



APPENDIX DOP-19

On Site Boiler



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This document will detail in full the entire process of boiler operations for vessel cleaning applications.

PURPOSE

The purpose of this document is to ensure that all parties involved with the preparations and operations of executing boiler operations for vessel cleaning applications; at mobile and CG on-site locations have a clear understanding of the full process and utilize the best practice for executing this procedure. This will reduce the risk of potential injury to personnel, damage to equipment and material releases onsite and/or (mobile) the customer's location.

SCOPE

- **BACKGROUND**

Boiler, also called a Steam Generator, apparatus designed to convert a liquid to vapor. In a conventional steam power plant, a boiler consists of a furnace in which fuel is burned, surfaces to transmit heat from the combustion products to the water, and a space where steam can form and collect. It is a pressure vessel that provides a heat transfer surface (generally a set of tubes) between the combustion products and the water. A boiler is usually integrated into a system with many components.

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Boilers are used to produce steam. The generation part of a steam system uses a boiler to add energy to a feedwater supply to generate steam. The energy is released from the combustion of fossil fuels or from process waste heat.



The boiler itself is a main component of a generation system that also includes the fuel supply, combustion air system, feedwater system, and exhaust gases venting system. Typical major components required for conventional boilers systems include:

- *Burner*
- *Controls*
- *Deaerator*
- *Economizer*
- *Fan*
- *Heat Exchanger*
- *Instrumentation*
- *Stoker*
- *Tubes*

Section 1: Basic Types of Boilers

Firetube Boiler

In firetube boilers, the combustion gases pass inside boiler tubes, and heat is transferred to water between the tubes and the outer shell. Today, larger firetube boilers are over 1,500 boiler horsepower (about 50,000 pounds per hour). Firetube boilers are often characterized by their number of passes, referring to the number of times the combustion (or flue) gases flow the length of the pressure vessel as they transfer heat to the water. The turnaround zones can be either dryback or waterback. In dryback designs, the turnaround area is refractory-lined. In waterback designs, this turnaround zone is water-cooled, eliminating the need for the refractory lining.

Watertube Boiler

In watertube boilers, boiler water passes through the tubes while the exhaust gases remain in the shell side, passing over the tube surfaces. Because tubes can typically withstand higher internal pressure than the large chamber shell in a firetube, watertube boilers are used where high steam pressures (3,000 psi, sometimes higher) are required. Watertube boilers are also capable of high efficiencies and can generate saturated or superheated steam. In fact, the ability of watertube boilers to generate superheated steam makes these boilers particularly attractive in applications that require dry, high-pressure, high energy steam, including steam turbine power generation. The performance characteristics of watertube boilers make them highly favorable in process industries, including chemical manufacturing, pulp and paper manufacturing, and refining. Although firetube boilers



account for most boiler sales in terms of units, watertube boilers account for the majority of boiler capacity.

Waste Heat Recovery Boiler (WHRB)

These boilers may be either firetube or watertube design and use heat that would otherwise be discarded to generate steam. Typical sources of heat for WHRBs include exhaust gases or high-temperature products from an external manufacturing process in refineries and chemical manufacturing facilities, or combustion of a waste fuel in the boiler furnace.

Heat Recovery Steam Generators (HRSGs)

HRSGs transfer energy from the exhaust of a gas turbine to an unfired or supplementary fired heat-recovery steam generator to produce steam. Exhaust gases leave the gas turbine at temperatures of 1,000°F (538°C) or higher and can represent more than 75% of the total fuel energy input. This energy can be recovered by passing the gases through a heat exchanger (steam generator) to produce hot water or steam for process needs.

Summary

The main difference between a firetube and watertube boiler is the construction and design of each system. In a firetube boiler, water inside a vessel is surrounded by tubes that contain combustion gases. In other words, the ‘fire’ is inside the tubes, making it a ‘firetube’. Watertube boilers are essentially the opposite in design. Combustion gases surround a series of tubes that contain water, coining the name, watertube.

High and Low pressure Systems

By definition, high pressure boilers are built to a maximum allowable working pressure (MAWP) above 15 psig, while low pressure boilers are designed for operation at 15 psig or below. Low pressure boilers are most commonly utilized in heating applications and require less maintenance than that of a high pressure unit. Furthermore, firetube boilers can be built for both low- and high-pressure applications, while watertube boilers are typically built for high pressure needs.

Some may think that firetube and watertube boilers are in the same category as hot water and steam boilers. However, steam and hot water boilers are a classification, and can be considered a subcategory to firetube & watertube boilers.

Hot water and steam boilers operate in a very similar manner, but hot water boilers don’t actually produce steam. In reality, a hot water boiler is just a fuel fired hot water heater, in which heat is added to increase the temperature to a level below the boiling point. Hot water boilers are not as powerful as steam boilers, which is why they are more commonly used in heating applications providing hot water at 120 – 220F.

Steam boilers heat water to levels that are above boiling point, in order to produce steam. They are much more powerful and are utilized in more industrial and heavy-commercial



applications. Steam boilers can be designed to produce either saturated or superheated steam.

Summary of Boiler Types

Combi Boiler

A combi boiler is a single unit that generates all the heating and hot water for the home. There are no hot water tanks. A combination boiler heats water via an integral heat exchanger directly from the cold mains. It provides instantaneous hot water.

Heat Only (regular) Boiler

Referred to as a 'regular' or 'conventional' boiler, a heat only boiler only provides heating. It works with a hot water cylinder. A heat only boiler (also) provides heating directly to the radiators and works with a cylinder to provide hot water. They often work on what is called an 'open-vented' heating system, i.e. there is a Feed and Expansion tank in the loft, but they can work on a 'sealed' system too.

System Boiler

A system boiler has all the same components as a combi boiler without hot water production. It often works with a steel hot water cylinder but can work with vented cylinders also. Like regular boilers, system boilers work with a hot water cylinder. Unlike regular boilers, the system is not open-vented, i.e. there are no tanks in the loft, and some of the components that would normally be outside a heat only boiler (pumps, valves etc) are integrated into the boiler. These are a modern version of the regular boiler and are often installed alongside unvented hot water cylinders but can be used with copper vented cylinders



Section 8: Glossary of Boiler Terms

A

ABSOLUTE PRESSURE - Pressure above zero pressure; the sum of the gauge and atmospheric pressures.

ACCUMULATOR - (STEAM) A pressure vessel containing water and/or steam, which is used to store the heat of steam for use at a later period and at some lower pressure.

ACID CLEANING - The process of cleaning the interior surfaces of steam generating units by filling the unit with dilute acid accompanied by an inhibitor to prevent corrosion, and subsequently draining, washing and neutralizing the acid by a further wash of alkaline water.

ACIDITY - Represents the amount of free carbon dioxide, mineral acids and salts (especially sulphates of iron and aluminum) which hydrolyze to give hydrogen ions in water and is reported as milliequivalents per liter of acid, or ppm acidity as calcium carbonate, or pH the measure of hydrogen ions concentration.

ADIABATIC FLAME TEMPERATURE - The theoretical temperature that would be attained by the products of combustion provided the entire chemical energy of the fuel, the sensible heat content of the fuel and combustion above the datum temperature were transferred to the products of combustion. This assumes: No heat loss to surroundings and no dissociation.

AIR - The mixture of oxygen, nitrogen, and other gases, which with varying amounts of water vapor, forms the atmosphere of the earth.

AIR ATOMIZING OIL BURNER - A burner for firing oil in which the oil is atomized by compressed air, which is forced into and through one or more streams of oil which results in the breaking of the oil into a fine spray.

AIR DEFICIENCY - Insufficient air, in an air-fuel mixture, to supply the oxygen required for complete oxidation of the fuel.

AIR-FREE - The descriptive characteristic of a substance from which air has been removed.



AIR-FUEL RATIO - The ratio of the weight, or volume, of air to fuel.

AIR INFILTRATION - The leakage of air into a setting or duct.

AIR, SATURATED - Air which contains the maximum amount of water vapor that it can hold at its temperature and pressure.

AIR VENT - A valved opening in the top of the highest drum of a boiler or pressure vessel for venting air.

ALARM - A suitable horn, bell, light or other device which when operated will give notice of malfunction or off normal condition.

ALKALINITY - Represents the amount of carbonates, bicarbonates, hydroxides and silicates or phosphates in the water and is reported as grains per gallon, or ppm as calcium carbonate.

ALLOWABLE WORKING PRESSURE - See design pressure.

AMBIENT AIR - The air that surrounds the equipment. The standard ambient air for performance calculations is air at 80 °F, 60% relative humidity, and a barometric pressure of 29.921 in. Hg, giving a specific humidity of 0.013 lb of water vapor per lb of dry air.

AMBIENT TEMPERATURE - The temperature of the air surrounding the equipment.

ANALYSIS - Quantitative determination of the constituent parts.

ANALYSIS, ULTIMATE - Chemical analysis of solid, liquid or gaseous fuels. In the case of coal or coke, determination of carbon, hydrogen, sulfur, nitrogen, oxygen, and ash.

AQUASTAT - Water limit temperature control, a safety device often used on boilers.

ARRESTER - A device to impede the flow of large dust particles or sparks from a stack, usually screening at the top.

AS-FIRED FUEL - Fuel in the condition as fed to the fuel burning equipment.

ASH - The incombustible inorganic matter in the fuel.

ASH-FREE BASIS - The method of reporting fuel analysis, whereby ash is deducted and other constituents are recalculated to total 100%.

ASH PIT - A pit or hopper located below a furnace where refuse is accumulated and from which refuse is removed at intervals. **ASME** - The American Society of Mechanical Engineers.

ASPIRATING BURNER - A burner in which the fuel in a gaseous or finely divided form is burned in suspension, the air for combustion being supplied by bringing into contact with the



fuel, air drawn through one or more openings by the lower static pressure created by the velocity of the fuel stream.

AS-RECEIVED FUEL - Fuel in the condition as received at the plant.

ATMOSPHERIC AIR - Air under the prevailing atmospheric conditions.

ATMOSPHERIC PRESSURE - The barometric reading of pressure exerted by the atmosphere. At sea level 14.7 lb per sq in. or 29.92 in. of mercury.

ATOMIZER - A device by means of which a liquid is reduced to a very fine spray.

AVAILABLE DRAFT - The draft which may be utilized to cause the flow of air for combustion or the flow of products of combustion.

AVAILABILITY FACTOR - The fraction of time during which the unit is in operable condition.

AXIAL FAN - Consists of a propeller or disc type of wheel within a cylinder that discharges air parallel to the axis of the wheel.

B

BAFFLE - A plate or wall for deflecting gases or liquids.

BAFFLE TILE - A tile for deflecting gases.

BAFFLE-TYPE COLLECTOR - A device in gas paths utilizing baffles so arranged as to deflect dust particles out of the gas stream.

BAG FILTER - A device containing one or more cloth bags for recovering particles from the dust laden gas or air which is blown through it.

BAG-TYPE COLLECTOR - A filter in which the cloth filtering medium is made in the form of cylindrical bags.

BAROMETRIC PRESSURE - Atmospheric pressure as determined by a barometer usually expressed in inches of mercury.

BASE LOAD - Base load is the term applied to that portion of a station or boiler load that is practically constant for long periods.

BEADED TUBE END - The rounded exposed end of a rolled tube when the tube metal is formed over against the sheet in which the tube is rolled.

BLIND NIPPLE - A nipple, or a short piece of pipe or tube, closed at one end.



BLOWDOWN - Boiler water that is removed from the boiler in order to maintain the desired concentration levels of suspended and dissolved solids in the boiler and removal of sludge.

BLOWDOWN SAFETY VALVE - The difference between the pressure at which a safety valve opens and at which it closes.

BLOWDOWN VALVE - A valve generally used to continuously regulate concentration of solids in the boiler, not a drain valve. (Often called continuous blowdown.)

BLOW-OFF VALVE - A specially designed, manually operated, valve that connects to the boiler for the purpose of reducing the concentration of solids in the boiler or for draining purposes. (Often called bottom blowdown.)

BLOWER - A fan used to force air under pressure.

BOILER - A closed vessel in which water is heated, steam is generated, steam is superheated, or any combination thereof, under pressure or vacuum by the application of heat from combustible fuels, electricity or nuclear energy.

BOILER EFFICIENCY - The term boiler efficiency is often substituted for combustion or thermal efficiency. True boiler efficiency is the measure of fuel-to-steam efficiency.

BOILER HORSEPOWER - The evaporation of 34-1/2 lbs of water per hour from a temperature of 212 °F into dry saturated steam at the same temperature. Equivalent to 33,475 Btu/hr.

BOILER RATING - The heating capacity of a boiler expressed in boiler horsepower, Btu/ hour, or pounds of steam/hour. **BOILER SHELL**- The outer cylindrical portion of a pressure vessel.

BOILER WATER - A term construed to mean a representative sample of the circulating boiler water, after the generated steam has been separated and before the incoming feed water or added chemical becomes mixed with it so that its composition is affected.

BOILING - The conversion of a liquid into vapor with the formation of bubbles.

BOILING OUT - The boiling of highly alkaline water in boiler pressure parts for the removal of oils, greases, etc.

BOOSTER FAN - A device for increasing the pressure or flow of a gas.

BREECHING - A duct that transports the products of combustion between parts of a steam generating unit or to the stack.

BRIDGEWALL - A wall in a furnace over which the products of combustion pass.



BRITISH THERMAL UNIT (Btu) - The mean British Thermal Unit is 1/180 of the heat required to raise the temperature of 1 lb of water from 32 °F to 212 °F at a constant atmospheric pressure. A Btu is essentially 252 calories.

BUCKSTAY - A structural member placed against a furnace or boiler wall to restrain the motion of the wall.

BUNKER C OIL - Residual fuel oil of high viscosity commonly used in marine and stationary steam power plants. (No. 6 fuel oil) **BURNER** - A device for the introduction of fuel and air into a furnace at the desired velocities, turbulence, and concentration.

BURNER WINDBOX - A plenum chamber around a burner that maintains an air pressure sufficient for proper distribution and discharge of secondary air.

BURNER WINDBOX PRESSURE - The air pressure maintained in the windbox or plenum chamber measured above atmospheric pressure.

BY-PASS - A passage for a fluid, permitting a portion of the fluid to flow around its normal pass flow channel. **C C** - Carbon element, the principal combustible constituent of all fuels. **CaCO₃** - Calcium Carbonate.

CALORIE - The mean calorie is 1/100 of the heat required to raise the temperature of 1 gram of water from Zero C to 100 °C at a constant atmospheric pressure. It is about equal to the quantity of heat required to raise one gram of water 1 °C. Another definition is: A calorie is 3600/860 joules.

CALORIMETER - Apparatus for determining the calorific value of a fuel.

CAPACITY FACTOR - The ratio of the average load carried to the maximum design capacity.

CARBON - Element. The principal combustible constituent of all fuels.

CARRYOVER - The chemical solids and liquid entrained with the steam from a boiler.

CASING - A covering of sheets of metal or other material such as fire-resistant composition board used to enclose all or a portion of a steam generating unit.

CENTRAL STATION - A power plant or steam heating plant that generates power or steam.

CENTRIFUGAL FAN - Consists of a fan rotor or wheel within a housing that discharges air at a right angle to the axis of the wheel.

CHEMICAL ANALYSIS - Determination of the principal chemical constituents.



CHEMICAL FEED PIPE - A pipe inside a boiler drum through which chemicals for treating the boiler water are introduced.

CHIMNEY - A brick, metal or concrete stack.

CIRCULATION - The movement of water and steam within a steam generating unit.

CIRCULATION RATIO - The ratio of water entering a circuit to the steam generated by that passes that circuit in a unit of time.

CIRCULATOR - A pipe or tube to pass steam or water between upper boiler drums usually located where the heat absorption is low. Also used to apply to tubes connecting headers of horizontal water tube boilers with drums.

CLEANOUT DOOR - A door placed so that accumulated refuse may be removed from a boiler setting.

CO - Carbon monoxide.

CO₂ - Carbon dioxide.

COLLECTOR - A device used for removing gas borne solids from flue gas.

COLLOID - A finely divided organic substance which tends to inhibit the formation of dense scale and results in the deposition of sludge, or causes it to remain in suspension, so that it may be blown from the boiler.

COMBUSTIBLE LOSS - The loss representing the unliberated thermal energy occasioned by failure to oxidize completely some of the combustible matter in the fuel.

COMBUSTIBLES - The heat producing constituents of a fuel.

COMBUSTION - The rapid chemical combination of oxygen with the combustible elements of a fuel resulting in the release of heat.

COMBUSTION AIR - Air used in the combustion process. Air contains oxygen which is required to combust fuel.

COMBUSTION CHAMBER - See Furnace.

COMBUSTION EFFICIENCY - The effectiveness of the burner to completely burn the fuel. A well designed burner will operate with as little as 10 to 20% excess air, while converting all combustibles in the fuel to useful energy.



COMPLETE COMBUSTION - The complete oxidation of all the combustible constituents of a fuel.

CONCENTRATION - (1) The weight of solids contained in a unit weight of boiler or feed water. (2) The number of times that the dissolved solids have increased from the original amount in the feedwater to that in the boiler water due to evaporation in generating steam.

CONDENSATE - Condensed water resulting from the removal of latent heat from steam.

CONDUCTION - The transmission of heat through and by means of matter unaccompanied by any obvious motion of the matter.

CONDUCTIVITY - (1) A material property relating heat flux (heat transferred per unit area per unit time) to a temperature difference. In American units, it is typically defined as the amount of heat (Btu) transmitted in one hour through one square foot of material 1 inch thick, with a temperature difference of 1°F between the two surfaces of the material. (2) The property of a water sample to transmit electric current under a set of standard conditions. Usually expressed as microohms conductance.

CONTINUOUS BLOWDOWN - The uninterrupted removal of concentrated boiler water from a boiler to control total solids concentration in the remaining water.

CONTROL - Any manual or automatic device for the regulation of a machine to keep it at normal operation. If automatic, the device is motivated by variations in temperature, pressure, water level, time, light, or other influences.

CONTROL VALVE - A valve used to control the flow of air, gas, water, steam or other substance.

CONVECTION - The transmission of heat by the circulation of a liquid or gas. It may be natural, with the circulation caused by buoyancy affects due to temperature differences, or forced with circulation caused by a mechanical device such as a fan or pump.

CORROSION - The wasting away of metal due to chemical action. In a boiler, usually caused by the presence of O₂, CO₂, or an acid.

CROWN SHEET - In a firebox boiler, the plate forming the top of the furnace.

CRUDE OIL - Unrefined petroleum.

CSD-1 - Abbreviation for the ASME standard for Controls and Safety Devices.

D



DAMPER - A device for introducing a variable pressure drop in a system used for regulating the volumetric flow of a gas, such as air.

DAVIT - The structure on large firetube boilers from which the front and rear doors are suspended when opened.

DEAERATION - Removal of air and gases from boiler feed water prior to its introduction to a boiler.

DEGASIFICATION - Removal of gases from samples of steam taken for purity test. Removal of CO₂ from water as in the ion exchange method of softening.

DELAYED COMBUSTION - A continuation of combustion beyond the furnace. (See also Secondary Combustion.)

DESIGN LOAD - The load for which a steam generating unit is designed, considered the maximum load to be carried.

DESIGN PRESSURE - The pressure used in the design of a boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the different parts of the boiler.

DESIGN STEAM TEMPERATURE - The temperature of steam for which a boiler is designed.

DEW POINT - The temperature at which condensation starts.

DISENGAGING SURFACE - The surface of the boiler water from which steam is released.

DISSOCIATION - The process by which a chemical compound breaks down into simpler constituents, as do CO₂ and H₂O at high temperature.

DISSOLVED SOLID - Those solids in water which are in solution.

DISTILLATE FUELS - Liquid fuels distilled usually from crude petroleum.

DISTILLATION - Vaporization of a substance with subsequent recovery of the vapor by condensation. Often used in less precise sense to refer to vaporization of volatile constituents of a fuel without subsequent condensation.

DISTILLED WATER - Water produced by vaporization and condensation with a resulting higher purity.

DOWNCOMER - A tube or pipe in a boiler or waterwall circulating system through which fluid flows downward.

DOWNTIME - Amount of time a piece of equipment is not operational.



DRAFT - The difference between atmospheric pressure and some lower pressure existing in the furnace stack or gas passages of a steam generating unit.

DRAFT DIFFERENTIAL - The difference in static pressure between two points in a system.

DRAFT GAUGE - A device for measuring draft, usually in inches of water.

DRAIN - A valved connection at the lowest point for the removal of all water from the pressure parts.

DRUM - A cylindrical shell closed at both ends designed to withstand internal pressure.

DRY AIR - Air with which no water vapor is mixed. This term is used comparatively, since in nature there is always some water vapor included in air, and such water vapor, being a gas, is dry.

DRYBACK BOILER - Firetube boiler with a refractory lined back door. Door opens to allow maintenance and/or inspection.

DRY GAS - Gas containing no water vapor.

DRY-GAS LOSS - The loss representing the difference between the heat content of the dry exhaust gases and their heat content at the temperature of ambient air.

DRY STEAM - Steam containing no moisture. Commercially dry steam containing not more than one half of one percent moisture.

DUCT - A passage for air or gas flow.

E

ECONOMIZER - Utilizes waste heat by transferring heat from flue gases to warm incoming feedwater.

EDR - Equivalent direct radiation is the rate of heat transfer from a radiator or convector. It is equivalent to the square feet of surface area necessary to transfer heat at the same rate at which it is produced by a generator. A single boiler horsepower equals 140 ft² EDR.

EFFICIENCY - The ratio of output to input. See also Combustion, Fuel-to-Steam and Thermal Efficiency.

EJECTOR - A device which utilizes the kinetic energy in a jet of water or other fluid to remove a fluid or fluent material from tanks or hoppers.

ELECTRIC BOILER - A boiler in which electric energy is used as the source of heat.



ELECTROSTATIC PRECIPITATOR - A device for collecting dust, mist or fume from a gas stream, by placing an electrical charge on the particle and removing that particle onto a collecting electrode.

ENTRAINMENT - The conveying of particles of water or solids from the boiler water by the steam.

EQUALIZER - Connections between parts of a boiler to equalize pressures.

EQUIVALENT EVAPORATION - Evaporation expressed in pounds of water evaporated from a temperature of 212 °F to dry saturated steam at 212 °F.

EVAPORATION - The change of state from a liquid to a vapor.

EVAPORATION RATE - The number of pounds of water that is evaporated in a unit of time.

EXCESS AIR - Air supplied for combustion in excess of that theoretically required for complete oxidation.

EXPANSION JOINT - The joint to permit movement due to expansion without undue stress.

EXPLOSION DOOR - A door in a furnace or boiler setting that is designed to be opened by a pre-determined gas pressure.

EXTERNAL TREATMENT - Treatment of boiler feed water prior to its introduction into the boiler.

F

FAN - A machine consisting of a rotor and housing for moving air or gases at relatively low pressure differentials.

FAN PERFORMANCE - A measure of fan operation in terms of volume, total pressures, static pressures, speed, power input, mechanical and static efficiency, at a stated air density.

FAN PERFORMANCE CURVES - The graphical presentation of total pressure, static pressure, power input, mechanical and static efficiency as ordinates and the range of volumes as abscissa, all at constant speed and air density.

FEED PUMP - A pump that supplies water to a boiler.

FEEDWATER - Water introduced into a boiler during operation. It includes make-up and return condensate.



FEEDWATER TREATMENT - The treatment of boiler feed water by the addition of chemicals to prevent the formation of scale or to eliminate other objectionable characteristics.

FGR - Flue Gas Recirculation or the recirculation of flue gas with combustion air to reduce NO_x emissions.

FILTER - Porous material through which fluids or fluid - and solid mixtures are passed to separate matter held in suspension.

FIN - A fin is an extended surface, a solid, experiencing energy transfer by conduction within its boundaries, as well as energy transfer with its surroundings by convection and/or radiation, used to enhance heat transfer by increasing surface area.

FIN TUBE - A tube with one or more fins.

FIRED PRESSURE VESSEL - A vessel containing a fluid under pressure exposed to heat from the combustion of fuel.

FIRETUBE - A type of boiler design in which combustion gases flow inside the tubes and water flows outside the tubes.

FIRING RATE CONTROL - A pressure temperature or flow controller which controls the firing rate of a burner according to the deviation from pressure or temperature set point. The system may be arranged to operate the burner on-off, high-low or in proportion to load demand.

FIXED CARBON - The carbonaceous residue less the ash remaining in the test container after the volatile matter has been driven off in making the proximate analysis of a solid fuel.

FLAME - A luminous body of burning gas or vapor.

FLAME DETECTOR - A device which indicates if a fuel (liquid, gaseous, or pulverized) is burning, or if ignition has been lost. The indication may be transmitted to a signal or to a control system.

FLAME PROPAGATION RATE - Speed of travel of ignition through a combustible mixture.

FLAME SAFEGUARD - A control that sequences the burner through several stages of operation to provide proper air purge, ignition, normal operation, and shutdown for safe operation.

FLAMMABILITY - Susceptibility to combustion.

FLASHING - The process of producing steam by discharging water into a region of pressure lower than the saturation pressure that corresponds to the water temperature.



FLASH POINT - The lowest temperature at which, under specified conditions, fuel oil gives off enough vapor to flash into a momentary flame when ignited.

FLUE - A passage for products of combustion.

FLUE GAS - The gaseous product of combustion in the flue to the stack.

FOAMING - The continuous formation of bubbles which have sufficiently high surface tension to remain as bubbles beyond the disengaging surface.

FORCED CIRCULATION - The circulation of water in a boiler by mechanical means external to the boiler.

FORCED-DRAFT FAN - A fan supplying air under pressure to the fuel burning equipment.

FOULING - The accumulation of refuse in gas passages or on heat absorbing surfaces which results in undesirable restriction to the flow of gas or heat.

FM - Factory Mutual.

FREE ASH - Ash which is not included in the fixed ash.

FUEL - A substance containing combustible used for generating heat.

FUEL-AIR MIXTURE - Mixture of fuel and air.

FUEL-AIR RATIO - The ratio of the weight, or volume, of fuel to air.

FUEL OIL - A liquid fuel derived from petroleum or coal.

FUEL-TO-STEAM EFFICIENCY - The ratio of heat added to boiler feedwater to produce the output steam to the amount of energy inputted with fuel.

FURNACE - An enclosed space provided for the combustion of fuel.

FURNACE PRESSURE - Pressure occurring inside the combustion chamber; positive if greater than atmospheric, negative if less than atmospheric, and neutral if equal to atmospheric.

FURNACE VOLUME - The cubic contents of the furnace or combustion chamber.

FUSIBLE PLUG - A hollowed threaded plug having the hollowed portion filled with a low melting point material.

G



GAS ANALYSIS - The determination of the constituents of a gaseous mixture.

GAS BURNER - A burner that uses gas or fuel.

GAS PRESSURE REGULATOR - A spring loaded, dead weighted or pressure balanced device which will maintain the gas pressure to the burner supply line.

GAUGE COCK - A valve attached to a water column or drum for checking water level.

GAUGE GLASS - The transparent part of a water gauge assembly connects directly or through a water column to the boiler, below and above the water line, to indicate the water level in a boiler.

GAUGE PRESSURE - The pressure above atmospheric pressure.

GRADE - Oil classification according to quality, generally based on ASTM specifications.

GRAINS PER CU-FT - The term for expressing dust loading in weight per unit of gas volume (7000 grains equals one pound).

GRAINS (WATER) - A unit of measure commonly used in water analysis for the measurement of impurities in water (17.1 grains = 1 part per million - ppm).

GRAVITY - Weight index of fuels: liquid, petroleum products expressed either as specific, Baume or A.P.I. (American Petroleum Institute) gravity; weight index of gaseous fuels as specific gravity related to air under specified conditions; or weight index of solid fuels as specific gravity related to water under specified conditions.

H

HANDHOLE - An access opening in a pressure part usually not exceeding 6 inches in its longest dimension.

HANDHOLE COVER - A handhole closure.

HARDNESS - A measure of the amount of calcium and magnesium salts in water. Usually expressed as grains per gallon or ppm as CaCO_3 .

HARD WATER - Water which contains calcium or magnesium in an amount which require an excessive amount of soap to form a lather.

HEAT AVAILABLE - The thermal energy above a fixed datum that is capable of being absorbed for useful work.



HEAT BALANCE - An accounting of the distribution of the heat input, output and losses.

HEAT EXCHANGER - A vessel in which heat is transferred from one medium to another.

HEAT RELEASE RATE - Rate that describes the heat available per square foot of heatabsorbing surface in the furnace or per cubic foot of volume.

HEATING SURFACE - Those surfaces which are exposed to products of combustion on one side and water on the other. This surface is measured on the side receiving the heat.

HEATING VALUE - The quantity of heat released by a fuel through complete combustion. It is commonly expressed in Btu per lb, per gallon, or cu-ft.

HIGH GAS PRESSURE CONTROL - A control to stop the burner if the gas pressure is too high.

HIGH OIL TEMPERATURE CONTROL - A control to stop the burner if the oil temperature is too high.

HYDROCARBON - A chemical compound of hydrogen and carbon.

HYDROSTATIC TEST - A strength and tightness test of a closed pressure vessel by water pressure.

I

IGNITION - The initiation of combustion.

IGNITION TEMPERATURE - Lowest temperature of a fuel at which combustion becomes self-sustaining.

ILLUMINANTS - Light oil or coal compounds that readily burn with a luminous flame, such as ethylene, propylene and benzene.

INCOMPLETE COMBUSTION - The partial oxidation of the combustible constituents of a fuel.

INDUCED DRAFT FAN- A fan exhausting hot gases from the heat absorbing equipment.

INERT GASEOUS CONSTITUENTS - Incombustible gases such as nitrogen which may be present in a fuel.

INHIBITOR - A substance which selectively retards a chemical action. An example in boiler work is the use of an inhibitor, when using acid to remove scale, to prevent the acid from attacking the boiler metal.



INJECTOR - A device utilizing a steam jet to entrain and deliver feed water into a boiler.

INSULATION - A material of low thermal conductivity used to reduce heat losses.

INTEGRAL BLOWER - A blower built as an integral part of a device to supply air thereto.

INTEGRAL-BLOWER BURNER - A burner of which the blower is an integral part.

INTERLOCK - A device to prove the physical state of a required condition, and to furnish that proof to the primary safety control circuit.

INTERMITTENT BLOWDOWN - the blowing down of boiler water at intervals.

INTERNAL TREATMENT - The treatment of boiler water by introducing chemicals directly into the boiler.

ION - A charged atom or radical which may be positive or negative.

IRI - Industrial Risk Insurers.

L

LAGGING - A light gauge steel covering used over a boiler, usually combined with insulation, to provide a low temperature outer surface.

LEAKAGE - The uncontrolled quantity of fluid which enters or leaves through the enclosure of air or gas passages.

LIBERATION - See Heat Release.

LIMIT CONTROL - A switching device that completes or breaks an electrical circuit at predetermined pressures or temperatures. Also known as an interlock. See interlock.

LINING - The material used on the furnace side of a furnace wall. It is usually of high grade refractory tile or brick or plastic refractory material.

LOAD - The rate of output required; also the weight carried.

LOAD FACTOR - The ratio of the average load in a given period to the maximum load carried during that period.

LOW GAS PRESSURE CONTROL - A control to stop the burner if gas pressure is too low.



LOW OIL TEMPERATURE CONTROL - (Cold Oil Switch) A control to prevent burner operation if the temperature of the oil is too low.

LOW WATER CUTOFF - Safety device that shuts off the boiler/burner in the event of low water, preventing pressure vessel failure.

LUG - Any projection, like an ear, used for supporting or grasping.

M

MAKE-UP - The water added to boiler feed to compensate for that lost through exhaust, blowdown, leakage, etc.

MANHOLE - The opening in a pressure vessel of sufficient size to permit a man to enter.

MANIFOLD - A pipe or header for collection of a fluid from, or the distribution of a fluid to a number of pipes or tubes.

MANUAL GAS SHUTOFF VALVE - A manually operated valve in a gas line for the purpose of completely turning on or shutting off the gas supply.

MANUFACTURED GAS - Fuel gas manufactured from coal, oil, etc., as differentiated from natural gas.

MAXIMUM ALLOWABLE WORKING PRESSURE - The maximum gauge pressure permissible in a completed boiler. The MAWP of the completed boiler shall be less than or equal to the lowest design pressure determined for any of its parts. This pressure is based upon either proof tests or calculations for every pressure part of the boiler using nominal thickness exclusive of allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure relieving devices protecting the boiler.

MAXIMUM CONTINUOUS LOAD - The maximum load which can be maintained for a specified period.

MAXIMUM INSTANTANEOUS DEMAND - The sudden load demand on a boiler beyond which an unbalanced condition may be established in the boilers internal flow pattern and/or surface release conditions.

MECHANICAL ATOMIZING OIL BURNER - A burner which uses the pressure of the oil for atomization.

MECHANICAL DRAFT - The negative pressure created by mechanical means.

MICRON - One millionth of a meter, or 0.000039 in. or 1/25400 in. The diameter of dust particles is often expressed in microns.



MINIATURE BOILER - Fire pressure vessels which do not exceed the following limits: 16 in. inside diameter of shell; 42 in., overall length to outside of heads at center; 20 sq ft water heating surface; or 100 psi maximum allowable working pressure.

MMBtu - Millions of Btus (British Thermal Units).

MOISTURE - Water in the liquid or vapor phase.

MOISTURE IN STEAM - Particles of water carried in steam, expressed as the percentage by weight.

MOISTURE LOSS - The boiler flue gas loss representing the difference in the heat content of the moisture in the exit gases and that at the temperature of the ambient air.

MULTIFUEL BURNER - A burner by means of which more than one fuel can be burned.

MULTIPOINT BURNER - A burner having a number of nozzles from which fuel and air are discharged.

