



AQUATM PLUS



Indirect-Fired Water Heaters

Product Manual

- Installation
- Maintenance
- Startup
- Parts



Mobile Product Library

NOTICE

User — Read important user safety information found on page 3, page 24 and page 25. Installation and service should only be performed by a qualified service technician. Retain this manual for future reference.

WARNING

This manual must only be used by a qualified heating installer/service technician. BEFORE installing, read all instructions in this manual and all other information shipped with the water heater. Perform steps in the order given. Failure to comply could result in severe personal injury, death or substantial property damage.



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Please read before proceeding

Hazard definitions

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

⚠ DANGER Indicates presence of hazards that will cause severe personal injury, death or substantial property damage.

⚠ WARNING Indicates presence of hazards that can cause severe personal injury, death or substantial property damage.

⚠ CAUTION Indicates presence of hazards that will or can cause minor personal injury or property damage.

NOTICE Indicates special instructions on installation, operation or maintenance that are important but not related to personal injury or property damage.

⚠ WARNING This manual provides installation and operation guidelines for Weil-McLain AQUA PLUS indirect water heaters. The installer is responsible for ensuring that the installation complies with this manual, the boiler manual and all applicable codes.

NOTICE **Massachusetts installations** — The water heater must be installed by a licensed plumber. The installation must follow all Massachusetts code requirements. The domestic water piping must comply with the piping shown in this manual. See “Domestic water piping,” page 6, for details and code requirements.

NOTICE When calling or writing about the water heater — Please have the water heater serial number from the serial number label, located on the back side of the water heater, adjacent to the rating plate.

Any claims for damage or shortage in shipment must be filed immediately against the transportation company by the consignee.

⚠ WARNING Failure to adhere to the guidelines on this page can result in severe personal injury, death or substantial property damage.

Read all instructions before installing. Failure to follow all instructions in proper order can cause severe personal injury, death or substantial property damage.

When servicing water heater

- To avoid electric shock, disconnect electrical supply before performing maintenance.
- To avoid severe burns, allow water heater to cool before performing maintenance.

Operating restrictions

- Maximum domestic hot water temperature: residential sizes — **160°F**, commercial sizes — **180°F**. Pay attention to the water temperature warnings throughout this manual.
- Maximum boiler water temperature — 200°F.
- Maximum working pressure for tank — 150 PSIG.
- Water chemistry limits:
 - hardness — less than 6 grains/gal.
 - pH — above 6 and less than 8.
 - chlorides — less than 200 ppm.

Boiler water restrictions

- Thoroughly flush the boiler system (without water heater connected) to remove sediment.
- The water heater heat exchanger can be damaged by build-up or corrosion due to sediment.
- Boiler water (including additives) must be practically non-toxic, having toxicity rating or class of 1, as listed in Clinical Toxicology of Commercial Products.
- If antifreeze is used in boiler system:
 - Local codes may require a backflow preventer on cold water supply line.
 - Use antifreeze specifically intended for hydronic heating systems. Inhibited propylene glycol is recommended.
 - Follow boiler manual instructions for antifreeze usage.
 - Do not use automotive, ethylene glycol or petroleum-based antifreeze. Do not use any undiluted antifreeze.

Location

- This water heater is not intended for outdoor installation.
- Install the water heater so if the tank or any connections should leak, the water flow will not cause damage to area near water heater, or to lower floors of structure. When such locations cannot be avoided, install a suitable drain pan under water heater. Drain pans are available at your local plumbing supply store.
- This product is designed for vertical installation only.



Pre-installation

Codes

1. Installation must conform with instructions in this manual and, where applicable:
 - local, state, provincial, and national codes, laws, regulations and ordinances.
 - in Canada — B149.1 or B149.2 Installation Code.
2. AQUA PLUS water heaters are exempt from ASME Section VIII, Division 1 Code construction per Interpretation VIII-1-86-136. Check with local codes for applicability.
3. Where recommendations in this manual differ from local or national codes, local or national codes take precedence.

Code restrictions

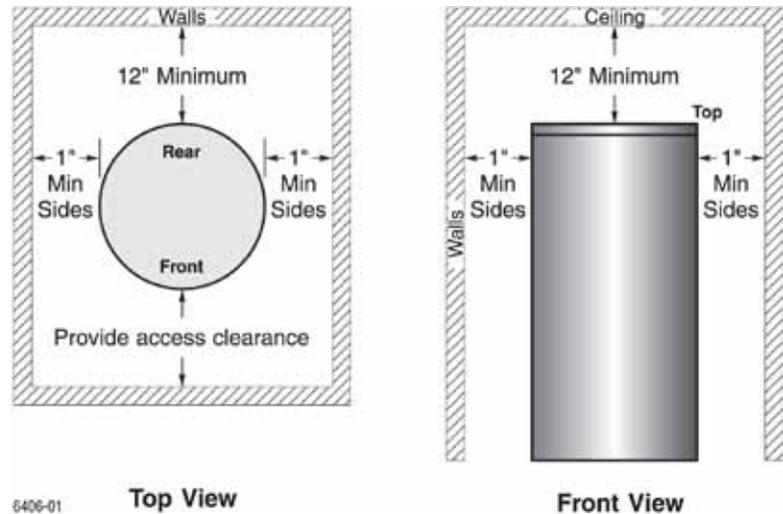
National Standard Plumbing Code

1. Single-wall heat exchanger in water heater complies with National Standard Plumbing Code, provided that:
 - a. boiler water (including additives) is practically non-toxic, having toxicity rating or class of 1, as listed in Clinical Toxicology of Commercial Products, and
 - b. boiler water pressure is limited to maximum 30 PSIG by approved relief valve.

Uniform Plumbing Code

1. Single-wall heat exchangers are permitted if they satisfy all of the following requirements —
 - a. The heat transfer medium is potable water or contains only substances which are recognized as safe by the U. S. Food and Drug Administration.
 - b. The pressure of the heat transfer medium is maintained less than the normal minimum operating pressure of the potable water system.
 - c. Exception: Steam complying with #a, above.
 - d. The equipment is permanently labeled to indicate that only additives recognized as safe by the FDA shall be used in the heat transfer medium.
2. Other heat exchanger designs may be permitted where approved by the Administrative Authority.

Figure 1 Clearance recommendations



Recommended clearances

Installation location must provide adequate clearances for servicing and proper operation of the water heater. See Figure 1.

- 1" clearance is permissible to either side of water heater, but the Instruction label or other labels may be hidden.
- Top (vertical) clearance is 12" minimum.
- Refer to boiler manual for boiler clearances.

Clearance to combustible materials

1. Provide at least 1/2" clearance between all hot water pipes and combustible materials.

Water heater placement

1. Read and comply with "Location," page 3 of this manual.
2. Select a convenient location for the water heater, based on domestic and boiler piping hook-ups.
3. Keeping the distance between boiler and water heater short will:
 - reduce piping heat loss.
 - provide minimum friction loss.

Install levelling legs

1. Carefully tip the water heater onto its side.
2. Screw the four levelling legs into the base.
3. Return the water heater to the upright position and set in place.
4. Adjust the legs as necessary to level the water heater.



Pre-installation *(continued)*

Domestic water piping requirements

1. Install unions on all piping for easy removal of water heater.
2. Use **dielectric unions or couplings** to protect hot and cold water fittings from corrosion when connecting dissimilar materials such as copper and galvanized iron pipe.
3. **When the supply pressure is higher than 70 PSIG**, install a pressure reducing valve on cold water supply line to prevent water loss through T&P relief valve. A thermal expansion tank is also required.
4. If the water heater will replace a tankless coil in the boiler, disconnect piping to coil or remove coil from boiler and replace with a cover plate. Allow water to drain from coil. **Do not** plug the tankless coil.

⚠ DANGER Plugging tankless coil inlet and outlet will result in severe personal injury, death or substantial property damage.

⚠ WARNING Studies have indicated that dangerous bacteria, including **legionella pneumophila**, can form in the potable water distribution system if certain minimum water temperatures are not maintained. Contact your local health department for more information.

Water heater operating restrictions

1. Read the operating limits under “Operating restrictions,” page 3.

⚠ WARNING **Magnesium anode** — The water heater is equipped with a magnesium sacrificial anode. The anode may erode over time, and should be inspected at least once annually, only by a qualified service technician. For installations with a likelihood of poor water conditions, the anode should be inspected at least every six months. Failure to comply could result in loss of protection by the anode, causing possible severe personal injury, death or substantial property damage due to water heater leakage.

⚠ WARNING The domestic water chloride concentration must not exceed 200 ppm. High chloride concentrations can rapidly disintegrate the water heater’s protective anode.

Boiler water restrictions

1. Read the WARNINGS under “Boiler water restrictions,” page 3.



Hot Water Can Scald!

- Water heated to temperature for clothes washing, dish washing and other sanitizing needs can scald and cause permanent injury.
- Children, elderly, and infirm or physically handicapped persons are more likely to be permanently injured by hot water. Never leave them unattended in bathtub or shower. Never allow small children to use a hot water tap or draw their own bath.
- If anyone using hot water in the building fits the above description, or if state laws or local codes require certain water temperatures at hot water taps, you must take special precautions:
 - Use lowest possible temperature setting.
 - Install some type of tempering device, such as an automatic mixing valve, at hot water tap or water heater. Automatic mixing valve must be selected and installed according to valve manufacturer’s recommendations and instructions.
- Water passing out of drain valves may be extremely hot. To avoid injury:
 - Make sure all connections are tight.
 - Direct water flow away from any person.

Protection must be taken against excessive temperature and pressure! — Installation of a temperature & pressure (T&P) relief valve (provided with water heater) and a thermostatic mixing valve (provided by installer) is required.



Domestic water piping

Piping overview

WARNING **THERMAL EXPANSION TANK** — If a backflow preventer, check valve, or pressure reducing valve is piped on cold water inlet of water heater, you must install an expansion tank on cold water supply line to prevent normal thermal expansion from repeatedly forcing open T&P relief valve.

The T&P relief valve is not intended for constant duty, such as relief of pressure due to repeated normal system expansion. Refer to expansion tank manufacturer’s instructions for proper sizing.

Failure to comply could result in severe personal injury, death or substantial property damage.

General applications

1. Figure 2 — This piping configuration can be used in most cases, except where local codes require special components or piping not illustrated.
2. Some codes may require the items listed as optional, such as a vacuum breaker on the inlet line, or recirculation piping.

Massachusetts applications

1. For **Massachusetts code** applications, or as required elsewhere by local codes, install the following options.
 - a. Thermal siphon on DHW inlet and outlet.
 - b. Vacuum breaker on domestic water inlet line.
 - c. Recirculation — **Massachusetts code** applications require recirculation piping or heat-traced piping if the distance from the water heater to the furthest fixture exceeds 100 feet. See page 8 for details.

Figure 2 DHW piping

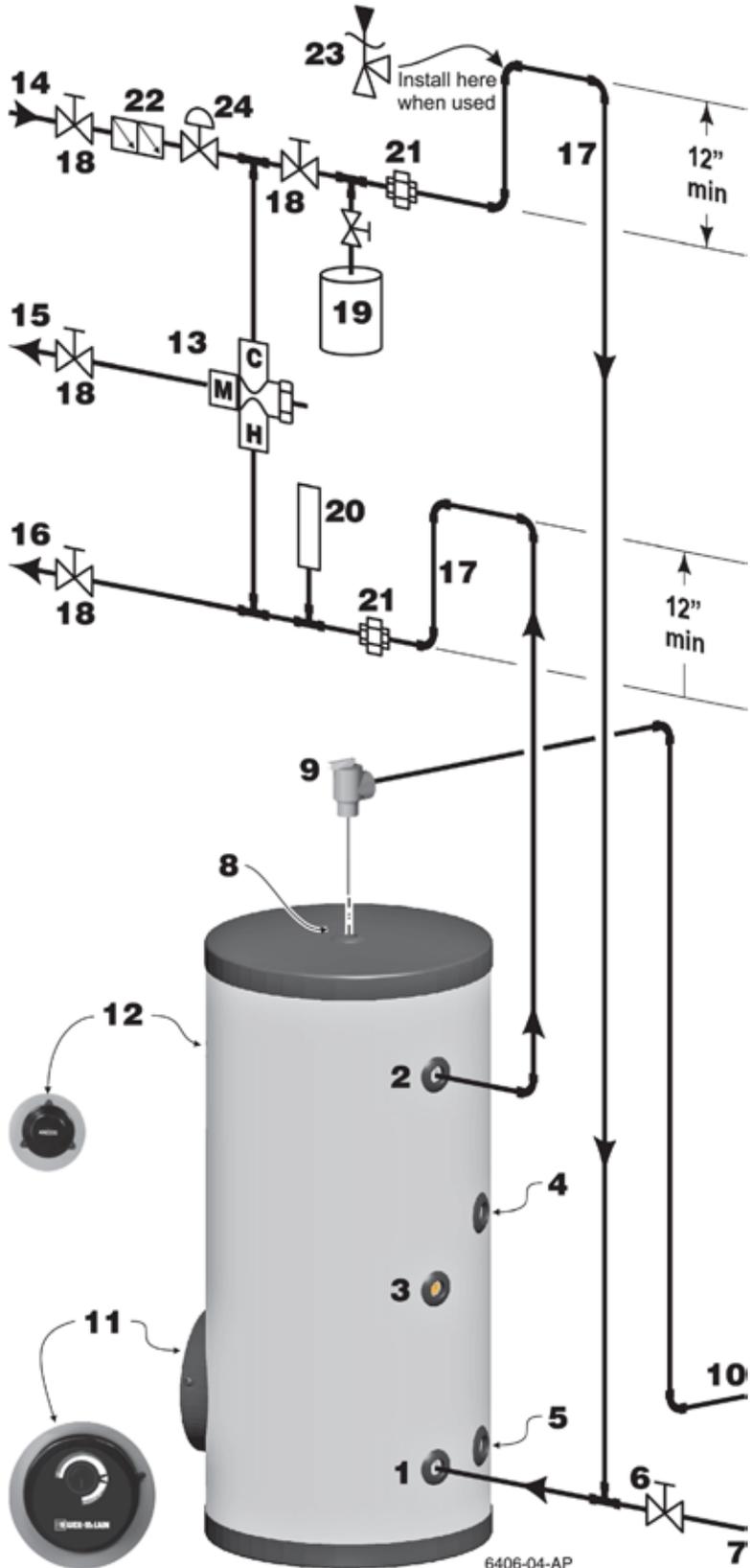


Figure 3 Piping connection sizes

Model AQUA PLUS	Connections (inches NPT)		
	DHW in/out	Boiler water in/out	Recirculation tapping
35	3/4	1	3/4
45	3/4	1	3/4
55	3/4	1	3/4
85	1	1	3/4
105	1	1	3/4



Domestic water piping *(continued)*

LEGEND for Figure 2, page 6

▲WARNING Domestic water supplied to fixtures that could pose an injury hazard due to high temperature, such as showers and faucets, should be equipped with a temperature regulating device, such as an **anti-scald mixing valve**.

When the supply pressure is higher than 70 PSIG, install a **pressure reducing valve** on cold water supply line to prevent water loss through T&P relief valve. A thermal expansion tank is also required.

Mass Code This symbol, where used in this manual, indicates the item is required by Massachusetts code.

OPTIONAL This symbol indicates the item is optional, unless required by applicable codes.

1 Domestic cold water inlet connection — see Figure 3, page 6 for size

2 Domestic hot water outlet connection — see Figure 3, page 6 for size

3 Domestic recirculation connection — unused

4 Boiler water inlet to coil — see Figure 3, page 6 for size

5 Boiler water outlet from coil — see Figure 3, page 6 for size

6 Drain valve — provided by installer

- Install a drain valve on the DHW inlet to the water heater as shown.

7 Piping from drain valve

- Pipe from drain to floor drain, if available.

8 T&P valve connection

9 T&P relief valve — supplied with water heater

- Use only the T&P valve supplied with the water heater. See Replacement parts for part number.
- Install the T&P relief valve in the top center tapping, as shown.

