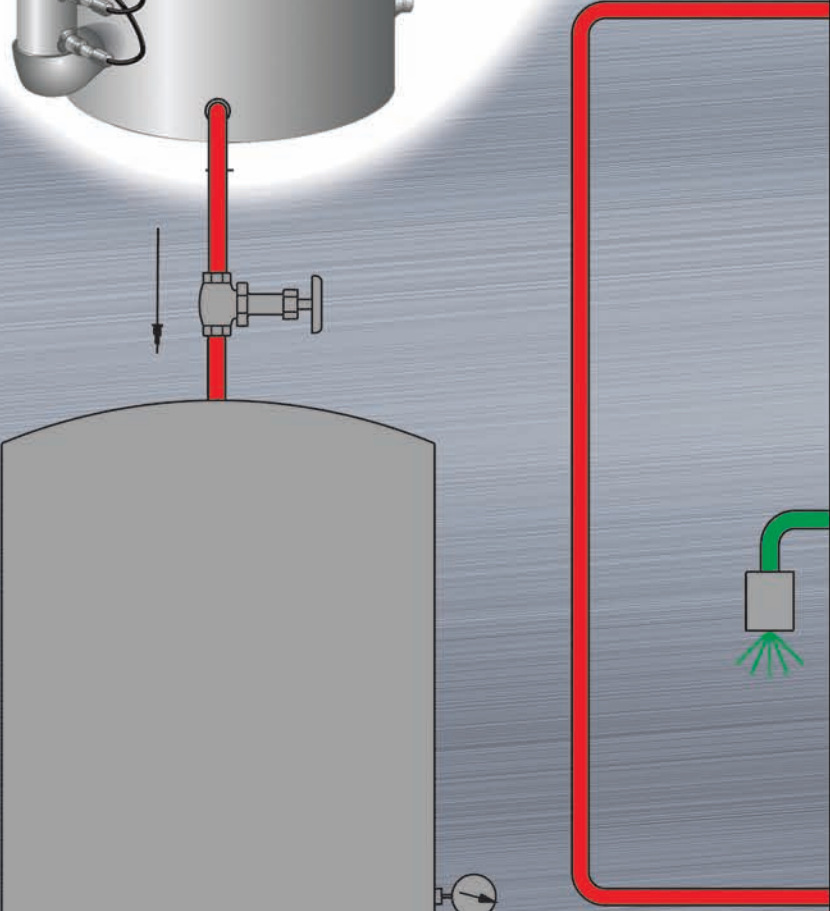
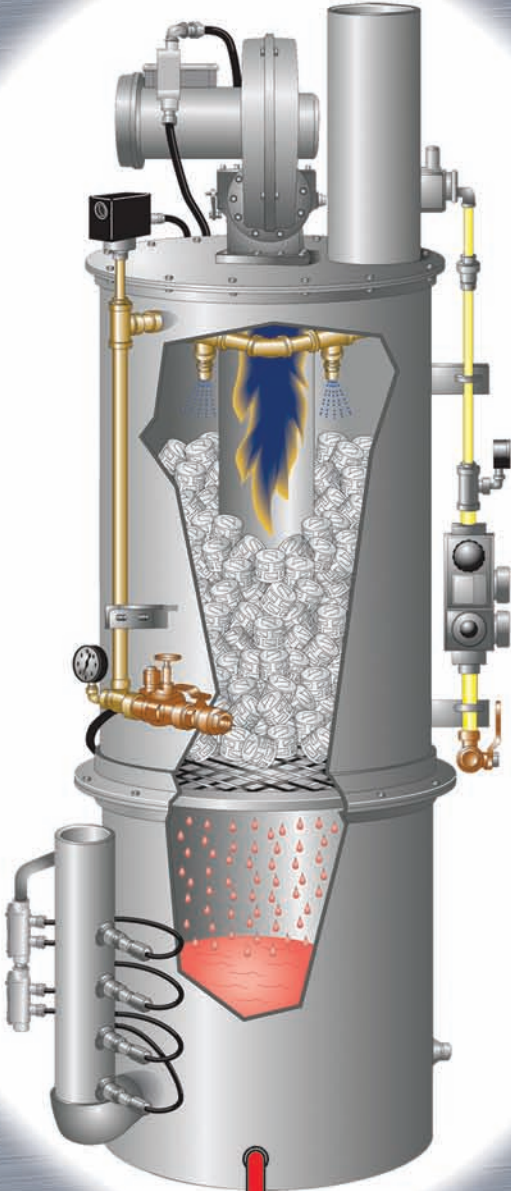