N

NATURAL CIRCULATION - The circulation of water in a boiler caused by differences in density.

NATURAL GAS - Gaseous fuel occurring in nature.

NET POSITIVE SUCTION HEAD (NPSH) - The liquid pressure that exists at the suction end of a pump. If the NPSH is insufficient, the pump can cavitate.

NO_x - Abbreviation for all the family of oxides of nitrogen.

NOZZLE - a short flanged or welded neck connection on a drum or shell for the outlet or inlet of fluids; also a projecting spout through which a fluid flows.

O

OIL BURNER - A burner for firing oil.

OIL HEATING AND PUMPING SET - A group of apparatus consisting of a heater for raising the temperature of the oil to produce the desired viscosity, and a pump for delivering the oil at the desired pressure.

OPERATING CONTROL - A control to start and stop the burner - must be in addition to the high limit control.



OPERATING PRESSURE - The pressure at which a boiler is operated.

ORGANIC MATTER - Compounds containing carbon often derived from living organisms.

ORIFICE - (1) The opening from the whirling chamber of a mechanical atomizer or the mixing chamber of a steam atomizer through which the liquid fuel is discharged. (2) A calibrated opening in a plate, inserted in a gas stream for measure velocity of flow.

ORSAT - a gas-analysis apparatus in which certain gaseous constituents are measured by absorption in separate chemical solution.

OVERPRESSURE - Minimum operating pressure of a hot water boiler sufficient to prevent the water from steaming.

OXIDATION - chemical combination with oxygen.

OXIDIZING ATMOSPHERE - An atmosphere which tends to promote the oxidation of immersed materials.

OXYGEN ATTACK - Corrosion or pitting in a boiler caused by oxygen.

P

PACKAGED BOILER - A boiler supplied with all components - burner, controls and auxiliary equipment, designed as a single engineered package, and ready for on-site installation.

PACKAGED STEAM GENERATOR - See Packaged Boiler.

PARTICLE SIZE - A measure of dust size, expressed in microns or per cent passing through a standard mesh screen.

PASS - A confined passageway, containing heating surface, through which a fluid flows in essentially one direction.

PERFECT COMBUSTION - The complete oxidation of all the combustible constituents of a fuel, utilizing all the oxygen supplied.

PETROLEUM - Naturally occurring mineral oil consisting predominately of hydrocarbons.

pH - The hydrogen ion concentration of a water to denote Acidity or Alkalinity. A pH of 7 is neutral. A pH above 7 denotes alkalinity while one below 7 denotes acidity. This pH number is the negative exponent of 10 representing hydrogen ion concentration in grams per liter. For instance a pH of 7 represent 10^{-7} grams per liter.



PILOT - (See also Ignitor.) A flame which is utilized to ignite the fuel at the main burner or burners.

PITOT TUBE - An instrument which will register total pressure and static pressure in a gas stream, used to determine its velocity.

PITTING - A concentrated attack by oxygen or other corrosive chemicals in a boiler, producing a localized depression in the metal surface.

PORT - An opening through which fluid passes.

POST PURGE - A method of scavenging the furnace and boiler passes to remove all combustible gases after flame failure controls have sensed pilot and main burner shutdown and safety shut-off valves are closed.

ppm - Abbreviation for parts per million. Used in chemical determinations as one part per million parts by weight.

PRECIPITATE - To separate materials from a solution by the formation of insoluble matter by chemical reaction. The material which is removed.

PRECIPITATION - The removal of solid or liquid particles from a fluid.

PREHEATED AIR - Air at a temperature exceeding that of the ambient air.

PRESSURE - Force per unit of area.

PRESSURE DROP - The difference in pressure between two points in a system, caused by resistance to flow.

PRESSURE VESSEL - A closed vessel or container designed to confine a fluid at a pressure above atmospheric.

PRIMARY AIR - Air introduced with fuel at the burner.

PRIMING - The discharge of steam containing excessive quantities of water in suspension from a boiler, due to violent ebullition.

PROCESS STEAM - Steam used for industrial purposes other than for producing power.

PRODUCTS OF COMBUSTION - The gases, vapors, and solids resulting from the combustion of fuel.

PULSATION - Rapid fluctuations in pressure.



PURGE - To introduce air into the furnace and the boiler flue passages in such volume and manner as to completely replace the air or gas-air mixture contained therein.

R

RADIATION LOSS - A comprehensive term used in a boiler-unit heat balance to account for the conduction, radiation, and convection heat losses from the boiler to the ambient air.

RATED CAPACITY - The manufacturers stated capacity rating for mechanical equipment; for instance, the maximum continuous capacity in pounds of steam per hour for which a boiler is designed.

RATE OF BLOWDOWN - A rate normally expressed as a percentage of the water fed.

RATING - See "Load."

RAW WATER - Water supplied to the plant before any treatment.

REACTION - A chemical transformation or change brought about by the interaction of two substances.

REASSOCIATION - The recombination of the products of dissociation.

RECIRCULATION - The reintroduction of part of the flowing fluid to repeat the cycle of circulation.

REDUCING ATMOSPHERE - An atmosphere which tends to 1) promote the removal of oxygen from a chemical compound; 2) promote the reduction of immersed materials.

REDUCTION - Removal of oxygen from a chemical compound.

REFRACTORY - Brickwork or castable used in boilers to protect metal surfaces and for boiler baffles.

RELATIVE HUMIDITY - The ratio of the mass of water vapor present in a unit volume of gas to the maximum possible mass of water vapor in unit volume of the same gas at the same temperature and pressure.

RELIEF VALVE (Safety Relief Valve) - An automatic pressure relieving device actuated by the pressure upstream of the valve and characterized by opening pop action with further increase in lift with an increase in pressure over popping pressure.

RESIDUAL FUELS - Products remaining from crude petroleum by removal of some of the water and an appreciable percentage of the more volatile hydrocarbons.



RESIN - A bead-like material used in chemical exchange for softeners and dealkalizers.

RESISTANCE - Impediment to gas flow, such as pressure drop or draft loss through a dust collector. Usually measured in inches water column (iwc).

RETURN FLOW OIL BURNER - A mechanical atomizing oil burner in which part of the oil supplied to the atomizer is withdrawn and returned to storage or to the oil line supplying the atomizer.

RINGELMANN CHART - A series of four rectangular grids of black lines of varying widths printed on a white background, and used as a criterion of blackness for determining smoke density in stack gas streams.

ROTARY OIL BURNER - A burner in which atomization is accomplished by feeding oil to the inside of a rapidly rotating cup.

S

SADDLE - A casting, fabricated chair, or member used for the purpose of support.

SAFE WORKING PRESSURE - See "Design Pressure."

SAFETY VALVE - A spring loaded valve that automatically opens when pressure attains the valve setting. Used to prevent excessive pressure from building up in a boiler.

SAFETY SHUT-OFF VALVE - A manually opened, electrically latched, electrically operated safety shut-off valve designed to automatically shut off fuel when de-energized.

SAMPLING - The removal of a portion of a material for examination or analysis.

SATURATED AIR - Air which contains the maximum amount of water vapor that it can hold at its temperature and pressure.

SATURATED STEAM - Steam at the temperature and pressure at which evaporation occurs.

SATURATED TEMPERATURE - The temperature at which evaporation occurs at a particular pressure.

SATURATED WATER - Water at its boiling point.

SCALE - A hard coating or layer of materials on surfaces of boiler pressure parts.

SECONDARY AIR - Air for combustion supplied to the furnace to supplement the primary air.



SECONDARY TREATMENT - Treatment of boiler feed water or internal treatment of boilerwater after primary treatment.

SEDIMENT - (1) Matter in water which can be removed from suspension by gravity or mechanical means. (2) A non-combustible solid matter which settles out at bottom of a liquid; a small percentage is present in residual fuel oils.

SEGREGATION - The tendency of refuse of varying compositions to deposit selectively in difference parts of the unit.

SELF-SUPPORTING STEEL STACK - A steel stack of sufficient strength to require no lateral support.

SERVICE WATER - General purpose water which may or may not have been treated for a special purpose.

SHELL - The cylindrical portion of a pressure vessel.

SLUDGE - A soft water-formed sedimentary deposit which normally can be removed by blowing down.

SLUG - A large "dose" of chemical treatment applied internally to a steam boiler intermittently. Also used sometimes instead of "priming" to denote a discharge of water out through a boiler steam outlet in relatively large intermittent amounts.

SMOKE - Small gas borne particles of carbon or soot, less than 1 micron in size, resulting from incomplete combustion of carbonaceous materials and of sufficient number to be observable.

SOFTENING - The act of reducing scale forming calcium and magnesium impurities from water.

SOFT WATER - Water which contains little or no calcium or magnesium salts, or water from which scale forming impurities have been removed or reduced.

SOLUTION - A liquid, such as boiler water, containing dissolved substances.

SOOT - Unburned particles of carbon derived from hydrocarbons.

SOOT BLOWER - A mechanical device for discharging steam or air to clean heat absorbing surfaces.

SPALLING - The breaking off of the surface of refractory material as a result of internal stresses.

SPECIFIC HEAT - The quantity of heat, expressed in Btu, required to raise the temperature of 1 lb of a substance 1°F.



SPECIFIC HUMIDITY - The weight of water vapor in a gas water-vapor mixture per unit weight of dry gas.

SPRAY ANGLE - The angle included between the sides of the cone formed by liquid fuel discharged from mechanical, rotary atomizers and by some forms of steam or air atomizers.

SPRAY NOZZLE - A nozzle from which a liquid fuel is discharged in the form of a spray.

STACK - A vertical conduit, which due to the difference in density between internal and external gases, creates a draft at its base.

STACK DRAFT - The magnitude of the draft measured at the inlet to the stack.

STACK EFFECT - That portion of a pressure differential resulting from difference in elevation of the points of measurement.

STACK EFFLUENT - Gas and solid products discharged from stacks.

STAGNATION - The condition of being free from movement or lacking circulation.

STANDARD AIR - Dry air weighing 0.075 lb per cu ft at sea level (29.92 in. Barometric Pressure) and 70 °F.

STANDARD FLUE GAS - Gas weighing 0.078 lb per cu ft at sea level (29.92 in. Barometric Pressure) and 70 °F.

STATIC PRESSURE - The measure of potential energy of a fluid.

STEAM - The vapor phase of water, unmixed with other gases.

STEAM ATOMIZING OIL BURNER - A burner for firing oil which is atomized by steam. It may be of the inside or outside mixing type.

STEAM BINDING - A restriction in circulation due to a steam pocket or a rapid steam formation.

STEAM GAUGE - A gauge for indicating the pressure of steam.

STEAM GENERATING UNIT - A unit to which water, fuel, and air are supplied and in which steam is generated. It consists of a boiler furnace, and fuel burning equipment, and may include as component parts water walls, superheater, reheater, economizer, air heater, or any combination thereof.

STEAM PURITY - The degree of contamination. Contamination is expressed in ppm.



STEAM QUALITY - The percent by weight of vapor in a steam and water mixture.

STEAM SEPARATOR - A device for removing the entrained water from steam.

STRAINER - A device, such as a filter, to retain solid particles allowing a liquid to pass.

STRATIFICATION - Non-homogeneity existing transversely in a gas stream.

STUD - A projecting pin serving as a support or means of attachment.

SUPERHEATED STEAM - Steam with its temperature raised above that of saturation. The temperature in excess of its saturation temperature is referred to as superheat.

SURFACE BLOWOFF - Removal of water, foam, etc. from the surface at the water level in a boiler. The equipment for such removal.

SURGE - The sudden displacement or movement of water in a closed vessel or drum.

SUSPENDED SOLIDS - Undissolved solids in boiler water.

SWINGING LOAD - A load that changes at relatively short intervals.

T

TERTIARY AIR - Air for combustion supplied to the furnace to supplement the primary and secondary air.

THEORETICAL AIR - The quantity of air required for perfect combustion.

THEORETICAL DRAFT - The draft which would be available at the base of a stack if there were no friction or acceleration losses in the stack.

THEORETICAL FLAME TEMPERATURE - See "Adiabatic Flame Temperature."

THERM - A unit of heat applied especially to gas. One therm = 100,000 Btu.

THERMAL EFFICIENCY - The efficiency of a boiler, based on the ratio of heat absorbed to total heat input. This does not include heat loss from the boiler shell.

THERMAL SHOCK - A cycle of temperature swings that result in failure of metal due to expansion and contraction.

THERMOCOUPLE - A temperature measuring instrument.



TILE - A preformed refractory, usually applied to shapes other than standard brick.

TOTAL AIR - The total quantity of air supplied to the fuel and products of combustion. Percent total air is the ratio of total air to theoretical air, expressed as percent.

TOTAL PRESSURE - The sum of the static and velocity pressures.

TOTAL SOLIDS CONCENTRATION - The weight of dissolved and suspended impurities in a unit weight of boiler water, usually expressed in ppm.

TRAP - A receptacle for the collection of undesirable material.

TREATED WATER - Water which has been chemically treated to make it suitable for boiler feed.

TRIM - Ancillary boiler components, like water level controls, pressure controls, and temperature controls. **TUBE** - A hollow cylinder for conveying fluids.

TUBE HOLE - A hole in a drum, heater, or tube sheet to accommodate a tube.

TURBULENT BURNER - A burner in which fuel and air are mixed and discharged into the furnace in such a manner as to produce turbulent flow from the burner.

TURNDOWN RATIO - Ratio of maximum to minimum fuel or steam input or boiler output.

U

ULTIMATE ANALYSIS - See "Analysis Ultimate."

UL LISTED - Product certification that indicates the product meets safety standards determined by Underwriters Laboratories. (ULC and cUL indicate Canadian requirements.)

UNACCOUNTED-FOR LOSS - That portion of a boiler heat balance which represents the difference between 100 per cent and the sum of the heat absorbed by the unit and all the classified losses expressed as per cent.

UNBURNED COMBUSTIBLE - The combustible portion of the fuel which is not completely oxidized.

UNFIRED PRESSURE VESSEL - A vessel designed to withstand internal pressure, neither subjected to heat from products of combustion nor an integral part of a fired pressure vessel system.

USE FACTOR - The ratio of hours in operation to the total hours in that period.



V

VA - Volt amperes.

VAPOR - The gaseous product of evaporation.

VAPORIZATION - The change from liquid or solid phase to the vapor phase.

VELOCITY PRESSURE - The measure of the kinetic energy of a fluid.

VENT - An opening in a vessel or other enclosed space for the removal of gas or vapor.

VERTICAL FIRING - An arrangement of a burner such that air and fuel are discharged into the furnace in practically a vertical direction.

VISCOSITY - Measure of the internal friction of a fluid or its resistance to flow.

VOLATILE MATTER - Those products given off by a material as gas or vapor, determined by definite prescribed methods.

VOLUME OF AIR - The number of cu ft of air per min expressed at fan outlet conditions.

W

WASTE HEAT - Sensible heat in non-combustible gases discharged to the environment.

WATER - A liquid composed of two parts of hydrogen and sixteen parts oxygen by weight.

WATER COLUMN - A vertical tubular member connected at its top and bottom to the steam and water space respectively of a boiler, to which the water gauge, water level controls, and fuel cutoff may be connected.

WATER GAUGE - The gauge glass and its fittings for attachment.

WATER HAMMER - A sudden increase in pressure of water due to an instantaneous conversion of momentum to pressure.

WATER LEVEL - The elevation of the surface of the water in a boiler.

WATER SOFTENER - Removes hardness (CaCO_3) from water through an ion exchange of sodium with calcium and magnesium.

WATER TUBE - A tube in a boiler having the water and steam on the inside and heat applied to the outside.

WATER VAPOR - A synonym for steam, usually used to denote steam of low absolute pressure.



WEEP - A term usually applied to a minute leak in a boiler joint which forms droplets (or tears) of water very slowly.

WETBACK BOILER - Firetube boiler design wherein the back portion of the boiler has a water jacket.

WET-BULB TEMPERATURE - The lowest temperature which a water wetted body will attain when exposed to an air current. This is the temperature of adiabatic saturation, and can be used to measure humidity.

WETNESS - A term used to designate the percentage of water in steam. Also used to describe the presence of a water film on heating surface interiors.

WET STEAM - Steam containing moisture.

WINDBOX - A chamber below the grate or surrounding a burner, through which air under pressure is supplied for combustion of the fuel.

WINDBOX PRESSURE - The static pressure in the windbox of a burner or stoker.

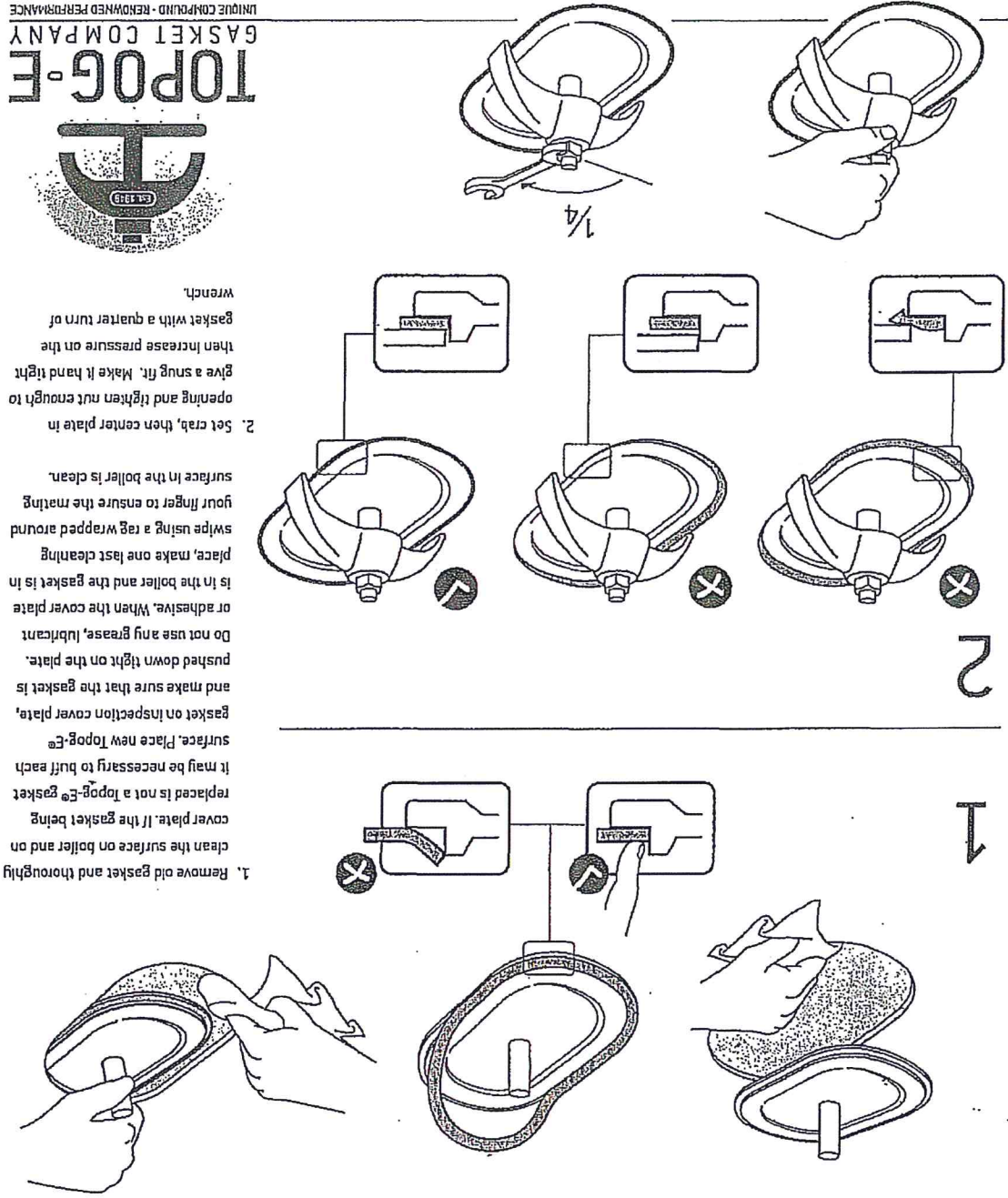
- **PROCEDURE**



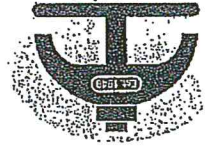
See Tab 1 of DOP-19

The Topog-E Gasket Company

Installation of Topog-E® gaskets in steam boilers.



UNIQUE COMPOUND - RENOWNED PERFORMANCE
GASKET COMPANY
TOPOG-E



TOPOG-E GASKET COMPANY

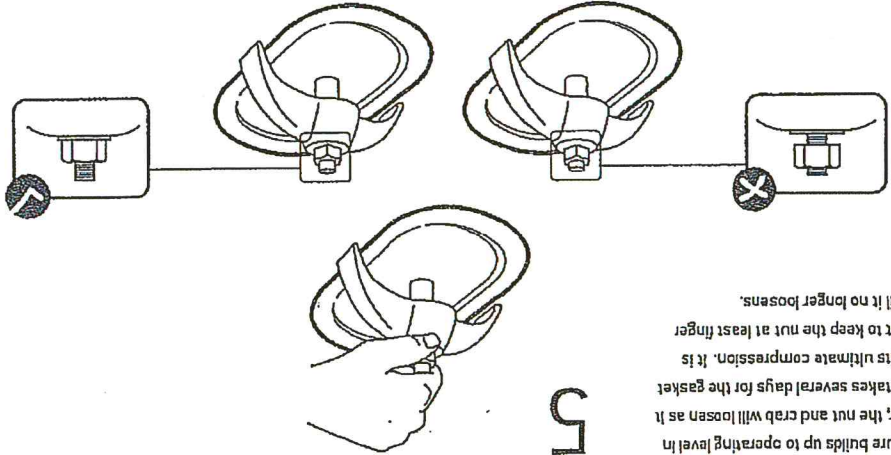
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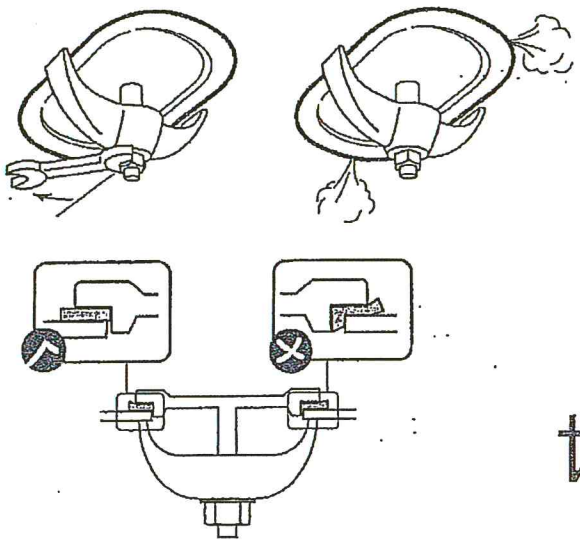
Topog-E® gaskets are sold for use in steam, water, air, and other selected applications only. Recommendations for their use are based on tests believed to be reliable and on actual customer experience. Since their installation and use are beyond our control we cannot guarantee the results, whether or not such use is in accordance with instructions. We disclaim any responsibility.

6. Never re-use a Topog-E® gasket!
7. Topog-E® bolt gaskets (when required) should be used with Topog-E® handhole gaskets.

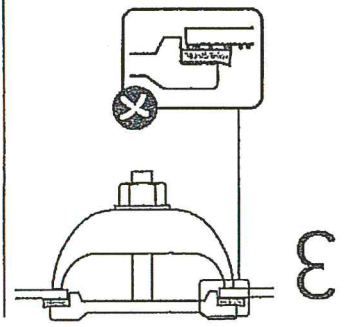


5. As pressure builds up to operating level in the boiler, the nut and crab will loosen as it typically takes several days for the gasket to reach its ultimate compression. It is important to keep the nut at least finger tight until it no longer loosens.

4. Do not over-tighten as it will over-compress the gasket and shorten its service life. If gasket leaks while pressure is being built up, tighten only enough to stop leakage.



3. Gaskets on the bottom of a boiler shell are typically more difficult to install without leaking because small particles tend to become lodged between the mating surfaces after they have been cleaned. This can lead to over-tightening of the gasket to stop leakage. It is recommended to drain the boiler and start over or the gasket's service life may be shortened.



As a rough generalization it may be stated that the speed of a reaction doubles for each 10°C (18°F) rise in temperature. The pressure-temperature gradation is non-linear and this tubular presentation of steam (PSI) vs. temperature (°F) picks off four levels that are separated successively by 18°F increments, and relates these levels with survival terms for the gasket.

180 psi	380°F	1 year
225 psi	398°F	6 months
280 psi	416°F	3 months
335 psi	432°F	1½ months

The Topog-E gasket material has specific and aggressive resistance to the hostile environment of live steam. If very low oxygen content is present in the steam, trouble rarely arises with a properly mounted Topog-E gasket inside the boiler.

From the exterior, however, the true difficulty arises. Here, we see an annulus of rubber beyond the cover plate. This rubber is exposed to the highly corrosive attack of an atmosphere that is 18% oxygen. The gas adjacent to the gasket is almost the temperature of the metal that is almost the temperature of the steam.

The situation is further complexed by the fact that rubber under stress degrades more rapidly than rubber not under stress. This may be verified by a rubber band in your desk drawer. Unperturbed, survival is measured in years. Stretched over a sheaf of papers - in months.

When stress is accompanied by extreme heat in the presence of oxygen, deterioration of the rubber begins. These three agents, stress, heat, and oxygen prevent extended survival of a Topog-E gasket.

Any action that reduces the magnitude of one or more of these agents extends the service life of the gasket. Now, the heat varies with steam pressure, so it is immune to an action. Limiting the amount of oxygen that reaches the rubber is a possibility and work is being done now on impermeable barrier substrates.

TOPOG-E GASKET

The remaining element stress exists, and fortunately a good degree of adjustment is possible and available in proper mounting. The target is to never let the gasket witness a greater pressure than the steam pressure that it is to seal.

The gasket should be well centered on the opening and snubbed up with only enough pressure to hold it in place. Fire up the boiler. During the interval preceding steam pressure, the rubber is acting as a heat sink. As in all elastomeric vulcanizates it is undergoing stress-relaxation. There is a reduction in modulus and a measurable change in resistance to compression deflection. Since the system is well within its elastic memory the system is unharmed. As heat mounts leakage will occur and further snubbing is necessary, but only to the extent of preventing serious leakage. The advent of steam will itself form the seal. The crab should be firmed and maintained firm since deactivating the boiler for night or weekend will create a negative pressure and interrupt the seal from within. Once the seal is broken it is difficult to reestablish.

Using this technique it is possible to exceed the charted terms by several magnitudes.

Low Water Cut-Offs – Mechanical For Steam Boilers

Series 157

Low Water Cut-Off/Pump Controllers



- For residential, commercial and industrial low or high pressure boiler applications
- For boilers of any steaming capacity
- Monel bellows provides corrosion resistance
- Float chamber with integral water column provided
- Mercury for high temperature service
- 1 Single pole, single throw switch for pump control
- 1 Single pole, double throw switch for low water cut-off and alarm actuation
- Optional features
 - Manual reset
 - Integral conductance probes for additional levels and greater operating differential-Model 157-RBP-MD
 - 1" or 1 1/4" NPT equalizing tapings
 - 1/2" or 3/4" NPT tapings for gauge/glass/tri-cock installations
 - BSPT threads
- Maximum pressure 150 psi (10.5 kg/cm²)
- For new electronic 150E Series see page 41

Model 157-MD

- Prevents nuisance burner shutdowns in low pressure applications
- Maximum operating pressure 50 psi (3.5 kg/cm²)
- For additional information see page 56

Electrical Ratings

Voltage	Cut-off and Pump		Pilot Duty
	Full Load	Locked Rotor	
120 VAC	7.4	44.4	345 VA at 120 or 240 VAC
240 VAC	3.7	22.2	

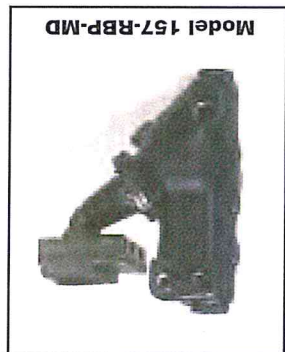
Ordering Information

Model	Part	Number	Description	Weight lbs. (kg)
157		173500	150 low water cut-off w/water column	39.7 (18.0)
157-MD		173600	157 w/maximum differential	39.7 (18.0)
157-A		173700	157 w/alternate tapings	39.5 (17.9)
157-A-M		173800	157-A w/manual reset	39.5 (17.9)
157-M		175400	157 w/manual reset	39.7 (18.0)
157-M-MD		175410	157-M w/maximum differential	39.7 (18.0)
157-R		176200	157 w/alternate tapings	42.0 (19.0)
157-R-M		177300	157-R w/manual reset	42.0 (19.0)
157-RBP-MD		176501	157 w/2 Integral conductance probes	51.0 (23.1)
157-R		176900	157 w/alternate tapings	42.0 (19.0)
157-R-L-M		177000	157-R-L w/manual reset	42.0 (19.0)

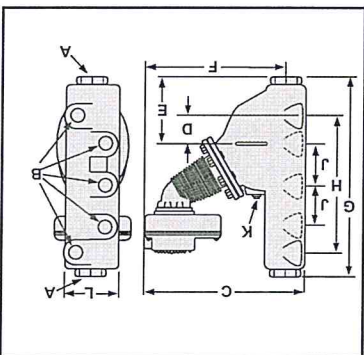
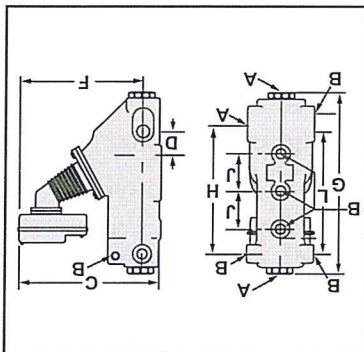
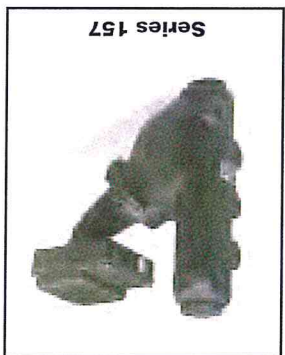
Dimensions, in. (mm)

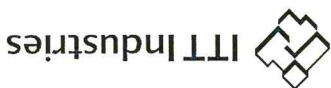
Model	A	B	C	D	E
157	1	1/2	13 3/8 (339)	2 5/16 (59)	4 15/16 (125)
157-A	1 1/4	3/4	13 3/8 (339)	2 5/16 (59)	4 15/16 (125)
157-R	1	1/2	13 3/8 (339)	2 1/4 (57)	5 7/8 (149)
157-R-L	1 1/4	1/2	13 3/8 (345)	3 1/2 (89)	5 7/8 (149)

Alarm Circuit Rating (Amperes)		Amps
Voltage	240 VAC	
120 VAC		1
240 VAC		1/2



Series 157





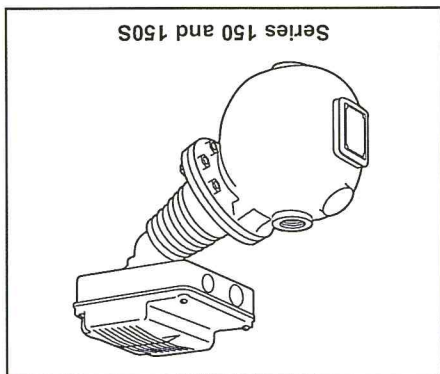
Series 150 and 157

(Mercury Switch)

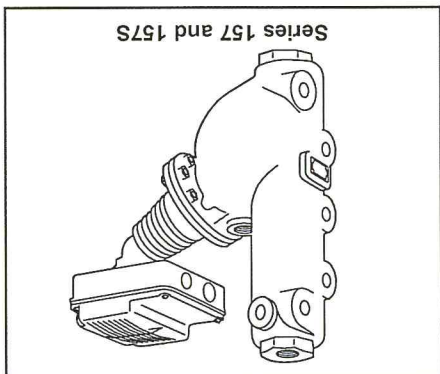
Series 150S and 157S

(Snap Switch, All Models except 157S-RB-P)

Low Water Cut-Off/Pump Controllers For Steam Boilers and Other Level Control Applications



Series 150 and 150S



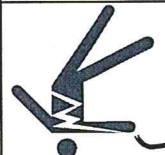
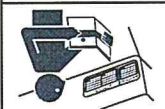
Series 157 and 157S

Typical Applications:

- Primary or secondary pump controller/low water fuel cut-off for steam boilers
- Motorized valve controller
- Low water cut-off
- High water cut-off
- Alarm actuator

WARNING

- Before using this product read and understand instructions.
- Save these instructions for future reference.
- All work must be performed by qualified personnel trained in the proper application, installation, and maintenance of plumbing, steam, and electrical equipment and/or systems in accordance with all applicable codes and ordinances.
- To prevent serious burns, the boiler must be cooled to 80°F (27°C) and the pressure must be 0 psi (0 bar) before servicing.
- To prevent electrical shock, turn off the electrical power before making electrical connections.
- This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.
- We recommend that secondary (redundant) Low Water Cut-Off controls be installed on all steam boilers with heat input greater than 400,000 BTU/hour 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. Moreover, at each annual outage, the low water cut-offs should be dismantled, inspected, cleaned, and checked for proper calibration and performance.
- To prevent serious personal injury from steam blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.
- To prevent a fire, do not use this low water cut-off to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.
- Failure to follow this warning could cause property damage, personal injury or death.



