

# Commercial and Industrial Boiler Controls Application Guide

*Complete selection for  
every application.*



McDonnell & Miller




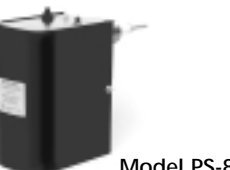





**ITT Industries**  
*Engineered for life*









## Characteristics and Features of McDonnell & Miller Boiler Controls.

Proper selection of a boiler control is critical to the satisfactory operation of a boiler system. McDonnell & Miller offers the most complete line of controls for commercial and industrial boilers in the industry. These controls detect liquid level either mechanically with a float mechanism or electronically through conductance probes. Each control has unique characteristics, features and system benefits.

### Characteristics and Features of McDonnell & Miller Low-Water Cutoff Controls.

Model	Characteristics	Features
 Series 61	Residential & Commercial Steam & Water Boilers Mechanical float level detection Max. boiler operating pressure - 20 psig.	Packless bellows Dual switches
 Series 63	Residential & Commercial Steam & Water Boilers Mechanical float level detection Max. boiler operating pressure - 50 psig.	Packless bellows SPDT switch Optional manual reset
 Series 64	Residential & Commercial Steam & Water Boilers Mechanical float level detection Max. boiler operating pressure - 50 psig.	Packless bellows Dual switches Optional manual reset
 Model PS-850	Residential & Commercial Steam & Water Boilers Conductance probe level detection Max. hot water boiler operating pressure - 160 psig. Max. steam boiler operating pressure - 15 psig.	Integrally mounted probe sensor 7,000 ohm sensitivity Test button standard Optional manual reset
 Model 750P-MT	Residential & Commercial Steam & Water Boilers Conductance probe level detection Max. hot water boiler operating pressure - 160 psig. Max. steam boiler operating pressure - 15 psig.	Integrally mounted probe sensor CSD-1 compliant 20,000 ohm sensitivity Test button standard Optional manual reset
 Model 750-MT with RS-1	Residential & Commercial Steam & Water Boilers Conductance probe level detection Remote mounted probe (purchased separately) Max. boiler operating pressure - 250 psig.	CSD-1 compliant 20,000 ohm sensitivity Test button standard Optional manual reset
 Model 750B-L (panel mount) or 750BM-L (plug-in module)	Commercial & Industrial Steam & Hot Water Boilers Panel or plug-in modular mount electronics Conductance probe level detection Remote chamber or boiler-mounted probes (purchased separately) Max. boiler operating pressure - 250 psig.	CSD-1 compliant 26,000 ohm sensitivity Optional manual reset

