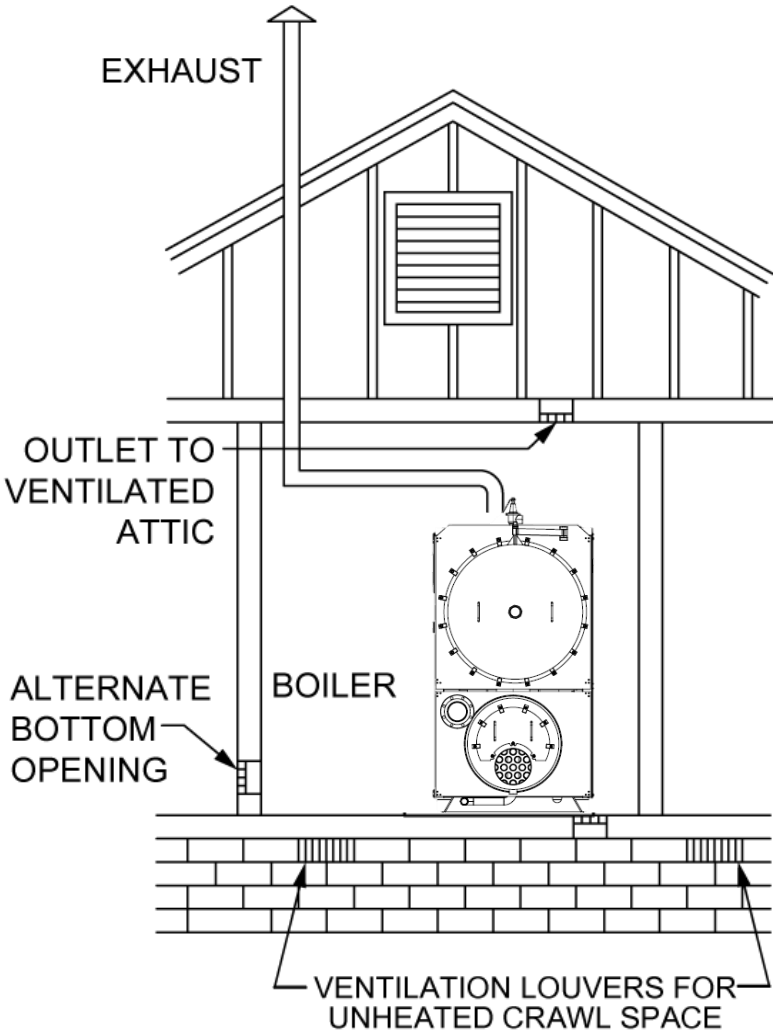

Figure 3: All Combustion Air From Outdoors - Inlet Air From Ventilated Crawl Space and Outlet Air to Ventilated Attic

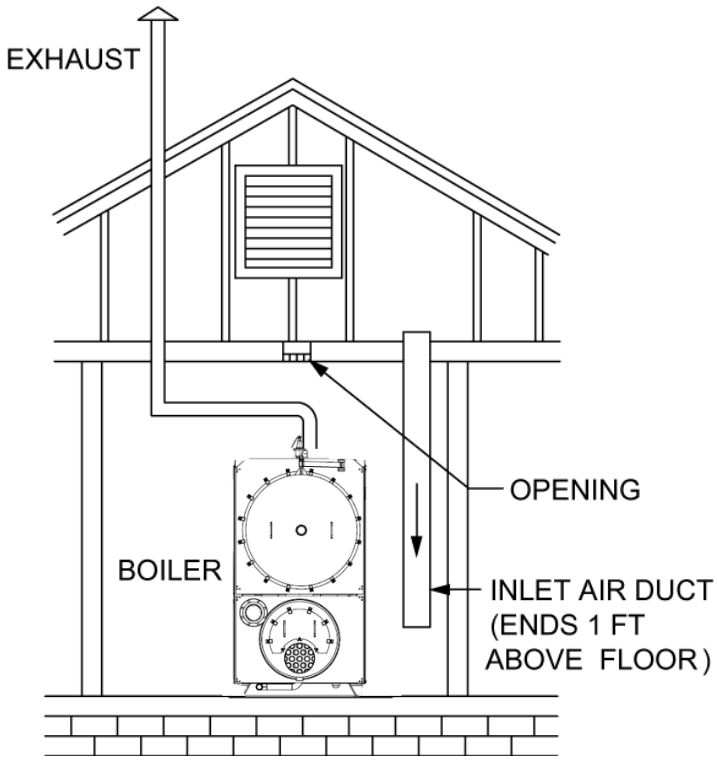

Figure 4: All Combustion Air from Outdoors - Through Ventilated Attic

- When communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 inch^2 per 2,000 BTU/hr. (1100 mm^2/kW) of total input rating of all appliances in the space (see Figure 5).

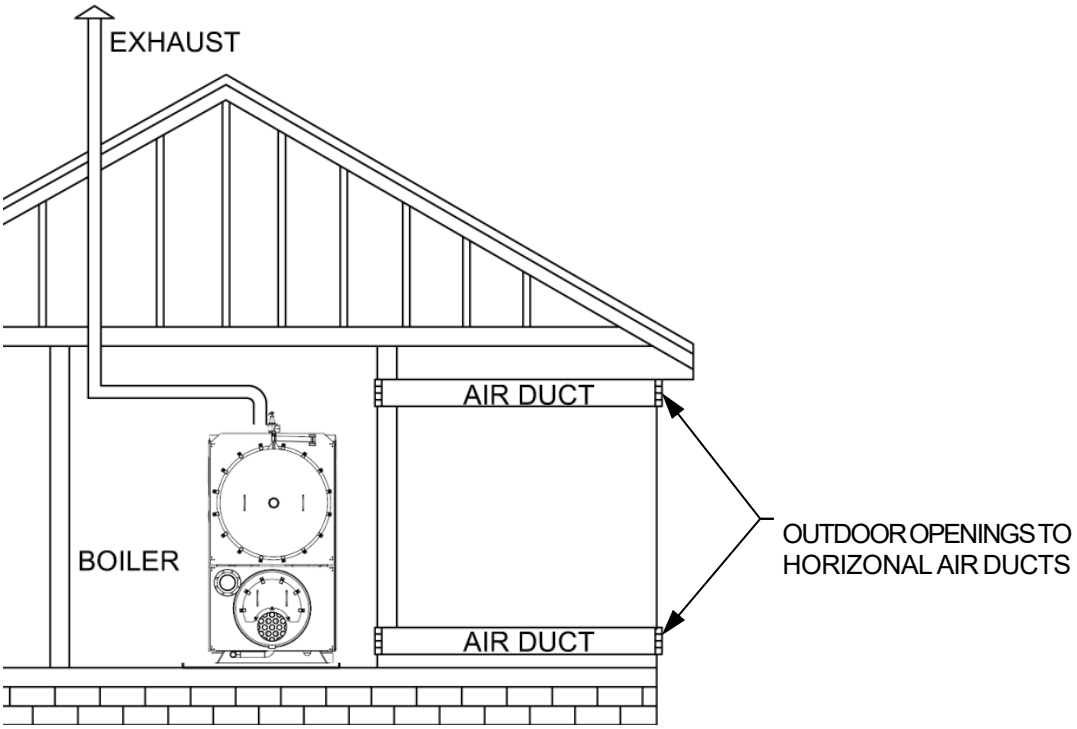

Figure 5: All Combustion Air from Outdoors through Horizontal Ducts

4.4 One Permanent Opening Method

One permanent opening shall be provided, commencing within 12 inches (300 mm) of the top of the enclosure. The appliance shall have clearances of at least 1 inches (25 mm) from the sides and back of the appliance, and a clearance of 6 inches (150 mm) from the front. The opening shall communicate with the outdoors directly or through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors (as shown in Figure 6) and shall have a minimum free area of 1 inch^2 per 3,000 BTU/hr (700 mm^2/kW) of the total input rating of all appliances located in the space.

