

Water Level Indication



THE COMPANY



In February 2022, **Fossil Power Systems (FPS)** became part of the Babcock & Wilcox (B&W) family of steam generation and emissions control technologies. The acquisition is a natural extension of the long relationship the two companies have had for more than 35 years when B&W began serving as the exclusive supplier of FPS ignitors in the U.S.

Founded in 1981 as a designer and manufacturer of ignitors, flame scanners and drum level probes, FPS has evolved to become a worldwide leader in the design and manufacture of firing equipment and safety systems for the power generation, pulp and paper, and petrochemical industries.

FPS developed many of the technologies that are currently being used throughout the industry on flame scanning, gas/oil ignition and water level measurement equipment. Our products are specified on new construction and retrofit projects around the world. FPS products are installed in over 70 countries, all developed, manufactured and tested in our factory in Nova Scotia, Canada.

FPS is one of very few companies in the world that can provide complete boiler gas conversion expertise, with the ability to provide the optimal ignition equipment, flame scanners, natural gas piping design/fabrication, burner management system (BMS), and combustion control system (CCS), as well as manage local approvals.

FPS continues to be an industry leader in technology advancement; we continue making boilers cleaner, safer and more reliable.



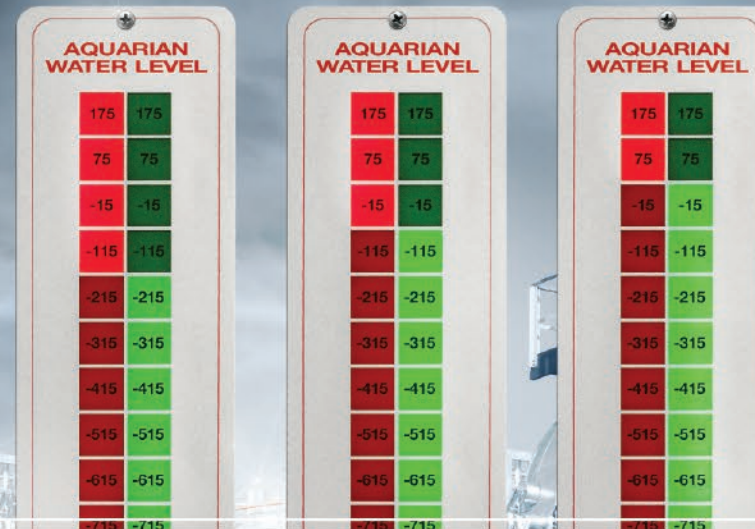
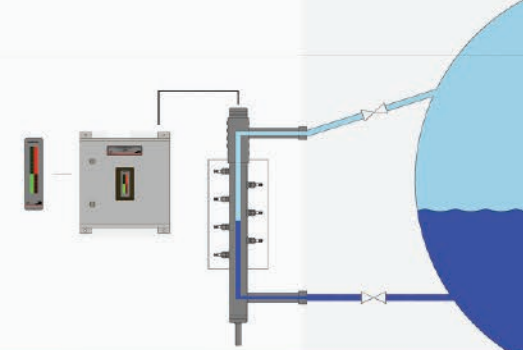
LOCATION

A 45,000 ft² facility in Dartmouth, Nova Scotia, Canada, is home for all project management and design engineering, R&D engineering, and manufacturing/testing of all high-pressure columns, fuel piping systems, ignition equipment, valves, control systems, and electronic products.

FPS also has an engineering and sales offices in Edmonton, Alberta, and Vancouver, British Columbia, with many authorized sales distributors located worldwide. We are also supported by B&W's expansive global network of Sales and Service personnel.

AQUARIAN

Aquarian electronic level products were specifically designed to meet the industry's growing needs and demand for a reliable, cost effective and versatile means of sensing water levels in a variety of high and low pressure applications. By passing a $\pm 5\text{VDC}$ square wave through each probe and processing the resulting signal, a distinction between steam and water is made, even in water conductivities as low as 0.5 micromho.