## Characteristics and Features of McDonnell & Miller Low-Water Cutoff and Level Controls.

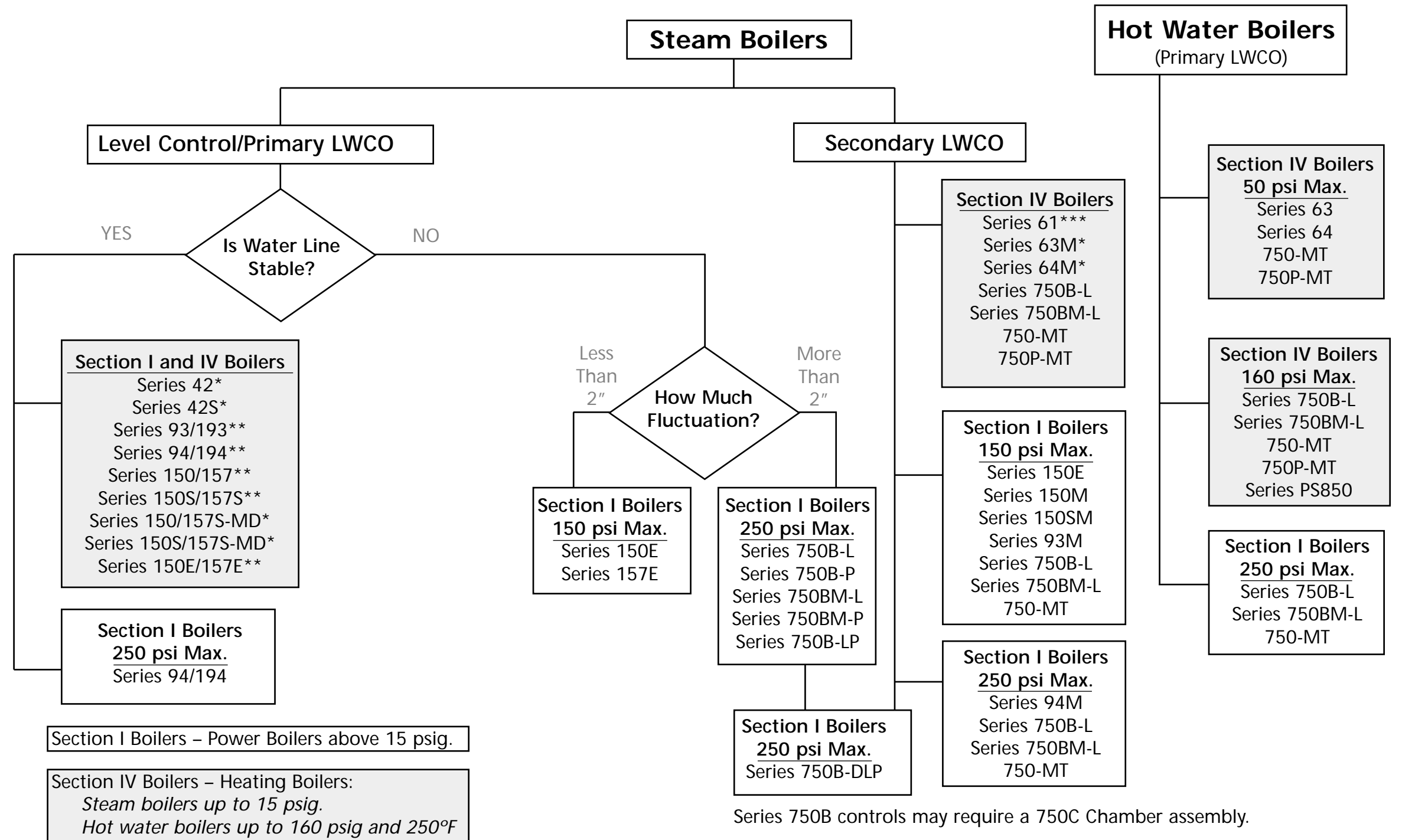
Model	Characteristics	Features
 Series 42	Residential & Commercial Steam & Water Boilers Mechanical float level detection Max. boiler operating pressure - 50 psig.	Monel bellows Mercury switches: 1 SPST for pump control 1 SPDT for low-water cutoff and alarm actuation Optional quick hook-up mountings
 Series 42S	Residential & Commercial Steam & Water Boilers Mechanical float level detection Max. boiler operating pressure - 50 psig.	Monel bellows Snap-action switches: 1 SPST for pump control 1 SPDT for low-water cutoff and alarm actuation Optional quick hook-up mountings
 Series 93 (shown)/193	Commercial & Industrial Steam Boilers Water column version - model 193 Mechanical float level detection Max. boiler operating pressure - 150 psig.	Maintains differentials throughout pressure range Magnetic repulsion switches Optional manual reset Optional proportional feed water control
 Series 94/194 (shown)	Commercial & Industrial Steam Boilers Water column version - model 194 Mechanical float level detection Max. boiler operating pressure - 250 psig.	Maintains differentials throughout pressure range Magnetic repulsion switches Optional manual reset Optional proportional feed water control
 Series 150/157 (shown)	Commercial & Industrial Steam Boilers Water column version - model 157 Mechanical float level detection Max. boiler operating pressure - 150 psig.	Monel bellows Mercury switches: 1 SPST for pump control 1 SPDT for low-water cutoff and alarm actuation Optional manual reset
 Series 150S/157S (shown)	Commercial & Industrial Steam Boilers Water column version - model 157S Mechanical float level detection Max. boiler operating pressure - 150 psig.	Monel bellows Snap action switches: 1 SPST for pump control 1 SPDT for low-water cutoff and alarm actuation Optional manual reset
 Series 150E/157E (shown)	Commercial & Industrial Steam Boilers Water column version - model 157E Conductance probe level detection Max. boiler operating pressure - 150 psig.	Maintains differentials throughout pressure range Conductance probes Adjustable 3/4" or 1-3/16" pump differentials Adjustable burner-off time delays 1 HP burner and pump relays CSD-1 compliant Optional manual reset
 Model 750B-P (panel mount) with 750C-3 chamber	Commercial & Industrial Steam and Hot Water Boilers Conductance probe level detection Remote chamber or boiler mounted probes Remote chamber with 3 sensor probes - model 750C-3 Max. boiler operating pressure - 250 psig.	Configurable by mixing/matching components Maintains differentials throughout pressure range Adjustable pump differentials via custom cut probes CSD-1 compliant 26,000 ohm sensitivity Manual reset by adding NC push button - (not provided)