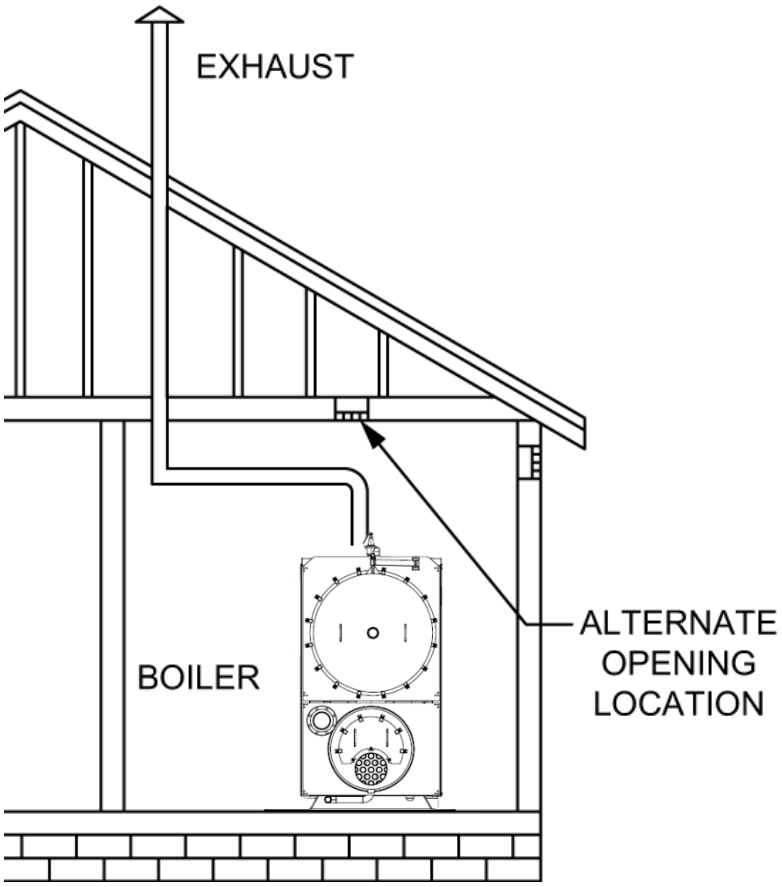

Figure 6: All Combustion Air from Outdoors through Single Combustion Air Opening

4.5 Opening a Louver Through the MFC II Series Boiler

If an AERCO supplied sequencing panel is being used to manage a multiple boiler installation, the louver can be opened using the System Start relays.

5. DIRECT VENT/DUCTED COMBUSTION AIR

The MFC II boiler is approved for direct vent installation; i.e., it can draw all combustion air from the outdoors through a metal or PVC duct connected between the unit(s) and the outdoors. This configuration is useful for situations in which room air is insufficient or otherwise unsuitable for combustion. The minimum ducted combustion-air duct sizes for the MFC II boilers are as follows:

- MFC II 4000 = 12-inch diameter
- MFC II 5000 = 12-inch diameter
- MFC II 6000 = 12-inch diameter
- MFC II 8000 = 16-inch diameter
- MFC II 10000 = 16-inch diameter
- MFC II 12000 = 16-inch diameter

In many installations, the combustion air duct can be manifolded for multiple unit applications.

The length and restriction of the ducted combustion duct directly impact the size, length and restriction of the discharge venting. The direct vent air intake should be located at least 3 feet below any vent termination within 10 feet.

A screen with mesh size not smaller than 1” x 1” must be installed at the inlet of the ducted combustion air duct.

5.1 Optional Air Intake Adapters

The following Air Inlet Adapters are available from AERCO:

MFC II Model	Part Number
Weishaupt Burner[1]	**Part Number**
WM-G20 & WM-GL20	89086-1
WM-G30 & WM-GL30	89086-2

[1] Burner model determined when MFC II product is configured. Contact your local AERCO Representative for additional information.

6. EXHAUST VENT AND COMBUSTION AIR SYSTEMS

The MFC II Series supports several venting and combustion air options, and although the application parameters vary, there are basic similarities among all systems. Tables 6 and 7 in Section 19 at the end of this Guide address the pressure drop of most applicable vent and duct fittings and sizes. The losses in the vent exit and air duct entrance are also included.

It should be noted that flow and vent or duct diameter have the most significant effects on overall system pressure drop. When using fittings or terminations not listed in Tables 6 and 7, consult the device manufacturer for actual pressure drop values. If a rectangular duct is to be used, consult Table 10 in Section 19 for a round diameter duct size that has the identical pressure drop per length of rectangular duct.

The pressure drop values in Section 19 are in equivalent feet for varying exhaust vent sizes based on each MFC II Series model. Consult your local AERCO representative if you require additional venting information.

7. GROSS NATURAL DRAFT

Flue gases have a lower density (and are lighter) than air and will rise, creating "gross natural draft." Gross natural draft is created when flue gases exit the vent at an elevation above the MFC II boiler. The amount of draft depends upon the height of the stack and the difference between the flue gas temperature and the surrounding air temperatures (densities). Gross natural draft values for stacks at various heights above the MFC II boiler are presented in Table 8 in Section 19, Part 1 and Part 2. These draft values are based on an installation site at sea level.

Adding the gross natural draft (negative) to the vent and air system pressure drop (positive) determines if the total system will be positive or negative pressure ("net natural draft"). As with most combustion equipment, negative pressure (net natural draft) systems should be treated differently from positive pressure systems when the discharge vents are manifolded. Note that sidewall vent terminations, as well as some vertical terminations, are positive pressure systems.

Contact your AERCO sales representative or AERCO International for design assistance and approval when designing manifolded exhaust vent systems.

CAUTION!
Do NOT install a non-sealed draft control damper.

8. ACCEPTABLE PRESSURE RANGES

For individually vented units, the exhaust system must be designed so that pressure measured at every point is in the range indicated in Table 3.

For individually vented units, pressures above the indicated maximum values (more positive) will prevent flue gases from exiting.

For common vented units, pressures above +0.10" WC (more positive) will prevent flue gases from exiting. For common vented units, pressures below 0" W.C. (negative) may cause flame instability.

TABLE 3: Exhaust System Pressure Range

Model	Exhaust manifold Connection	Vent Diam.	Exhaust System Pressure Range, Individual Vent	Exhaust System Pressure Range, Common Vent
MFC II 4000	12"	12"	-0.04" W.C. to + 0.20" W.C.	0" W.C. to + 0.10" W.C.
MFC II 5000	12"	12"	-0.04" W.C. to + 0.40" W.C.	0" W.C. to + 0.10" W.C.
* MFC II 6000	12"	14"	-0.04" W.C. to + 0.10" W.C.	0" W.C. to + 0.10" W.C.
		16"	-0.04" W.C. to + 0.10" W.C.	0" W.C. to + 0.10" W.C.
MFC II 8000	16"	16"	-0.04" W.C. to + 0.20" W.C.	0" W.C. to + 0.10" W.C.
MFC II 10000	16"	16"	-0.04" W.C. to + 0.10" W.C.	0" W.C. to + 0.10" W.C.
		18"	-0.04" W.C. to + 0.20" W.C.	0" W.C. to + 0.10" W.C.
MFC II 12000	16"	16"	-0.04" W.C. to + 0.10" W.C.	0" W.C. to + 0.10" W.C.
		18"	-0.04" W.C. to + 0.20" W.C.	0" W.C. to + 0.10" W.C.
		20"	-0.04" W.C. to + 0.10" W.C.	0" W.C. to + 0.10" W.C.

* The exhaust manifold connection for MFC II 6000 is 12", however, the minimum vent diameter required is 14". Therefore, a vent increaser must be installed immediately after the exhaust manifold.

9. EXHAUST FANS

If the MFC II series boiler exhaust system incorporates an exhaust fan, the system designer must size the vent pipe diameters, select the fan and determine the location of the fan sensor to maintain a 0" to +0.10" W.C. pressure range at the outlet of each boiler. Also, the designer must ensure that the exhaust fan material is acceptable for use with Category IV appliances.

10. CORRECTIONS FOR ALTITUDE

Table 9 in Section 19 lists correction factors for installation altitudes above sea level. These factors must be applied to both the natural draft and pressure drops of vent and air ducts. *The pressure drop through vents and combustion air ducts will increase at higher elevations, while the natural draft will decrease.*

11. MANIFOLDED SYSTEMS

In many instances it may be practical to connect multiple units using a manifolded vent or exhaust configuration. However, when multiple units are connected by a manifolded air intake or exhaust vent, the operation of a given unit can be affected by the others, if the venting or combustion air system is not designed properly. Properly designed common vent and air supply systems can be installed that will prevent "operational interaction" between units. **Do not use static regain method on common ductwork, but rather, use one duct size for the common run (See Figure 11 in Section 18).**

Contact AERCO for design assistance when designing manifolded exhaust and combustion air systems.

12. ELBOW QUANTITY AND SEPARATION

The quantity and angle of elbows and the distances between them can influence the system's exhaust and combustion air pressures, as well as its acoustical behavior. Designers should consider minimizing the quantity of elbows in the design and the use of angles less than 90°, whenever possible. Five or fewer elbows are recommended for individual venting/connections; five or fewer are recommended for common sections. **The minimum distance required between two elbows is five feet**.

13. EXHAUST MUFFLER AND AIR INLET ATTENUATOR GUIDELINES

MFC II Series boilers require an exhaust muffler when installed in a noise-sensitive application and when the exhaust vent ducting is relatively short in length. The following criteria should be used to determine when to include a field-installed muffler in an MFC II series installation:

- The exhaust is **sidewall vented** and the vent is terminated in close proximity to residences, offices, hotel/hospital rooms, classrooms etc. ***OR:***
- The **total vertical and horizontal section** of exhaust vent is **less than 25 linear feet** from the last unit, and the vent terminates nearby residences, offices, hotel/hospital rooms, classrooms etc.

For ***manifolded exhaust*** systems, the total vertical section length includes both horizontal and common vertical; individual boiler vertical connectors are included in the determination as well.

