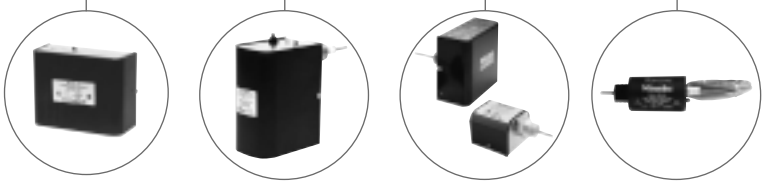
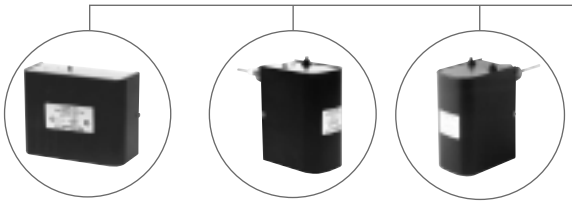
Understanding Residential Electronic Boiler Controls

Technical Guide

Hot Water Boilers



Steam Boilers



McDonnell & Miller

ITT Industries

Engineered for life

Get Control

McDonnell & Miller wants to help you Get Control. Control over the issues that affect the safe installation and maintenance of residential boilers… and to give you a better understanding of the features now available on today's boiler controls.

Experts agree… ALL boilers need low-water cutoff protection.

"All steam and hot boilers shall be protected with a low water cut-off control. The low water cut-off shall automatically stop the combustion operation of the equipment when the water level drops below the lowest safe water level as established by the manufacturer."

International Mechanical Code

"The ONLY thing that can protect a boiler against low water condition is a low water cut-off."

Dan Holohan
(hydronic heating consultant)

"A hot water boiler installed above radiation level must be must be provided with a low water cut-off device. Either as a part of the boiler or at the time of installation."

Boiler manufacturers

BOCA, the Southern Building Code Congress International and the Uniform Building Code recognize the importance of low-water cutoffs as safety features. These organizations assisted in drafting the IMC, a uniform code to require installation of low-water cutoffs on hot water boilers. More states are now requiring them, such as New Jersey, Connecticut and Rhode Island. Manufacturers also recommend using a low-water cutoff with hot water boilers particularly in applications located above radiation, such as perimeter heat, snow melt, slab on grade, and with indirect water heaters.

Index

Steam Boilers

They've been with us for over two hundred years, and most of the time, they're so reliable most folks don't give them much thought. They sit in buildings all over the world, transferring heat from fuel to water, allowing us to warm our buildings or complete our processes.

Steam boilers are simple, efficient and reliable. No machine does a better job of moving BTUs from one place to another. We've used them for space heating since before the United States Civil War in 1861.

Even before the Civil War, we used steam boilers for industrial processes. Today we use them to run factories, press clothes, wash dishes, pasteurize milk, sterilize medical equipment, and to heat entire cities! Their capabilities seem endless.

But despite its simplicity, any steam boiler can run into trouble if its control system doesn't act properly. If the energy you put into the boiler exceeds what the boiler can absorb, the boiler can rupture. So you must always be on guard.

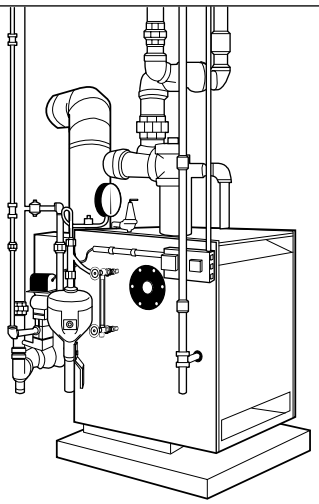
A simple safety relief valve of the right capacity and relief-pressure setting protects the boiler from over pressure. But over pressure isn't the only thing that can threaten a steam boiler. There are also the dangers of dry firing.

Should the internal water level drop too low, the boiler can burn out. So here too, you must always be on guard. You see, a steam boiler needs its water to move the heat away from its metal surfaces. Without the right internal level of water, heat quickly accumulates. Too much heat creates a very dangerous operating condition.

Boiler manufacturers have always set up minimum safe water level requirements for their equipment. Our controls help enforce those requirements in two ways:

- By maintaining a minimum safe water level in the boiler.
- By signaling the burner to stop should the water level drop below that point.

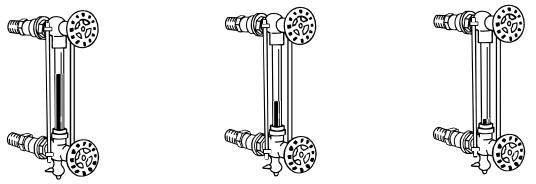
In this brief Systems Guide we will explain how we do these two very important jobs.



Steam Boilers

What's a "Normal" Water Level?

The proper steam boiler water level varies from manufacturer to manufacturer, but generally, we can say that it's "normal" to start by manually filling the boiler to the two-thirds-full point on the gauge glass. As the boiler operates, the water will quickly turn to steam and head out toward the system.



Gauge Glass Two-Thirds Full | **Gauge Glass One-Third Full** | **Gauge Glass Minimum Safe Water Level**

Steaming takes place at a constant rate of about one-half gpm per 240,000 BTU/HR (D.O.E. Heating Capacity Rating). This is a law of physics so it doesn't vary from manufacturer to manufacturer. If you're working with a boiler with a rating of, say, 1,000,000 BTU/HR, you can be assured the water is turning to steam and leaving that boiler at the rate of about two gpm. And it's leaving at speeds measured in miles per hour (sometimes exceeding 60 mph!). So it's very important for your near-boiler piping to be correct. If it's not, the fast moving steam will pull water out of the boiler and create problems for you in the system and the boiler.

As the water (in the form of steam) heads out toward the system, the water level in the boiler will, of course, drop. How far it drops, depends a lot on the size and condition of your piping system. You see, ideally, the water should begin to return to the boiler before the boiler's internal water line drops to a critical point. That's the point at which the low water cut-off will cut power to the burner, or an automatic water feeder will open.

Because the water is in the system piping and radiating during operation, the "normal" water level becomes a point that's somewhere in the lower-third of the gauge glass.

Remember, you're working with a range of operation here, not a fixed point. If the water were to stay at the top of the gauge glass all the while the burner was firing, you probably wouldn't be making steam! So don't get too caught up with the word "normal" because the only thing that's normal is that the water level will rise and fall.

Boiler manufacturers, as we said before, do establish a minimum safe water level for their boilers, however. That point is usually just out of sight of the bottom of the gauge glass. Should the water level drop to this point, the boiler may be in danger of overheating. We have to find a way to protect the boiler from itself.

All leading authorities and insurance companies recognize this need. The ASME Code for Low Pressure Heating Boilers, for instance, specifies, "Each automatically fired steam or vapor steam boiler shall be equipped with an automatic low water fuel cut-off." The device the code refers to is what most people in the field commonly call a "low water cut-off." Its job is to stop the burner and protect the boiler.

What Causes a Low Water Condition?

Because it's an open system, some evaporative water loss is normal for a steam system. How much depends on the size and condition of the system. If you're losing too much water, however, it's time to begin troubleshooting. There are many places to look.

Here are a few good places to start:

- The air vents are dirty, not seating properly, and passing steam to the atmosphere.
- Someone left the boiler blowdown valve partially open.
- Someone, for whatever reason, has been drawing hot water from the boiler.
- The relief valve has discharged.
- The condensate pump isn't working as it should.
  - The float may have come loose.
  - The condensate may be too hot to pump. (Check those steam traps!)
- Improper near-boiler piping may be throwing water up into the system, or causing the waterline to tilt during operation.
- The wet returns may be leaking. (Always suspect any buried pipe).
- A check valve may be stuck closed or partially closed.
- The boiler may be foaming and priming.
  - Check the pH of the water. It should be between 7 and 9.
  - Check the condition of the water. Dirty water will prime and foam.
  - Check the burner's firing rate. Over-firing can cause priming.
- The pipes may not be properly pitched.
- The automatic feeder may not be working properly.
  - Its chamber may be filled with sediment.
  - Its feed line may be clogged.
- All of the condensate may not be returning from the system (a common problem with process applications).
- The boiler metal may be corroded and leaking at the water line.
  - Flood the boiler to its header to check for leaks.

Good troubleshooters take the time to look over the entire system before deciding what's wrong. Take the time to do it right, and you'll be the person with the answers.

Watching the Water Level

The best way to prevent overheating damage to a boiler is to stop the burner if the water level falls too low. This is the low water cut-off's job. There are several types of low water cut-offs you can use. Let's look at them.

Float Operated Low Water Cut-Offs

Float operated low water cut-offs have been around since the 1920s and have earned a reputation worldwide for reliability. Usually, you'll mount this type of low water cut-off directly in the boiler's gauge glass tappings. We make "quick hook-up" fittings for these units to simplify installation.

The water level in the low water cut-off's chamber will mimic the water level in the boiler. As the water level drops in the boiler during steaming, the level in the chamber, and the cut-off's float drops with it. Should the float drop to the boiler's critical low water cut-off point, the float will trip an electrical switch that's wired in series with the burner. The burner instantly stops firing. It will stay off until the water level rises to a safe operating point.

This happens when the condensate returns from the system or when an automatic water feeder or a boiler attendant adds water to the boiler. When the level reaches a safe position, the low water cut-off will make its electrical connection and the burner will restart.

When a steam system is well balanced, the low water cut-off's job is to stand by and wait. The situation we just described suggests that there's something out of balance in that system. We'll look at this again in a few minutes.