## Selecting an Appropriate Boiler Control.

This Boiler Control Selection chart identifies system conditions for steam and hot-water boilers and lists appropriate controls to manage the conditions. The chart identifies several boiler control types or models for primary and secondary low-water cutoffs that may be used for a specific application.

Secondary (redundant) low-water cutoff (LWCO) controls are recommended for steam boilers with heat input greater than 400,000 BTU/hour (all ratings in non-residential service) or that operate above 15 psi of steam pressure. At least two controls should be connected in series with the burner control circuit to provide safety redundancy protection should the boiler experience a low-water condition.

## Boiler Control Selection.



- \* Maximum Operating Pressure = 50 psig.
- \*\* Maximum Operating Pressure = 150 psig.
- \*\*\* Maximum Operating Pressure = 20 psig.

Use chart as a guide only.

NOTE: Controls listed for higher pressure boilers may also be used on lower pressure boilers (i.e., 750-MT is frequently used on low-pressure boilers).

# Boiler Control Model Comparisons.

McDonnell & Miller has designed a full line of boiler controls with different features to provide reliable, continuous protection against low-water conditions in boilers, vessels and tanks. This Boiler Control Model Comparisons table shows the features of controls in the McDonnell & Miller series.

	Low-Water Cutoff Controls								Low-Water Cutoff and Level Controls													
Characteristic	61	63	64	PS-850	750P-MT	750-MT	750B-L	750BM-L	42	42S	93/193	94/194	150/157	150-MD/ 157-MD	150S/ 157S	150S-MD/ 157S-MD	150E/ 157E	750B-P	750BM-P	750B-LP	750B-DLP	
<b>Integral Water Column Model</b>							750C***	750C***			193	194	157	157-MD	157S	157S-MD	157E	750C***	750C***	750C***	750C***	
<b>Function:</b>																						
Low-water cutoff	X	X	X	X	X	X	X	X														
Differential level control																		X	X			
LWCO & differential level control									X	X	X	X	X	X	X	X	X			X		
Dual LWCO & differential level control																						X
<b>Water Line Stability:</b>																						
Stable water line - minimal fluctuations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fairly unstable water line < 2" fluctuations				X	X	X	X	X			X	X		X			X	X	X	X	X	X
Very unstable water line > 2" fluctuations							X	X										X	X	X	X	X
<b>Pressure Sensitivity:</b>																						
Differential/setpoints affected by operating pressure	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No
<b>Maximum Boiler Pressure:</b>																						
Hot water boilers	psi	50	50	160	160	250	250	250	50	50	150	250	150	50	150	50	150	250	250	250	250	250
	(bar)	(3.5)	(3.5)	(11.2)	(11.2)	(17.3)	(17.3)	(17.3)	(3.5)	(3.5)	(10.5)	(17.3)	(10.5)	(3.3)	(10.5)	(3.3)	(10.5)	(17.3)	(17.3)	(17.3)	(17.3)	(17.3)
Steam boilers	psi	20	50	50	15	250	250	250	50	50	150	250	150	50	150	50	150	250	250	250	250	250
	(bar)	(1.4)	(3.5)	(3.5)	(1.0)	(17.3)	(17.3)	(17.3)	(3.5)	(3.5)	(10.5)	(17.3)	(10.5)	(3.5)	(10.5)	(3.5)	(10.5)	(17.3)	(17.3)	(17.3)	(17.3)	(17.3)
<b>Liquid Level Sensing:</b>																						
Float mechanism	X	X	X						X	X	X	X	X	X	X	X						
Probes				X	X	X	X	X									X	X	X	X	X	X
Pump differentials	in. (mm)	N/A	N/A	N/A	N/A	N/A	Adjust*	Adjust*	3/4 (19)	3/4 (19)	1 (25)	1 (25)	3/4 (19)	3/4 (19)	3/4 (19)	3/4 (19)	Field Adjust*	Adjust*	Adjust*	Adjust*	Adjust*	
<b>Bellows</b>	X	X	X						X	X	X	X	X	X	X	X						
<b>Probes:</b>																						
Integral probe sensors				X	X												X					
Remote probe sensors						X	X	X										X	X	X	X	X
Probe sensitivity	ohms			7,000	20,000	20,000	26,000	26,000									55,000	26,000	26,000	26,000	26,000	26,000
<b>Control:</b>																						
Passive (no electricity required)	X	X	X						X	X	X	X	X	X	X	X						
Non-passive (electricity required to power unit)				X	X	X	X	X									X	X	X	X	X	X
<b>Switches:</b>																						
Mercury burner & pump									X				X	X								
Snap action burner & pump	X	X	X							X	X	X			X	X						
Snap action burner & proportional valve											Opt	Opt										
Magnetic repulsion											X	X										
Integral relays				X	X	X	X	X									X	X	X	X	X	X
<b>NPT Connection Size</b>	in.	1	1	3/4	3/4	X	X	X	1	1	1	1-1/4	1	1	1	1	1	X	X	X	X	X
<b>Manual Reset Lockout (CSD-1) Available</b>	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<b>Electrical Ratings at 120 VAC (Amperes)</b>	7.4	10.2	7.4	7.5	7.5	7.5	7.2	7.2	7.4	7.4	345 VA	345 VA	7.4	7.4	7.4	7.4	16	7.2	7.2	7.2	7.2	
<b>Burner-off Time Delay:</b>	N/A	N/A	N/A	N/A	N/A	N/A	Fixed	Fixed	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Adjust.	Fixed	Fixed	Fixed	Fixed	Fixed
Seconds							3	3									0 to 60	3	3	3	3	3
<b>Control Box Installations:</b>																						
Panel mount							X											X		X	X	X
Modular								X											X			
<b>Voltage Supply:</b>																						
24 VAC				X			X	X														
120 VAC				X	X	X	X	X									X	X	X	X	X	X
<b>Indicating Lights:</b>																						
Green "Power On"					X	X											X					
Red "Low Water"					X	X											X					
<b>Test Switch:</b>																						
Standard				X	X	X											X					
OEM/field installed							X	X										X	X	X	X	X

