CROWN BOILER

DESIGNED TO LEAD

# Supplemental Design Guide for Multiple Aruba 5 and Bali 2 Multiple Boiler Systems

**⚠ WARNING**

**Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury, or loss of life.**

- This manual provides supplementary information for the design and installation of multiple boiler systems; it does not replace the manuals provided with the boilers themselves. Boiler installation, operation, and service must be one be in accordance with the manuals shipped with the boiler and all applicable codes.
- This manual describes the application of controls by other manufacturers. Those controls must be installed in accordance with the control manufacturer's instructions and all applicable codes.

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**The following terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning product life.**

**⚠ DANGER**

**Indicates an imminently hazardous situation** that, if not avoided, will result in death or serious injury.

**⚠ CAUTION**

**Indicates a potentially hazardous situation** that, if not avoided, may result in moderate or minor injury or property damage.

**⚠ WARNING**

**Indicates a potentially hazardous situation** that, if not avoided, could result in death or serious injury.

***NOTICE:*** Indicates special instructions on installation, operation, or maintenance which are important but not related to personal injury hazards.

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**⚠ DANGER**

**Explosion Hazard. DO NOT store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance**.

If you smell gas vapors, DO NOT try to operate any appliance - DO NOT touch any electrical switch or use any phone in the building. Immediately, call the gas supplier from a remotely located phone. Follow the gas supplier's instructions or if the supplier is unavailable, contact the fire department.

**⚠ WARNING**

**Asphyxiation Hazard. Fire Hazard. Explosion Hazard. Shock Hazard. Burn Hazard.** Boilers referenced in these instructions use flammable gas, high voltage electricity, moving parts, and very hot water under high pressure.

- All boilers require regular maintenance and service to operate safely.
- Instructions provided with the boilers themselves include important precautions for their safe installation, operation, and maintenance. Review boiler manuals thoroughly before attempting to design or install a multiple boiler system.
- Assure that all gas and electric power supplies are off and that the water temperature is cool before attempting any disassembly or service. Note that there may be more than one electrical and/or gas supply to a multiple boiler system that must be turned off.
- Do not attempt any service work if gas is present in the air in the vicinity of the boilers.
- Never modify, remove, or tamper with any control device.

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# I Introduction

This manual provides guidance for the design and installation of multiple boiler systems using Aruba 5 and Bali 2 series boilers in light commercial applications. The use of multiple residential boilers in small commercial applications is a practice that has been around for decades. It offers several advantages over a single commercial boiler:

- Ease of installation – It may be easier to get two residential boilers into a boiler room than one larger commercial boiler. The need to assemble cast iron sections is also eliminated.
- Built in redundancy - Some heat will be available if one boiler must be shut down for repairs or service. If each boiler is isolated with valves and unions, one boiler can even be completely replaced without shutting down the entire system.
- Ease of service – Residential boilers tend to use parts that are simpler, less expensive, and more readily available than their commercial counterparts.
- Load matching – Sufficient boiler capacity has to be present to heat the building on a "design day", however for most of the heating season the heating load will be far smaller. Multiple boilers can be staged to provide an output closer to what is actually needed at any given outdoor temperature. This reduces burner cycling and improves system efficiency. When done using Aruba or Bali series boilers, this turndown capability is achieved using simple, rugged, cast-iron boilers.

These benefits do come with drawbacks that should also be considered:

- The piping and venting systems for multiple boilers are sometimes more complex than they would be for a single large boiler.
- The overall footprint for multiple residential boilers will likely be larger than for one commercial boiler (when piped as shown on the following pages, however, this may be mitigated by the fact that the two boilers don't necessarily need to be located next to each other).

This manual covers installations of up to four boilers of selected combinations. These are shown in Tables 1.1 and 1.2 below. Multiple boiler installations with more boilers and/or different combinations of boilers, are possible, but are outside the scope of this manual.

This manual provides supplementary information on locating, venting, piping, and controlling multiple boiler systems. It is not intended to replace the installation requirements provided with the boilers themselves, nor applicable local codes. Consult the boiler manual(s) for information on combustion/ventilation air, gas piping, start-up, service, operation, and maintenance. Also consult the locating, venting, piping, and wiring sections of those manuals for additional requirements not described here.

**Table 1.1: Multiple AWR Combinations**

| Boiler Size 1 | | Boiler Size 2 | | Total Input | Total Output | |
|---|---|---|---|---|---|---|
| | | | | | Gross | Net |
| Model | Qty | Model | Qty | (MBH) | (MBH) | (MBH) |
| AWR175B | 1 | AWR140B | 1 | 315 | 263 | 229 |
| AWR175B | 2 | | | 350 | 292 | 254 |
| AWR210B | 1 | AWR175B | 1 | 385 | 322 | 280 |
| AWR210B | 2 | | | 420 | 352 | 306 |
| AWR245B | 2 | | | 490 | 410 | 356 |
| AWR280B | 2 | | | 560 | 468 | 406 |
| AWR210B | 3 | | | 630 | 528 | 459 |
| AWR245B | 2 | AWR210B | 1 | 700 | 586 | 509 |
| AWR245B | 2 | AWR280B | 1 | 770 | 644 | 559 |
| AWR280B | 3 | | | 840 | 702 | 609 |
| AWR245B | 2 | AWR210B | 2 | 910 | 762 | 662 |
| AWR245B | 4 | | | 980 | 820 | 712 |
| AWR245B | 2 | AWR280B | 2 | 1050 | 878 | 762 |
| AWR280B | 4 | | | 1120 | 936 | 812 |

Note: : Input and output ratings shown are totals for individual boilers in each combination and are not AHRI certified. See boiler literature for certified ratings.

**Table 1.2a: Multiple BWF Natural Gas Combinations**

| Boiler Size 1 | | Boiler Size 2 | | Total Input | Total Output | |
|---|---|---|---|---|---|---|
| | | | | | Gross | Net |
| Model | Qty | Model | Qty | (MBH) | (MBH) | (MBH) |
| BWF175BN | 1 | BWF140BN | 1 | 315 | 270 | 234 |
| BWF175BN | 2 | | | 350 | 300 | 260 |
| BWF210BN | 1 | BWF175BN | 1 | 385 | 329 | 286 |
| BWF210BN | 2 | | | 420 | 358 | 312 |
| BWF245BN | 2 | | | 490 | 416 | 362 |
| BWF175BN | 2 | BWF210BN | 1 | 560 | 479 | 416 |
| BWF210BN | 3 | | | 630 | 537 | 468 |
| BWF245BN | 2 | BWF210BN | 1 | 700 | 595 | 518 |
| BWF210BN | 2 | BWF175BN | 2 | 770 | 658 | 572 |
| BWF210BN | 4 | | | 840 | 716 | 624 |
| BWF245BN | 2 | BWF210BN | 2 | 910 | 774 | 674 |
| BWF245BN | 4 | | | 980 | 832 | 724 |

Note: : Input and output ratings shown are totals for individual boilers in each combination and are not AHRI certified. See boiler literature for certified ratings.

**Table 1.2b: Multiple BWF LP Gas Combinations**

| Boiler Size 1 | | Boiler Size 2 | | Total Input | Total Output | |
|---|---|---|---|---|---|---|
| | | | | | Gross | Net |
| Model | Qty | Model | Qty | (MBH) | (MBH) | (MBH) |
| BWF157BL | 2 | | | 315 | 270 | 234 |
| BWF189BL | 1 | BWF157BL | 1 | 346.5 | 296 | 257 |
| BWF189BL | 2 | | | 378 | 322 | 280 |
| BWF220BL | 2 | | | 441 | 374 | 326 |
| BWF157BL | 2 | BWF189BL | 1 | 504 | 431 | 374 |
| BWF189BL | 3 | | | 567 | 483 | 420 |
| BWF220BL | 2 | BWF189BL | 1 | 630 | 535 | 466 |
| BWF189BL | 2 | BWF157BL | 2 | 693 | 592 | 514 |
| BWF189BL | 4 | | | 756 | 644 | 560 |
| BWF220BL | 2 | BWF189BL | 2 | 819 | 696 | 606 |
| BWF220BL | 4 | | | 882 | 748 | 652 |

Note: : Input and output ratings shown are totals for individual boilers in each combination and are not AHRI certified. See boiler literature for certified ratings.

# II Locating Boilers

Locate all boilers in accordance with the location/clearance requirements in the installation manual shipped with the boiler. In addition, observe the following:

- Usually vent constraints will be the primary factor determining where multiple boilers can be placed. By contrast the system piping shown in Section IV provides a lot of flexibility for locating boilers. Boilers can be arranged in a single row, multiple rows, or any other arrangement where they can be vented in accordance with this manual and where all clearance requirements in the boiler manuals are met. In laying out the location of the boilers consider venting and clearance requirements first.
- A 10" minimum clearance between boilers is generally recommended when adjacent boilers have supply and return piping connected to the same side of the boilers as shown in Figure 2.1.
- The clearance between two adjacent AWR and/or BWF boilers may be reduced to 1" as shown in Figure 2.2 provided all connections are made on opposite side of the boilers and adjoining tappings are plugged. When this option is taken, the relief valves must be installed in 1-1/4 x 1-1/4 x ¾ Tees connected directly to the boiler supplies as shown in Figure 2.2. Drain valves may be installed as shown in Figure 2.2 or at another point in the return piping that will allow the boiler to be completely drained.
- Boiler layout must allow access to all blocked vent switches located on the back of AWR Series boilers.

***NOTICE:*** Plugged boiler tappings will be inaccessible after installation if adjacent boilers are located as shown in Figure 2.2. For this reason, it is recommended that boilers are carefully pressure tested after installation of plugs, and before boilers are moved to their final position.

FIGURE 2.1: RECOMMENDED CLEARANCE BETWEEN BOILERS

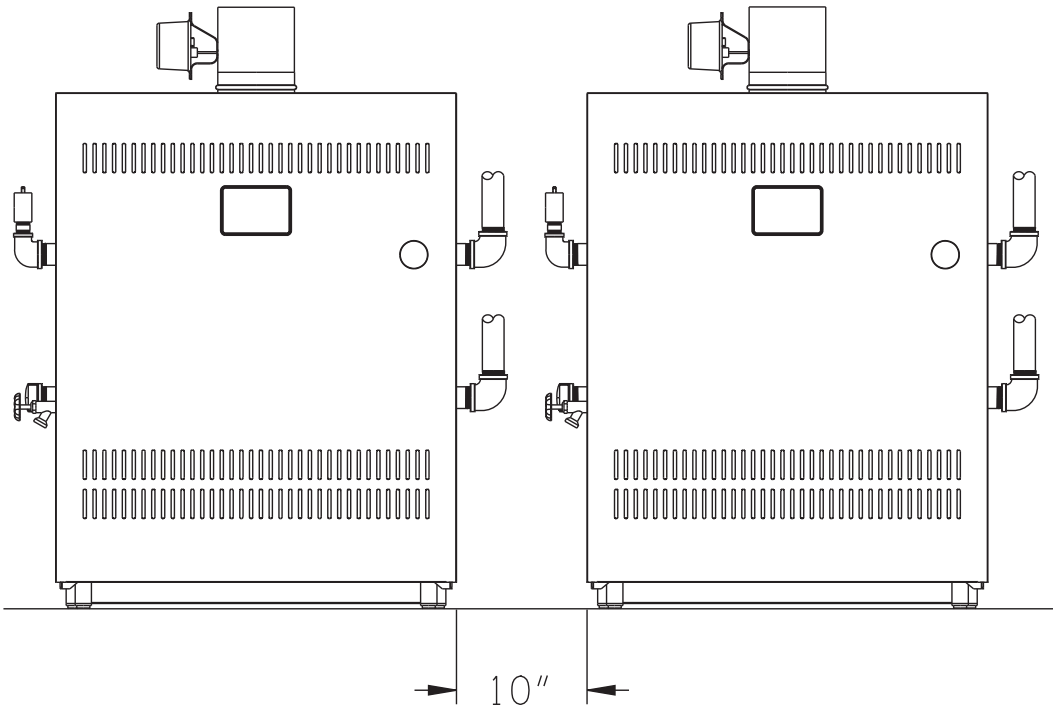
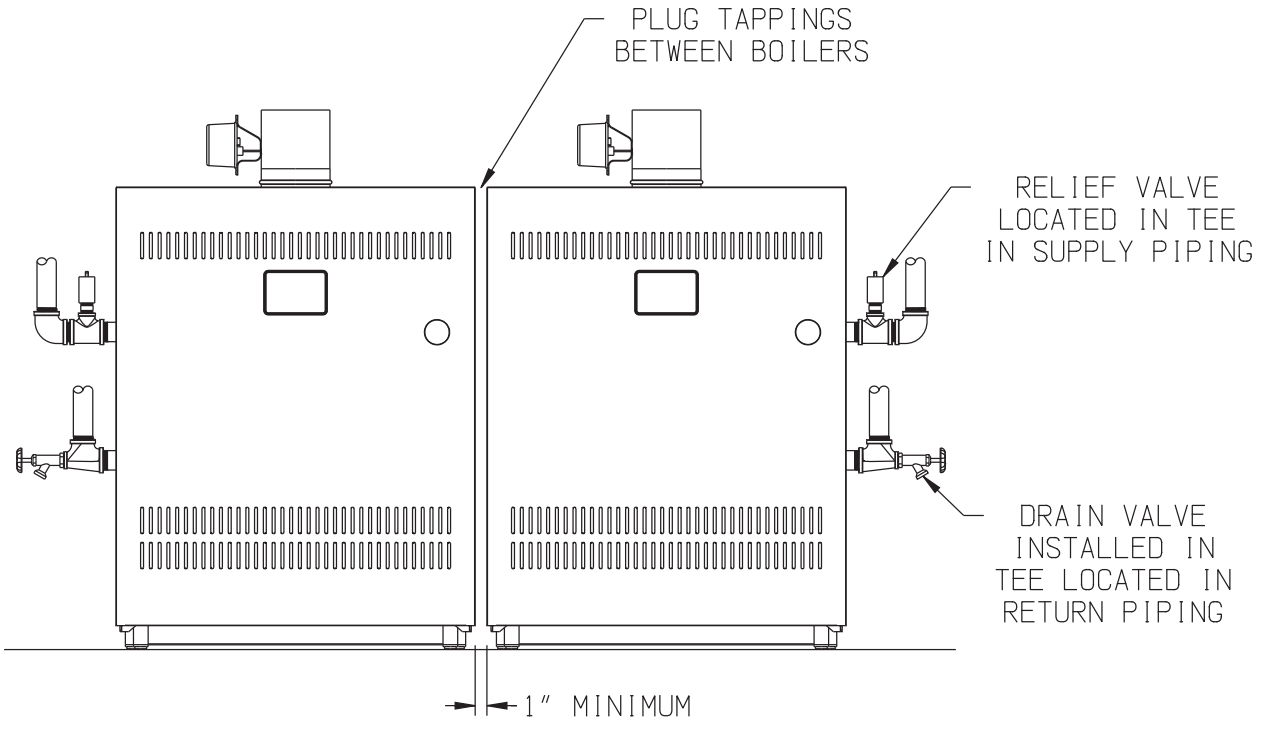