Aquarian™ Vertical Probe Column

Aquarian™ High Pressure Brazed Probe System

The Aquarian 3000Mini

The **Aquarian 3000Mini** was developed to satisfy basic level indication requirements for boiler drum, feedwater heaters and other liquid level applications. The Aquarian system consists of: the column with probes, the detection and verification unit (D&V) and the remote display for the control room. The electronic unit (D&V) is connected to 5 or more probes on the water column. The number of probes can be selected and spaced to indicate liquid level through a desired operating range in a custom manufactured water column to provide the most reliable indication for any application. An individual relay is provided for every probe level to provide versatility in selecting high/low or other system alarm and trip points. A remote LED display panel, customized for the number of probes and their locations is standard. A local display mounted on the D&V door is optional.



Aquarian™ 3000Mini

Operation of the system is based on measurement of the difference in resistance between water and steam, which is compared with a known reference resistor. The signal output to the probes is a $\pm 5\text{VDC}$ square wave which prevents electroplating of the probe. The Aquarian 3000Mini measures the returning signal to indicate water or steam. System diagnostics perform an ongoing wire continuity check (using optional two wires per probe) to verify the integrity of the cable connecting the probes to the D&V. System fault indication is provided by a relay which monitors the internal power supplies, clock and wire continuity. A second relay for level fault, activates if water is detected above steam.

Installation Options

Typical options with these systems include additional level displays. These can be a door mounted local display or remote display (feedwater station, blowdown station). The equipment can provide a 4-20 mA output proportional to the indicated level. This signal should not be used for level control, but is suitable for level indication or trend recording.

Importance of Maintaining Boiler Water Level

It is critically important that proper steam drum water level be maintained at all times. If the water level is too low, boiler tubes may be damaged. If the water level is too high, damage to the steam separator or steam turbine from water carry over can occur.

Boiler Water Level Measurement Options

At least one visual gauge is required for the boiler drum. However, indication from this gauge is often not visible to control room operators. Additional instrumentation is necessary to maintain proper water level. DP transmitters are commonly used for level control because they provide continuous signals. Multiple transmitters can be used to meet redundancy requirements. However, this arrangement is susceptible to common mode failure. Plugged sensing lines, empty reference legs, and improper configuration or calibration are all potential causes of failure. During a common mode failure, the issue may not become apparent to operators until damage has already occurred.

The Aquarian 3000Mini provides a completely independent point to point level indication which acts as a reliable backup for the level control device. Since the 1980s, Aquarian probe systems have consistently proven their value by protecting equipment when other instruments fail.

FEATURES

- NEMA 4X (IP66) stainless steel enclosure.
- Solid state electronics and two-color remote display.
- Three way adjustment for water conductivity.
- Power source: 120 or 240 VAC, single phase, 50-60 Hz, 1/2 - 1/4 A.
- 5 amp contact output for electronic & level faults.
- Electronic self-monitoring and indication in the D&V unit, power supply fault (redundant power supplies), clock fault (DC detection circuit).
- Swaged Style Probes Rated for 3000psi max, 1200° F max.
- 2000 & 3000psi (138 & 207bar) carbon steel water columns.
- NEMA 4X (IP66) column mounted junction box factory pre-wired to probes.
- $\pm 5\text{VDC}$ to the probe (prevents electroplating).

OPTIONS

- Vertical style probe columns.
- Two-color enclosure door mounted local display.
- 4-20mA and RS-485 serial display output.
- Two-color RS-485 serial remote display.
- Explosion Proof enclosure for hazardous area applications.
- Zener barriers for intrinsically safe probe connections.



FPS

ELECTRONIC LEVEL SWITCH

AQUARIAN

ASME TDP-1 for the "Prevention of Water Damage to Steam Turbines" covers design, operation, inspection, testing, and maintenance to prevent water induction from: motive steam systems, steam attemperation systems, feedwater heaters, and related equipment. The Aquarian 1000Plus and Single Probe Alarm Module are designed to detect the presence of water and initiate control actions that protect steam turbines from damage.