EXAMPLE: For an installation that has a 20-foot common vertical, 5-foot common horizontal after the last boiler, and each boiler has a 10-foot vertical connector, the total section linear length considered is 35 feet. Because this length is greater than 25 linear feet, a muffler is ***not*** required.

For ***manifolded ducted combustion***, the total section length includes both horizontal and common vertical; individual boiler vertical connectors are included in the determination.

EXAMPLE: For a manifolded ducted combustion with a 10-foot common vertical, 5-foot common horizontal after the last boiler and each boiler has an 8-foot vertical connector, the total section linear length considered is 23 feet. Because this is less than 25 feet, an attenuator is required.

Contact your local AERCO sales representative for more information on the AERCO exhaust muffler and air inlet attenuator.

14. VENT AND COMBUSTION AIR SYSTEM DESIGN REQUIREMENTS

TABLE 4: Minimum Exhaust Vent and Combustion Air Duct Sizes

MODEL	COMBUSTION AIR MINIMUM DIAMETER	EXHAUST	
		Exhaust Manifold Connection	MINIMUM Vent Diam.
MFC II 4000	12 inch dia.	12 inch dia.	12 inch dia.
MFC II 5000	12 inch dia.	12 inch dia.	12 inch dia.
* MFC II 6000	12 inch dia.	12 inch dia.	14 inch dia.
MFC II 8000	16 inch dia.	16 inch dia.	16 inch dia.
MFC II 10000	16 inch dia.	16 inch dia.	16 inch dia.
MFC II 10000	16 inch dia.	16 inch dia.	16 inch dia.

* The exhaust manifold connection for MFC II 6000 is 12", however, the minimum vent diameter required is 14". Therefore, a vent increaser must be installed immediately after the exhaust manifold.

24-inch length of straight vent is recommended downstream of the exhaust manifold.

The vent system should always be pitched up ¼ inch per foot of run towards the vent termination to enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided. Periodic inspection should be performed to assure correct drainage.

MFC II Series vents should not be interconnected to those of other manufacturers' equipment.

Horizontal vent and ductwork should be supported to prevent sagging, in accordance with local code and the vent manufacturer's requirements. Vertical vent and ductwork should be supported to prevent excessive stress on the horizontal runs. The exhaust manifold and inlet air adapter should never be used as weight-supporting elements. The supports should be so arranged and the overall layout designed to assure that stresses on the vent and combustion air connections are minimized.

The vents and combustion air ducts may be insulated in accordance with the vent manufacturer's instructions and local codes.

15. CONDENSATE REMOVAL

The exhaust vent system must be pitched back toward the MFC II Series unit by a minimum of ¼-inch per foot of duct length to enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided to prevent the condensate from collecting.

The condensate trap assembly is located directly below the exhaust manifold. Plastic hose should be connected to the trap assembly and run to drain. Care should be taken to avoid hose kinks and to avoid raising the hose above the trap assembly. Condensate should flow freely to drain. The condensate-to-drain run must not be hard-piped so the trap can be removed periodically for maintenance purposes.

If the condensate must be lifted above the trap assembly to a drain, it should be drained into a sump. From there, a pump can lift the condensate away.

Each unit will produce the following approximate condensate quantities in the full condensing mode:

- MFC II 4000 = 26 gallons per hour
- MFC II 5000 = 32 gallons per hour
- MFC II 6000 = 39 gallons per hour
- MFC II 8000 = 52 gallons per hour
- MFC II 10000 = 65 gallons per hour
- MFC II 12000 = 78 gallons per hour

Condensate drain systems must be sized for full condensing mode.

In multiple boiler applications, it is common to manifold these drains together in a plastic pipe manifold to a floor drain. Condensate manifolds must be large enough to handle the anticipated flow and must be properly secured and protected. Manifolds are generally located behind the boilers so that short runs of plastic tubing into the manifold can be used for the condensate drain. A base drain must be installed at the bottom of vertical common flue piping.

The pH level of the condensate, produced by MFC II Series boilers, ranges between 3.0 and 3.2. The installation should be designed in accordance with local codes that specify acceptable pH limits. If required, any type of commercially available neutralizer may be used.

16. INDIVIDUALLY VENTED SYSTEMS

Systems with individual vents may be used with any of the combustion systems described previously. The maximum combined pressure drop of the vent and combustion air system must not exceed the value indicated in Table 5.

TABLE 5: Exhaust Maximum Combined Equivalent Ft of Vent and Combustion Air

Model	Exhaust manifold connection	Vent Diam.	Max Eq Ft
MFC II 4000	12"	12"	140
MFC II 5000	12"	12"	140
* MFC II 6000	12"	14"	60
		16"	140
MFC II 8000	16"	16"	140
MFC II 10000	16"	16"	60
		18"	140
MFC II 12000	16"	16"	50
		18"	100
		20"	140

* The exhaust manifold connection for MFC II 6000 is 12”, however, the minimum vent diameter required is 14”. Therefore, a vent increaser must be installed immediately after the exhaust manifold.

To calculate the pressure drop:

1) Calculate the exhaust vent pressure drop.
2) Calculate the combustion duct pressure drop.
3) Divide the vent pressure drop by the altitude correction factor (CF) listed in Table 9 to correct for installations above sea level.
4) Determine the natural draft, if any, from Table 8 and multiply it by the altitude CF.
5) Add the altitude corrected vent pressure drop (positive) and the draft (negative) to get the total vent pressure drop.
6) Add total vent pressure drop to altitude corrected combustion air duct pressure drop.
7) The total system pressure drop must not exceed the values indicated in Table 5.

16.1 MFC II Series Pressure Drop Calculation Example

Calculate the maximum pressure drop for a single boiler installation at 500 feet above sea level having a winter design temperature of 20°F. The duct system of an MFC II 4000 consists of:

1) An 12-inch diameter exhaust vent with two (2) 90° elbows, one (1) 45° elbows, 75 feet of horizontal run, 20 feet of vertical run
2) A rain cap termination
3) A 12-inch diameter ducted combustion air duct with two 90° elbows and 50 feet of run

MFC II Series Pressure Drop Calculation

12-INCH DIAMETER EXHAUST VENT PRESSURE:

Two 90° elbows: 2 x 4.12 = 8.24 ft.

One 45° elbow: 1 x 3.19 = 3.19 ft.

95 feet total run (75 horizontal + 20 vertical):

95 x 0.38 = 36.10 ft.

Rain cap exit loss: 1 x 11.51 = 11.51 ft.

Vent drop subtotal: = 59.04 ft.

Altitude correction: $\frac{59.04}{0.982\ (CF)}$ = 60.12 ft.

Natural draft for 20 feet @ 20°F outside temperature:

= 12.6 ft.

Altitude correction: - 12.6 x 0.982 CF= - 12.37 ft.

TOTAL VENT DROP: = 47.75 ft.

12-INCH DIAMETER COMBUSTION AIR DUCT PRESSURE:

Two 90° elbows: 2 x 2.13 = 4.26 ft.

50 feet total run: 50 x 0.26 = 13.00 ft.

Entrance loss: 1 x 5.22 = 5.22 ft.

Combustion air drop subtotal: 22.48 ft.

Altitude correction: $= \frac{22.48}{0.982\ CF}$ = 22.89 ft.

COMBUSTION AIR DROP TOTAL: = 22.89 ft.

SYSTEM TOTAL PRESSURE DROP:

Vent drop + combustion air duct pressure drop:

= 47.75 + 22.89

FINAL PRESSURE DROP TOTAL: = 70.64 ft.

CONCLUSION:

For MFC II 4000 using a 12" vent, referring to Table 5, Pressure drop is less than 140 equivalent feet = **SYSTEM OK**.

17. MANIFOLDED DUCTED COMBUSTION AIR

For systems using manifolded ducted combustion ductwork, use the longest length of common duct and the individual branch to the furthest boiler to calculate the pressure drop.