FIGURE 2.2: ALTERNATE REDUCED CLEARANCE BETWEEN BOILERS



# III Venting

**⚠ WARNING**

- Failure to vent this boiler in accordance with these instructions, and those provided with the boilers themselves, could cause products of combustion and/or carbon monoxide to enter living space, resulting in severe personal injury death, or substantial property damage.
- Vent installation shall be in accordance with applicable local codes or, in the absence of such, the ***National Fuel Gas Code - ANSI Z223.1/NFPA 54.***
- Do not use plastic venting materials (such as CPVC, PVC and RADEL) to vent AWR or BWF series boiler.
- Inspect existing chimney before installing boilers. Failure to clean or replace damaged pipe or tile lining will cause severe injury or death.
- Do not common vent BWF series boilers or connect an AWR boiler to a common vent system operating under positive pressure. Doing so could cause products of combustion, such as carbon monoxide, to enter living space, resulting in severe personal injury, death, or substantial proper damage.

There are two basic ways to vent the multiple boiler installations covered by this manual:

1) Individual Vent Systems – Each boiler has a dedicated vent system (Fig. 3.1). For AWR boilers, this option is usually only practical in buildings where there is direct access from the boiler room to the roof (i.e., the boiler room is on the ground level of a one-story building or is located on the roof itself). When practical, however, this option minimizes the likelihood of problems with draft and/or excessive condensation when only one boiler is firing. It also may be more cost effective than constructing a common vent.

   a. Size and design individual vent systems for AWR series boilers using the National Fuel Gas Code. See the AWR installation manual for additional venting requirements and options.
   b. Because BWF series boilers are designed to operate in pressurized vent systems, they MUST be individually vented. BWF vent systems must be sized and designed in accordance with the BWF installation manual.

2) Common Vent Systems (AWR Boilers Only) – All boilers share a common vent system (Figures 3.2 and 3.3). This system must provide adequate natural draft, and minimize condensate formation in the vent system, regardless of what combination of boilers are firing.

   Tables 3.5, 3.6, and 3.7 have been adapted from the National Fuel Gas Code for cases where all of the following conditions are met:

   - The only appliances on the common vent system are one of the combinations of AWR series boilers shown.
   - A vent manifold is used as opposed to separate vent connector runs directly to the chimney.
   - The chimney is Type B vent, a listed corrugated metallic liner installed in a masonry chimney, or interior clay-lined masonry chimney.
   - There are no offsets in the chimney.
   - The chimney height (height from the top of the boilers to the top of the chimney) is between 15 and 50ft.

   If any of the above conditions are not met, use one of the following alternate design methods:

   - The National Fuel Gas Code permits many venting options that are not covered by the Tables in this manual and those options may be used in lieu of what is presented here where local codes permit.
   - Guidelines provided by a manufacturer of listed chimney/liner systems
   - Services of a licensed Engineer using design methods such as those found in Chapter 35 of the *ASHRAE HVAC Systems and Equipment Handbook.*

   To use Tables 3.5 - 3.7:

   a) Identify the desired combination of AWR boilers from Table 1.1.
   b) Select the appropriate Table for the chimney:
      - If the chimney is B vent, use Table 3.5. This Table may also be used for listed metallic smooth ID (non-corrugated) liners if they have insulating and other thermal properties equivalent to B vent. Consult the liner manufacturer to see if this is the case.
      - If the chimney consists of a listed corrugated (flex) liner in a masonry chimney, use Table 3.6. Where the liner's listing permits, it is recommended that it be insulated, particularly on exterior chimneys and liners made of stainless steel.

- If the chimney is interior masonry with a clay liner, and is in good condition, use Table 3.7. When this option is taken, the manifold and all vent connectors must be constructed of type B vent. Also note that this option cannot be used on all combinations of AWR boilers covered by this manual.

c) "Vent connectors" are the portions of the vent system connecting each boiler to the manifold:
   - When using these tables, vent connector size is equal to the boiler collar size.
   - Minimum vent connector rise is 3ft as shown in Figure 3.2 - 3.4.
   - In these Tables, a maximum of one 90 elbow (or two 45's) is permitted in the vent connector.

d) Table 3.7 expresses chimney sizes in terms of cross section area of the clay liner. See Table 3.8 for cross sectional areas of some common clay liners.

e) The "total vent lateral" is the total length of the horizontal runs for both the manifold and the longest vent connector:
   - The total vent lateral must be no longer than that shown in the table for the chimney height-boiler combination.
   - The horizontal vent connector length is limited in length to that shown to the right of the total vent length.
   - Any combination of manifold length and vent connector lateral may be used as long as the above two constraints are met.

   *Example: Two AWR175's are to be vented into a B vent chimney having a height of 15 ft. From Table 3.5 the total vent lateral must not exceed 13.5 feet and the maximum vent connector lateral cannot exceed 10.5ft. If the longest vent connector lateral is 5ft, the length of the manifold must not exceed 8.5 ft. Alternatively, if the vent connector lateral is zero (meaning vent connector runs into the bottom of the manifold as shown for boilers 1-3 in Figure 3.2) the manifold may be as long as 13.5ft. The vent connector lateral may not exceed 10.5ft, even if the manifold is shorter than 3ft.*

f) The use of single wall pipe for vent connectors and manifolds reduces installation cost, but also may increase vent system "wet times" (the time during the boiler cycle when condensate forms on portions of the vent system). Observe the following guidelines for use of single wall vent components when using the Tables 3.5-3.7:
   - When single wall vent connectors or single wall manifolds are used, it may be necessary to stage more than one boiler at a time to minimize wet times. The columns at the far right of Tables 3.5 and 3.6 show when this is recommended. See the wiring section for methods of staging two boilers together.
   - The manifold and all vent connectors must be B vent when Table 3.7 is used.
   - Unusually low boiler room ambient temperatures may dictate the use of B vent connectors and manifolds where these guidelines otherwise do not. As always, local experience, as well as code requirements, should be considered when selecting venting components.

g) When the chimney height is between two heights shown in Tables 3.4 and 3.5, use the shorter height to design the vent system.

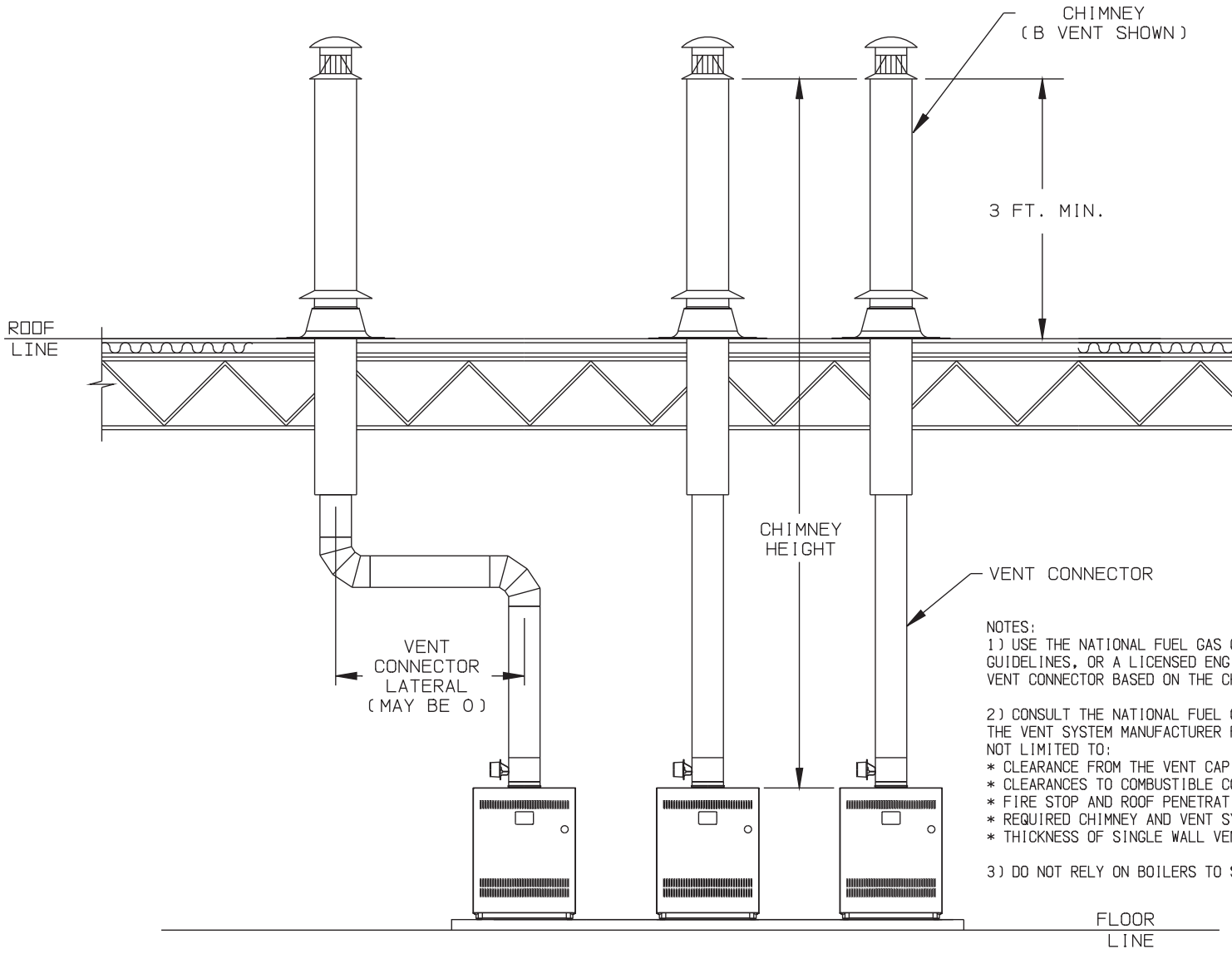
h) Do not increase the manifold size above that shown in Tables 3.5-3.7 and 3.5. EXCEPTION:
   - In Tables 3.5 and 3.6, where a 9" minimum chimney size is shown, the manifold may be 10" provided the chimney/liner size is at least 10".
   - In Table 3.7 where a 9" minimum manifold is shown, the manifold may be 10" provided the chimney cross sectional area is at least 78in$^2$.

i) Maximum chimney sizes shown are provided to allow the reuse of existing chimneys. If a new chimney or chimney liner is installed, it is best to stay at, or just above, the minimum allowable size shown. Aside from the obvious installation cost penalty, unnecessarily large chimneys will generally undergo longer "wet times" and are more prone to "priming" issues when cold.

j) If boilers are installed back-to back, the vent manifold may be run between the two rows of boilers as shown in Figure 3.4. If this is done, and if connections are made to the manifold with Tees, stagger the Tees as shown so that they are not directly across from each other.

k) Refer to the National Fuel Gas Code, and the listed vent system manufacturer's instructions, for requirements not covered by this manual such as:
   - Clearances from the venting system to combustible construction.
   - Means of vent system support and attachment
   - Fire stop, flashing, and storm collar requirements.
   - Thickness of and permitted material for single wall vent connectors and manifolds.