Series 67 Float Type Low Water Cut-Off

Probe and Float Type Built-In Low Water Cut-Offs

There are some jacketed boilers that don't easily accept quick hook-up fittings. These boilers will often have a tapping for a built-in low water cut-off. These built-in units do the same thing as the external units we just looked at, but instead of being in a chamber, the "built-ins" are right inside the boiler where they can sense the water level directly.

We make two types of built-in low water cut-offs:

Probes – The boiler manufacturer will specify the point where they'd like to have this type of low water cut-off inserted. It will usually sit just below the water line, at a point above the boiler's crown. A probe uses the boiler's water to complete an electrical circuit past an insulator (the center portion of the probe) back to a ground (the threaded portion of the probe). As long as water covers the probe an electronic "go" signal will travel to the burner. When water drops off the probe for a continuous ten seconds, an electronic "stop" signal goes to the burner, shutting it down and protecting the boiler from a low water condition.

Series PS-800 Probe Type Low Water Cut-Off

At ITT McDonnell & Miller, we manufacture several different types of probe low water cut-offs to meet any of your job applications.

One of those applications might involve the boiler's water level. The water capacity of today's boilers is considerably less than that of boilers from decades ago. Along with this, the water level operating range of today's boilers is smaller. Further, the amplitude of surging water levels is increasing. As a result, the low water cut-off must be "smart" enough to recognize these variations and react appropriately. We have done this by incorporating delay features in the probe's operating logic. These include a delay on break feature (DOB) which keeps the burner lit for 10 seconds after water leaves the probe. This minimizes the effects of a surging water line. Another addition – the delay on make feature (DOM) – allows an additional feed time of 15 seconds once water comes in contact with the probe. This minimizes rapid burner and feeder cycling by slightly elevating the water level so that water lost to steaming will return (in the form of condensate) before the water level drops below the probe.

Float Type – In operation, these are similar to the external, float operated low water cut-offs we looked at before. The difference is that instead of sensing a duplicated water level outside the boiler, these units sense the level directly inside the boiler.

We make them for you in five mounting-barrel sizes (Series 69) to accommodate different boiler insulation thicknesses. When you select a built-in, float type control make sure it fits as far as possible into the boiler, without the float shield coming contact with the boiler.

When a low water cut-off stops a burner, it also stops the entire heating system. Nothing will happen until the water in the boiler returns to a safe operating level.

While this is very good for the boiler, it may not be the best thing for the system. If the heat in the building is off for too long a time, water pipes may begin to freeze.

This is where automatic water feeders come in. An automatic feeder will maintain a safe minimum water level in the boiler and keep it operating, even if the system is leaking. It keeps the system operating automatically until you can make the repairs.

Combination Low Water Cut-Offs and Automatic Water Feeders

Two of our most popular and versatile feeders are the Uni-Match® and the 101A. These are ideal for use in residential or small commercial applications. They are versatile in that they are compact and they are easily installed to operate with either a probe type OR a float type low water cut-off. These feeders are always ready to add water when given the signal from the low water cut-off. The benefits they offer are the convenience of not having to manually add water – and most importantly – they will protect the boiler from a dry fire condition by maintaining a safe minimum water level in the boiler should a system leak occur.

Uni-Match® Water Feeder

Series 101-A Water Feeder

Series 42-2 Combination Mechanical Water Feeder/Low Water Cut-Off

A mechanical feeder can also protect a boiler should a fuel-regulating device malfunction, causing the burner to lock in and stay there. Or suppose someone jumps-out a control, putting the burner on continuous operation. A mechanical automatic water feeder will continue to feed the boiler whenever the level drops to the "feed" point.

Under normal circumstances, the electrical low water cut-off (the second part of the feeder/cut-off combination) is always standing by, ready to shut off the burner should something go wrong with the automatic feeder.

An automatic water feeder doesn't feed at the two-thirds full point on the gauge glass. You set this by hand when you first start the system. As we said before, the "normal" level will range up and down as the system operates. An automatic feeder will maintain a safe minimum water line only. By doing this, it will lessen the possibility of human error.

Consider this. A boiler attendant might put too much water in a steam boiler. He doesn't have an automatic feeder and he's tired of checking the water level every day so he fills the boiler to the two-thirds full point while it's operating. When the condensate returns, the boiler floods. By adding water the attendant has limited the boiler's steam-making space. Without enough room to break free of the water, the steam will now carry water up into the system piping. This leads to higher fuel bills, uneven heating, water hammer, scale formation in the boiler and burner short-cycling. Suddenly, problems plague this system, and no one is sure why.

Automatic water feeders help you avoid these problems. They watch that water level, maintaining a safe minimum. They allow the boiler water line to rise and fall naturally through its normal operating range.

How a Feeder/Cut-Off Combination Works

During Normal Operation – This is how a McDonnell & Miller feeder/cut-off combination looks on a steam boiler. Notice how we have it installed well below the boiler's "normal" start-up operating range (that's about two-thirds up the gauge glass). We don't want it to feed while the water is out in the system as steam. Remember, the automatic water feeder is there to maintain a safe minimum water line, not a "normal," start-up water line.

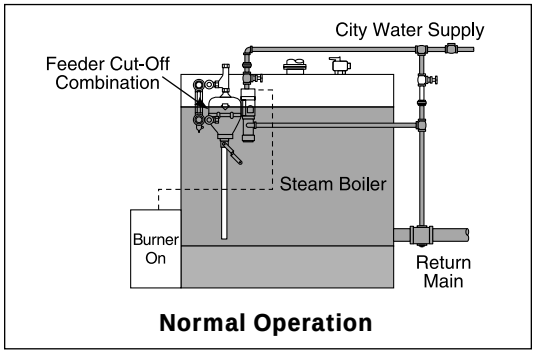
As you now see it in the drawing, the feeder is closed and the burner is firing. The boiler is working, sending steam out to the building, and both the automatic water feeder and low water cut-off are standing by.

The Feeder Opens – If the boiler's water line drops to the feeder/cut-off combination's feeder-operating point (which is very near the bottom of the gauge glass), the feed valve will open mechanically and add water to the boiler. How much water will enter the boiler depends on several things, but there will always be enough to keep the boiler operating at a safe minimum water level. Once it has added the right amount of water, the feeder closes.

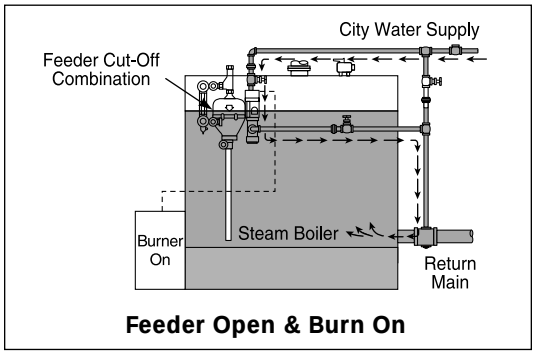
While this is happening, the burner continues to run because the feeder keeps the boiler from dropping to its low water cut-off point.

The Low Water Cut-Off Stops the Burner – But suppose something happens and the automatic water feeder can't keep up with the rate at which the boiler is losing water. Suppose, for instance, that a pipe breaks or someone opens a boiler drain, causing the boiler to suddenly lose water. Should this happen, the water level will drop to a preset point, and the automatic feeder/cut-off combination will instantly cut power to the burner, shutting it down and protecting the boiler from a dry-firing condition. Though the burner is off, the automatic feeder will continue to add water to the boiler in an attempt to restore a safe minimum water level.

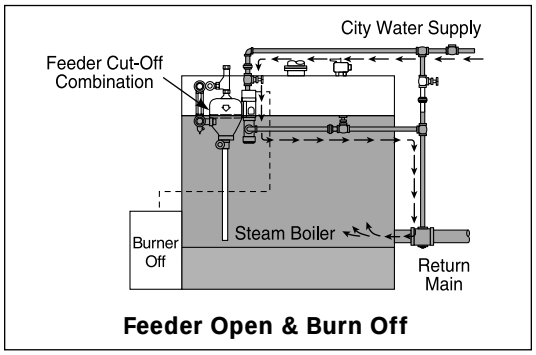
As you can see, a combination mechanical water feeder and electrical low water cut-off provides you with boiler protection even if the power fails or something goes wrong in the burner circuitry.



Normal Operation



Feeder Open & Burn On



Feeder Open & Burn Off

Hot Water Boilers

Low water protection isn't just for steam boilers. Hot water boilers face the same perils of overheating damage if the water line drops too low. Many people don't think of this as often as they should because hot water boilers serve "closed" systems. They have pressure reducing valves that are supposed to feed water automatically should a leak develop.

The truth, however, is that a pressure reducing valve is no substitute for a low water cut-off. Pressure reducing, or "feed" valves, often clog with sediment and wind up not feeding at all. A buried pipe can corrode and spring a leak that flows faster than a "feed" valve can satisfy. Relief valves can pop and, while dumping water at a great rate, actually prevent the feed valve from operating.

Let's take a closer look at how we can protect these boilers.

Hot Water Systems

As we said, the things that affect steam boilers also affect hot water boilers. If you run them with too much water the relief valve will open. If you run them with too little water they'll overheat and suffer damage.

A low water cut-off is the only sure way of protecting a hot water boiler from sudden loss of water. The ASME boiler code recognizes this by requiring all hot water boilers of 400,000 BTU/HR or more input to have low water fuel cut-off devices.

ASME doesn't call for low water cut-offs on smaller, residential boilers, but we think all hot water boilers, regardless of their size, must have protection. However, the International Mechanical Code requires low water cut-offs on ALL hot water and steam boilers. ITT McDonnell & Miller make several devices, both float and probe type, that protect and meet the needs of any boiler whether it's cast iron, steel, or copper construction.