Industrial Hot Water Solutions

Generation
Distribution
Control



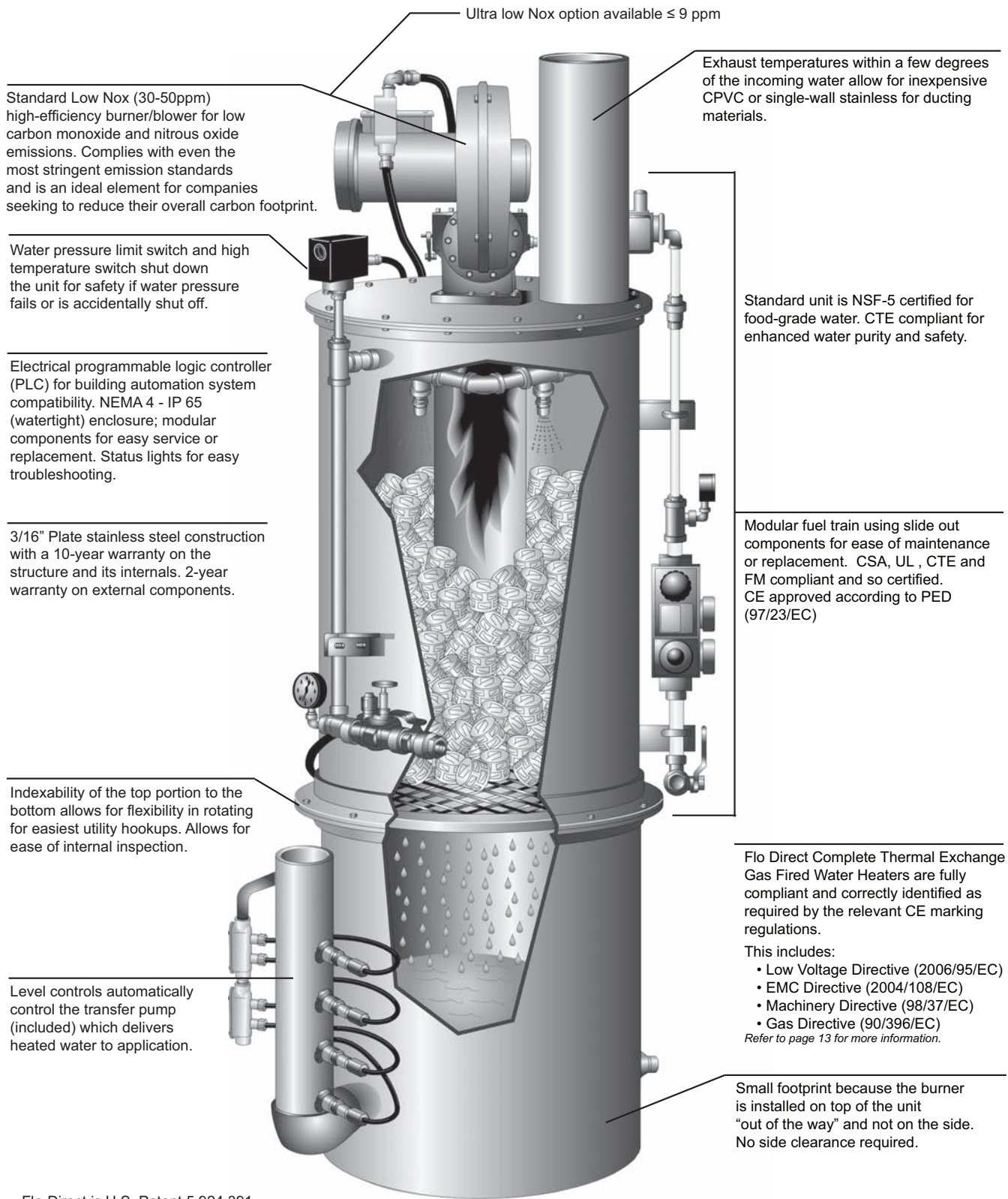
Armstrong





Flo-Direct®

Complete Thermal Exchange Gas Fired Water Heater



Ultra low Nox option available ≤ 9 ppm

Standard Low Nox (30-50ppm) high-efficiency burner/blower for low carbon monoxide and nitrous oxide emissions. Complies with even the most stringent emission standards and is an ideal element for companies seeking to reduce their overall carbon footprint.

Exhaust temperatures within a few degrees of the incoming water allow for inexpensive CPVC or single-wall stainless for ducting materials.

Water pressure limit switch and high temperature switch shut down the unit for safety if water pressure fails or is accidentally shut off.

Standard unit is NSF-5 certified for food-grade water. CTE compliant for enhanced water purity and safety.

Electrical programmable logic controller (PLC) for building automation system compatibility. NEMA 4 - IP 65 (watertight) enclosure; modular components for easy service or replacement. Status lights for easy troubleshooting.

Modular fuel train using slide out components for ease of maintenance or replacement. CSA, UL, CTE and FM compliant and so certified. CE approved according to PED (97/23/EC)

3/16" Plate stainless steel construction with a 10-year warranty on the structure and its internals. 2-year warranty on external components.

Indexability of the top portion to the bottom allows for flexibility in rotating for easiest utility hookups. Allows for ease of internal inspection.

Flo Direct Complete Thermal Exchange Gas Fired Water Heaters are fully compliant and correctly identified as required by the relevant CE marking regulations.

This includes:

- Low Voltage Directive (2006/95/EC)
- EMC Directive (2004/108/EC)
- Machinery Directive (98/37/EC)
- Gas Directive (90/396/EC)

Refer to page 13 for more information.

Level controls automatically control the transfer pump (included) which delivers heated water to application.

Small footprint because the burner is installed on top of the unit "out of the way" and not on the side. No side clearance required.

Flo-Direct is U.S. Patent 5,924,391

For additional information and to view our educational video, visit www.armstronginternational.com/flo-direct

Flo-Direct® Complete Thermal Exchange Gas Fired Water Heater



Armstrong Flo-Direct® CTE gas fired water heaters offer a complete range of high efficiency, compact, all stainless steel water heaters which are remarkably dependable, simple in design and operation, and suitable for a wide variety of hot water applications.

The Flo-Direct® CTE gas fired water heaters often deliver fuel savings as high as 30-60% when compared to steam/water heating systems. Standard operating capacities are between 1 million and 15 million BTU per hour and customized systems up to 25 million BTU per hour.

With a small footprint, 99.7% or greater high heat value (110% approx. low heat value) heat transfer efficiencies*, remarkable dependability, ease of maintenance, and the ability to operate well with poor water quality, Armstrong Flo-Direct® CTE gas fired water heaters are the product of choice for companies seeking to achieve Energy Conservation Measure (ECM) and reduced carbon footprint objectives.

Primary Markets include:

Food Process Industries

- Washdown
- Batch Production
- Vessel Filling
- Tank Cleaning

Concrete Plants

- Pre-heated water for batch production.

Space Heating

- Greenhouses
Re-circulated hot water for general space heating
- Light Manufacturing/Warehouses
Re-circulated hot water for general space heating

General Industry

- Boiler Make-Up Water

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include transfer pumps, storage tanks, variable frequency drive (VFD) pump skid-packaged solutions, hose stations and circulating pumps. In addition, Armstrong offers downstream digital water temperature controls/loops with BAS/DDC interface, along with a multitude of performance matched components which can be application engineered specifically to meet the projects requirements.

Additionally, where appropriate, Armstrong can integrate engineering services, turn key installation, project management, system assessment and optimization along with energy conservation measure (ECM) capability through Armstrong Service Incorporated.

*See page 12 for high heat value (HHV) and low heat value (LHV) explanation.

Flo-Direct® Complete Thermal Exchange Gas-Fired Water Heaters deliver unrivaled Performance and Efficiency.

Incoming water is introduced into the top of the water heater through a series of calibrated dispersion nozzles. Cold water travels down through a bed of multifaceted stainless steel packing rings (Pall Rings) which break the water into smaller and smaller droplets.

A burner is mounted on top of the unit, firing downward through a centrally located flame tube. The flame tube is cooled by incoming cold water, and all of the fuel gasses are consumed within this flame tube. The design allows all combustion to take place within a dry and cool environment, and produces very low levels of nitrous oxide (NO) and carbon monoxide (CO).