FIGURE 3.1: INDIVIDUAL VENT SYSTEM (SHOWN FOR AWR SERIES BOILERS USING B VENT CHIMNEYS)

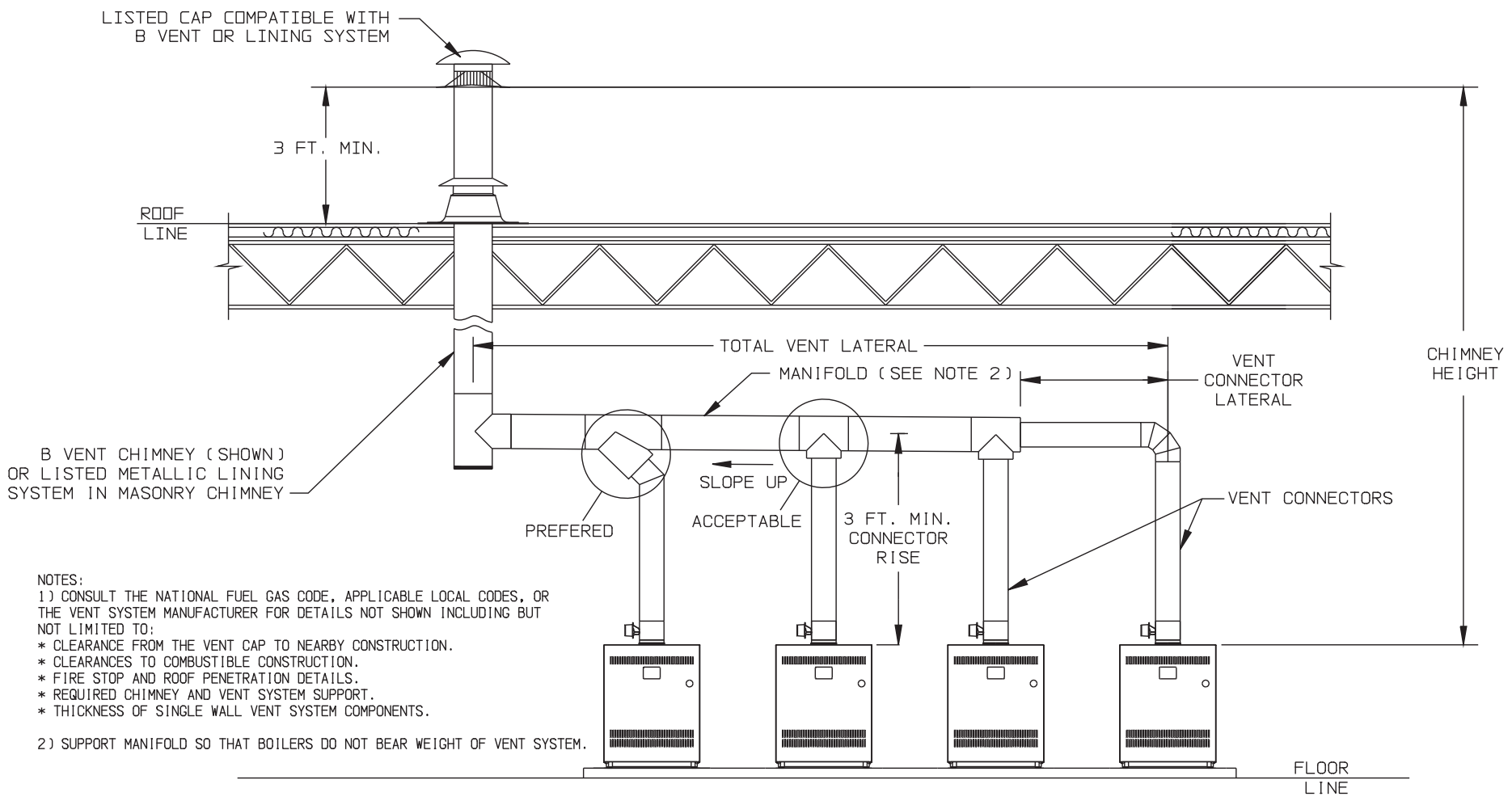



NOTES:
1) USE THE NATIONAL FUEL GAS CODE, THE VENT SYSTEM MANUFACTURER'S GUIDELINES, OR A LICENSED ENGINEER TO SIZE THE CHIMNEY/LINER AND VENT CONNECTOR BASED ON THE CHIMNEY HEIGHT AND LATERAL.

2) CONSULT THE NATIONAL FUEL GAS CODE, APPLICABLE LOCAL CODES, OR THE VENT SYSTEM MANUFACTURER FOR DETAILS NOT SHOWN INCLUDING BUT NOT LIMITED TO:
* CLEARANCE FROM THE VENT CAP TO NEARBY CONSTRUCTION.
* CLEARANCES TO COMBUSTIBLE CONSTRUCTION.
* FIRE STOP AND ROOF PENETRATION DETAILS.
* REQUIRED CHIMNEY AND VENT SYSTEM SUPPORT.
* THICKNESS OF SINGLE WALL VENT SYSTEM COMPONENTS.

3) DO NOT RELY ON BOILERS TO SUPPORT VENT SYSTEM.

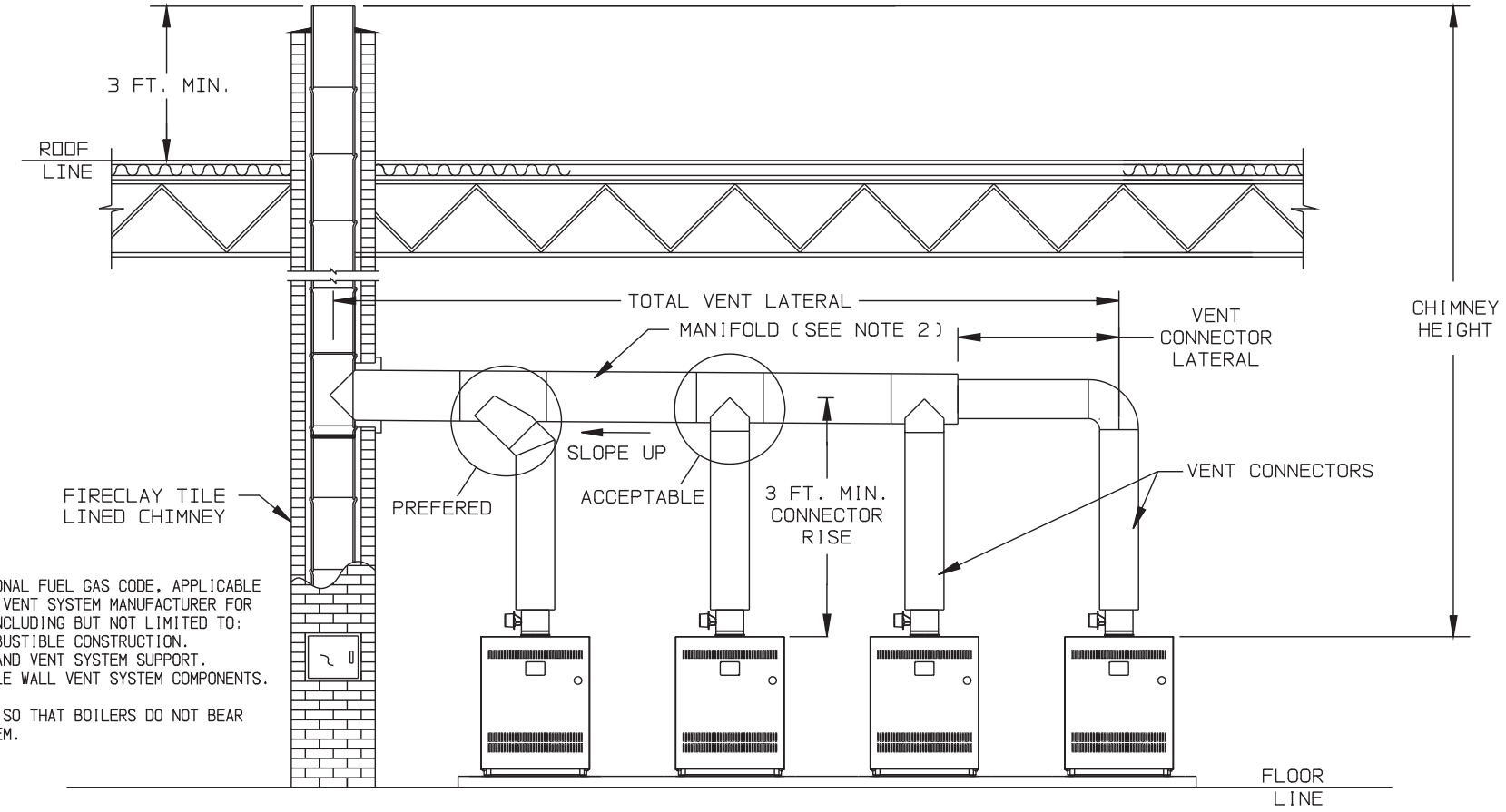
FIGURE 3.2: COMMON VENT SYSTEM, AWR BOILERS ONLY (B VENT CHIMNEY SHOWN)




NOTES:
1) CONSULT THE NATIONAL FUEL GAS CODE, APPLICABLE LOCAL CODES, OR THE VENT SYSTEM MANUFACTURER FOR DETAILS NOT SHOWN INCLUDING BUT NOT LIMITED TO:
* CLEARANCE FROM THE VENT CAP TO NEARBY CONSTRUCTION.
* CLEARANCES TO COMBUSTIBLE CONSTRUCTION.
* FIRE STOP AND ROOF PENETRATION DETAILS.
* REQUIRED CHIMNEY AND VENT SYSTEM SUPPORT.
* THICKNESS OF SINGLE WALL VENT SYSTEM COMPONENTS.

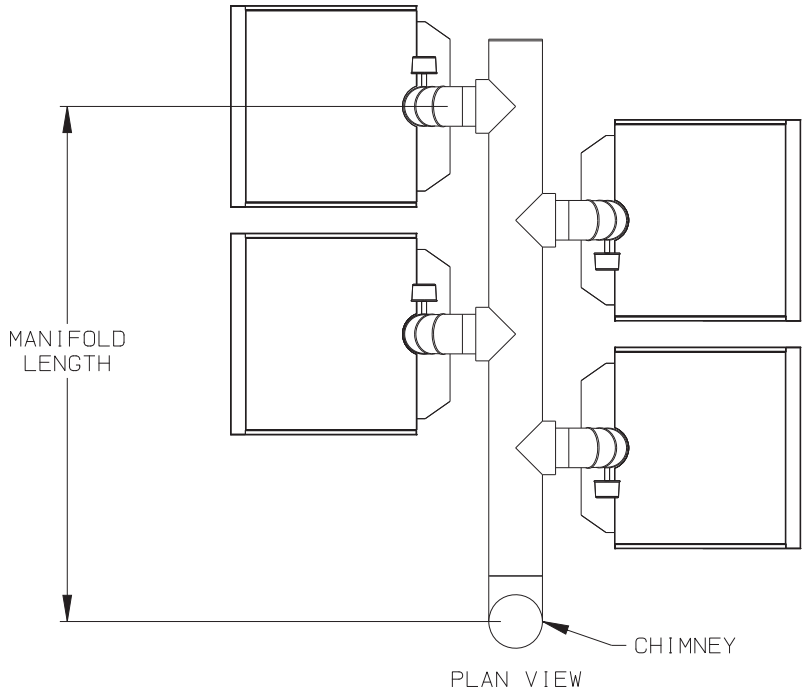
2) SUPPORT MANIFOLD SO THAT BOILERS DO NOT BEAR WEIGHT OF VENT SYSTEM.

FIGURE 3.3: COMMON VENT SYSTEM, AWR BOILERS ONLY (MASONRY CHIMNEY SHOWN)




NOTES:
1) CONSULT THE NATIONAL FUEL GAS CODE, APPLICABLE LOCAL CODES, OR THE VENT SYSTEM MANUFACTURER FOR DETAILS NOT SHOWN INCLUDING BUT NOT LIMITED TO:
* CLEARANCES TO COMBUSTIBLE CONSTRUCTION.
* REQUIRED CHIMNEY AND VENT SYSTEM SUPPORT.
* THICKNESS OF SINGLE WALL VENT SYSTEM COMPONENTS.

2) SUPPORT MANIFOLD SO THAT BOILERS DO NOT BEAR WEIGHT OF VENT SYSTEM.




TOTAL VENT LATERAL = MANIFOLD LENGTH + LONGEST VENT CONNECTOR LATERAL

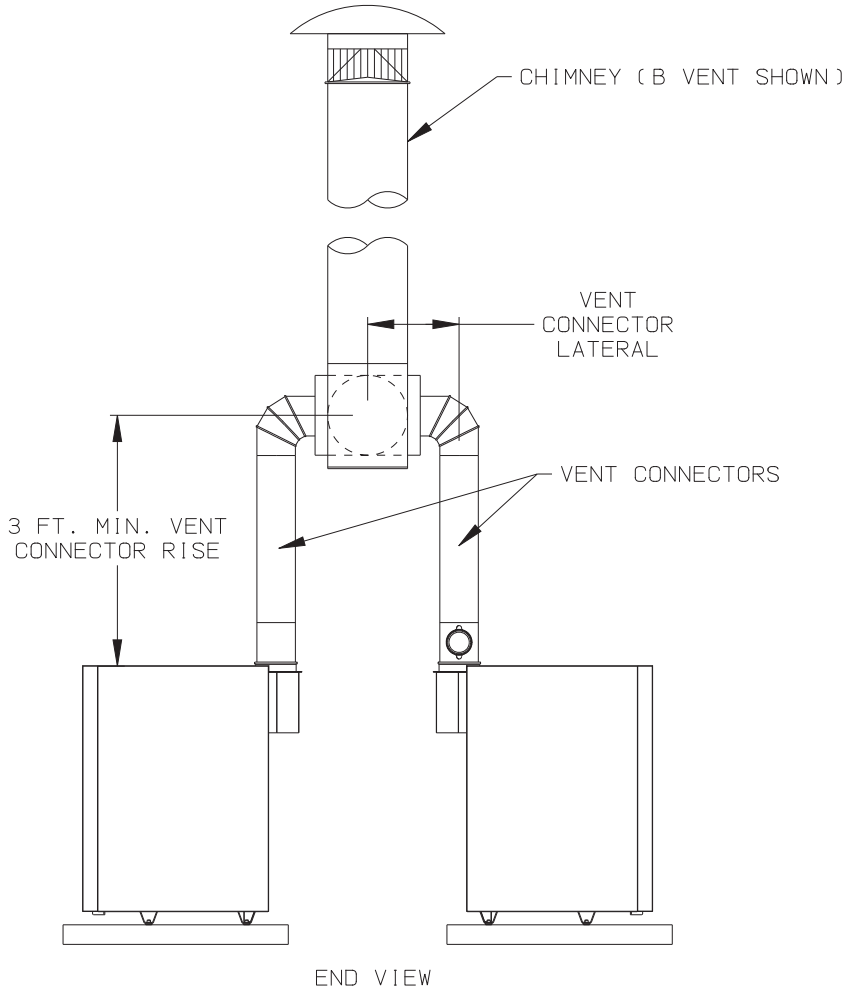



FIGURE 3.4: COMMON VENT SYSTEM (BOILERS INSTALLED BACK TO BACK)