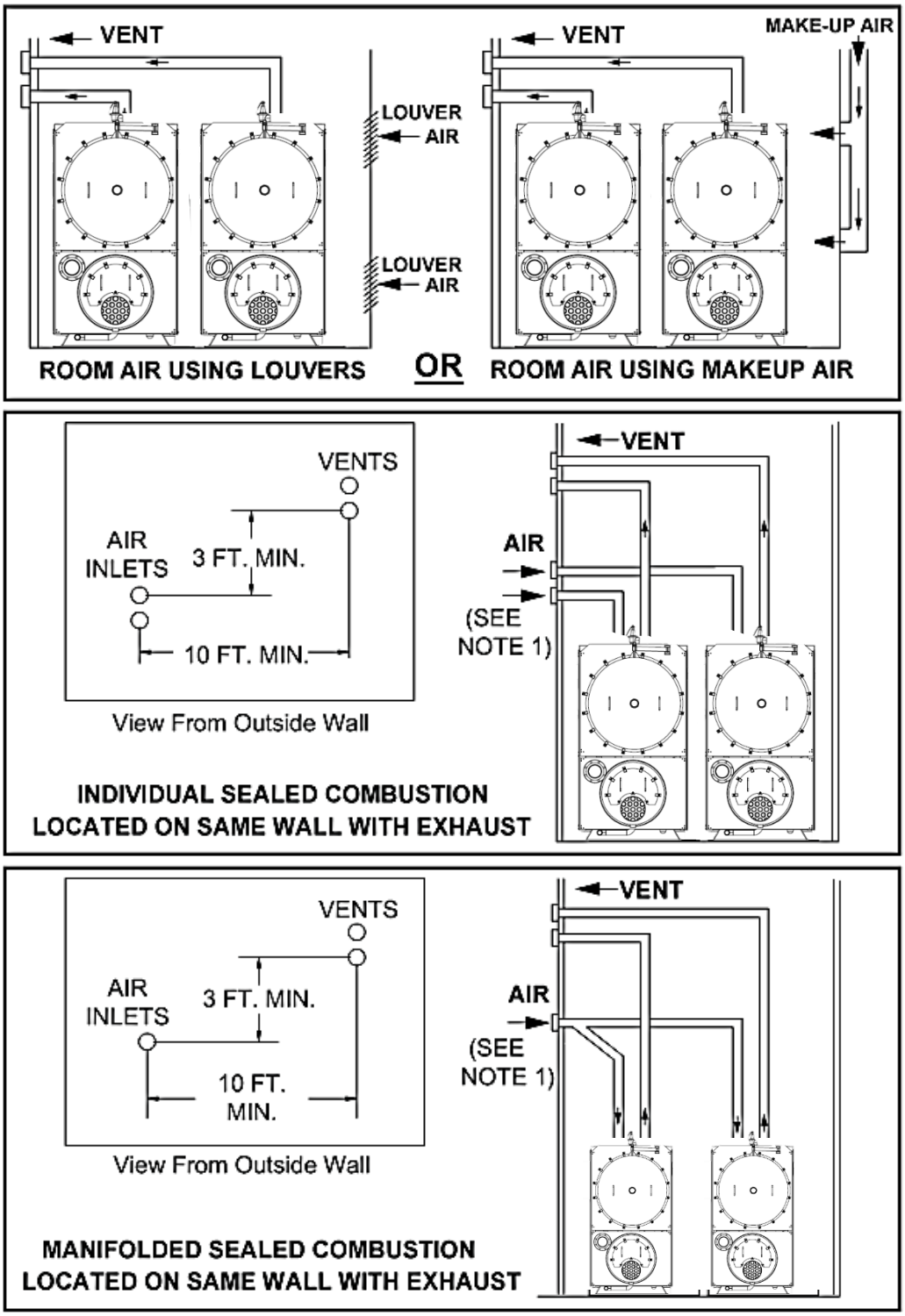

Figure 8a: Individual Vents – Preferred Installations

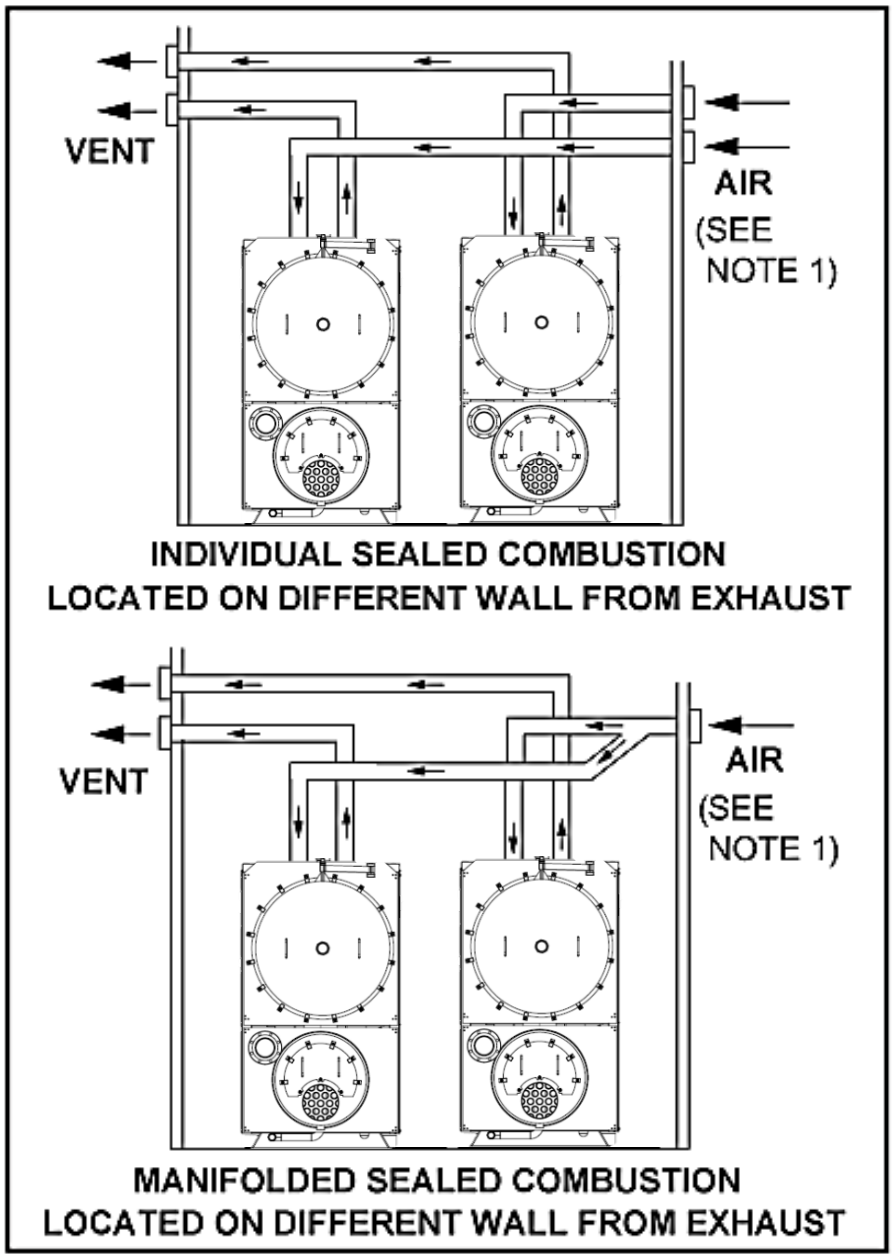

Figure 8b: Individual Vents – Acceptable Installations

NOTES:

1. For high wind, wind blocked sites, a tee may be installed at the fresh air inlet. The leg of the tee connects to the combustion air intake.
2. On the flue vent side, a tee or exit cone (velocity cone) may be utilized in place of a rain cap for high wind or wind blocked sites.
3. The branches of the tee can be in the horizontal or vertical direction, as determined by the system designer and site conditions.

18. COMMON VENT BREECHING (MANIFOLDED)

Connections to common vent breeching or duct work must be accomplished with a 45° elbow in the direction of flow in the main breeching. "Tees" should not be used to accomplish these connections - see Figure 9a. The recommended minimum individual boiler vent length before joining the common vent breech is 10 feet.

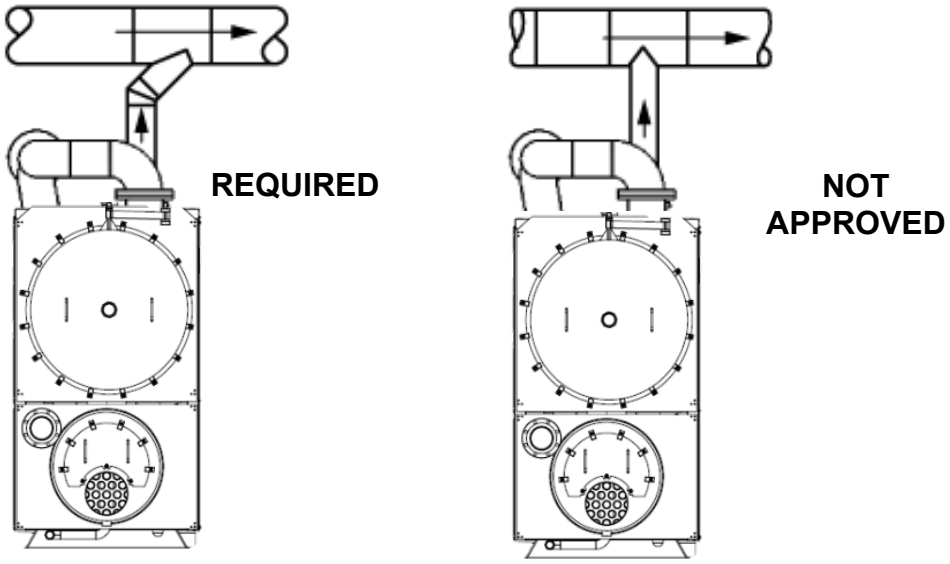

Figure 9a: Recommended Connections to Common Vent Breeching

Interconnection of groups of units must *never* be accomplished via a "tee". As shown in Figure 9b, change the direction with one of the mains and then connect the second three diameters (common section diameter) from this turn via a 45° connection.