Brazed High Pressure Swaged Style Probe



Single Probe Alarm Module



Aquarian™ 1000Plus

The Aquarian Single Probe Alarm Module and Aquarian 1000Plus

The Single Probe Alarm Module (SPAM) is an accurate and reliable instrument that provides positive indication of steam or water in high temperature and pressure applications. The SPAM measures resistance and reports the presence of either steam or water, based on fluid conductivity. The probe can be mounted in a column or a 1-½" tee. The Swagelok® metal to metal seal assures a leak proof installation with no moving parts. The SPAM is an effective electronic replacement for mechanical float switches. The electronic unit can be conveniently located up to 65 feet away from the probe with low conductivity water and 500 feet away with high conductivity water. Two Form-C contacts provide relay outputs for control circuits. LEDs indicate "WATER" or "STEAM" and a third LED flashes for "POWER/CLOCK", to indicate the presence of power and proper clock function.

The Aquarian 1000Plus is configured with 1 to 4 independent probe channels, redundant power supplies, continuity, level fault monitoring and optional 4-20mA output. Each level relay output is rated at 5A which enables this system to serve as

a trip, alarm or on-off control device. Measuring the difference in resistance between high purity water and steam, the Aquarian 1000Plus is commonly used on feedwater heaters, piping and drains, main steam header drains, hot/cold reheat drains and main boiler high/low alarm/trip. The Aquarian 1000Plus is popular on turbine drain systems for turbine water induction protection (TWIP).

The Aquarian probe has set the industry standards for high performance and reliability. Designed for use with a Swagelok™ fitting, the seal profile is machined to the probe body, eliminating the need for gaskets. Every Aquarian probe is gas tested and hydrostatically tested to ensure the probe will provide reliable water/steam indication. The OEM genuine Aquarian probe will proudly display the FPS logo, part number 9300-0002, rating 3000psi and the Aquarian™ name. Aquarian Probes are only manufactured by FPS using proprietary vacuum brazing at our facility in Nova Scotia, Canada.



Aquarian system installation to meet the ASME requirements for Turbine Water Induction Protection (TWIP).

FEATURES AND BENEFITS

- Level fault, power supply fault and clock fault monitoring.
- Reliable and economical alternative to float level switches.
- Conductivity capability: 0.5 micromho and up.
- Detects presence of water throughout entire range of operating temperatures.
- Relay can be set as "fail safe" in case of power failure.

OPTIONS

- Nema 4X enclosure for Alarm Module.
- Probe wiring continuity monitor (1000Plus).
- Explosion proof enclosure for hazardous area.
- Zener barriers for intrinsically safe probe connections.
- Tee or water column materials: carbon steel, stainless steel, chrome moly P11, P22 & P91.

FPS AQUARIAN PROBE FEATURES

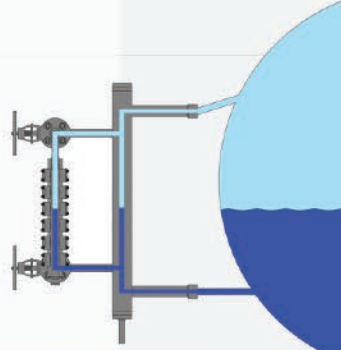
- High density zirconium oxide ceramic wetted insulator improves steam/water detection through minimized contaminant build-up and enhanced water shedding.
- Manufactured from ASME approved materials.
- Body & Tip are in house vacuum brazed to insulator.
- 100% Hydro tested to 6000psi (414bar).
- Rated for 3000psi max, 1200°F max.
- **Two year unconditional warranty.**

FPS

VISUAL LEVEL GAUGE (SIGHT GLASS)

AQUARIAN

Visual Gauge, commonly referred to as a Sight Glass or Level Gauge, is the only technology available to provide "Direct" indication of steam drum water level thus satisfying the ASME Boiler and Pressure Vessel Code requirements.