Hot water systems regularly lose water through faulty air vents, loose valve stem packing, cracked boiler sections, loose nipples, corroded pipes, broken or loose pump seals, leaking gaskets, dripping relief valves, to name just a few places. Most installers depend on their pressure reducing or feed valve, to replace the lost water automatically. But feed valves often clog with sediment, especially in hard water areas. And it's very easy to close the supply valve to a feed valve and forget to open it again.

Series PS-851 Probe Type Low Water Cut-Off

Series RB-24 Probe Type Low Water Cut-Off

On systems with buried pipes (say, a radiant heating system) a feed valve will open if a pipe breaks. It will feed fresh water continuously until it either clogs (and stops feeding) or destroys the ferrous components of the system with oxygen corrosion. A simple feed valve can wind up costing a lot more than its purchase price. This is why major suppliers of feed valves, such as ITT Bell & Gossett, recommend you close the feed valve once you've established your initial fill pressure.

This is also why we strongly recommend you use a low water cut-off on every hot water boiler. Feed valves are not a substitute for low water cut-offs. They can't protect your boilers from a low water condition. Feed valves are fine for filling the system initially, and for helping you vent air from the radiators. But once the system is up and running, you shouldn't look to them for protection.

Over firing

There are times when hot water boilers don't lock-out on safety. Whether by control failure or human error, things go wrong. And when they go wrong in a hot water heating system, the water temperature can rise quickly to a point where the compression tank can't take up the expansion of the water. This causes the relief valve to discharge.

When the relief valve opens, there's a sudden drop in system pressure. The water, which at this point is probably much hotter than 212°F (100°C), will flash into steam. This is why ASME insists that relief valves for hot water boilers carry steam-discharge ratings.

If a feed valve doesn't open to replace this rapidly exiting water, a low water condition will quickly result. The only thing that can protect the boiler at this point is a low water cut-off. The feed valve can't protect the boiler because its typical setting is 12 psig (.83 bar). In other words, the system pressure must drop below 12 psig (.83 bar) before the feed valve will open.

The trouble is that while the relief valve is open and flashing steam to atmosphere, the internal system pressure never drops anywhere near 12 psig (.83 bar). A relief valve with a 30 psig (2.1 bar) setting, for instance, will open at 30 psig (2.1 bar), and close again when the pressure drops to about 26 psig (1.79 bar). The result is a loss of water with no make-up. Repeat this cycle enough times and the boiler will be in a dangerous, low water condition. Keep in mind, steam exerts pressure. It can easily fool a feed valve, and that's why feed valves offer very little protection at all against low water.

New and Improved Series PS-800 for Steam Boilers

- For residential and commercial applications
- Electronic operation

New Features:

- User-friendly diagnostics
  - Red low water and shorted probe LED
  - Green power and test LED
- Higher probe sensitivity: 7,000 ohms
- No lock out with loss of power if probe is in water
- Delay on Make (DOM) feature (15 seconds)
- Delay on Break (DOB) feature (10 seconds)
- No blow down of control required when mounted directly into boiler tappings
- Test button standard on all models
- Options available include
  - – Manual reset
  - – Extended barrel, remote and short probe models
  - – 120 volt and 24 volt models (24 volt models meet ANSI specification Z21.13a)
- Power consumption 1.7 VA
- Provisions to add alarm or automatic water feeder
- Maximum ambient temperature 120°F (49°C)
- Maximum steam pressure 15 psi (1 kg/cm2)
- Maximum water temperature 250°F (121°C)

Series PS-800

New and Improved Series PS-850 for Hot Water Boilers

- For residential, commercial and industrial applications
- Electronic operation

New Features:

- User-friendly diagnostics
  - Red low water and shorted probe LED
  - Green power and test LED
- Higher probe sensitivity: 7,000 ohms
- No lock out with loss of power if probe is in water
- No blow down of control required when mounted directly into boiler tappings
- Test button standard on all models
- Options available include
  - – Manual reset
  - – Extended barrel, remote and short probe models
  - – 120 volt and 24 volt models (24 volt models meet ANSI specification Z21.13a)
- Power consumption 1.7 VA
- Provisions to add alarm
- Maximum ambient temperature 120°F (49°C)
- Maximum water pressure 160 psi (11.2 kg/cm2)
- Maximum water temperature 250°F (121°C)

Series PS-850

Series RB-24 for Hot Water Boilers

- For residential applications
- Compact size
- Easy to install and wire
- Automatic reset feature resumes operation after a power outage when water is on probe
- Green power on indicating LED
- Red low water indicating LED
- Solid state operation
- 15,000 ohms probe sensitivity
- Maximum ambient temperature 120°F (49°C)
- Maximum water temperature 250°F (121°C)
- Maximum water pressure 50 psi (3.5 kg/cm2)

Model RB-24

Series RB-120 for Hot Water Boilers

- For residential and (where codes allow) commercial applications
- Electro-mechanical operation
- Automatic reset feature resumes operation after a power outage when water is on probe
- No blow down required
- 6,000 ohms probe sensitivity
- Maximum ambient temperature 120°F (49°C)
- Maximum water temperature 250°F (121°C)
- Maximum water pressure 160 psi (11.2 kg/cm2)

Series RB-120

New Series RB-122 for Hot Water Boilers

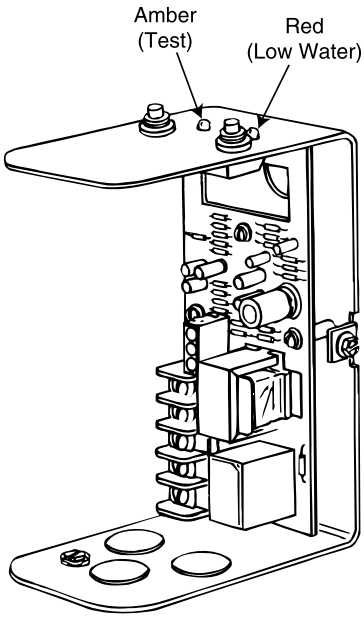
- For residential and (where codes allow) commercial applications
- Electronic operation
- Red low water indicating LED
- Green power indicating LED
- Automatic reset
- No blow down required
- 15,000 ohms probe sensitivity
- Maximum ambient temperature 120°F (49°C)
- Maximum water temperature 250°F (121°C)
- Maximum water pressure 160 psi (11.2 kg/cm2)

Series RB-122

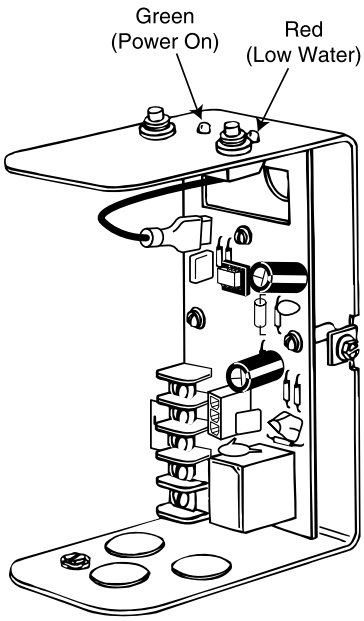
Series PS Product Changes

- Green power indicates light
- Flashing red light time delay diagnostics
- Flashing green light test indication
- Alternate flashing red and green light grounded probe detection
- 7,000 ohms higher sensitivity
- New terminal panel

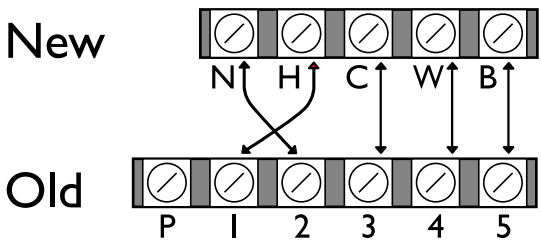
Old Models (Before April 2001)



New Models (After April 2001)



PS-801/851 Terminal Panel



PS-801/851 (old)		PS-802/852 (new)
2	Neutral	N
1	Hot	H
3	Common	C
4	Feeder/Alarm	W
5	Burner/Load	B

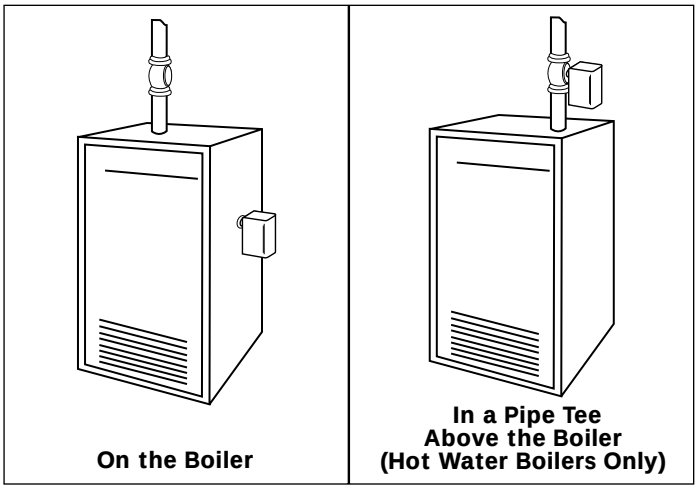
For Steam Boilers:

1. Refer to boiler manufacturers instructions to determine suitable tapping for the probe.

For Hot Water Boilers:

1. Refer to boiler manufacturers instructions to determine suitable tapping for the probe.
2. Locate probe in supply piping using a tee fitting if suitable tapping is not available.
3. The low water cut-off must be installed above the minimum safe water level, as determined by the boiler manufacturer.
4. The low water cut-off should not be installed in any position or vertical pocket that could allow entrapped air or water to collect around the probe.