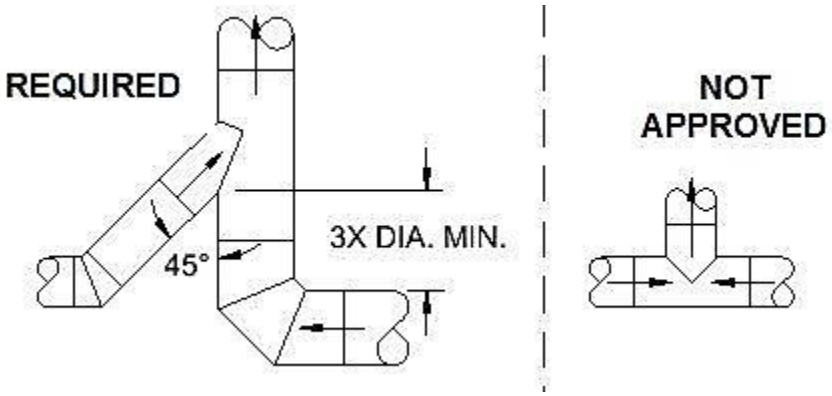

Figure 9b: Required Interconnection of Groups of Units

Figure 10 illustrates the preferable "transition vent section" when making the 45° connection into a main. The main can also remain at one diameter, as long as it is sized for the total number of units vented and the 45° branch connection is retained. Use of the recommended "transition" assembly will reduce the overall system pressure drop.

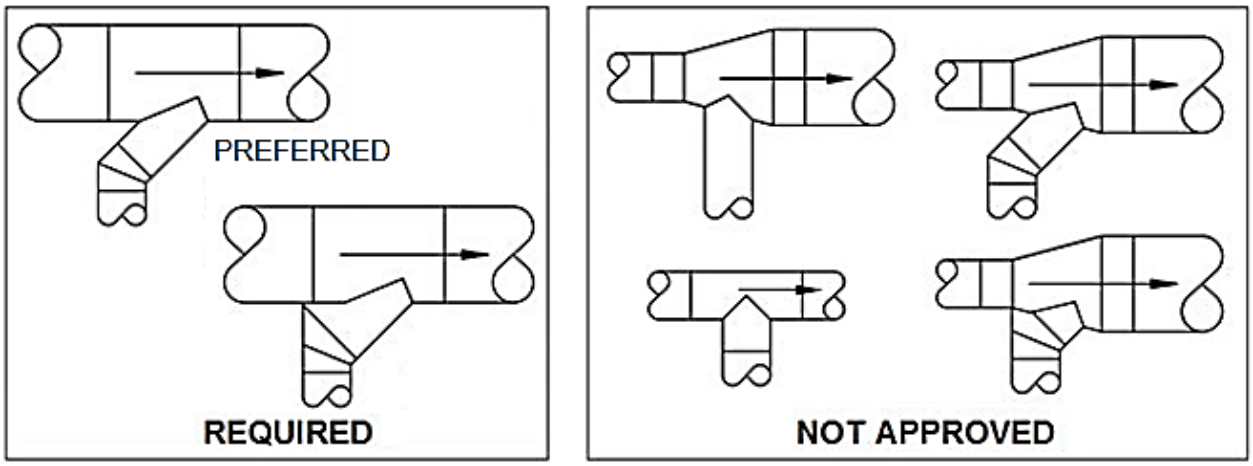

Figure 10: Required Transition Vent Sections

The vent system should always be pitched up ¼-inch per foot of run towards the vent termination (see Figure 11). This will enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided. Inspect periodically to ensure correct drainage.

As shown in Figure 11, the unit at the end of the vent main must be connected via an elbow. An end cap must not be used as it may cause vibration and flue pressure fluctuations.

As discussed previously, the static regain method should not be used for common ductwork, but rather, the one duct size should be used for the common run.

MFC II vents should never be interconnected to those connected to other manufacturers' equipment.

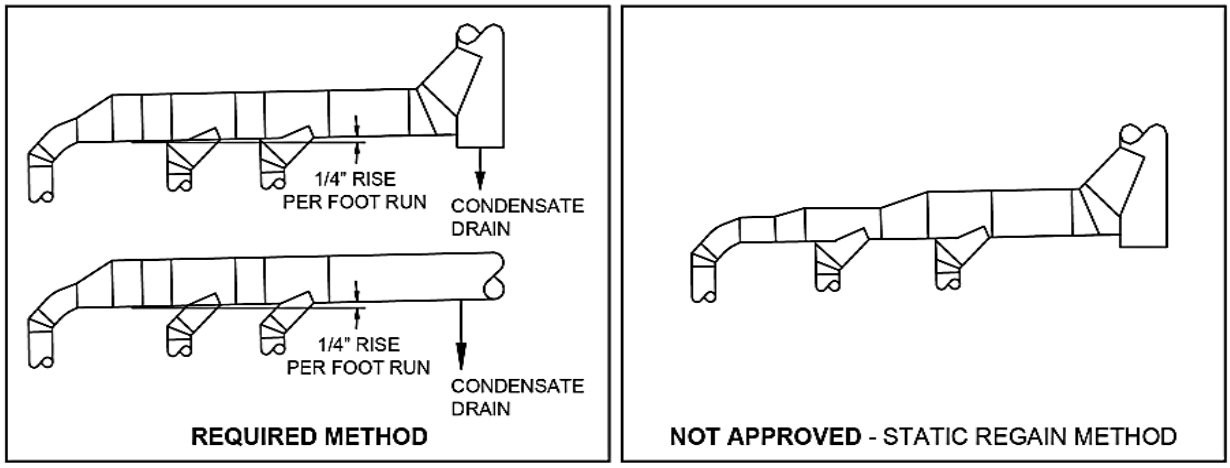

Figure 11: Connection of Unit at End of Vent Main

19. PRESSURE DROP AND DRAFT DATA TABLES

TABLE 6: Discharge Flue Vent Pressure Drop (Eq. Ft.)

Single MFC II 4000 Boiler (Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

FLUE VENT (IN. DIA.)	FLUE VELOCITY (FT/SEC)	STRAIGHT RUN (EQ. FT / FOOT)	90° ELBOW (EQ. FT)	45° ELBOW (EQ. FT)	EXIT LOSS HORIZ. TERM. (EQ. FT)	EXIT LOSS RAIN CAP (EQ. FT)
12	24.94	0.38	4.12	3.19	8.06	11.51
14	18.32	0.18	2.06	1.61	4.35	8.08
16	14.03	0.09	1.14	0.89	2.55	4.74
18	11.08	0.05	0.68	0.53	1.59	2.96
20	8.98	0.03	0.42	0.33	1.04	1.94

Single MFC II 5000 Boiler (Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

FLUE VENT (IN. DIA.)	FLUE VELOCITY (FT/SEC)	STRAIGHT RUN (EQ. FT / FOOT)	90° ELBOW (EQ. FT)	45° ELBOW (EQ. FT)	EXIT LOSS HORIZ. TERM. (EQ. FT)	EXIT LOSS RAIN CAP (EQ. FT)
12	31.17	0.58	6.44	4.98	12.59	23.39
14	22.90	0.27	3.23	2.51	6.80	12.62
16	17.53	0.14	1.78	1.39	3.98	7.40
18	13.85	0.08	1.06	0.83	2.49	4.62
20	11.22	0.05	0.66	0.52	1.63	3.03

Single MFC II 6000 Boiler (Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

FLUE VENT (IN. DIA.)	FLUE VELOCITY (FT/SEC)	STRAIGHT RUN (EQ. FT / FOOT)	90° ELBOW (EQ. FT)	45° ELBOW (EQ. FT)	EXIT LOSS HORIZ. TERM. (EQ. FT)	EXIT LOSS RAIN CAP (EQ. FT)
14	27.48	0.38	4.65	3.61	9.79	18.18
16	21.04	0.19	2.57	2.00	5.74	10.66
18	16.63	0.11	1.52	1.19	3.58	6.65
20	13.47	0.06	0.95	0.74	2.35	4.36
22	11.13	0.04	0.62	0.49	1.61	2.98

Single MFC II 8000 Boiler (Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

FLUE VENT (IN. DIA.)	FLUE VELOCITY (FT/SEC)	STRAIGHT RUN (EQ. FT / FOOT)	90° ELBOW (EQ. FT)	45° ELBOW (EQ. FT)	EXIT LOSS HORIZ. TERM. (EQ. FT)	EXIT LOSS RAIN CAP (EQ. FT)
16	28.06	0.33	4.56	3.56	10.20	18.94
18	22.17	0.18	2.71	2.11	6.37	11.83
20	17.96	0.11	1.70	1.32	4.18	7.76
22	14.84	0.07	1.11	0.86	2.85	5.30
24	12.47	0.04	0.75	0.58	2.01	3.74

Single MFC II 10000 Boiler (Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