10 T&P relief valve discharge piping —

- must be made of material serviceable for temperatures of 250°F or greater.
- must be directed so that hot water flows away from all persons.
- must be directed to a suitable place for disposal.
- must be installed so as to allow complete draining of the T&P relief valve and discharge line.
- must NOT be excessively long — using more than 2 elbows or 15 feet of piping can reduce discharge capacity.
- must NOT be directly connected to a drain — terminate discharge piping within 6" from floor — refer to local codes.
- must NOT be plugged, reduced or restricted.
- must NOT be subjected to freezing.

▲WARNING Do not install any valve between T&P relief valve and tank connection, or on T&P relief valve discharge piping. Do not plug T&P relief valve or its discharge piping. Improper placement and piping of T&P relief valve can cause severe personal injury, death or substantial property damage.

11 Temperature adjustment knob

12 Anode access

- The anode is specially made for this water heater. Use only the anode available from Weil-McLain, as listed in Replacement parts.

13 Mixing valve — **OPTIONAL** — **RECOMMENDED**

- See Replacement parts for thermostatic mixing valves available from Weil-McLain.

14 Domestic cold water supply

▲WARNING When the water supply pressure is higher than 70 PSIG, install a pressure-reducing valve on the cold water supply line to prevent leakage from the T & P relief valve. A thermal expansion tank is also required.

15 Domestic mixed-temperature water supply to system (when used — requires mixing valve)

16 Domestic high-temperature hot water supply to system

17 Heat trap loops (12" minimum) — **OPTIONAL**

18 Isolation valves

19 Thermal expansion tank — **OPTIONAL**

- **REQUIRED** if cold water line is equipped with a backflow preventer or pressure reducing valve — see **EXPANSION TANK WARNING** on page 6.

20 Shock arrester — **OPTIONAL**

▲WARNING Dishwashers, clothes washers, and fast-closing positive shutoff valves incorporated in the system all contribute to creating water shock. Install a water hammer arrester to prevent damage to pipes and appliances. See control manufacturer's instructions for application and installation.

21 Unions

- Use dielectric unions or couplings to protect hot and cold water fittings from corrosion when connecting dissimilar materials such as copper and galvanized iron pipe.

22 Backflow preventer — **OPTIONAL** — **Mass Code** — (required for Commonwealth of Massachusetts)

23 Vacuum breaker — **OPTIONAL**

24 Pressure reducing valve — **OPTIONAL**

- **REQUIRED** when the supply pressure is higher than 70 PSIG — A thermal expansion tank is also required.



Recirculation

NOTICE

Massachusetts code applications require recirculation piping or heat-traced piping if the distance from the water heater to the furthest fixture exceeds 100 feet.

Maintaining domestic water temperature in the supply piping

1. Recirculation is used to reduce wait time for water use, to minimize hot water and energy waste caused during the waiting period, and to prevent degradation of the system supply water temperature. ASPE recommends recirculation when the distance from the water heater to the furthest fixture exceeds 100 feet or the time lag for hot water to reach a fixture(s) exceeds 30 seconds.
2. Consult local codes and American Society of Plumbing Engineers (ASPE) Domestic Water Heating Design Manual, 1998, for further information.

Time delay at fixtures

1. Figure 4, page 9 is from the ASPE Domestic Water Heating Design Manual, 1998. It shows the time required for usable hot water to arrive at a fixture based on the fixture flow rate (available from industry and manufacturer's data) and the length and diameter of the dead-end branch pipe supplying the fixture.
2. The time lag should generally not exceed 30 seconds.
3. For residential and office applications, the owner may prefer a limit of 10 seconds.
4. You can use Figure 4 as a guide to determining the location of circulation return lines relative to fixtures.

Balancing

1. When multiple branches are connected to the supply piping, each branch must be connected to the recirculation system.
 - a. At each of these connections to the return piping, install shutoff valves, a flow metering device, check valve and a strainer as shown in Figure 5, page 9.
 - b. Check local codes for specific installation requirements.

2. These branches must be balanced to prevent pipe erosion and unacceptable time delays at some fixtures.
3. Balancing options include circuit setters, memory stop valves or factory preset devices (with flow metering provision in the piping).

Components required

1. For residential applications, consult circulator manufacturer's data for circulator selection and additional components required.
2. On most commercial systems, install the devices shown in Figure 5, page 9, and any other devices or piping methods required by local codes.
 - a. The check valves are required to prevent fixtures from taking hot water through the return lines.
 - b. Shutoff valves are needed to allow cleaning and replacing balancing devices.
 - c. Include strainers to remove sediment which could damage the circulator and/or affect the flow balancing devices.
3. Size the circulator and piping based on the temperature drop allowed between the water available at the water heater and the water delivered at the fixture.
 - a. The return piping will almost always be smaller than the supply piping, but should never be smaller than ½" to prevent problems with the circulator.
4. Make provision for removal of air in all return lines. Where the returns cannot be vented by topmost fixtures in the system, install automatic air venting at the top of the return piping.

Connecting to the water heater

1. Install the domestic water components as shown in Figure 2, page 6.
2. See Figure 6, page 10 for the piping required to the water heater.

— Continued on page 10 —



Recirculation *(continued)*

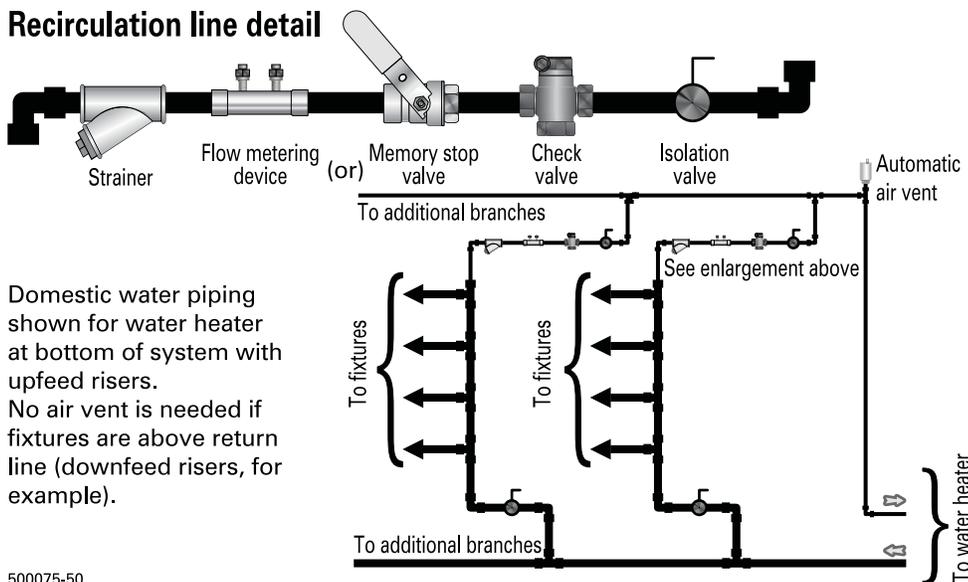
Figure 4 Time lag to obtain hot water at fixture for branch lengths of 10 and 25 feet (ASPE Domestic Water Heating Design Manual)

Time in seconds required to get hot water at fixture (from ASPE)									
Fixture flow rate (GPM) -		0.5		1.5		2.5		4.0	
Piping length (feet) -		10	25	10	25	10	25	10	25
Copper pipe	½"	25	63	8	21	5	13	3	8
	¾"	48	119	16	40	10	24	6	15
Steel pipe	½"	63	157	21	52	13	31	8	20
	¾"	91	228	30	76	18	46	11	28
CPVC pipe	½"	64	159	21	53	13	62	8	20
	¾"	95	238	32	79	19	48	12	30

NOTE: Select branch size and length for less than 31 seconds delay.

Figure 5 Recirculation components

Recirculation line detail



Domestic water piping shown for water heater at bottom of system with upfeed risers. No air vent is needed if fixtures are above return line (downfeed risers, for example).

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Recirculation *(continued)*

Components

Circulator (Figure 6, item 1)

1. Little flow is required to maintain a temperature in the piping.
2. Size of circulator depends on minimum flow requirements of the tempering valve.
3. Minimum flow rates of the tempering valve must be maintained.

Aquastat (Figure 6, item 2)

1. Used to control the on-off position of the circulator. Aquastat is set 5° to 10° lower than mixed water outlet of the mixing valve (#7).
2. The circulator cannot run continuously as bypass through the mixing valve will eventually allow the temperature on the piping to climb to the water heater temperature during draw periods.

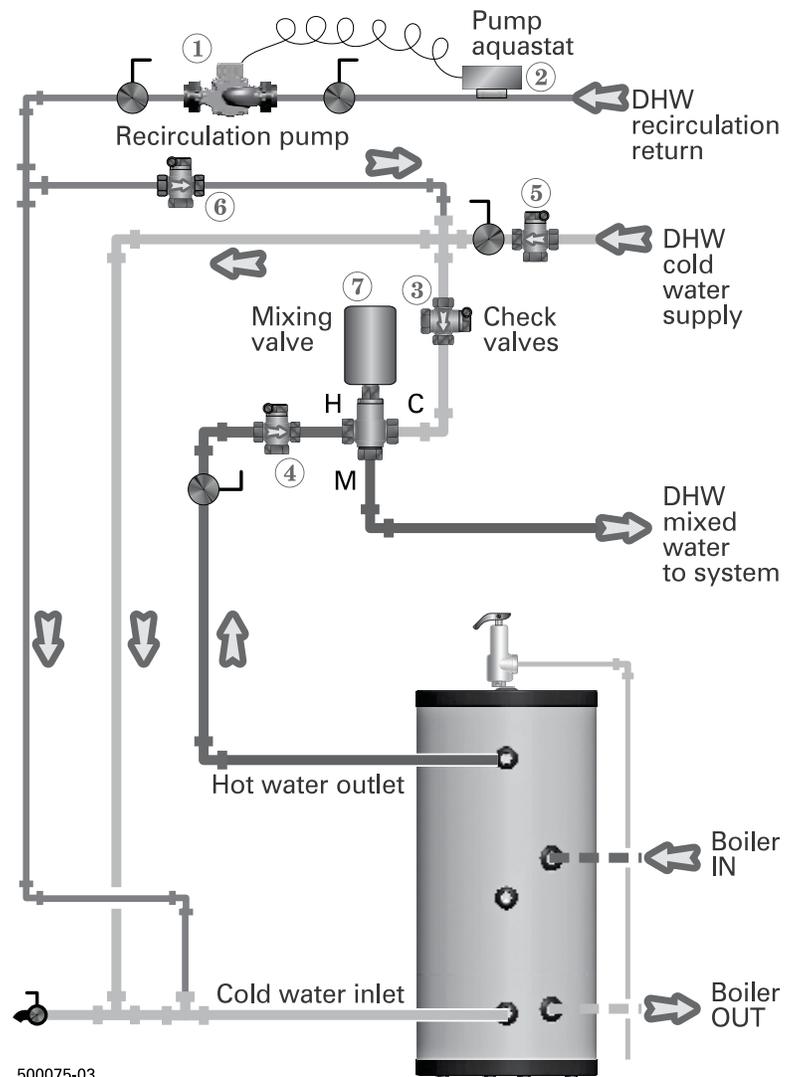
Check valves (Figure 6, items 3–6)

1. Assure the flow of water in one direction.
2. Each check valve functions as follows:
 - a. #3 and #4 prevent bypass in the event of pressure drop.
 - b. #5 prevents thermal siphoning of hot water to the cold water supply.
 - c. #6 prevents flow of cold water to the tempered water supply. A draw of tempered water will not result in flow of cold water into the return loop.

Operation

1. During period of normal use (fixtures on) — Circulator is off. There is no flow through #6, there is flow through #5 equal to the flow at the fixtures, there is flow through #3 and/or #4 equal to flow at fixture.
2. When all fixtures are off — Circulator is off. There is no flow through #3, #4, #5 or #6. Water temperature in piping is cooling.
3. When temperature at aquastat #2 falls 10° below temperature to be maintained — Circulator is on. There is flow through #6 equal to the minimum required by the mixing valve, flow through #3 and #4 equals the flow of the circulator. There is no flow through #5.
4. Aquastat reaches temperature — Circulator is off. There is no flow through #3, #4, #5 or #6.

Figure 6 Recirculation piping



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Potential problems

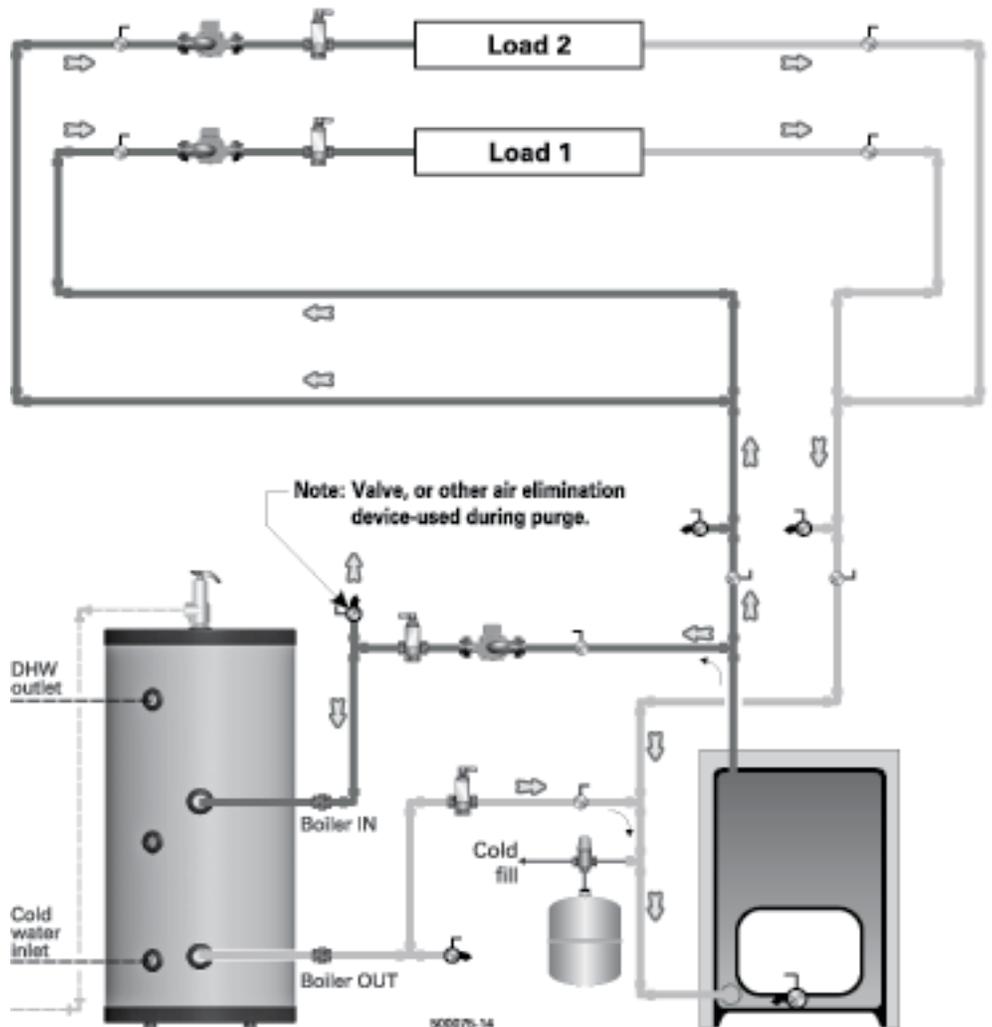
1. Missing check valves #3 or #4 — Extreme pressure drop can cause reverse flow of water; hot to cold supply or cold to hot supply.
2. Missing check valve #5 — Hot water can migrate from the water heater back through the cold water supply.
3. Missing check valve #6 — Cold water can be forced back through the tempered water supply when a fixture is opened.
4. No aquastat #2 — Circulator runs continuously. Small amount of water will pass through mixing valve. Eventually all hot water is flowing through valve. Recirculated water through cold port, hot water through hot port.
5. Circulator too small — Mixing valve performance erratic.