**Table 3.5: Chimney Constructed of Type B Double Wall Gas Vent**

| Boiler Size 1 | | | Boiler Size 2 | | | Total Input | Chimney Height[1] | | | | | | | | | | | | | | | Min. Boilers/Stage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 15ft | | | | | 20ft | | | | | 30 - 50ft | | | | | | | |
| | | | | | | | Chimney Dia (in)[2] | | | Max Vent Lateral (ft) | | Chimney Dia (in)[2] | | | Max Vent Lateral (ft) | | Chimney Dia (in)[2] | | | Max Vent Lateral (ft) | | B Vent Connectors and B Vent Manifold | S.W. Connector ≤ 6ft B Vent Manifold | S.W. Connectors and S.W. Manifold |
| Model | Boiler Qty | Vent Connector Size (in) | Model | Boiler Qty | Vent Connector Size (in) | (MBH) | Min | Max | Manifold Size (in)[2] | Total | Vent Connector | Min | Max | Manifold Size (in)[2] | Total | Vent Connector | Min | Max | Manifold Size (in)[2] | Total[3] | Vent Connector | | | |
| AWR175 | 1 | 7 | AWR140 | 1 | 6 | 315 | 8 | 14 | 8 | 12.0 | 9.0 | 8 | 14 | 8 | 12.0 | 9.0 | 7 | 14 | 7 | 10.5 | 7.5 | | | |
| AWR175 | 2 | 7 | | | | 350 | 9 | 18 | 9 | 13.5 | 10.5 | 8 | 18 | 8 | 12.0 | 9.0 | 8 | 18 | 8 | 12.0 | 9.0 | | | |
| AWR210 | 1 | 7 | AWR175 | 1 | 7 | 385 | 9 | 18 | 9 | 13.5 | 10.5 | 9 | 18 | 9 | 13.5 | 10.5 | 8 | 18 | 8 | 12.0 | 9.0 | | | |
| AWR210 | 2 | 7 | | | | 420 | 10 | 18 | 10 | 15.0 | 10.5 | 9 | 18 | 9 | 13.5 | 10.5 | 8 | 18 | 8 | 12.0 | 9.0 | | | 1 |
| AWR245 | 2 | 8 | | | | 490 | 10 | 20 | 10 | 15.0 | 12.0 | 10 | 20 | 10 | 15.0 | 12.0 | 9 | 20 | 9 | 13.5 | 10.5 | | | |
| AWR280 | 2 | 8 | | | | 560 | 12 | 20 | 12 | 15.0 | 12.0 | 10 | 20 | 10 | 15.0 | 12.0 | 10 | 20 | 10 | 15.0 | 12.0 | | | |
| AWR210 | 3 | 7 | | | | 630 | 12 | 18 | 12 | 15.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | 10 | 18 | 10 | 15.0 | 10.5 | | | |
| AWR245 | 2 | 8 | AWR210 | 1 | 7 | 700 | 12 | 18 | 12 | 15.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | 1 | 1 | |
| AWR245 | 2 | 8 | AWR280 | 1 | 8 | 770 | 14 | 20 | 14 | 15.0 | 12.0 | 12 | 20 | 12 | 18.0 | 12.0 | 12 | 20 | 12 | 18.0 | 12.0 | | | |
| AWR280 | 3 | 8 | | | | 840 | 14 | 20 | 14 | 15.0 | 12.0 | 14 | 20 | 14 | 20.0 | 12.0 | 12 | 20 | 12 | 18.0 | 12.0 | | | |
| AWR245 | 2 | 8 | AWR210 | 2 | 7 | 910 | 14 | 18 | 14 | 15.0 | 10.5 | 14 | 18 | 14 | 20.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | | | 2 |
| AWR245 | 4 | 8 | | | | 980 | 14 | 20 | 14 | 15.0 | 12.0 | 14 | 20 | 14 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | | |
| AWR245 | 2 | 8 | AWR280 | 2 | 8 | 1050 | 16 | 20 | 16 | 15.0 | 12.0 | 14 | 20 | 14 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | | |
| AWR280 | 4 | 8 | | | | 1120 | 16 | 20 | 16 | 15.0 | 12.0 | 14 | 20 | 14 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | | |

Notes

1. For chimney heights between those shown, use the shorter height (e.g., for a 18ft high chimney use the 15ft height.
2. All chimnney and manifold sizes shown are nominal. 9" manifolds may be increased to 10" provided chimney size is 10" or greater.
3. Total Vent Lateral = Length of Manifold + Longest Vent Connector Lateral

**Table 3.6: Listed Corrugated Metallic Liner in Interior or Exterior Masonry Chimney**

| Boiler Size 1 | | | Boiler Size 2 | | | Total Input | Chimney Height[1] | | | | | | | | | | | | | | | Min. Boilers/Stage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 15ft | | | | | 20ft | | | | | 30 - 50ft | | | | | | | |
| | | | | | | | Chimney Dia (in)[2] | | | Max Vent Lateral (ft) | | Chimney Dia (in)[2] | | | Max Vent Lateral (ft) | | Chimney Dia (in)[2] | | | Max Vent Lateral (ft) | | B Vent Connectors and B Vent Manifold | S.W. Connector ≤ 6ft B Vent Manifold | S.W. Connectors and S.W. Manifold |
| Model | Boiler Qty | Vent Connector Size (in) | Model | Boiler Qty | Vent Connector Size (in) | (MBH) | Min | Max | Manifold Size (in)[2] | Total | Vent Connector | Min | Max | Manifold Size (in)[2] | Total | Vent Connector | Min | Max | Manifold Size (in)[2] | Total | Vent Connector | | | |
| AWR175 | 1 | 7 | AWR140 | 1 | 6 | 315 | 9 | 14 | 9 | 13.5 | 9.0 | 9 | 14 | 9 | 13.5 | 9.0 | 8 | 14 | 8 | 12.0 | 9.0 | 1 | 2 | 2 |
| AWR175 | 2 | 7 | | | | 350 | 10 | 18 | 10 | 15.0 | 10.5 | 10 | 18 | 10 | 15.0 | 10.5 | 9 | 18 | 9 | 13.5 | 10.5 | | | |
| AWR210 | 1 | 7 | AWR175 | 1 | 7 | 385 | 10 | 18 | 10 | 15.0 | 10.5 | 10 | 18 | 10 | 15.0 | 10.5 | 9 | 18 | 9 | 13.5 | 10.5 | | 1 | |
| AWR210 | 2 | 7 | | | | 420 | 12 | 18 | 12 | 15.0 | 10.5 | 10 | 18 | 10 | 15.0 | 10.5 | 9 | 18 | 9 | 13.5 | 10.5 | | | |
| AWR245 | 2 | 8 | | | | 490 | 12 | 20 | 12 | 15.0 | 12.0 | 12 | 18 | 12 | 18.0 | 12.0 | 10 | 18 | 10 | 15.0 | 12.0 | | | 2 |
| AWR280 | 2 | 8 | | | | 560 | 12 | 20 | 12 | 15.0 | 12.0 | 12 | 18 | 12 | 18.0 | 12.0 | 12 | 18 | 12 | 18.0 | 12.0 | | | |
| AWR210 | 3 | 7 | | | | 630 | 14 | 18 | 14 | 15.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | | | |
| AWR245 | 2 | 8 | AWR210 | 1 | 7 | 700 | 14 | 18 | 14 | 15.0 | 10.5 | 14 | 18 | 14 | 20.0 | 10.5 | 12 | 18 | 12 | 18.0 | 10.5 | | | |
| AWR245 | 2 | 8 | AWR280 | 1 | 8 | 770 | 14 | 20 | 14 | 15.0 | 12.0 | 14 | 20 | 14 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | | |
| AWR280 | 3 | 8 | | | | 840 | 16 | 20 | 16 | 15.0 | 12.0 | 14 | 20 | 14 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | 2 | |
| AWR245 | 2 | 8 | AWR210 | 2 | 7 | 910 | 16 | 18 | 16 | 15.0 | 10.5 | 16 | 18 | 16 | 20.0 | 10.5 | 14 | 18 | 14 | 21.0 | 10.5 | | | |
| AWR245 | 4 | 8 | | | | 980 | 16 | 20 | 16 | 15.0 | 12.0 | 16 | 20 | 16 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | | NR |
| AWR245 | 2 | 8 | AWR280 | 2 | 8 | 1050 | 16 | 20 | 16 | 15.0 | 12.0 | 16 | 20 | 16 | 20.0 | 12.0 | 14 | 20 | 14 | 21.0 | 12.0 | | | |
| AWR280 | 4 | 8 | | | | 1120 | 18 | 20 | 18 | 15.0 | 12.0 | 16 | 20 | 16 | 20.0 | 12.0 | 16 | 20 | 16 | 24.0 | 12.0 | | | |

Notes

1. For chimney heights between those shown, use the shorter height (e.g., for a 18ft high chimney use the 15ft height).
2. All chimnney and manifold sizes shown are nominal. 9" manifolds may be increased to 10" provided chimney size is 10" or greater.
3. Total Vent Lateral = Length of Manifold + Longest Vent Connector Lateral

**Table 3.7: Interior Masonry Chimney with Clay Liner and B Vent Manifold and B Vent Connectors**

| Boiler Size 1 | | | Boiler Size 2 | | | Total Input | Chimney Height[1] | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 15ft | | | | | 20ft | | | | | 30 - 50ft | | | | |
| | | | | | | | Internal Chimney Cross-Sectional Area ($in^2$) | | | Max Vent Lateral (ft) | | Internal Chimney Cross-Sectional Area ($in^2$) | | | Max Vent Lateral (ft) | | Internal Chimney Cross-Sectional Area ($in^2$) | | | Max Vent Lateral (ft) | |
| Model | Boiler Qty | Vent Connector Size (in) | Model | Boiler Qty | Vent Connector Size (in) | (MBH) | Min | Max | Manifold Size (in) | Total | Vent Connector | Min | Max | Manifold Size (in) | Total | Vent Connector | Min | Max | Manifold Size (in) | Total | Vent Connector |
| AWR175 | 1 | 7 | AWR140 | 1 | 6 | 315 | 78 | 177 | 10 | 14.9 | 9.0 | 78 | 177 | 10 | 14.9 | 9.0 | 63 | 177 | 9 | 13.4 | 9.0 |
| AWR175 | 2 | 7 | | | | 350 | 113 | 254 | 12 | 15.0 | 10.5 | 78 | 254 | 10 | 14.9 | 10.5 | 78 | 254 | 10 | 14.9 | 10.5 |
| AWR210 | 1 | 7 | AWR175 | 1 | 7 | 385 | 113 | 254 | 12 | 15.0 | 10.5 | 113 | 254 | 12 | 18.0 | 10.5 | 78 | 254 | 10 | 14.9 | 10.5 |
| AWR210 | 2 | 7 | | | | 420 | 113 | 254 | 12 | 15.0 | 10.5 | 113 | 254 | 12 | 18.0 | 10.5 | 78 | 254 | 10 | 14.9 | 10.5 |
| AWR245 | 2 | 8 | | | | 490 | 113 | 346 | 12 | 15.0 | 12.0 | 113 | 346 | 12 | 18.0 | 12.0 | 113 | 346 | 12 | 18.0 | 12.0 |
| AWR280 | 2 | 8 | | | | 560 | | | | | | 113 | 346 | 12 | 18.0 | 12.0 | 113 | 346 | 12 | 18.0 | 12.0 |
| AWR210 | 3 | 7 | | | | 630 | | | | | | | | | | | 113 | 254 | 12 | 18.0 | 10.5 |

Notes

1. For chimney heights between those shown, use the shorter height (e.g., for a 18ft high chimney use the 15ft height).
2. Manifold and vent connector sizes shown are nominal. 9" manifolds may be increased to 10" provided chimney cross sectional area is at least 78$in^2$.
3. Total Vent Lateral = Length of Manifold + Longest Vent Connector Lateral

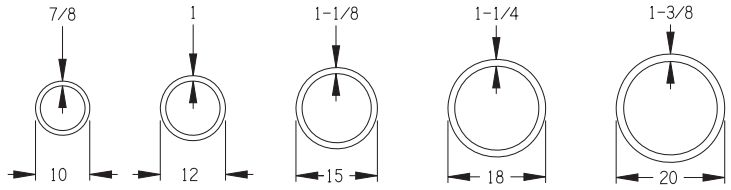
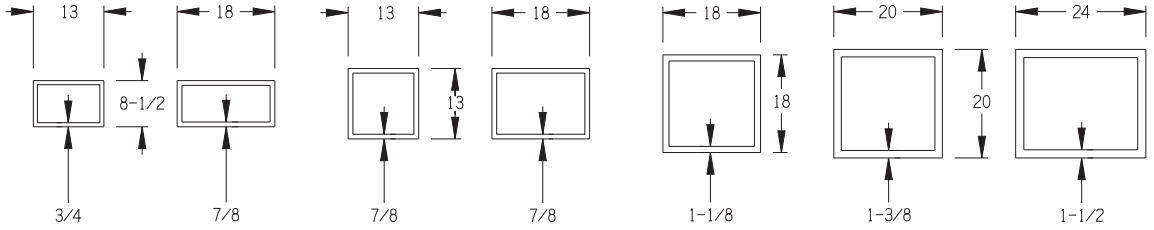



FIGURE 3.8: AREA OF TYPICAL MASONRY FLUE TILES
NOTE: FLUE AREAS SHOWN IN ALL TABLES ARE MINIMUM INSIDE AREAS.