FLUE VENT (IN. DIA.)	FLUE VELOCITY (FT/SEC)	STRAIGHT RUN (EQ. FT / FOOT)	90° ELBOW (EQ. FT)	45° ELBOW (EQ. FT)	EXIT LOSS HORIZ. TERM. (EQ. FT)	EXIT LOSS RAIN CAP (EQ. FT)
16	35.07	0.51	7.13	5.56	15.94	29.60
18	27.71	0.28	4.23	3.30	9.95	18.48
20	22.44	0.17	2.65	2.07	6.53	12.12
22	18.55	0.10	1.73	1.35	4.46	8.28
24	15.59	0.07	1.17	0.91	3.15	5.85

Single MFC II 12000 Boiler (Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

FLUE VENT (IN. DIA.)	FLUE VELOCITY (FT/SEC)	STRAIGHT RUN (EQ. FT / FOOT)	90° ELBOW (EQ. FT)	45° ELBOW (EQ. FT)	EXIT LOSS HORIZ. TERM. (EQ. FT)	EXIT LOSS RAIN CAP (EQ. FT)
16	42.08	0.72	10.26	8.01	22.95	42.62
18	33.25	0.40	6.09	4.75	14.33	26.61
20	26.93	0.23	3.82	2.98	9.40	17.46
22	22.26	0.15	2.50	1.94	6.42	11.92
24	18.70	0.09	1.69	1.31	4.53	8.42

TABLE 7: Ducted Combustion Air Duct Pressure Drop (Eq. Ft.)										
for MFC II 4000 MMBTU Boiler										
Inlet Duct & No. Boilers	Duct Section Type	OUTSIDE AIR TEMPERATURE (°F)								
		-30 °F	-15 °F	0 °F	20 °F	40 °F	60 °F	80 °F	100 °F	120 °F
12" Duct Single Boiler	Straight Run	0.22	0.23	0.24	0.25	0.27	0.29	0.31	0.32	0.34
	90° Elbow	1.81	1.90	1.99	2.12	2.27	2.42	2.58	2.75	2.94
	45° Elbow	1.40	1.47	1.54	1.64	1.75	1.87	2.00	2.13	2.27
	Ent. Loss	4.45	4.67	4.90	5.22	5.57	5.94	6.34	6.77	7.22
14" Duct Single Boiler	Straight Run	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.16
	90° Elbow	0.91	0.95	1.00	1.06	1.14	1.21	1.29	1.38	1.47
	45° Elbow	0.71	0.74	0.78	0.83	0.88	0.94	1.01	1.07	1.14
	Ent. Loss	2.40	2.52	2.64	2.82	3.01	3.21	3.42	3.65	3.90
16" Duct Two Boilers	Straight Run	0.19	0.20	0.21	0.22	0.24	0.25	0.27	0.29	0.30
	90° Elbow	2.00	2.10	2.20	2.35	2.51	2.68	2.86	3.05	3.25
	45° Elbow	1.56	1.64	1.72	1.83	1.96	2.09	2.23	2.38	2.54
	Ent. Loss	5.63	5.91	6.20	6.61	7.05	7.52	8.03	8.56	9.14
18" Duct Two Boilers	Straight Run	0.11	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.17
	90° Elbow	1.19	1.25	1.31	1.40	1.49	1.59	1.69	1.81	1.93
	45° Elbow	0.93	0.97	1.02	1.09	1.16	1.24	1.32	1.41	1.51
	Ent. Loss	3.51	3.69	3.87	4.13	4.40	4.70	5.01	5.35	5.70
18" Duct Three Boilers	Straight Run	0.23	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.36
	90° Elbow	2.67	2.80	2.94	3.14	3.35	3.57	3.81	4.07	4.34
	45° Elbow	2.09	2.19	2.30	2.45	2.61	2.79	2.98	3.17	3.39
	Ent. Loss	7.91	8.30	8.71	9.29	9.91	10.57	11.28	12.03	12.83
20" Duct Three Boilers	Straight Run	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21
	90° Elbow	1.68	1.76	1.84	1.97	2.10	2.24	2.39	2.55	2.72
	45° Elbow	1.31	1.37	1.44	1.53	1.64	1.75	1.86	1.99	2.12
	Ent. Loss	5.19	5.44	5.71	6.09	6.50	6.93	7.40	7.89	8.42
20" Duct Four Boilers	Straight Run	0.23	0.24	0.26	0.27	0.29	0.31	0.33	0.35	0.37
	90° Elbow	2.98	3.13	3.28	3.50	3.73	3.98	4.25	4.53	4.84
	45° Elbow	2.32	2.44	2.56	2.73	2.91	3.11	3.31	3.53	3.77
	Ent. Loss	9.22	9.68	10.15	10.83	11.55	12.33	13.15	14.03	14.97
22" Duct Four Boilers	Straight Run	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.22	0.23
	90° Elbow	1.95	2.04	2.14	2.29	2.44	2.60	2.78	2.96	3.16
	45° Elbow	1.52	1.59	1.67	1.78	1.90	2.03	2.16	2.31	2.46
	Ent. Loss	6.30	6.61	6.94	7.40	7.89	8.42	8.98	9.58	10.22

NOTES:

1) Calculation assumes **935 scfm** per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)

3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

TABLE 7: Ducted Combustion Air Duct Pressure Drop (Eq. Ft.)										
for MFC II 5000 MMBTU Boiler										
Inlet Duct & No. Boilers	Duct Section Type	OUTSIDE AIR TEMPERATURE (°F)								
		-30 °F	-15 °F	0 °F	20 °F	40 °F	60 °F	80 °F	100 °F	120 °F
12" Duct Single Boiler	Straight Run	0.33	0.35	0.37	0.39	0.41	0.44	0.47	0.50	0.53
	90° Elbow	2.83	2.97	3.12	3.33	3.55	3.79	4.04	4.31	4.60
	45° Elbow	2.19	2.30	2.41	2.57	2.75	2.93	3.13	3.33	3.56
	Ent. Loss	6.96	7.31	7.67	8.18	8.72	9.31	9.93	10.60	11.30
14" Duct Single Boiler	Straight Run	0.15	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.24
	90° Elbow	1.42	1.49	1.56	1.67	1.78	1.90	2.02	2.16	2.30
	45° Elbow	1.10	1.16	1.22	1.30	1.38	1.48	1.57	1.68	1.79
	Ent. Loss	3.76	3.94	4.14	4.41	4.71	5.02	5.36	5.72	6.10
16" Duct Two Boilers	Straight Run	0.29	0.31	0.32	0.34	0.36	0.39	0.41	0.44	0.47
	90° Elbow	3.13	3.29	3.45	3.68	3.93	4.19	4.47	4.77	5.09
	45° Elbow	2.45	2.57	2.69	2.87	3.06	3.27	3.49	3.72	3.97
	Ent. Loss	8.81	9.25	9.70	10.35	11.04	11.78	12.57	13.41	14.31
18" Duct Two Boilers	Straight Run	0.16	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.26
	90° Elbow	1.86	1.95	2.05	2.18	2.33	2.49	2.65	2.83	3.02
	45° Elbow	1.45	1.52	1.60	1.71	1.82	1.94	2.07	2.21	2.36
	Ent. Loss	5.50	5.77	6.06	6.46	6.89	7.35	7.85	8.37	8.93
18" Duct Three Boilers	Straight Run	0.35	0.37	0.39	0.41	0.44	0.46	0.49	0.53	0.56
	90° Elbow	4.19	4.39	4.61	4.92	5.24	5.60	5.97	6.37	6.80
	45° Elbow	3.27	3.43	3.60	3.84	4.09	4.37	4.66	4.97	5.30
	Ent. Loss	12.38	12.99	13.63	14.54	15.51	16.55	17.66	18.84	20.10
20" Duct Three Boilers	Straight Run	0.21	0.22	0.23	0.24	0.26	0.27	0.29	0.31	0.33
	90° Elbow	2.62	2.75	2.89	3.08	3.29	3.51	3.74	3.99	4.26
	45° Elbow	2.05	2.15	2.25	2.40	2.56	2.73	2.92	3.11	3.32
	Ent. Loss	8.12	8.52	8.94	9.54	10.18	10.86	11.58	12.36	13.19
20" Duct Four Boilers	Straight Run	0.36	0.38	0.39	0.42	0.45	0.47	0.50	0.54	0.57
	90° Elbow	4.66	4.89	5.14	5.48	5.84	6.23	6.65	7.10	7.57
	45° Elbow	3.64	3.82	4.01	4.27	4.56	4.86	5.19	5.53	5.90
	Ent. Loss	14.44	15.15	15.90	16.96	18.09	19.30	20.59	21.97	23.44
22" Duct Four Boilers	Straight Run	0.22	0.23	0.24	0.26	0.28	0.29	0.31	0.33	0.35
	90° Elbow	3.05	3.20	3.36	3.58	3.82	4.08	4.35	4.64	4.95
	45° Elbow	2.37	2.49	2.62	2.79	2.98	3.17	3.39	3.61	3.86
	Ent. Loss	9.86	10.35	10.86	11.58	12.36	13.18	14.07	15.01	16.01

NOTES:

1) Calculation assumes **1170 scfm** per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