Boiler-side piping

Figure 7 Zoning with circulators — direct-connected system piping

- Notes**
- Place circulators at beginnings of zones. Placing them at the ends of zones could result in heating idle zones.
 - Size manifold piping for total flow of all zone circulators.
 - Locate flow/check valves as close as possible to water heater boiler side connections — to reduce heat loss between cycles.
- Wiring**
- WMCR zone controller, optional priority — Figure 18, page 21.



NOTICE

- This drawing is conceptual only. It shows representative piping components and layout. Weil-McLain does not represent that this drawing meets any particular mechanical or building codes. The installer is responsible for inclusion of all required safety devices, or other miscellaneous piping hardware not shown on drawing. The installer is responsible for proper sizing / selection of all hardware shown on this diagram.
- See boiler manual for specific details on installing the boiler.

Recommended flow rate and minimum boiler-side pipe size					
Heater model	GPM	Pipe size	Heater model	GPM	Pipe size
35	8	1"	85	14	1 1/4" *
45	8	1"	105	14	1 1/4" *
55	8	1"	Requires 1 1/4"x1" reducers at water heater		

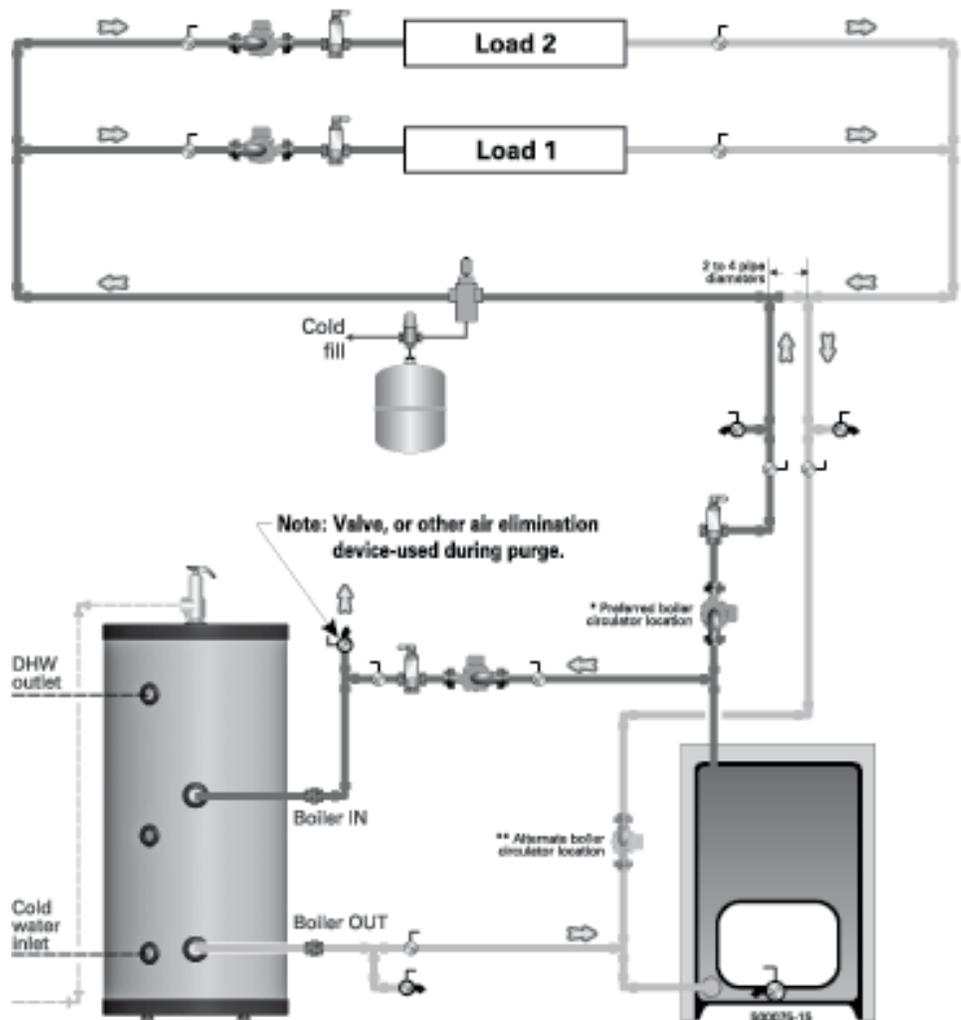
- NOTICE**
- ECO, Evergreen, GV90+ Ultra or WM97+ gas boilers:**
- DO NOT** apply the drawings in this manual. Refer only to the boiler manual.



Boiler-side piping *(continued)*

Figure 8 Zoning with circulators — primary/secondary system piping

- Notes**
- Place circulators at beginnings of zones. Placing them at the ends of zones could result in heating idle zones.
 - Size manifold piping for total flow of all zone circulators.
 - Locate flow/check valves as close as possible to water heater boiler side connections — to reduce heat loss between cycles.
- Wiring**
- WMCR zone controller, optional priority — Figure 18, page 21.



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 - See boiler manual for specific details on installing the boiler.

Recommended flow rate and minimum boiler-side pipe size

Heater model	GPM	Pipe size	Heater model	GPM	Pipe size
35	8	1"	85	14	1 1/4" *
45	8	1"	105	14	1 1/4" *
55	8	1"	Requires 1 1/4"x1" reducers at water heater		

NOTICE

ECO, Evergreen, GV90+, Ultra or WM97+ gas boilers:

DO NOT apply the drawings in this manual. Refer only to the boiler manual.

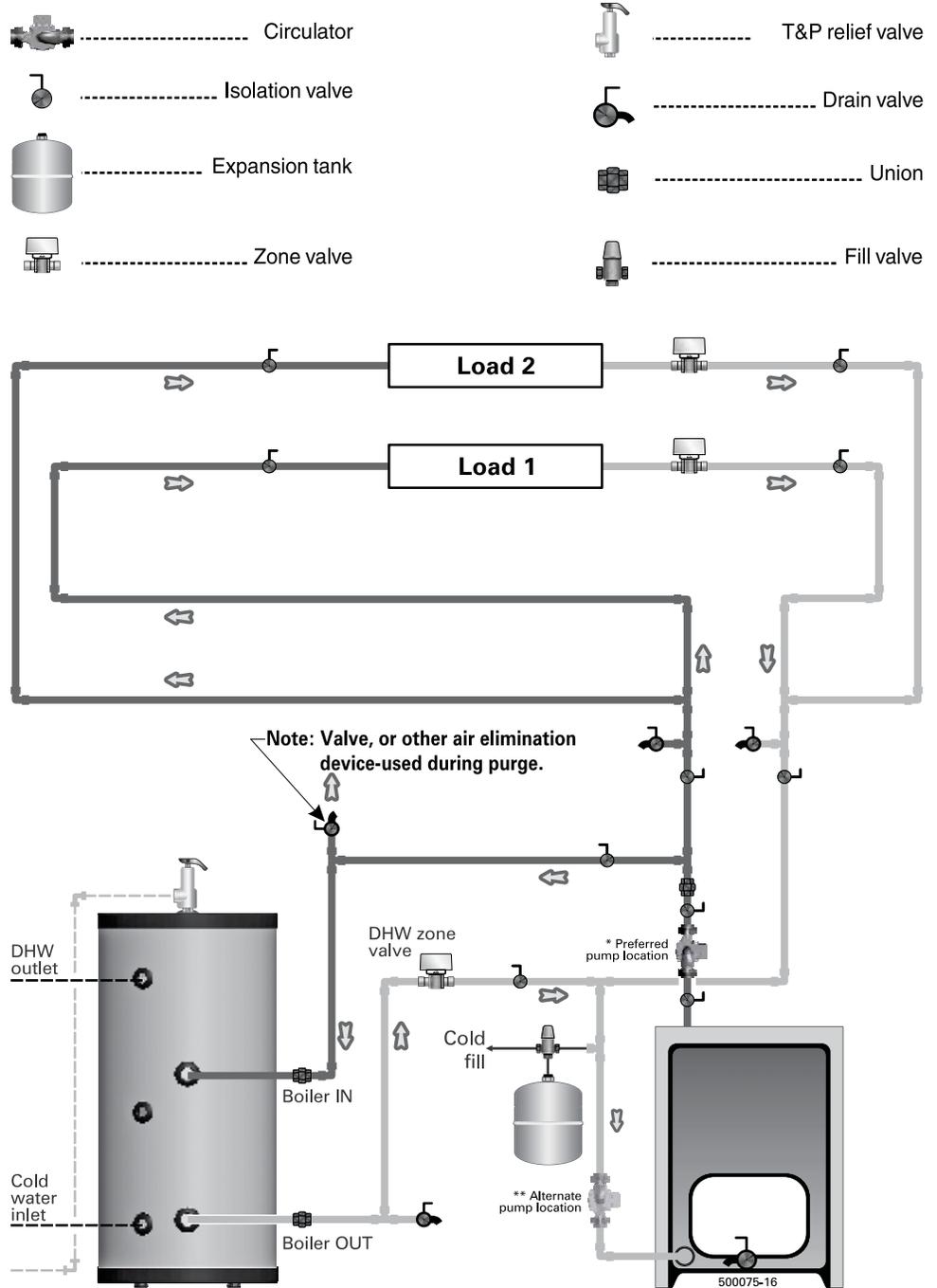


Boiler-side piping *(continued)*

Figure 9 Zoning with zone valves — direct-connected system piping

- Notes**
- Place circulators at beginnings of zones. Placing them at the ends of zones could result in heating idle zones.
 - Size manifold piping for total flow of all zone circulators.
 - Locate flow/check valves as close as possible to water heater boiler side connections — to reduce heat loss between cycles.
- Wiring**
- WMZV zone controller, optional priority — Figure 19, page 22.

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 - See boiler manual for specific details on installing the boiler.



Recommended flow rate and minimum boiler-side pipe size

Heater model	GPM	Pipe size	Heater model	GPM	Pipe size
35	8	1"	85	14	1¼" *
45	8	1"	105	14	1¼" *
55	8	1"	Requires 1¼"x1" reducers at water heater		

- NOTICE**
- ECO, Evergreen, GV90+, Ultra or WM97+ gas boilers:**
- DO NOT** apply the drawings in this manual. Refer only to the boiler manual.

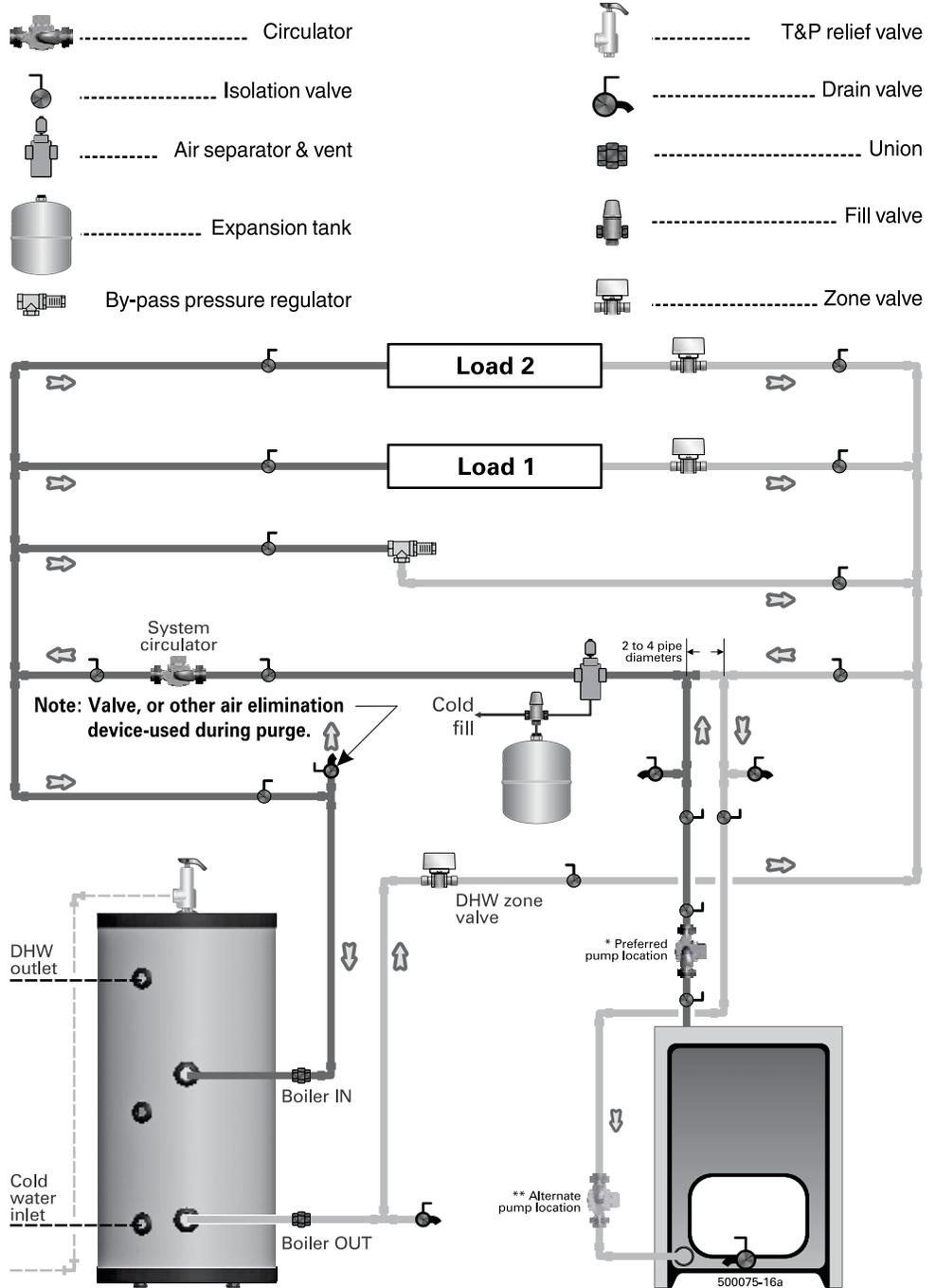


Boiler-side piping *(continued)*

Figure 10 Zoning with zone valves — primary/secondary system piping

- Notes**
- Place circulators at beginnings of zones. Placing them at the ends of zones could result in heating idle zones.
 - Size primary piping for total flow of all zone circulators.
 - Locate flow/check valves as close as possible to water heater boiler side connections — to reduce heat loss between cycles.
- Wiring**
- WMZV zone controller, optional priority — Figure 19, page 22.

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Recommended flow rate and minimum boiler-side pipe size

Heater model	GPM	Pipe size	Heater model	GPM	Pipe size
35	8	1"	85	14	1 1/4" *
45	8	1"	105	14	1 1/4" *
55	8	1"	Requires 1 1/4"x1" reducers at water heater		

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DO NOT apply the drawings in this manual. Refer only to the boiler manual.