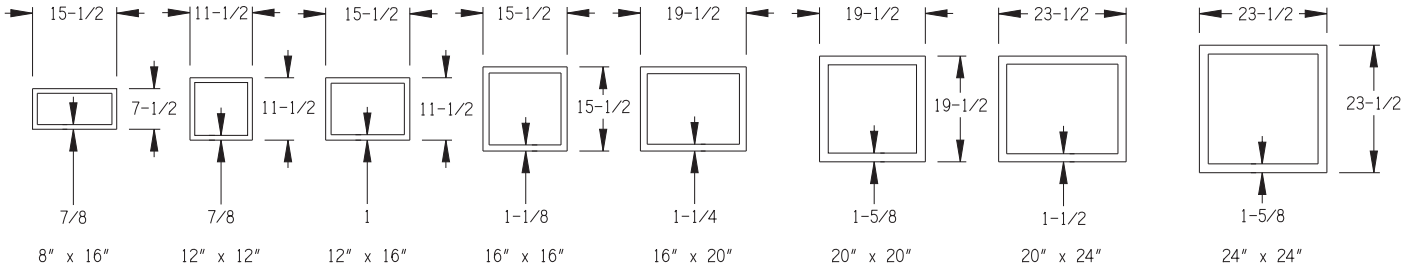



## FLUE TILES NM TYPE

NOMINAL FLUE SIZE FOR ROUND FLUES IS INSIDE DIAMETER.
NOMINAL FLUE SIZE FOR RECTANGULAR FLUES IS OUTSIDE DIMENSION.

| COMMON VENT | NOMINAL DIMENSIONS | | | | |
|---|---|---|---|---|---|
| ROUND TILES | 10"DIA. | 12"DIA. | 15"DIA. | 18"DIA. | 20"DIA. |
| AREA SQ. IN. | 74.5 | 108 | 171 | 240 | 298 |

| COMMON VENT | NOMINAL DIMENSIONS | | | | | | |
|---|---|---|---|---|---|---|---|
| RECTANGULAR TILES | 8-1/2"X13" | 8-1/2"X18" | 13"X13" | 13"X18" | 18"X18" | 20"X20" | 20"X24" |
| AREA SQ. IN. | 78.57 | 107.75 | 124.63 | 168 | 232 | 279 | 337.5 |




## FLUE TILES M TYPE

DIMENSIONS SHOWN ARE ACTUAL DIMENSIONS.
SIZES UNDER DIAGRAMS ARE NOMINAL DIMENSIONS.

| COMMON VENT | NOMINAL DIMENSIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| RECTANGULAR TILES | 8"X16" | 12"X12" | 12"X16" | 16"X16" | 16"X20" | 20"X20" | 20"X24" | 24"X24" |
| AREA SQ. IN. | 74 | 87 | 120 | 162 | 208 | 262 | 320 | 385 |

# IV System Piping

**⚠ WARNING**

- Failure to properly pipe boiler may result in improper operation and damage to boiler or building.
- Install boilers so that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, etc.).
- Operation of non-condensing boilers with continuous return temperatures below 120°F can cause severe boiler corrosion damage.
- Operation of cast iron boilers in a system having significant amounts of dissolved oxygen can cause severe heat exchanger corrosion damage.
- Do not use toxic additives, such as automotive antifreeze, in a hydronic system.
- Pipe relief valve discharges to a safe location. Safety relief valves may discharge scalding hot water.
- Do not install a valve in safety relief valve discharge lines.
- Install relief valves only in locations specified in this or the boiler manual.
- Do not plug relief valve discharges. Blocking the safety relief valve may result in boiler explosion.

Basic recommended boiler piping is shown in Figure 4.1. This method employs primary-secondary piping, which offers several advantages over other techniques sometimes used to pipe multiple boilers:

- Water does not flow through boilers which are not firing, minimizing off-cycle losses
- The boiler loop (loop between each boiler and the boiler manifolds shown) can use standard residential boiler pumps, such as the Taco 007e. There is also a lot of flexibility in the size and length of boiler loop piping, which minimizes installation costs and provides flexibility in locating boilers.
- The “System Header” shown in the Figure 4.1 can often be “cut-in” to an existing system with minimal modifications.

Sizing recommendations for the system header and boiler manifolds are shown in Table 4.2. The sizes and dimensions shown are primarily intended to minimize “ghost flow” through boilers that are not firing and to assure that adequate flow is always present through the system and any boilers which are firing.

Table 4.2a shows the minimum recommended pipe size for both the system header and boiler manifolds based on the total heating capacity for all boilers (see Tables 1.1 or 1.2). The system header size may be larger than that of the boiler manifolds as long as both meet the specified minimum size.

Table 4.2b shows the maximum dimension for “A” in Figure 4.1. If system header is larger than 4-inch, limit dimension A to no more than 4 system header diameters. Dimensions “B” and “C” are minimum runs of straight pipe intended to prevent the flow in the system from inducing from through off-cycle boilers. If these minimums cannot be maintained, they can be reduced at the risk of some ghost flow through off-cycle boilers. If the system header is greater than 4”, use 8 diameters and 4 diameters as minimums for dimensions “B” and “C” respectively.

Table 4.2c shows minimum boiler loop pipe size for the boilers covered by this manual. These pipe sizes are based on a 40F maximum rise across the boiler, the use of a Taco 007e boiler circulator, and a maximum 100 equivalent feet of boiler loop pipe. See Table 4.2d for equivalent lengths of common fittings. In calculating the equivalent length of the boiler loop, ignore the boiler itself, the boiler manifolds, the system bypass, and the system header piping between the closely spaced Tees. Total the equivalent length of all other fittings in the boiler loop and add it to the amount of straight pipe in the loop. If the total exceeds 100ft, it may be necessary to use a larger pump than that supplied with the boiler and/or larger boiler loop piping than that shown in Table 4.2d.

FIGURE 4.1
BASIC MULTIPLE BOILER PIPING

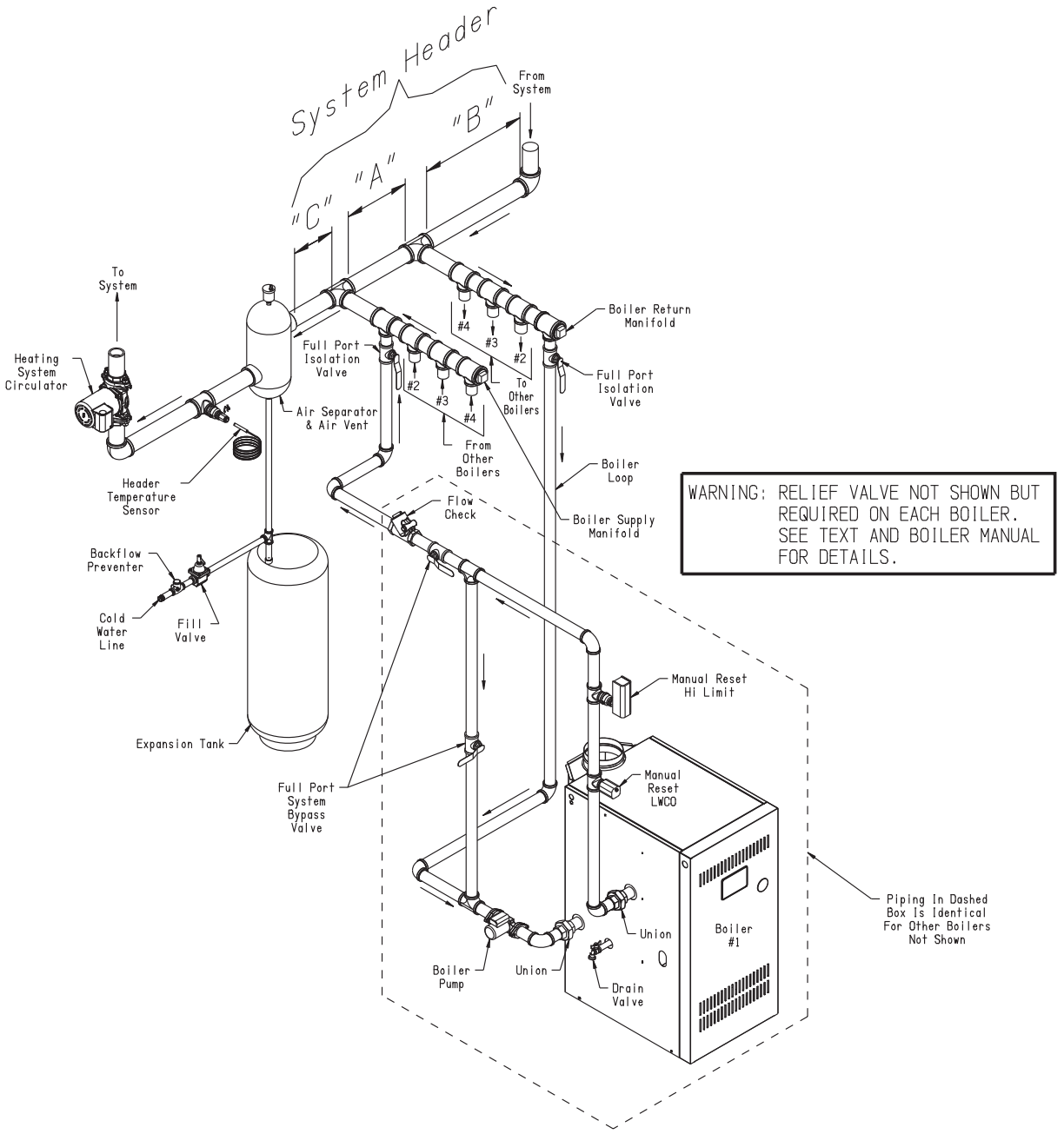


**Table 4.2a: Minimum System Header and Manifold Sizes**

| Total Heating Capacity (MBH) | Minimum Pipe Size |
|---|---|
| 260 - 410 | 2” |
| 411 - 600 | 2-1/2” |
| 601 - 1000 | 3” |

**Table 4.2b: System Header Recommended Distances (inches) (Also See Figure 4.1)**

| System Header Pipe Size | Max “A” | Min “B” | Mln “C” |
|---|---|---|---|
| 2” | 12 | 17 | 8 |
| 2-1/2” | 12 | 20 | 10 |
| 3” | 12 | 25 | 12 |
| 3-1/2” | 14 | 28 | 14 |
| 4” | 16 | 32 | 16 |

**Table 4.2c: Minimum Boiler Loop Pipe Sizes**

| Boiler Model | Minimum Loop Size |
|---|---|
| AWR140B, AWR175B<br>BWF175BN, BWF157BL | 1” |
| AWR210B, AWR245B, AWR280B<br>BWF210BN, BWF245BN<br>BWF189BL, BWF220BL | 1-1/4” |

**Table 4.2d: Fitting Equivalent Lengths (ft)**

| Fitting | Nominal Pipe Size | |
|---|---|---|
| | 1” | 1-1/4” |
| 90° Elbow | 2.8 | 3.8 |
| Turn in Tee | 6.0 | 8.0 |
| Run of Tee | 2.0 | 2.5 |
| Gate Valve | 0.6 | 0.8 |
| Full Port Ball Valve | 1.9 | 1.4 |
| Swing Check Valve | 7.0 | 10.0 |