\* Adjustable - Custom cut probes provide differentials as needed.  
 \*\* Field adjustable - 2 positions [3/4 or 1-3/16 in. (19 or 30mm.)].  
 \*\*\* 750C Chamber assembly includes sensing probes.

## Types of Boiler Controls.

Boiler controls are divided into two basic types: Mechanical (float-type) and Electronic (conductance probe-type). Each type has characteristics to be considered in selecting a specific control.

### Mechanical (Float-Type) Controls.

- Float reacts to the water line.
- As water level moves up/down, the float transfers that motion to a switch or valve.

### Electronic (Conductance Probe-Type) Controls.

- Electrical current is sent from control unit through probe and out probe tip.
- Current passes through water to boiler shell and back to control unit via threaded portion of probe.

	Mechanical Control (Float-Type)	Electronic Control (Probe-Type)
<b>Boiler Mounting Location</b>	External	Internal or external
<b>Level Sensor and Control Units Mounting:</b>		
Self-contained	X	X
Can be mounted remote from probe		X
<b>Control logic capability</b>	Burner on/off Pump/feeder on/off	Burner on/off Pump/feeder on/off
<b>Electrical</b>	Passive	Requires power
<b>Test Method</b>	Blowdown – confirm burner off	Test Button – confirm burner off
<b>Foaming</b>	Senses true water line regardless of foam	May sense foam line instead of water line
<b>Required Maintenance:</b>		
Daily – Section I boilers	Blowdown	None
Weekly – Section IV boilers	Blowdown	None
Annual	Disassemble & clean – test functionality	Remove probes & clean – test functionality
<b>Units with Bellows Switch Control:</b>		
Susceptible to significant water hammer damage	X	
Boiler operating pressure affects differentials and set points	X	
<b>Replacement Intervals</b>	Switch & float – 5 yrs. Control – 10 yrs.	Probe – 10 yrs. Control – 15 yrs.