Heat from the flame enters the lower chamber from the bottom of the flame tube, and travels slowly upward through the packing rings. Efficient heat transfer occurs as the descending water comes in contact with the rising hot gasses as both pass through the bed of packing rings in opposite directions.

This "rain" of hot water then falls into the lower chamber and is pumped out to a storage tank. Water temperatures up to 185°F are available within a minimum of 30 seconds after the unit starts. Outlet water temperature is set with a value controlling the incoming water flow.

More incoming water results in cooler outlet water temperatures, and less incoming water produces hotter outlet water temperatures. The products of combustion are vented out of the top of the unit, and this exhaust is typically within a few degrees of incoming water temperature.

Features

- CTE Compliant
- NSF 5 certified for food-grade water
- Meets multiple global water quality standards (page 4)
- No internal moving parts
- Low-temperature exhaust
- 99.7% or greater high heat value efficiency
- Water treatment not required
- Stainless steel construction
- Takes up minimal floor space
- Ten year warranty on structure/two years on all other components



Flo-Direct® Complete Thermal Exchange Gas Fired Water Heater

CTE Technology

Developed from direct contact water heating science, which was first introduced more than two decades ago, Complete Thermal Exchange (CTE) technology has revolutionized high efficiency water heating methods. Today CTE enjoys a proven record and has rapidly become the new standard in high efficiency water heating and energy savings.

While traditional direct contact water heating can offer significant energy savings when compared to a conventional steam boiler system, the Armstrong Flo-Direct® CTE gas fired water heater offers an unparalleled, 99.7% high heat value (110% approx. low heat value) efficiency rating* throughout each phase of its operation cycle.

The sustained operational efficiency of Flo-Direct® CTE gas fired water heaters creates the most energy efficient method of hot water production currently available.

No Scale Build-Up

The Flo-Direct® CTE gas fired water heater's unique design prevents scale build-up because there are no "hot spots" internally or externally, and because calcium is prevented from completely falling out of suspension during operation. As a result, the mineral content of the influent water and the effluent water will be equal.

Armstrong Flo-Direct® CTE gas fired water heaters achieve CTE Standards

The Flo-Direct® CTE direct contact water heaters, meet five standards not available with the older designs and traditional methods of direct contact water heater technology:

1. CTE units maintain a minimum of 99.7% high heat value (110% approx. low heat value) efficiency in all modes of operation, not just under optimal conditions.
2. CTE units have multiple thermal passes. Water and the combustion gasses (or heat from the combustion) repeatedly come in contact. This ensures that the maximum amount of heat or energy from combustion is transferred to the water.
3. CTE units have a dry combustion chamber. This is vital to maintaining complete combustion at all times during operation.
4. CTE units maintain complete combustion at all times.
5. CTE units must have an integral water quality integrity system. Operational procedures must be in place to ensure that effluent water quality is equal to the influent water quality.

Complete Combustion = Complete Water Quality

While many traditional-method direct contact water heaters spray water directly on the flame – sometimes called "flame quenching" – Flo-Direct®, using CTE technology, avoids this process altogether. According to the Industrial Heating Equipment Association's "Combustion Technology Manual," flame quenching promotes incomplete combustion, and produces alcohols, aldehyde, formic acid, higher order acids, carbon monoxide, as well as carbon dioxide and water vapor. With CTE technology, Flo-Direct® maintains 99.7% high heat value* (110% approx. low heat value) combustion efficiency, while maintaining water quality at all times.

*See page 12 for high heat value (HHV) and low heat value (LHV) explanation.



Global Quality Water Standards

Flo-Direct Complete Thermal Exchange (CTE) Gas Fired Water Heating Technology significantly limits the effluent water chemical additives typically attributed to other process water heating systems.

Our unique CTE water heating process deaerates the water significantly. Independent third party testing has verified CTE technology can actually remove some chemical constituents from the influent water.

The National Sanitary Foundation (NSF) certifies that the effluent water from a Flo-Direct CTE Gas Fired Water Heater meets US, European Union and PRC bottled drinking water standards* and has been tested and documented as fully compliant with:

- NSF 5 - Food Grade
- USFDA- The United States Food and Drug Administration, Code of Federal Regulations Bottled Water Standard: Chapter I, Title 21, Part 165, Subpart B, Section 165.110.
- EU-TRW- The European Union Directives(s) - Treated Waters: 98/83/EC.
- Peoples Republic of China Standards for Drinking Water: GB5749-2006

*Statement presumes influent water also meets listed standards.

Flo-Direct® Complete Thermal Exchange Gas Fired Water Heater



Specifications	
Gas Supply Pressure	2 - 6 psig (0.14 - 0.41 bar)
Dynamic Water Supply Pressure	Constant water pressure (+/-5 psi variation maximum) within a minimum of 30 psig (2 bar) and a maximum of 100 psig (6.8 bar) range is required for optimum performance.
Maximum Inlet Water Temperature	120°F (49°C)
Minimum Inlet Water Temperature	32°F (0°C)
Maximum Effective Outlet Temperature	185°F (85°C)

Materials	
Upper and Lower Canister	Type 304 Stainless Steel #10 Glass Finish
Inlet Gas Train Piping	Malleable Iron with Standard Yellow Finish
Inlet Water Train Piping	Copper with Brass/Bronze Fittings
Spray Ring	Type 304/316 Stainless Steel
Canister Gaskets	Warco White
Flame Tube	Type 304 Stainless Steel
Pall Rings	Type 304 Stainless Steel

Optional/Custom materials of construction available upon request.