FIGURE 4.3
INDIRECT WATER HEATER ON SINGLE BOILER

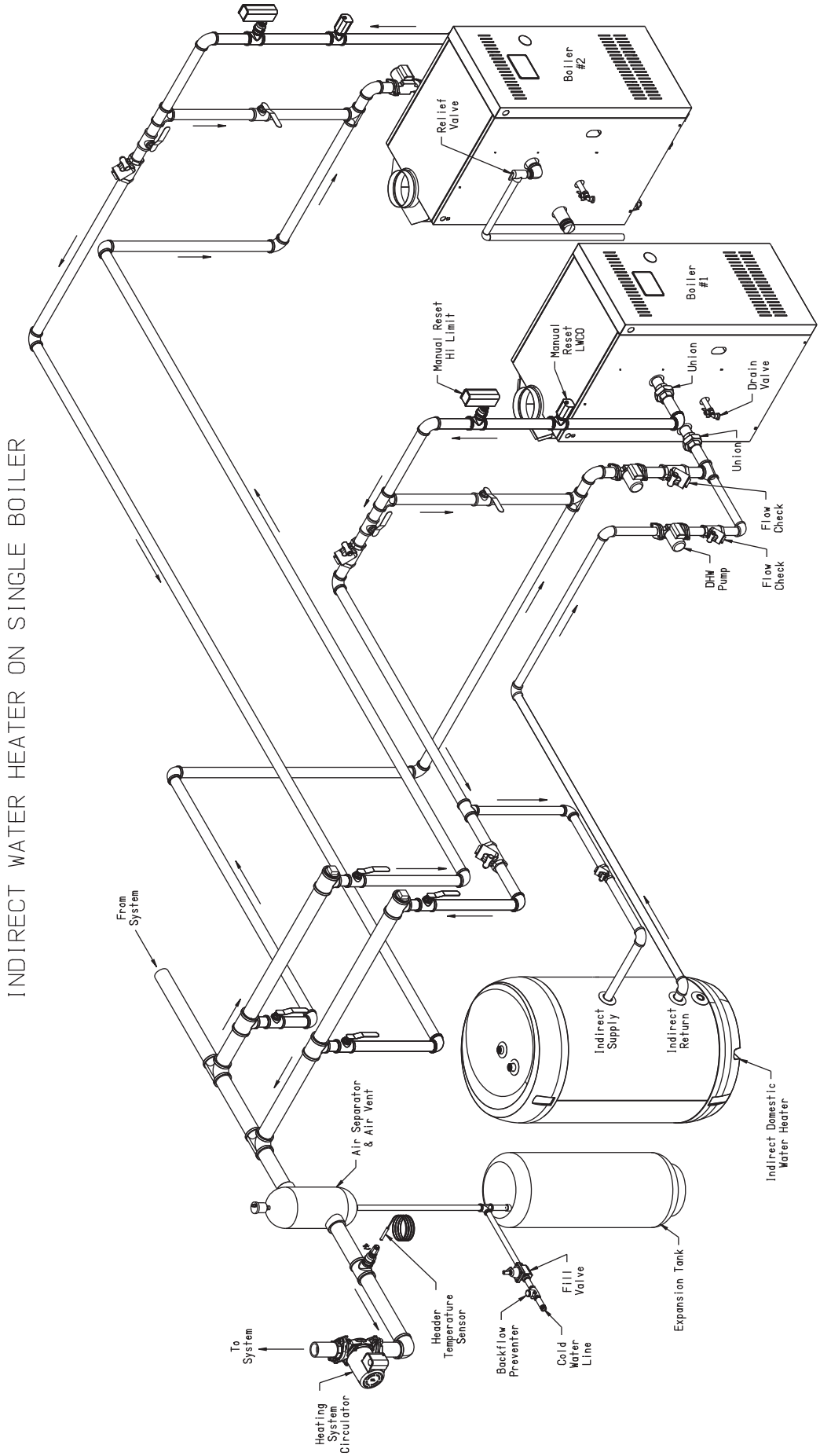
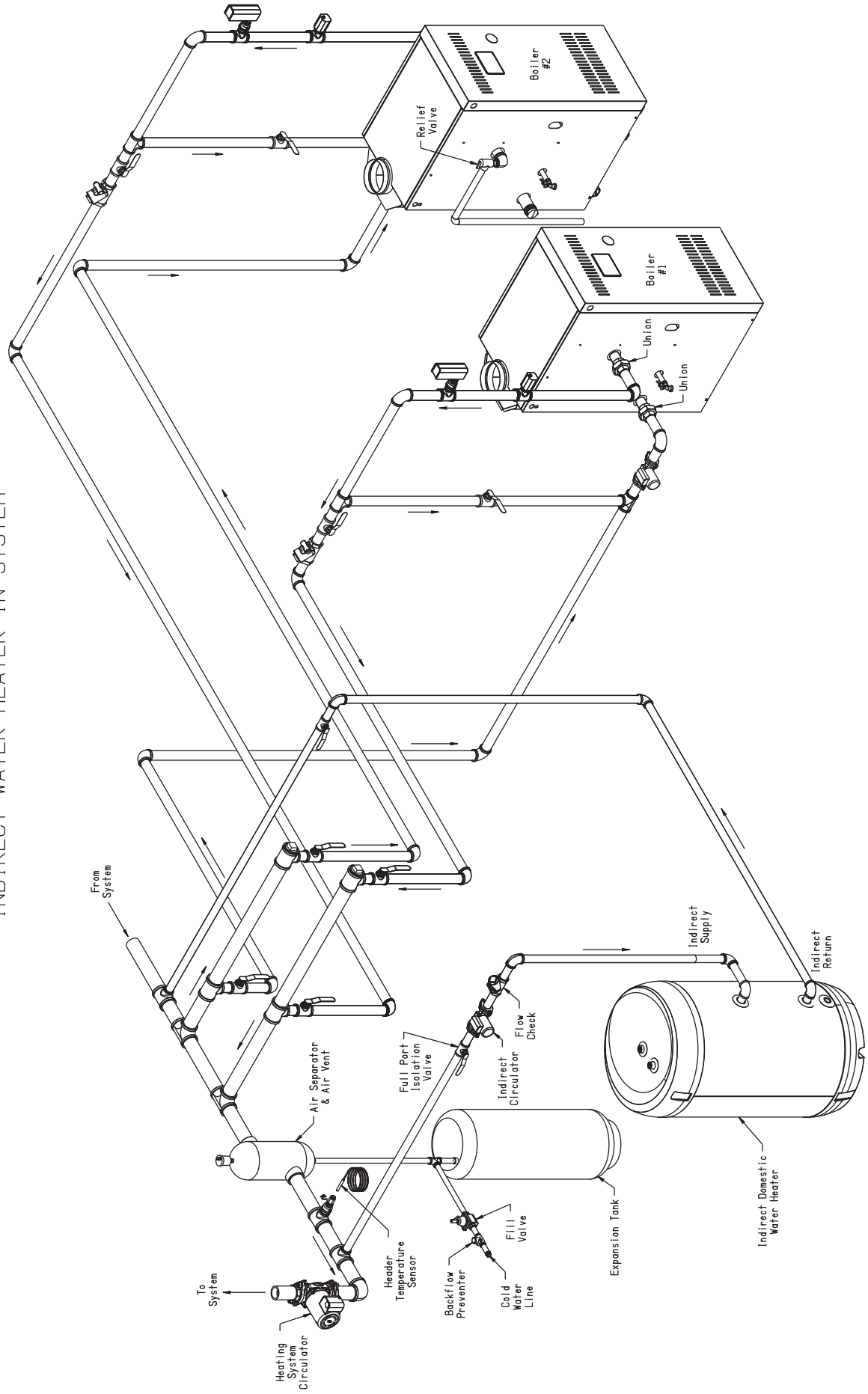


FIGURE 4.4
INDIRECT WATER HEATER IN SYSTEM



*Example:*

*A multiple boiler system consists of 4 AWR280s. From Table 1.1:*

*a) The total heating capacity = 936 MBH*

*b) From Table 3.2a system header and boiler manifolds should be at least 3". In this example assume that old system piping is 4" and that it is desirable to keep this size for the new system header. Since this is larger than what is shown in Table 3.2a, 4" is acceptable. Boiler manifolds can still be 3".*

*c) Because we are using a 4" system header, select minimum value for "A" and max values for B and C from Table 4.2b based on 4". Closely spaced Tees should therefore be no further apart than 16". There should be at least 32 inches of straight pipe upstream of the closely spaced Tees ("B") and 16 inches of straight pipe downstream of the closely spaced Tees ("C").*

*d) The longest boiler loop will consist of the following (not counting the common manifold and system header piping):*

- *30ft straight pipe*
- *3 Full port Ball valves (two for isolation and a third in the boiler loop for system bypass).*
- *6 Elbows*
- *1 Flow check*
- *30ft of straight pipe.*

*e) From Table 4.2c the minimum boiler loop piping for an AWR280 is 1-1/4". Using the equivalent lengths in Table 4.2d for 1-1/4" piping:*

*Total equivalent length = 30 + (3 x 1.4) + (6 x 3.8) + (1 x 10) = 67ft.*

*f) Since this is less than 100ft, the Taco 007e supplied with the boiler is deemed adequate.*

As previously noted, the temperature rise, across the boiler using the above procedure may be as high as 40F. If the system is designed for a 20F rise, this means that the boiler limits will need to be set at least 20F higher than the design supply water temperature. For example, if the system is designed for a 180F supply/160F return temperature, the boiler limits should be set to at least 200F. The maximum boiler limit setting on AWR and BWF series boilers is 220F. If local codes, or design temperature requirements, preclude the use of boiler limit settings higher than the system design supply temperature, it may be necessary to use larger boiler loop piping and/or pumps.

In addition to the above pipe sizing requirements, note the following:

1) Varying Boiler Loop Lengths - The length of each boiler loop may vary from others in the system as long as adequate flow through each boiler is maintained as described above.

2) Left vs. Right Side Boiler Piping – Supply and return connections may be made on either side of any boiler as long as both connections are made on the same side of the boiler. Do not connect the supply and return to opposite sides of the same boiler. See the boiler manual, and Figure 2.2 of this manual, for acceptable drain valve and relief valve locations.

3) System Bypass Valves – Figure 4.1 shows a system bypass connection, and bypass valves, that are used to protect the boiler from prolonged operation at low return water temperatures. This bypass works by diverting some of the supply water directly back into the return. The two throttling valves shown are adjusted so that the return temperature rises above 120°F during the first few minutes of operation.

4) Isolation Valves and Unions – Provide isolation valves and unions on each boiler as shown in Figure 4.1 so that any boiler can be drained, or even removed, without shutting shown the entire boiler plant.

5) Manual Reset Limits and Low Water Cut-offs – All boilers covered by this manual are equipped with a built in listed automatic reset low water cut-off (LWCO) and high limit. Some codes may require an additional manual reset LWCO or high limit. If these are required, and if isolation valves are installed as recommended, one LWCO and/or manual reset limit will be required. The following controls may be used to meet these requirements:

- Manual Reset LWCO – Hydrolevel 1100M or Taco LTRM0243T-1
- Manual Reset High Limit – Resideo L4006E (Select complete Resideo PN based on required temperature range).

Wire these controls to boiler limit field connections as described in Figure 5.2 – 5.6.

6) Relief Valve – Each boiler requires its own relief valve installed as shown in the boiler instruction manual or Figure 2.2.

7) Header Sensor – If the multiple boiler system employs a staging control, such as the Taco PC702 or Tekmar 294 shown in this manual, a header sensor will be required to measure the temperature of the water being supplied to the system. By design this temperature will often be much lower than that exiting the supply manifold. Install the header sensor on the system header far enough downstream of the boiler supply manifold that the water from the supply manifold is thoroughly mixed with that returned from the system (Figure 4.1). Consult the staging control manufacturer's instructions for selection and installation of the header sensor. That said, installation of the header sensor in an immersion well is generally preferred to surface mounting.

8) Indirect Water Heater Piping – This manual shows two methods of connecting an indirect water heater (IWH) to a multiple boiler system:

   a) Single boiler connection - Connecting an indirect water heater to just one of the boilers as shown in Figure 4.3 may simplify piping. It also allows the use of the existing DHW zone control built into the boiler, thus saving a relay. In many cases one boiler will be sufficient to power the DHW load, so there is no reason to ever start a second boiler for a DHW demand. This tradeoff for this simplicity is some loss of redundancy – if the connected boiler goes down, so does the indirect water heater. See Figure 5.4 for wiring associated with this system.

   b) System connection – The indirect water heater is connected to the system in parallel with the heating zone(s) as shown in Figure 4.4. See Figure 5.5 or 5.6 for wiring associated with this system.

# V Wiring

**⚠ WARNING**

- All wiring and grounding must be done in accordance with the authority having jurisdiction or, in the absence of such requirements, with the *National Electrical Code (ANSI/NFPA 70).* In Canada, all wiring and grounding must be done in accordance with the ***Canadian Electrical Code, Part 1 (CSA C22.1 - latest edition).***
- Electrical power may be supplied from more than one circuit. Disconnect electrical power to the boiler and heating system before servicing. Positively assure that no voltage is present. Lock electrical boxes to prevent someone from inadvertently restoring power before the heating system is safe to operate.
- Never defeat or jump out safety devices.
- Protect each boiler circuit with a properly sized over-current protection device.
- Make electrical connections carefully according to the boiler and staging control wiring diagrams and instructions. Failure to properly wire electrical connections to the boiler and/or staging control may result in serious physical harm or property damage.
- Wire additional field supplied safety limits, such as low water cut-offs and temperature limit devices, so as to break the 120V power supply to the boiler. Alternatively, some 24V safety limits can be wired in place of the limit jumper shown in the boiler manual and this section. Do not alter the boiler's factory wiring when adding a field supplied limit device.

This section shows several wiring options based on the number of boilers present and the way in which they are piped:

**Table 5.1: Wiring Options**

| Figure | Max Boilers | Staging? | Indirect Water Heater? | Multiple Boiler Controls |
|---|---|---|---|---|
| 5.2 | 2 | No | None | None |
| 5.3 | 2 | Yes | None | Taco PC702+SR501-EXP-4 |
| 5.4 | 2 | Yes | On Single Boiler | Taco PC702+SR501-EXP-4 |
| 5.5 | 2 | Yes | On System | Taco PC702+SR503-EXP-4 |
| 5.6 | 4 | Yes | None,<br>On Single Boiler,<br>On System | Tekmar 294 |

Note the following:

1) The wiring diagrams shown will work for AWR ("Aruba 5") series boilers, BWF ("Bali 2") series boilers, or a combination of both.

2) Internal boiler wiring is <u>not</u> modified:

   a) Each boiler, and its associated boiler pump, is cycled on and off using the thermostat connections on that boiler.

   b) The AWR and BWF boilers have built in auto-reset temperature limits and low water cut-offs. Many jurisdictions will also require manual reset limits and low water cutoffs. When required, these will be needed for each boiler. They are wired in place of the external limit jumper as shown in Figures 5.2 - 5.6.

3) Both the Taco and Tekmar staging controls shown vary the target system water temperature during calls for space heat based on outdoor air temperature (the colder the outdoor air temperature, the higher the target water temperature). The controls then fire as many boilers as are needed to achieve this target temperature. Consult the control instructions for details on this operation and making adjustments to the control.

4) Both the Taco and Tekmar staging controls shown employ a "header sensor" to determine how many boilers are needed to achieve the target temperature. To work properly, this header sensor needs to be located in the system piping downstream of all boiler connections to the system, so that it is monitoring the actual temperature of water headed to the loads. See Figure 4.1 for the correct location of this sensor.

5) Basic operation of the systems shown are as follows:

a) Unstaged Boilers (Fig. 5.2) – This option sacrifices some system efficiency for control simplicity and lower installation cost. The system thermostat closes the thermostat connections on the first boiler and also powers an isolation relay with contacts connected to the thermostat of the second boiler. The system pump is wired in parallel with the boiler pump on either boiler. Both boiler pumps, and the system pump, will start as soon as the thermostat calls for heat. Both boilers will then fire after completing the thermal purge described in the Operation section of the boiler manual. They will continue firing until either their limit setting (180F default) is reached or the call for heat ends. If the combined draw of the boiler and system pump exceeds 7 Amp, use a separate relay to control the system pump.

b) Two Staged Boilers for Heat Only (Fig. 5.3) – A call for heat from the system thermostat starts the system pump. The PC702 will start each boiler as needed see (3) above and Taco installation sheet) by closing the space heating thermostat connections for that boiler. The boiler's circulator will start, and the boiler will fire after completing the thermal purge described in the Operation section of the boiler manual.

c) Two Staged Boilers with Indirect Water Heater Connected to One Boiler (Fig 5.4) – Connecting an indirect water heater to just one of the boilers as shown in Figure 4.3 simplifies piping and allows the use of the existing DHW zone control built into the boiler, thus saving a relay. In many cases one boiler will be sufficient to power the DHW load, so there is no reason to ever start the second boiler for a DHW demand. This simplicity does come at the expense of some loss of some boiler redundancy, however.