Boiler-side piping *(continued)*

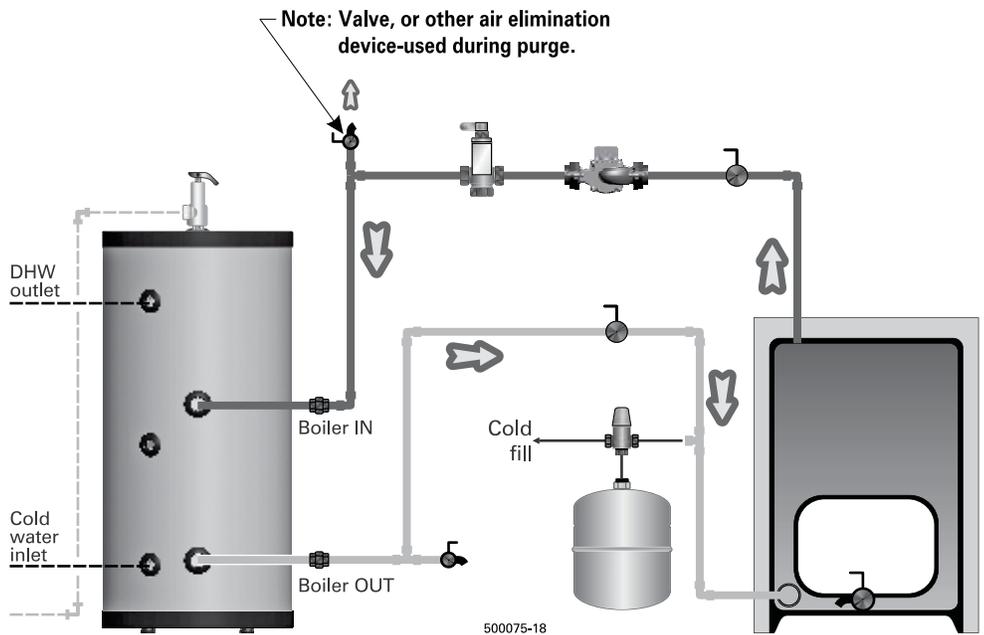
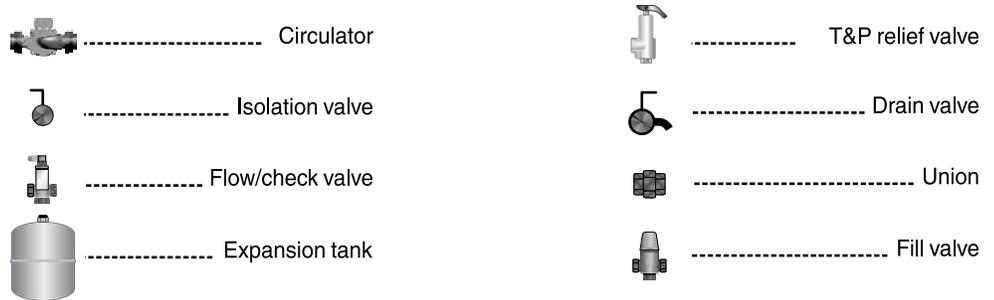
Figure 11 Dedicated single-boiler piping

Notes

- Place circulators at beginnings of zones. Placing them at the ends of zones could result in heating idle zones.
- Size manifold piping for total flow of all zone circulators.
- Locate flow/check valves as close as possible to water heater boiler side connections — to reduce heat loss between cycles.

Wiring

- Connect water heater thermostat wires to boiler’s T-T terminals or heat demand connection.



NOTICE

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2. See boiler manual for specific details on installing the boiler.

Recommended flow rate and minimum boiler-side pipe size

Heater model	GPM	Pipe size	Heater model	GPM	Pipe size
35	8	1"	85	14	1¼" *
45	8	1"	105	14	1¼" *
55	8	1"	Requires 1¼"x1" reducers at water heater		

NOTICE

ECO, Evergreen, GV90+, Ultra or WM97+ gas boilers:
DO NOT apply the drawings in this manual. Refer only to the boiler manual.



Boiler-side piping *(continued)*

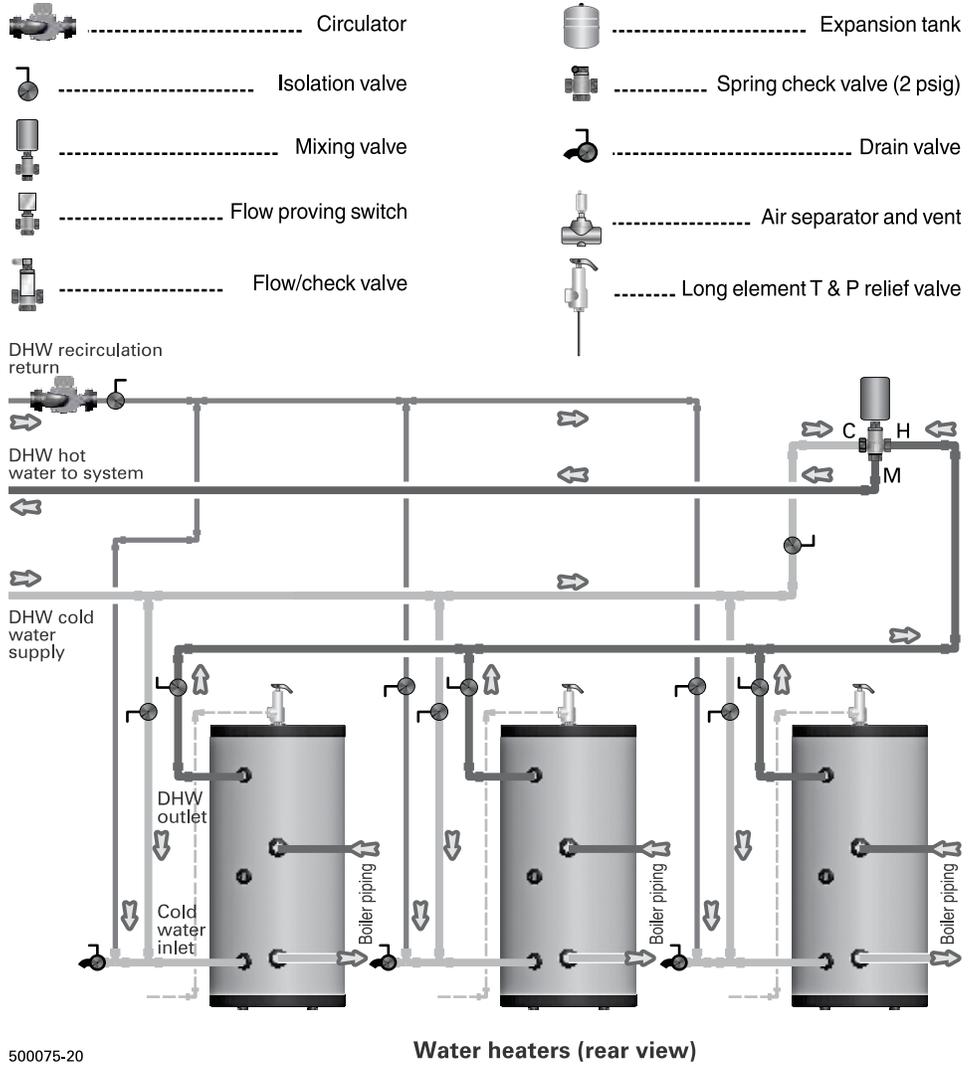
Figure 12 Multiple water heaters — domestic water piping

WARNING

Failure to install automatic mixing valve where recommended can result in severe personal injury or death.

NOTICE

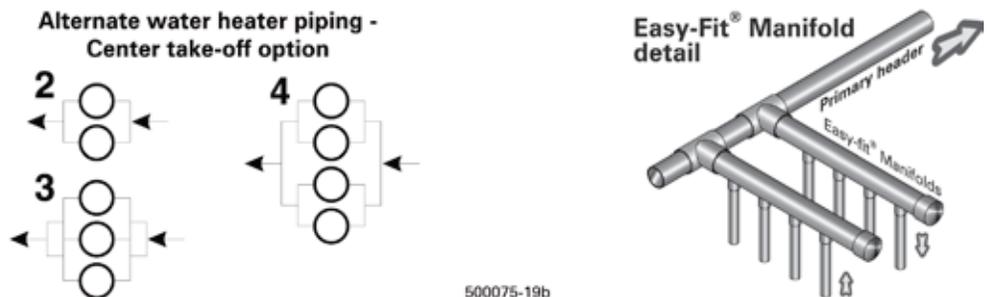
1. This drawing is conceptual only. It shows representative piping components and layout. Weil-McLain does not represent that this drawing meets any particular mechanical or building codes. The installer is responsible for inclusion of all required safety devices, or other miscellaneous piping hardware not shown on drawing. The installer is responsible for proper sizing / selection of all hardware shown on this diagram.
2. Wire water heater thermostats in series when connecting to boiler controller or boiler T-T terminals.
3. Install automatic mixing valve at either the system hot water connection or at each water heater.
4. See page 8 through page 10 for additional recirculation information and piping details.



500075-20

Water heaters (rear view)

Figure 13 Alternate methods of revers-return piping and Easy-Fit® Manifold detail



500075-19b

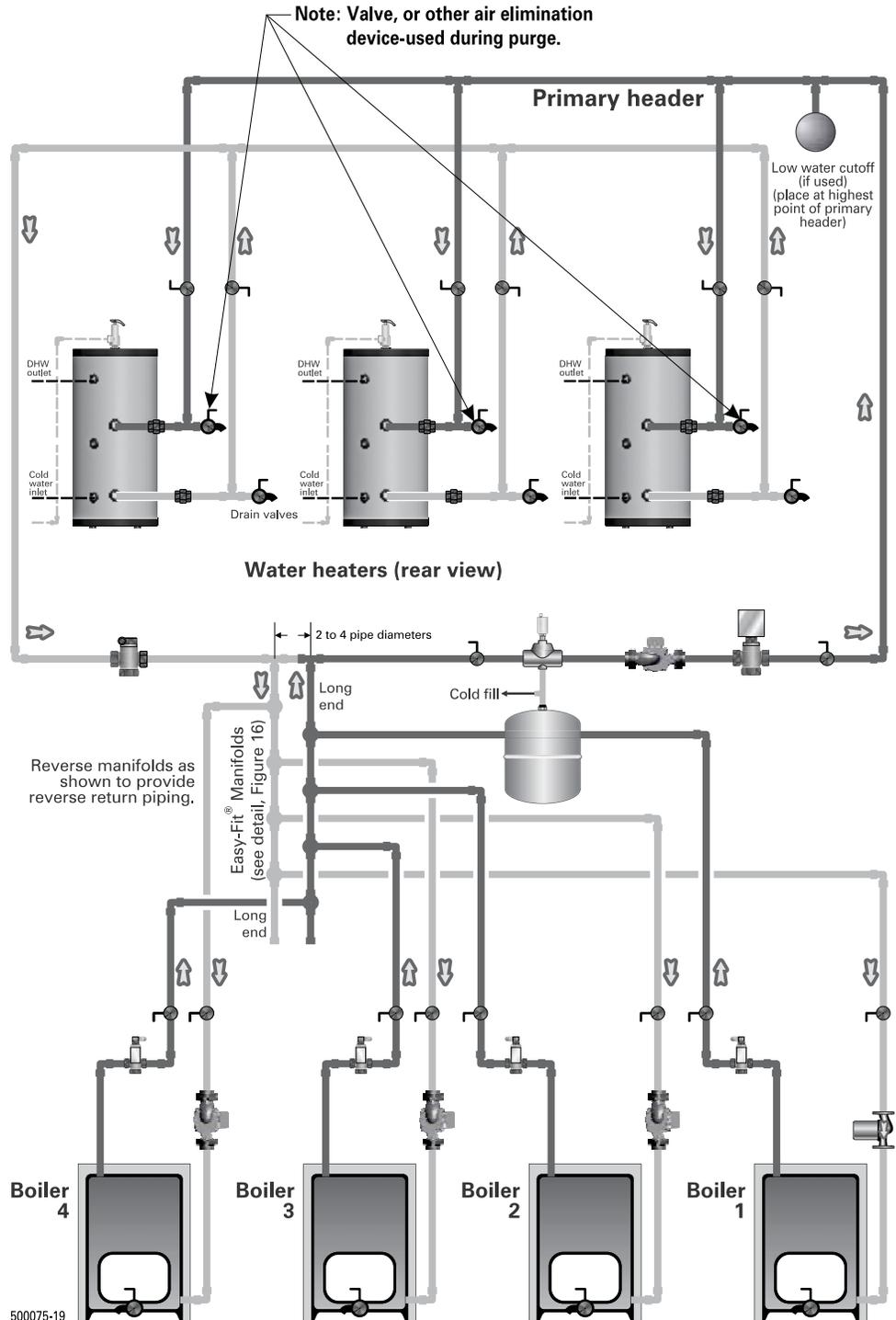


Boiler-side piping *(continued)*

Figure 14 Multiple water heaters and dedicated multiple boilers — boiler water piping

Notes

- See legend and details in Figure 12, page 16.



NOTICE

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2. See boiler manual for specific details on installing the boiler.

NOTICE

ECO, Evergreen, GV90+, Ultra or WM97+ gas boilers:
DO NOT apply the drawings in this manual. Refer only to the boiler manual.



Connecting to a low-pressure steam boiler

Special considerations

When designing steam and domestic hot water systems, there are some key issues that must be taken into consideration during the initial design phase. By designing the system properly from the start, you can avoid problems and have a hot water loop in a steam boiler system.

- The domestic water demand should preferably not exceed 1/3 of the steam boiler capacity. Larger demand may cause difficulty obtaining steam as needed.
- Keep the loop temperature below the flash point. Flashing can result in noise and circulator damage or shortened life.
- Be sure the loop is completely closed, with no automatic or manual air vents, or anything that could allow air to enter the system when the pump shuts off.
- Pipe supply from one side of the boiler, return to the opposite side as shown.
- Supply from a tapping that is high enough to prevent introducing sediment into the piping and circulator yet still below the water line. Avoid the mud leg of the boiler.
- Use an all bronze circulator.
 - Avoid wet rotor circulators. Select a circulator with a large volute, such as a typical 3-piece circulator.
 - This will reduce clogging and will resist the corrosion potential from the steam condensate.
- Make sure the circulator is properly sized. If the circulator runs too far out on its curve, cavitation potential increases significantly.
- Use (2) flow/check valves as shown to reduce the potential for gravity circulation.
 - DO NOT use spring-loaded check valves in place of the flow/check valves shown in Figure 16, page 19.

Installation and start-up of water heaters connected to steam boilers

1. See Figure 16, page 19, for suggested piping schematic.
2. Pipe the domestic water connections to the water heater per “Domestic water piping,” page 6.

CAUTION Boiler connections for the water heater must be below the water line. DO NOT use the gauge glass tapping or a low water cut-off tapping if a LWCO is installed there.

For steam piping, refer to the steam boiler manual.

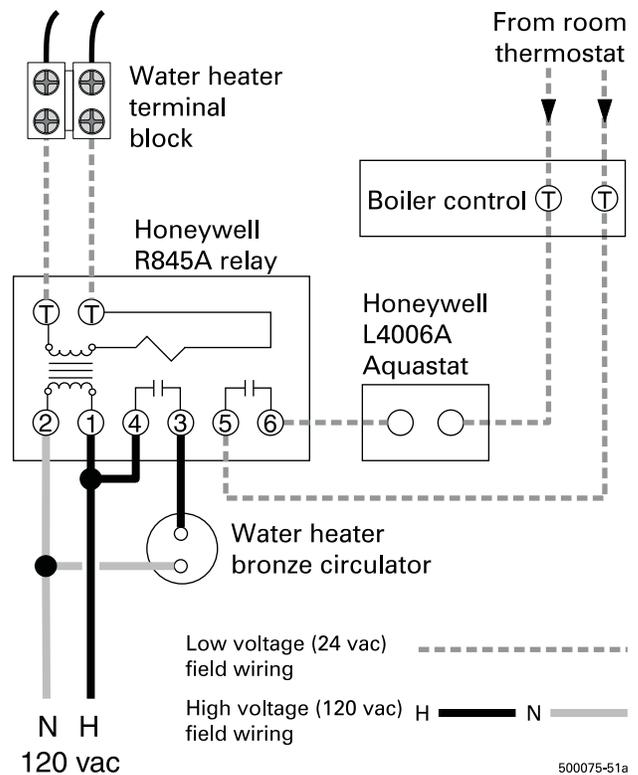
DO NOT install an air vent anywhere in the piping. The piping must be air tight.

3. Wire the water heater and circulator to the boiler per suggested wiring in Figure 15. The water heater must be wired and ready to operate before proceeding. Note that the L4006A aquastat is located in the boiler and sets a boiler operating temperature when there is no call for steam heating.

To fill the boiler and water heater:

1. Follow the procedure given in Figure 16, page 19 to fill the water heater piping.
2. Follow the boiler manual instructions to fill the steam boiler.

Figure 15 Typical wiring for connection to low-pressure steam boiler



Install the Honeywell L4006A aquastat in the boiler, below the water line. Set for a temperature of 180 to 190°F to control boiler temperature when there is no call for steam heating.

CAUTION

Valve 7, the memory stop valve, must be supplied, piped and adjusted as instructed. This valve allows cooler return water to mix with the hot water from the steam boiler. The valve is set to yield approximately 180°F water entering the circulator. Higher temperature water could cause cavitation in the circulator, damaging the impeller and shortening circulator life.

DO NOT connect the piping to the boiler’s mud leg. This would probably cause excessive sediment to enter the water heater piping, damaging the circulator.