OPERATION

Maximum Pressure: 150 psi (10.5 kg/cm²)

Electrical Ratings

Voltage	Pump/Circuit Rating (Ampere)	Full Load	Locked Rotor	Pilot Duty
		7.4	44.4	
		3.7	22.2	
240 VAC				345 VA at 120 or 240 VAC

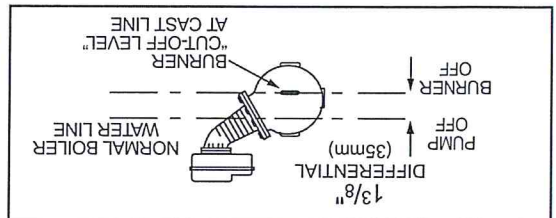
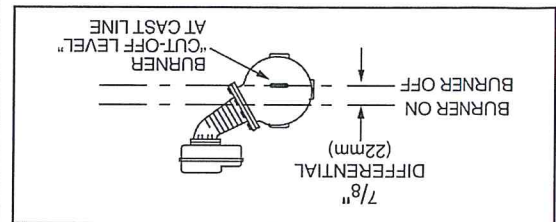
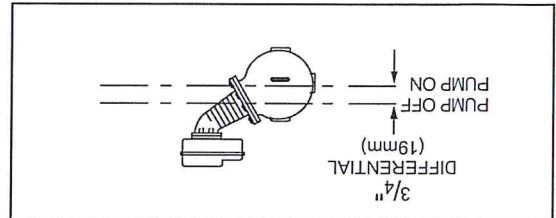
Enclosure rating: NEMA 1 General Purpose

Settings and Differential Pressures

Values are $\pm 1/8"$ (3.2mm).

Pressure	Setting	Approximate Cast Line Distance Above In. (mm)		Differential In. (mm)
		0 psi (0 kg/ cm ²)	150 psi (10.5 kg/ cm ²)	
	Pump Off	15/16 (24)	5/8 (16)	5/16 (8)
	Pump On	5/8 (16)	5/8 (16)	
	Burner On	5/8 (16)	3/8 (16)	
	Burner Off	1/4 (6.4)	3/8 (16)	
	Pump Off	13/8 (41)	5/8 (16)	3/4 (19)
	Pump On	5/8 (16)	7/8 (22)	
	Burner On	7/8 (22)	7/8 (22)	
	Burner Off	0 (0)	7/8 (22)	

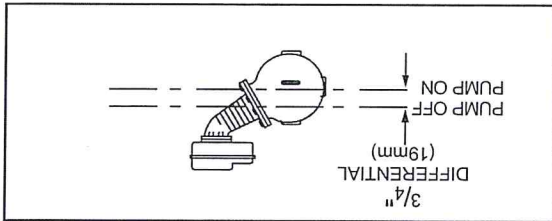
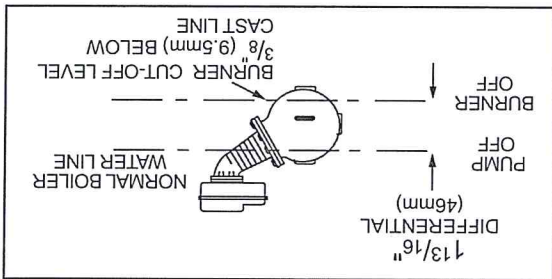
Series 150, 150S, 157 and 157S

150 psi (10.5 kg/cm²) Levels

Pressure Setting	0 psi (0 kg/cm ²)	Pump Off	15/16 (24)	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
		Pump On	9/16 (14)		
		Burner Off	0 (0)		
	150 psi (10.5 kg/cm ²)	Pump Off	17/16 (37)	3/4 (19) N/A	
		Pump On	11/16 (17)		
		Burner Off	- 3/8 (-16)		

Model 150-MD, 150S-MD, 157-MD and 157S-MD

150 psi (10.5 kg/cm²) Levels

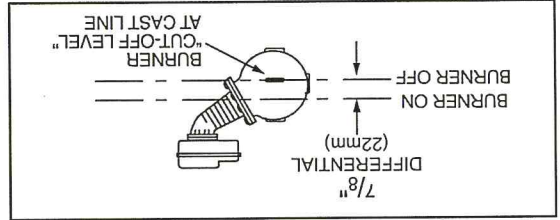
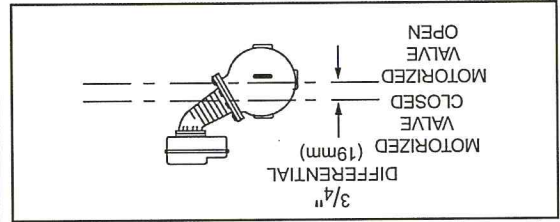
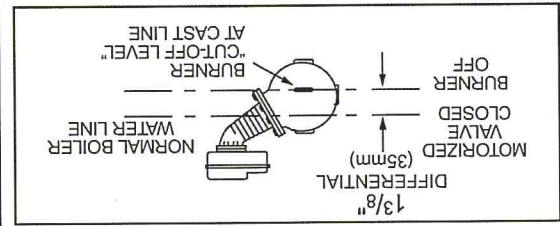


Settings and Differential Pressures (continued)

Values are $\pm 1/8"$ (3.2mm).

Pressure	Setting	Approximate Cast Line Distance Above Differential In. (mm)	0 psi (0 kg/ cm ²)			150 psi (10.5 kg/ cm ²)			Burner On 7/8 (22)	Burner Off 0 (0)	7/8 (22)
			Motorized 15/16 (24)	Valve Closed 5/8 (16)	Motorized 5/8 (16)	Valve Closed 13/8 (41)	Motorized 5/8 (16)	Valve Open 3/4 (19)			
Model 158/158S			5/16 (8)		3/8 (16)						

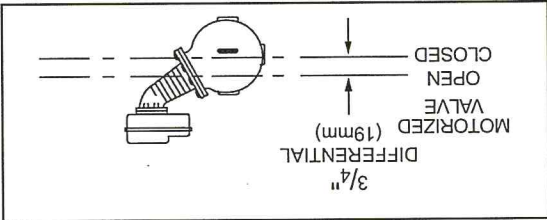
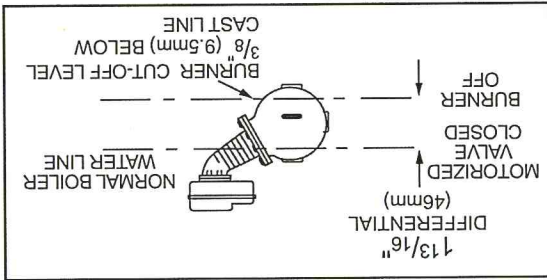
150 psi (10.5 kg/cm²) Levels



NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.

Pressure	Setting	Approximate Cast Line Distance Above Differential In. (mm)	0 psi (0 kg/ cm ²)			150 psi (10.5 kg/ cm ²)			Burner On 11/16 (17)	Burner Off - 3/8 (-16)	N/A
			Pump Off 15/16 (24)	Pump On 9/16 (14)	Motorized 5/8 (16)	Pump Off 17/16 (37)	Pump On 11/16 (17)	Valve Open 3/4 (19)			
Model 158-MD/158S-MD			3/8 (16)		N/A						

150 psi (10.5 kg/cm²) Levels



NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.

Model 159/159S									
Pressure		Setting	Approximate Distance Above Cast Line	In. (mm)	Differential	In. (mm)	0 psi (0 kg/cm ²)	150 psi (10.5 kg/cm ²)	cm ² (10.5 kg/cm ²)
5/16 (8)	Pump #1 Off	15/16 (24)	5/8 (16)	5/8 (16)	5/8 (16)	5/16 (8)	Pump #1 On	Pump #2 Off	Pump #2 On
	Pump #1 On	5/8 (16)	5/8 (16)	5/8 (16)	5/8 (16)	3/8 (16)	Pump #1 On	Pump #2 Off	Pump #2 On
	Pump #2 Off	5/8 (16)	5/8 (16)	5/8 (16)	5/8 (16)	3/4 (19)	Pump #1 On	Pump #2 Off	Pump #2 On
	Pump #2 On	1/4 (6.4)	13/8 (41)	13/8 (41)	13/8 (41)	7/8 (22)	Pump #1 On	Pump #2 Off	Pump #2 On
3/8 (16)	Pump #2 Off	5/8 (16)	5/8 (16)	5/8 (16)	5/8 (16)	7/8 (22)	Pump #2 Off	Pump #2 On	Pump #2 On
	Pump #2 On	1/4 (6.4)	13/8 (41)	13/8 (41)	13/8 (41)	7/8 (22)	Pump #2 On	Pump #2 On	Pump #2 On
	Pump #1 Off	13/8 (41)	13/8 (41)	13/8 (41)	13/8 (41)	7/8 (22)	Pump #1 Off	Pump #1 On	Pump #1 On
	Pump #1 On	5/8 (16)	5/8 (16)	5/8 (16)	5/8 (16)	7/8 (22)	Pump #1 On	Pump #1 On	Pump #1 On
7/8 (22)	Pump #1 Off	13/8 (41)	13/8 (41)	13/8 (41)	13/8 (41)	7/8 (22)	Pump #1 Off	Pump #1 On	Pump #1 On
	Pump #1 On	5/8 (16)	5/8 (16)	5/8 (16)	5/8 (16)	7/8 (22)	Pump #1 On	Pump #1 On	Pump #1 On
	Pump #2 Off	5/8 (16)	5/8 (16)	5/8 (16)	5/8 (16)	7/8 (22)	Pump #2 Off	Pump #2 On	Pump #2 On
	Pump #2 On	1/4 (6.4)	13/8 (41)	13/8 (41)	13/8 (41)	7/8 (22)	Pump #2 On	Pump #2 On	Pump #2 On

150 psi (10.5 kg/cm²) Levels

Diagram 1: 13/8" Differential (35mm)

Diagram 2: 3/4" Differential (19mm)

Diagram 3: 7/8" Differential (22mm)

INSTALLATION

TOOLS NEEDED:

Two (2) pipe wrenches, one (1) flathead screw driver, and pipe sealing compound.

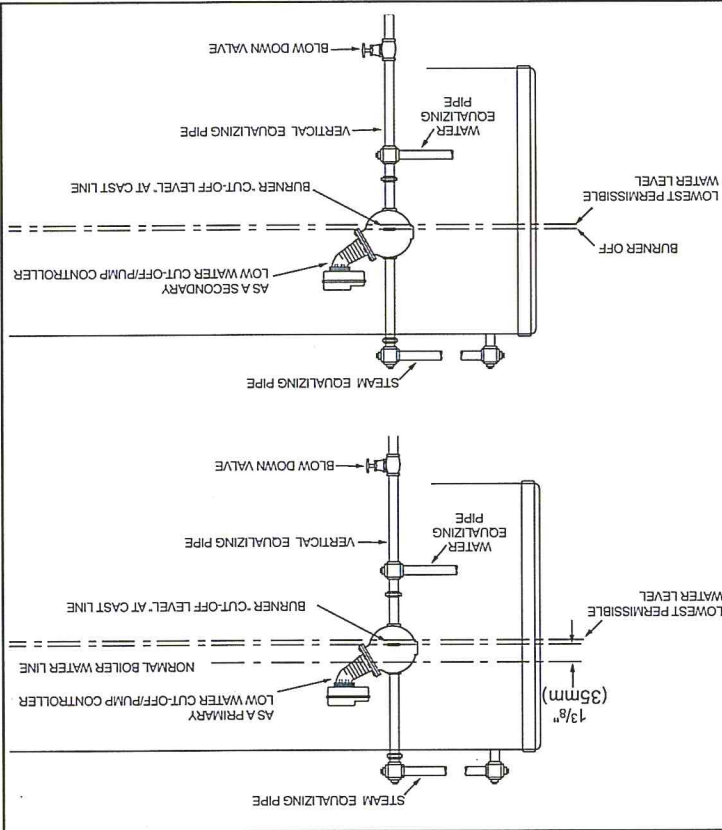
IMPORTANT: Follow the boiler manufacturer's instructions along with all applicable codes and ordinances for piping, blow down valve and water gauge glass requirements.

STEP 1 - Determine the Elevation at Which the Low Water Cut-Off/Pump Controller Must be Installed

If the control will be the primary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is $1\frac{3}{8}$ " (35mm) below the boiler's normal water level, but not lower than the lowest, safe permissible water level, as determined by the boiler manufacturer.

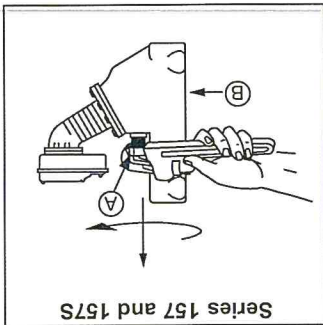
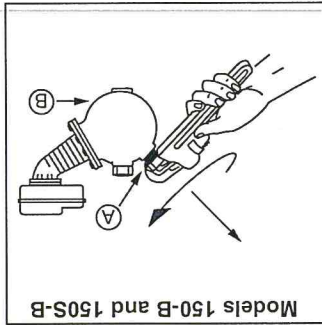
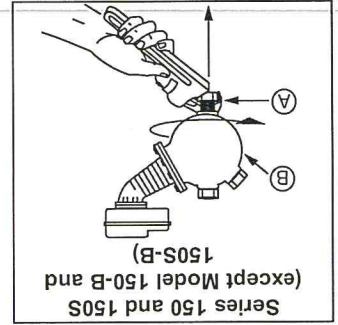
OR

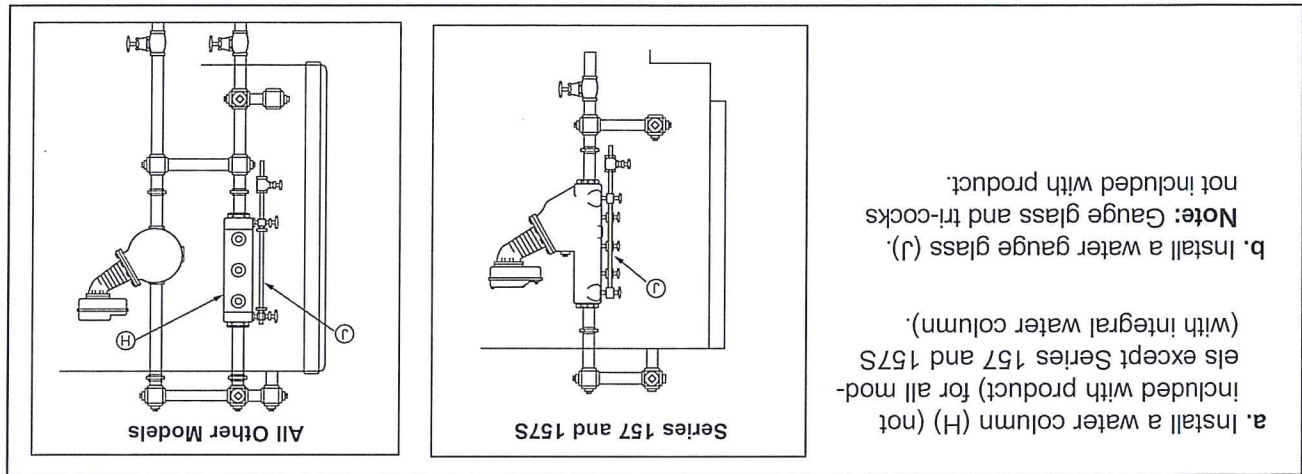
If the control will be the secondary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is at or above, the lowest, safe permissible water level, as determined by the boiler manufacturer.



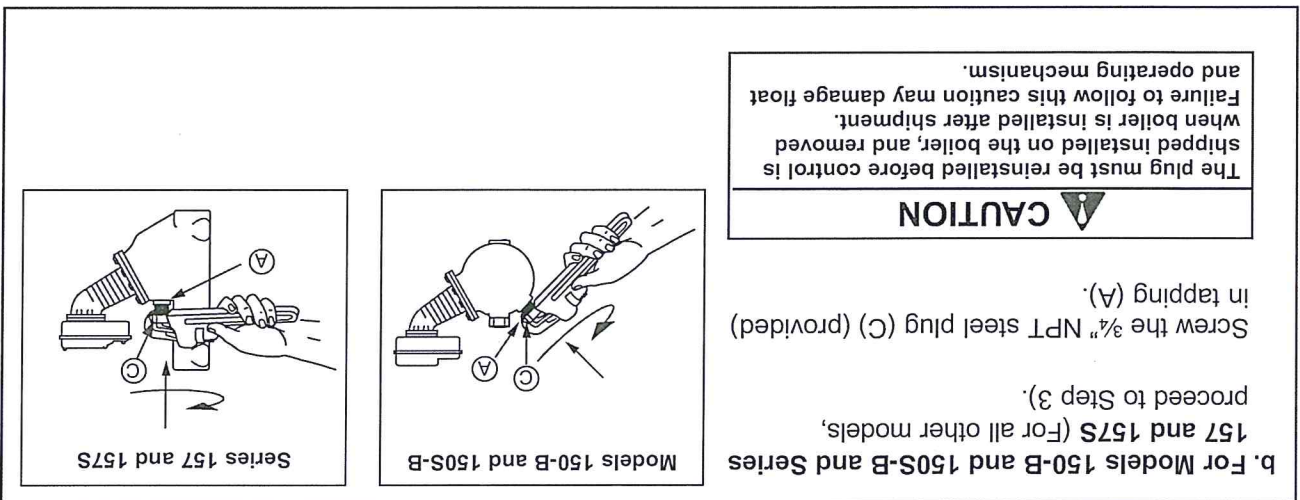
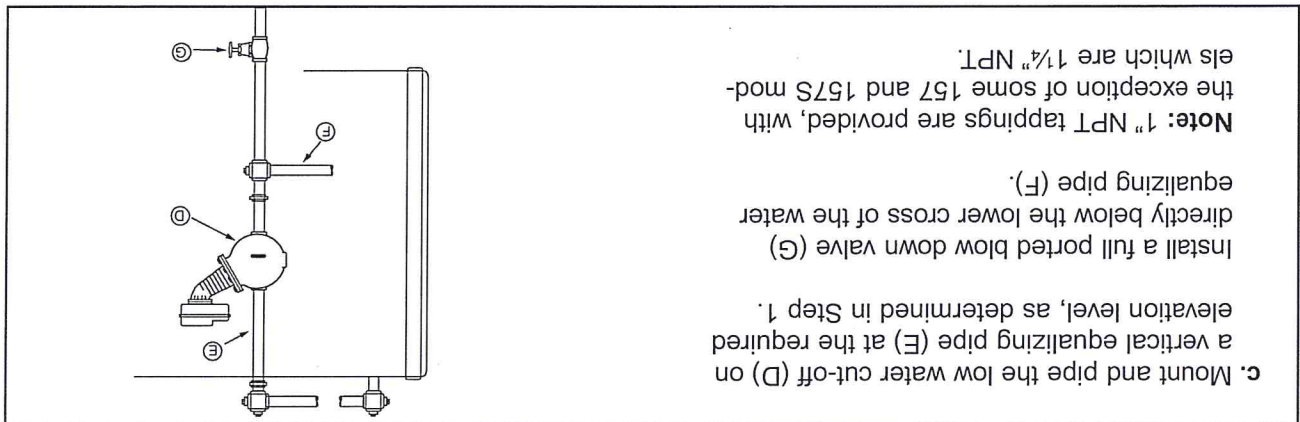
STEP 2 - Installing the Low Water Cut-Off

- Using a pipe wrench, unscrew the plastic float blocking plug (A) from the low water cut-off body (B).





STEP 3 - Installing a Water Gauge Glass (Required on all steam boilers)



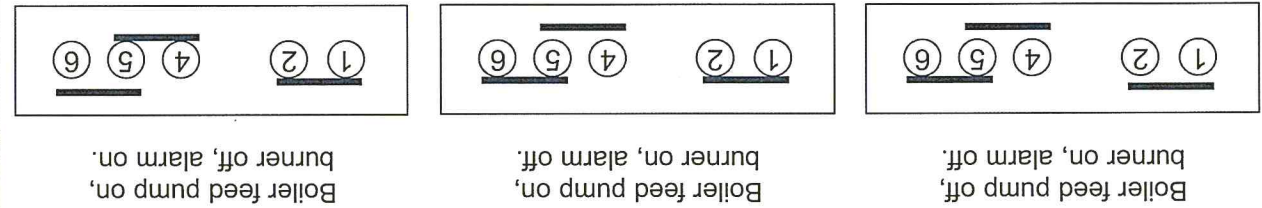
STEP 4 - Electrical Wiring

WARNING

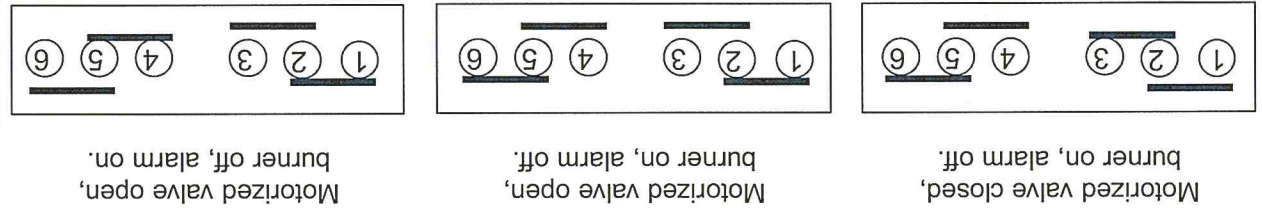
- To prevent a fire, do not use this product to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.
- To prevent electrical shock, turn off the electrical power before making electrical connections.
- This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.
- Modification of the switch assembly before or after installation could cause damage to the boiler and/or boiler system.
- Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result in property damage, personal injury or death.

Switch Operation

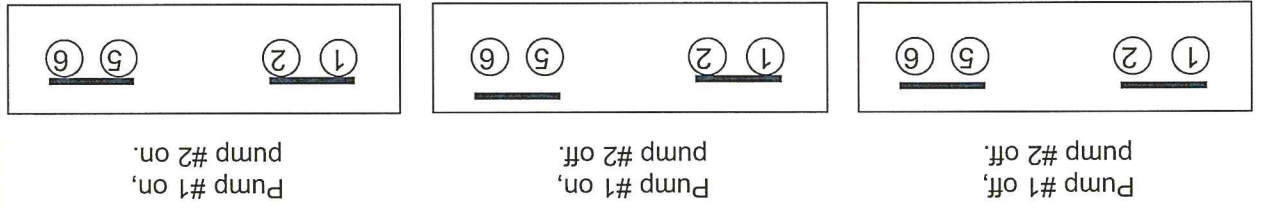
For all Models except 158/158S and 159/159S



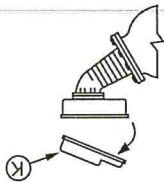
For Models 158 and 158S



For Models 159 and 159S



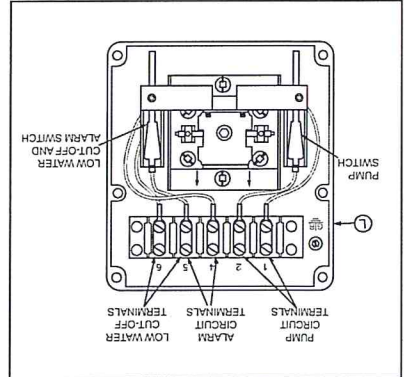
a. Using a flathead screwdriver, remove the junction box cover (K).



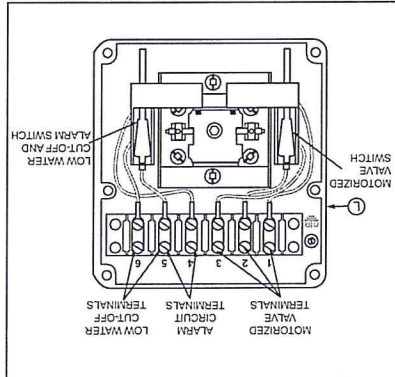
b. Following the appropriate wiring diagram, (refer to page 9) based on your application requirements, and using BX armored cable or Thinline electrical metal tubing connector fittings, make electrical connections to the junction box (L).

IMPORTANT: There must be a minimum space of 1/2" (13mm) between connector fittings and electrical live metal parts.

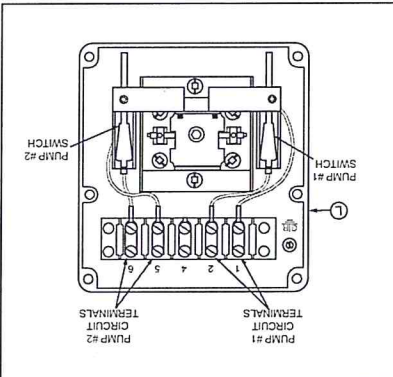
Snap Switches (Series 150S and 157S)



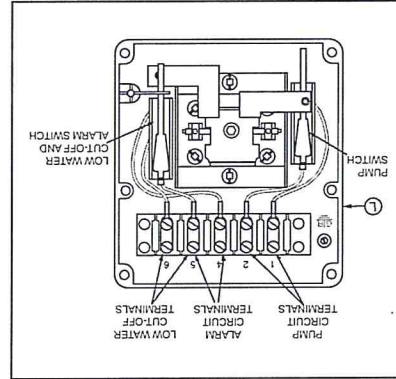
Automatic Reset (All models except 158S and 159S)



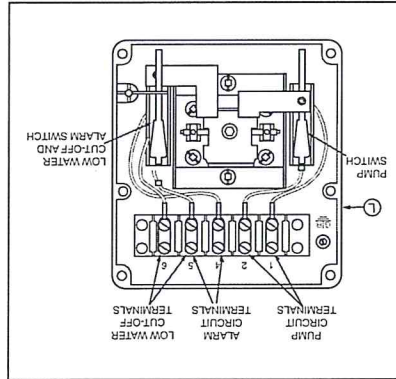
Automatic Reset Model 158S



Automatic Reset Model 159S

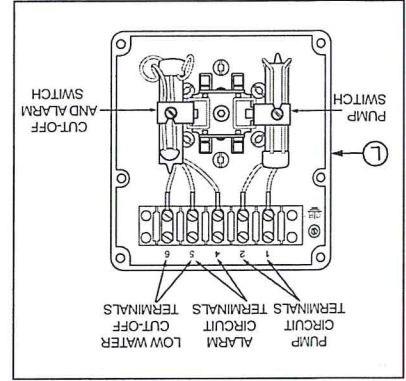


Manual Reset (All models except 158S)

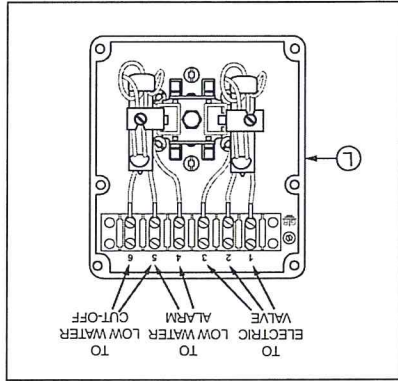


Manual Reset Model 158S-M

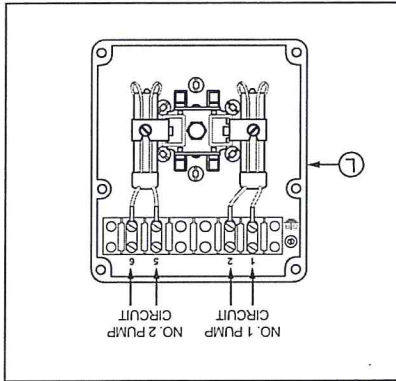
Mercury Switches (Series 150 and 157)



(All models except 158 and 159)



Model 158



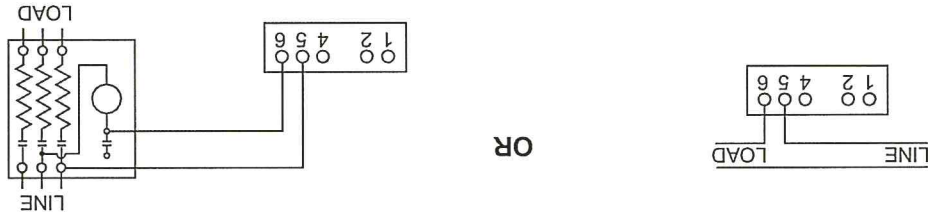
Model 159

WIRING DIAGRAMS

For Motorized Valves, refer to the valve manufacturer's wiring instructions.

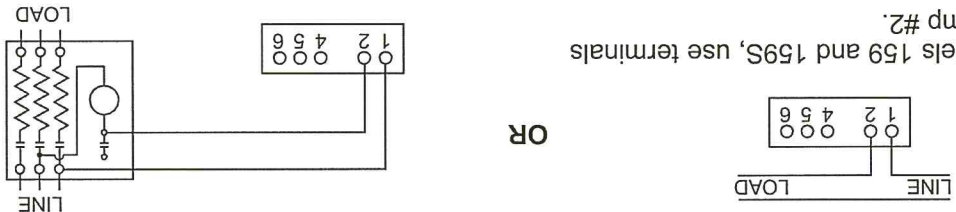
Low Water Cut-Off Only

- 1. Main Line Switch - For burner circuits within the switch's electrical rating.
- 2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch's electrical rating.



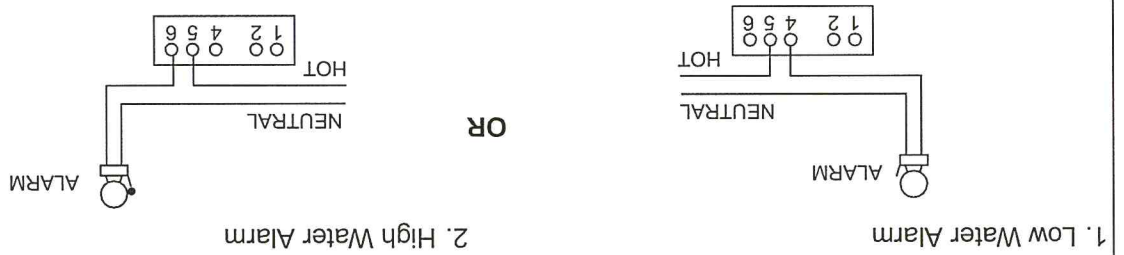
Pump Control Only

- 1. Main Line Switch - For pump motors within the switch's electrical rating.
- 2. Pilot Switch - To holding coil of a starter when the pump circuit exceeds the switch's electrical rating.



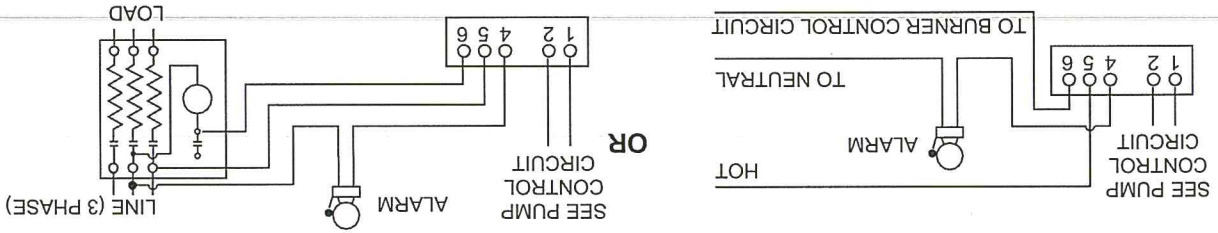
Note: For Models 159 and 159S, use terminals 5 and 6 for pump #2.

Alarm Circuit Only



Combination Pump Control, Low Water Cut-Off and Alarm

- 1. Main Line Switch - For burner circuits within the switch's electrical rating.
- 2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch's electrical rating.




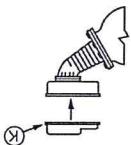
STEP 5 - Testing

This control is factory calibrated for specific applications. The following testing procedure is only meant to serve as a verification of proper operating sequence. Dimensions provided are typical for a boiler not being fired and/or not at pressure. Actual operating ranges are shown on page 2 in the "Operation" section.

IMPORTANT: Follow the boiler manufacturer's start-up and operating instructions along with all applicable codes and ordinances. **Note:** Water levels stated below are only for 150 psi (10.5 kg/cm²) operation.

6. Re-attach the junction box cover (K).

Note:
Cover must be installed correctly as shown

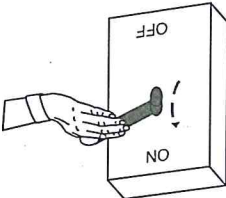


a. Turn on the electric power to the boiler. With the boiler empty the pump should go on and the burner must remain off.

WARNING

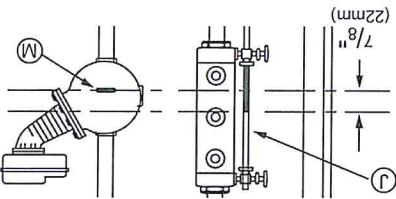
If the burner comes on, immediately turn the boiler off and make the necessary corrections.

Failure to follow this warning could cause an explosion or fire and result in property damage, personal injury or death.



b. The boiler should begin to fill with water. Watch the gauge glass (J) until the water level reaches approximately 7/8" (22mm) above the horizontal cast line (M) on the low water cut-off.

IMPORTANT: If water does not start filling the boiler, immediately turn off the boiler and make the necessary corrections.



INSTALLATION COMPLETE

- e. Blow down the control when the water in the boiler is at its normal level and the burner is on. Follow Blow Down Procedure found in Maintenance Section on the last page of these instructions.

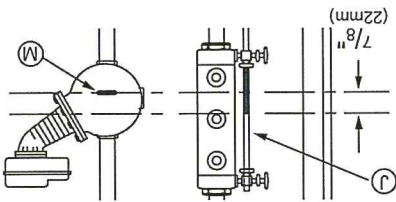
To prevent serious personal injury from steam pipe blow down, connect a pipe to avoid exposure to steam discharge.

Failure to follow this caution could cause personal injury.