## Typical Boiler Control Installations.

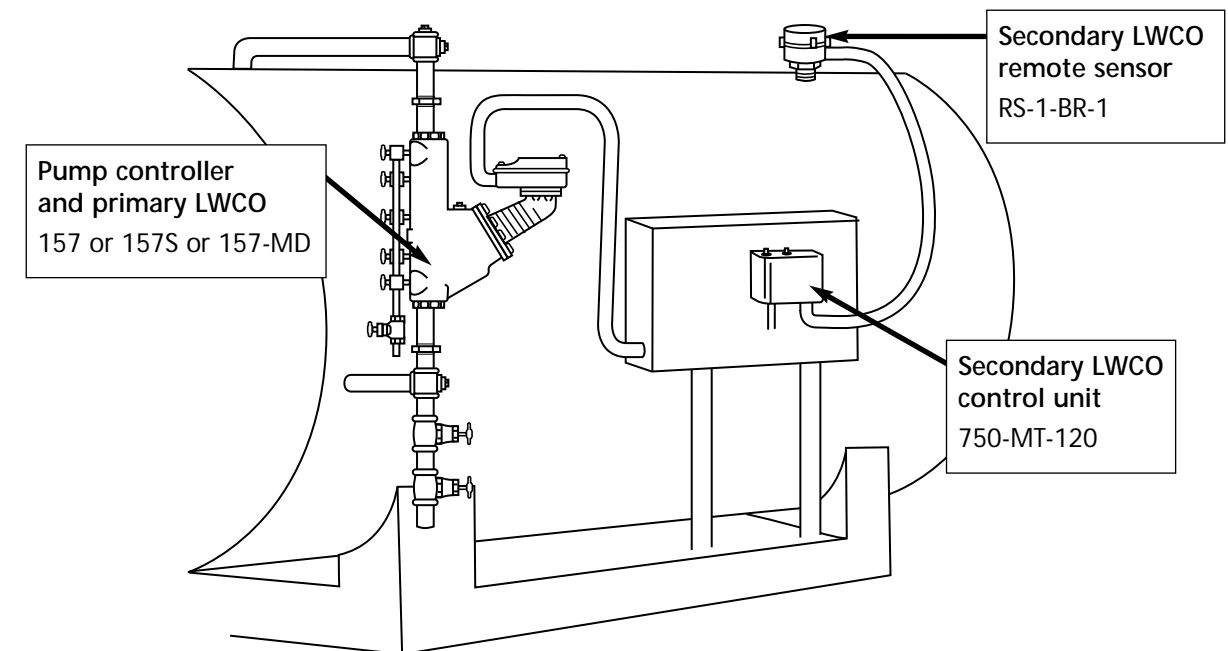
A number of options are available for controlling the pump and burner on a boiler. For pump control and primary LWCO, either mechanical (float-type) or electronic (conductance probe-type) controllers are appropriate. Secondary LWCO is normally accomplished using a conductance probe-type controller unit, although float controls also work well.

A secondary LWCO control is recommended on all steam boilers with heat input greater than 400,000 BTU/hour (all ratings in non-residential service) or operating above 15 psi of steam pressure. At least two controls should be connected in series with the burner control circuit to provide safety redundancy protection should the boiler experience a low-water condition.

The following illustrations show typical combinations of McDonnell & Miller mechanical and electronic control units. McDonnell & Miller's complete line of controls gives you maximum flexibility in choosing the combination that best fits your situation and requirements.