The strainer in the circulator suction line must be serviced regularly. NOTE that noise from the circulator is a likely sign that the strainer is restricting circulator flow, causing cavitation.



Connecting to a low-pressure steam boiler *(continued)*

Figure 16 Low pressure steam boiler application — Domestic water heating using water pumped from steam boiler

Notes

- Locate flow / check valve as close as possible to water heater boiler side connections — to reduce heat loss between cycles.

NOTICE

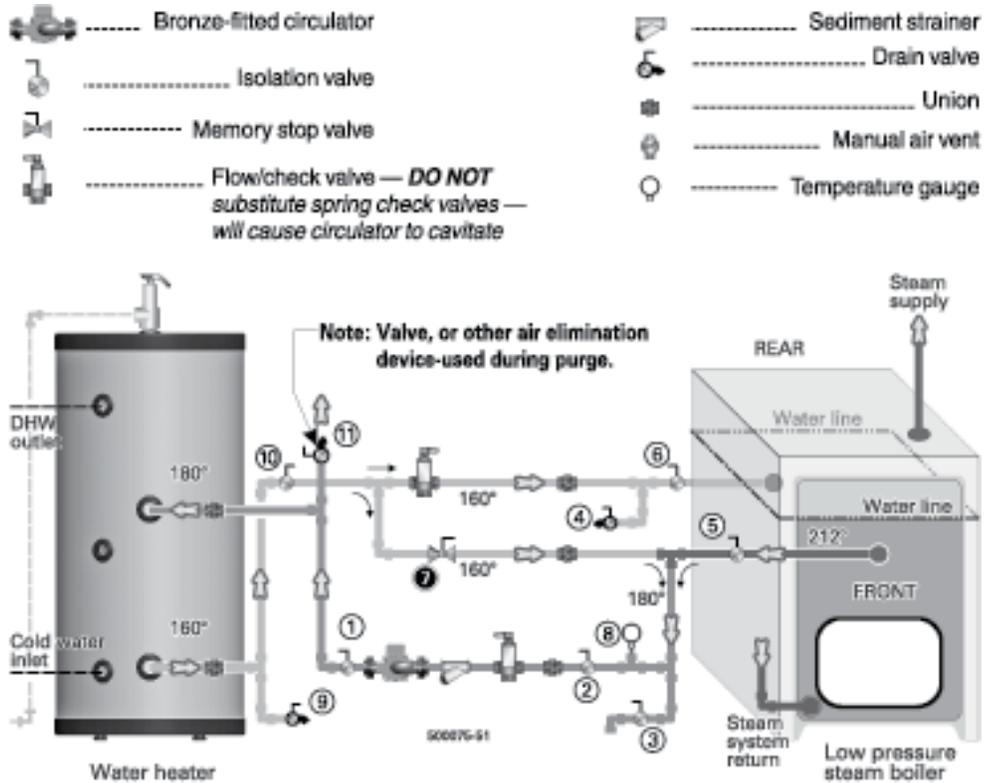
Use memory stop valve 7 to blend some of the water returning to the boiler with the hot water coming from the boiler. This will reduce the possibility of flashing (cavitation) in the circulator. Slowly open valve 7 until temperature gauge 8 reads 200°F.

Set the memory stop on valve 7 after adjusting. Attach a tag to the valve warning no to close or change valve position.

NOTE — If the boiler water level should drop below either the water heater boiler water supply or return line, the filling procedure will have to be repeated.

NOTICE

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- See boiler manual for specific details on installing the boiler.



Filling the piping

- Parts of the boiler water piping to the water heater may be higher than the water line, depending on the height of the water heater boiler supply connection. The piping must be air tight to prevent air from pocketing at the top of the piping, stopping flow.
 - The boiler **MUST** be filled and ready to operate before proceeding. Follow the boiler manual to fill the boiler.
 - Follow the procedure below to fill the boiler-to-water heater piping. See Figure 16.
- Step 1** Close isolation valves 5 and 6 to isolate the boiler.
- Step 2** Close valve 3 and open valve 4. Connect a cold water supply hose to valve 3. Connect a hose from valve 4 to a drainable location.
- Step 3** Close valve 10. Open valve 7.
- Step 4** Open valve 3. Water will flow through valve 7 and out through valve 4 to drain. Open valve 11. Let water run until all air has been removed from the line through valve 11. Close valve 11. Close valve 4. Then close valve 3.

- Step 5** Close valve 7. Then open valve 10.
- Step 6** Open valve 3. Water will flow through the circulator line, the water heater coil and the return piping, then out through valve 4 to drain. Let water run until all air has been removed from the line. Close valve 4. Then close valve 3. Remove hoses.
- Step 7** Follow the instructions in “Water heater filling and start-up,” page 23, to fill the domestic water side of the water heater.
- Step 8** Open valve 7 about ¼ turn for an initial setting.
- Step 9** Open isolation valves 5 and 6. Make sure the boiler water level is correct per the boiler manual.
- Step 10** Start the boiler per instructions given in the boiler manual. Allow boiler to begin steaming.
- Step 11** Start the DHW circulator. Watch the temperature at gauge 8. Adjust valve 7 until gauge 8 reads about 180°F with system at steady operation.
- Step 12** Continue checking under varying DHW demand conditions to ensure system will operate as required.



Boiler-side wiring and controls

⚠ WARNING **Electrical shock hazard** — Can cause severe personal injury, death or substantial property damage. Disconnect power before installing and/or servicing.

Wiring requirements

1. All wiring must be a minimum of 18 gauge and installed in accordance with:
 - U.S.A. — National Electrical Code and any other national, state or local code requirements having jurisdiction.
 - Canada — CSA C22.1 Canadian Electrical Code Part 1 and any other national, provincial and local code requirements having jurisdiction.
2. If original wire as supplied with appliance must be replaced, Type 90° C or its equivalent must be used.
3. Refer to control component instructions packed with boiler for application information.
4. An optional service switch may be installed in water heater electrical circuit. This switch would only shut off the water heater, not the home heating system. Do not shut off water heater if there is a chance of freezing.
5. All electrical contacts are shown with no power applied — off-the-shelf condition.

Circulators

1. Size priority relay for total amp draw of all circulators.

Zone Valves

1. Size transformer for maximum load of all zone valves.

Wiring to the water heater

1. Field connections to the water heater thermostat are for 24 VAC only, connecting to the two-pole terminal block shown in Figure 17.

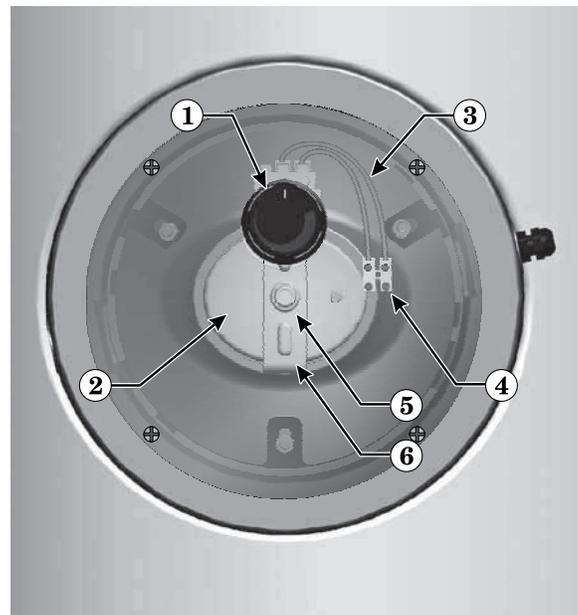
Wiring options

1. This manual shows wiring only for use of Weil-McLain WMCR Circulator Zone Controller or Weil-McLain WMZV Zone Valve Zone Controller.
2. Other wiring methods may be acceptable and are left to the installer.

Use domestic priority

1. When possible, set controls to provide domestic priority — that is, on a call for domestic water the control switches from space heating to DHW only.
2. Domestic priority ensures the fastest possible response to the DHW call for heat.
3. The smaller the water heater, the greater the need for rapid response.

Figure 17 Inspection hatch assembly (hatch cover shown transparent)



- | | |
|----------|--|
| 1 | Temperature adjustment knob |
| 2 | Inspection plate (handhole) |
| 3 | Factory wires from thermostat to field wiring terminal block |
| 4 | Field wiring terminal block |
| 5 | M8 hex nut |
| 6 | Inspection plate bracket |



Wiring — zoning with circulators

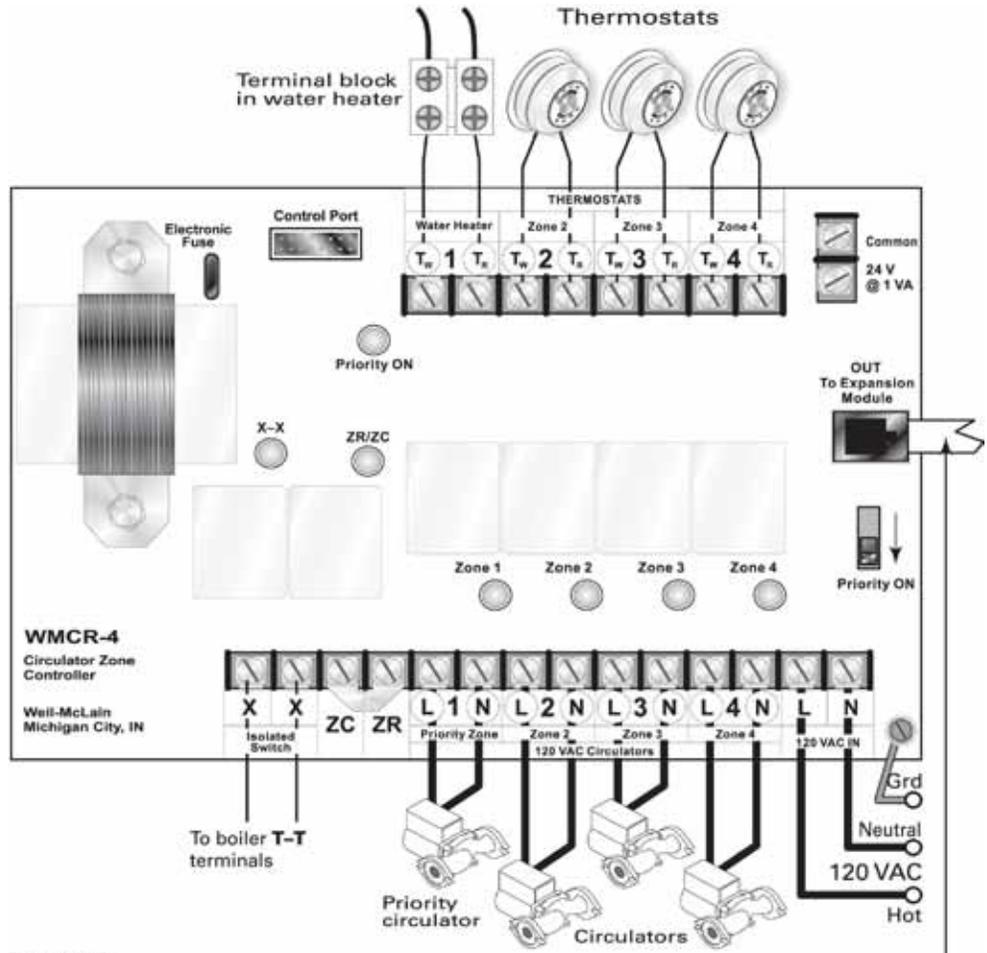
Figure 18 Typical wiring — zoning with circulators — DHW priority with Weil-McLain WMCR Circulator Zone Controller

Notes

- Also refer to the WMCR manual and *Weil-McLain Boiler Zone Wiring Guide* for further details.
- Refer to Wiring requirements on page 20.

System piping

- Figure 7, page 11
- Figure 8, page 12



Legend

- 24 VAC field wiring
- 24 VAC factory wiring
- 120 VAC ground lead
- 120 VAC field wiring
- 120 VAC factory wiring

Notice:
 WMCR-4 (4-zone control) is shown. Also available are:
 WMCR-2 (2-zone)
 WMCR-3 (3-zone)
 WMCR-6 (6-zone)

Optional:
 Provide additional zones by connecting to WMCR-1E or WMCR-4E Expansion Modules. See WMCR manual for examples.
DO NOT exceed a total of 15 zones.

50075-40

NOTICE

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2. Follow component manufacturer's instructions for installation of all items shown.
3. See boiler manual for specific details on installing the boiler.

NOTICE

ECO, Evergreen, GV90+, Ultra or WM97+ gas boilers:
DO NOT apply the drawings in this manual. Refer only to the boiler manual.



Wiring — zoning with zone valves

Figure 19 Typical wiring — zoning with zone valves — DHW priority with Weil-McLain WMZV Zone Valve Zone Controller

Notes

- Also refer to the WMZV manual and *Weil-McLain Boiler Zone Wiring Guide* for further details.
- Refer to Wiring requirements on page 20.

System piping

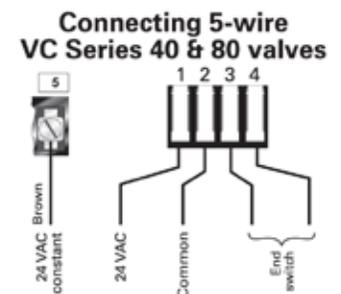
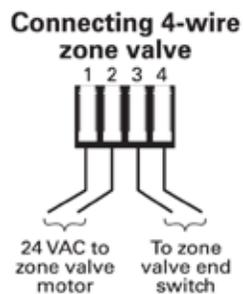
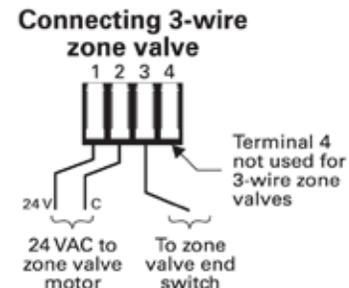
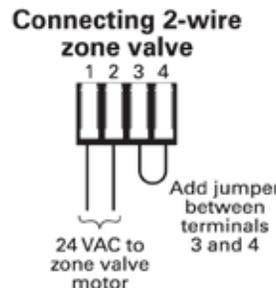
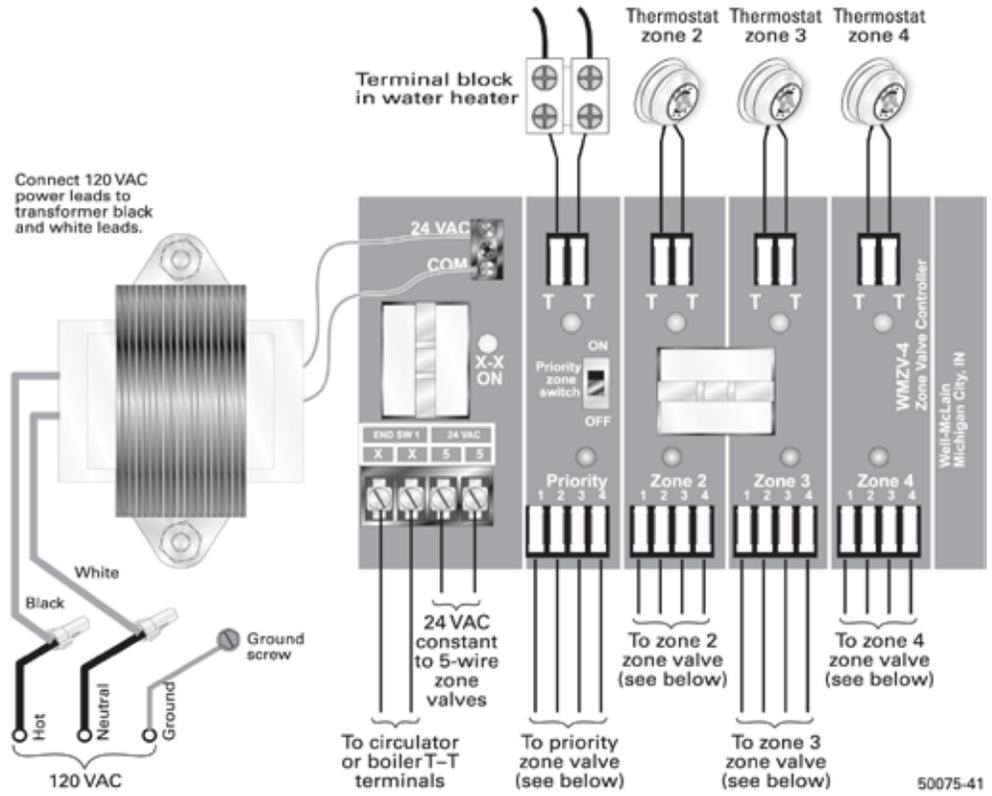
- Figure 9, page 13
- Figure 10, page 14

NOTICE

Install all zone valves per valve manufacturer's instructions.