This system responds to a call for space heat in the exact same manner as described for (b) above. A call from the DHW thermostat starts Boiler #1, and the DHW pump, without waiting for the thermal purge. Boiler #1 will then continue firing until the call for DHW ends, or until the boiler's high limit setting is reached. If Boiler #1 simultaneously sees calls for heat from both the PC702 and the DHW thermostat, the boiler will behave as follows:

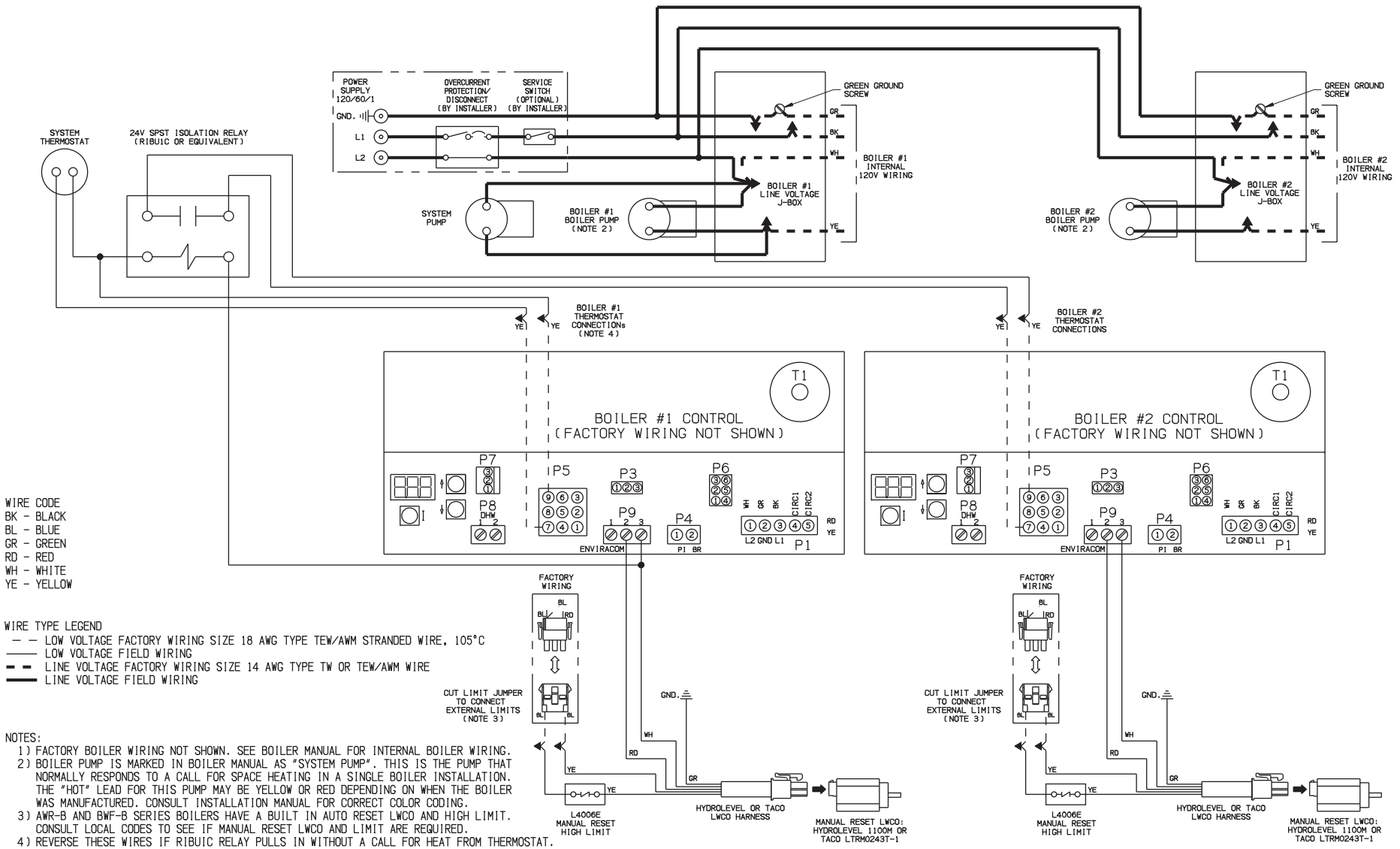
- If the boiler's priority setting is ON (factory default), the boiler pump will be held off until the call for DHW is satisfied.
- If the boiler's priority setting is OFF, both the boiler and DHW pumps will run simultaneously.

d) Two Staged Boilers with Indirect Water Heater Connected to System (Fig 5.5) – The indirect water heater is connected to the system and calls for DHW are managed by the system zone relay (SR503 in Figure 5.5). This allows the output of both boilers to be used for DHW production and therefore will provide some DHW if either one of the two boilers is down. When there is a call for DHW, 120V is applied to the "DHW Demand Wires" on the PC702. This defeats the outdoor reset function in the PC702 so that the target header temperature is at least 180F during the call for DHW, regardless of the outdoor temperature.

e) Up to Four Staged Boilers (Fig 5.6) – The Tekmar 294 boiler controls up to four boilers with or without indirect water heaters. Like the Taco PC702, it determines a target system water temperature based on the outdoor temperature and type of load (DHW vs. space heat). The 294 then brings on boilers as needed to obtain this target system temperature. In addition, it controls the heating system pump.

Figure 5.6 shows wiring for a system-piped indirect water heater (Figure 4.5). If the indirect water heater is piped to a single boiler as shown in Fig 4.3, connect the DHW thermostat and circulator to that boiler as shown in Figure 5.4. Connect one of the Boiler Enable contacts from the Tekmar 294 to that boiler's thermostat connections. The boiler piped to the indirect water heater will then respond to competing demands for space and DHW exactly as described in (c ) above.

FIGURE 5.2
WIRING FOR TWO UNSTAGED AWR-B OR BWF-B BOILERS

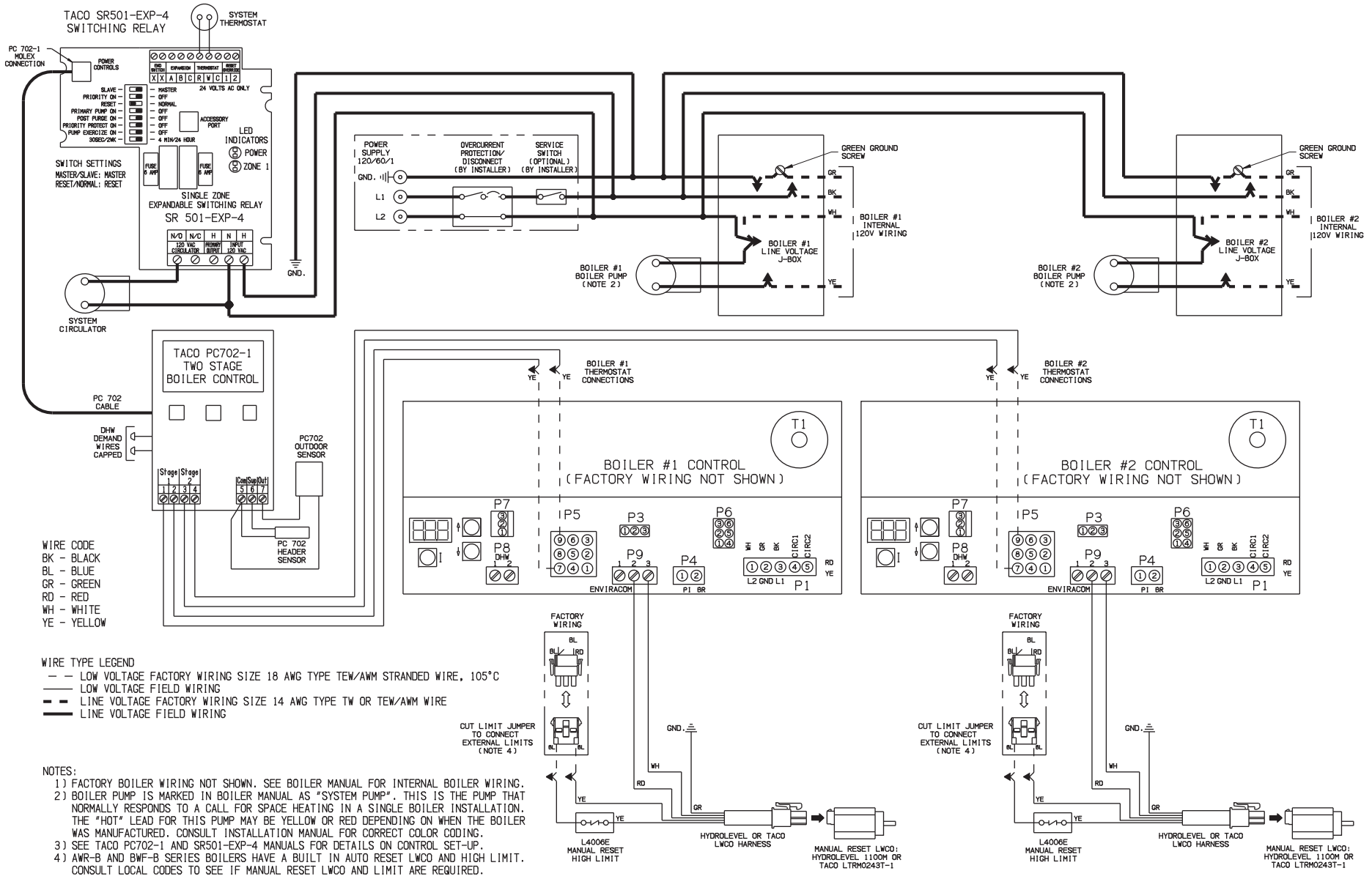



WIRE CODE
BK - BLACK
BL - BLUE
GR - GREEN
RD - RED
WH - WHITE
YE - YELLOW

WIRE TYPE LEGEND
- – – LOW VOLTAGE FACTORY WIRING SIZE 18 AWG TYPE TEW/AWM STRANDED WIRE, 105°C
- —— LOW VOLTAGE FIELD WIRING
- ▬ ▬ LINE VOLTAGE FACTORY WIRING SIZE 14 AWG TYPE TW OR TEW/AWM WIRE
- ▬▬ LINE VOLTAGE FIELD WIRING

NOTES:
1) FACTORY BOILER WIRING NOT SHOWN. SEE BOILER MANUAL FOR INTERNAL BOILER WIRING.
2) BOILER PUMP IS MARKED IN BOILER MANUAL AS "SYSTEM PUMP". THIS IS THE PUMP THAT NORMALLY RESPONDS TO A CALL FOR SPACE HEATING IN A SINGLE BOILER INSTALLATION. THE "HOT" LEAD FOR THIS PUMP MAY BE YELLOW OR RED DEPENDING ON WHEN THE BOILER WAS MANUFACTURED. CONSULT INSTALLATION MANUAL FOR CORRECT COLOR CODING.
3) AWR-B AND BWF-B SERIES BOILERS HAVE A BUILT IN AUTO RESET LWCO AND HIGH LIMIT. CONSULT LOCAL CODES TO SEE IF MANUAL RESET LWCO AND LIMIT ARE REQUIRED.
4) REVERSE THESE WIRES IF RIBUIC RELAY PULLS IN WITHOUT A CALL FOR HEAT FROM THERMOSTAT.

FIGURE 5.3
TWIN HEAT-ONLY BOILER WIRING USING AWR-B OR BWF-B BOILERS

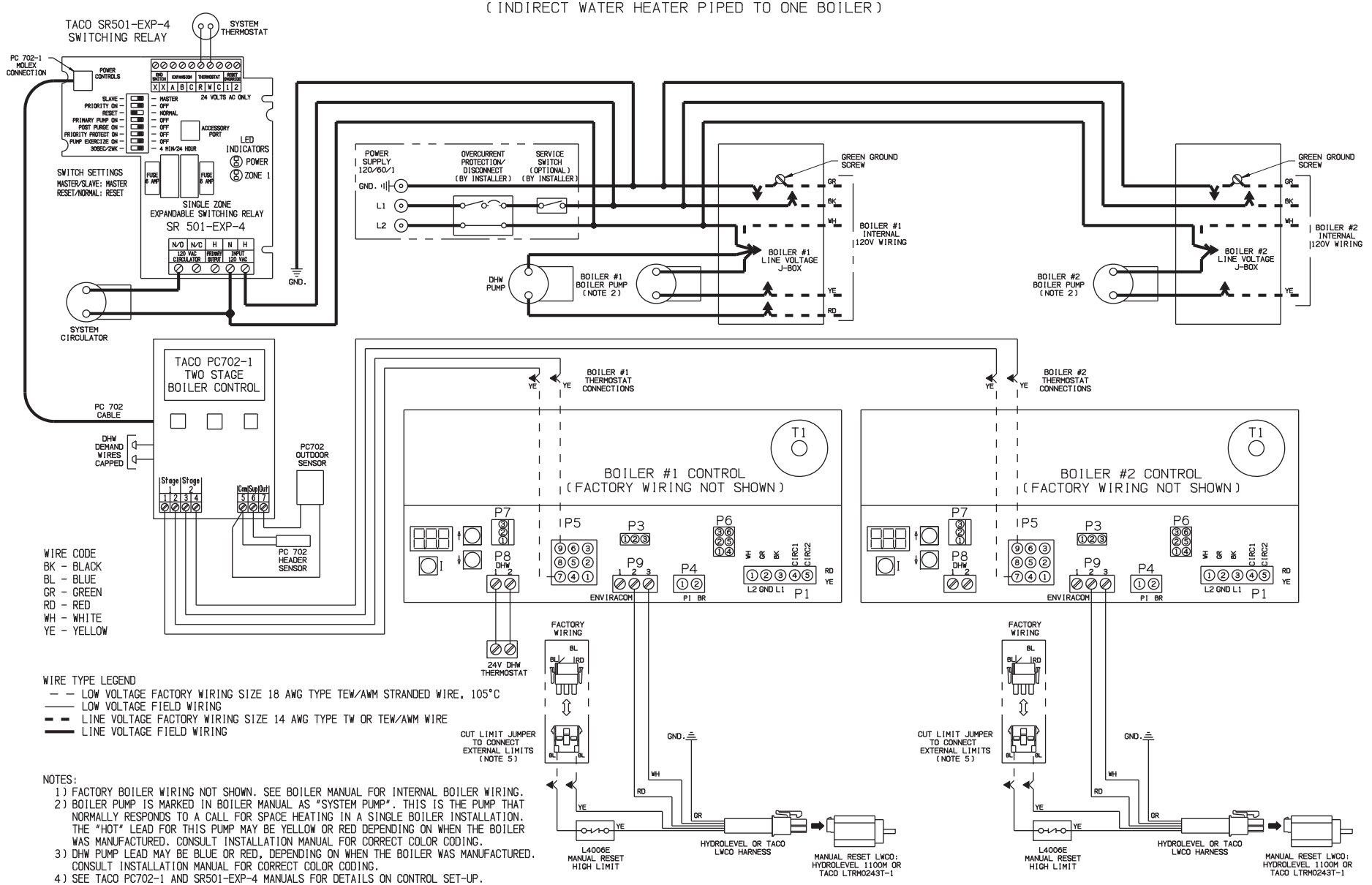



WIRE CODE
BK - BLACK
BL - BLUE
GR - GREEN
RD - RED
WH - WHITE
YE - YELLOW

WIRE TYPE LEGEND
- – – LOW VOLTAGE FACTORY WIRING SIZE 18 AWG TYPE TEW/AWM STRANDED WIRE, 105°C
- ——— LOW VOLTAGE FIELD WIRING
- – – LINE VOLTAGE FACTORY WIRING SIZE 14 AWG TYPE TW OR TEW/AWM WIRE
- ——— LINE VOLTAGE FIELD WIRING