CAUTION

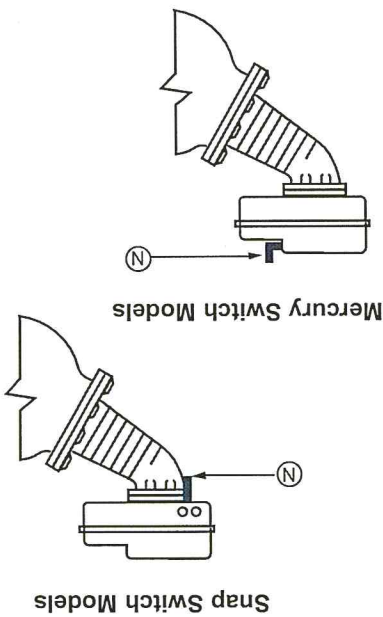
- d. Continue watching the gauge glass (J) to see that the water continues to rise to approximately $1\frac{3}{8}$ " (35mm) ($1\frac{7}{16}$ " (37mm) for MD models) above the horizontal cast line (M). The pump should shut off (the motorized valve should close with Models 158 and 158S, or with Models 159 and 159S, pump #1 should shut off).



For manual reset models only. When the water level reaches approximately $\frac{7}{8}$ " (22mm) above the horizontal cast line press the reset button (N). The burner should then come on.

OR

- c. **For automatic reset models only.** When the water level reaches approximately $\frac{7}{8}$ " (22mm) above the horizontal cast line (lower for MD models) the burner should come on (pump #2 should shut off with Models 159 and 159S).



MAINTENANCE


SCHEDULE:

- Blow down control as follows when boiler is in operation.
 - Daily if operating pressure is above 15 psi.
 - Weekly if operating pressure is below 15 psi.

NOTE

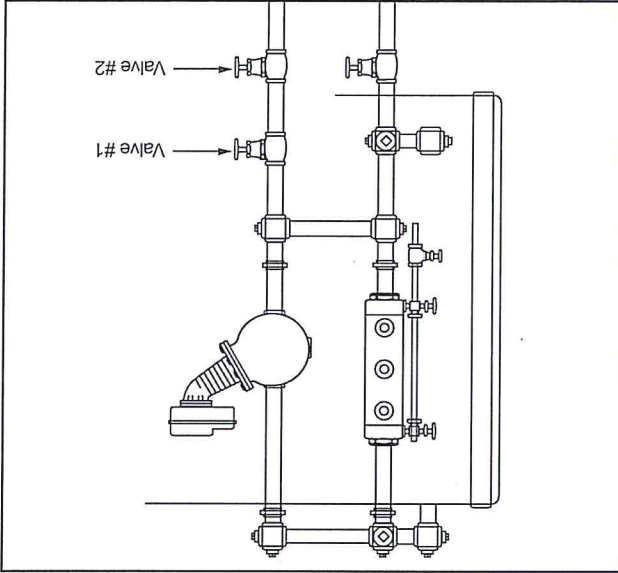
More frequent blow-down may be necessary due to dirty boiler water and/or local codes.

BLOW DOWN PROCEDURE:

<p>CAUTION</p> <p>To prevent serious personal injury from steam pipe blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.</p> <p>Failure to follow this caution could cause personal injury.</p>	
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Blow down the control when the water in the boiler is at its normal level and the burner is on. **Slowly** open the upper then the lower blow-down valves and observe the water level fall in the sight glass. Close the valves (lower first then upper) after verifying that the pump contacts have closed and the burner shuts off. If this does not happen, immediately shut off the boiler, correct the problem and retest.

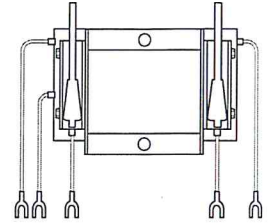
For Models 158 and 158S, close the blow down valve after the motorized valve opens and the burner shuts off. For Models 159 and 159S, close the blow down valve after both pumps come on. If this does not happen, immediately shut off the boiler and correct the problem.



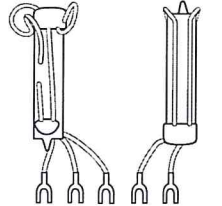
Snap switches must be replaced as an assembly.

CAUTION

Replacement Switch Assembly



Replacement Pump 3-Wire Burner Mercury Tubes



- Disassemble and inspect annually. Replace the low water cut-off/pump controller if it is worn, corroded, or if components no longer operate properly.
- Inspect the float chamber and equalizing piping annually. Remove all sediment and debris.
- Replace head mechanism every 5 years.
- More frequent replacement may be required when severe conditions exist such as rapid switch cycling, surging water levels, and use of water treatment chemicals.
- We recommend head mechanism replacement when the switch(es) no longer operate properly. If you choose to replace the switch(es), order the proper McDonnell & Miller replacement switch or switch assembly and follow the Repair Procedure provided.

Series 1 – Electromechanical Controls

- ▶ 2 or 3 Pole Output Contact
- ▶ Up to 20K Ohms/cm Sensitivity
- ▶ U.L. "Limit Control"
- ▶ U.L. "Motor Control"

One of Warrick's first products, Series 1 electromechanical controls offer 2 or 3 pole output contacts with 16 amp rating. These versatile controls can be configured for single level service, differential control, low water cutoff (with manual reset or lock out capability) control and many other functions.

Specifications

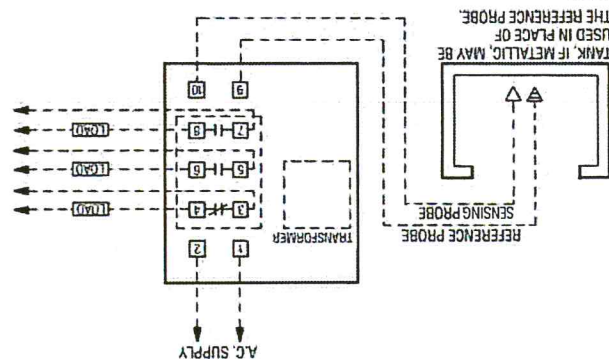
Contact Design	2 or 3 pole, single throw, electromechanical relay
Contact Rating (110 VAC)	16 amp Resistive 1 hp
Mode of Operation	Direct only
Sensitivity	0 - 20K ohm maximum, factory set
Primary Voltage	24 VAC, 115 VAC, 230 VAC, 460 VAC, 575 VAC (+10%/-15%)
Power Consumption	4 watts (15 VA)
Secondary Voltage	25 VAC, 75 VAC, 150 VAC, 300 VAC, 500 VAC*
Temperature	-30°F to 130°F
Approvals	U.L. Rec., FM, CSA, U.L. Listed Limit Control, U.L. 353
Connections	All screw type connections

* Due to high secondary voltage, if personnel can come in contact with electrodes, we suggest using Series 16, 26 or 19 controls.

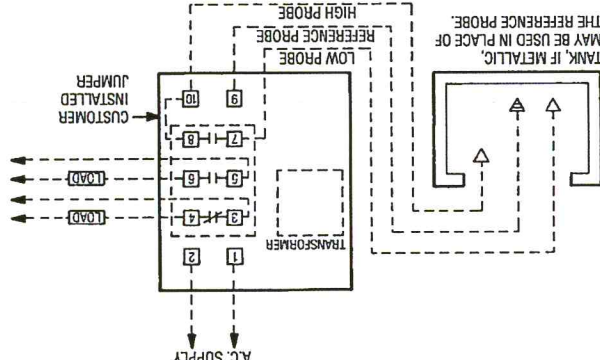
How to Order
Use the **Bold** characters from the chart below to construct a product code.

Series 1	1	X	X	X	X	X
Contact Configuration	C - 2 (N.O.), 0 (N.C.)	D - 1 (N.O.), 1 (N.C.)	E - 0 (N.O.), 2 (N.C.)	F - 3 (N.O.), 0 (N.C.)	G - 2 (N.O.), 1 (N.C.)	H - 1 (N.O.), 2 (N.C.)
Supply Voltage	1 - 115 VAC	2 - 230 VAC	3 - 460 VAC	4 - 575 VAC	5 - 115VAC/230VAC	6 - 24 VAC
Secondary Voltage (Sensitivity)	A - 25 (50 Ω)	B - 75 (450 Ω)	C - 150 (1.5K Ω)	D - 300 (7K Ω)	E - 500 (20K Ω)	F - None
Enclosure	0 - None	1 - NEMA 1	4 - NEMA 4			

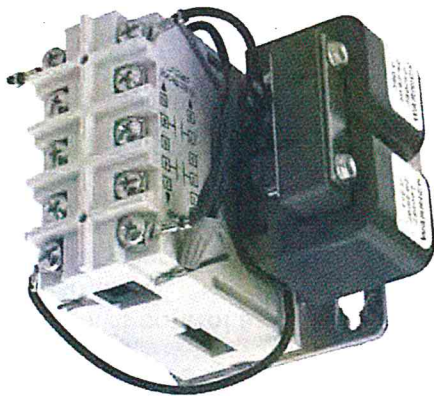
Typical Single Level Wiring



Typical Differential Wiring



- Applications
- Boiler Level Control
 - Boiler LLCO
 - General Purpose
 - On/Off Control
 - Pump Control
- Dimensions
-





Warrick® Series 1 Electromechanical Controls Installation and Operation Bulletin

Form 70
Sheet PIN 7600590
Rev. E

This bulletin should be used by experienced personnel as a guide to the installation of Series 1 controls. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Gems Sensors or its representatives if further information is required.

IMPORTANT!

Before proceeding to install the control,
Read and thoroughly understand these instructions.

General

Series 1 controls are simple, industrial type controls for low sensitivity applications. They contain 2 or 3 pole contacts with high contact ratings. The transformer/relay combinations allow for multiple primary and secondary voltages. They are suitable for use in non-hazardous locations with conductive liquids less than 20,000 Ohm/cm specific resistance.

Specifications

Control Design: Electrical-Mechanical level relay for use with conductivity probes.

Contact Design: 2 or 3 SPST (Non-Powered). Offered in both N.O. and N.C. - See contact configuration chart.

Contact Rating: 16A @ 115VAC, 8A @ 230VAC, 1H.P. @ 115 of 230 VAC

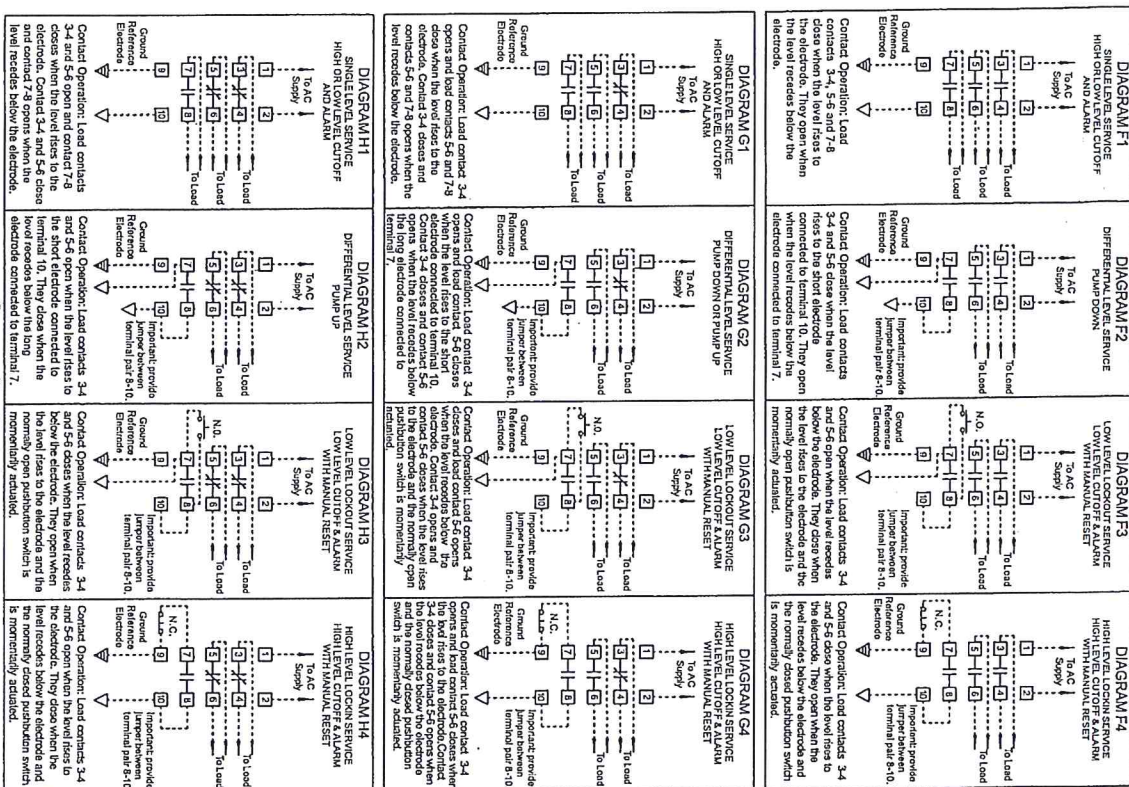
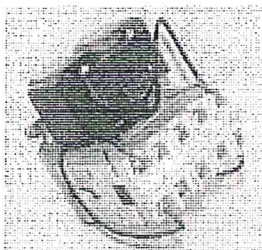
Supply Voltage: 24, 115, 230, 460, 575 nominal, plus 10%, minus 15%, 50/60 Hz.

Supply Current: 115, 230, 460, 575 VAC. Relay energized draws 15VA.

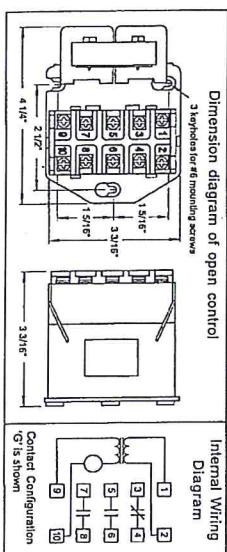
Secondary Voltage: 25, 75, 150, 300, 500 VAC RMS with open circuit on probes.

Secondary Current: 6VA with short circuited electrode circuit.

Sensitivity: Models operate from 50 to 20,000 OHM maximum specific resistance - Factory Set.



Gems
Sensors
One Cowles Road
Plainville, CT 06062-1198
Tel: 860-733-4579



Application Table

Basic Service	Function	**Required Electronics Diagram	Wiring Symbol	Contacts** N.O., N.C.
Single Level	High Level Alarm or Low Level Cutoff or	2	C1	C 2 0
	High Level Alarm	2	E1	F 3 0
	Low Level Alarm	2	J1	E 0 2
	High or Low Level Cutoff or Alarm	2	D1	D 1 1
Differential Level	Pump Down	3	G1	G 2 2
	Pump Up	3	H1	H 1 2
	Pump Down or Pump Up	3	C2	C 2* 0
	Low Level Alarm with Manual Reset	2	F2	F 3* 0
Low Level Lockout	Low Level Cutoff with Manual Reset	2	D2	D 1* 1
	Low Level Cutoff and Alarm with Manual Reset	2	H2	H 1* 2
	High Level Alarm with Manual Reset	2	G2	G 2* 1
	High Level Cutoff with Manual Reset	2	D3	D 1* 2
High Level Lockout	High Level Cutoff with Manual Reset	2	H3	H 1* 2
	High Level Cutoff and Alarm with Manual Reset	2	C3	C 2* 0
	High Level Cutoff with Manual Reset	2	F3	F 3* 0
	High Level Cutoff and Alarm with Manual Reset	2	G3	G 2* 1
High Level Lockout	High Level Alarm with Manual Reset	2	C4	C 2* 0
	High Level Cutoff with Manual Reset	2	F4	F 3* 0
	High Level Cutoff with Manual Reset	2	D4	D 1* 1
	High Level Cutoff with Manual Reset	2	H4	H 1* 2

* One normally open contact required to seal electrode circuit. Number of normally open contacts available for load duty therefore one less than figure indicated.
 ** Terminal 9 of control assumed connected to a reference electrode. Terminal 9 may be grounded to the vessel if the vessel is metallic.
 ^ Letters represent 2nd place symbol in the component number of the control.
 ^ All contacts available for load duty unless otherwise indicated by footnote.

Mounting and Wiring Instructions

The Series 1 control may be wired in various ways. Select the wiring diagram, on pages 3 and 4, that matches the contact configuration of your model number and your application. The Application Table on this page can assist you in determining which wiring diagram to use.

The Series 1 control must be mounted on a vertical surface with the transformer on the left-hand side. The control should be mounted in an enclosure of proper Nema integrity and wired following N.E.C. and local codes. Terminals on the control are numbered and are in the same relative position as the terminals shown in the wiring diagrams.

Each control has a data label on the right hand side of the terminal block. Terminal pair 1-2 must be continuously energized from an AC supply line of the same electrical characteristics as shown on the data label. Each dry contact used for load duty must be wired in series with the load, and that series branch connected across a power source compatible with the load.

Grounding:

Series 1 controls mounted in an enclosure have a grounding terminal and wires provided for adequate grounding of the control and conduit entrances to any external metal parts that may become energized. Conduit connections on fiberglass enclosures must be connected via the green ground wire provided for in the enclosure. *Caution:* Bonding between conduits must be made.

Wiring must be provided to the electrodes as shown. Terminal 9 is a reference electrode termination and may be grounded to the vessel if the vessel is metallic. When the vessel is non-metallic, terminal 9 must be connected to an additional electrode of a length equal to, or longer than, the longest electrode used in the vessel. If the electrode fitting used has a metallic body and is supported directly upon a metallic vessel, the ground reference connection is facilitated by securing that end of the reference conductor beneath the head of one of the four screws which fasten the terminal housing to the body of the fitting. The jumper between terminal pair 8-10 and the pushbutton switch wiring on diagrams X2, X3 and X4 are required field connections.

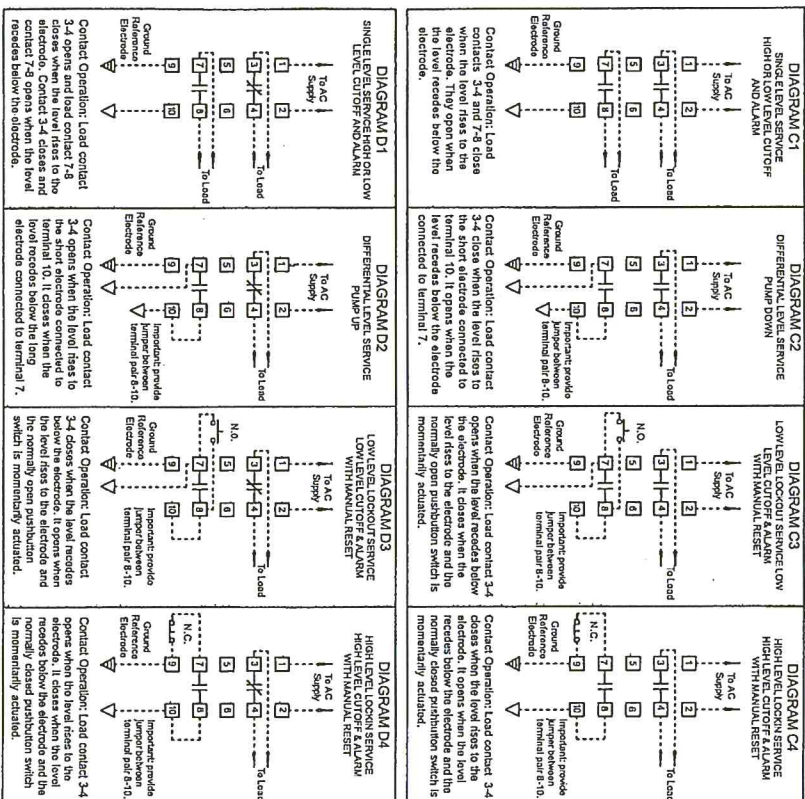
The control-to-fitting wire distance should not exceed those listed in the secondary voltage chart located on page 3.

Series 1 X X X X X			
Contact Configuration		AC Line Voltage	
Letter	N.O. N.C.	#	Voltage
A	2	1	115 VAC
B	0	2	230 VAC
C	1	3	460 VAC
D	0	4	460 VAC
E	0	5	460 VAC
F	2	6	115/230 VAC
G	1	7	24 VAC
H	0	8	24 VAC
J	0	3	24 VAC




Note: For liquids of known specific resistance choose a sensitivity greater than and closest to that value in ohm/cm.

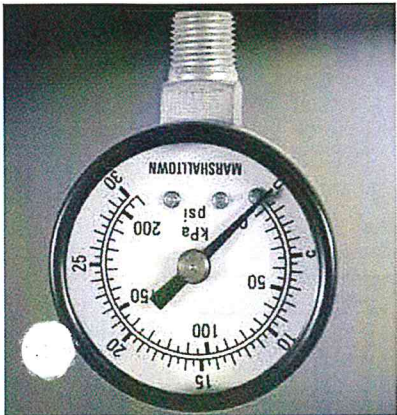
* Distance based on 14 AWG wire Type THHN or MTW

Dashed Lines Represent Field Wiring



Custom options available. Consult factory.

3E		<p>1" to 3" NPT</p> <p>1 thru 7</p> <p>Series 3E fittings are cast metal, pressure-tight assemblies capable of handling 1-7 probes. Attachment to vessels is accomplished with external pipe threading. 3E Fittings require the use of 3R rigid or 3W wire suspended electrodes.</p>	<p>Die-cast aluminum, epoxy coated</p> <p>Cast iron, red brass, 316 stainless steel</p> <p>Teflon®</p> <p>125 psig @ 353°F (cast iron) 250 psig @ 406°F (brass, 316 S.S.)</p>	<p>U.L. File #MP2489, Vol. 1 Sec. 1; CSA; FM</p>	<p>3N</p> <p>3E</p> <p>No. of Probes</p> <p>Attachment to Vessel</p> <p>Conduit Boss Thread Size (W" x D" x H")</p> <p>Terminal Housing Size</p> <p>1" NPT</p> <p>2" NPT</p> <p>2-1/2" NPT</p> <p>3" NPT</p> <p>2-1/4" square flat pad, 1-1/2" dia. hole in top of vessel secured with #10 machine screws at the corners of a 1-1/2" square</p> <p>1-3</p> <p>1</p> <p>2-3</p> <p>4</p> <p>5-7</p>	3N		<p>#10 Machine Screws from Underside</p> <p>1 thru 3</p> <p>Series 3N fittings accommodate 1-3 probes operating at atmospheric pressure. The assembly mounts on a flat surface atop open tanks or closed vessels. 3N Fittings require the use of 3R rigid or 3W wire suspended electrodes.</p>	<p>Die-cast aluminum, epoxy coated</p> <p>PVC, red brass, 316 stainless steel</p> <p>Teflon®</p> <p>0 psig @ 150°F (PVC) 0 psig @ 500°F (brass, 316 S.S.)</p>	<p>CSA File #LR11644</p>	<p>3R, 3W</p> <p>Series 3N</p> <p>Number of Probes</p> <p>Body Material</p> <p>1 thru 3</p> <p>A - PVC B - Red Brass C - 316 Stainless Steel</p>	3B		<p>3/8" - 18NPT, 5/8" - 18UNF, 5/8" - 24UNEF</p> <p>1</p> <p>Series 3B fittings are compact pressure tight assemblies that hold a single electrode probe for use in water and chemicals. These fittings incorporate a 1/4-20 female thread that must be combined with a Series 3R (rigid rod electrode) or Series 3W/3Y (wire suspended electrode) to make a complete assembly.</p>	<p>—</p> <p>316 stainless steel</p> <p>Teflon®</p> <p>250 psig @ 406°F 500 psig @ 75°F</p>	<p>U.L. File #MP2489, Vol. 1 Sec. 1; CSA; FM</p>	<p>Series 3B</p> <p>Thread</p> <p>1 - 3/8" - 18 NPT 2 - 5/8" - 18 UNF 3 - 5/8" - 24 UNEF</p> <p>Metal Parts</p> <p>B - 316 Stainless Steel</p>	<p>3R solid rod (up to 4") 3W or 3Y (greater than 4")</p>
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SPECIFICATIONS

ACCURACY
ASME Grade B = $\pm 3/2/3\%$ ($\pm 2\%$ of range across middle half of scale)

CASE SIZES
1" and 2" diameter

CASE MATERIAL
Steel, black painted

CASE STYLE
CB - Center Back Mount

LM - Lower Mount

UC - U-Clamp Mount

Right Mount

Left Mount

TUBE & SOCKET
Copper alloy

MOVEMENT
Brass

CONNECTION
1/8" & 1/2" NPT

RANGES
15 to 5,000 psi

DIAL STANDARD
Dual scale psi and kPa

DIAL COLOR
Black markings on white

POINTER
Aluminum, black painted

WINDOW
Flat plastic with steel friction ring

RESTRICTOR
Standard for all ranges

WEIGHT
1-1/2" 0.2 lb.

2" 0.3 lb.

2-1/2" 0.4 lb.

3-1/2" 0.5 lb.

4-1/2" 0.75 lb.

STANDARD RANGES & PART NUMBERS

TYPE	MARSHALLTOWN VALUE SERIES GAUGES				1"			
	Mounting	Connection	LM	UC	CB	Right	Left	% NPT
0 to 15 psi			GG1515L8	GG1515U8	GG1515C8			
0 to 30 psi			GG1530L8	GG1530U8	GG1530C8			
0 to 60 psi			GG1560L8	GG1560U8	GG1560C8			
0 to 100 psi			GG15100L8	GG15100U8	GG15100C8			
0 to 160 psi			GG15160L8	GG15160U8	GG15160C8			
0 to 200 psi			GG15200L8	GG15200U8	GG15200C8			
0 to 300 psi			GG15300L8	GG15300U8	GG15300C8			
0 to 400 psi			GG15400L8	GG15400U8	GG15400C8			
0 to 600 psi			GG15600L8	GG15600U8	GG15600C8			
0 to 1,000 psi			GG151000L8	GG151000U8	GG151000C8			

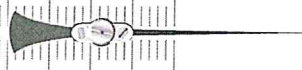
TYPE	MARSHALLTOWN VALUE SERIES GAUGES				2"			
	Mounting	Connection	LM	UC	CB	% NPT	% NPT	UC
0 to 15 psi			GG2015L4	GG2015U4	GG2015C4	GG2015U8	GG2015U4	GG2015U4
0 to 30 psi			GG2030L4	GG2030U4	GG2030C4	GG2030U8	GG2030U4	GG2030U4
0 to 60 psi			GG2060L4	GG2060U4	GG2060C4	GG2060U8	GG2060U4	GG2060U4
0 to 100 psi			GG20100L4	GG20100U4	GG20100C4	GG20100U8	GG20100U4	GG20100U4
0 to 160 psi			GG20160L4	GG20160U4	GG20160C4	GG20160U8	GG20160U4	GG20160U4
0 to 200 psi			GG20200L4	GG20200U4	GG20200C4	GG20200U8	GG20200U4	GG20200U4
0 to 300 psi			GG20300L4	GG20300U4	GG20300C4	GG20300U8	GG20300U4	GG20300U4
0 to 400 psi			GG20400L4	GG20400U4	GG20400C4	GG20400U8	GG20400U4	GG20400U4
0 to 600 psi			GG20600L4	GG20600U4	GG20600C4	GG20600U8	GG20600U4	GG20600U4
0 to 1,000 psi			GG201000L4	GG201000U4	GG201000C4	GG201000U8	GG201000U4	GG201000U4
0 to 1,500 psi			GG201500L4	GG201500U4	GG201500C4	GG201500U8	GG201500U4	GG201500U4
0 to 2,000 psi			GG202000L4	GG202000U4	GG202000C4	GG202000U8	GG202000U4	GG202000U4
0 to 3,000 psi			GG203000L4	GG203000U4	GG203000C4	GG203000U8	GG203000U4	GG203000U4
0 to 5,000 psi			GG205000L4	GG205000U4	GG205000C4	GG205000U8	GG205000U4	GG205000U4

New Expanded
Ranges and Sizes!

• ASME Grade B Accuracy
• Extra Savings with Quantity Pricing
• 5 Standard Mounting Options: LM, CB, UC, Right & Left
Marshmallow Value Series are the most economical, general purpose gauges in the Marsh gauge line. Suited for use with water, oil, air, gas, or other non-corrosive media.
Typical applications include FRL's, compressors, pumps, boilers, regulators, dryers as well as commercial and industrial equipment.

MARSHALLTOWN VALUE SERIES GAUGE

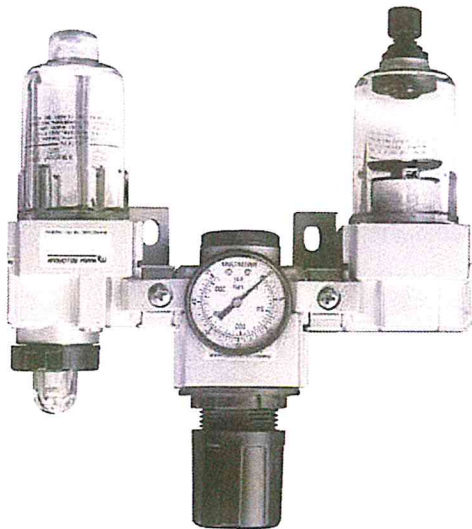


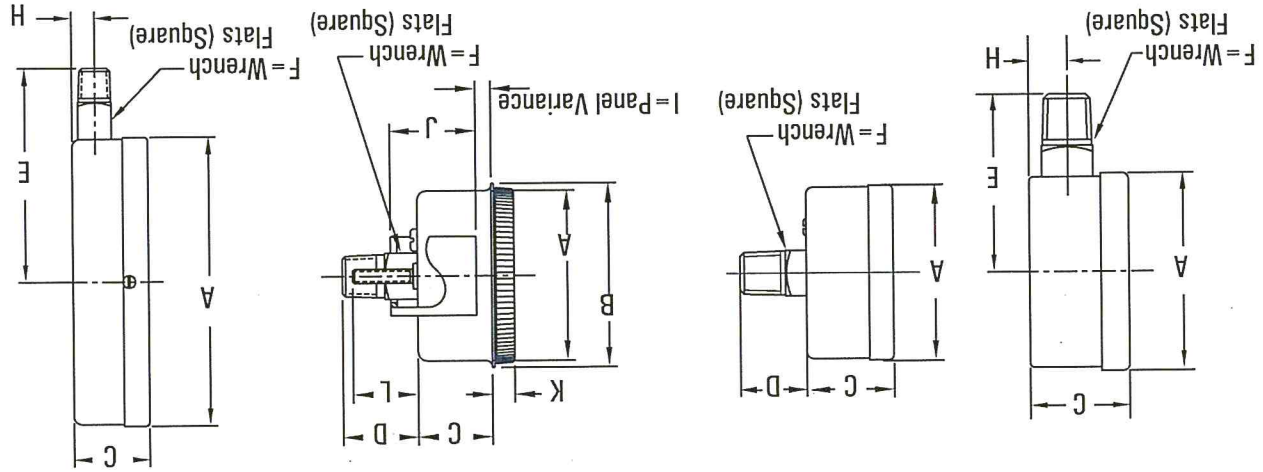


TYPE	Size	Mounting	Connection	0 to 30 psi	0 to 60 psi	0 to 100 psi	0 to 160 psi	0 to 200 psi	0 to 300 psi	0 to 400 psi	0 to 600 psi	0 to 1,000 psi	0 to 1,500 psi	0 to 2,000 psi	0 to 3,000psi	0 to 5,000psi
MARSHALLTOWN VALUE SERIES GAUGES	3"	LM	% NPT	GG2530L8	GG2560L8	GG25100L8	GG25160L8	GG25200L8	GG25300L8	GG25400L8	GG25600L8	GG251000L8	GG251500L8	GG252000L8	GG253000L8	GG255000L8
		LM	% NPT	GG2530C4	GG2560C4	GG25100C4	GG25160C4	GG25200C4	GG25300C4	GG25400C4	GG25600C4	GG251000C4	GG251500C4	GG252000C4	GG253000C4	GG255000C4
MARSHALLTOWN VALUE SERIES GAUGES	2 1/2"	CB	% NPT	GG2530C8	GG2560C8	GG25100C8	GG25160C8	GG25200C8	GG25300C8	GG25400C8	GG25600C8	GG251000C8	GG251500C8	GG252000C8	GG253000C8	GG255000C8
		CB	% NPT	GG2530U8	GG2560U8	GG25100U8	GG25160U8	GG25200U8	GG25300U8	GG25400U8	GG25600U8	GG251000U8	GG251500U8	GG252000U8	GG253000U8	GG255000U8
MARSHALLTOWN VALUE SERIES GAUGES	2"	CB	% NPT	GG2530C4	GG2560C4	GG25100C4	GG25160C4	GG25200C4	GG25300C4	GG25400C4	GG25600C4	GG251000C4	GG251500C4	GG252000C4	GG253000C4	GG255000C4
		UC	% NPT	GG2530U4	GG2560U4	GG25100U4	GG25160U4	GG25200U4	GG25300U4	GG25400U4	GG25600U4	GG251000U4	GG251500U4	GG252000U4	GG253000U4	GG255000U4
MARSHALLTOWN VALUE SERIES GAUGES	4 1/2"	LM	% NPT	GG4530L4	GG4560L4	GG45100L4	GG45160L4	GG45200L4	GG45300L4	GG45400L4	GG45600L4	GG451000L4	GG451500L4	GG452000L4	GG453000L4	GG455000L4
		LM	% NPT	GG4530U4	GG4560U4	GG45100U4	GG45160U4	GG45200U4	GG45300U4	GG45400U4	GG45600U4	GG451000U4	GG451500U4	GG452000U4	GG453000U4	GG455000U4
MARSHALLTOWN VALUE SERIES GAUGES	4"	LM	% NPT	GG4530L4	GG4560L4	GG45100L4	GG45160L4	GG45200L4	GG45300L4	GG45400L4	GG45600L4	GG451000L4	GG451500L4	GG452000L4	GG453000L4	GG455000L4
		LM	% NPT	GG4530U4	GG4560U4	GG45100U4	GG45160U4	GG45200U4	GG45300U4	GG45400U4	GG45600U4	GG451000U4	GG451500U4	GG452000U4	GG453000U4	GG455000U4