### Stable Water Line Applications – Minimal Fluctuations.

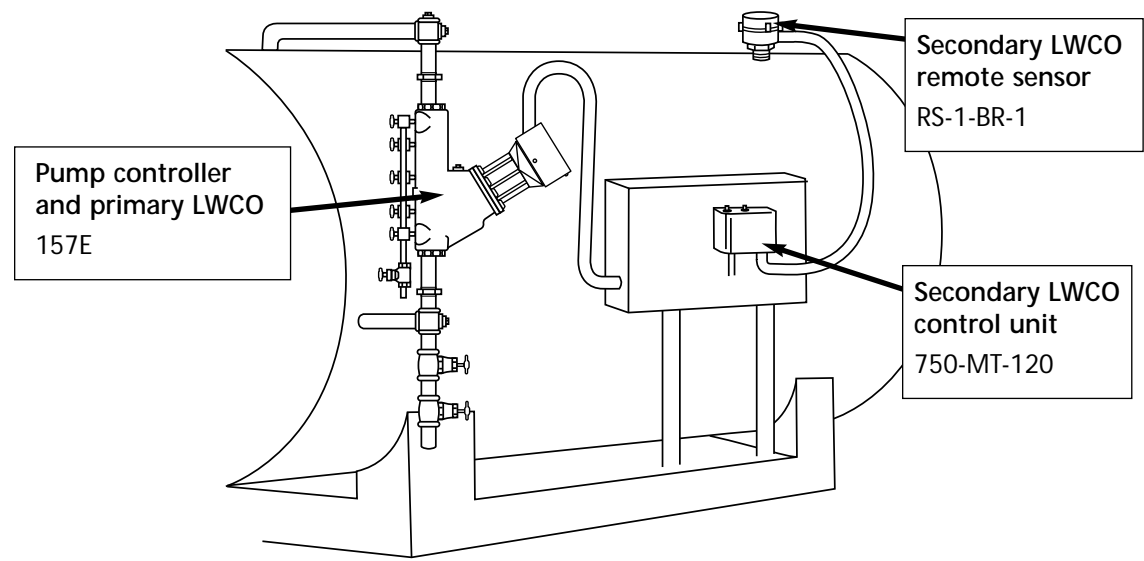
<b>157/157S/157MD</b>	Self-contained mechanical pump controller and primary LWCO. Mounted at boiler's water line.
<b>750-MT-120</b>	Self-contained electronic secondary LWCO control unit. Can be mounted in any convenient location on boiler.
<b>RS-1-BR-1*</b>	Secondary LWCO remote sensor. Mounted vertically at convenient location on boiler shell.



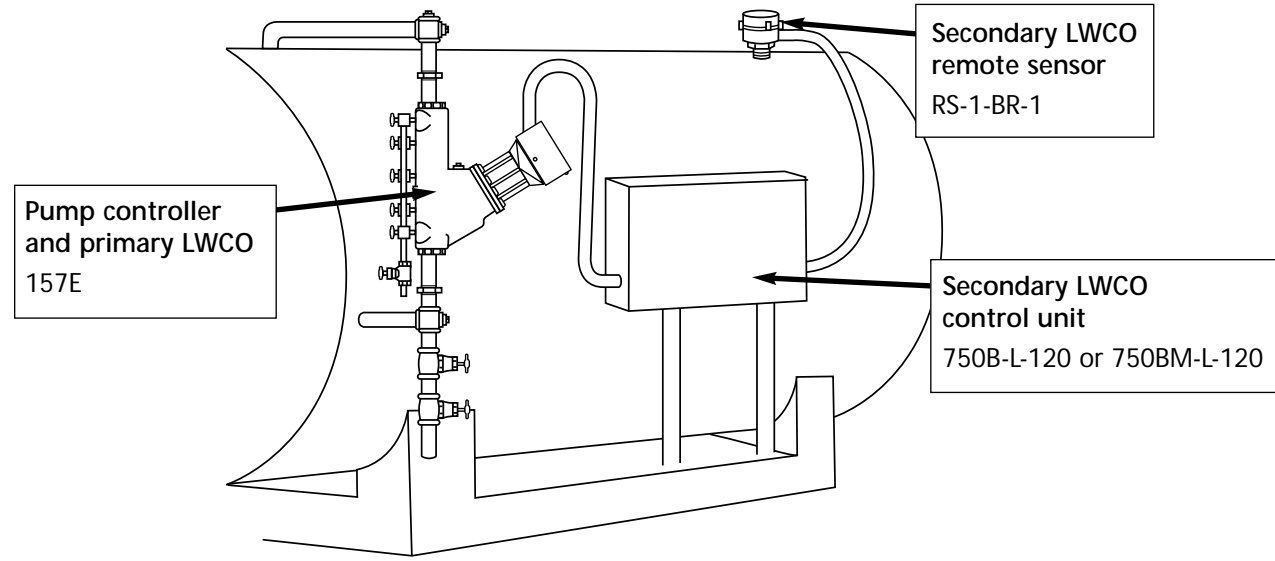
\* NOTE: RS-1-LP remote sensor may be used in place of RS-1-BR-1 sensor for steam applications up to 15 psig and hot water applications up to 160 psig. The RS-1-LP must be installed horizontally and is typically installed in the upper drum of a watertube boiler.

Fairly unstable water line applications - Less than 2" fluctuations.