PS 800/850s



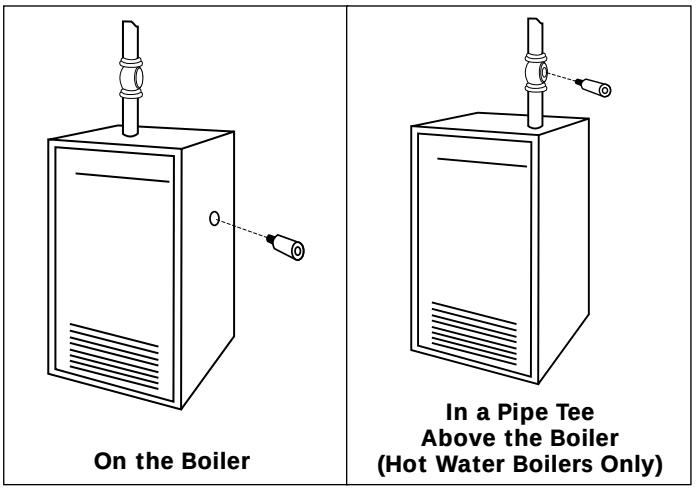
On the Boiler

(RECOMMENDED)

In a Pipe Tee Above the Boiler (Hot Water Boilers Only)

(OK)

RB 24



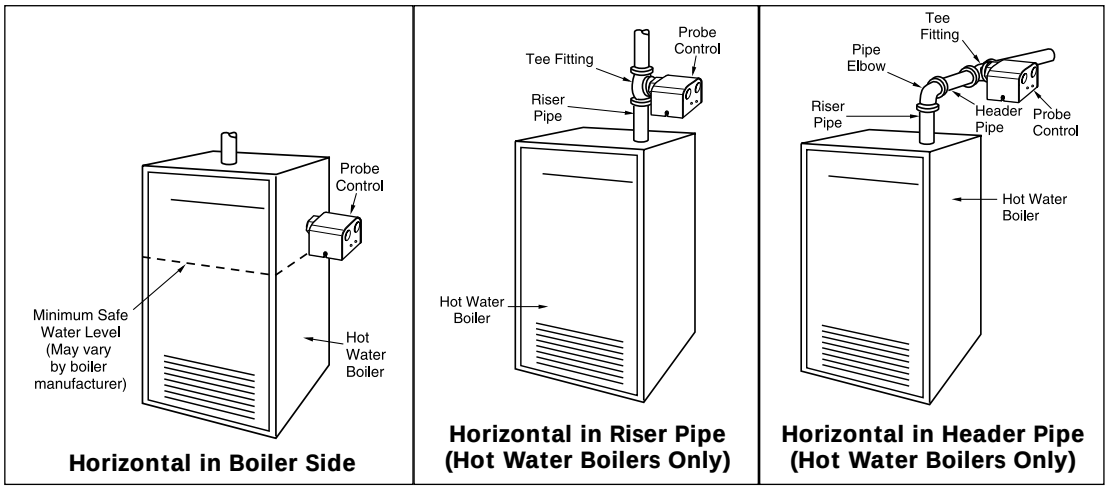
On the Boiler

(RECOMMENDED)

In a Pipe Tee Above the Boiler (Hot Water Boilers Only)

(OK)

RB 120,122



Horizontal in Boiler Side

(RECOMMENDED)

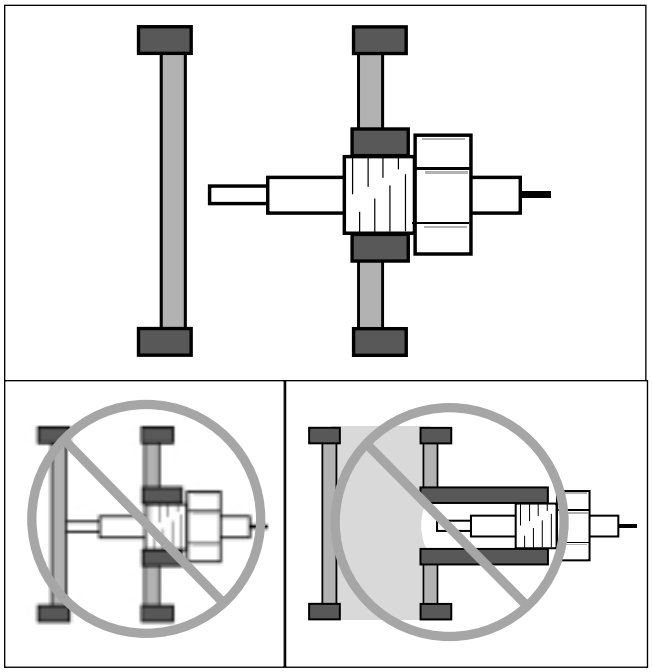
Horizontal in Riser Pipe (Hot Water Boilers Only)

(OK)

Horizontal in Header Pipe (Hot Water Boilers Only)

(OK)

All boiler manufacturers designate the preferred (and sometimes secondary) location for installation of the probe on their boiler. They have determined that this location is above the minimum safe water level and provides the 1⁄4" clearance needed to ensure the probe is not grounded. Always install the probe in these locations, especially on a hot water boiler. If installed in other locations on a hot water boiler, this area could be prone to develop an air pocket.

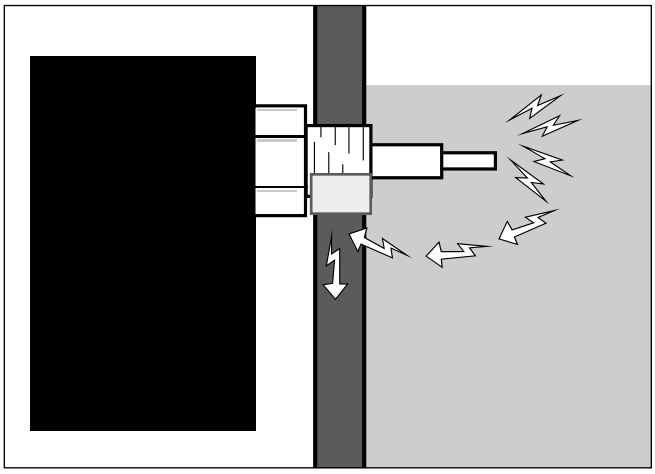


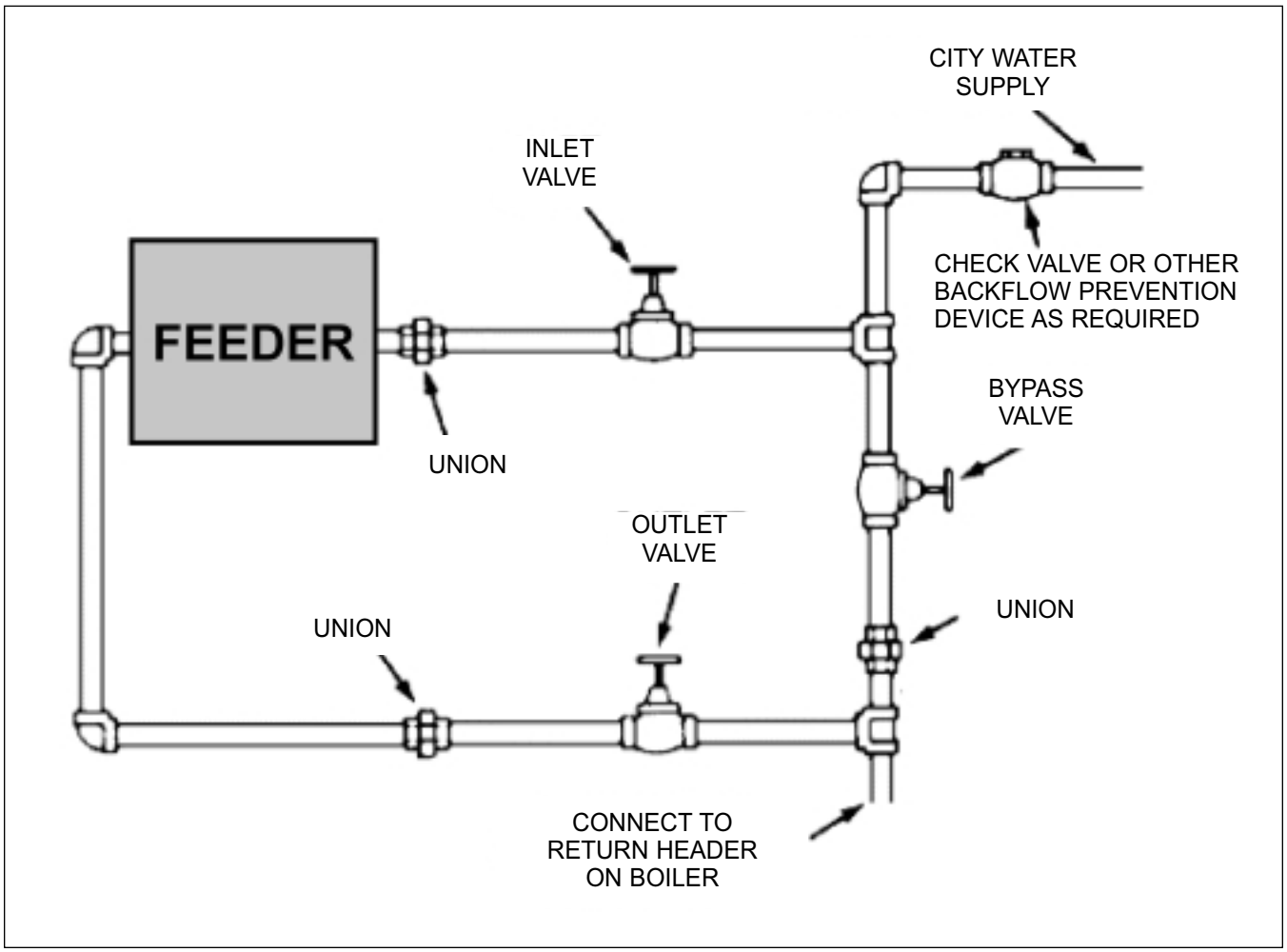
Installation in piping external to the boiler on hot water systems has its own pitfalls. The first problem is if the probe is too long. If the probe touches the wall of the pipe, the circuit is completed and the LWCO “thinks” there is water in the system. If the water level drops below the level of the probe in this situation, the burner circuit will never be interrupted and a dry-fire could occur.