TYPE	Size	Mounting	Connection	0 to 30 psi	0 to 60 psi	0 to 100 psi	0 to 160 psi	0 to 200 psi	0 to 300 psi	0 to 400 psi	0 to 600 psi	0 to 1,000 psi	0 to 1,500 psi	0 to 2,000 psi	0 to 3,000psi	0 to 5,000psi
MARSHALLTOWN VALUE SERIES GAUGES	3"	LM	% NPT	GG3530L4	GG3560L4	GG35100L4	GG35160L4	GG35200L4	GG35300L4	GG35400L4	GG35600L4	GG351000L4	GG351500L4	GG352000L4	GG353000L4	GG355000L4
		CB	% NPT	GG3530C4	GG3560C4	GG35100C4	GG35160C4	GG35200C4	GG35300C4	GG35400C4	GG35600C4	GG351000C4	GG351500C4	GG352000C4	GG353000C4	GG355000C4
MARSHALLTOWN VALUE SERIES GAUGES	3"	UC	% NPT	GG3530U4	GG3560U4	GG35100U4	GG35160U4	GG35200U4	GG35300U4	GG35400U4	GG35600U4	GG351000U4	GG351500U4	GG352000U4	GG353000U4	GG355000U4
		UC	% NPT	GG3530U4	GG3560U4	GG35100U4	GG35160U4	GG35200U4	GG35300U4	GG35400U4	GG35600U4	GG351000U4	GG351500U4	GG352000U4	GG353000U4	GG355000U4

TYPE	Size	Mounting	Connection	0 to 30 psi	0 to 60 psi	0 to 100 psi	0 to 160 psi	0 to 200 psi	0 to 300 psi	0 to 400 psi	0 to 600 psi	0 to 1,000 psi	0 to 1,500 psi	0 to 2,000 psi	0 to 3,000psi	0 to 5,000psi
MARSHALLTOWN VALUE SERIES GAUGES	4 1/2"	LM	% NPT	GG4530L4	GG4560L4	GG45100L4	GG45160L4	GG45200L4	GG45300L4	GG45400L4	GG45600L4	GG451000L4	GG451500L4	GG452000L4	GG453000L4	GG455000L4
		LM	% NPT	GG4530U4	GG4560U4	GG45100U4	GG45160U4	GG45200U4	GG45300U4	GG45400U4	GG45600U4	GG451000U4	GG451500U4	GG452000U4	GG453000U4	GG455000U4
MARSHALLTOWN VALUE SERIES GAUGES	4"	LM	% NPT	GG4530L4	GG4560L4	GG45100L4	GG45160L4	GG45200L4	GG45300L4	GG45400L4	GG45600L4	GG451000L4	GG451500L4	GG452000L4	GG453000L4	GG455000L4
		LM	% NPT	GG4530U4	GG4560U4	GG45100U4	GG45160U4	GG45200U4	GG45300U4	GG45400U4	GG45600U4	GG451000U4	GG451500U4	GG452000U4	GG453000U4	GG455000U4





DIMENSIONS													
Part Number	Dial Size	Mount	A	B	C	D	E	F	H	I	J	K	L
GG15XXXXL8	1.5"	1/8" LM	1.606		0.89		1.488	0.433	0.296				
GG15XXXXC8	1.5"	1/8" CB	1.57		0.92	1.61		0.433					
GG15XXXXU8	1.5"	1/8" UC	1.606	1.86	0.89	0.61		0.433		0.0-0.25	1.05	0.16	0.52
GG20XXXXL8	2.0"	1/8" LM	2.047		1.122		1.787	0.534	0.376				
GG20XXXXC8	2.0"	1/8" CB	2.047		1.122	0.64		0.534					
GG20XXXXU8	2.0"	1/8" UC	1.97	2.24	1.01	0.64		0.534		0.0-0.26	1.15	0.16	0.52
GG20XXXXL4	2.0"	1/4" LM	2.047		1.122		1.787	0.551	.0385				
GG20XXXXC4	2.0"	1/4" CB	2.047		1.022	0.74		0.534					
GG20XXXXU4	2.0"	1/4" UC	1.97	2.24	1.01	0.74		0.534		0.0-0.26	1.15	0.16	0.52
GG25XXXXL8	2.5"	1/8" LM	2.496		1.134		1.961	0.539	0.388				
GG25XXXXC8	2.5"	1/8" CB	2.496		1.134	0.66		0.543					
GG25XXXXU8	2.5"	1/8" UC	2.55	2.55	0.97	0.74		0.543		0.0-0.24	1.18	0.23	0.52
GG25XXXXL4	2.5"	1/4" LM	2.496		1.134		1.961	0.543	0.39				
GG25XXXXC4	2.5"	1/4" CB	2.496		1.122	0.771		0.543					
GG25XXXXU4	2.5"	1/4" UC	2.55	2.55	0.97	0.74		0.543		0.0-0.24	1.18	0.23	0.52
GG35XXXXL4	3.5"	1/4" LM	3.488		1.22		2.717	0.543	0.413				
GG35XXXXC4	3.5"	1/4" CB	3.488		1.22	0.86		0.543					
GG35XXXXU4	3.5"	1/4" UC	3.75	3.96	0.99	0.71		0.543		0.0-0.37	1.2		0.73
GG45XXXXL4	4.5"	1/4" LM	4.941		1.142		3.409	0.551	0.394				

L404A-D, F; L604A,L Pressuretrol® Controllers

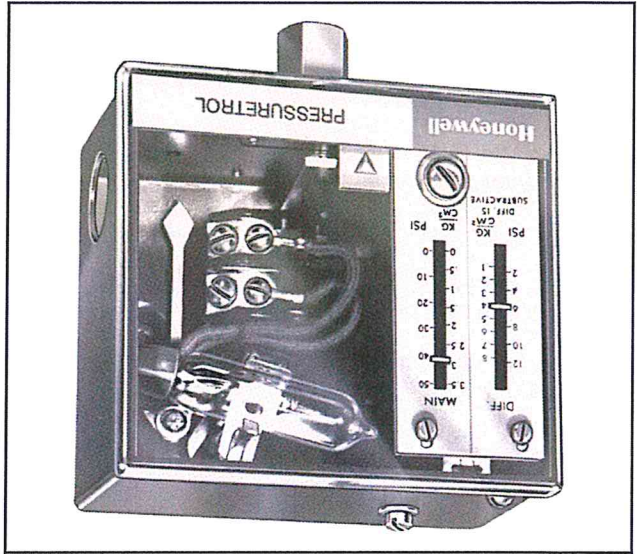
PRODUCT DATA

FEATURES

- Can be used with steam, air, non-combustible gases, or fluids non-corrosive to the pressure sensing element.
- Stainless steel diaphragm (except 300 psi [21.1 kg/cm², 2068 kPa] models) also allows use with ammonia, oxygen, distilled water and similar media.
- L404B is recommended for supervision of atomizing medium pressure in oil burner systems.
- Models are available with single-pole, single-throw (spst), single-pole, double-throw (spdt), or double-pole single-throw (dpst) switching and in a variety of operating ranges.
- Dustproof, trouble-free mercury switches (all models except L404F, which has snap-acting switch).
- Automatic reset models have adjustable, subtractive differential.
- Trip-free mechanism on manual reset models assures that limit function of controller cannot be defeated by jamming reset lever.
- Screw adjustments made on top of case.
- Scaleplates marked in English (psi) and Metric (kg/cm²) units.
- L404F models available with European enclosure, British Standard Pipe Threads, ground screw, and scale plates marked in kg/cm² and either psi or kPa.
- Clear plastic cover on case to observe pressure settings and switch action.
- Levelling indicator visible through cover.
- Hexagonal fitting with 1/4-18 NPT internal threads for direct mounting to 14026 Steam Trap (siphon loop).
- Surface mount is available using screws through holes (knockouts) in case backing.

APPLICATION

L404 and L604 Pressuretrol® Controllers are line voltage pressure controllers that provide operating control, automatic limit protection, or manual reset limit protection for pressure systems of up to 300 psi (21.1 kg/cm² or 2068 kPa).



1	Application
1	Features
2	Specifications
2	Ordering Information
5	Installation
8	Setting and Checkout
10	Service Information

Contents



SPECIFICATIONS

TRADELIN® Models

TRADELIN® models are selected and packaged to provide ease of stocking, ease of handling and maximum replacement value. Specifications of TRADELIN® controls are the same as those of standard models, except as noted below.

TRADELIN® Models Available:

L604A Pressuretrol® Controllers—available in 2 to 15, 5 to 50, 10 to 150 and 20 to 300 psi (0.14 to 1.1 kg/cm² [14 to 103 kPa], 0.4 to 3.5 kg/cm² [34 to 345 kPa], 0.7 to 10.6 kg/cm² [69 to 1034 kPa], and 1.4 to 21.0 kg/cm² [138 to 2068 kPa]).
Additional Features: TRADELIN® pack with cross-reference label.

Standard Models:

Models:
L404A-D, F and L604A, L Pressuretrol® Controllers. See Table 1.

NOTE: A 14026 Steam Trap (siphon loop) is available, except where noted in Table 1. The steam trap is necessary for boiler installations.

Switches:
Mercury switches in all models except the L404F which has a Micro Switch™ snap-acting switch.

Pressure Sensing Element:
Stainless steel diaphragm (brass bellows in 300 psi

[21.1 kg/cm² (2068 kPa)] models).

Ambient Temperature Range:
-35°F (-37°C) to +150°F (66°C).

NOTE: Also, see the NOTE in the Location and Mounting section.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELIN® wholesaler or distributor, refer to the TRADELIN® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:
1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
1885 Douglas Drive North
Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Table 1. Models Available .

Model	Switching Action on Pressure Rise to Setpoint	Operating Ranges ^a				Midscale Subtractive Differential ^a (Adjustable)				Maximum Surge Pressure	
		psi	kg/cm ²	kPa	psi	kg/cm ²	kPa	psi	kg/cm ²	psi	kg/cm ²
L404A	spst, breaks circuit	0.5 to 5	0.035 to 0.35	3.4 to 35	Fixed (0.30 ± 0.15 psi maximum @ 1.5 psi)	0.14 to 1.10	1.03 to 2.76	500	35.2	8.5	0.6
L404A	spst, breaks circuit	2 to 15 ^b	.14 to 1.0	14 to 103	2 to 6	0.14 to 0.41	14 to 4	50	3.5	345	59
		5 to 50	.35 to 3.5	34 to 345	4 to 12	.28 to 0.82	127 to 83	85	6.0	586	
		10 to 150	.66 to 10.6	69 to 1034	8 to 16	.56 to 1.10	55 to 110	225	15.8	1550	
		20 to 300 ^c	1.4 to 21.0	138 to 2068	15 to 40	1.04 to 2.76	103 to 276	500	35.2	3445	
L404B ^f	spst, makes circuit	2 to 15 ^b	.14 to 1.1	14 to 103	2 to 6	0.14 to 0.41	14 to 41	50	3.5	345	
		5 to 50	.35 to 3.5	24 to 345	4 to 12	.28 to 0.82	27 to 83	85	6.0	586	
		10 to 150	.66 to 10.6	69 to 1034	8 to 16	.56 to 1.10	55 to 110	225	15.8	1550	
		20 to 300 ^c	1.4 to 21.0	138 to 2068	15 to 40	1.04 to 2.76	103 to 276	500	35.2	3445	
L404C	spst, breaks circuit	2 to 15	.14 to 1.0	14 to 103	14 to 103	1.04 to 2.76	103 to 276	500	35.2	345	
		5 to 50	.35 to 3.5	34 to 345	34 to 345	1.04 to 2.76	103 to 276	500	35.2	586	
		10 to 150	.66 to 10.6	69 to 1034	69 to 1034	1.04 to 2.76	103 to 276	500	35.2	1550	
		20 to 300 ^c	1.4 to 21.0	138 to 2068	138 to 2068	1.04 to 2.76	103 to 276	500	35.2	3445	
L404D	spst, makes circuit	2 to 15	.14 to 1.0	14 to 103	14 to 103	1.04 to 2.76	103 to 276	500	35.2	345	
		10 to 150	.66 to 10.6	69 to 1034	69 to 1034	1.04 to 2.76	103 to 276	500	35.2	1550	
		20 to 300 ^c	1.4 to 21.0	138 to 2068	138 to 2068	1.04 to 2.76	103 to 276	500	35.2	3445	
L404E	spst snap-acting switch, makes R1-W, breaks R2-B	2 to 15	.14 to 1.0	14 to 103	2 to 6	0.14 to 0.41	14 to 41	50	3.5	345	
		5 to 50	.35 to 3.5	34 to 345	6 to 14	.41 to 0.97	41 to 97	85	6.0	586	
		10 to 150	.66 to 10.6	69 to 1034	10 to 22	.69 to 1.52	60 to 152	225	15.8	1550	
		20 to 300 ^c	1.4 to 21.0	138 to 2068	20 to 50	1.4 to 3.5	138 to 345	500	35.2	3445	
L604A	spst circuit makes R-W, breaks R-B	2-15 ^b	.14 to 1.0	14 to 103	2 to 6	0.14 to 0.41	14 to 41	25	1.8	172	
		5 to 50	.35 to 3.5	34 to 345	4 to 12	.28 to 0.82	27 to 83	85	6.0	586	
		10 to 150	.66 to 10.6	69 to 1034	8 to 16	.56 to 1.10	55 to 110	225	15.8	1550	
		20 to 300 ^c	1.4 to 21.0	138 to 2068	15 to 40	1.04 to 2.76	103 to 276	500	35.2	3445	
L604L	spst circuit makes R-W, breaks R-B	2-15	.14 to 1.0	14 to 103	14 to 103	1.04 to 2.76	103 to 276	25	1.8	172	

^a Scales are marked in both psi and kg/cm².^b L404A,B and L604A models are available with 1 to 6 psi midscale subtractive differential in 2 to 15 psi models.^c Brass bellows replace stainless steel diaphragm. Not suitable for use with ammonia, oxygen, or other corrosive materials.^d L404C,D and L604L models are designated as Manual Reset 2 controllers; the trip-free reset mechanism does not permit the controller to function as an automatic-reset device when the manual reset lever is held in the reset position. The subtractive differential is fixed at the minimum value of the adjustable differential of the L404A for each corresponding operating range.^e L404F only; all other models have mercury switches.^f Also recommended for supervision of atomizing medium pressure (air or steam) in an oil burner system.

Table 2. Switch Contact Rating (in Amperes at 50/60 Hz).

Model	Load	120 vac	240 Vac	120 Vdc	240 Vdc
L404	Full Load	8.0	5.1	2.4	1.2
	Locked Rotor	48.0	30.5	24.0	12.0
L604A,L ^b	Noninductive ^a	10.0	5.0	5.0	2.0
	Full Load	8.0	5.1	2.0	1.0
	Locked Rotor	48.0	30.6	20.0	10.0
	Noninductive	10.0	5.0	8.0	4.0

^a L404F (snap-acting) does not have noninductive or dc ratings.

^b L604A and L have also been tested (and listed by Underwriters Laboratories Inc.) and breaking (not making) a load with a total rating of 9.8A full load, plus 360 VA ignition, plus 250 VA pilot duty at 120 Vac.

Table 3. Conversion Table (psi to kPa).

Operating Range		Subtractive Differential	
Scale-Plate (psi)	kg/cm ²	Scale-Plate (psi)	kg/cm ²
0 to 15	0 to 10	—	—
2 to 15	0.14 to 1.0	1 to 6	0.77 to 4
5 to 50	0.3 to 3.5	4 to 12	0.3 to 0.8
5 to 150	0.3 to 10.3	5 to 14	0.4 to 1.0
10 to 150	0.7 to 10.3	8 to 16	0.6 to 1.1
20 to 360	1.4 to 20.7	15 to 40	1.0 to 2.8
		138 to 2068	103 to 276
			138 to 345

MERCURY NOTICE



If this control is replacing a control that contains mercury in a sealed tube, do not place your old control in the trash. Dispose of properly. This control also contains mercury in a sealed tube. It must also be disposed of properly when it is replaced.

Contact your local waste management authority for instructions regarding recycling and the proper disposal of an old control.

WARNING

Electrical Shock Hazard.

Can cause severe injury, death or property

4. After installation is complete, check out product operation as provided in these instructions.

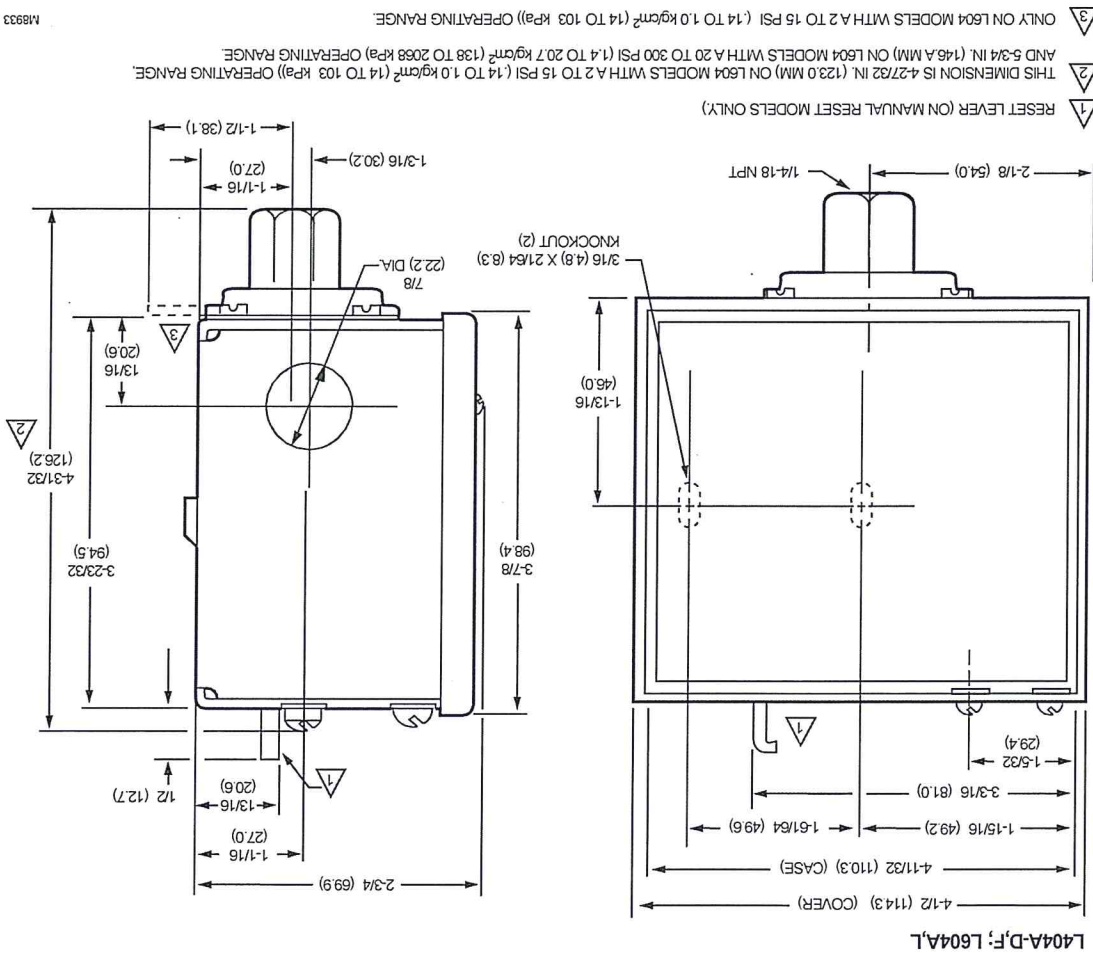
operation as provided in these instructions.

1. Locate the controller where the ambient temperature will not exceed 150°F (66°C).
2. Use pipe compound sparingly to avoid clogging the hole in the pipe or diaphragm fitting.
3. Do not tighten the controller by hand by holding the case.
4. Accurately level the controller for proper operation.

J. D. H.

WARNING

Fig. 1. Mounting dimensions of the L404A,B,C,D,F and L604A,L Pressurretrol® Controllers in in. (mm).



Location and Mounting

NOTE: For most accurate operation, add supplemental heat

to installations where the heat falls below -20°F (-29°C). Never locate the controller where the temperature falls below -35°F (-37°C), because mercury in the switch freezes at this temperature.

When used with steam boilers, always mount the controller above the water line in the boiler. A steam trap (siphon loop) must always be connected between the controller and the boiler (see Fig. 2) to prevent boiler scale and corrosive vapors from attacking the diaphragm. The loop on the steam trap must always be perpendicular to the face of the controller. If the loop is parallel to the controller, expansion or contraction of the loop tips the controller and causes inaccurate operation of the switch.

The controller can be mounted:

- alongside the pressure gauge,
- in a fitting on the boiler provided by the manufacturer,
- at a remote location in case of excessive vibration,
- in a special mounting on a low water cutoff.

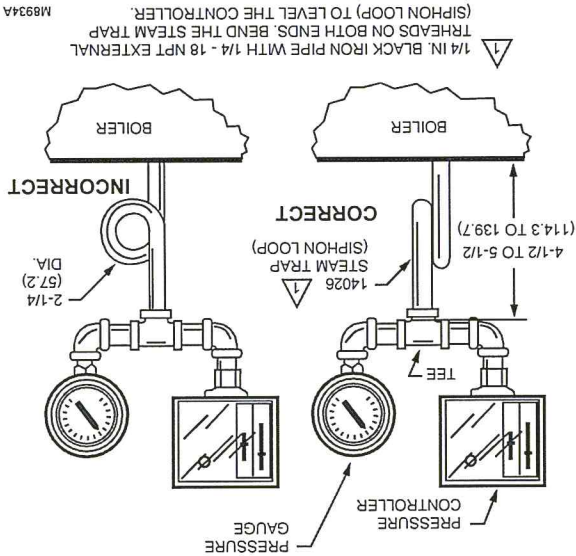


Fig. 2. Right and wrong mounting of a steam trap (siphon loop), with approximate dimensions in in. (mm).

Make all pipe connections in accordance with approved standards. Use only a small amount of pipe compound to seal the connection joints. Excess pipe compound can clog the small hole in the fitting and prevent the controller from operating properly.

To avoid leaks and damage to the case, use a parallel jaw wrench on the controller hexagonal fitting. Do not tighten the controller by hand by holding the case.



WARNING

Electrical Shock Hazard.
Can cause severe injury, death or equipment damage.
Disconnect the power supply before beginning wiring to prevent electrical shock or equipment damage.

Wiring

The L404B is recommended for this application. It makes a circuit when the pressure rises to the setpoint and breaks when the pressure falls to the setpoint minus the differential (Fig. 10).

When air or steam is used as an atomizing medium in an oil burner system, authorities having jurisdiction (approval bodies and codes) often require a low limit to prevent opening the main oil valve until sufficient atomizing pressure is present, and to shut down the system when the atomizing pressure falls too low.

Supervision of Atomizing Medium Pressure (Air or Steam)—L404B

If there is excessive vibration at the boiler than can adversely affect the operation of the controller, mount the controller at a remote location. The piping from the boiler must be suitable and solidly mounted. The piping must be properly pitched to drain all condensation back to the boiler. A steam trap (siphon loop) must be mounted between the remote piping and the controller. Level the controller after installation.

Mounting at a Remote Location

If it is not convenient to mount the controller alongside the pressure gauge, install steam trap (siphon loop) in the fitting provided by the boiler manufacturer. If there is no fitting, mount the steam trap at a location recommended by the boiler manufacturer. Screw the controller directly to the steam trap and level the controller.

Mounting on a Boiler

To mount the controller alongside a pressure gauge (Fig. 2), remove the gauge. In its place, install a steam trap (siphon loop) with a tee on top. Using elbows and pipe nipples, mount the controller and pressure gauge on the ends of the tee. Level the controller after installation.

Mounting Alongside a Pressure Gauge

A controller with a mercury switch must be accurately leveled for proper operation. It is level when the leveling indicator (see Fig. 11) hangs freely with its pointer directly over the index mark inside the back of the case. Level the controller by carefully bending the steam trap (siphon loop).

Leveling

1. Assure all wiring complies with applicable electrical codes, ordinances and regulations. Use NEC Class 1 (line voltage) wiring.
2. For normal installation, use moisture-resistant No. 14 wire suitable for at least 167°F (75°C) when you are using the controller with a flame safeguard primary control, or at least 194°F (90°C) when using it with a programming control.
3. For high temperature installations, use moisture-resistant No. 14 wire, selected for a temperature rating above the maximum operating temperature.
4. All models have a terminal block inside the cover (see Fig. 3 and 4) and a 7/8 in. (22 mm) hole in one side for 1/2 in. conduit, cable or wires. Remove the front cover by loosening the screw at the bottom of the main scale. Refer to Fig. 5 through 9 for typical hookups. Follow the burner or boiler manufacturer wiring diagrams, if provided.
5. Make sure the loads do not exceed the Switch Contact Ratings in the Specifications section.
6. Replace the front cover when the wiring is completed.

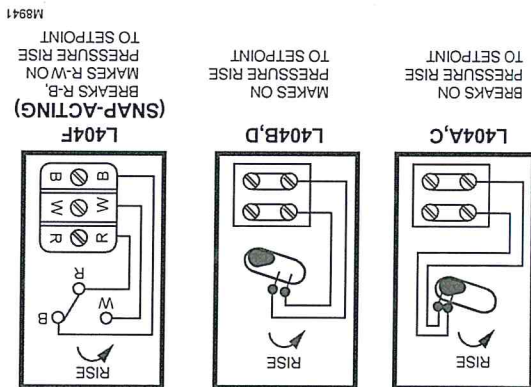


Fig. 3. L404 terminal blocks and internal schematics.

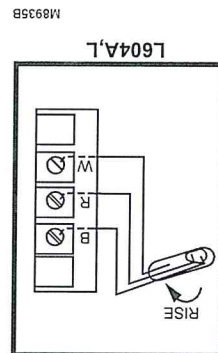


Fig. 4. L604 terminal block and internal schematic.

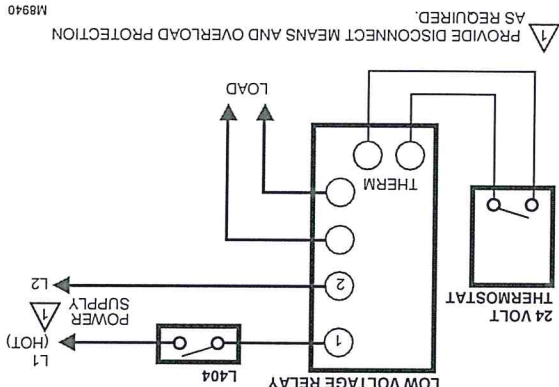


Fig. 5. L404 used as a limit or as an operating controller.

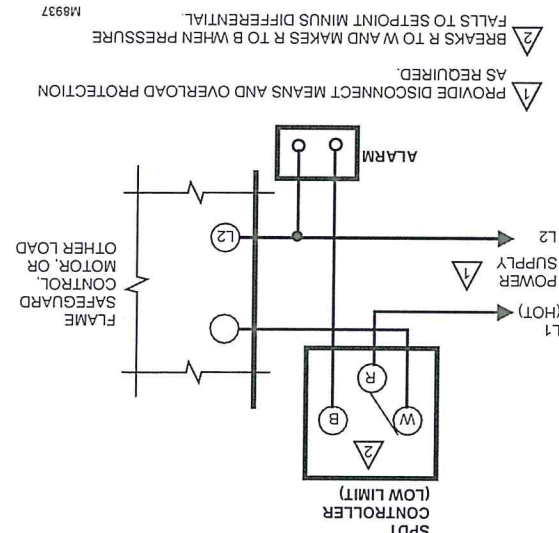


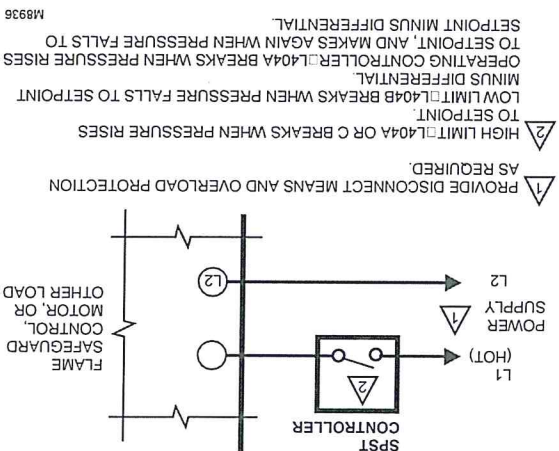
Fig. 6. L404 with a low voltage relay.

1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO W AND MAKES R TO B WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

3 FALLS TO SETPOINT MINUS DIFFERENTIAL.

Fig. 7. L404F, L604A (lumper installed) used as a high limit, with an alarm circuit.



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 HIGH LIMIT L404A OR C BREAKS WHEN PRESSURE RISES TO SETPOINT.

3 LOW LIMIT L404B BREAKS WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

4 OPERATING CONTROLLER L404A BREAKS WHEN PRESSURE RISES TO SETPOINT, AND MAKES AGAIN WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

M8936

SETTING AND CHECKOUT

Setting

In all models, the differential is subtractive from the main scale set point. The upper operating point is determined by the main scale set point, while the lower operating point is determined by the main scale setting less the differential setting. The L404F and L604A (with jumper installed), L have spdt switching action. Operating points are shown in Fig. 10.

Fig. 9. L404F or L604 with jumper installed, controlling an M6184 motor.

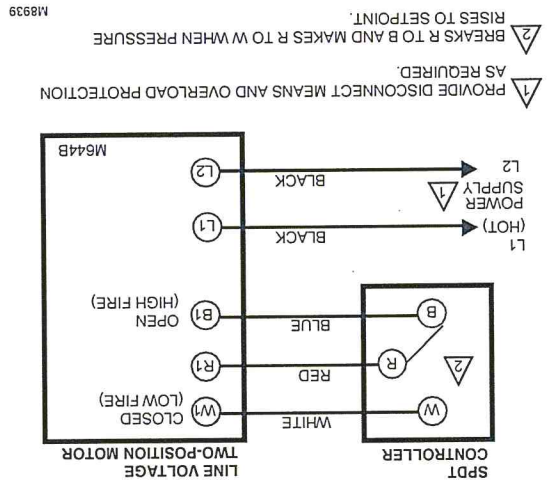
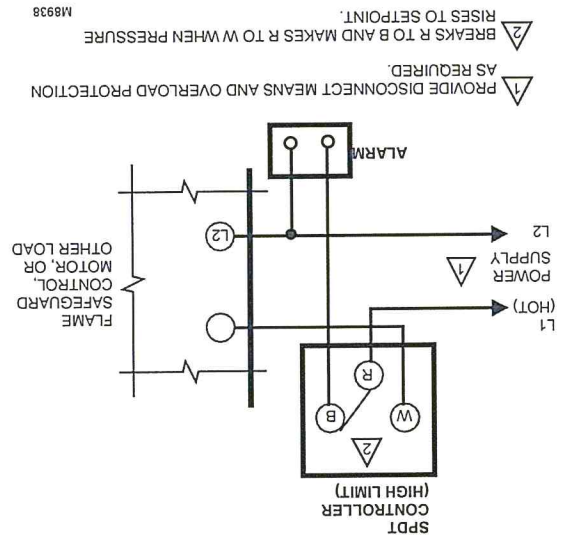
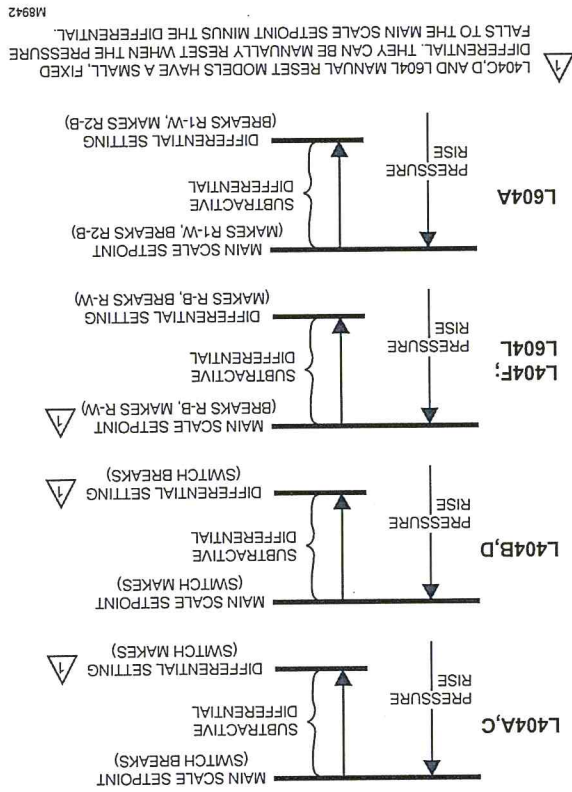


Fig. 8. L404F or L604A (with jumper installed) used as a low limit, with an alarm circuit.



Adjust the main scale set point for the desired operating pressure by turning the main scale adjusting screw (Fig. 11) on the top of the case until the main scale setting indicator is at the desired value. On an L404A, B, F with a 5 to 150 psi (.3 to 10.3 kg/cm² [34 to 1034 kPa]) operating range, or an L604A, adjust the differential setting by turning the differential adjusting screw (Fig. 11) until the differential setting indicator is at the desired value. L404C, D and L604L are manual reset models: see the next paragraph. The scaleplates are marked psi and kg/cm².

Fig. 10. L404 and L604 operating points.