Aquarian™
3000 Visual
Bi-Color Water
Level Gauge

Aquarian 3000 Visual Bi-Color Ported Gauge

The **Aquarian 3000 Visual** is a 3000psi (207bar) ported water level gauge that produces a red/green image to indicate the water level in high-pressure boiler steam drums.

The ASME Boiler and Pressure Vessel Code states "ported gages or reflex gages that use refraction of light to aid ready determination of the liquid level, may omit the requirement for overlapping sections."

The solid state bi-color gauge illuminator and display attach to the ported gauge to produce a red or green image on the display. A red image indicates that steam is present and a green image indicates that water is present. The red/green image is produced by an array of solid-state LEDs and precision lenses that focus the image through the gauge body onto the display. The LEDs replace the unfocused incandescent light bulb and colored glass that are currently used in conventional bi-color illuminators.

The LED arrays and precision Plano-convex lens provide a bright, clear and unmistakable image in the presence of steam and water. The high intensity narrow beam LEDs are mounted on an electronic printed circuit board with current limiting resistors. A precision 24VDC power supply provides the Illuminator with the exact current that is required for a constant clean image.

Complete Port Rebuild Kit P/N 9300-0110

The **Aquarian 3000 Visual Bi-Color Water Level Gauge** is designed to reduce the frequency of maintenance.

The Belleville Spring Washers eliminate the need for hot re-torque and two pieces of high quality mica in the glass kit allow this gauge to operate for longer periods of time.

The clarity of the three red or three green LEDs in each port will indicate the operating condition of the gauge.



Ported Gauge
Components

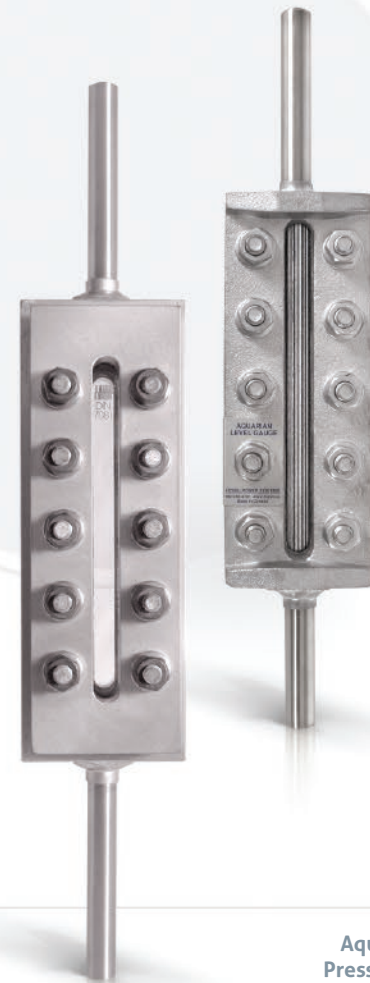
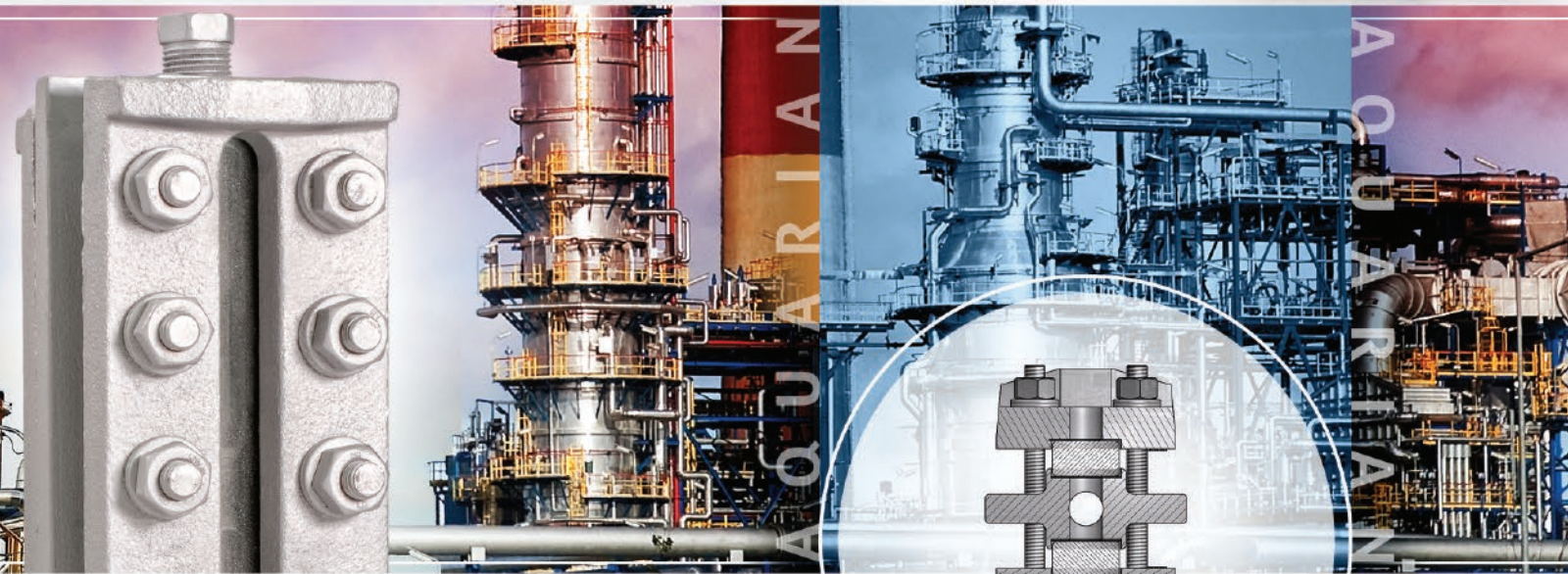
FEATURES