NOTES:
1) FACTORY BOILER WIRING NOT SHOWN. SEE BOILER MANUAL FOR INTERNAL BOILER WIRING.
2) BOILER PUMP IS MARKED IN BOILER MANUAL AS "SYSTEM PUMP". THIS IS THE PUMP THAT NORMALLY RESPONDS TO A CALL FOR SPACE HEATING IN A SINGLE BOILER INSTALLATION. THE "HOT" LEAD FOR THIS PUMP MAY BE YELLOW OR RED DEPENDING ON WHEN THE BOILER WAS MANUFACTURED. CONSULT INSTALLATION MANUAL FOR CORRECT COLOR CODING.
3) SEE TACO PC702-1 AND SR501-EXP-4 MANUALS FOR DETAILS ON CONTROL SET-UP.
4) AWR-B AND BWF-B SERIES BOILERS HAVE A BUILT IN AUTO RESET LWCO AND HIGH LIMIT. CONSULT LOCAL CODES TO SEE IF MANUAL RESET LWCO AND LIMIT ARE REQUIRED.

FIGURE 5.4
TWIN BOILER WIRING USING AWR-B OR BWF-B BOILERS
( INDIRECT WATER HEATER PIPED TO ONE BOILER )

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WIRE TYPE LEGEND
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- ——— LOW VOLTAGE FIELD WIRING
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- ▬▬▬ LINE VOLTAGE FIELD WIRING

NOTES:
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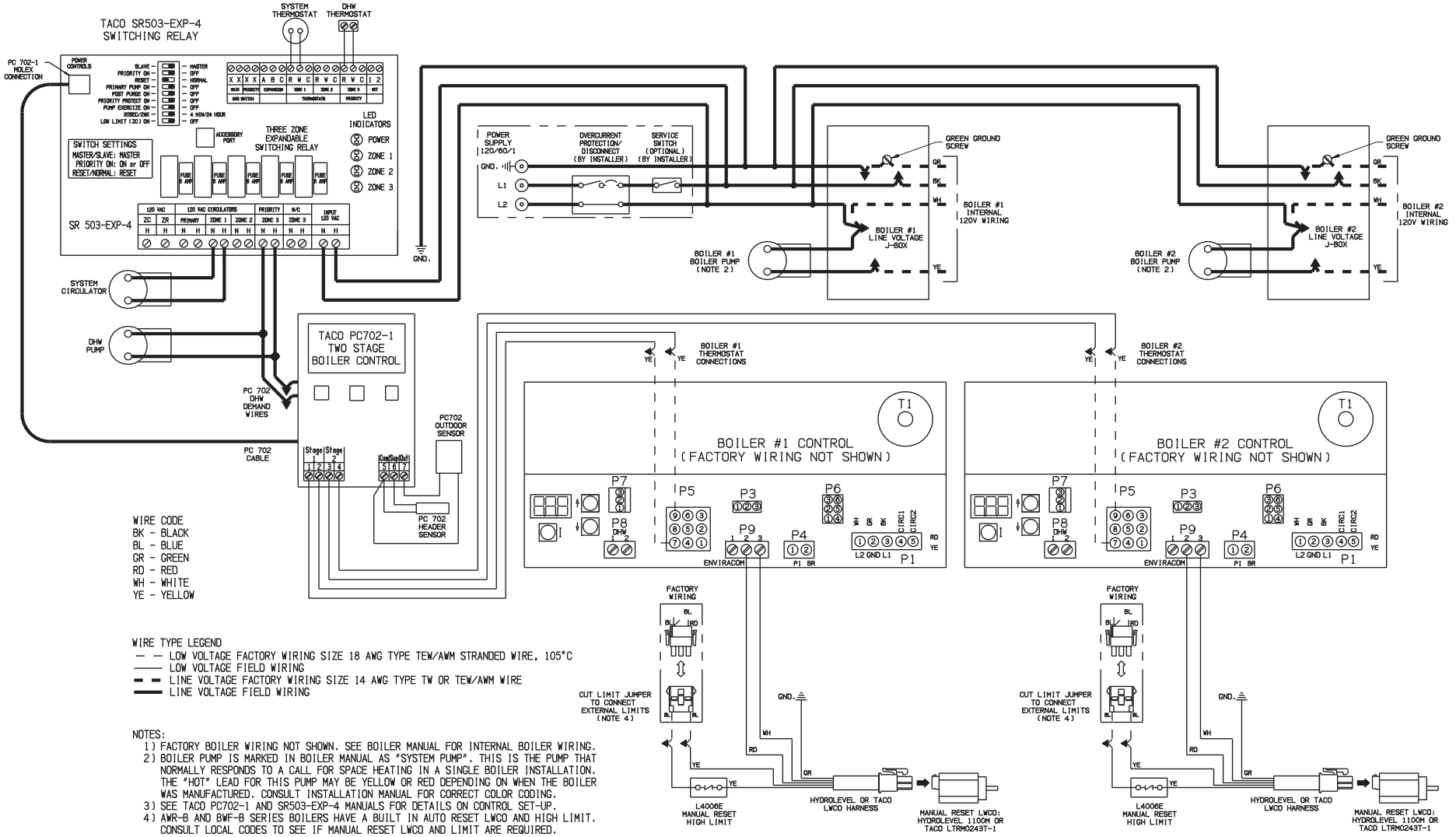
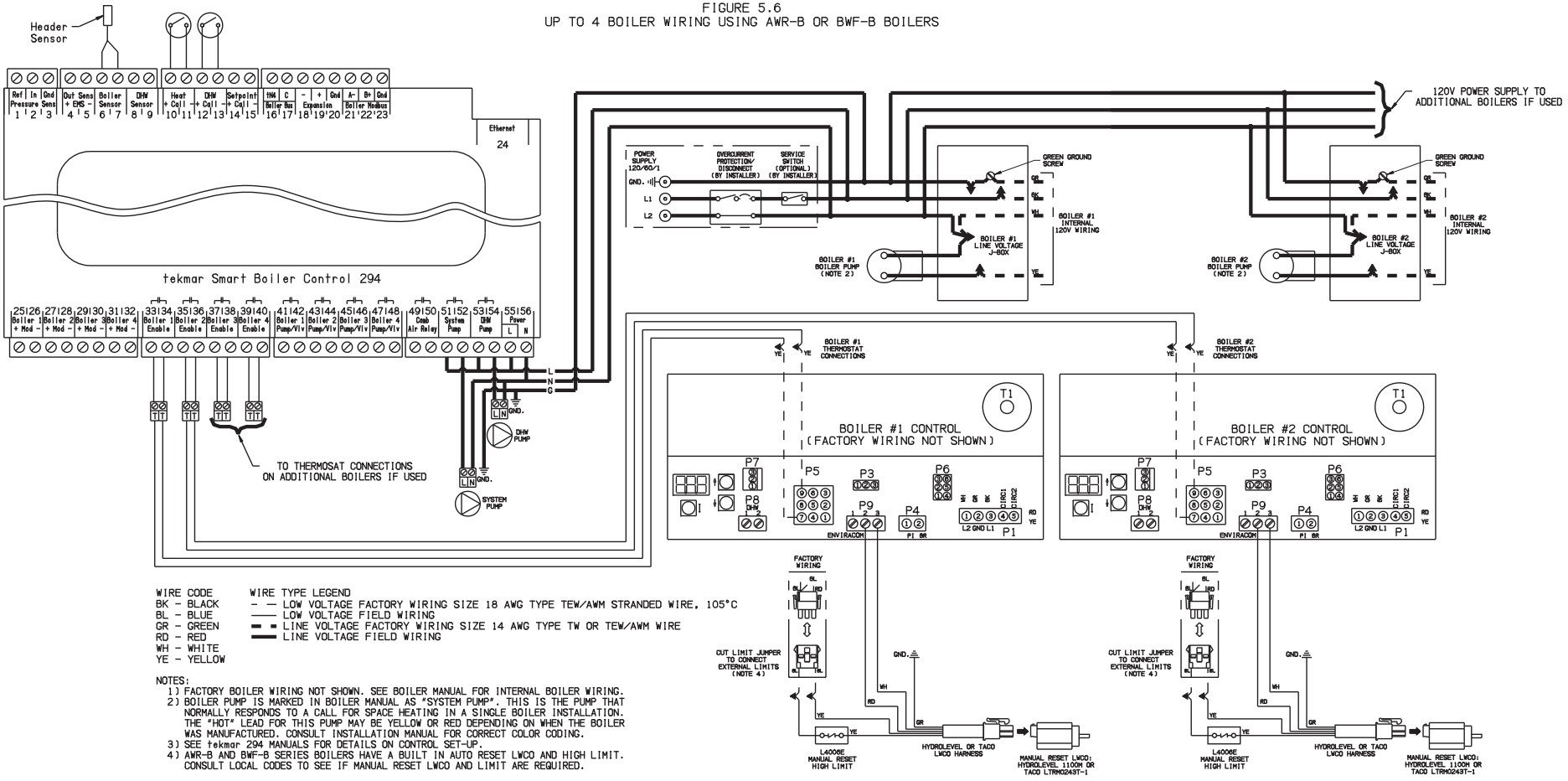
3) DHW PUMP LEAD MAY BE BLUE OR RED, DEPENDING ON WHEN THE BOILER WAS MANUFACTURED. CONSULT INSTALLATION MANUAL FOR CORRECT COLOR CODING.
4) SEE TACO PC702-1 AND SR501-EXP-4 MANUALS FOR DETAILS ON CONTROL SET-UP.
5) AWR-B AND BWF-B SERIES BOILERS HAVE A BUILT IN AUTO RESET LWCO AND HIGH LIMIT. CONSULT LOCAL CODES TO SEE IF MANUAL RESET LWCO AND LIMIT ARE REQUIRED.

FIGURE 5.5
TWIN BOILER WIRING USING AWR-B OR BWF-B BOILERS
(INDIRECT WATER HEATER PIPED TO HEATING SYSTEM)




NOTES:
1) FACTORY BOILER WIRING NOT SHOWN. SEE BOILER MANUAL FOR INTERNAL BOILER WIRING.
2) BOILER PUMP IS MARKED IN BOILER MANUAL AS "SYSTEM PUMP". THIS IS THE PUMP THAT NORMALLY RESPONDS TO A CALL FOR SPACE HEATING IN A SINGLE BOILER INSTALLATION. THE "HOT" LEAD FOR THIS PUMP MAY BE YELLOW OR RED DEPENDING ON WHEN THE BOILER WAS MANUFACTURED. CONSULT INSTALLATION MANUAL FOR CORRECT COLOR CODING.
3) SEE TACO PC702-1 AND SR503-EXP-4 MANUALS FOR DETAILS ON CONTROL SET-UP.
4) AWR-B AND BWF-B SERIES BOILERS HAVE A BUILT IN AUTO RESET LWCO AND HIGH LIMIT. CONSULT LOCAL CODES TO SEE IF MANUAL RESET LWCO AND LIMIT ARE REQUIRED.

FIGURE 5.6
UP TO 4 BOILER WIRING USING AWR-B OR BWF-B BOILERS

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——— LOW VOLTAGE FIELD WIRING
- - - LINE VOLTAGE FACTORY WIRING SIZE 14 AWG TYPE TW OR TEW/AWM WIRE
——— LINE VOLTAGE FIELD WIRING

NOTES:
1) FACTORY BOILER WIRING NOT SHOWN. SEE BOILER MANUAL FOR INTERNAL BOILER WIRING.
2) BOILER PUMP IS MARKED IN BOILER MANUAL AS "SYSTEM PUMP". THIS IS THE PUMP THAT NORMALLY RESPONDS TO A CALL FOR SPACE HEATING IN A SINGLE BOILER INSTALLATION. THE "HOT" LEAD FOR THIS PUMP MAY BE YELLOW OR RED DEPENDING ON WHEN THE BOILER WAS MANUFACTURED. CONSULT INSTALLATION MANUAL FOR CORRECT COLOR CODING.
3) SEE tekmar 294 MANUALS FOR DETAILS ON CONTROL SET-UP.
4) AWR-B AND BWF-B SERIES BOILERS HAVE A BUILT IN AUTO RESET LWCO AND HIGH LIMIT. CONSULT LOCAL CODES TO SEE IF MANUAL RESET LWCO AND LIMIT ARE REQUIRED.


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