Trip-Free Manual Reset Feature (L404C, D and L604L only)

The L404C breaks, the L404D makes, and the L604L makes R-V and breaks R-B when the pressure rises to the main scale setpoint. They will not automatically return to their former positions. To reset one of these controllers, wait until the pressure falls to the set point minus the differential (Fig. 10). Then depress the manual reset lever (Fig. 11) and release it. The controller will not be reset until you release the manual reset lever. This prevents the controller from becoming an automatic-reset device if the reset lever is stuck, held in, or tied down.

3. The L404A or C should break the control circuit(s) automatically when the boiler pressure gauge reading equals or slightly exceeds the controller setting.
4. The L404B or D should make the circuit under the same circumstances.
5. The L404F; L604L should make the R-W circuit and break the R-B circuit under the same circumstances.
6. The L604A should make the R1-W circuit and break the R2-B circuit under the same circumstances.
7. If the controller is operating properly, turn the main scale adjusting screw (Fig. 11) until the main scale setting indicator is at the desired set point.

If a Controller Seems to Operate Improperly

If the controller is suspected of operating improperly, it may be further checked as follows (Fig. 12):

1. Disconnect all power to the controller, loosen the cover screw, and remove the cover.
2. Disconnect the wires from the controller.
3. Connect an ohmmeter between the switch terminals.
4. Lower the set point of the controller (simulating a pressure increase) through a range greater than the differential. The switch should either make or break, depending on the model of the controller. (An L404A or L604L should break R-B and make R-W, and an L404F; C should break, an L404B or D should make, an L404F; L604L should break R-B and make R1-W.) If it makes, the ohmmeter reads zero; if it breaks, the ohmmeter reads infinity.
5. Raise the set point of the controller (simulating a pressure decrease) through a range greater than the differential. The switch should break or make, just the opposite of its action in step 4 (except for the L404C,D and L604L manual reset models).

NOTE: An approximation of the differential can be made by observing the change in set point required for a resistance change from zero to infinity.

6. If the controller operates improperly, replace it.
7. When the controller is operating properly, reconnect the wires to the terminal block, replace the cover and tighten the cover screw, and reconnect the power.



CAUTION

Equipment Damage Hazard.

Improper operation can damage the equipment.

Do not put the system into service until you have satisfactorily completed all applicable tests described in this Checkout section, in the Checkout section of the applicable instructions for the flame safeguard control, and any others required by the burner and boiler manufacturers.

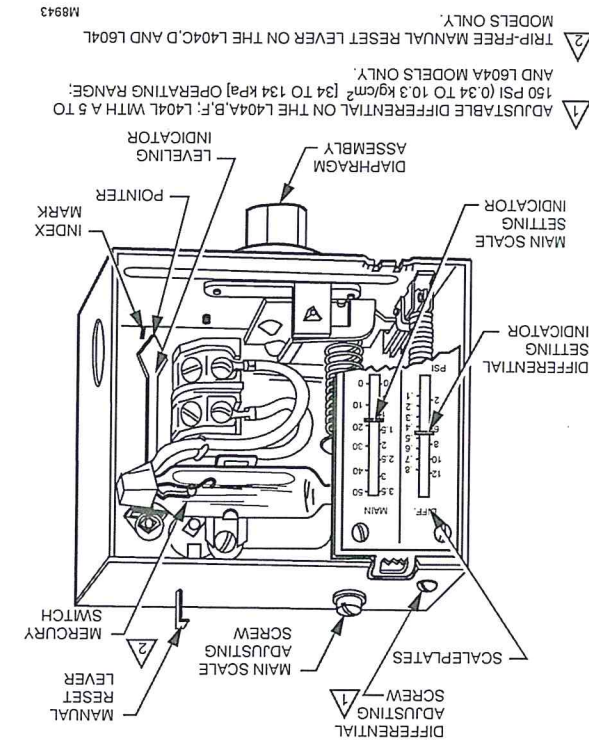


Fig. 11. Setting a Pressuretrol® Controller.

Checkout

After the controller has is installed, wired, and set, test it with the system in operation. First allow the system to stabilize. Then observe the operation of the controller while raising and lowering its setpoint. Pressure should increase when the setpoint is raised and decrease when the set point is lowered. Also check the make and break points of the controller. If they do not agree with a separate, accurately calibrated pressure gauge, a slight adjustment of the scaleplate(s) may be necessary.

Use accurate pressure testing equipment when checking out the controller. Do not rely on inexpensive gauges. The controllers are carefully calibrated at the factory.

Boiler Installation

If the controller is being used on a boiler installation, test it as follows:

1. Note the boiler pressure by checking the boiler pressure gauge. (To perform this test properly, the boiler should have a pressure reading near the middle of the controller's main scale range.)
2. Turn the main scale adjusting screw (Fig. 11) until the main scale setting indicator on the controller corresponds to the boiler pressure gauge reading.

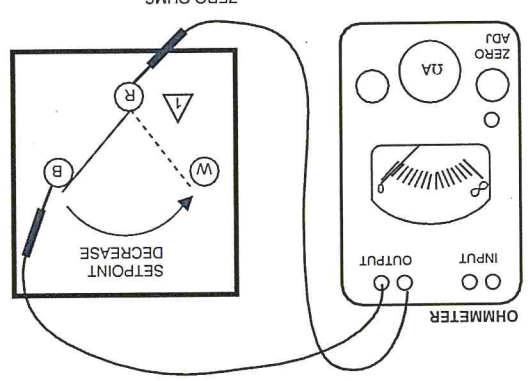
SERVICE INFORMATION

Calibration

The controller was carefully calibrated during manufacturing and should not require recalibration. Most calibration errors are caused by improper leveling. The controller should be level when the pointer on the leveling indicator is directly over the index mark (Fig. 11). In some cases, the leveling indicator may not be accurate enough. The pointer may be over the index mark, but the controller still may not be operating within the tolerance of its scale setting. In this case, carefully bend the steam trap (siphon loop) until the controller switches properly.

Maintenance

The cover of the controller should be in place at all times to protect the internal components from dirt, dust, and physical damage. Routine maintenance should consist of occasional inspection and blowing or brushing away any accumulated dirt and dust. To ensure proper functioning of the controller at all times, perform an operational check of the entire system during routine maintenance checks.



AN L604 IS SHOWN. AN L404F OPERATES SIMILARLY (SPDT SWITCHING). AN L404A, B, C OR D HAS ONLY TWO TERMINALS (SPST SWITCHING). DECREASED FAR ENOUGH.

M8944A

Fig. 12. Checking controller operation using an ohmmeter.

Honeywell

Automation and Control Solutions
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L91A,B,D Proportioning Pressuretrol® Controllers

PRODUCT DATA

FEATURES

- Models available for pressure systems up to 300 psi (2068 kPa).
- May be used with steam, air, noncombustible gases, or other fluids noncorrosive to brass or phos-bronze (300 psi model) bellows.
- When used with steam boilers, a steam trap (siphon loop) is recommended.
- Wiper on controller potentiometer moves in response to pressure changes.
- L91D has two potentiometers for unison control of two motors.
- L91B,D models have adjustable proportioning (throttling) range to allow selection of desired pressure control range.
- Adjustments made with screws on case top.
- Large, easily-read scaleplates in both U.S. customary (oz/sq. in., psi, or in. Hg) and metric (kPa, MPa, or mm Hg) units.
- Steel case with clear plastic cover to observe pressure settings and potentiometer action.
- Fitting with 1/4 -18 NPT threads allows rapid installation.
- Surface mount with screws through knockout holes in case back.

APPLICATION

L91 Proportioning Pressuretrol® Controllers are Series 90 Modulating Pressure Controllers that provide direct control of modulating motors or valves used on automatic burners or steam heating systems.



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SPECIFICATIONS

Table 1. Models available.

Operating Ranges ^a		Proportioning (Throttling) Range at Midscale				Maximum Surge Pressure	
Model	U.S. Customary Units	Metric Units	Part No. ^b	Adjustable	U.S. Customary Units	Metric Units	psi kPa
L91A	0 to 15 psi	0 to 103 kPa	23176CB	No	0.5 psi	3.4 kPa	25
	5 to 150 psi	0.03 to 1.03 MPa	23176CB	No	5 psi	0.03 MPa	225
	10 to 300 psi ^b	0.07 to 2.07 MPa	23176CB	No	12 psi	0.08 MPa	350
L91B	0 to 15 psi	0 to 103 kPa	23176CF	Yes	1.5 to 12 psi	10 to 83 kPa	25
	5 to 150 psi ^c	0.03 to 1.03 MPa	23176CB	Yes	5 to 23 psi	35 to 160 kPa	225
	10 to 300 psi ^c	0.07 to 2.07 MPa	23176CB	Yes	12 to 48 psi	85 to 330 kPa	350
	10 to 300 psi	0.07 to 2.07 MPa	23176CF	Yes	30 to 110 psi	0.21 to 0.76 MPa	350
	0 to 15 psi	0 to 103 kPa	23176CF	Yes	1.5 to 12 psi	10 to 83 kPa	25
	5 to 150 psi ^c	0.03 to 1.03 MPa	23176CF	Yes	13 to 52 psi	0.09 to 0.36 MPa	225
L91D	10 to 300 psi ^c	0.07 to 2.07 MPa	23176CF	Yes	30 to 110 psi	0.21 to 0.76 MPa	350
	0 to 150 psi ^c	0.03 to 1.03 MPa	23176CF	Yes	13 to 52 psi	0.09 to 0.36 MPa	225
	10 to 300 psi ^c	0.07 to 2.07 MPa	23176CF	Yes	30 to 110 psi	0.21 to 0.76 MPa	350

Adjustment Means: Screws on controller case top; knurled knob for main scale setting on 10 to 300 psi (0.07 to 2.07 MPa) models.

Setpoint: At low pressure end of proportioning (throttling) range.

Main Scaleplate: Marked in both U.S. customary (oz/sq. in. psi, or in. Hg) and metric (kPa, MPa, or mm Hg) units.

Proportioning Range Scaleplate (L91B,D only): Graded from A to F with a MIN (minimum) value below A. (See Table 2 for the value of each division.)

Mounting Means: Fitting on bellows has 1/4 - 18 NPT threads (external on 0 to 16 oz/sq. in., 0 to 4 psi, and 0 to 15 psi models; internal on all other models) for mounting on a pipe or steam trap (siphon loop).

NOTE: Some models are available with 1/4 - 19 BSP-TR internal threads; see Table 1.

Also can be surface mounted by screws through two knockout holes in case back.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care

1885 Douglas Drive North
Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Toronto, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Electrical Connections: Internal screw terminals. Hole inside of case for 1/2 in. conduit.

Dimensions: See Fig. 1; see Fig. 2 for mounting steam trap (siphon loop).

Weight: 1 lb, 15 oz (0.88 kg).

Finish: Gray.

Replacement Parts:

129178 Thermoplastic Cover.
23176CB Potentiometer: For all L91A models and a few L91B models (see Table 1); 140 ohms (nominal); length of active winding is 7/64 in. (2.8 mm).

Accessories:
50024585-001 Steam Trap (siphon loop): 1/4 in. brass pipe with 1/4 -18 NPT external threads on both ends.
14026 Steam Trap (siphon loop): 1/4 in. steel pipe with 1/4 -18 NPT external threads on both ends.
33312B Knurled Adjustment Knob: With setscrew; fits on main scale pressure adjusting screw.
4074BWJ Limit Stop Assembly: To limit setpoint ranges; includes 129564 Range Stop 107194 Range Stop Screw, and 23466 Wrench.

Table 2. Approximate value of each division (A to B, B to C, etc.) on proportioning (throttling) range scaleplate (L91B,D,F only)

Operating Range		Value of Each Division	
U.S. Customary Units		U.S. Customary Units	Metric Units
0 to 10 oz/sq in.	0 to 7 kPa	6.2 oz/ sq in.	2.7 kPa
0 to 15 psi	0 to 103 kPa	1.8 psi	12.4 kPa
5 to 150 psi (L91B)	0.03 to 1.03 MPa	7.8 psi	0.054 MPa
5 to 150 psi (L91D)	0.03 to 1.03 MPa	6.7 psi	0.046 MPa
10 to 300 psi (L91B with 7/64 in. potentiometer)	0.07 to 2.07 MPa	16.4 psi	0.113 MPa
10 to 300 psi (L91B,D with 1/4 in. potentiometer)	0.07 to 2.07 MPa	13.8 psi	0.095 MPa

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TABLE 1. DIMENSIONS OF DIMENSIONS A, B, AND C

OPTIONAL ACCESSORY FOR OTHER MODELS.

 PROPORTIONING RANGE ADJUSTING SCREW ON L918,D MODELS ONLY.

EXTERNAL THREADS ON 0 TO 15 PSI MODELS; INTERNAL THREADS ON ALL OTHER MODELS. SOME MODELS ARE ALSO AVAILABLE WITH 1/4-19 BSP-TR INTERNAL THREADS; SEE TABLE 1.



INSTALLATION

When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

WARNING

- Electrical Shock Hazard.**
- Can cause severe injury, death or property damage.
1. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.
 2. When using the controller with a compressor, install a dampening device (such as a needle valve, header, or surge tank) to dampen pulsations that can damage the controller or reduce its life.

IMPORTANT

1. Locate the controller where the ambient temperature will not exceed 150° F (66° C).
2. When the controller is used on a boiler, be sure to connect a steam trap (siphon loop) between the controller and the boiler.
3. Before installing controller, be sure the siphon loop has enough water in it to fill lower trap.
4. Use pipe compound sparingly to avoid clogging the hole in the pipe or bellows fitting.
5. Do not tighten the controller by hand by holding onto the case and turning it.

Location and Mounting

When used with steam boilers, always mount the controller above the water line in the boiler. A steam trap (siphon loop) must always be connected between the controller and the boiler (Fig. 2) to prevent boiler scale and corrosive vapors from attacking the bellows. Before installing controller, be sure the siphon loop has enough water in it to fill lower trap.

The controller can be mounted (1) beside the pressure gauge, (2) in a fitting on the boiler provided by the manufacturer, or (3) at a remote location in case of excessive vibration.

Make all pipe connections in accordance with approved standards. Use only a small amount of pipe compound to seal the connection joints. Excess pipe compound may clog the small hole in the fitting and prevent the controller from operating properly.

To avoid leaks and damage to the case, use a parallel jaw wrench on the controller fitting. Do not tighten the controller by hand by holding onto the case and turning it.

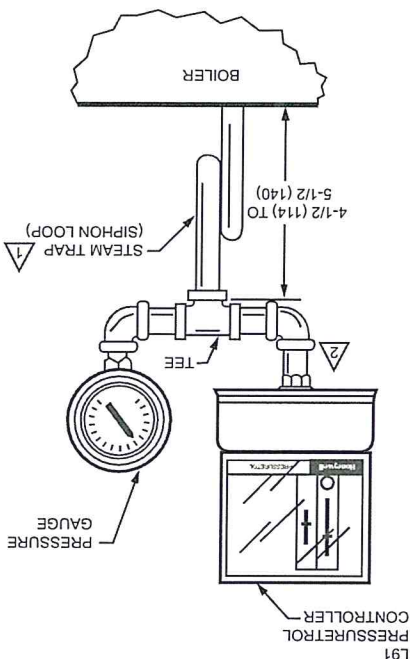


Fig. 2. Approximate dimensions in in. (mm) for mounting L91 Pressuretrol® Controller beside Pressure Gauge on Steam Trap (Siphon Loop).

Mounting Beside a Pressure Gauge

To mount the controller beside a pressure gauge (Fig. 2), remove the gauge. In its place, install a steam trap (siphon loop) with a tee on top. Using elbows and pipe nipples, mount the controller and pressure gauge on the ends of the tee.

Mounting on a Boiler

If it is not convenient to mount the controller beside the pressure gauge, install a steam trap (siphon loop) in the fitting provided by the boiler manufacturer. If there is no fitting, mount the steam trap at a location recommended by the boiler manufacturer. Screw the controller directly to the steam trap, if possible.

Mounting at a Remote Location

If there is excessive vibration at the boiler that may adversely affect the operation of the controller, mount the controller at a remote location. The piping must be properly pitched to drain all condensation back to the boiler. If this causes the controller to be located at an inconvenient height (on large boilers), it may be mounted at a lower level if the connecting piping is filled with clean water. A steam trap (siphon loop) must be mounted between the remote piping and the controller.

- Refer to Fig. 4 for typical hookup. W and B connections may be interchanged at the motor for reverse action (cooling). Follow the burner or boiler manufacturer's wiring diagram if provided. Also refer to the wiring diagrams in the motor instructions.
- Replace the front cover when wiring is completed.

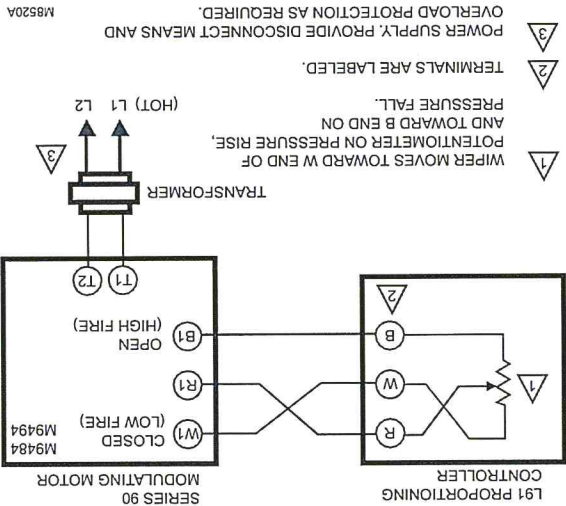


Fig. 4. Hookup of L91 Proportioning Pressuretrol®

Setting

In all models, the proportioning range (also called throttling range) extends above the main scale setpoint (Fig. 5). The proportioning range is fixed on L91A models, but is adjustable on L91B,D models. (For values, refer to Table 1 in the Specifications section.)

Main Scale Set Point (All models)

Adjust the main scale setpoint for the desired operating pressure by turning the main scale adjusting screw (Fig. 7) or knurled adjustment knob on 10 to 300 psi (0.07 to 2.07 MPa) models, on the top of the case, until the main scale setting indicator is at the minimum pressure desired. The proportioning range extends above this value. The scaleplate is marked in both customary (oz/sq in., psi, or in. Hg) and metric (kPa, MPa, or mm Hg) units.

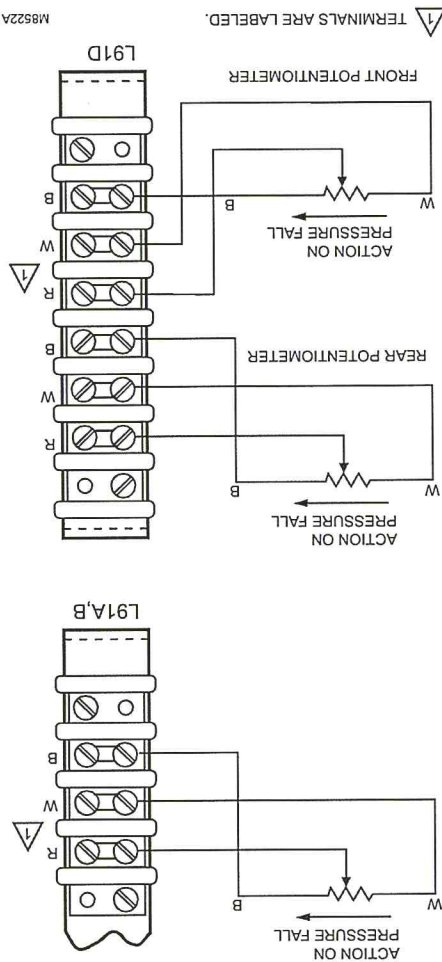
Use of L91 Proportioning Controller with Limit Controllers

The L91 main scale setpoint plus the value of the differential (proportioning range) must be less than or equal to the limit controller's (L404) main scale setpoint. For example, to control system pressure between 70 and 80 psi: select an L91B, 5-150 psi operating range, adjustable differential (proportioning, throttling range) of 5 to 23 psi and an L404A, 10-150 psi, adjustable differential of 8 to 16 psi. Set the L404A main scale setpoint at 80 psi and its adjustable differential at 10 psi. The L404A settings will then provide boiler pressure limit control between 70 and 80 psi. An L91B differential (proportioning range) pressure of 5 psi is desired. Therefore, an L91B main scale setpoint of between 70 and 75 psi is required (L91 main scale setpoint plus its differential must be less than or equal to the limit controller main scale set

WIRING

Fig. 3. L91 terminal blocks and internal schematics.

- Disconnect power supply before beginning installation to prevent electric shock and equipment damage. All wiring must comply with applicable electrical codes, ordinances, and regulations. Use NEC Class 1 (line voltage) wiring.
- For normal installation, use moisture-resistant No. 14 wire suitable for at least 167°F (75°C) if you are using the controller with a flame safeguard primary control, or at least 194°F (90°C) if you are using it with a program-ming control.
- For high temperature installations, use moisture-resistant No. 14 wire, selected for a temperature rating above the maximum operating temperature. Disconnect the power supply before beginning wiring to prevent electrical shock and equipment damage.
- All models have a terminal block inside the cover (Fig. 3) and two 7/8 in. (22.2 mm) holes in one side for 1/2 in. conduit, cable, or wires. Remove the front cover by loosening the screw at the bottom of the scaleplate.



The L91B settings provide system modulation between 70 and 75 psi or between 75 and 80 psi, depending on the exact setting of the L91B main scale setpoint. Due to device tolerances, the scaleplate settings are approximate and, therefore, the settings should be fine-tuned with the system operating.

Proportioning Range (L91B,D Only)

Adjust the proportioning range (throttling range) by turning the proportioning range adjusting screw (Fig. 6) on the top of the case until the proportioning range setting indicator is at the desired value. The proportioning range scale is graduated from A to F with a MIN (minimum) value below A. The value of each division depends on the operating range of the controller. Refer to Table 2 in the Specifications section.

Typical Operation

Pressure variations cause the bellows to expand or contract. Linkage between the bellows and the potentiometer wiper causes the wiper to move across the potentiometer windings. This varies the resistance between R and B, and between R and W, causing an unbalance in the circuit connected to the controller. See Fig 7.

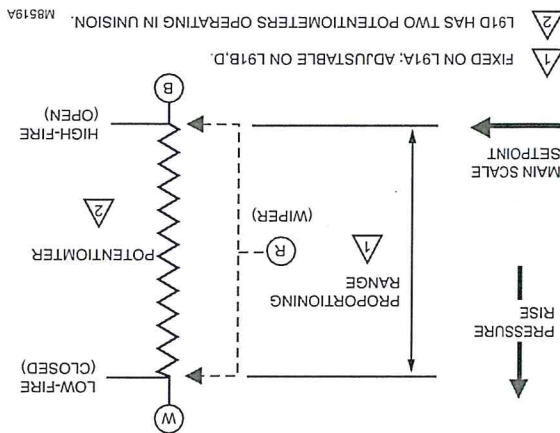


Fig. 5. L91A,B,D operating points.

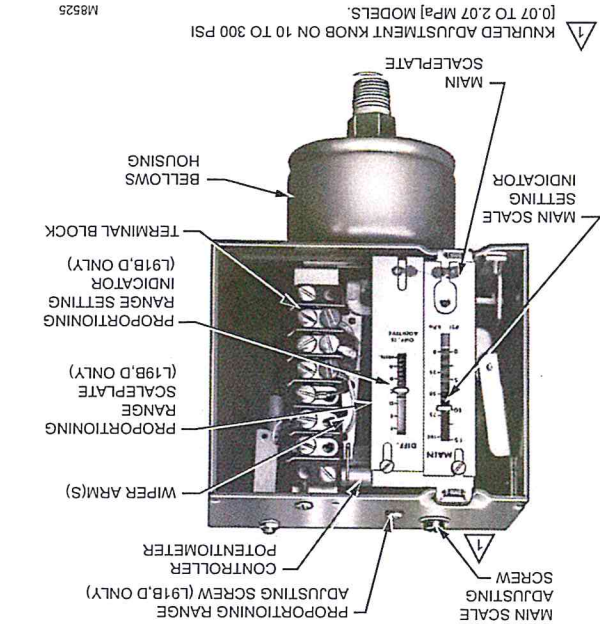


Fig. 6. Setting L91 Proportioning Pressuretrol® Controller.

A proportioning controller is used most often to regulate the firing rate of a burner by controlling a modulating motor (Fig. 4) or a modulating valve. The controller potentiometer, the feedback potentiometer in the motor (or in the valve actuator), and a balancing relay in the motor (or actuator) form an electric bridge circuit. As long as the pressure of the controlled medium remains at the setpoint of the controller, the circuit is balanced; that is, equal the relay contacts are open. When the circuit is balanced, the motor (or actuator) does not run. If the pressure of the medium rises, the wiper in the controller moves toward W. This unbalances the circuit, so a larger current flows through one side of the balancing relay. The close contacts in the relay make, causing the motor (or valve actuator) to drive toward its closed position. As the motor (or actuator) runs, the wiper on the feedback potentiometer moves in a direction to balance the circuit. When the circuit is again in balance, the balancing relay contacts open and the motor (or actuator) stops. The valves and dampers connected to the motor or actuator will be partially closed, decreasing the firing rate and reducing the pressure. Similarly, if the pressure of the controlled medium falls, the wiper on the controller potentiometer moves toward B, and the open contacts in the balancing relay make. The motor (or actuator) drives toward its open position until circuit balance is achieved. The valves and dampers will be opened wider and the firing rate will increase, thus increasing the pressure. A small change in the pressure of the controlled medium will cause a change in the firing rate to compensate for it, thus keeping the pressure constant. This process is called modulation.

CHECKOUT

After the controller is installed, wired, and set, it should be tested with the system in operation. First, allow the system to stabilize. Then, observe the operation of the controller while raising and lowering its setpoint. Pressure should increase when the setpoint is raised and decrease when the setpoint is lowered. Use accurate pressure testing equipment when checking out the controller. Do not rely on inexpensive gauges. The controllers are carefully calibrated at the factory.

Make sure the modulating motor or modulating valve actuator reaches the low- and high-fire positions at the proper points. If the motor or actuator runs in the proper direction when the setpoint is adjusted, assume that the controller is operating properly. If it runs in the wrong direction, reverse the B and W wires. Observe the action of the motor or actuator until it stabilizes. If the motor or valve is moving constantly, widen the proportioning range (not adjustable on an L91A) incrementally until the system is stable.

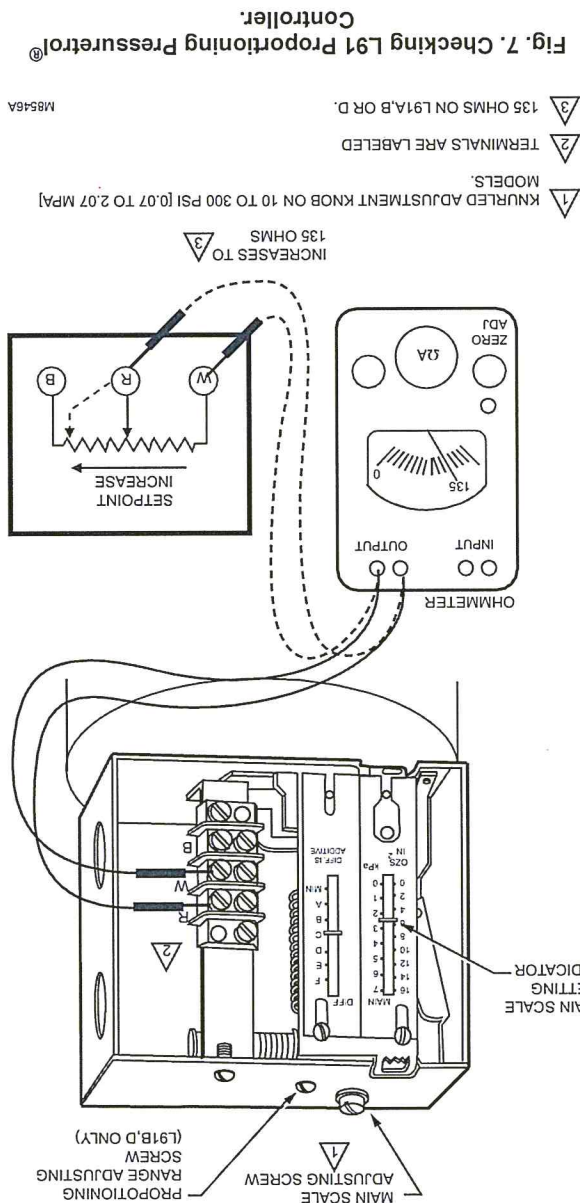
If a Controller Seems to Operate Improperly

If the controller is suspected of operating improperly, it may be further checked by:

1. Leaving the controller installed where it is, but disconnecting all power to the controller or valve.
2. Loosening the cover screw below the main scaleplate and removing the cover.
3. Disconnecting the wires from the controller.
4. Connecting an ohmmeter between controller terminals B and W to measure the resistance for the potentiometer in the controller. The ohmmeter should read about 135 ohms for an L91A,B, or D.
5. Connecting the ohmmeter between controller terminals W and R (Fig. 8) and raising the setpoint of the controller above the actual pressure being measured. The ohmmeter should read the full value of the potentiometer measured in step 4 (135 ohms for an L91A,B, or D).
6. Slowly lowering the setpoint of the controller while observing the ohmmeter reading. The resistance should drop to zero at some setpoint below the actual pressure. Making an approximation of the proportioning range by observing the change in setpoint required for a resistance change from zero to full value.
8. When the controller is operating properly, reconnecting the wires, replacing the cover, tightening the cover screw, and resetting the controller to the desired value.
9. Reconnecting power to the controlled motor or valve.

CAUTION

Equipment Damage Hazard.
Failure to follow checkout instructions can damage components or systems.
Do not put the system into service until you have satisfactorily completed all applicable tests described in this Checkout section, all tests in the Checkout section of the applicable instructions, all tests for the flame safeguard control, and any tests required by the burner and boiler manufacturers.



SERVICE INFORMATION

CAUTION



Electrical Shock Hazard

1. Only qualified service technicians should attempt to service or repair flame safeguard controls and burner systems.
2. Disconnect power supply before cleaning the potentiometer windings or wiper, or before replacing the controller potentiometer.

Calibration

All controllers are carefully tested and calibrated at the factory under controlled conditions. If the actual operating pressure does not match the setpoint, move the main scaleplate slightly up or down until the setpoint agrees with the actual pressure.

Maintenance

Keep the cover of the controller in place at all times to protect the internal components from dirt, dust, and physical damage. Perform routine maintenance occasionally by inspecting and blowing or brushing away any accumulated dirt and dust. To assure proper functioning of the controller at all times, perform an operational check of the entire system during routine maintenance checks. Be sure to handle controllers carefully at the time of installation, during actual use, and during maintenance.

Cleaning the Potentiometer Windings or Wiper

Occasionally, the windings or wiper on the potentiometer (two on the L91D) may need cleaning. Disconnect the power supply before removing the cover from the controller and before cleaning the potentiometer.

IMPORTANT

1. Use an electrical contact cleaner that does not contain solvents.
2. Use extreme care to avoid bending the wiper arm, changing the wiper tension and damaging the potentiometer windings.
3. Do not use an abrasion or burnishing tool to clean the potentiometer windings or wiper.
4. Do not use hard paper, such as a business card, or abrasive materials (sandpaper, emery boards, file, etc.) to clean the windings or wiper.

Solvent-type electrical contact cleaners can deteriorate plastic components and wire insulation and leave an oily residue that accumulates particulate matter (dust, etc.). The residue can break down to form various carbonaceous substances that cause early potentiometer failure.

Use of abrasive materials results in wearing of the potentiometer windings and accumulation of particulate matter that changes the resistance between the windings and the wiper.

Replacing the Controller Potentiometer (Fig. 8-10)

IMPORTANT:

1. Replace the controller potentiometer only when necessary. The controller potentiometer will decrease the life of the new potentiometer.
2. When replacing the potentiometer, be very careful not to bend or damage the wiper arm, and not to change the wiper tension. Any damage or change in tension will decrease the life of the new potentiometer.

1. Disconnect all power to the controller.
2. Loosen the cover screw below the main scaleplate and remove the cover.
3. Mark the wires to the external device (motor or valve actuator) and disconnect them from the terminal block.
4. Remove the screw holding the terminal block bracket to the top of the case (Fig. 8). Put this screw in a safe place because it will be needed later.
5. While careful not to damage the potentiometer wiper or bracket, remove any of the internal wiring, lift out the terminal block and before removing any potentiometer wires, carefully note and record (sketch) the position (off-center) of the active winding on the potentiometer and the location and connections of all wiring terminals. The new potentiometer must be inserted and connected the same.

Example: In Fig. 9, the active winding is on the left half of the potentiometer; the wire from the left end of the winding is connected to the (W) terminal on the terminal block, and the wire from the right end of the winding is connected to the (B) terminal on the terminal block.

7. Loosen the (W) and (B) screws on the terminal block, and remove the two wires to the active winding of the potentiometer. Leave the wire to the wiper arm intact.
8. Carefully unscrew the bolt that holds the potentiometer to the bracket. Make sure the potentiometer wires do not entangle with the wiper and bend it.
9. Carefully slide the old potentiometer off the bolt.
10. Make sure that:
 - a. The off-center position of the winding on the new potentiometer is the same as the old potentiometer. (Consult sketch in step 6.)
 - b. The wiper will contact bare wires. (Rotate the potentiometer on the bolts so the surface of the winding where the brown enamel was removed is toward you.)

11. Screw the bolt into the potentiometer bracket. Make sure the wiper is contacting bare wires (step 10.b); then tighten the bolt.
12. Connect the two potentiometer wires to the (W) and (B) terminals on the terminal block and tighten the screws. Make sure these wires are connected to the same terminals as in the old potentiometer. (Consult sketch in step 6.)