The most common problem with installation on hot water systems occurs when installing the probe in copper pipe. The sweat to thread adapters installed could result in the probe not being inserted in the pipe. An air pocket could develop or scale bridging could occur. While an air pocket causes nuisance shutdown of the boiler, scale bridging can result in a dry-fire if the water drops below the level of the probe. Always make sure at least 1⁄2 the length of the probe is in the run of the pipe to ensure proper operation.

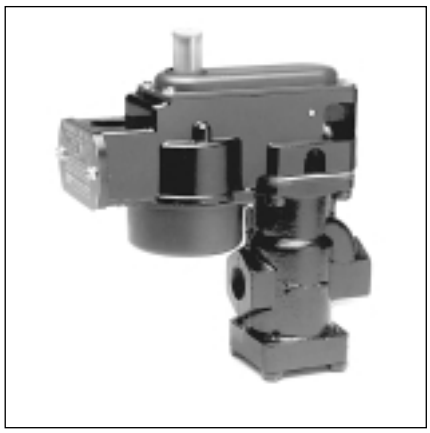
The use of Teflon tape or certain thread sealants can block the current path.

Use pipe dope or boiler grease as a thread sealant when installing the probe.





Uni-Match®



Series 101A

Series 47-2

Standard Combinations

These are suggested wiring diagrams but not the only solution to a particular installation. They cover different combinations of controls including different control voltages. Boiler manufacturers' wiring diagrams should be followed whenever possible.

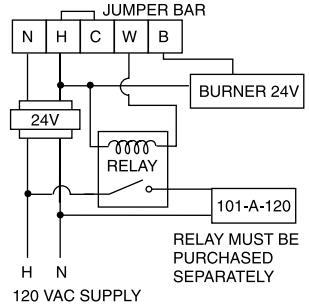
Note:

- An electric water feeder should never be connected to a manual reset LWCO
- The LWCO should always be wired first-in-line before any other operating or limit controls
- The voltage of the feeder should be the same as the LWCO whenever possible.

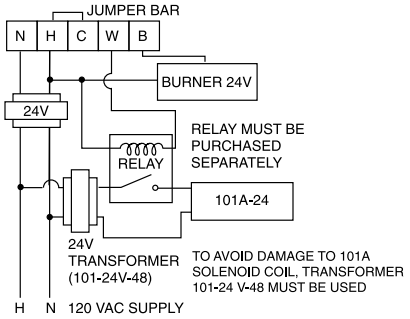
Always follow local codes whenever selecting and installing a LWCO.

Series PS-802-24

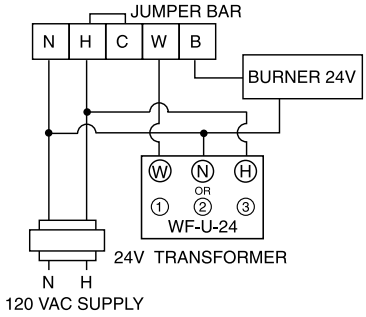
With 101A-120 Feeder



With 101A-24 Feeder

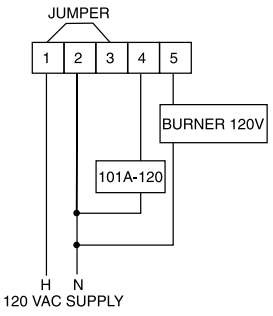


With Uni-Match® 24v Feeder

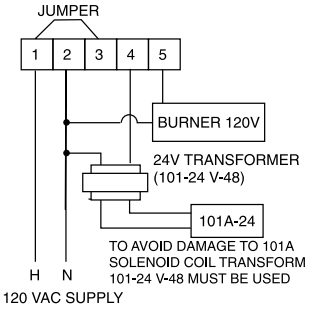


Series PS-801-120

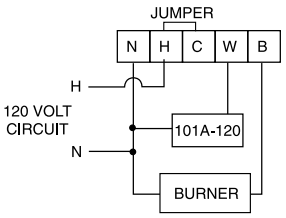
With 101A-120 Feeder



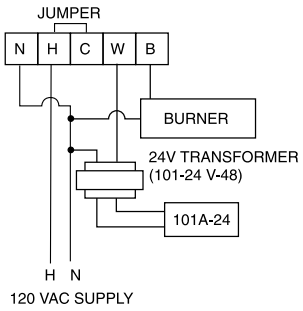
With 101A-24 Feeder



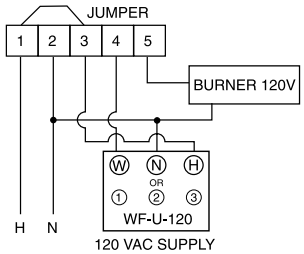
New Models (After April 2001) With 101A-120 Feeder



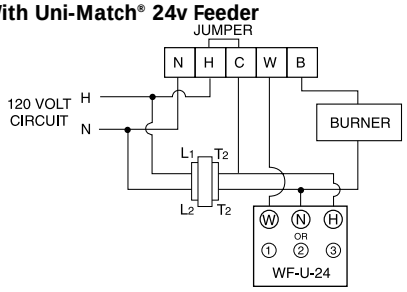
New Models (After April 2001) With 101A-24 Feeder



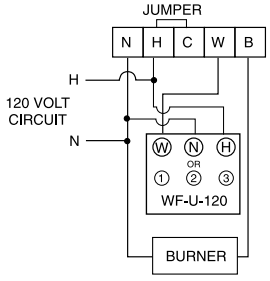
With Uni-Match® 120v Feeder



New Models (After April 2001) With Uni-Match® 24v Feeder



New Models (After April 2001) With Uni-Match® 120v Feeder

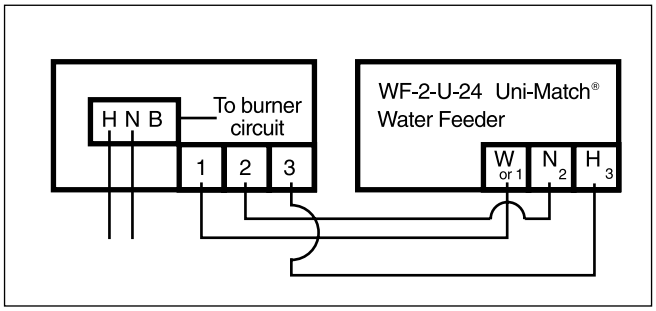


OEM PS-802

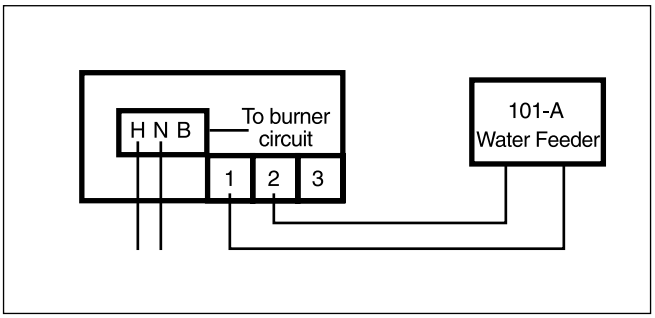
OEM specific 24 volt Model PS-802 LWCO's were manufactured from January 1996 to February 1997. These controls have a receptacle for the wiring harness plug and 3 pole terminal strip for feeder wiring. A feeder can be added to these controls by following the wiring diagrams shown below. The feeder voltage must be 24 volt because of internal wiring.

Note: The LWCO should always be first-in-line before any other operating or limit controls.