TABLE 7: Ducted Combustion Air Duct Pressure Drop (Eq. Ft.)										
for MFC II 6000 MMBTU Boiler										
Inlet Duct & No. Boilers	Duct Section Type	OUTSIDE AIR TEMPERATURE (°F)								
		-30 °F	-15 °F	0 °F	20 °F	40 °F	60 °F	80 °F	100 °F	120 °F
12" Duct Single Boiler	Straight Run	0.47	0.49	0.51	0.54	0.58	0.62	0.66	0.70	0.74
	90° Elbow	4.06	4.26	4.47	4.76	5.08	5.42	5.78	6.17	6.58
	45° Elbow	3.14	3.29	3.45	3.69	3.93	4.19	4.48	4.77	5.09
	Ent. Loss	9.97	10.46	10.98	11.71	12.49	13.33	14.22	15.17	16.19
14" Duct Single Boiler	Straight Run	0.22	0.23	0.24	0.25	0.27	0.28	0.30	0.32	0.34
	90° Elbow	2.03	2.13	2.24	2.39	2.55	2.72	2.90	3.09	3.30
	45° Elbow	1.58	1.66	1.74	1.86	1.98	2.11	2.25	2.41	2.57
	Ent. Loss	5.38	5.65	5.93	6.32	6.74	7.19	7.68	8.19	8.74
18" Duct Two Boilers	Straight Run	0.23	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.36
	90° Elbow	2.66	2.79	2.93	3.13	3.34	3.56	3.80	4.05	4.32
	45° Elbow	2.08	2.18	2.29	2.44	2.60	2.78	2.97	3.16	3.38
	Ent. Loss	7.88	8.27	8.67	9.25	9.87	10.53	11.24	11.99	12.79
20" Duct Two Boilers	Straight Run	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21
	90° Elbow	1.67	1.75	1.84	1.96	2.09	2.23	2.38	2.54	2.71
	45° Elbow	1.30	1.37	1.43	1.53	1.63	1.74	1.86	1.98	2.11
	Ent. Loss	5.17	5.42	5.69	6.07	6.48	6.91	7.37	7.87	8.39
22" Duct Three Boilers	Straight Run	0.18	0.19	0.20	0.21	0.22	0.24	0.25	0.27	0.29
	90° Elbow	2.46	2.58	2.70	2.88	3.08	3.28	3.50	3.74	3.99
	45° Elbow	1.91	2.01	2.11	2.25	2.40	2.56	2.73	2.91	3.11
	Ent. Loss	7.94	8.33	8.75	9.33	9.95	10.62	11.33	12.09	12.89
24" Duct Three Boilers	Straight Run	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.19
	90° Elbow	1.66	1.74	1.83	1.95	2.08	2.22	2.37	2.52	2.69
	45° Elbow	1.29	1.35	1.42	1.52	1.62	1.73	1.84	1.96	2.10
	Ent. Loss	5.61	5.88	6.18	6.59	7.03	7.50	8.00	8.53	9.10
24" Duct Four Boilers	Straight Run	0.20	0.21	0.22	0.24	0.25	0.27	0.28	0.30	0.32
	90° Elbow	2.95	3.09	3.25	3.46	3.69	3.94	4.21	4.49	4.79
	45° Elbow	2.30	2.41	2.53	2.70	2.88	3.07	3.27	3.49	3.73
	Ent. Loss	9.97	10.46	10.98	11.71	12.49	13.33	14.22	15.17	16.19
26" Duct Four Boilers	Straight Run	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21
	90° Elbow	2.04	2.14	2.25	2.40	2.56	2.73	2.91	3.11	3.32
	45° Elbow	1.59	1.67	1.75	1.87	1.99	2.13	2.27	2.42	2.58
	Ent. Loss	7.24	7.60	7.97	8.50	9.07	9.68	10.32	11.02	11.75

NOTES:

1) Calculation assumes **1400 scfm** per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

TABLE 7: Ducted Combustion Air Duct Pressure Drop (Eq. Ft.) for MFC II 8000 MMBTU Boiler										
Inlet Duct & No. Boilers	Duct Section Type	OUTSIDE AIR TEMPERATURE (°F)								
		-30 °F	-15 °F	0 °F	20 °F	40 °F	60 °F	80 °F	100 °F	120 °F
16" Duct Single Boiler	Straight Run	0.19	0.20	0.21	0.22	0.24	0.25	0.27	0.29	0.30
	90° Elbow	2.00	2.10	2.20	2.35	2.51	2.68	2.86	3.05	3.25
	45° Elbow	1.56	1.64	1.72	1.83	1.96	2.09	2.23	2.38	2.54
	Ent. Loss	5.63	5.91	6.20	6.61	7.05	7.52	8.03	8.56	9.14
18" Duct Single Boiler	Straight Run	0.11	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.17
	90° Elbow	1.19	1.25	1.31	1.40	1.49	1.59	1.69	1.81	1.93
	45° Elbow	0.93	0.97	1.02	1.09	1.16	1.24	1.32	1.41	1.51
	Ent. Loss	3.51	3.69	3.87	4.13	4.40	4.70	5.01	5.35	5.70
20" Duct Two Boilers	Straight Run	0.23	0.24	0.26	0.27	0.29	0.31	0.33	0.35	0.37
	90° Elbow	2.98	3.13	3.28	3.50	3.73	3.98	4.25	4.53	4.84
	45° Elbow	2.32	2.44	2.56	2.73	2.91	3.11	3.31	3.53	3.77
	Ent. Loss	9.22	9.68	10.15	10.83	11.55	12.33	13.15	14.03	14.97
22" Duct Two Boilers	Straight Run	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.22	0.23
	90° Elbow	1.95	2.04	2.14	2.29	2.44	2.60	2.78	2.96	3.16
	45° Elbow	1.52	1.59	1.67	1.78	1.90	2.03	2.16	2.31	2.46
	Ent. Loss	6.30	6.61	6.94	7.40	7.89	8.42	8.98	9.58	10.22
22" Duct Three Boilers	Straight Run	0.31	0.33	0.34	0.37	0.39	0.42	0.44	0.47	0.50
	90° Elbow	4.38	4.60	4.82	5.15	5.49	5.86	6.25	6.67	7.11
	45° Elbow	3.41	3.58	3.76	4.01	4.28	4.56	4.87	5.19	5.54
	Ent. Loss	14.17	14.87	15.60	16.64	17.76	18.94	20.21	21.56	23.01
24" Duct Three Boilers	Straight Run	0.20	0.21	0.22	0.24	0.25	0.27	0.28	0.30	0.32
	90° Elbow	2.96	3.10	3.26	3.48	3.71	3.96	4.22	4.50	4.80
	45° Elbow	2.30	2.42	2.54	2.71	2.89	3.08	3.29	3.51	3.74
	Ent. Loss	10.01	10.50	11.02	11.75	12.54	13.38	14.27	15.23	16.24
24" Duct Four Boilers	Straight Run	0.35	0.37	0.39	0.41	0.44	0.47	0.50	0.53	0.56
	90° Elbow	5.26	5.52	5.79	6.18	6.59	7.03	7.50	8.00	8.54
	45° Elbow	4.09	4.30	4.51	4.81	5.13	5.47	5.84	6.23	6.65
	Ent. Loss	17.79	18.66	19.59	20.89	22.29	23.78	25.37	27.07	28.88
26" Duct Four Boilers	Straight Run	0.23	0.25	0.26	0.27	0.29	0.31	0.33	0.35	0.37
	90° Elbow	3.64	3.82	4.01	4.28	4.57	4.87	5.20	5.55	5.92
	45° Elbow	2.84	2.98	3.13	3.33	3.56	3.79	4.05	4.32	4.61
	Ent. Loss	12.91	13.55	14.22	15.17	16.18	17.26	18.42	19.65	20.97

NOTES:

1) Calculation assumes **1870 scfm** per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