13. Carefully fit the hole in the bottom of the terminal block bracket over the screw protruding upward from the bottom of the case (Fig. 10). Insert the screw (removed in step 4) through the hole in the top of the case (Fig. 8) and into the top of the bracket, and tighten it.
14. Reconnect the wires from the external device (motor or actuator) to the terminal block.
15. Replace the cover and tighten the cover screw.
16. Reconnect power to the controller.

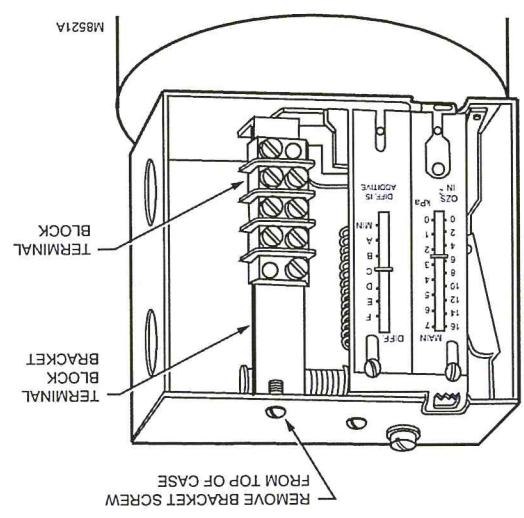


Fig. 8. Removing terminal block bracket.

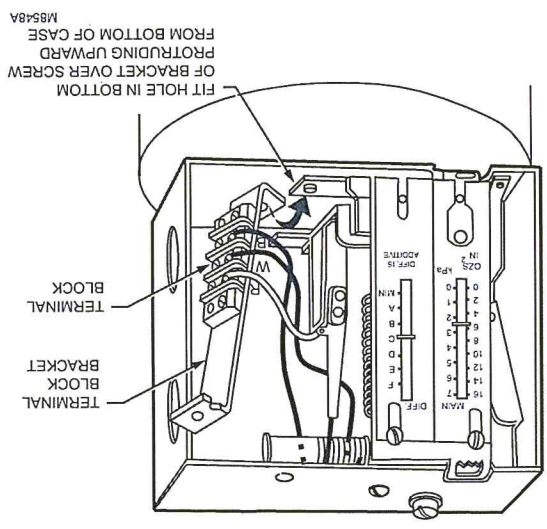


Fig. 10. Replacing terminal block bracket.

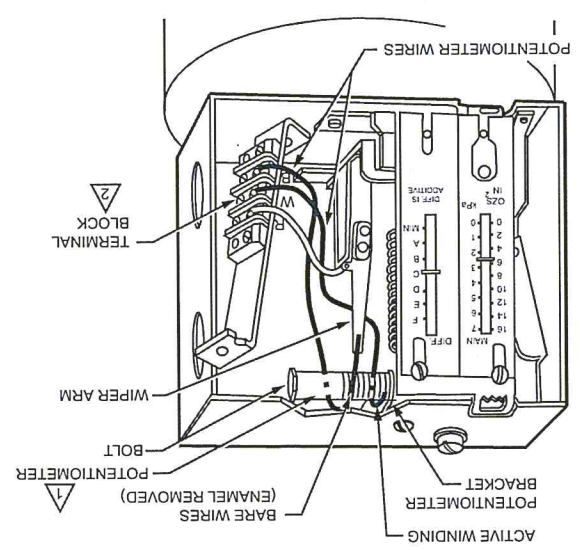


Fig. 9. Replacing potentiometer in L91.

1 THE POTENTIOMETER IN AN L91A IS MOUNTED AT A 45 DEGREE ANGLE INSTEAD OF HORIZONTALLY. AN L91D HAS TWO POTENTIOMETERS.

2 TERMINALS ARE LABELED.



KUNKLE SERIES 6000 SAFETY VALVES SAFETY AND RELIEF PRODUCTS

Bronze safety valves to ASME section I and VIII, steam, 'V' and 'UV'; section VIII, air/gas, 'UV'. PED certified for non-hazardous gas including models to ASME section IV, steam 'HV'. PED certified for non-hazardous gas

- O-ring seats available for exceptional leak-free performance, reduced maintenance cost, multiple cycles with tight shutoff and improved sealing integrity.
- Heavy duty casting.
- Wide hex on valve nozzle provides clearance for easy installation.
- Seats lapped to optical flatness.
- Dual control rings offer easy adjustability for precise opening with minimum pre-open or simmer and exact blowdown control.
- Pivot between disc and spring corrects misalignment and compensates for spring side thrust.
- Grooved piston type disc reduces sliding area and friction.
- Heavy duty lift lever assembly.
- Each valve tested and inspected for pressure setting and leakage.

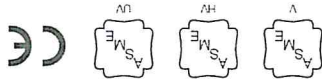


GENERAL APPLICATION

These valves are suitable for use on steam boilers and generators, reciprocating or rotary, portable or stationary air/gas compressors, intercoolers and aftercoolers. Also for pressure vessels containing steam, air or non-hazardous gas and on pressure reducing stations.

TECHNICAL DATA

Connections: Threaded NPT
Temperature Range: -60° to 425°F (-51° to 219°C)
Pressure Range: 3 to 300 psig (0.2 to 20.7 barg)
Code: ASME I, IV, VIII and PED



NOTE

1. See page 2 for more temperature and pressure range information.

KUNKLE SERIES 6000 SAFETY VALVES
SAFETY AND RELIEF PRODUCTS

MODELS OVERVIEW

Model 6010:	Side outlet. Full nozzle design with bronze/brass trim. Available with O-ring seats.
Model 6021:	As model 6010 with Teflon® (PFA) disc insert (use on steam only).
Model 6030:	As model 6010 except stainless steel (SS) trim (nozzle and disc). Available with O-ring seats.
Model 6182:	Top outlet. Full nozzle design with bronze/brass trim. O-ring seat available.
Model 6121:	As model 6182 with Teflon® (PFA) disc insert (use on steam only).
Model 6130:	As model 6182 except SS trim (nozzle and disc). Available with O-ring seats.
Model 6186:	Top outlet. Full nozzle design with bronze/brass trim. 150 psig (10.3 barg) maximum set pressure. Replaces Model 86 (original equipment only). For air service only.
Model 6283:	Over-sized side outlet. Full nozzle design bronze/brass trim.
Model 6221:	As model 6283 with Teflon® (PFA) disc insert (use on steam only).
Model 6230:	As model 6283 except SS trim (nozzle and disc).
Model 6933:	As model 6010 except certified for ASME code Section IV. Low pressure steam heating boilers set at 15 psig (1.0 barg) only.
Model 6934:	As model 6021 except certified for ASME code Section IV. Low pressure steam heating boilers set at 15 psig (1.0 barg) only.
Model 6935:	As model 6030 except certified for ASME code Section IV. Low pressure steam heating boilers set at 15 psig (1.0 barg) only.

PRESSURE AND TEMPERATURE LIMITS¹

Models 6010, 6021, 6182, 6121, 6283, 6221	Steam Service: 3 to 250 psig (0.2 to 17.2 barg) -60° to 406°F (-51° to 208°C)
	Air/Gas Service: 3 to 300 psig (0.2 to 20.7 barg) -60° to 406°F (-51° to 208°C)
Models 6030, 6130, 6230	Steam and air/gas Service: 3 to 300 psig (0.2 to 20.7 barg) -60° to 425°F (-51° to 218°C)

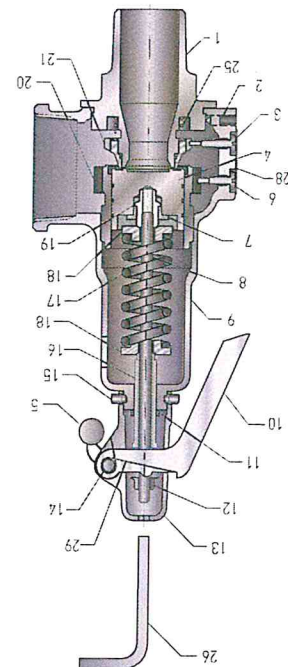
SPECIFICATIONS

SERVICE RECOMMENDATIONS FOR SERIES 6000 RESILIENT SEAT/SEAL MATERIALS

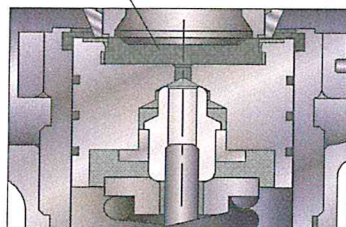
Seal/Seat Materials	Service Recommendation
Viton® A (FKM) [-15 to 406°F [-26 to 208°C]]	Air and Gas
Ethylene propylene [-60 to 425°F [-51 to 218°C]]	Steam
Teflon® (PFA) [-60 to 406°F [-51 to 208°C]]	Steam

- NOTE**
1. Resilient seats determine temperature range [see Specifications section].
 2. Viton® and Teflon® are registered trademarks of E.I. du Pont de Nemours and Company.

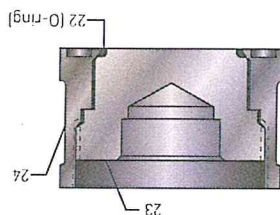
Parts and Materials



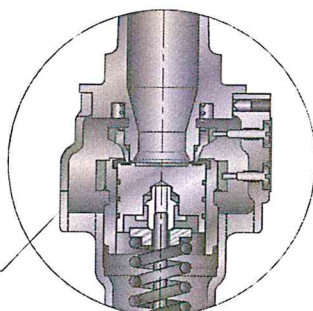
MODELS 6010, 6030, 6283, 6230, 6933, 6935



MODELS 6021, 6121, 6221, 6934
Teflon® (PFA) seat configuration



MODELS 6010, 6030, 6182,
6130, 6186, 6283, 6230
Optional soft seat



MODELS 6182, 6121, 6130, 6186
Top outlet configuration

PARTS AND MATERIALS

No.	Part name	Materials
1	Nozzle	BRS B283-C48500 or BRZ SB62 ¹
2	Body set screw	STL A108 Black oxide
3	Warm ring set screw	SS 18-8
4	Disc	BRS B21 C48500 ¹
5	Wire and seal	SS wire and lead seal
6	Guide set screw	SS 18-8
7	Retainer nut ²	BRS B16
8	Stem	SS A582-303 for D orifice SS A582-416 for E thru J orifice
9	Body	BRZ B584-C84400
10	Lever	STL A109 or JIS SPC equivalent/ZN plated yellow
11	Compression screw locknut	BRS B16
12	Lift nut	STL A108-1018/ZN plated
13	Cap	Aluminum, anodized
14	Lever pin	STL A108-12L14
15	Cap set screw ¹⁰	STL A108 Black oxide
16	Compression screw	BRS B16
17	Spring	ASTM A-313 TY 631
18	Spring step	BRS B16
19	Stem end ¹²	BRS B16
20	Guide	BRS B283-C37700
21	Warm ring ⁷	BRS B283-C37700
22	Seat	Note 1
23	Seat retainer ⁵	BRS B16 ⁵
24	Soft seat disc ³	BRS B21 C48500 ¹
25	Warm ring spring ⁶	SS A313-302/316
26	Gag screw ⁷	STL A108-1018/ZN plated
27 ¹¹	Pop rivet	Aluminum
28	Namplate	Aluminum
29 ¹	Vibration damper spring	PH BRZ B159-C51000

- NOTES**
1. Models 6021, 6121, 6221 and 6934 Teflon® (PFA), optional O-ring seat available for all others
 2. Section IV only.
 3. Models 6030, 6130, 6230 and 6935 are
 4. Models 6030, 6130, 6230 and 6935 are
 5. Models 6030, 6130 and 6230 are SS SA479-304.
 6. Variation 02 (vibration dampening) only.
 7. Soft seat 'D', 'E' and 'F' orifice require special warm ring (notch on O.D. of fins).
 8. Applies only to soft seat options.
 9. Applies only to gag options. Remove when valve is in service. Failure to remove gag screw may cause serious damage to equipment; personal injury and death.
 10. Rotated 90° for clarity.
 11. Not shown on assembly.
 12. Soft seat 'D' orifice requires special stem end (no hex).

KUNKLE SERIES 6000 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

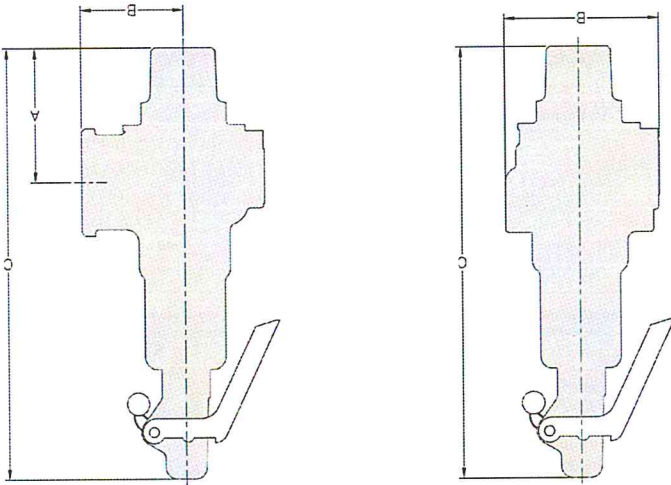
SPECIFICATIONS

Model Number ¹	Office	Connections ANSI Standard		Valve Dimensions, inch (mm)			C	lb	kg
		Inlet	Outlet	A	B				
60**DC#	D	1/2 (12.7)	3/4 (19.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[0.7]
60**DD#	D	3/4 (19.0)	1 (25.4)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[0.8]
61**DC#	D	1/2 (12.7)	3/4 (19.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[0.6]
60**ED#	E	3/4 (19.0)	1 (25.4)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.1]
60**EE#	E	3/4 (19.0)	1 (25.4)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.2]
61**ED#	E	3/4 (19.0)	1 (25.4)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.0]
62**ED#	E	3/4 (19.0)	1 (25.4)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.2]
60**FE#	F	1 (25.4)	1 1/4 (31.8)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.6]
60**FF#	F	1 (25.4)	1 1/4 (31.8)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.7]
61**FE#	F	1 (25.4)	1 1/4 (31.8)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.5]
62**FE#	F	1 (25.4)	1 1/4 (31.8)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[1.7]
60**GF#	G	1 1/4 (31.8)	1 1/2 (38.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[2.5]
60**GG#	G	1 1/4 (31.8)	1 1/2 (38.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[2.6]
61**GF#	G	1 1/4 (31.8)	1 1/2 (38.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[2.3]
62**GF#	G	1 1/4 (31.8)	1 1/2 (38.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[2.5]
60**HG#	H	1 1/2 (38.0)	2 (51.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[3.5]
60**HH#	H	1 1/2 (38.0)	2 (51.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[3.6]
61**HG#	H	1 1/2 (38.0)	2 (51.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[3.3]
62**HG#	H	1 1/2 (38.0)	2 (51.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[3.6]
60**JH#	J	2 (51.0)	2 1/2 (64.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[7.0]
60**JJ#	J	2 (51.0)	2 1/2 (64.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[7.2]
61**JH#	J	2 (51.0)	2 1/2 (64.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[6.8]
62**JH#	J	2 (51.0)	2 1/2 (64.0)	2 1/2 (54)	1 1/2 (41)	6 1/2 (165)		1 1/2	[7.0]

Dimensions are for reference only.

NOTES

1. Replace asterisks with desired model number.
2. Replace # with desired seat material.
3. Model 6030 and 6935 available only 1/2 x 3/4".
4. [12.7 x 19 mm], 3/4 x 1" [19 x 25.4 mm], 1 x 1 1/4" [25.4 x 31.8 mm], 1 1/4 x 1 1/2" [31.8 x 38 mm], 1 1/2 x 2" [38 x 51 mm] and 2 x 2 1/2" [51 x 64 mm].
5. Models 6933, 6934 and 6935 have same dimensions as model 6010.
6. 2 1/2" for BSP [57].
7. 3 1/2" for BSP [192.5].



KUNKLE SERIES 6000 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

Capacities

NON-CODE¹ AND ASME SECTION VIII AIR (SCFM) Flow Coefficient = 0.878

Set Pressure (psig)	D (0.121)	E (0.216)	F (0.336)	G (0.554)	H (0.863)	J (1.414)
------------------------	--------------	--------------	--------------	--------------	--------------	--------------

3	28	50	77	127	198	325
4	32	57	89	146	228	374
6	39	70	108	178	278	456
8	45	80	124	205	319	523
10	50	89	138	228	355	582
15	64	114	177	292	454	744
20	73	131	204	336	524	858
25	83	148	231	381	593	972
30	93	166	258	425	663	1086
35	104	185	288	474	739	1211
40	114	204	317	523	815	1336
45	125	223	347	572	892	1461
50	136	242	377	621	968	1586
55	146	261	407	671	1045	1711
60	157	281	436	720	1121	1837
65	168	300	466	769	1197	1962
70	179	319	496	818	1274	2087
75	189	338	526	867	1350	2212
80	200	357	555	916	1426	2337
85	211	376	585	965	1503	2462
90	221	395	615	1014	1579	2588
95	232	414	645	1063	1656	2713
100	243	434	674	1112	1732	2838
105	254	453	704	1161	1808	2963
110	264	472	734	1210	1885	3088
115	275	491	764	1259	1961	3213
120	286	510	793	1308	2038	3339
125	296	529	823	1357	2114	3464
130	307	548	853	1406	2190	3589
135	318	567	883	1455	2267	3714
140	329	586	912	1504	2343	3839
145	339	606	942	1553	2420	3964
150	350	625	972	1602	2496	4090
160	371	663	1031	1700	2649	4340
170	393	701	1091	1798	2802	4590
180	414	739	1150	1897	2954	4841
190	436	778	1210	1995	3107	5091
200	457	816	1269	2093	3260	5341
210	478	854	1329	2191	3413	5592
220	500	892	1388	2289	3566	5842
230	521	931	1448	2387	3718	6092
240	543	969	1507	2485	3871	6343
250	564	1007	1567	2583	4024	6593
260	586	1045	1626	2681	4177	6843
270	607	1084	1686	2779	4329	7094
280	628	1122	1745	2877	4482	7344
290	650	1160	1805	2975	4635	7594
300	671	1198	1864	3074	4788	7845

NOTE

1. No code stamp or 'NB' on nameplate below 15 psig set.

KUNKLE SERIES 6000 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

Capacities - Metric Units

NON-CODE¹ AND ASME SECTION VIII AIR (Nm³/h) Flow Coefficient = 0.878

Set Pressure (barg)	D (0.781)	E (1.394)	F (2.168)	G (3.574)	H (5.67)	J (9.123)
0.2	44	78	121	199	311	509
0.3	53	95	148	243	379	621
0.4	61	109	170	280	436	715
0.6	74	133	206	340	530	869
1.0	95	169	263	433	675	1106
1.5	123	219	340	561	874	1433
2.0	145	259	403	664	1035	1696
2.5	170	303	471	777	1210	1982
3.0	195	347	540	890	1386	2272
3.5	219	391	609	1004	1563	2562
4.0	244	436	678	1117	1740	2851
4.5	269	480	746	1231	1917	3141
5.0	294	524	815	1344	2094	3431
5.5	319	569	884	1458	2270	3721
6.0	343	613	953	1571	2447	4010
6.5	368	657	1022	1685	2624	4300
7.0	393	701	1091	1798	2801	4590
7.5	418	746	1160	1912	2978	4880
8.0	443	790	1228	2025	3154	5169
8.5	467	834	1297	2139	3331	5459
9.0	492	878	1366	2252	3508	5749
9.5	517	923	1435	2366	3685	6039
10.0	542	967	1504	2479	3862	6328
10.5	567	1011	1573	2593	4038	6618
11.0	591	1056	1642	2706	4215	6908
11.5	616	1100	1710	2820	4392	7197
12.0	641	1144	1779	2933	4569	7487
12.5	666	1188	1848	3047	4746	7777
13.0	691	1233	1917	3160	4922	8067
13.5	715	1277	1986	3274	5099	8356
14.0	740	1321	2055	3387	5276	8646
14.5	765	1365	2124	3501	5453	8936
15.0	790	1410	2192	3614	5630	9226
16.0	839	1498	2330	3841	5983	9805
17.0	889	1587	2468	4068	6337	10385
18.0	939	1675	2605	4295	6690	10964
19.0	988	1764	2743	4522	7044	11543
20.0	1038	1852	2881	4749	7398	12123

NOTE

1. No code stamp or 'NB' on nameplate below 1.0 barg set.

KUNKLE SERIES 6000 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

Capacities

NON-CODED AND ASME SECTION VIII STEAM (lb/h) Flow Coefficient = 0.878

Orifice Area, in ²					
Set Pressure (psig)	D (0.121)	E (0.216)	F (0.336)	G (0.554)	H (0.863)
J (1.414)					

3	87	155	242	398	621	1017
4	100	178	277	457	711	1166
6	121	215	335	552	860	1409
8	137	245	382	629	980	1606
10	152	271	422	695	1083	1775
15	179	319	497	819	1276	2091
20	206	368	573	944	1471	2410
25	234	417	649	1070	1666	2730
30	261	466	725	1195	1861	3050
35	291	520	808	1333	2076	3401
40	321	573	892	1470	2291	3753
45	351	627	975	1608	2505	4105
50	381	681	1059	1746	2720	4456
55	411	734	1143	1884	2934	4808
60	442	788	1226	2022	3149	5160
65	472	842	1310	2159	3364	5511
70	502	896	1393	2297	3578	5863
75	532	949	1477	2435	3793	6215
80	562	1003	1560	2573	4008	6566
85	592	1057	1644	2710	4222	6918
90	622	1110	1727	2848	4437	7270
95	652	1164	1811	2986	4651	7621
100	682	1218	1895	3124	4866	7973
105	712	1272	1978	3262	5081	8325
110	742	1325	2062	3399	5295	8676
115	773	1379	2145	3537	5510	9028
120	803	1433	2229	3675	5725	9380
125	833	1487	2312	3813	5939	9731
130	863	1540	2396	3950	6154	10083
135	893	1594	2479	4088	6368	10434
140	923	1648	2563	4226	6583	10786
145	953	1701	2647	4364	6798	11138
150	983	1755	2730	4502	7012	11489
160	1043	1863	2897	4777	7442	12193
170	1104	1970	3064	5053	7871	12896
180	1164	2077	3232	5328	8300	13599
190	1224	2185	3399	5604	8729	14303
200	1284	2292	3566	5879	9159	15006
210	1344	2400	3733	6155	9588	15709
220	1404	2507	3900	6430	10017	16413
230	1465	2615	4067	6706	10446	17116
240	1525	2722	4234	6981	10876	17819
250	1585	2829	4401	7257	11305	18523
260	1645	2937	4569	7533	11734	19226
270	1705	3044	4736	7808	12163	19929
280	1766	3152	4903	8084	12592	20632
290	1826	3259	5070	8359	13022	21336
300	1886	3367	5237	8635	13451	22039

NOTE

1. No code stamp or 'NB' on nameplate below 15 psig set.

KUNKLE SERIES 6000 SAFETY VALVES
SAFETY AND RELIEF PRODUCTS

Capacities - Metric Units

NON-CODE¹ AND ASME SECTION VIII STEAM (kg/h) Flow Coefficient = 0.878

Set Pressure [barg]	Orifice Area, cm ²			
	D	E	F	G
	(0.781)	(1.394)	(2.168)	(5.574)
				(9.123)

0.2	39	69	108	177	276	453
0.3	47	84	131	215	335	549
0.4	54	96	149	246	383	628
0.6	65	115	180	296	461	756
1.0	81	144	224	370	576	944
1.5	98	175	272	448	698	1144
2.0	116	207	322	530	826	1354
2.5	135	242	376	620	966	1582
3.0	155	277	431	711	1107	1814
3.5	175	312	486	801	1248	2045
4.0	195	348	541	892	1389	2276
4.5	215	383	596	982	1530	2508
5.0	234	419	651	1073	1671	2739
5.5	254	454	706	1164	1812	2970
6.0	274	489	761	1254	1954	3201
6.5	294	525	816	1345	2095	3433
7.0	314	560	871	1436	2236	3664
7.5	333	595	926	1526	2377	3895
8.0	353	631	981	1617	2518	4127
8.5	373	666	1036	1707	2659	4358
9.0	393	701	1091	1798	2800	4589
9.5	413	737	1146	1888	2942	4820
10.0	432	772	1201	1979	3083	5052
10.5	452	807	1255	2070	3224	5283
11.0	472	843	1310	2160	3365	5514
11.5	492	878	1365	2251	3506	5746
12.0	512	913	1420	2341	3647	5977
12.5	531	949	1475	2432	3788	6208
13.0	551	984	1530	2523	3929	6439
13.5	571	1019	1585	2613	4071	6671
14.0	591	1055	1640	2704	4212	6902
14.5	611	1090	1695	2795	4353	7133
15.0	630	1125	1750	2885	4494	7365
16.0	670	1196	1860	3066	4776	7827
17.0	710	1267	1970	3248	5059	8290
18.0	749	1337	2080	3429	5341	8752
19.0	789	1408	2190	3610	5623	9215
20.0	828	1479	2300	3791	5905	9678

NOTE

1. No code stamp or 'NB' on nameplate below 1.1 barg set.

KUNKLE SERIES 6000 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

Capacities

ASME SECTION I STEAM (lb/h) Flow Coefficient = 0.878

Set Pressure (psig)	D (0.121)	E (0.216)	F (0.336)	G (0.554)	H (0.863)	J (1.414)
15	173	310	482	794	1237	2027
20	201	356	558	919	1432	2346
25	228	407	634	1045	1627	2666
30	256	456	710	1170	1822	2986
35	283	505	785	1295	2017	3306
40	310	554	861	1420	2213	3625
45	338	603	937	1546	2408	3945
50	365	651	1013	1671	2603	4265
55	392	700	1089	1796	2798	4584
60	420	749	1165	1921	2993	4904
65	447	798	1241	2047	3188	5224
70	475	848	1319	2174	3383	5550
75	503	898	1397	2303	3588	5879
80	531	948	1475	2432	3789	6208
85	559	999	1553	2561	3990	6538
90	588	1049	1632	2690	4191	6867
95	616	1099	1710	2819	4392	7196
100	644	1150	1788	2948	4593	7525
105	672	1200	1866	3077	4794	7855
110	700	1250	1945	3206	4995	8184
115	728	1300	2023	3335	5196	8513
120	757	1351	2101	3464	5397	8842
125	785	1401	2179	3593	5598	9172
130	813	1451	2258	3722	5799	9501
135	841	1502	2336	3851	6000	9830
140	869	1552	2414	3980	6201	10160
145	898	1602	2492	4109	6402	10489
150	926	1653	2571	4238	6603	10818
160	982	1753	2727	4497	7004	11477
170	1038	1854	2884	4755	7406	12135
180	1095	1954	3040	5013	7808	12794
190	1151	2055	3197	5271	8210	13452
200	1208	2156	3353	5529	8612	14111
210	1264	2256	3510	5787	9014	14769
220	1320	2357	3666	6045	9416	15428
230	1377	2457	3823	6303	9818	16087
240	1433	2558	3979	6561	10220	16745
250	1489	2659	4136	6819	10622	17404
260	1546	2759	4292	7077	11024	18062
270	1602	2860	4448	7335	11426	18721
280	1658	2960	4605	7593	11828	19379
290	1715	3061	4761	7851	12230	20038
300	1771	3162	4918	8109	12632	20696

KUNKLE SERIES 6000 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

Capacities - Metric Units

ASME SECTION I STEAM (kg/h) Flow Coefficient = 0.878

Set Pressure (bar)	D	E	F	G	H	J
(0.781)	(1.394)	(2.168)	(3.574)	(5.567)	(9.123)	

Orifice Area, cm ²	D	E	F	G	H	J
95	170	265	437	680	1115	1535
113	202	315	519	809	1325	1746
131	235	365	601	937	1535	1956
149	267	415	684	1065	1746	2166
167	299	465	766	1193	1956	2376
185	331	515	849	1322	2166	2592
203	363	565	931	1450	2376	2808
222	396	616	1015	1581	2592	3025
240	429	667	1100	1714	2808	3241
259	462	719	1185	1846	3025	3458
277	495	770	1270	1978	3241	3675
296	528	822	1355	2110	3458	3891
315	561	873	1440	2242	3675	4108
333	595	925	1524	2374	3891	4324
352	628	976	1609	2507	4108	4541
370	661	1028	1694	2639	4324	4757
389	694	1079	1779	2771	4541	4974
407	727	1131	1864	2903	4757	5191
426	760	1182	1949	3035	4974	5407
444	793	1233	2033	3167	5191	5624
463	826	1285	2118	3300	5407	5840
481	859	1336	2203	3432	5624	6057
500	892	1388	2288	3564	5840	6273
519	925	1439	2373	3696	6057	6490
537	959	1491	2458	3828	6273	6707
556	992	1542	2542	3960	6490	6923
574	1025	1594	2627	4092	6707	7140
593	1058	1645	2712	4225	6923	7356
611	1091	1697	2797	4357	7140	7573
630	1124	1748	2882	4489	7356	7789
648	1157	1800	2967	4621	7573	8009
667	1190	1851	3052	4753	7789	8223
686	1223	1902	3137	4885	8009	8437
704	1256	1954	3221	5018	8223	8656
723	1289	2005	3305	5150	8437	8870
741	1323	2057	3391	5282	8656	9089
778	1389	2160	3561	5546	9089	

Capacities

ASME SECTION IV STEAM, LB/H (kg/h) - Models 6933, 6934 and 6935

Set Pressure (psig (bar))	D	E	F	G	H	J
0.121 (0.781)	0.216 (1.394)	0.336 (2.168)	0.554 (3.574)	0.863 (5.567)	1.414 (9.123)	

KUNKLE PRESSURE RELIEF VALVES

Installation and Operating Instructions

Pre-Installation Handling

This pressure relief valve is designed to protect equipment from overpressure. The valve should be handled with care, not subjected to heavy shock loads, and protected to prevent contamination from getting inside. It should be installed correctly per A.S.M.E. Boiler & Pressure Vessel Code requirements. Failure to do so could result in property damage or serious injury to personnel. When hoisting the valve into position for installation, care should be exercised so that lifting straps do not contact the valve lift lever.

Installation

Always wear proper safety equipment, including safety glasses and ear protection.

1. Mount the valve in a vertical position so that the valve body is self-draining. If a body drain port is provided, make sure it is open when required by the ASME code. Do not plug any bonnet vent openings. The inlet piping should be as short as possible, with no elbows, and equal to or greater than the size of the pressure relief valve inlet connection. This will help to limit the inlet pressure drop to 3% or less when the valve is relieving.

2. When discharge piping is connected to valve outlet, make sure it is self draining if a body drain port is not used. The valve should not be connected to any discharge pipe that contains pressure before the valve opens or to any pipe where the pressure build-up is greater than 10% of the set pressure when the valve is open and relieving.

Discharge piping, other than a short tailpipe, must be supported. For steam service, a drip pan elbow or flexible connection between the valve and the pipe should be used to prevent excessive pipe stress, due to thermal expansion, from being imposed on the valve body.

3. For threaded valves, to prevent sealing compound from entering and damaging the valve, apply a small amount of pipe thread sealing compound to external threads only. Do not put any sealing compound on the first thread or on any internal threads. To do so may cause the sealing compound to enter the valve and cause seat leakage.
- Do not use the valve body or bonnet for installing the valve in threaded connections. Use the wrench flats provided to tighten the valve to the connecting pipe, and do not overtighten. To do so may cause valve leakage.

4. For flanged valves, use new gaskets and tighten the mounting studs evenly.

Operation

1. Maintain a system operating pressure at least 5 psig or 10% below the set pressure of the valve, whichever is greater. Operating too close to the valve set pressure will cause seat leakage and will shorten the time between valve maintenance.
2. Do not use the safety valve as a control valve to regulate system operating pressure. Excessive operation will cause the seat to leak and will require more frequent valve maintenance.

3. ASME Section I and VIII valves equipped with lift levers are designed to be operated only when the system pressure is 75% of set pressure or greater. ASME Section IV valves may be operated at any set pressure. When hand operating the valve, hold it open long enough to purge any foreign matter from the seat area. If a cable or wire is attached to the lift lever for remote actuation, make sure the direction of pull is the same as it would be if the lever were pulled directly by hand.

Maintenance

Maintenance should be performed on a regular basis. An initial inspection interval of 12 months is recommended. Depending on the service conditions and the condition of the valve, the inspection interval may be decreased or increased. Use only Kunkle parts for repair. Depending on the local jurisdictional requirements where the valve is installed, repairs may have to be made by a repair facility holding a VR stamp.

WARNING!

Removal of the seal wires or any attempt to adjust, repair or modify this product by non-authorized persons voids the product guarantee and may cause serious damage to equipment, personal injury, and death. Kunkle Valve is not liable for any damage resulting from misuse or misapplication of its products.

Kunkle Valve Division

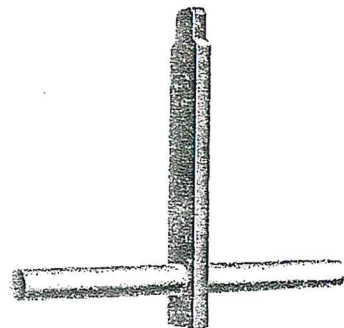
953 Old US 70, Black Mountain, NC 28711

Fax: 828-669-4017

Rev B 01/14/2002

Phone: 828-669-5515

Y BLOW-DOWN VALVES



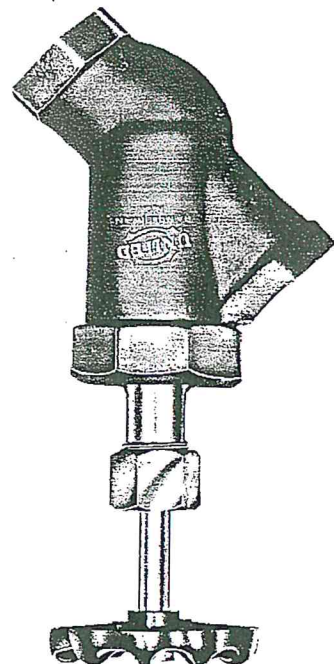
No. 225N

Seat Ring Wrench



No. 225J

Seat Ring



225UT

For Replacement Discs See Page 43

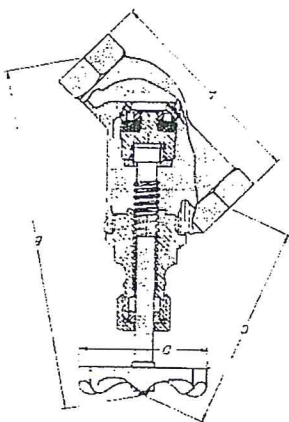
Resemble gate valves in their ability to permit maximum flow and globe valves in their ability to attain tight closure. These combined qualities make this valve unequal for blowing off boilers. Because of their construction, they can withstand the frequent opening and closing necessary for this application. The valve is built with a renewable seat made of cast bronze. The No. 24T Teflon* disc can be replaced without moving the valve from the line.