PS-802 with WF-2-U-24



PS-802 with 101A-24

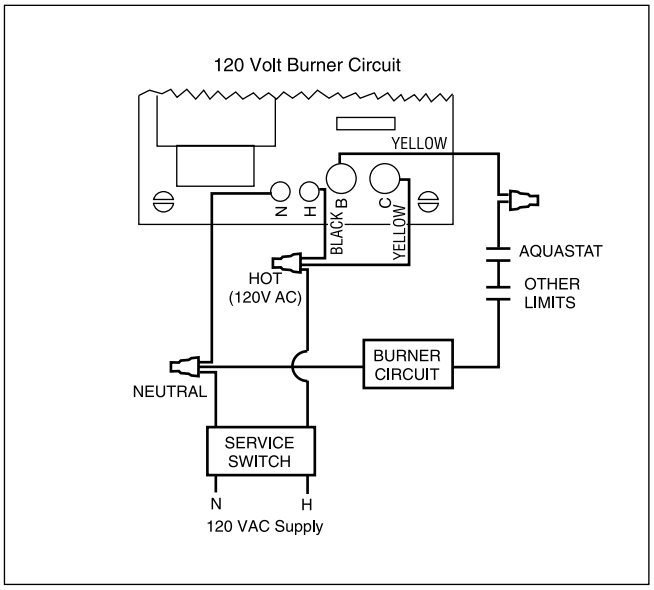


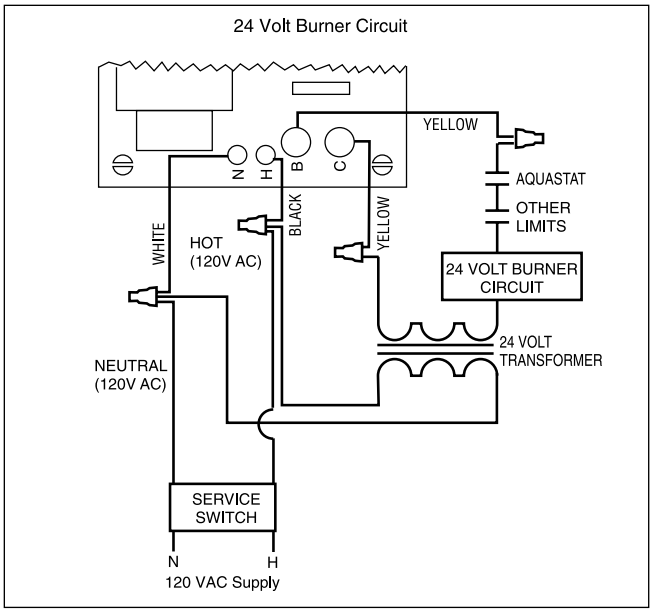
Note: Replace existing transformer on boiler with the one supplied with the feeder

RB-122

The RB-122 should be wired first-in-line when the control is installed on a new boiler. The control will require a constant source of 120 volt power which should be from the same circuit as the existing boilers' power source which is typically the service switch.

The following diagrams show how to wire a RB-122 for 120 volt and 24 volt burner circuits.





RB-24

The RB-24 can be used on gas and oil fired boilers with 24 volt control circuit including boilers with spark ignition. The wiring diagrams show connecting the RB-24 on typical burner circuits. Note that the control requires a constant source of power with the red (hot) and white (neutral) wires connected directly to the transformer.

The yellow wires can be connected at the beginning of the burner circuit (Fig. 1) or in series (Fig. 2). In burner circuits utilizing relays, it is recommended to connect the RB-24 wires as shown in Fig. 3. This ensures there is enough current draw to hold in the triac circuit. The control could be wired as shown in Fig. 4 as long as the current draw in the circuit is greater than 15mA. A digital voltmeter can be used to determine the current draw of the circuit the RB-24 will be wired into.

It is important to determine if the secondary side of the transformer is grounded. The instructions included with the control have a procedure to determine if the circuit is grounded. This is important because the RB-24 may not work if there is no ground on the secondary side of the transformer. If the secondary side of the transformer is already grounded and the ground wire on the RB-24 is grounded, a short across the transformer could occur.

Figure 1

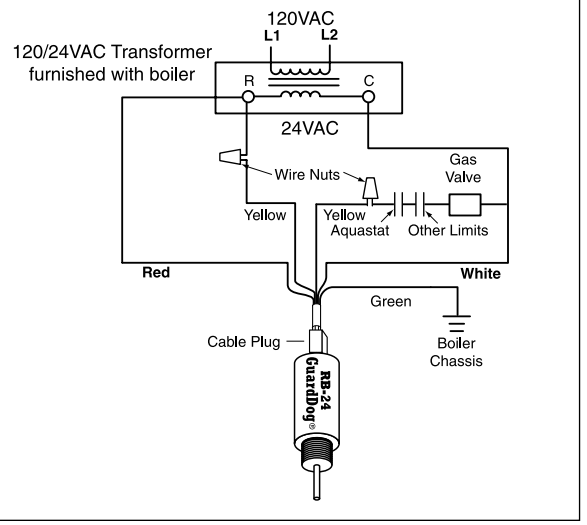


Figure 2

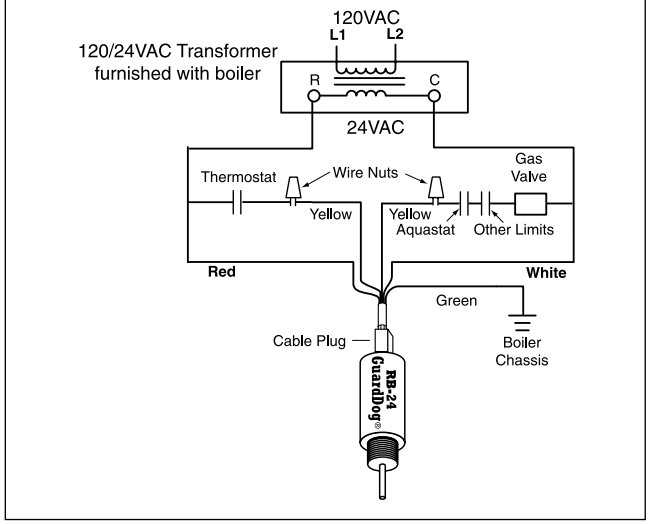


Figure 3

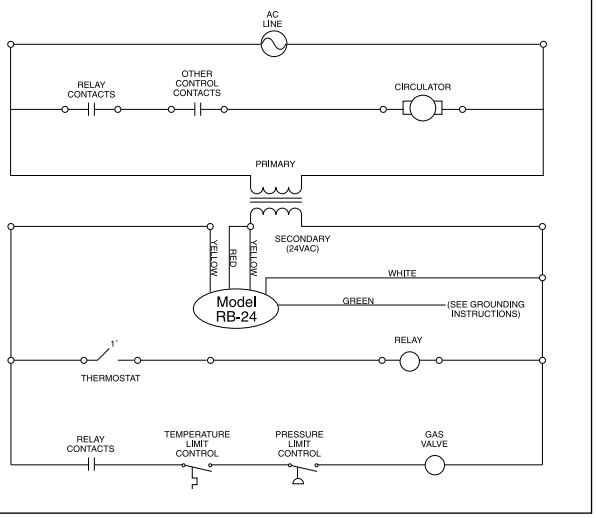
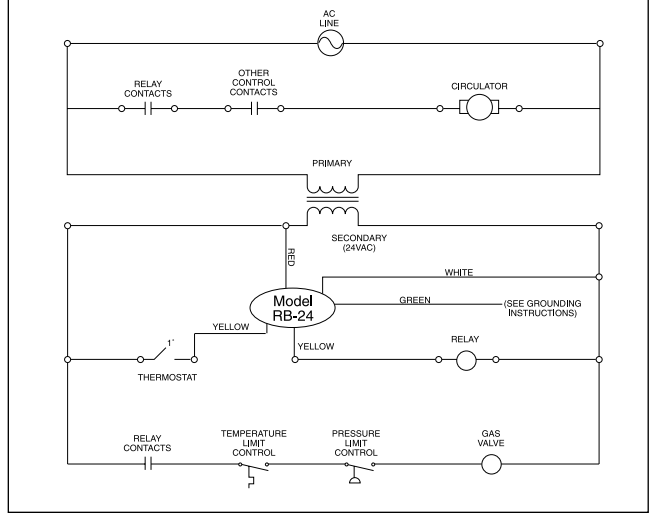


Figure 4



Problem: Troubleshooting nuisance low-water indication for units manufactured prior to May 2001.

One of the most common causes of a Series 'PS' electronic LWCO not operating properly is related to the sensitivity of the unit. If the water in the boiler is above the level of the probe and the control indicates low water, there is a possibility that the water is not conductive enough.

First, let's review how the unit uses the combination of current and water to determine if there is water in the boiler. A probe uses the boiler's water to complete an electrical circuit past an insulator (the center portion of the probe) back to a ground (the threaded portion of the probe). As long as water covers the probe an electronic "go" signal will travel to the burner. When water drops below the probe, an electronic "stop" signal shuts down the burner.

The control is conductance actuated and relies on the mineral content of the water to complete the circuit. The purer the water, the higher the unit sensitivity needs to be. This is less of a problem with steam boilers than it is with hot water boilers. The use of chemicals, glycol and water with low mineral content in closed loop systems can cause the Series PS LWCO to not operate properly.

You can determine what the unit is sensing by using a voltmeter set to the AC scale. With water above the level of the probe and power to the LWCO, touch one lead to the end of the probe (A) and the other lead to probe lug (B) as shown in Figure 1. Using the chart below, convert the voltage reading to resistance. As long as the resistance is below 3000, the unit should operate satisfactorily.

If the reading is above 3000, do not automatically assume that the problem is with the water. Where the probe is located or the type of thread sealant used can affect the operation of the control. Some thread sealants, Teflon tape for instance, reduce the ability of the control to sense current. The reading can also be affected if the probe is located where an air pocket can develop. Also, if there is more than a 50/50 glycol mix in the system, the control's ability to sense current is hampered because glycol is non-conductive.

Check out the entire system if the Series PS control is not functioning properly. The problem may be elsewhere in the system, rather than with the control.