NOTICE

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2. Follow component manufacturer's instructions for installation of all items shown.
3. See boiler manual for specific details on installing the boiler.



Legend

- 24 VAC field wiring
- 24 VAC factory wiring
- 120 VAC field wiring
- 120 VAC factory wiring
- 120 VAC ground lead

NOTICE

ECO, Evergreen, GV90+, Ultra or WM97+ gas boilers:
DO NOT apply the drawings in this manual. Refer only to the boiler manual.



Water heater filling and start-up

⚠ WARNING

The installation and water chemistry must meet the requirements below. Failure to comply could result in damage to the water heater, causing possible severe personal injury, death or substantial property damage.

Boiler water restrictions

- Thoroughly flush the boiler system (without water heater connected) to remove sediment.
- The water heater heat exchanger can be damaged by build-up or corrosion due to sediment.
- Boiler water (including additives) must be practically non-toxic, having toxicity rating or class of 1, as listed in Clinical Toxicology of Commercial Products.
- If antifreeze is used in boiler system:
 - Local codes may require a backflow preventer on cold water supply line.
 - Use antifreeze specifically intended for hydronic heating systems. Inhibited propylene glycol is recommended.
 - Follow boiler manual instructions for antifreeze usage.
 - Do not use automotive, ethylene glycol or petroleum-based antifreeze. Do not use any undiluted antifreeze.

Maximum boiler-side flow rate

- Select the boiler-side circulator carefully. The flow rate through the boiler side of the water heater must not exceed the values below. Higher flow rates could result in an input above the rating of the T&P valve.
- **Models AQUA PLUS-32, 42 and 52 — do not exceed 12 GPM.**
- **Models AQUA PLUS-80 and 105 — do not exceed 16 GPM.**

Filling the domestic water tank

1. Fill the domestic water tank with fresh water that meets the chemistry requirements above.
2. Do not exceed a fill pressure of 70 PSIG.

⚠ WARNING

When the water supply pressure is higher than 70 PSIG, make sure that a pressure-reducing valve is installed on the cold water supply line to prevent leakage from the T&P relief valve. A thermal expansion tank is also required.

3. Vent the piping as necessary to remove any trapped air.

Start-up and operation

1. Follow the “Start-up checklist,” page 23 to prepare for start-up.

Start-up checklist

- Verify that T&P relief valve is properly installed and piped as directed in this manual and per local code requirements.
- Verify that the DHW tank and boiler-side piping are complete and are filled with water and pressurized.
- Verify that all air has been bled from both domestic and boiler water systems.
- Verify that cold and hot water lines are correctly connected to domestic water system.
- Verify that supply and return piping from boiler is correctly connected to water heater.
- Check all fittings and piping for leaks.
- Verify that all wiring is installed correctly.
- Set water heater thermostat according to system requirements. See “Water heater temperature adjustment,” page 24.
- Start boiler according to the Boiler Manual.
- Verify that the boiler and water heater are operating correctly, per “Water heater temperature adjustment,” page 24.
- Review the following sections with the homeowner or system operator:
 - **Water Heater Start-Up**
 - **Adjusting Water Heater Temperature**
 - **Water Heater Maintenance**



Water heater temperature adjustment

General notes

- Household water usage patterns will affect water temperature at any faucet or shower.
 - Occasionally check temperature at each point of use, then adjust thermostat accordingly.
 - Always recheck temperature after adjusting thermostat.
- When hot water is used in repeated small quantities, a “stacking” effect can develop in hot water tank. The upper layer of water in tank can be much hotter than lower layers.
- Lowering the thermostat setting or installing automatic mixing valves as indicated in these instructions will reduce water temperature levels. Consult your installer or service technician.

⚠ WARNING At no time should boiler limit control be set above 200°F. This can cause severe personal injury, death or substantial property damage if ignored.

⚠ WARNING Studies have indicated that dangerous bacteria, including *legionella pneumophila*, can form in the potable water distribution system if certain minimum water temperatures are not maintained. Contact your local health department for more information.

Setting the thermostat

- The water heater thermostat is factory set to its lowest temperature. This may or may not be suitable for your needs.
- Turn thermostat knob **clockwise to increase** water temperature.
- Turn thermostat knob **counter-clockwise to reduce** water temperature.
- When decreasing temperature setting, the stored hot water must be drawn off before checking temperature at faucet.
- Check water temperature at a hot water faucet immediately after first heating cycle. Further temperature adjustment may be necessary as water heating system is used. Recheck water temperature at faucet after adjustment.
- When adjusting thermostat, be sure boiler limit control is set a minimum 20°F higher.

Figure 20 Water heater temperature adjustment knob (on lower front of water heater)



Hot Water Can Scald!

- Water heated to temperature for clothes washing, dish washing and other sanitizing needs can scald and cause permanent injury.
- Children, elderly, and infirm or physically handicapped persons are more likely to be permanently injured by hot water. Never leave them unattended in bathtub or shower. Never allow small children to use a hot water tap or draw their own bath.
 - If anyone using hot water in the building fits the above description, or if state laws or local codes require certain water temperatures at hot water taps, you must take special precautions:
 - Use lowest possible temperature setting.
 - Install some type of tempering device, such as an automatic mixing valve, at hot water tap or water heater. Automatic mixing valve must be selected and installed according to valve manufacturer's recommendations and instructions.
- Water passing out of drain valves may be extremely hot. To avoid injury:
 - Make sure all connections are tight.
 - Direct water flow away from any person.

Protection must be taken against excessive temperature and pressure! — Installation of a temperature & pressure (T&P) relief valve (provided with water heater) and a thermostatic mixing valve (provided by installer) is required.



Water heater maintenance

▲WARNING Boiler water — read and comply with all requirements under “Boiler water restrictions,” page 3.

▲WARNING Water from opened drain valves, unions and other connections may be extremely hot. To avoid severe personal injury, death or substantial property damage:

- Tighten all drain hose connections.
- Direct hot water away from all persons.

ATTENTION USER!

▲WARNING Have the water heater serviced at least once annually by a qualified service technician.

Follow the **maintenance procedures** below at least monthly.

Read “Water heater temperature adjustment,” page 24.

Failure to comply with the above can result in severe personal injury, death or substantial property damage.

MONTHLY maintenance by user

- At least **MONTHLY**, visually check valves, pipes and fittings for leaks.
- Check hot water supply at several outlets. Make sure water temperature is not too hot.
- Call qualified service technician to repair leaks or address problems.

MONTHLY maintenance by user

- At least **MONTHLY**, visually check valves, pipes and fittings for leaks.
- Check hot water supply at several outlets. Make sure water temperature is not too hot.
- Call qualified service technician to repair leaks or address problems.

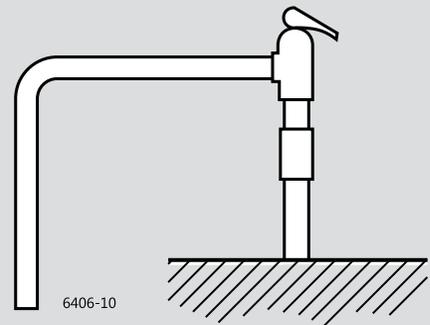
ANNUAL start-up by qualified service technician

NOTICE Obtain an Inspection and service kit (see “Replacement parts,” page 39) before attempting to perform the annual start-up. This kit contains items that will usually have to be replaced.

▲WARNING Check water supply temperature at several outlets to ensure the water temperature is acceptable for intended use and that all temperature control devices are functioning properly. Read page 3 and verify that all requirements are met by the installation.

Figure 21 T&P valve operation

▲WARNING Before operating the T&P relief valve, make sure no one is in front of or around the T&P relief valve discharge piping. Hot discharge water can cause severe personal injury or substantial property damage.



▲WARNING Plugging T&P relief valve or discharge piping can cause excessive pressure in the water heater, resulting in severe personal injury, death or substantial property damage.

Perform the following procedures:

- Perform any procedures required by local codes.
- Verify system pressure both on domestic water and boiler water sides.
- Manually operate T&P relief valve at least once a year (see Figure 21). This will release some hot water. Move operating lever to open position for a few seconds and then move it back, allowing it to snap closed. After T&P relief valve is operated, if it continues to release water, close cold water inlet to water heater immediately. Follow draining instructions, and replace the T&P relief valve. If T&P relief valve weeps periodically, it may be due to thermal expansion. Install an expansion tank if not already installed.
- Follow instructions on circulator to oil it, if oil-lubricated.
- Follow instructions in “Inspect anode and water heater interior,” page 26.
- Check valves, pipes and fittings for leaks.
- Check function of all controls and valves (see control manufacturer’s instructions).
- Review homeowner’s maintenance responsibilities and their frequencies, including any not listed in the following paragraphs.



Water heater maintenance *(continued)*

⚠ WARNING

The purpose of the **magnesium anode** is to reduce the damaging effects of aggressive water on the water heater. Aggressive water will cause the anode to erode.

The anode must be inspected at least annually to determine whether a new anode should be installed.

Severe or rapid deterioration of the anode indicates very aggressive water. If this occurs, have the water tested to verify whether it is within the limits given under “Operating restrictions,” page 3.

Failure to inspect the anode regularly and replace if necessary could result in damage to the water heater, causing possible severe personal injury, death or substantial property damage.

Inspect anode and water heater interior

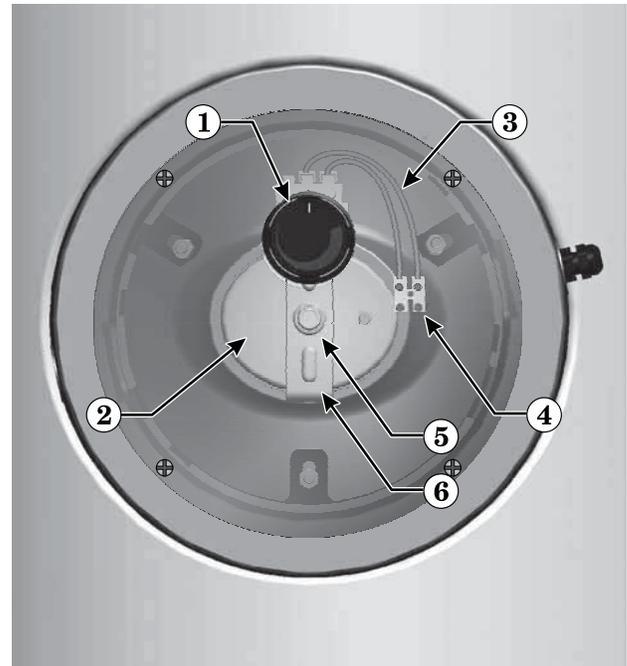
1. Close domestic water isolation valves.
2. Drain the water heater completely and allow it to cool off.
3. Remove the inspection hatch cover (Figure 24, page 39, item 8).
 - a. The temperature control bulb will have to be pulled out of the immersion well, located in the inspection plate.
4. After the water heater has drained and cooled, remove the inspection plate (Figure 22, page 26, item 2).

NOTICE

There will be some water remaining in the bottom of the water heater. This can be siphoned off or removed with a wet/dry vacuum.

- a. Partially unscrew the M8 hex nut (Figure 22, page 26, item 5) while holding the bracket (Figure 22, page 26, item 6). DO NOT completely remove the nut.
- b. Hold and turn the bracket 90 degrees, being careful not to drop the inspection plate inside the tank.
- c. Remove the inspection plate.
5. Use a work light or flash light to inspect the interior of the tank.
6. Use a plastic scraper if needed to remove any accumulation on the coil. DO NOT use abrasives or metallic objects.
7. Remove as much sediment as possible through the inspection opening.
8. Rinse the bottom and remove remainder with a wet/dry shop vacuum.
9. Remove the magnesium anode cover and anode (Figure 24, page 39, items 10 and 1).
10. Inspect the anode and replace if needed with part list in (Figure 24, page 39). See WARNING above.
11. Replace the inspection plate gasket if necessary. Then re-install the inspection plate. Align the gasket carefully. DO NOT over-tighten the bolt. This could damage or extrude the gasket, or distort the plate.

Figure 22 Inspection hatch assembly (hatch cover shown transparent)



- | | |
|---|--|
| 1 | Temperature adjustment knob |
| 2 | Inspection plate (handhole) |
| 3 | Factory wires from thermostat to field wiring terminal block |
| 4 | Field wiring terminal block |
| 5 | M8 hex nut |
| 6 | Inspection plate bracket |

12. Re-install the access cover hatch and tighten the four M8 Phillips-head screws. Do not over-tighten the screws.
13. Refill the water heater and restore to operation.
14. Verify operation of boiler and water heater.

Drain the water heater if necessary during shutdown periods

1. Drain the water heater if it will be shut off and exposed to freezing temperatures. Freezing water will expand and may damage water heater.
 - a. If boiler water contains sufficient antifreeze, then only the domestic water needs to be drained.
 - b. If boiler water does not contain sufficient antifreeze, then the boiler water and the domestic water must be drained.



Troubleshooting

Troubleshooting procedures

NOTICE

Follow the troubleshooting guidelines step by step. Always double-check your results. Skipping or not completing steps can lead to wrong conclusions, repeated callbacks to the job site and unhappy customers.

Preparation for troubleshooting

Tools needed

- Electrical meter to measure voltage and continuity.
- Pressure gauge (such as Watts #276H300 test gauge).
- Temperature gauge.
- Stopwatch.
- Bucket —
1 gallon or larger, with volume markings.

Suggested parts to have on hand.

- Tank thermostat (AquaStat) — see Replacement parts for part number.
- Inspection and service kit — see Replacement parts for part number.

Information needed before the service call

- Know the water heater model number.
- Know the boiler manufacturer and model number.
- Have the boiler manual and wiring and piping schematics readily available.
- Get the latest revisions from www.Weil-McLain.com.
- Review all manuals before leaving for the job site.



Troubleshooting *(continued)*

Figure 23 Typical problems and causes and page location for details

Problem	Check possible causes	Page
Insufficient hot water	YES →	<ol style="list-style-type: none"> 1 Undersized water heater? 2 Boiler system improperly sized? 3 Check component parts. 4 Check boiler operating temperatures.
	→ NO ↓	<ol style="list-style-type: none"> 5 Check location of flow control devices. 6 Check for air in the system. 7 Clean the boiler water system. 8 Check tank thermostat setting.
29		
Excessive domestic water temperature	YES →	<ol style="list-style-type: none"> 1 Reduce stacking <ul style="list-style-type: none"> • Lower boiler operating temperature.
	→ NO ↓	<ol style="list-style-type: none"> 2 Install a thermostatic mixing valve. 3 Install a recirculation loop.
32		
Boiler relief valve lifting or weeping	YES →	<ol style="list-style-type: none"> 1 Undersized expansion tank? 2 Faulty boiler expansion tank? 3 Faulty boiler relief valve?
	→ NO ↓	<ol style="list-style-type: none"> 4 Faulty boiler fill valve?
33		
Temperature/pressure relief valve lifting or weeping	YES →	<ol style="list-style-type: none"> 1 Undersized or missing domestic water side expansion tank? 2 Faulty domestic water side expansion tank? 3 Faulty T & P relief valve?
	→ NO ↓	<ol style="list-style-type: none"> 4 High domestic water supply pressure? 5 Possible water hammering or pressure spikes? 6 Check boiler operating temperature.
34		
Water on the floor near the tank	YES →	<ol style="list-style-type: none"> 1 Check for leaks from sources other than the water heater.
	→ NO ↓	<ol style="list-style-type: none"> 2 T & P relief valve lifting and discharging? 3 Loose piping connections?
35		
Top of tank or insulation wet	YES →	<ol style="list-style-type: none"> 1 Check for leaks from sources other than the water heater.
	→ NO ↓	<ol style="list-style-type: none"> 2 Loose piping connections?
35		
Water quality problems	YES →	<ol style="list-style-type: none"> 1 Water smells like “rotten eggs.” 2 Milky water.
	→ NO ↓	<ol style="list-style-type: none"> 3 Discolored water from the hot water faucet.
37		



Troubleshooting *(continued)*

Insufficient hot water

1 Undersized water heater?

- There are many methods of sizing various applications, i.e. ASHRAE sizing tables or ASPE domestic water heating design manual.
 - Confirm the water demand required for the application.
- Confirm the flow rates of the fixtures.
 - For example, was the tank sized for shower heads at 2.0 gpm, while the actual heads are 5.0 gpm?
 - Use a bucket and a stopwatch to determine fixture flow rates.
- Evaluate the hot water usage pattern for a day.
 - Is the peak demand unusually high for the application?
- Has the demand for domestic hot water changed since the system was installed?
 - A bathroom remodeling project with a newly installed whirlpool tub will substantially change the domestic water demand.