Standard Sizing Formulas

$$\frac{\text{gpm} \times \Delta T}{2} = \text{AFD Model}$$

$$\frac{(\text{AFD model}) \times 2}{\Delta T} = \text{gpm}$$

$$(\text{AFD model}) \times 2 = \Delta T \text{ gpm}$$

Use the Flo-Direct sizing tool at www.armstronginternational.com/flo-direct

Standard Formula Key

gpm = Gallons per minute

ΔT = Temperature rise (°F)

AFD = Armstrong Flo-Direct (e.g., 1000, 5000)

Metric Sizing Formulas

$$\frac{\text{lpm} \times \Delta T}{4.2} = \text{AFD Model}$$

$$\frac{(\text{AFD model}) \times 4.2}{\Delta T} = \text{lpm}$$

$$(\text{AFD model}) \times 4.2 = \Delta T \text{ lpm}$$

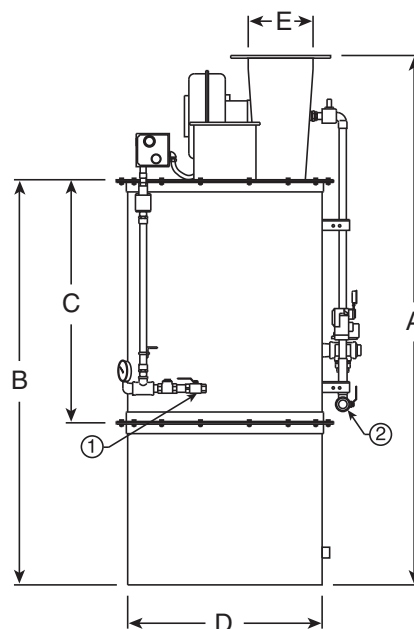
Use the Flo-Direct sizing tool at www.armstronginternational.eu/flo-direct

Metric Formula Key

lpm = Liters per minute

ΔT = Temperature rise (°C)

AFD = Armstrong Flo-Direct (e.g., 1000, 5000)



For fully detailed certified drawing, refer to CDY #1088.

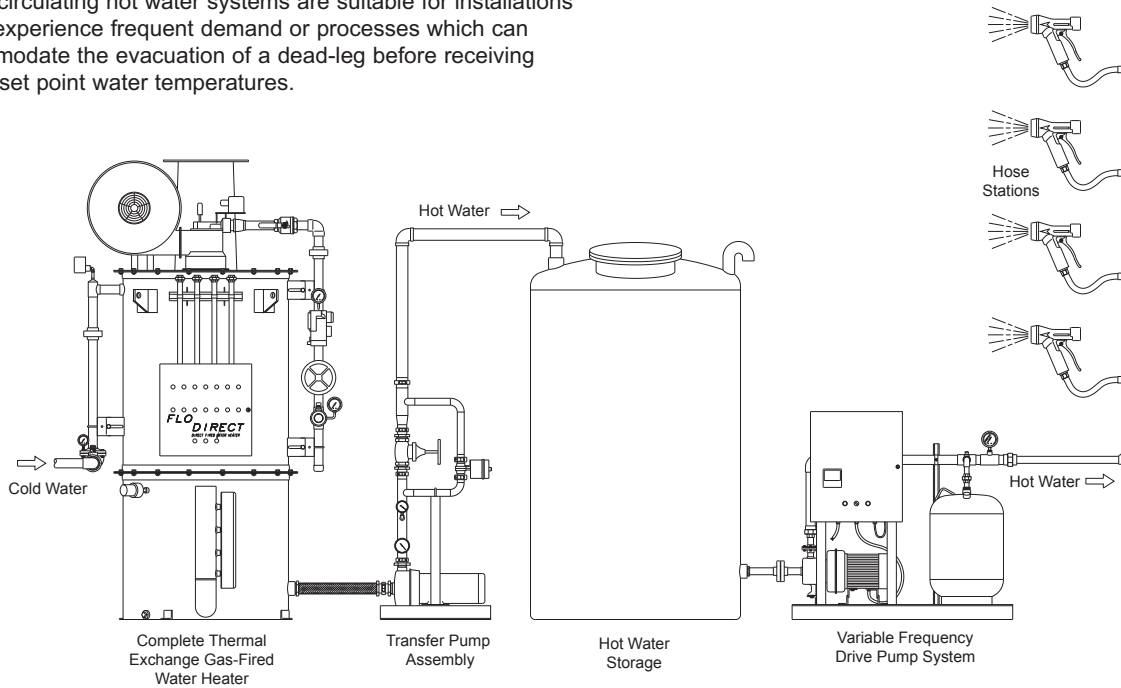
Flo-Direct Dimensions and Weights																		
Model	Connections*				Dimensions										Weight*		btu/hr	kj/hr (rounded)
	1		2		A		B		C		D		E		lb	kg		
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm				
1000	1	25	1	25	95	2413	71	1803	39	991	24	610	8	203	825	375	1,000,000	1,000,000
1500	1	25	1	25	97	2464	73	1854	41	1041	26	660	8	203	850	386	1,500,000	1,500,000
2000	1-1/2	40	1-1/2	40	100	2540	76	1930	44	1118	30	762	10-3/4	273	1500	680	2,000,000	2,000,000
3000	1-1/2	40	1-1/2	40	100	2540	76	1930	44	1118	36	914	12	305	1600	725	3,000,000	3,000,000
4000	2	50	2	50	104	2642	80	2032	48	1214	40	1016	14	356	2000	907	4,000,000	4,200,000
5000	2-1/2	65	2	50	127	3226	97	2464	65	1651	44	1118	14	356	2500	1136	5,000,000	5,300,000
6000	3	80	2	50	132	3353	100	2540	70	1778	47	1194	18	457	2900	1316	6,000,000	6,300,000
7000	3	80	2	50	139	3531	107	2718	77	1956	50	1270	18	457	3200	1455	7,000,000	7,400,000
8000	3	80	2	50	139	3531	107	2718	77	1956	50	1270	18	457	3200	1455	8,000,000	8,400,000
9000	3	80	2	50	169	4293	139	3531	107	2718	60	1524	20	508	5000	2273	9,000,000	9,500,000
10000	3	80	2	50	181	4597	151	3835	119	3023	61	1549	20	508	5200	2405	10,000,000	10,500,000
11000	4	100	3	80	181	4597	151	3835	119	3023	61	1549	22	559	5500	2495	11,000,000	11,600,000
12000	4	100	3	80	181	4597	151	3835	119	3023	61	1549	22	559	5500	2495	12,000,000	12,600,000
13000	4	100	3	80	192	4877	161	4089	129	3277	70	1778	24	610	7000	3175	13,000,000	13,700,000
14000	4	100	3	80	192	4877	161	4089	129	3277	70	1778	24	610	7000	3175	14,000,000	14,700,000
15000	4	100	3	80	192	4877	161	4089	129	3277	70	1778	24	610	7000	3175	15,000,000	15,800,000

All dimensions and weights are approximate. Use certified print for exact dimensions. Design and materials are subject to change without notice.

Flo-Direct Complete Thermal Exchange Gas Fired Water Heaters deliver a wide variety of hot water solutions.