- Designed for 3000psi (207bar) and 696°F (369C) steam service.
- One piece type 304/304L stainless steel body and covers provide corrosion resistance and long service life.
- Belleville spring washers maintain gasket loading under thermal and pressure cycles.
- Precision tempered and ground aluminosilicate glass provides clear visibility.
- Laminated and die-formed graphoil sealing gasket.
- Two discs of premium V-1 quality clear ruby mica protect the glass from the steam and extend the service life.
- Constructed to the ASME Boiler and Pressure Vessel Code requirements for design, materials and construction.
- LEDs are immune to failure from vibration.
- Average LED life is 11 years, resulting in reduced maintenance and service costs.
- Display and Illuminator can be installed on either side of the gauge to provide viewing flexibility.
- 6 LEDs per port produce extremely bright image visible at more than 100 ft. away and various angles.
- Level Display enables operator to view the image clearly.
- Adjustable end plate for exact placement of viewing screen, provides an unmistakable steam and water image.

FPS

LEVEL GAUGES (FOR STEAM & PROCESS APPLICATIONS)

AQUARIAN



Aquarian™ 650R
Reflex Gauge

Aquarian 650R Reflex Gauge

The **Aquarian 650R Reflex Gauge** is rated for 975psi (67bar) for process applications, and 350psi (24bar) for steam applications. It provides excellent visibility of liquid level. Light refracting grooves in the glass cause the liquid to appear black and steam to appear white. The high contrast between water and vapor allows this style gauge to be stacked on top of one another without concern for blind spots between gauges. Recessed gasket surfaces in both the cover and body facilitate glass and gasket alignment and also help prevent gasket blowout. Belleville spring washers maintain constant gasket loading under thermal and pressure cycles.

Aquarian 1000T Transparent Flat Glass Gauge

The **Aquarian 1000T Transparent Flat Glass Gauge** is rated for 1000psi (69bar) and is structurally designed with a thicker and wider body to resist deflection. The design meets the ASME Boiler and Pressure Vessel Code, which no longer permits the use of cross webbing. For longer ranges of visibility, this style gauge must have a minimum of 1" for overlapping sections. Belleville spring washers maintain constant gasket loading under thermal and pressure cycles. Precision tempered and ground Borosilicate glass provides high strength and clear visibility, while a mica shield protects the glass from the effects of erosion for an extended service life.