2 Boiler system improperly sized?

- Can the boiler provide the required output to meet the domestic water load? Determine the boiler domestic water capacity, GPH, by the following:

$$\text{Boiler DHW capacity, GPH} = \frac{\text{Boiler output Btuh}}{\text{Temp. rise } ^\circ\text{F} \times 8.33}$$

[Temp. rise °F = Required DHW temp. °F – Incoming temp. °F]

[8.33 = Density of water (lbs/gal) x 1 Btu/lb-°F]

- Example — A single family home with a 3.0 GPM shower fixture and a 150,000 Btuh output boiler capacity.
 - The shower demand of 3.0 GPM equals 180 GPH (60 times the GPM).
 - Is the boiler capacity enough to deliver this hot water flow at 115°F for an extended period? Determine the boiler capacity:

$$\text{Boiler DHW capacity, GPH} = \frac{150,000 \text{ Btuh}}{(115^\circ\text{F} - 50^\circ\text{F}) \times 8.33} = 277 \text{ GPH}$$

- The boiler is capable of delivering 277 GPH (or 4.6 GPM) continuously, which is enough for this application.
- Measure the BTU input to the boiler by clocking the gas meter or finding the oil flow rate based on nozzle size and pump pressure.
- Does the hot water system need to be wired for domestic priority? For systems in which either the storage or BTU's available are marginal it is recommended to wire the domestic water heater in a priority manner.
- Is the boiler piping to the water heater properly sized to allow the required flow rate for maximum BTU transfer? The temperature differential of the boiler supply and return water should be 20°F to 30°F.



Troubleshooting *(continued)*

Insufficient hot water *(continued)*

- Is the circulator between the boiler and the water heater properly sized to provide enough flow for maximum BTU transfer? Check the table below:

Pipe size	Flow, GPM	MBH	Pipe size	Flow, GPM	MBH
¾"	1 to 4	50 to 100	1½"	14 to 22	200 to 450
1"	4 to 8	100 to 180	2"	22 to 45	300 to 650
1¼"	8 to 14	160 to 300			

3 Check component parts.

- Is the domestic water thermostat functioning properly?
 - Check the water heater thermostat (requires an electrical meter).
 1. Disconnect the field wiring to the water heater thermostat terminals.
 2. Turn the thermostat knob to the highest setting — clockwise — to initiate a call for heat.
 3. Check for continuity across the water heater thermostat terminals. On a call for heat, these contacts should close.
 4. Continue checking for continuity while turning the thermostat knob to the lowest setting — counter clockwise — to satisfy the call for heat. The contacts should open, breaking the continuity.
 5. If any of these steps fail, replace the thermostat.
- Is the thermostat setting too low?
 - If the thermostat setting is too low, the boiler may not have the opportunity to deliver the maximum BTU's required to completely heat the entire volume of water stored in the tank.
- During a call for heat by the water heater, does the boiler circulator begin pumping, does the zone valve open, does the boiler fire? Check every component in the system to ensure they are properly functioning.



Troubleshooting *(continued)*

Insufficient hot water *(continued)*

4 Check boiler operating temperatures.

- If possible, increase the boiler operating temperature to 180°F or 200°F.
- Maintain a minimal temperature in the boiler during non-heating seasons.
 - A boiler typically has a higher standby loss than the indirect water heater.
 - After a long standby period, the colder boiler may absorb the stored energy within the water heater during the initial call for heat.

5 Check location of flow control devices.

- Lab tests have shown that during long standby periods the boiler piping can act as a thermal siphon and draw stored heat from the domestic water.
 - Locate flow control devices (zone valve, spring check valves...) or heat trap loops in the boiler piping close to the water heater.
 - Insulate all boiler piping to and from the water heater.

6 Check for air in the system; check water heater air vent.

- An air-bound water heater or boiler will not circulate system water properly, resulting in a lack of heat transfer.

7 Clean the boiler water system.

- A dirty boiler system can cause deposits to form on the water heater coil. This insulates the coil, reducing the heat transfer.
 - Clean the boiler system per the boiler manufacturer's instructions.
- Install a strainer in the boiler piping on older installations or for systems likely to carry sediment.



Troubleshooting *(continued)*

Excessive domestic water temperature

1 Reduce stacking.

- Excessive water temperature is usually the result of stacking within the water heater.
 - Stacking is the occurrence of various water temperatures layering within the water heater with the hottest water in the uppermost layer.
 - This layering or stacking effect typically occurs during small draws of hot water (typically less than 25% of the storage capacity) that are long enough to create a call for heat on the thermostat, but are short enough not to deplete the stored energy within the tank.
 - Excessive stacking can occur when frequent short-to-moderate draws are taken in quick succession.
 - During this condition, the temperature of the domestic water can approach the temperature of the boiler water.
- REMEMBER — All water heaters (direct or indirect) will stack.
- To reduce stacking within the tank:
 - Reduce the boiler operating temperature to 160°F - 170°F. This will limit the maximum domestic outlet water temperature during high stacking water usage.

2 Install a thermostatic mixing valve.

- Installing a thermostatic mixing valve will provide uniform delivery temperature with minimal regard to water usage.

3 Install a recirculation loop.

- Installing a properly-sized recirculation loop not only provide prompt delivery of hot water, but it will provide circulation and mixing of the water within the tank.



Troubleshooting *(continued)*

Boiler relief valve lifting or weeping

1 Undersized expansion tank?

- Insufficient allowance for expansion on the boiler side can cause the boiler pressure relief valve to lift.
- The additional quantity of boiler water contained in the outer tank must be considered when sizing the boiler side expansion tank.

AQUA PLUS model	Boiler side volume — gallons
35	1.6
45	1.9
55	2.2
85	2.5
105	3.5

2 Faulty boiler expansion tank?

- Is the expansion tank defective, waterlogged or improperly charged?
 - Check for failed gaskets or bladders, or a faulty Schraeder valve.
 - Use a tire gauge to check the charge pressure of the tank.
- Turn the boiler limit up to a higher setting and let the system run at a higher temperature. This will simulate maximum expansion in the boiler system.
 - If the boiler relief valve lifts and/or there is a significant increase in the boiler system pressure, the expansion tank is flooded or undersized.

3 Faulty boiler relief valve?

- Is the boiler pressure relief valve functioning properly? Dirt and water deposits can accumulate under the valve seat.

4 Faulty boiler fill valve?

- Is the valve filling to the correct pressure?



Troubleshooting *(continued)*

Temperature/pressure relief valve lifting or weeping

1 Undersized or missing domestic water side expansion tank?

- Is there a thermal expansion tank installed on the domestic supply piping and is it properly sized?
 - A thermal expansion tank is required if the domestic supply piping includes a backflow preventer or pressure reducing valve.
 - Ensure the potable water expansion tank is properly sized according to the water heater volume and supply pressure.
 - During long periods when there are no draws from the tank (i.e. overnight), the T&P relief valve may lift or weep due to thermal expansion, but may function properly during normal periods of tank draws.

2 Faulty domestic water side expansion tank?

- Is the expansion tank defective, water logged or improperly charged?
 - Check for failed gaskets or bladders, or a faulty Schraeder valve.
 - Use a tire gauge to check the charged pressure of the tank.

3 Faulty T&P relief valve?

- Is the temperature/pressure relief valve functioning properly? Dirt and water deposits can accumulate under the valve seat.

4 High domestic water supply pressure?

- Check the domestic supply pressure entering the water heater.
 - If the pressure is over 70 psi it is recommended to install a pressure reducing valve. A thermal expansion tank is required if a PRV is installed.
 - This will prevent any pressure spikes or increases in pressure due to thermal expansion which may cause the T&P valve to lift or weep.

5 Possible water hammering or pressure spikes?

- Check the domestic system for possible sources of water hammering or pressure spikes.
 - Some appliances such as clothes washers and dishwashers utilize fast acting valves which may cause water hammering or pressure spikes through the domestic water system.
- Install water hammer arrestors as required per the manufacturer's instructions, or install flexible connectors to isolate the tank from the domestic system.

6 Check boiler operating temperature.

- If the boiler operating temperature is too high, stacking can occur in the water heater raising the domestic water temperature close to the boiler operating temperature. — Reduce the boiler operating temperature to 180°F. Also follow page 32 suggestions if the problem persists.



Troubleshooting *(continued)*

Water on the floor near the tank

1 Check for leaks from sources other than the water heater.

- Check for possible water seepage through foundation cracks. Did the water appear after a heavy rain?

2 Is the source of water from the T&P relief valve?

- Place a bucket under the discharge piping of the T&P relief valve and monitor it for a day or two. This is a procedure that can be done by the homeowner.
- If the T&P relief valve is the source, refer to page 34 of this guide.

3 Loose piping connections?

- Check all connections – boiler connections, domestic connections, etc.
- Check all the boiler connections to the water heater.
 - A build-up of corrosion is a sure sign of a leak.
- Excessive force or water hammer can damage the welds where the piping connections enter the water heater tank.
 - If water is leaking from around one of the tank connections, a weld may have been broken. Contact your Weil-McLain supplier to determine how to handle the problem.

Top of tank or insulation wet

1 Check for leaks from sources other than the water heater

- Check for possible overhead pipes leaking onto the tank.

2 Loose piping connections?

- Check all connections – piping connections to the tank and elsewhere in the vicinity.
- Check around valve stems.
- A build-up of corrosion around a joint is a sure sign of a leak.



Troubleshooting *(continued)*

Rapid decay of magnesium anode

1 Anodes last less than two years



The purpose of the **magnesium anode** is to reduce the damaging effects of aggressive water on the water heater. Aggressive water will cause the anode to erode.

The anode must be inspected at least annually to determine whether a new anode should be installed.

Severe or rapid deterioration of the anode indicates very aggressive water. If this occurs, have the water tested to verify whether it is within the limits given under “Operating restrictions,” page 3.

Failure to inspect the anode regularly and replace if necessary could result in damage to the water heater, causing possible severe personal injury, death or substantial property damage.



Troubleshooting *(continued)*

Water quality problems

1 Water smells like “rotten eggs.”

- The most common cause of water to smell like “rotten eggs” is a non-toxic sulfate reducing bacteria.
 - The bacteria usually enters into the water system through a break in the supply piping or during construction/maintenance of the supply piping.
 - The bacteria survives in the water system by converting sulfate (SO_4) in the water to hydrogen sulfide (H_2S) gas.
 - It is this gas that creates the “rotten egg” smell.
 - The presence of hydrogen sulfide can also affect the taste of the water.
- Along with the stench caused by this bacteria, black deposits that typically indicate pipe and/or fitting corrosion may also appear in the water.

▲WARNING In extremely high concentrations, hydrogen sulfide gas can be toxic. However, the gas is detectable prior to reaching harmful levels.

- The bacteria will thrive in any water system under the following conditions:
 - High levels of sulfur in the water.
 - Activated hydrogen in the water from cathodic reactions within the tank.
 - Water with little or no dissolved oxygen.
 - Storing the domestic water below 130°F.
- Other causes of smelly water:
 - Chlorides of magnesium and calcium gives water a bitter taste.
 - Chloride of sodium will produce a salty tasting water.
 - Sulfates above 50 ppm in the water gives the water a medicinal taste.
 - Carbon dioxide in water with a low pH results in water that is fizzy.
 - Iron and tannic waters will produce water with a bad taste and odor.
- Treatment
 - The treatment of this situation requires the water system to be shock-chlorinated. Depending on the severity of the bacteria within the water system, several treatments may be needed.

2 Milky water.

- When water is initially drawn from the faucet it appears to be milky or cloudy, but it becomes clear after the water is allow to stand for several minutes.
 - This is usually an indication that the water contains high levels of soluble gases, such as oxygen, chlorine, carbon dioxide, hydrogen sulfide or others.
 - As the water system pressure increases, the amount of gas that water can hold in a solution decreases.
 - When air and gases are forced out of the heated water, the problem may be evident in one or both of the following conditions:
 - Gases, in the form of small bubbles, may make the water appear milky from the tap, but clear after several minutes when those bubbles will separate.



Troubleshooting *(continued)*

Water quality problems *(continued)*

- This is similar to the reaction that occurs as air bubbles form on the walls of a pan shortly before the water begins to boil.
- The release of dissolved gas can also create air pockets and air locks in the water system piping. This can cause spurts of air or gases when opening the hot water faucet.
- There is generally no cure for milky water caused by dissolved gases, although it can be reduced with aerated faucets. In some applications the amount of air and gases precipitating out of the water will be reduced in time. It should be noted that these gases are not harmful to the end user.

3 Discolored water from the hot water faucet.

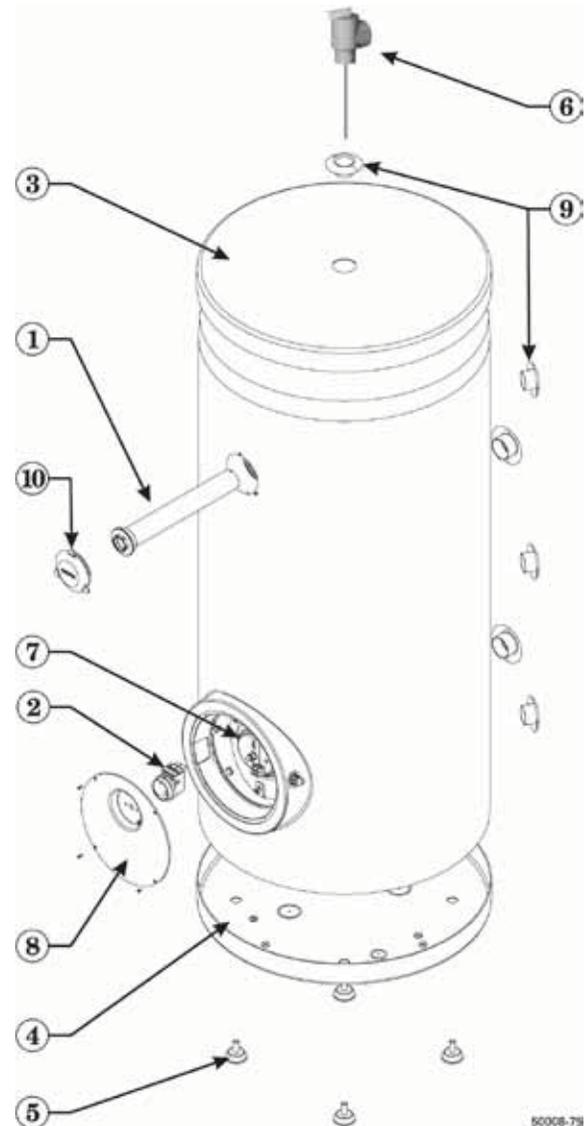
- The water from the hot water faucet appears discolored, either rusty, brown, black or yellow.
 - Because the tank is stainless steel, which is resistant to corrosion, the problem is not tank-related.
 - The problem is usually a non-toxic iron-reducing bacteria that is commonly found in soil, well water, water treatment plants and piping systems.
 - The bacteria usually thrives in systems in which the soluble iron exceeds 0.2 ppm.
 - The bacteria will feed on the soluble iron in the water, producing “rusty-color” water as a by-product of the feeding process.
- Variables in which the bacteria can thrive:
 - Elevated levels of iron and manganese in the water.
 - Water with little or no dissolved oxygen.
 - Water storage temperatures below 140°F.
- Items that can potentially increase the presence of the bacteria:
 - Water softeners.
 - Well water.
 - Long periods of no water movement.
- Treatment
 - Treatment requires the water system to be shock-chlorinated.
 - Depending on the severity of the bacteria within the water system, several treatments may be needed.
 - Check the pH and chlorides of the water in the water heater tank and the boiler system.
 - The pH must be between 6 and 8.
 - Chlorides must be less than 200 ppm.
 - Note the pH and chloride readings on the warranty sheet.
- Items that can affect the pH reading:
 - Water softeners.
 - Water treatment plants.
 - Cl (chlorides) added, especially during the summer.
 - Fl (fluorides) added in treatment in large cities.
 - Elevated levels of iron, manganese, and sulfur.
- If the pH is high or low, this has a major effect on the metal tanks, piping and heat transfer surfaces.