TABLE 7: Ducted Combustion Air Duct Pressure Drop (Eq. Ft.)										
for MFC II 10000 MMBTU Boiler										
Inlet Duct & No. Boilers	Duct Section Type	OUTSIDE AIR TEMPERATURE (°F)								
		-30 °F	-15 °F	0 °F	20 °F	40 °F	60 °F	80 °F	100 °F	120 °F
16" Duct Single Boiler	Straight Run	0.29	0.31	0.32	0.34	0.36	0.38	0.41	0.44	0.46
	90° Elbow	3.12	3.27	3.44	3.67	3.91	4.17	4.45	4.75	5.07
	45° Elbow	2.44	2.56	2.68	2.86	3.05	3.26	3.47	3.71	3.95
	Ent. Loss	8.78	9.21	9.66	10.31	10.99	11.73	12.52	13.35	14.25
18" Duct Single Boiler	Straight Run	0.16	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.26
	90° Elbow	1.85	1.94	2.04	2.18	2.32	2.48	2.64	2.82	3.01
	45° Elbow	1.45	1.52	1.59	1.70	1.81	1.93	2.06	2.20	2.35
	Ent. Loss	5.48	5.75	6.03	6.43	6.86	7.32	7.81	8.34	8.89
20" Duct Two Boilers	Straight Run	0.36	0.37	0.39	0.42	0.44	0.47	0.50	0.54	0.57
	90° Elbow	4.64	4.87	5.11	5.45	5.82	6.21	6.62	7.07	7.54
	45° Elbow	3.62	3.80	3.99	4.25	4.54	4.84	5.17	5.51	5.88
	Ent. Loss	14.38	15.09	15.83	16.89	18.01	19.22	20.51	21.88	23.34
22" Duct Two Boilers	Straight Run	0.22	0.23	0.24	0.26	0.27	0.29	0.31	0.33	0.35
	90° Elbow	3.04	3.19	3.34	3.57	3.80	4.06	4.33	4.62	4.93
	45° Elbow	2.36	2.48	2.60	2.78	2.96	3.16	3.37	3.60	3.84
	Ent. Loss	9.82	10.30	10.81	11.53	12.30	13.13	14.01	14.94	15.94
22" Duct Three Boilers	Straight Run	0.48	0.50	0.53	0.56	0.60	0.64	0.68	0.72	0.77
	90° Elbow	6.83	7.17	7.52	8.02	8.56	9.13	9.74	10.39	11.09
	45° Elbow	5.32	5.58	5.86	6.25	6.67	7.11	7.59	8.10	8.64
	Ent. Loss	22.10	23.18	24.33	25.95	27.68	29.54	31.51	33.62	35.87
24" Duct Three Boilers	Straight Run	0.31	0.32	0.34	0.36	0.39	0.41	0.44	0.46	0.49
	90° Elbow	4.61	4.84	5.08	5.42	5.78	6.17	6.58	7.02	7.49
	45° Elbow	3.59	3.77	3.95	4.22	4.50	4.80	5.12	5.46	5.83
	Ent. Loss	15.60	16.37	17.18	18.32	19.55	20.85	22.25	23.74	25.33
24" Duct Four Boilers	Straight Run	0.54	0.57	0.59	0.63	0.67	0.72	0.76	0.81	0.86
	90° Elbow	8.20	8.61	9.03	9.63	10.28	10.96	11.70	12.48	13.32
	45° Elbow	6.38	6.70	7.03	7.50	8.00	8.53	9.11	9.72	10.36
	Ent. Loss	27.74	29.10	30.54	32.57	34.75	37.07	39.56	42.20	45.03
26" Duct Four Boilers	Straight Run	0.36	0.38	0.39	0.42	0.45	0.48	0.51	0.54	0.58
	90° Elbow	5.68	5.96	6.26	6.67	7.12	7.60	8.11	8.65	9.23
	45° Elbow	4.43	4.64	4.87	5.20	5.55	5.92	6.31	6.74	7.19
	Ent. Loss	20.14	21.13	22.17	23.65	25.23	26.92	28.72	30.64	32.69

NOTES:

1) Calculation assumes **2335 scfm** per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)

3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

TABLE 7: Ducted Combustion Air Duct Pressure Drop (Eq. Ft.) for MFC II 12000 MMBTU Boiler										
Inlet Duct & No. Boilers	Duct Section Type	OUTSIDE AIR TEMPERATURE (°F)								
		-30 °F	-15 °F	0 °F	20 °F	40 °F	60 °F	80 °F	100 °F	120 °F
16" Duct Single Boiler	Straight Run	0.41	0.43	0.45	0.48	0.51	0.55	0.58	0.62	0.66
	90° Elbow	4.49	4.71	4.94	5.27	5.62	6.00	6.40	6.83	7.29
	45° Elbow	3.50	3.67	3.86	4.11	4.39	4.68	4.99	5.33	5.68
	Ent. Loss	12.62	13.24	13.89	14.82	15.81	16.87	18.00	19.20	20.49
18" Duct Single Boiler	Straight Run	0.23	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.36
	90° Elbow	2.66	2.79	2.93	3.13	3.34	3.56	3.80	4.05	4.32
	45° Elbow	2.08	2.18	2.29	2.44	2.60	2.78	2.97	3.16	3.38
	Ent. Loss	7.88	8.27	8.67	9.25	9.87	10.53	11.24	11.99	12.79
22" Duct Two Boilers	Straight Run	0.31	0.33	0.34	0.37	0.39	0.41	0.44	0.47	0.50
	90° Elbow	4.37	4.58	4.81	5.13	5.47	5.84	6.23	6.64	7.09
	45° Elbow	3.40	3.57	3.74	3.99	4.26	4.55	4.85	5.17	5.52
	Ent. Loss	14.12	14.82	15.55	16.58	17.69	18.88	20.14	21.49	22.92
24" Duct Two Boilers	Straight Run	0.20	0.21	0.22	0.24	0.25	0.27	0.28	0.30	0.32
	90° Elbow	2.95	3.09	3.25	3.46	3.69	3.94	4.21	4.49	4.79
	45° Elbow	2.30	2.41	2.53	2.70	2.88	3.07	3.27	3.49	3.73
	Ent. Loss	9.97	10.46	10.98	11.71	12.49	13.33	14.22	15.17	16.19
24" Duct Three Boilers	Straight Run	0.44	0.46	0.48	0.51	0.55	0.58	0.62	0.66	0.70
	90° Elbow	6.63	6.96	7.30	7.79	8.31	8.87	9.46	10.10	10.77
	45° Elbow	5.16	5.42	5.69	6.07	6.47	6.90	7.37	7.86	8.38
	Ent. Loss	22.43	23.54	24.70	26.35	28.11	29.99	31.99	34.14	36.42
26" Duct Three Boilers	Straight Run	0.29	0.31	0.32	0.34	0.36	0.39	0.41	0.44	0.47
	90° Elbow	4.60	4.82	5.06	5.40	5.76	6.14	6.56	6.99	7.46
	45° Elbow	3.58	3.76	3.94	4.20	4.49	4.79	5.11	5.45	5.81
	Ent. Loss	16.29	17.09	17.93	19.13	20.41	21.77	23.23	24.78	26.44
26" Duct Four Boilers	Straight Run	0.51	0.54	0.56	0.60	0.64	0.68	0.72	0.77	0.82
	90° Elbow	8.17	8.57	9.00	9.60	10.24	10.92	11.66	12.44	13.27
	45° Elbow	6.36	6.68	7.01	7.47	7.97	8.51	9.08	9.68	10.33
	Ent. Loss	28.95	30.38	31.88	34.01	36.28	38.70	41.30	44.06	47.01
28" Duct Four Boilers	Straight Run	0.35	0.37	0.39	0.41	0.44	0.46	0.50	0.53	0.56
	90° Elbow	5.77	6.06	6.36	6.78	7.23	7.72	8.24	8.79	9.37
	45° Elbow	4.51	4.73	4.96	5.30	5.65	6.03	6.43	6.86	7.32
	Ent. Loss	21.53	22.59	23.70	25.28	26.97	28.78	30.70	32.76	34.95

NOTES:

1) Calculation assumes **2800 scfm** per boiler at full fire rate

2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)

3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

TABLE 8: Gross Natural Draft for MFC II Boilers									
(Inch. W.C.)									
STACK HEIGHT (FT)	OUTSIDE AIR TEMPERATURE (°F)								
	-30°F	-15°F	0°F	20°F	40°F	60°F	80°F	100°F	120°F
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275
(Eq. Ft.)									
STACK HEIGHT (FT)	OUTSIDE AIR TEMPERATURE (°F)								
	-30°F	-15°F	0°F	20°F	40°F	60°F	80°F	100°F	120°F
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160 °F to 180 °F

TABLE 9: Altitude Correction	
Site Elevation (feet above sea level)	**Altitude Correction Factor (CF)**
0	1
500	0.982
1000	0.964
1500	0.947
2000	0.930
2500	0.913
3000	0.896
3500	0.880
4000	0.864
4500	0.848
5000	0.832
5500	0.817
6000	0.801
6500	0.787
7000	0.772
7500	0.758
8000	0.743
8500	0.729
9000	0.715
9500	0.701
10000	0.688

TABLE 10: Round Duct of Identical Pressure Drop to Rectangular Duct										
Adjacent Side of Duct (in.)	**Side of Rectangular Duct (in.)**									
	6	8	10	12	14	16	18	20	22	24
6	6.6									
8	7.6	8.7								
10	8.4	9.8	10.9							
12	9.1	10.7	12	13.1						
14	9.8	11.5	12.9	14.2	15.3					
16	10.4	12.2	13.7	15.1	16.4	17.5				
18	11	12.9	14.5	16	17.3	18.5	19.7			
20	11.5	13.5	15.2	16.8	18.2	19.5	20.7	21.9		
22	12	14.1	15.9	17.6	19.1	20.4	21.7	22.9	24	
24	12.4	14.6	16.5	18.3	19.9	21.3	22.7	23.9	25.1	26.2

Reference:

1. *National Fuel Gas Code, 2006 edition*, American National Standards Institute, Inc (ANSI Z223.1-2006) and National Fire Protection Association (NFPA54-2006)
2. CSA B149.1 (For Canada installations)