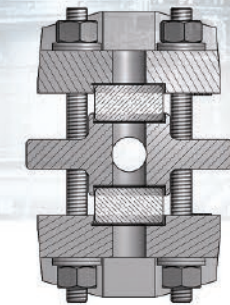
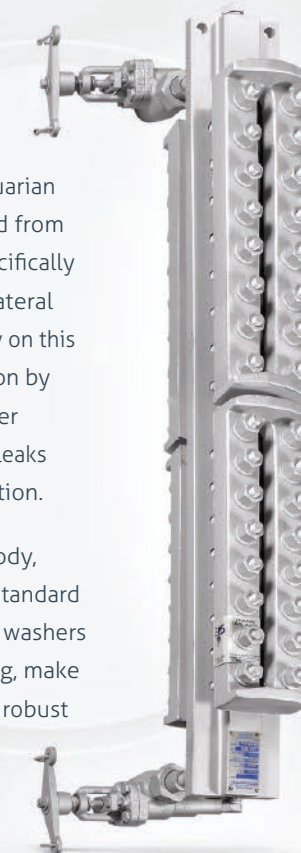
Aquarian™ 1000T High
Pressure Flatglass Gauge

(ASME BPVC Section 1, PG-60.1.1) Boilers having a maximum allowable working pressure of 400psi (27bar) or less shall have at least one gage glass in service at all times.

Aquarian 2000T Transparent Flat Glass Gauge for NON-ASME Section 1 Applications

Most transparent gauges are machined from bar stock that is only slightly wider than the glass itself. The Aquarian 2000T is manufactured from an extruded shape specifically designed to improve lateral strength. The wide body on this gauge reduces deflection by 75% compared to other gauges, which reduces leaks caused by body deflection.

The extruded gauge body, combined with FPS's standard use of Belleville spring washers to maintain bolt loading, make the AQ2000T the most robust stackable transparent gauge in the industry.



AQ2000T
Cross Section

FEATURES

AQ 650R and AQ 1000T Gauges

- Full length visibility with no obstructions gives definitive readings and conforms to the latest ASME code for sight glass gauges.
- Reflex Gauge is rated for 975psi (67bar) on process applications and 350psi (24bar) for steam applications.
- AQ 1000T is rated for 1000psi (69bar) for steam applications.

AQ 2000T Gauge

- AQ 2000T is rated for 2000psi (137bar) CWP for process applications.
- Wide Gauge body design resists deflection, which prevents gasket failure.

AQ 650R, AQ 1000T and AQ 2000T Gauges

- Belleville spring washers maintain constant gasket loading under thermal and pressure cycles.
- Precision tempered and ground borosilicate glass provides high strength and clear visibility.
- Optional aluminosilicate glass available for some designs.
- Optional LED illuminators are available (not required).

FPS LEVEL GAUGES (FOR STEAM & PROCESS APPLICATIONS)

AQUARIAN

Magnetic Level Indicators for steam and process applications are designed by FPS for high performance and reliability while providing a totally leak-proof, non-invasive method to measure level.



The FPS logo is proudly displayed on all products for authentication.

Aquarian 4000 Magnetic Level Indicator

The Aquarian 4000 Magnetic Level Indicator (MLI) is a new approach to level measurement. The MLI provides a totally leak-proof, non-invasive method to measure level. This is especially advantageous when process fluids are dangerous or flammable. The isolation of the indicator from the process fluid also limits the amount of regular maintenance required for the indicator.

The Magnetic Level Indicator uses a float with an internal magnet that is coupled to the magnetic two-color indicator flags. The float is enclosed within a 316 stainless steel pipe chamber that is connected to the process vessel. The flags are held in an aluminum frame within a sealed polycarbonate extrusion. As the process fluid rises or lowers, the flags rotate to indicate the fluid level.