Non-Recirculating Hot Water Systems

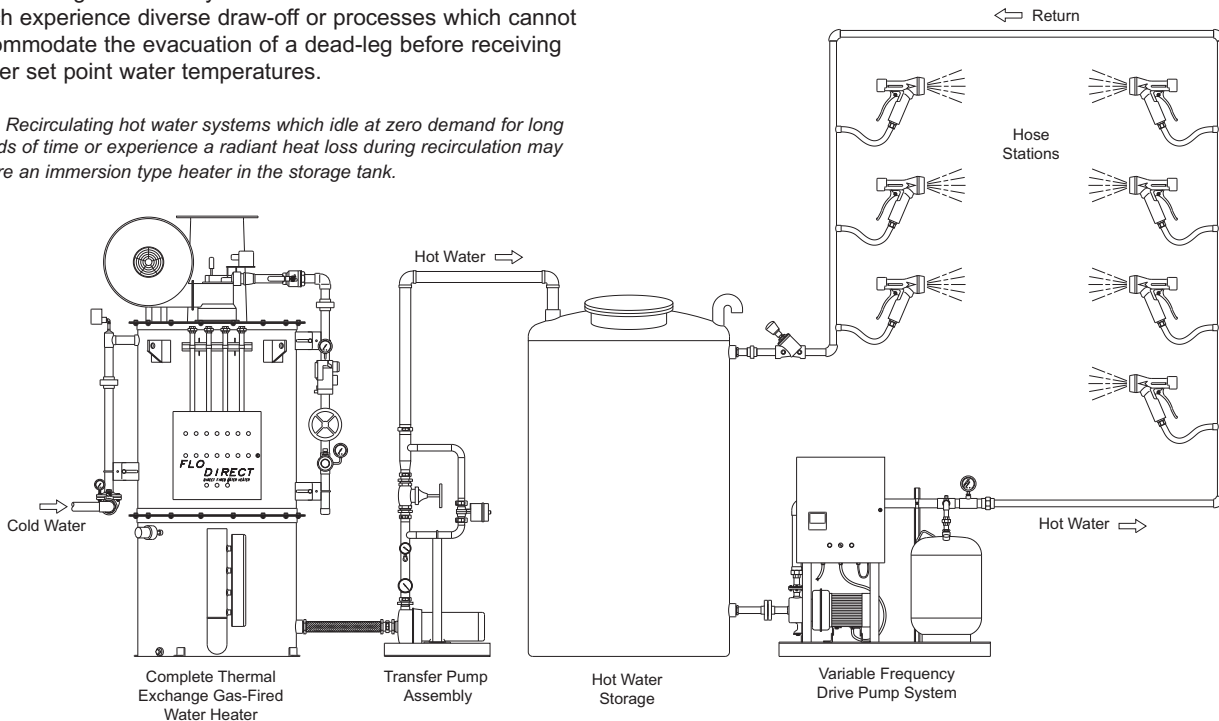
Non-recirculating hot water systems are suitable for installations which experience frequent demand or processes which can accommodate the evacuation of a dead-leg before receiving heater set point water temperatures.



Recirculating Hot Water Systems

Recirculating hot water systems are suitable for installations which experience diverse draw-off or processes which cannot accommodate the evacuation of a dead-leg before receiving heater set point water temperatures.

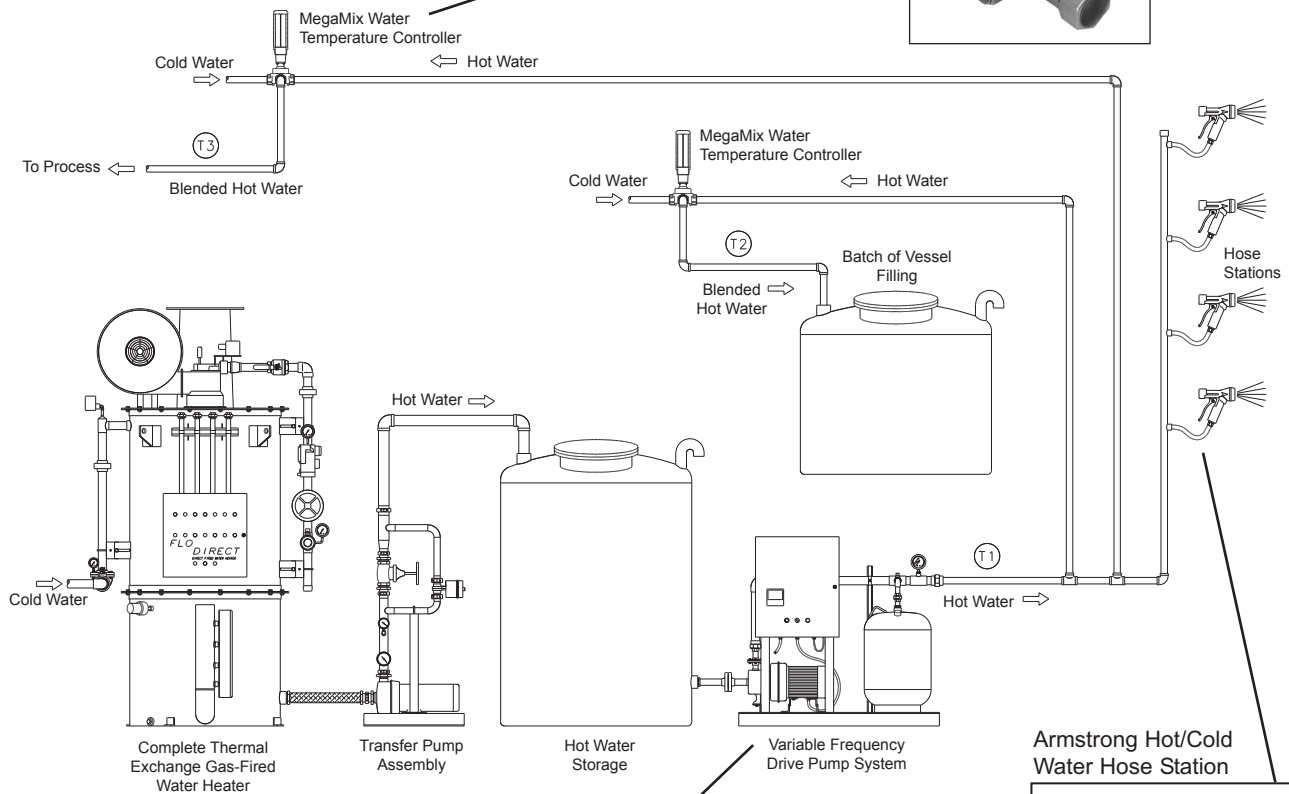
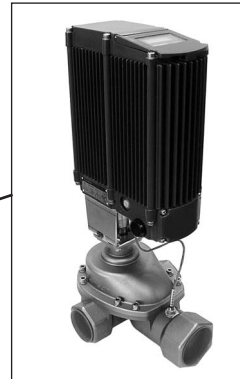
Note: Recirculating hot water systems which idle at zero demand for long periods of time or experience a radiant heat loss during recirculation may require an immersion type heater in the storage tank.