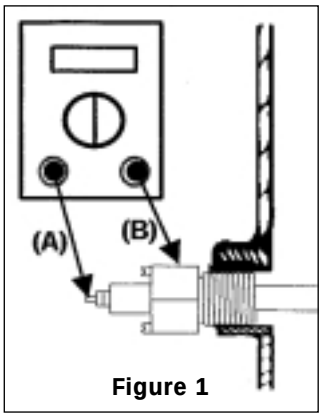
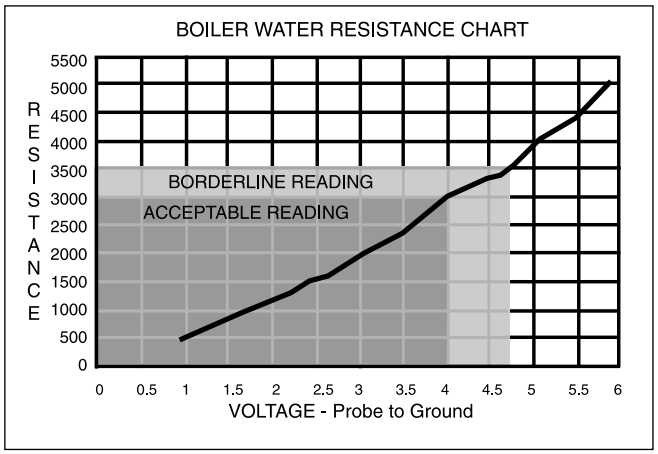
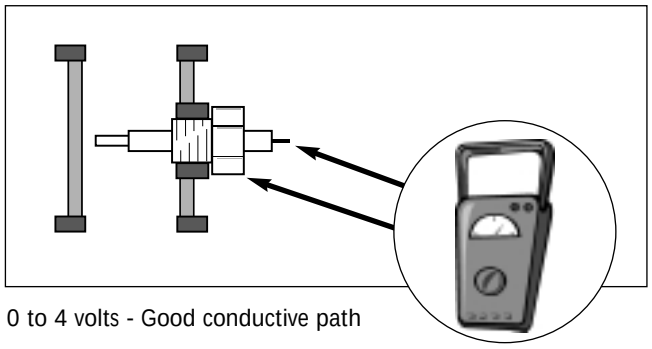


Figure 1





0 to 4 volts - Good conductive path

4 to 5 volts - Tolerance band

5 to 10 - Poor conductive path

10 to 14 volts - Probe out of water

Note: Control must be properly installed and powered during test.

Working With Electronic Feeders

By Edward M. Murdock

The first water feeders were introduced more than 75 years ago.

The first water feeders were mechanical devices attached directly to the boiler. In the era of coalfired boilers with no electrical controls, they did the job and were applauded by both the homeowner and insurance industry. The feeders were a convenience for the homeowner, who did not have to worry if the water level lowered during the night. The insurance companies praised them as a means of reducing property damage and injuries.

With the introduction of electricity into the home and oil fired boilers replacing coal, float or solenoid type low-water cutoffs were introduced. They used a switch to interrupt the power to the burner and featured an additional switch to operate the feeder. These feeders are still around today. They feature high flow rates that were designed to be used on high water content boilers.

With the introduction of the modern high efficiency boilers, control and boiler manufacturers worked together to develop an electronic feeder with a lower feed rate that would compensate for the slow return of condensate from the system to the boiler.

Water feeders should be installed above the water line of the boiler and the inlet connected to the domestic cold water line. The piping should include shutoff valves, unions and a bypass. This piping arrangement serves a dual purpose. It allows water to be fed into the boiler if the feeder is not working and is also used to verify operation.

Some municipalities require the installation of a backflow preventor to keep boiler water from backing up into the domestic water line if the pressure of the boiler becomes greater than the water supply.

The discharge line from the feeder should be connected to the condensate return line at the bottom of the boiler. The connection of the discharge should be made following the manufacturer's instructions. Connecting the feed piping directly to the boiler should be avoided.

Wiring a feeder should be done following the manufacturer's instructions. In looking at the boiler and low-water cutoff don't get caught in the trap of thinking that a certain color wire should be hot all the time.

Whenever possible, the voltage of the feeder should be the same as the low-water cutoff. This makes wiring the feeder easier and ensures that the feeder will not operate when the power to the boiler is turned off. Nothing is worse than operating the feeder from a different circuit than the boiler. The power to the boiler could be off, which in the case of some low-water cutoffs, could activate the feeder. Finally, never wire a feeder to a manual reset low-water cutoff.

In diagnosing a problem if the feeder is not operating or continues to operate when the water level is above the low-water cutoff, the following should be considered:

- Is the low-water cutoff working properly? If the low-water cutoff is not working, the feeder is not working, the feeder will not operate. The feeder is a dumb control requiring a signal from another control to operate.
- Is the low-water cutoff sending a signal to the feeder? Check to make sure the contacts are closing/opening as the water rises or falls above/below the level of the low-water cutoff.
- Is the wiring to the feeder from the low-water cutoff connected properly? The wire connections should be as shown in the installation diagrams. In the case of three wire feeders, a true Hot and Neutral are required for proper operation.
- Check the operation of the feeder. Disconnect the wires from the feeder terminals, and using a separate source of power, check the operation of the feeder.
- Check the strainer. If the strainer is clogged, little or no water will pass through the feeder.
- Do a broken union test. The feeder may be operating, but because pipes are clogged, no water will be getting to the boiler.
- Review the manufacturer's instructions. Check the boiler's wiring diagram, the low-water cutoffs wiring diagram, and the feeder's installation.

Edward M. Murdock is associated with Wallace Eanance Associates in Franklin Lakes, N.J. He can be reached at 201/891-9550; e-mail at emmcjs@aol.com.

Reprinted from February 2000 Fuel Oil News Magazine.

Recommended Replacement Intervals

Product	Series	Recommended Maintenance	Recommended Replacement Interval (Maximum)
Low Water Cut-Offs	150, 157, 158, 159, 150S, 157S, 158S, 159S	Blow down and test daily inspect annually.	15 years
	69, 169, 269, 369, 469	Inspect and test annually.	10 years
	67, 767 70, 70-B	Blow down weekly. Inspect and test annually.	10 years
	61, 63, 64, 764	Blow down weekly. Inspect and test annually.	10 years
	42	Blow down daily. Inspect and test annually.	10 years
	93, 94, 193, 194	Blow down and test daily. Inspect and test annually.	15 years
	750, PS-800, PA-850, 900, RB-120	Inspect and test annually.	15 years
	RB-24	Inspect and test annually.	10 years
Water Feeders	WF2/Uni-Match®	Inspect and test annually. Replace filter annually.	10 years
	101-A	Inspect, test, and replace cartridge valve annually.	10 years
	21, 221, 25-A, 53, 551-S, 847, 3155	Inspect and test annually.	15 years
	47, 51, 53, 247	Blow down weekly. Inspect and replace cartridge valve annually.	10 years
Liquid Level Controls	LPC-2000, PS-850, PCH PCL, PFC, VFC, VFS	Inspect and test annually.	15 years
	18, 18-SS, 27-W	Inspect and test annually.	5 years
Replacement Blow Down Valves	14-B	Inspect and test annually.	10 years
	14	Replace with 14-B blow down valve.	3 years
Replacement Probes	750, PS-800, PS-850, 900, RB-120, PCH, PCL	Inspect annually.	10 years
Replacement Head Mechanisms for Commercial/Industrial Applications	25-A, 42, 51, 51-S, 53, 61, 63, 64, 67, 70, 93 94, 150, 150S, 157, 157S, 193, 194	Inspect and test annually.	5 years

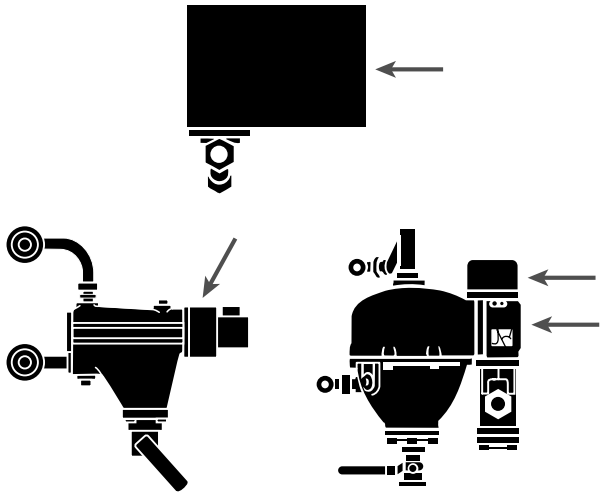
ITT McDonnell & Miller controls manufactured after 1972 feature a stamped date code, so you can easily check the life expectancy and recommended replacement intervals. If a control has no date stamp or does not have the ITT logo on it – replace it!

See the chart on page 21 for more specific information on maintenance and replacement intervals. Below are guides to help you quickly locate and translate the date code on McDonnell & Miller controls.

WHERE TO FIND

McDonnell & Miller

DATE CODES



McDonnell & Miller

Product Date Code Translation

Month	Year	Example
A = January B = February C = March D = April E = May F = June G = July H = August J = September K = October L = November M = December	W = 1979 X = 1980 Y = 1981 Z = 1982 38 = 1983 48 = 1984 58 = 1985 68 = 1986 78 = 1987 88 = 1988 98 = 1989 09 = 1990 19 = 1991 29 = 1992 39 = 1993 49 = 1994 59 = 1995	**K09** Translates to **October 1990**
	96 = 1996 97 = 1997 98 = 1998 99 = 1999 00 = 2000 01 = 2001 02 = 2002	Beginning 1996 the year is no longer reversed. **96K** Translates to **October 1996**

Upgrade to M&M...here's how.