200 lbs. WSP
400 lbs. WOG
500 lbs. Hydrostatic Testing
Screwed Ends — Rising Stem
Replaceable Teflon* Disc
Removable Bronze Seat Ring
Screwed Bonnet
Ventilated Aluminum Alloy Hand Wheel
Body Material: Bronze Conforming to
ASTM B62

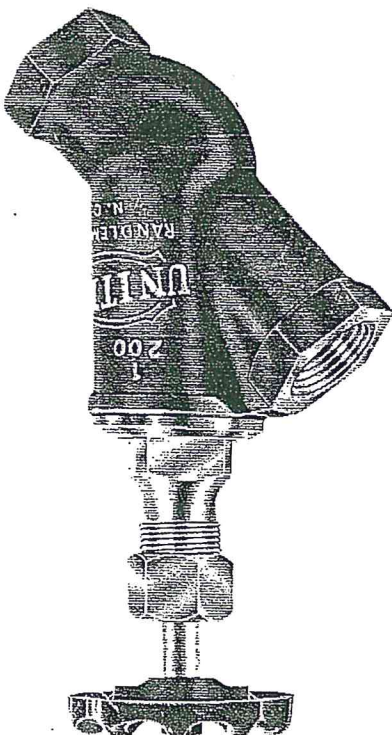
Size	A	B	C	D	Ship Wt. (lbs.)	Quan. Per Ctn.
3/4"	4 17/32"	8 3/16"	5 1/16"	2 25/32"	2.63	6
1"	5 3/16"	9 13/16"	6 1/4"	2 15/16"	4.20	4
1 1/4"	5 15/16"	11 1/2"	7 3/8"	3 15/32"	5.88	4
1 1/2"	6 13/16"	12 5/16"	8 1/8"	3 23/64"	8.37	2
2"	8 3/16"	15 5/16"	9 15/16"	4 1/2"	13.75	1

Used where state codes require a union bonnet boiler "Y" type blow down valve or where a heavy duty blow down valve is required.

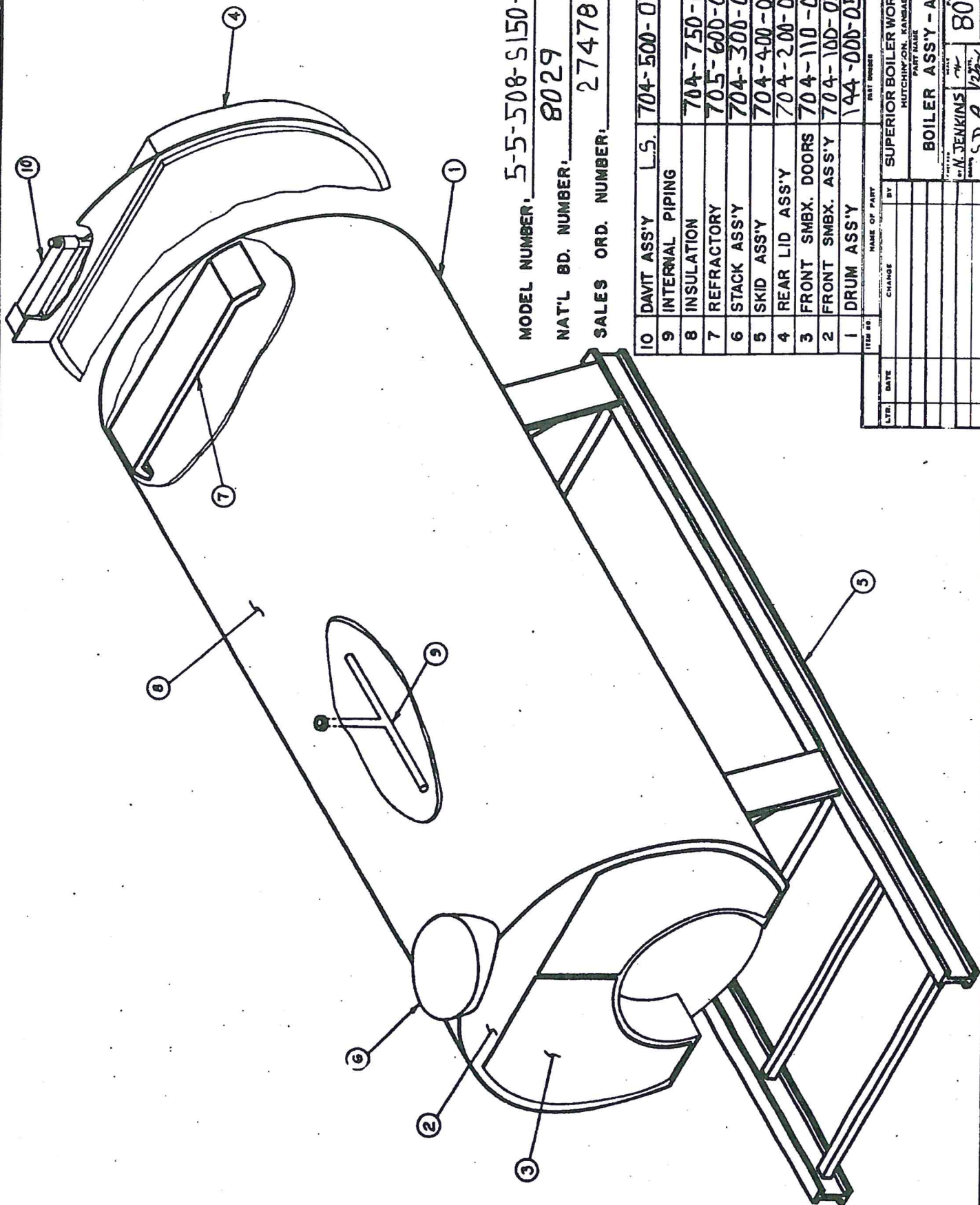
200 lbs. WSP
400 lbs. WOG
500 lbs. Hydrostatic Testing
Screwed Ends — Rising Stem
Replaceable No. 24T Teflon* Disc
Replaceable Bronze Seat Ring
Union Bonnet
Ventilated Aluminum Alloy
Hand Wheel
Body Material: Bronze Conforming to
ASTM B62



225T







MODEL NUMBER: 5-5-508-5150-1C

NAT'L BD. NUMBER: 8029

SALES ORD. NUMBER: 27478

10	DAVIT ASS'Y	L.S.	704-500-035
9	INTERNAL PIPING		
8	INSULATION		704-750-035
7	REFRACTORY		705-600-050
6	STACK ASS'Y		704-300-035
5	SKID ASS'Y		704-400-050
4	REAR LID ASS'Y		704-200-035
3	FRONT SMBX. DOORS		704-110-035
2	FRONT SMBX. ASS'Y		704-100-035
1	DRUM ASS'Y		144-000-050

DATE	BY	CHANGE	NAME OF PART	DATE ORDER
			SUPERIOR BOILER WORKS, INC.	
			MITCHAM, KANSAS	
			PART NAME	
			BOILER ASSY - AZTEC	
			BY	
			N. JENKINS	
			SDA	
			8029	

Rev. A

BOILER SPECIFICATION SHEET

DATE RECEIVED: 12-14-77

JOB NAME: Sun Chemical

SHIPPING DATE (WK. OF): 2-6-78

PAGE 1 OF 2

REPRESENTATIVE: Royle

P.O. #

SALES ORDER NO. 27478

NAT'L BOARD NO. 8029

SOLD TO:

P.O. #

SERIAL NO.

SHIP TO: Boyle Services

701 West 41st Street

Tulsa, Oklahoma 74107

SHIPPING INST.

CALL _____ AT

A.C. _____ HRS. BEFORE DELIVERY

DATE RELEASED:

REVISIONS			
REV.	DATE	BY	REVISION OR CHANGE
A	2-16-78	DeWB	Change 2nd gas val to K3
B			
C			
D			

MANUALS: REQ'D 5 MAILED _____ ON _____ BY _____

SUBMITTAL: _____ SETS REQ'D ON _____ CERTIFIED ☐BOILER R & D ☐ W.D. ☐ S.W.D. ☐

SUBMITTAL#

MAILED _____ ON _____ BY _____

MODEL NO. 5-5-508 + S150-1C

DESIGN PRESSURE 150 PSI STEAM ☒ WATER ☐ HI-TEMP WATER ☐

PER SECTION I ASME BOILER/P.V. CODE

STEAM NOZZLE: STD. ☒ SPL. ☐WATER SUPPLY: STD. ☐ SPL. ☐RETURN: STD. ☐ SPL. ☐SAFETY VALVE CONNECTIONS SIZES: STD. ☒ SPL. ☐

() ()

() ()

SKINNER COUPLING: STD. ☐ SPL. ☐CONTINUOUS BLOWDOWN COUPLING: STD. ☐ SPL. ☐W/DIP TUBE ☐W/INTERNAL PIPING ☐SPECIAL CONNECTIONS: T.C. ☐ R.S. ☐ B.C. ☐ L.S. ☐ 45° ☐

() ()

() ()

TUBES: ROLLED ☐ ROLLED/FLARED ☐ ROLLED/BEADED ☒ ROLLED/WELDED ☐ROLLED/BEADED W/SEAL WELD ☐OTHER ☐

BOILER

NAME PLATE Aztec PAINT Blue

HTG. SURFACE 508 SQ. FT. OUTPUT 3347 M.B.

OPERATING PRESS. _____ PSI OPERATING TEMP. _____ °F

SKID: STD. ☒ SPL. ☐STACK CONNECTION: STD. ☒ SPL. ☐ 16"DAMPER W/LOCKING QUAD. ☐ W/BEARINGS ☐ MOTORIZED ☐HINGE ☐ DAVIT ☒ SWING: RIGHT SIDE ☐ LEFT SIDE ☒OBSERVATION PORT: STD. ☐ MOVEABLE ☒ FRONT ☐ REAR ☐EXPLOSION DOORS: ☐ FRONT ☐ REAR ☐ SPL. ☐INSULATION: STD. ☒ FIBERGLASS ☐ OTHER ☐JACKET: STD. ☒ WEATHERPROOF ☐ OTHER ☐WALKWAY: STD. ☐ SPL. ☐HANDHOLES: STD. ☒ SPL. ☐MANWAY: STD. ☒ SPL. ☐

BURNER MOUNT: I.C. M2G 42

BURNER FACTORY MOUNTED ☒ FIELD MOUNTED ☐

BURNER MOTOR VOLTAGE 220-60-3 HP 2

BOILER TRAIN

CONTROL CIRCUIT: S.W.D. _____ VOLTAGE 115-60-1

CONDUIT: STD. ☒ LIQUID TIGHT ☐ RIGID ☐ WEATHERPROOF (SYSTEM) ☐L.W.C.O.: RS ☐ LS ☒ W/GAUGE GLASS - TRI-COCKS ☐AUX. L.W.C.O.: RS ☐ LS ☒ 101004 W/3E1B4 holder (M)WATER COLUMN: RS ☐ LS ☐ W/GAUGE GLASS - TRI-COCKS ☐ ()WATER FEEDER: RS ☐ LS ☐ ()OPERATING CONTROL GROUP: RS ☐ LS ☒ RANGE

GAUGE: 6" M.A. shallown 0-300# (M)

W/GAUGE COCK ☒ W/TEST COCK ☒

OPERATING CONTROL 2704A 1396 10-150# (M)

LIMIT CONTROL: 2704C 1162 10-150# (M)

NIGHT LIMIT W/SWITCH: ()

()

()

()

FIRING RATE CONTROL 2704A 1052 5-150# (M)

STACK THERMOMETER: _____ STEM LGTH _____ ()

ALARM ISOLATING RELAY ☐BOILER TO MEET THE FOLLOWING CODE(S) ☐☐FACTORY FIRETEST ☒ W/REPORT ☒ ASME SHORT FORM ☐FACTORY START-UP ☐ W/ _____ DAY(S) SUPERVISION

COMPLETED BY: _____ DATE

SALES: _____ 12-14-77 (L) SHIPPED LOOSE

SCHEDULING: _____ 12-21-77 (M) SHIPPED MOUNTED

ENG: _____ 12-22-77 (P) PREPARED/SHIPPED LOOSE

PURCH: _____ 12-14-77

COPIES FOR: ENG. ☐ SALES DEPT. ☐ QUALITY CONTROL ☐ PLANT MGR. ☐SCHD. ☐PURCHASING ☐FINAL ASSY. ☐STOCK ROOM ☐BOILER: STOCK (PRINTS IN SHOP) ☐HYDROSTATIC TEST ☐

SAFETY VALVE(S): MFG. Kunkle (L)

(L) Fig 6000 SIZE 1x1/4 SET @ 150 PSI

(L) Fig 6000 SIZE 1x1/2 SET @ 150 PSI

() SIZE SET @ PSI

BOILER FEED VALVES: RS ☐ LS ☐ ()

GATE _____ SIZE _____

CHECK _____ SIZE _____

AUTOMATIC: ELEC. ☐ OTHER ☐ MOD ☐ 2 POS ☐BOILER BLOWDOWN VALVE(S): RS ☐ LS ☐ FRONT ☐ REAR ☐ ()

() SIZE _____

() SIZE _____

WATER COLUMN BLOWDOWN VALVE(S): RS ☐ LS ☒ RS ☐ (M)

(L) 4B4# 225 SIZE 1" (M)

CONTINUOUS BLOWDOWN VALVE(S): RS ☐ LS ☐ ()

_____ SIZE _____

INJECTOR: RS ☐ LS ☐ SIZE _____ ()

W/ () GATE VALVES _____ SIZE _____ ()

CHECK VALVE _____ SIZE _____ ()

SPECIAL INSTRUCTIONS: _____

TURBULATORS: Full - 2 1/2 DIA. DIVERS _____ LGTH. _____

SPRAY PAINT: _____ CAN(S) FLUE BRUSH: _____ DIA. _____

BOILER SPECIFICATION SHEET

DATE RECEIVED: _____

JOB NAME: _____

REPRESENTATIVE: _____ P.O. # _____

SOLD TO: _____ P.O. # _____

SHIP TO: _____

SHIPPING INST.: _____

CALL _____ AT _____

A.C. _____ HRS. BEFORE DELIVERY

DATE RELEASED: _____

PAGE 2 OF 2

SHIPPING DATE (WK. OF) March

SALES ORDER NO. 27478

REVISIONS			
REV.	DATE	BY	REVISION OR CHANGE
A			
B			
C			
D			

MANUALS: REQ'D _____ MAILED _____ ON _____ BY _____

SUBMITTAL: _____ SETS REQ'D ON _____ CERTIFIED _____

BURNER ☐ GAS PIPING DIAG. ☐ OIL PIPING DIAG. ☐ COMPONENT LIST ☐

SUBMITTAL: _____

MAILED _____ ON _____ BY _____

COMBUSTION - EQUIPMENT

BOILER-BURNER W.D.: _____

GAS PIPING DIAG.: _____

AVAILABLE GAS PRESS.: 1 # PSI ALTITUDE _____ FT.

MFG.: 1. C. MODEL: MHG-42 SERIAL NO. _____

FUEL(S): Gas - #2 oil OPERATION(S): Modulation

FIRING RATE: 4200 CFH OIL 30 GPH

FLAME SAFEGUARD CONTROL: 5022 Fireye (L)

SERIAL NO.: _____

FLAME DETECTOR: GAS ☐ OIL ☐ GAS-OIL ☒ - 48 PT2

GAS PILOT: _____

PILOT GAS PRESSURE REGULATOR: RV52 SIZE 1/2"

PILOT SHUT-OFF COCK: Brass SIZE _____

PILOT SOLENOID VALVE: K3R SIZE 1/2"

PILOT SAFETY SOLENOID VALVE: _____ SIZE _____

PILOT N.O. VENT. VALVE: _____ SIZE _____

PILOT GAS PRESSURE GAUGE: _____ SIZE _____

LEAK TEST COCK: _____ SIZE _____

MAIN SHUT-OFF COCK: hub plug cock SIZE 2" (M)

GAS STRAINER: _____ SIZE _____

MAIN GAS PRESSURE REGULATOR: RV110 SIZE 2" (M)

SPRING RANGE: _____ ORIFICE SIZE _____

AUTOMATIC GAS VALVE: V4055 SIZE 2" (M)

SAFETY GAS VALVE: K3 SIZE 2" (M)

N.O. VENT VALVE: Asco SIZE _____

FIRING RATE VALVE: Eclipse SIZE 2"

FIRING COCK: hub plug cock SIZE 2"

LOW GAS PRESSURE SWITCH: LGP RANGE _____ "W.C. (M)

HIGH GAS PRESSURE SWITCH: HGP RANGE _____ "W.C. (M)

GAS PRESSURE GAUGE (1): Fig 83 RANGE 0-10 "W.C.

AIR FLOW SWITCH ☒ Cleveland AIR PRESSURE SWITCH ☐

LOW DRAFT SWITCH: _____

FIRING RATE MOTOR: HI-LO ☐ MOD ☒ M934P

LOW FIRE INTERLOCK: INCH

CONTROL PANEL: HI-LO ☒ BURNER ☒ BOILER ☐ REMOTE ☐

DEAD FRONT PANEL ☐ DRAFT GAUGE ☐ D.C. VOLTMETER ☐

POWER ON SWITCH ☐ FUEL CHANGE-OVER SWITCH ☒

MANUAL FIRING RATE CONTROL: 1. C.

INDICATING LIGHTS 4 STD. ☒ OIL TIGHT ☐

POWER ON ☒

MAIN FUEL ☒ HIGH GAS PRESS. ☐

CALL FOR HEAT ☐ LOW GAS PRESS. ☐

IGNITION ON ☒

FLAME FAILURE ☒

LOW WATER ☐

CONTROL SYSTEM NO.: _____

OIL PIPING DIAG.: _____

BURNER W.D.: _____

BLOWER MOTOR VOLTAGE: 220-60-34 H.P. 2

STARTER AH SIZE 0 HEATER INCL

OIL PUMP MOTOR VOLTAGE: 220-60-34 H.P. 1/2

STARTER 44 SIZE 00 HEATER INCL

OIL METERING PUMP MOTOR VOLTAGE: _____ H.P. _____

STARTER _____ SIZE _____ HEATER _____

AIR COMPRESSOR MOTOR STARTER VOLTAGE: _____ H.P. _____

STARTER _____ SIZE _____ HEATER _____

OIL PUMP: INTEGRAL ☒ Webster

REMOTE ☐

OIL STRAINER: Integral SIZE _____

OIL FILTER: _____ SIZE _____

BY-PASS OIL RELIEF VALVE: _____ SIZE _____

PRESSURE _____ PSI

MAIN OIL VALVE: K10 SIZE 3/8"

SAFETY OIL VALVE: _____ SIZE _____

BY-PASS OIL SOLENOID VALVE: _____ SIZE _____

3 WAY OIL VALVE: _____ SIZE _____

LOW FIRE OIL VALVE: _____ SIZE _____

HIGH FIRE OIL VALVE: _____ SIZE _____

OIL METERING VALVE: 1. C. SIZE _____

OIL PRESSURE SWITCH: HI ☐ LOW ☒ L4040 1353 RANGE 20-300

OIL PRESSURE GAUGE (1): Fig 23 RANGE 0-300

OIL TEMPERATURE SWITCH: _____ RANGE _____

OIL TEMPERATURE GAUGE () _____ RANGE _____

OIL HEATER: (INTEGRAL ELEC.) _____ VOLTAGE _____

GAS IGNITION TRANSFORMER: 1. C. 6000

OIL IGNITION TRANSFORMER: _____

CONTROL-CIRCUIT-STEP DOWN TRANSFORMER: 1 C 220-115

AUTO-MANUAL FAN SWITCH: ☐

ALARMS REQ'D TO SOUND ALARM:

FLAME FAILURE ☒ HIGH GAS PRESS ☐

LOW WATER ☐ LOW GAS PRESS ☐

LOW DRAFT ☐ LOW WATER PRESS ☐

ALARM: BELL ☒ 4" HORN ☐ REMOTE ☐

W/SILENCING SWITCH ☐ W/MOMENTARY CONTACT SILENCING SWITCH ☐

BURNER TO MEET THE FOLLOWING CODES: UL ☐ FIA ☒ FM ☐

SPECIAL INSTRUCTIONS: _____

COMPLETED BY: _____ DATE _____

SALES: JER 12-14-77

SCHEDULING: AW 12-21-77

ENG: DBE 12-22-77

PURCH: 3072 12-16-77

(L) SHIPPED LOOSE

(M) SHIPPED MOUNTED

(P) PREPARED/SHIPPED LOOSE

BURNER ORDERED 12-14-77 P.O. # 13249 BURNER IN STOCK

FORM NO. 251-30.2 9-8-71 P.1

FORM P-2 MANUFACTURERS' DATA REPORT FOR ALL TYPES OF BOILERS EXCEPT WATERTUBE
As Required by the Provisions of the ASME Code Rules

1. Manufactured by SUPERIOR BOILER WORKS, INC. HUTCHINSON, KANSAS
(Name and address of manufacturer)

2. Manufactured for STOCK
(Name and address of purchaser)

3. Location of Installation _____
(Name and address)

4. Type S.M. Boiler No. 8029 8029 8029 Year Built 1978
(HRT, etc.) (Mfr's Serial No.) (CRN) (Drawing No.) (Nat'l. Board No.)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section I, 1977 and Addenda to Winter 1977
(Year) (Date)

Remarks: Manufacturers' Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report: _____
(Name of part, item number, mfr's name and identifying stamp)

6. Boiler Shells or Drums: No. 1 Dia. 60" Length 121½" Dia. _____ Length _____

7. Shell Plates ARM & USS SA515-70 .384" .398"
(For each Shell or Drum state: Material Specification No. & grade, nominal thickness)

8. Longitudinal Joint(s) Welded Joint Efficiency 90%
(Seamless, Welded) (As compared to Seamless)

9. Heads BTH SA285C .709" .710" Both Flat
(Material Specification No.; Thickness—Flat, Dished, Ellipsoidal—Radius of Dish)

10. Girth Joint(s) Welded No. of Shell Courses 2
(Seamless, Welded)

11. Tube Sheet _____ Tube Holes _____
(Mat'l Spec., Grade, Thickness) (Dia.)

12. Boiler Tubes: No. 72 SA178-A Straight
(Mat'l. Spec., Grade) (Straight or Bent)

Dia. 2½" Length 122" Gauge 12
(If various, give max. & min.) (or thickness)

13. Furnace No. 1 Size 24" O.D. Length, each section _____ Total 121½"
(O.D. or W x H)

Type Corrugated
(Plain, Adamson, Ring Reinforced, Corrugated, Combined or Stayed)

ARM SA285C .340" Seams: Type Welded
(Mat'l Spec., Grade, Thickness) (Seamless, Welded)

14. Staybolts: No. _____ Size _____
(Diam., Mat'l. Spec. Grade Size Telltale, Net Area)

Pitch _____ Max. AWP _____ psi.
(Hor. and Vert.)

15. Stays or Braces

Location	Material Spec. No.	Type	No. & Size	Max. Pitch	Total Net Area	Fig. PFT-32 L/1	Dist. Tubes to Shell	Area to be Stayed	Max. A.W.P. psi.
(a) F.H. above tubes					None Required				
(b) R.H. above tubes									
(c) F.H. below tubes									
(d) R.H. below tubes									
(e) Through stays									
(f) Dome braces									

16. Other Parts. 1. _____ 2. _____ 3. _____
(Brief Description—i.e. Dome, Boiler Piping, etc.)

1. _____
2. _____
3. _____
(Mat'l. Spec., Grade, Size, Material Thickness, Max. AWP)

Form P-2 (Back)

17. Openings: (a) Steam 1-1/4" Flange (No., Size, and Type) (b) Safety Valve 1-1/4", 1-1/2" Threaded coup. (No., Size, and Type)
 (c) Blowoff 1-1/2" Threaded coup. Shell (No., Size, Type, and Location) (d) Feed 2-1/2" Threaded coup. Shell (No., Size, Type, and Location)
 (e) Manholes: No. 1 Size 11"x15" Location Shell
 (f) Handholes: No. 4 Size 3"x4" Location 2-Front Head, 2-Shell

18. Fusible Plug (if used) _____ (No., Diam., Location, Mfrs. Stamp)

19. Boiler Supports: No. 4 Type Saddles Attachment Welded
 (Saddles, Legs, Lugs) (Bolted or Welded)

20. Max. AWP 150 psi Based On PG-46.1 Heating Surface 508 sq ft
 (Code Par. and/or Formula) (Total)

21. Shop Hydrostatic Test 225 psig. _____ kw.
 (Electric Boilers)

CERTIFICATE OF COMPLIANCE

We certify the statements in this data report to be correct.

Date 2/13/78 Signed Superior Blr. Wks. Inc. by John C. Hedison
 (Manufacturer) (Authorized Representative)
 Our Certificate of Authorization No. 3236 to use the (A) or (S) S Symbol expires
March 30 19 79

CERTIFICATE OF SHOP INSPECTION

BOILER MADE BY SUPERIOR BOILER WORKS, INC. at HUTCHINSON, KANSAS

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State or Province of PENN. WC 2755 and employed by H.S.B. I.&I. CO. of HARTFORD, CONN. have inspected parts of this boiler referred to as data items 6-7-8-9-10-12-13-15-17-19-20-21 and have examined Manufacturer's Partial Data Reports for items

and state that, to the best of my knowledge and belief, the manufacturer has constructed this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 02-13-78 Michael J. Ling Commissions N.B. 8422
 Inspector Nat'l Board, State, Province and No.

CERTIFICATE OF COMPLIANCE

We certify that the field assembly of all parts of this boiler conforms with the requirements of SECTION I of the ASME BOILER AND PRESSURE VESSEL CODE.

Date _____ Signed _____ By _____
 (Assembler) (Representative)
 Our Certificate of Authorization No. _____ to use the (A) or (S) _____ Symbol expires
 _____ 19 _____

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State or Province of _____ and employed by _____ of _____ have compared the statements in this Manufacturer's Data Report with the described boiler and state that the parts referred to as data items _____, not included in the certificate of shop inspection, have been inspected by me and that to the best of my knowledge and belief the manufacturer and/or the assembler has constructed and assembled this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test of _____ psi.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____ Commissions _____
 Inspector Nat'l Board, State, Province and No.

GAS FUEL FIRING

	Low Fire	High Fire
Firing Rate M.B.H.	<u>1680</u>	<u>4200</u>
Flame Signal Pilot <u>24.5 VDC</u>	<u>25 VDC</u>	<u>25 VDC</u>
Gas Press Inlet <u>1 Psi</u>	<u>1 Psi</u>	<u>1 Psi</u>
Gas Press Manifold	<u>.5"</u>	<u>4.6"</u>
Boiler Press. or Temp.	<u>100 Psi</u>	<u>100 Psi</u>
Firebox Press Inches W.C.	<u>.1</u>	<u>1</u>
Stack Temperature degree F.	<u>325</u>	<u>355</u>
Ambient Temperature degree F. <u>45</u>		
CO ₂ Percent	<u>8.5</u>	<u>9</u>
Combustion Efficiency Percent	<u>82.9</u>	<u>82.8</u>
Drum Losses percent <u>1.5</u>		
Fuel to Steam Efficiency percent	<u>81.4</u>	<u>81.3</u>

High Limit	Set at ----	100 Psi	----Checked	✓ Manual Reset
Operating Limit	Set at ----	95 Psi	----Checked	✓
Modulating Control	Set at ----	90 Psi	----Checked	✓
High Oil Press Switch	Set at ----		----Checked	✓
Low Oil Press Switch	Set at ----	175 Psi	----Checked	✓
High Oil Temp Switch	Set at ----		----Checked	✓
Low Oil Temp Switch	Set at ----		----Checked	✓
High Gas Press Switch	Set at ----	15"	----Checked	✓
Low Gas Press Switch	Set at ----	10"	----Checked	✓
Primary LWCO-----			-----Checked	✓
Auxillary LWCO-----			-----Checked	✓
Air Flow Switch-----			-----Checked	✓
Burner Door Switch -----			-----Checked	✓
Oil System Checked for Leaks -----			-----Checked	✓
Gas Train Checked for Leaks-----			-----Checked	✓
Doors & Burner Checked for Leaks-----			-----Checked	✓
Dielectric Test-----			-----Checked	✓
Blower Motor Amps <u>5.2/5.4/5.2</u>				



FACTORY FIRETEST REPORT

Gas Firing ☐Oil Firing ☐Gas-Oil Firing ☒Representative: BOYLE Date: 2/17/1978Job Name: SUN CHEMICAL National Board Number: 8029Boiler Model: 5-5-508-S150-ICBurner Model: IC MLG 42SFuel(s): Nat. Gas & #2-OilType of Firing: ModulationVoltage and Phase 220-60-3phDamper Manual None Auto72 Energy Extractors InstalledCombustion Control Type: Fireye 5022A

		Low Fire 12	High Fire 30
Firing Rate GPH			
Flame Signal Pilot	<u>24.5 VDC</u>	<u>25 VDC</u>	<u>25 VDC</u>
Air Press Supply			
Air Press Nozzle			
Oil Temp. F. #2			
Before Preheater			
After Preheater			
At Nozzle			
Oil Press Pump	<u>5 Psi</u>		
Oil Press Nozzle		<u>290 Psi</u>	<u>290 Psi</u>
Oil Press Return		<u>80 Psi</u>	<u>145 Psi</u>
Boiler Press, or Temp.		<u>100 Psi</u>	<u>100 Psi</u>
Firebox Press Inches W.C.		<u>.1</u>	<u>1</u>
Stack Temperature Degree F.		<u>325</u>	<u>360</u>
Ambient Temperature Degree F.	<u>45</u>		
CO ₂ Percent		<u>11.5</u>	<u>13</u>
Smoke - Bacharach		<u>0</u>	<u>0</u>
Combustion Efficiency Percent		<u>86.1</u>	<u>86.1</u>
Drum Losses Percent	<u>1.5</u>		
Fuel to Steam Efficiency Percent		<u>84.6</u>	<u>84.6</u>

Firetest Conducted By Ed NalleyReport Approved By Quality Control AP

See Reverse Side for Gas Fuel & Control Checks

Form #TFR-3

SUPERIOR BOILER WORKS, INC.
NON- DESTRUCTIVE TESTING DEPT.

X-RAY RECORD

IN ACCORDANCE WITH PROCEDURE NO. 1

N.B. No. 8029

DATE 2-2-78

RADIOGRAPHER DAVID WHITE

DARK ROOM TECHNICIAN MARK R. SMITH

WELDING OPERATOR LONG SEAM L

WELDING OPERATOR ROUND SEAM L

BRAND OF FILM Dupont TYPE OF FILM RDT-75

NO. OF EXPOSURES LONG SEAM 10 ROUND SEAM 17

TYPE AND SIZE 508

TYPE OF INTENSIFYING SCREEN LEAD

FRONT SCREEN THICKNESS .005

BACK SCREEN THICKNESS .010

DEGREE OF DENSITY REQUIRED 1.8 - 3.0 OBTAINED OK

MATERIAL THICKNESS 3/8"

ALL MATERIAL IS GROUP P-1

ALL PENETRAMETERS ARE STAINLESS STEEL GRADE -1

MAN HOURS SPENT IN X-RAY 3 hrs

ACTUAL EXPOSURE TIME 18 min

MRH OUTSIDE BARRIER .7

ALL EXPOSURES, WHETHER
ORIGINALS OR RETAKEN FOR
ANY REASON ARE NOW
ACCEPTABLE AND READY TO BE
FILED.

SBW Q.C. FB

HSB SIS 02-06-78 mgp

INSPECTION REPORT

S. O. # 27478 N. B. # B029 Serial # _____
Boiler Model # 5-5-508-5150-1C
Purchaser Boyle
User Sun Chemical

This is an Official Document required by Superior Boiler Works, Inc., A.S.M.E.,
The National Board of Boiler and Pressure Vessel Inspectors and the Hartford
Steam Boiler Inspection and Insurance Company. It must be properly signed and
filed with all other data pertaining to this particular boiler. PLEASE COOPERATE
in keeping this document filled out and in its proper place.

Fred Palstring
Quality Control Supervisor

ENGINEERING DEPT.

Design Criteria	<u>S.D.A. 12-23-77</u>	<u>S.D.C. 1-23-78</u>	<u>012578</u>	<u>W/P</u>
Material Ident	<u>S.D.A. 12-23-77</u>	<u>S.D.C. 1-23-78</u>	<u>012578</u>	<u>W/P</u>
Calculations Completed	<u>S.D.A. 12-23-77</u>	<u>S.D.C. 1-23-78</u>	<u>012578</u>	<u>W/P</u>
Dwgs. Completed	<u>S.D.A. 12-23-77</u>	<u>S.D.C. 1-23-78</u>	<u>012578</u>	<u>W/P</u>