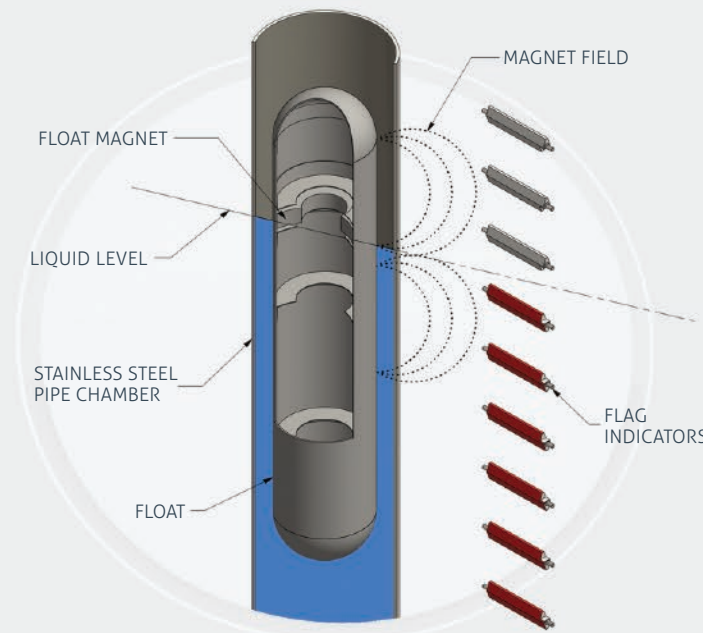
Each float is specifically designed to function in the specific gravity (S.G.) of the process fluid present, providing accurate level readings.



SS Pipe Chamber and Aluminium Indicator Assembly

APPLICATIONS

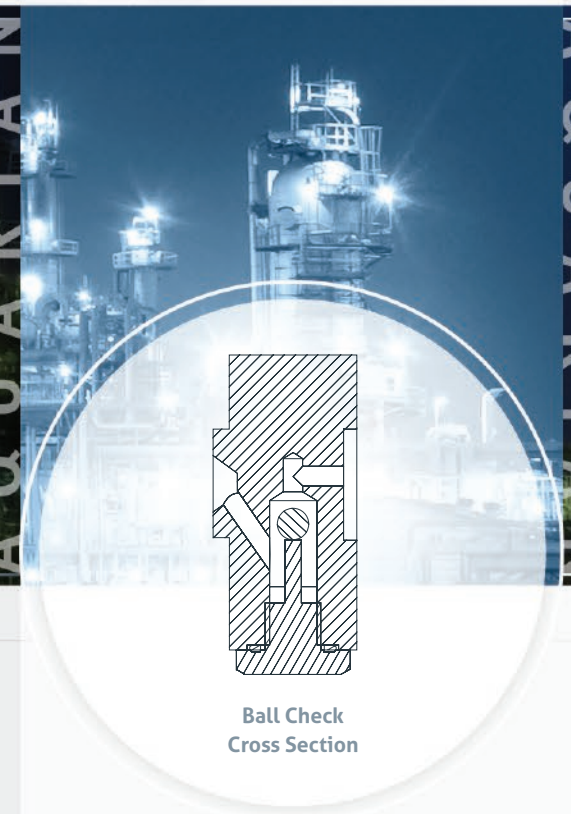
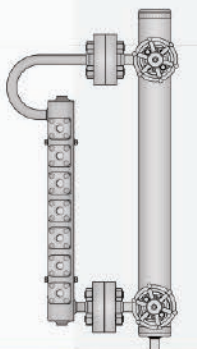
- Boiler Drums
- Hot Wells
- Blowdown Tanks
- Feedwater Heaters
- Deaerators
- Propane Vessels
- Oil/Water Separators
- Chemical Tanks
- Gas Chillers
- Oil and Gas Industry
- Pulp and Paper Industry