157E	Self-contained electronic pump controller and primary LWCO. Mounted at boiler's water line.
750-MT-120	Self-contained electronic secondary LWCO control unit. Can be mounted in any convenient location on boiler.
RS-1-BR-1*	Secondary LWCO remote sensor. Mounted vertically at convenient location on boiler shell.

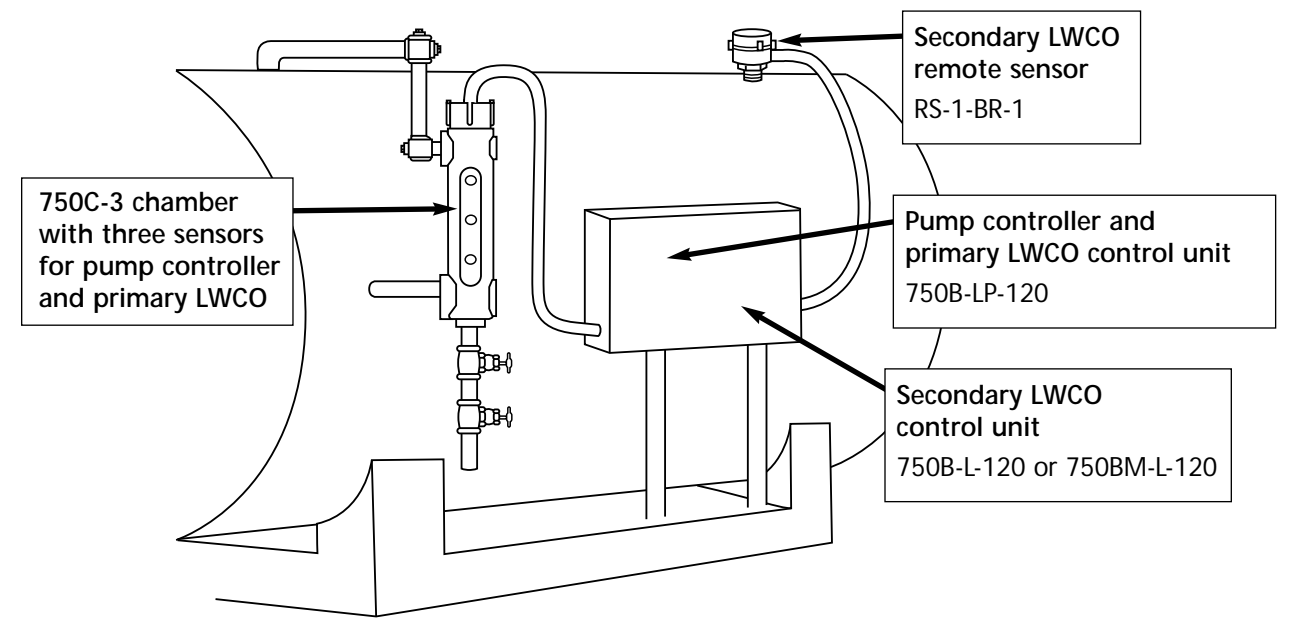


157E	Self-contained electronic pump controller and primary LWCO. Mounted at boiler's water line.
750B-L-120 or 750BM-L-120	Electronic secondary LWCO control unit. Can be installed in convenient location as part of boiler's main control panel.
RS-1-BR-1*	Secondary LWCO remote sensor. Mounted vertically at convenient location on boiler shell.



Very unstable water line applications - Fluctuations of 2" or more.

750C-3 Chamber	Containing conductance probes. Mounted at boiler's water line.
750B-LP-120	Electronic pump controller and primary LWCO control unit. Can be installed in convenient location as part of boiler's main control panel.
750B-L-120 or 750BM-L-120	Electronic secondary LWCO control unit. Can be installed in convenient location as part of boiler's main control panel.
RS-1-BR-1*	Secondary LWCO remote sensor. Mounted vertically at convenient location on boiler shell.



McDonnell & Miller Advantages

- Complete boiler control product line from which to choose:
  - Mechanical controls
  - Electronic controls
- Quality products:
  - ISO 9001 and 14001 Certified
  - 100% inspection
- Technical knowledge and support:
  - Experience and understanding of boiler applications
  - Nearly 80 years of manufacturing boiler controls
- Service support provided through:
  - McDonnell & Miller
  - Representatives
  - Wholesalers
- Boiler controls comply with UL® limit control standard (UL 353) and ASME CSD-I standard.

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