Multiple Temperature Hot Water Systems

Multiple temperature hot water systems can be designed as either recirculating, non-recirculating or a combination of both. To achieve multiple temperatures for the same hot water system, Armstrong recommends one or more MegaMix™ electronic water temperature controllers and Armstrong thermostatic hot and cold water hose stations.

MegaMix™ Water Temperature Controller

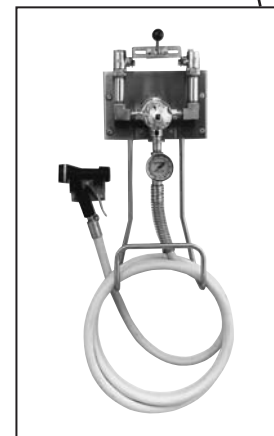


Armstrong Variable Frequency Drive Pump Assemblies



It is strongly recommended that the hot water storage temperatures are maintained at 140°F (60°C) or higher in accordance with US OSHA and CDC and corresponding global legionella guidelines. If water temperatures below 140°F (60°C) are required, Armstrong offers a variety of supplemental thermostatic, electronic and digital water temperature controllers.

Armstrong Hot/Cold Water Hose Station



Variable Frequency Drive Pump Assemblies

The Armstrong Variable Frequency Drive (VFD) Pump Packages team with our Flo-Direct CTE water heaters and our optional storage tanks at a central location to maintain flow and pressure levels at variable usage draw-off points within the hot water distribution system.

Standard and custom designed assemblies are application engineered and configured specifically to the needs of the installation site to provide a complete high efficiency, low energy consumption hot water solution.



For additional information, visit www.armstronginternational.com/files/common/allproductscatalog/vfd.pdf

Precision Mixed Water Flow & Temperature Control

MegaMix™ Water Temperature Mixing Unit

MegaMix 3-port mixing valves utilize ceramic shear action disc technology to provide tight shut-off, high pressure differential capability, and a long service life.

Fitted with an electronic actuator and integral temperature sensor, MegaMix delivers high performance, stand-alone temperature control with $\pm 1^{\circ}\text{F}$ ($\pm 0.5^{\circ}\text{C}$) accuracy over a 32°F to 212°F (0°C to 100°C) setpoint range.

MegaMix Water Temperature Mixing Units offer:

- Five Models.
- On-board keypad for valve operation.
- Flow capacities up to 1000GPM/3800LPM.
- Operating inlet temperature range:
-13°F to 257°F (-25°C to 125°C)
- Analog (4-20mA) input and output control signals.
- Software configurable control settings.
- 316 Stainless Steel construction.



For additional information, visit www.armstronginternational.com/electronic-mixing-units

High Capacity Steam & Water Mixing

MegaMix™ Steam & Water Mixing Unit

MegaMix 3-port mixing valves utilize stainless steel shear action disc technology to provide precise controlled mixing of steam and water.

Fitted with the electronic actuator and an integrated temperature sensor, MegaMix ensures fast response time and temperature control stability in a single stand-alone unit.

MegaMix Steam/Water Mixing Units offer:

- On-board keypad for valve operation.
- Three Models.
- Flow capacities up to 170GPM/646LPM.
- Analog (4-20mA) input and output control signals.
- Software configurable control settings.
- 316 Stainless Steel construction.



For additional information, visit www.armstronginternational.com/electronic-mixing-units

Point of Use Single Temperature Washdown

Armstrong Single Temperature Hose Stations

Armstrong Single Temperature Hose Stations are supplied with a heavy duty washdown hose and a self closing industrial quality spray nozzle. They are ideal for installation in hot water systems which do not require a secondary point of use water temperature adjustment.

- Stainless Steel Construction.
- Stainless Steel Ball Valve Flow Control.
- Stainless Steel Hose Rack.
- Spray Nozzle.
- Washdown Hose.



For additional information, visit www.armstronginternational.com/hose-stations-single-temperature



Armstrong® User Friendly Hot & Cold Water Hose Stations

Armstrong Hot & Cold Water Hose Stations

Armstrong Hot & Cold Water Hose Stations are supplied with an integral Rada 320 Thermostatic Mixing Valve.

Rada 320 offers:

- Full range temperature control from full cold to a field adjustable maximum temperature limit stop (which the user cannot override) in a single handle rotation.
- A single temperature lock out.
- Will hold outlet temperatures +/- 2°F (1°C) in the event of inlet pressure and/or temperature change.
- Thermal shutdown capability to protect the operator in the event of an inlet supply failure.

Available in bronze or with a heavy duty industrial nickel plate finish.



For additional information, visit www.armstronginternational.com/hot-cold-water-hose-stations

Super Safe Steam & Water Hose Stations

Steamix Hose Stations Will not Pass Live Steam

Steamix Hose Stations will not pass live steam in the event of:

- a significant cold water pressure reduction.
- a complete failure of the cold water supply.
- mechanical failure of its primary operating component.

STEAMIX Hose Stations are designed to improve efficiency and reduce risk when mixing STEAM and WATER for washdown. When your process demands high washdown temperatures, adjusting the mix of steam and water becomes much more difficult and dangerous. With the older style, dual globe valve Mixing "Y," it is easy to introduce too much steam—with dangerous consequences for your personnel.

Not with STEAMIX!

Available in bronze and Type 316 stainless steel.



For additional information, visit www.armstronginternational.com/steam-water-hose-stations

Water Temperature Control for Emergency Fixtures

Armstrong Model Z358 Thermostatic Mixing Valves

Armstrong Model Z358 Thermostatic Mixing Valves are suitable for installation at or near a point of use for direct tepid water supply to an emergency fixture or grouping of fixtures.