McDonnell & Miller	HydroLevel		Honeywell
PS-801-120	450	OEM-170TD	RW700A1080 RW700A1056
PS-801-M-120			RW700B1021 RW700B1054
PS-802-24	400	OEM-24TD	RW700A1098
PS-802-RX2-24	400RA	OEM-24RTDA	
PS-851-120	650	OEM-170C	RW700A1031 RW700A1106 RW700A1007
PS-851-M-120	550 750	OEM-170MC OEM-170M	RW700B1039
PS-851-M-U-120	550P	OEM-170MCP	
PS-852-24	600	OEM-24C	
PS-852-M-24	500 700	OEM-24MC OEM-24M	
PS-851-SP-120	650SV	OEM-170CSV OEM-170SV	
PS-851-SP-M-120	550SV 750SV	OEM-170MCSV OEM-170MSV	
PS-852-SP-24	600SV	OEM-24CSV	
PS-852-SP-M-24	500SV 700SV	OEM-24MCSV OEM-24MSV	
RB-24		OEM-24	
RB-120 or RB-122		OEM-170	
WF2-U-24V	VXT-24/V-24-1/V-24-2		VW400A1004
WF2-U-120V	VXT-120/V-120-1/V-120-2		VW800A1000

Cross-reference

Part #	Catalog #	Replace With
153855	PS-801-24	Purchase a PS-802-24
153856	PS-801-U-24	Purchase a PS-802-U-24
153860	PS-801-M-24	Purchase a PS-802-M-24
153891	PS-851-24	Purchase a PS-852-24
153892	PS-851-M-24	Purchase a PS-852-M-24
158419	PS-801-RX2-24	Purchase a PS-802-RX2-24
144625	900	Purchase a PS851-120
144635	900-C	Purchase a PS851-120
144650	900-M	Purchase a PS851-M-120
144660	901	Purchase an RB-120 or RB-122
144670	901-M	Purchase a PS851-M-120
144680	902-M	Purchase a PS851-M-120
—	M-9000	Purchase an RB-120 or RB-122

The definitions given in this section are only those that apply to heating and as referenced in this catalog. It is realized that some do not define the terms for all usages, but in the interest of clearance and space this sacrifice was made.

Absolute Pressure – Actual pressure above zero, which is the atmospheric pressure added to the gauge pressure. It is expressed as a unit pressure such as lbs. per sq. in absolute.

Atmospheric Pressure – The weight of a column of air, one square inch in cross section and extending from the earth to the upper level of the blanket of air surrounding the earth. This air exerts a pressure of 14.7 pounds per square inch at sea level, where water will boil at 212 degrees F. High altitudes have lower atmospheric pressure with correspondingly lower boiler point temperatures.

Blow Down Valve – Also referred to as a blowoff valve. A valve which permits a boiler control to be flushed out, and the function of same to be checked.

Boiler – A closed vessel in which steam is generated or in which water is heated by fire or electricity.

Boiler Crown – The part of a boiler which forms the top of the furnace in a fire box boiler, or the equivalent surface in other types of boilers.

Boiler Feed Pump – A pump that is governed by a control that monitors the actual boiler water level; and only adds water to the boiler when the boiler needs it. The pump controller is mounted on the boiler.

Boiler Heating Surface – The area of the heat transmitting surfaces in contact with the water (or steam) in the boiler on one side and the fire or hot gases on the other.

Boiler Horse Power – The equivalent evaporation of 34.5 lbs of water per hour at 212 degrees F to steam at 212 degrees F. This is equal to a heat output of 33,475 BTU per hour, which is equal to approximately 140 sq. ft. of steam radiation (EDR).

British Thermal Unit (BTU) – The quantity of heat required to raise the temperature of 1 lb. of water 1 degree F. This is somewhat approximate but sufficiently accurate for any work discussed in this catalog.

BSPT – British Standard Pipe Thread

Built-Ins – A float-type control that screws directly into the boiler, such as the Series 69 and Series 70 low water cutoffs.

Condensate – In steam heating, the water formed by cooling steam as in a radiator. The capacity of traps, pumps, etc., is sometimes expressed in lbs. of condensate they will handle per hour. One pound of condensate per hour is equal to approximately 4 sq. ft. of steam heating surface (240 BTU per hour per sq. ft.).

Condensate Pump – A pump that is controlled by a switch mounted on the condensate tank. It adds water to the boiler when the condensate tank becomes full, whether the boiler needs water or not.

Dry Fire – Insufficient water in a boiler to carry off the heat of combustion. It causes dry fire which results in cracked cast iron sections, and melted fire tubes.

Dry Saturated Steam – Saturated steam containing no water in suspension.

EDR – (Equivalent Direct Radiation) The amount of heating surface that will give off 240 BTU per hour when filled with a liquid that is heated to 215°F and surrounded by 70°F air. It may not have a direct relation to the actual surface area.

Fire Tube Boiler – This type of boiler has the water on the external side of the tube and the heat (fire) on the internal side of the tube.

Flash (Steam) – The rapid passing into steam of water at a high temperature when the pressure it is under is reduced so that its temperature is above that of its boiling point for the reduced pressure. For example: if hot condensate is discharged by a trap into a low pressure return or into the atmosphere, a certain percentage of the water will be immediately transformed into steam. It is also called re-evaporation.

Foaming – A condition that occurs when an organic substance, usually oil, is floating on the surface of the water in a boiler. When the boiler is fired, a layer of foam develops on the surface of the water. This generally is indicated in the gauge glass by large swings in water level.

Freeze Up – This refers to a structure that has lost its heating system, and the water in the piping freezes.

Furnace – That part of a boiler or warm air heating plant in which combustion takes place. Sometimes also the complete heating unit of a warm air heating system.

Gauge Glass – Sometimes called water glass or sight glass. It is a device that gives a visual means of the water level in a boiler. By code, all steam boilers are required to have one.

Head – Unit pressure usually expressed ft. of water or mil-inches of water.

Heat – That form of energy into which all other forms may be changed. Heat always flows from a body of higher temperature to a body of lower temperature. See also: Latent Heat, Sensible Heat, Specific Heat, Total Heat, Heat of the Liquid.

Heat of the Liquid – The heat (BTU) contained in a liquid due to its temperature. The heat of the liquid for water is zero at 32 degrees F, and increases 1 BTU: approximately for every degree rise in temperature.

Heat Unit – In the foot-pound-second system, the British Thermal Unit (BTU).

Heating Medium – A substance such as water, steam, or air used to convey heat from the boiler, furnace, or other source of heat to the heating units from which the heat is dissipated.

Hot Water Heating System – A heating system in which water is used as the medium by which heat is carried through pipes from the boiler to the heating units.

Latent Heat of Evaporation – The heat (BTU of pound) necessary to change 1 pound of liquid into vapor without raising its temperature. In round numbers, this is equal to 960 BTU per pound of water.

Low Pressure Steam – As defined by ASME, low pressure steam is 15 PSIG or less.

Make-Up Water – Fresh water added to the system, by various means, to replace normal and abnormal water losses.

Manual Reset – A control that has to have human input before the burner will come back on after a low water condition.

Maximum Differential (MD) – A control with this designation has a greater spread between pump on and burner off.

Minimum Safe Water Level – Also known as the minimum safe operating level. The minimum level of water in a boiler where the burner will still operate. Below this level, the burner should be off due to low water.

NPT – National Pipe Thread

Overfiring – A situation where the burner does not turn off, for a number of reasons. The pressure of the system rises and the safety relief valve opens.

Pilot Valve – A valve that uses a small valve to control a large valve.

Pressure – Force per unit area such lb. per sq. inch.

Pressure Reducing Valve – A piece of equipment for changing the pressure of a gas or liquid from a higher to a lower one.

Priming – When the steam leaving the boiler carries large amounts of water with it, this is called priming. Insufficient heat, water hammer, and a flooded boiler, if the system has an automatic water feeder are some of the symptoms. It is generally caused by a high water level in the boiler, and near boiler piping.

Radiator – A heating unit located within the room to be heated and exposed to view. A radiator transfers heat by radiation to objects “it can see” and by conduction to the surrounding air which in turn is circulated by natural convection.

Sensible Heat – Heat which only increases the temperature of objects as opposed to latent heat.

Skimming – A procedure for cleaning the surface of the water in a boiler. This procedure should be done on all new boiler installations, and when there is a foaming condition.

Steam – Water in the vapor phase. The vapor formed when water has been heated to its boiling point, corresponding to the pressure it is under. See also Dry Saturated Steam, Wet Saturated Steam, Super Heated Steam.

Steam Heating System – A heating system in which the heating units give up their heat to the room by condensing the steam furnished to them by a boiler or other source.

Steam Pop Safety Valve (Relief Valve) – A device to prevent over pressure in a boiler. It should be set for 15 psi on low pressure steam boilers. On high pressure boilers, it should be set at the maximum working pressure of the boiler, or lower if the boiler is not going to be operated at its maximum pressure.

Steam Trap – A device for allowing the passage of condensate and air but preventing the passage of steam.

Supply Mains – The pipes through which the heating medium flows from the boiler or source of supply to the run-outs and riser leading to the heating units.

Two-Pipe System (Steam or Water) – A heating system in which one pipe is used for the supply main and another for the return main. The essential feature of a two-pipe hot water system is that each heating unit receives a direct supply of the heating medium which cannot have served a preceding heating unit.

Tube Bundle – A single tube (pipe) formed into a tight array so as to present a large surface area in a small space.

Vacuum Heating System (Steam) – A one or two-pipe heating system equipped with the necessary accessory apparatus to permit the pressure in the system to go below atmospheric.

Vapor – Any substance in the gaseous state.

Vapor Heating System (Steam) – A two-pipe heating system which operates under pressure at or near atmospheric and which returns the condensation to the boiler or receiver by gravity.

Vent Valve (Steam) – A device for permitting air to be forced out of a heating unit or pipe and which closes against water and steam.

Vent Valve (Water) – A device permitting air to be pushed out of a pipe or heating unit but which closes against water.

Water Tube Boilers – This type of boiler has the water circulated through a tube bundle with the heat applied on the external side of the tube.

Wet Return (Steam) – That part of a return main of a steam heating system which is completely filled with water of condensation

McDonnell & Miller

ITT Industries

Engineered for life