Replacement parts

Figure 24 Water heater replacement parts

Item	Description	Size/Model AQUA PLUS	Weil-McLain Part Number
1	Magnesium anode replacement kit (includes anode, o-ring, insulating washer and brass bushing)	35/45/55/85	633-500-014
		105	633-500-016
2	Thermostat repair kit	Aqua PLUS Residential (35/45/55/85)	633-500-020
		Aqua PLUS Commercial (105)	633-500-021
3	Top plastic cap replacement kit	35/45/55	633-500-024
		85	633-500-025
		105	633-500-026
4	Bottom plastic cap replacement kit (plastic cap and 4 screws)	35/45/55	633-500-030
		85	633-500-031
		105	633-500-032
5	Leveling leg replacement kit (4)	All	633-500-036
6	Temperature & pressure relief valve kit	35/45/55	633-500-038
		85/105	633-500-039
NS	Inspection and service kit (includes inspection plate and anode seals)	All	633-500-042
7	Inspection plate replacement kit	All	633-500-044
8	Inspection hatch cover replacement kit	All	633-500-046
9	Fitting grommet	¾" 1"	633-500-064 633-500-037
10	Anode cover	All	633-500-048
NS	Jacket replacement kit	35, Pewter	633-500-049
		45, Pewter	633-500-050
		55, Pewter	633-500-051
		85, Pewter	633-500-052
		105, Pewter	633-500-053
NS	Mixing valve kit, 1"	All	633-500-012





AHRI ratings



Model AQUA PLUS	AHRI certified ratings									
	180°F boiler water entering 58°F to 135°F domestic water									
	First Hour Rating	Continuous Draw Rating	Minimum Heat Output Rate	Minimum Heat Source Flow Rate	Heat Source Friction Loss	First Draw Rating	Standby Loss	Potable Volume	Heat Source Volume	
(Gal/hr)	(Gal/hr)	(MBH)	GPM	Feet w.c.	(Gal/hr)	Degrees F per hour	(Gal)	(Gal)		
35	229	204	115	10.0	2.5	25	1.5	29.6	1.7	
45	263	228	125	11.0	8.8	35	1.2	39.9	1.9	
55	316	266	167	13.9	5.0	50	1.0	53.1	2.2	
85	330	270	175	12.0	6.5	60	0.8	80.6	2.4	
105	448	373	220	14.0	8.0	75	0.7	109.4	3.5	



Ratings with 200°F boiler supply water

NOTICE

For water heater to achieve the rated performance below: Boiler water must be supplied to the water heater at 200°F, and the boiler water flow rate must be no less than given in the tables below. (For Ultra Gas boiler, Ultra Oil boiler or GV90+ boiler applications, with supply water at 190°F, see the ratings in the boiler manual.)

Boiler Heating Capacity MBH	First Hour Rating Capacity (GPH) — Boiler Water Supply at 200°F										
	⚠ WARNING DO NOT exceed the boiler-side flow rate listed in “Maximum boiler-side flow rate,” page 23										
	DHW temps	AQUA PLUS 35	Boiler Water Min GPM & Head Loss	AQUA PLUS 45	Boiler Water Min GPM & Head Loss	AQUA PLUS 55	Boiler Water Min GPM & Head Loss	AQUA PLUS 85	Boiler Water Min GPM & Head Loss	AQUA PLUS 105	Boiler Water Min GPM & Head Loss
50	DHW 50°F to 140°F	93	8 GPM minimum @ 1.6 ft wc	103	8 GPM minimum @ 1.6 ft wc	124	8 GPM minimum @ 1.6 ft wc	138	14 GPM minimum @ 5.4 ft wc	148	14 GPM minimum @ 7.1 ft wc
70		120		130		151		165		175	
90		147		157		178		192		202	
110		174		184		205		219		229	
130		201		211		232		246		256	
150		223		237		259		273		283	
170		223		243		286		300		310	
190		223		243		302		327		337	
210		223		243		302		354		363	
250		223		243		302		374		417	
300		223		243		302		374		483	
350		223		243		302		374		483	
400		223		243		302		374		483	
450		223		243		302		374		483	
500		223		243		302		374		483	
50	DHW 50°F to 115°F	119	8 GPM minimum @ 1.6 ft wc	129	8 GPM minimum @ 1.6 ft wc	150	8 GPM minimum @ 1.6 ft wc	164	14 GPM minimum @ 5.4 ft wc	174	14 GPM minimum @ 7.1 ft wc
70		157		166		188		201		211	
90		194		203		225		239		249	
110		231		241		262		276		286	
130		268		278		299		313		323	
150		306		315		337		351		360	
170		337		352		374		388		398	
190		337		363		411		425		435	
210		337		363		443		462		472	
250		337		363		443		537		547	
300		337		363		443		551		640	
350		337		363		443		551		715	
400		337		363		443		551		715	
450		337		363		443		551		715	
500		337		363		443		551		715	



Ratings with 190°F boiler supply water

NOTICE

For water heater to achieve the rated performance below: Boiler water must be supplied to the water heater at least 190°F, and the boiler water flow rate must be no less than given in the tables below.

Boiler Heating Capacity MBH	First Hour Rating Capacity (GPH) — Boiler Water Supply at 190°F										
	⚠ WARNING DO NOT exceed the boiler-side flow rate listed in “Maximum boiler-side flow rate,” page 23										
	DHW temps	AQUA PLUS 35	Boiler Water Min GPM & Head Loss	AQUA PLUS 45	Boiler Water Min GPM & Head Loss	AQUA PLUS 55	Boiler Water Min GPM & Head Loss	AQUA PLUS 85	Boiler Water Min GPM & Head Loss	AQUA PLUS 105	Boiler Water Min GPM & Head Loss
50	DHW 50°F to 140°F	93	8 GPM minimum @ 1.6 ft wc	103	8 GPM minimum @ 1.6 ft wc	124	8 GPM minimum @ 1.6 ft wc	138	14 GPM minimum @ 5.4 ft wc	148	14 GPM minimum @ 7.1 ft wc
70		120		130		151		165		175	
90		147		157		178		192		202	
110		174		184		205		219		229	
130		201		211		232		246		256	
150		202		222		259		273		283	
170		202		222		278		300		310	
190		202		222		278		327		337	
210		202		222		278		343		363	
250		202		222		278		343		417	
300		202		222		278		343		442	
350		202		222		278		343		442	
400		202		222		278		343		442	
450		202		222		278		343		442	
500		202		222		278		343		442	
50	DHW 50°F to 115°F	119	8 GPM minimum @ 1.6 ft wc	129	8 GPM minimum @ 1.6 ft wc	150	8 GPM minimum @ 1.6 ft wc	164	14 GPM minimum @ 5.4 ft wc	174	14 GPM minimum @ 7.1 ft wc
70		157		166		188		201		211	
90		194		203		225		239		249	
110		231		241		262		276		286	
130		268		278		299		313		323	
150		306		315		337		351		360	
170		311		335		374		388		398	
190		311		335		411		425		435	
210		311		335		411		462		472	
250		311		335		411		511		547	
300		311		335		411		511		640	
350		311		335		411		511		662	
400		311		335		411		511		662	
450		311		335		411		511		662	
500		311		335		411		511		662	



Ratings with 180°F boiler supply water

NOTICE

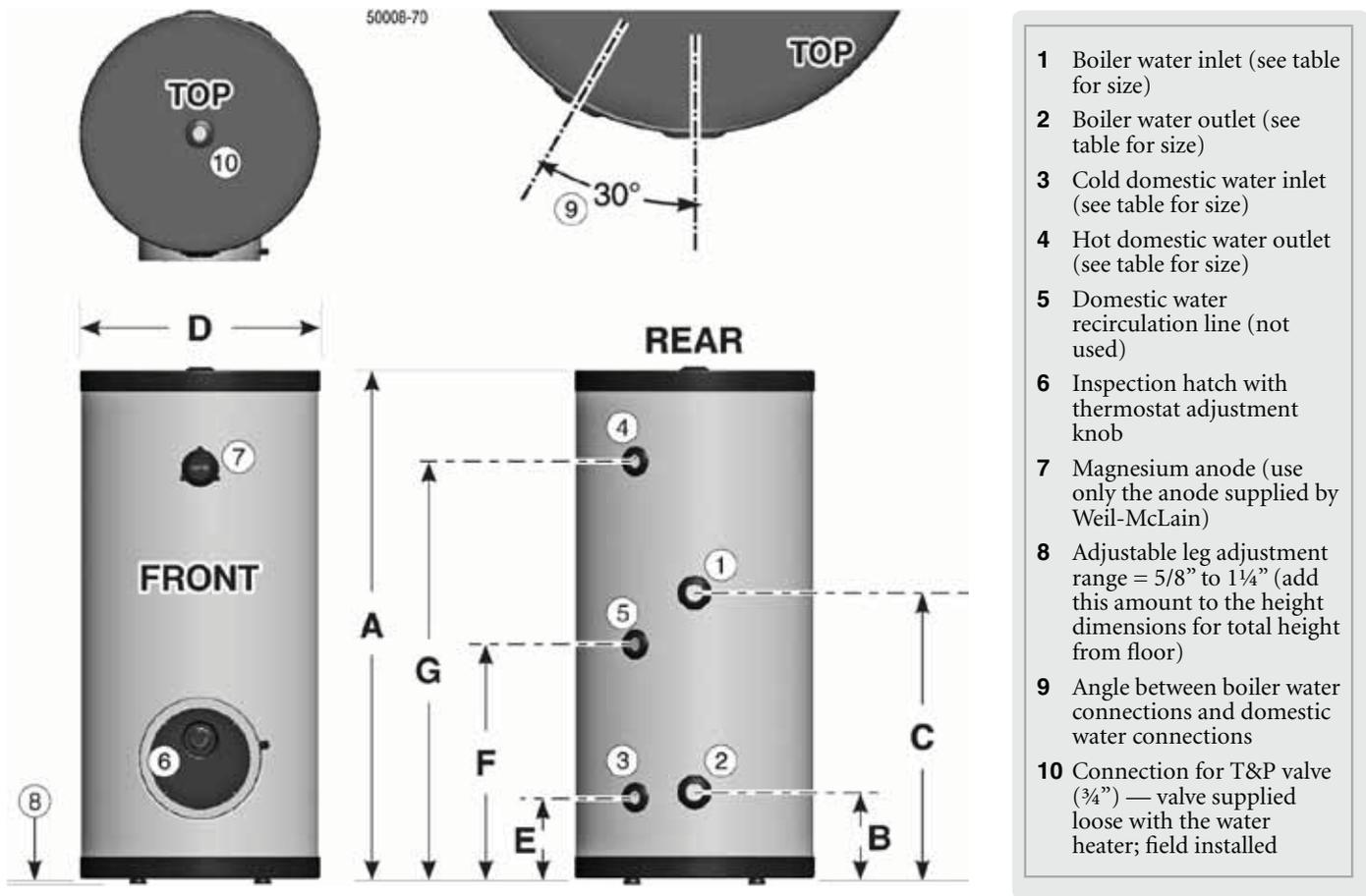
For water heater to achieve the rated performance below: Boiler water must be supplied to the water heater at least 180°F, and the boiler water flow rate must be no less than given in the tables below.

Boiler Heating Capacity MBH	First Hour Rating Capacity (GPH) — Boiler Water Supply at 180°F										
	⚠️ WARNING DO NOT exceed the boiler-side flow rate listed in “Maximum boiler-side flow rate,” page 23										
	DHW temps	AQUA PLUS 35	Boiler Water Min GPM & Head Loss	AQUA PLUS 45	Boiler Water Min GPM & Head Loss	AQUA PLUS 55	Boiler Water Min GPM & Head Loss	AQUA PLUS 85	Boiler Water Min GPM & Head Loss	AQUA PLUS 105	Boiler Water Min GPM & Head Loss
50	DHW 50°F to 140°F	93	8 GPM minimum @ 1.6 ft wc	103	8 GPM minimum @ 1.6 ft wc	124	8 GPM minimum @ 1.6 ft wc	138	14 GPM minimum @ 5.4 ft wc	148	14 GPM minimum @ 7.1 ft wc
70		120		130		151		165		175	
90		147		157		178		192		202	
110		174		184		205		219		229	
130		181		200		232		246		256	
150		181		200		252		273		283	
170		181		200		252		300		310	
190		181		200		252		310		337	
210		181		200		252		310		363	
250		181		200		252		310		400	
300		181		200		252		310		400	
350		181		200		252		310		400	
400		181		200		252		310		400	
450		181		200		252		310		400	
500		181		200		252		310		400	
50	DHW 50°F to 115°F	119	8 GPM minimum @ 1.6 ft wc	129	8 GPM minimum @ 1.6 ft wc	150	8 GPM minimum @ 1.6 ft wc	164	14 GPM minimum @ 5.4 ft wc	174	14 GPM minimum @ 7.1 ft wc
70		156		166		187		201		211	
90		193		203		224		238		248	
110		231		240		262		275		285	
130		268		277		299		313		322	
150		284		307		336		350		360	
170		284		307		373		387		397	
190		284		307		378		424		434	
210		284		307		378		461		471	
250		284		307		378		470		545	
300		284		307		378		470		608	
350		284		307		378		470		608	
400		284		307		378		470		608	
450		284		307		378		470		608	
500		284		307		378		470		608	



Dimensions

Figure 25 Dimensions and ratings — AQUA PLUS indirect-fired water heaters



- 1 Boiler water inlet (see table for size)
- 2 Boiler water outlet (see table for size)
- 3 Cold domestic water inlet (see table for size)
- 4 Hot domestic water outlet (see table for size)
- 5 Domestic water recirculation line (not used)
- 6 Inspection hatch with thermostat adjustment knob
- 7 Magnesium anode (use only the anode supplied by Weil-McLain)
- 8 Adjustable leg adjustment range = 5/8" to 1 1/4" (add this amount to the height dimensions for total height from floor)
- 9 Angle between boiler water connections and domestic water connections
- 10 Connection for T&P valve (3/4") — valve supplied loose with the water heater; field installed

Model AQUA PLUS	Storage		Connections		Dimensions (inches)							Ship. weight (approx.)
	DHW side	Boiler side	DHW In/Out	Boiler water In/Out	A	B	C	D	E	F	G	
	Gallons	Gallons	Inches NPT	Inches NPT	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pounds
35	29.6	1.7	3/4	1	36 3/8	7 7/8	24	21 7/8	7 3/8	17 5/8	28	94
45	39.9	1.9	3/4	1	46 1/4	7 7/8	26	21 7/8	7 3/8	21 1/4	37 7/8	111
55	53.1	2.2	3/4	1	60	7 7/8	29 7/8	21 7/8	7 3/8	28 1/8	51 5/8	122
85	80.6	2.4	1	1	59 1/2	10 3/8	33 1/4	26	8 7/8	31 1/2	50 3/8	223
105	109.4	3.5	1	1	59 3/4	14 1/4	41 3/8	30	9 7/8	29 5/8	48 5/8	238



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