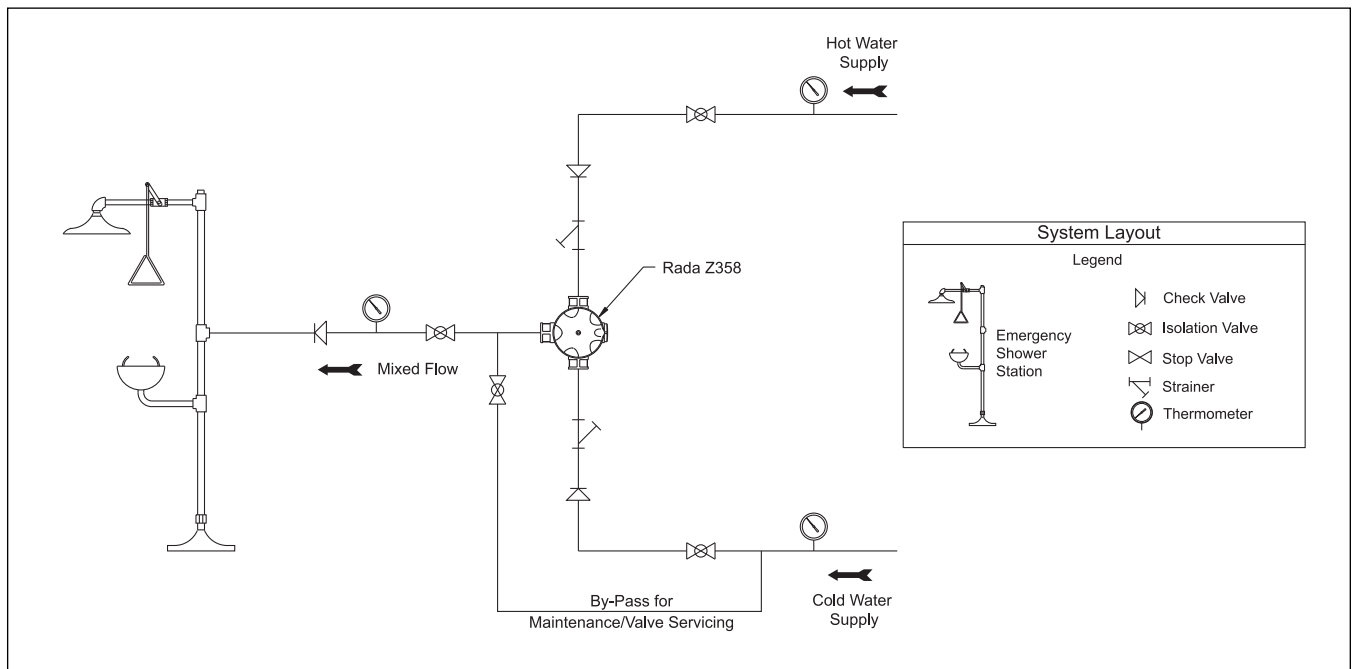
The Z358 series has been designed specifically to provide tepid water to emergency fixtures as detailed in ANSI Z358.1-2004.

The Z358 Series offers:

- Site Adjustable—Mechanical maximum-temperature limit stop and single-temperature locking features as a function of the temperature control handle design.
- Thermal shutdown feature is designed to protect user from unsafe water temperatures or hot water/chemical reaction should cold supply be interrupted during use.
- Unique constant cold water flow design ensures that in the event of a hot supply failure the Z358 Series will allow cold water to flow to fixture.



For additional information, visit www.armstronginternational.com/water-temperature-control-emergency-fixtures





High Heat Value vs. Low Heat Value

High Heat Value = Total Energy Content of Fuel

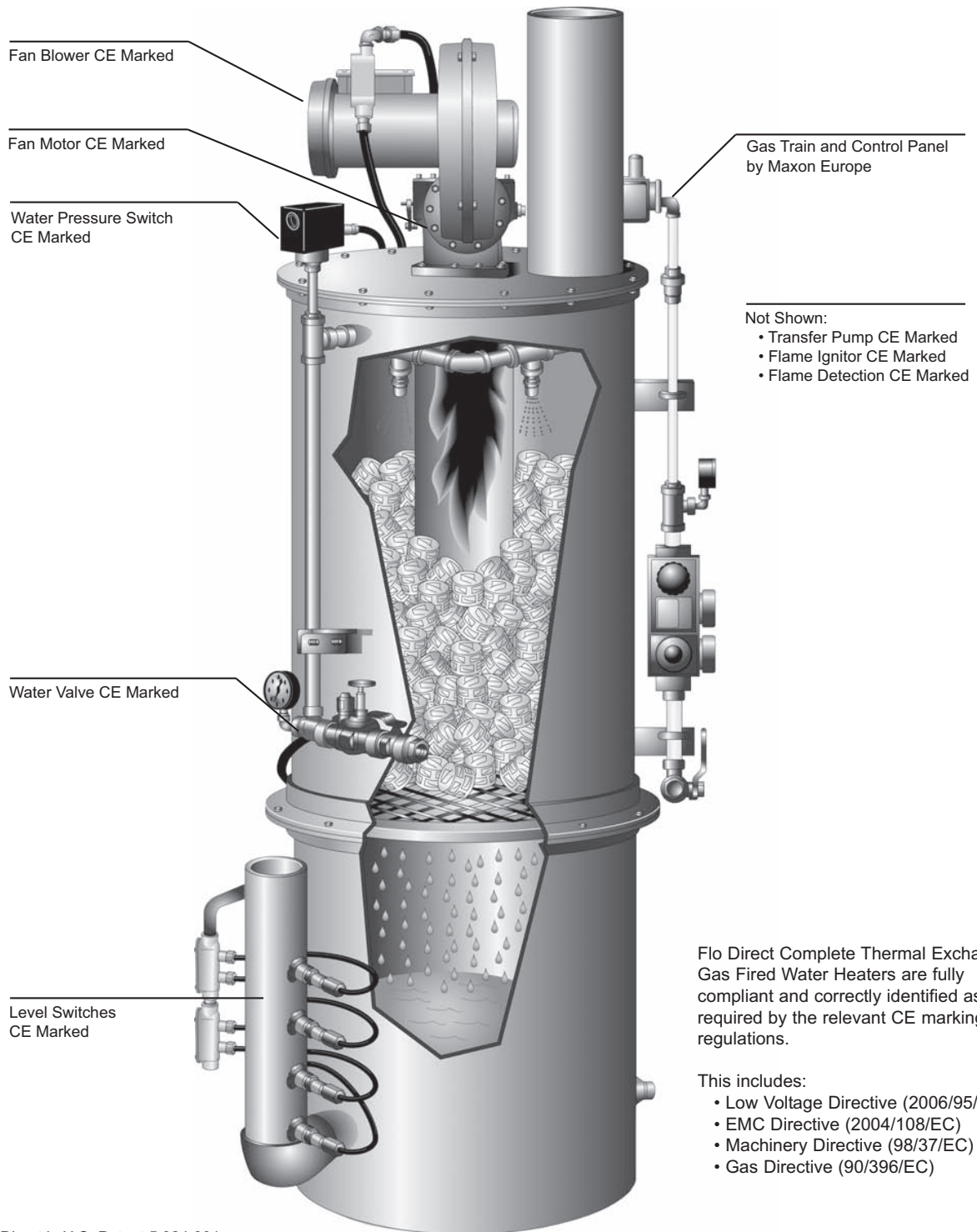
Low Heat Value = Total Heat of Hot Water or Steam Generated by the Boiler