FEATURES AND BENEFITS

- Designed for pressures up to 1350psi (93bar).
- Designed for temperatures up to 1000F (538C).
- 5 year warranty on all parts.
- 1.75-inch flag width provides 300 ft. viewing distance with 140° viewing angle.
- Machined flag holders provide accurate flag spacing and low flag rotation friction.
- Floats constructed in type 321 stainless steel or titanium, depending on application requirements.
- High strength rare earth float magnet provides reliable magnetic coupling to the flags.
- High contrast bi-colored indicator flags for easy visibility.
- Fully sealed and nitrogen purged flag assembly for reliability in all environmental conditions.
- Specific Gravity fluids as low as 0.66.
- Constructed to the ASME Boiler and Pressure Vessel Code requirements for design, materials, and construction.

FPS offers a variety of high quality valves designed for visual level gauge isolation. All valves are forged steel and constructed to meet the rigorous demands of high pressure steam boiler service. The valves meet the requirements of ASME Boiler and Pressure Vessel Code, Section 1.



GV 3100 Angled Globe Valve

GV 3100 Angled Globe Valve

- 1" angled globe valve.
- Rated class 2155.
- Stellite seat and disc, free rotating.
- "T" handle or chainwheel operator.
- ¾" flanged gauge connections.
- Conval Clampseal® body construction.
- Pressure seal threaded bonnet/yoke.
- Outside screw & yoke (OS&Y) construction.
- SA-105 forged steel body & yoke, nickel plated.
- Pressure actuated fixed leak-tight backseat.
- Standard SW drain, optional SW vent.
- Integral packing gland wrench.
- In-line repairable seat.
- Optional ball check.



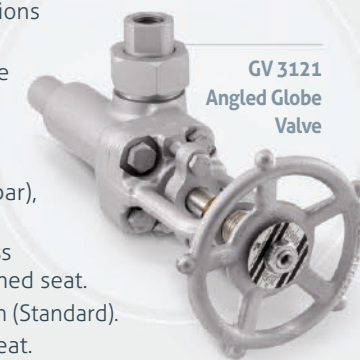
GV 3200 Angled Globe Valve

GV 3200 Angled Globe Valve

- 1" angled globe valve.
- Rated Class 1500.
- Stellite seat and disc free rotating.
- Handwheel or chainwheel operator.
- ¾" flanged gauge connections.
- Bolted bonnet/yoke.
- Outside screw & yoke (OS&Y) construction.
- SA-105 forged steel body & Yoke.
- Standard SW drain, optional SW vent.
- In-line replaceable seat.
- Optional ball check.

GV 3110 & GV 3121 Angled Globe Valve

- ¾" offset angled globe valve.
- Handwheel or chainlever operator.
- ¾" pipe nipple gauge connections (GV3110).
- Union gauge connections (GV3121).
- Outside screw & yoke (OS&Y) construction.
- Forged steel body and bolted bonnet.
- Rated 1500psi (103bar), and 597°F (313C).
- Non-rotating stainless steel stem and hardened seat.
- ¾" NPT vent and drain (Standard).
- In-line replaceable seat.
- Optional ball check.



GV 3121 Angled Globe Valve

Series 3500 Ball Check & 3501 Flow Restrictor

- Forged steel body, stainless steel ball.
- Meets ASME section 1 and appendix A-18 requirements.
- Reduces steam discharge in case of gauge glass failure.
- Rated for 3000psi (206bar) steam service @ 696°F (368C).
- Can be inspected in-line.



3500 Ball Check

VALVE SUMMARY

When engineering your project, FPS will select the corresponding valve to satisfy the requirements for your particular application.

The optional Ball Check and Flow Restrictor valves are designed to be used with visual level gauges to prevent excessive discharge from the gauge in case of glass failure.

Contact FPS to discuss valve options for your level gauges.

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RENEWABLE | ENVIRONMENTAL | THERMAL

Established in 1867, Babcock & Wilcox is a global leader in advanced energy and environmental technologies and services for the power, industrial and renewable markets.

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