High Heat Value (HHV) is traditionally used in USA for measuring boiler efficiency. The efficiency is calculated by comparing the total heat content (enthalpy) of the hot water or steam generated by the boiler, with the total potential energy content of the fuel feeding the boiler. Therefore, efficiency measured by using HHV cannot be higher than 100%.

Boiler efficiency measurement using Low Heat Value (LHV) is more frequently used in Europe. The exhaust gas generated by boiler combustion contain, among others, some vaporized water created through the evaporation of the moisture contained in the fuel and through the chemical reaction occurring during the combustion. In the past, it was considered impossible to recover the heat contained in this vaporized water. Therefore, the LHV is actually the total heat of the fuel minus the total heat of vaporized water contained in exhaust gas. The development of condensation economizers and boilers has allowed to recover also the latent heat of this vaporized water. Therefore, the total heat of the hot water or steam leaving the boiler could be higher than the LHV of the fuel. The efficiency calculations based on the LHV result sometimes to an efficiency of more than 100%.

When making unit and system efficiency comparisons it is important to determine whether you are reviewing HHV or LHV heat transfer efficiencies.

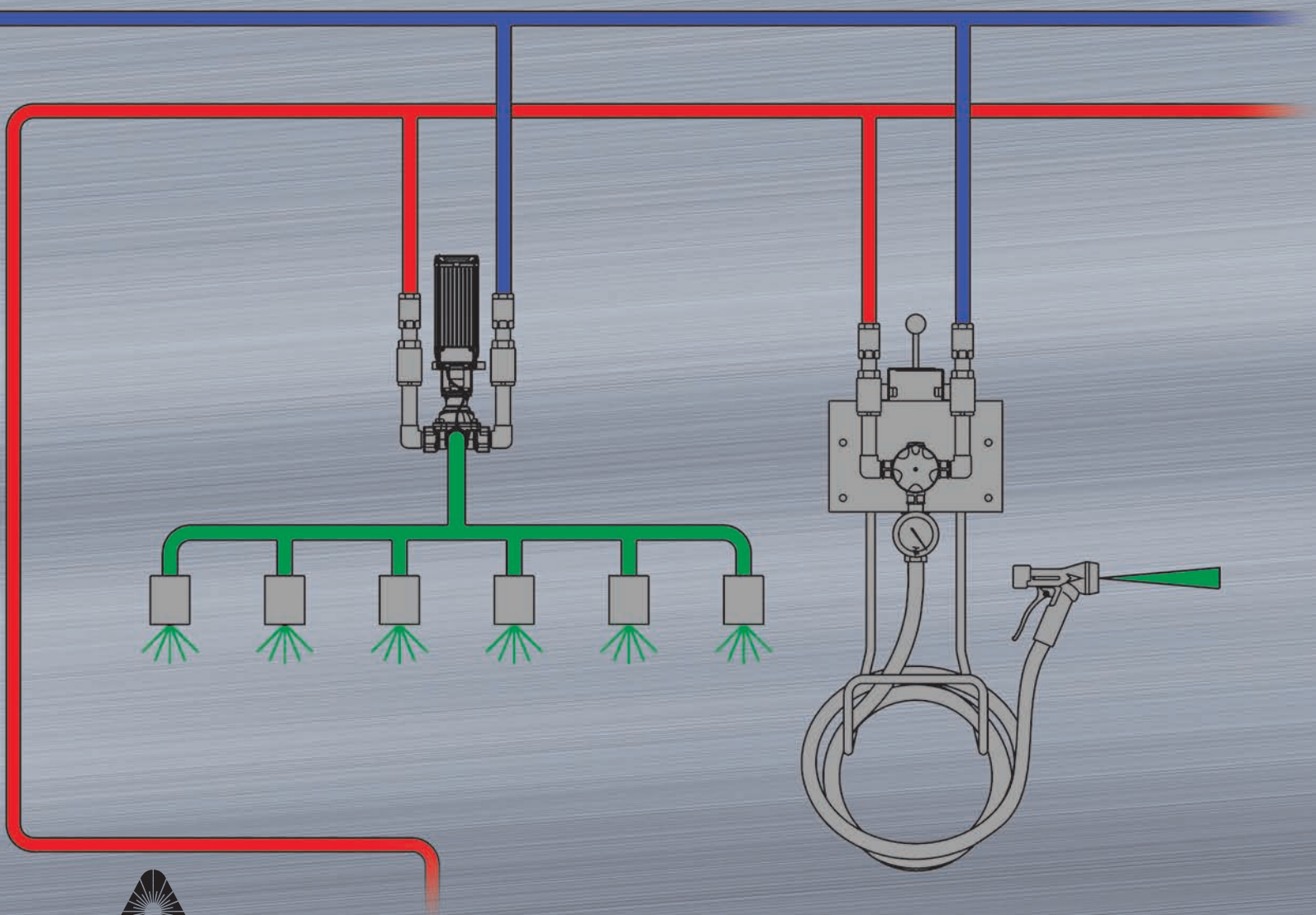
Flo Direct Complete Thermal Exchange Gas Fired Water Heaters are fully compliant and correctly identified as required by the relevant CE marking regulations.



Flo-Direct is U.S. Patent 5,924,391



Armstrong® Notes



Armstrong Hot Water Group

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