



evoqua
WATER TECHNOLOGIES



PERMUTIT™ NUCLEAR INDUSTRY PRODUCTS



YOUR TRUSTED NUCLEAR POWER INDUSTRY SOURCE

Permutit™ Nuclear Industry Products have been the trusted source for all grades of nuclear and commercial flow nozzles, orifice plates, flow straighteners and venturi elements. Our primary emphasis is the flow related equipment supply to the Nuclear Power industry.

PERMUTIT™ NUCLEAR INDUSTRY POWER PRODUCTS

Evoqua has fabricated and supplied feedwater meters and other flow related devices to the Nuclear industry since 1970. Virtually all of the feedwater meters/ventururis installed in Nuclear Power plants in the US, and US-designed plants overseas are provided by Evoqua. We maintain the records for all such devices furnished. We can easily retrofit, replicate or upgrade these devices to fit into existing installations.

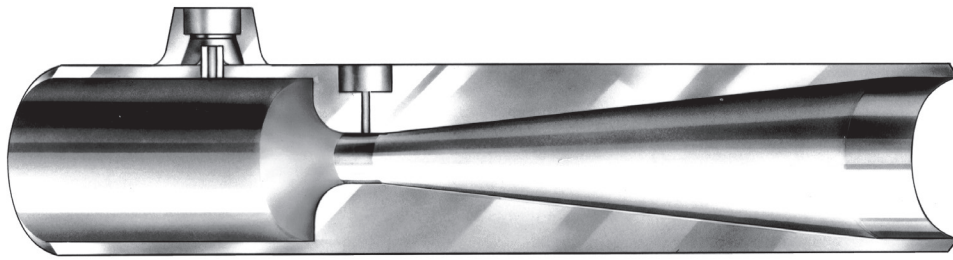
Over the years, we have maintained the continuity in the design and fabrication methodology, while at the same time updating to newer standards to maintain the reliability and ruggedness of the equipment we have provided in the past. All components provided continue to meet or exceed the stringent requirements of the Nuclear industry and various codes as applicable.

Permutit Nuclear Industry Products have an established Nuclear Quality program which meets the criteria of NCA-3800, 10CFR21, 10CFR50 appendix B, ANSI N45.2, NQA 1, ANSI B31.1 and other codes.

Permutit XP and NS series non-regenerable demineralizers are used routinely for decontaminating water containing radioactive isotopes. Each unit has resin retention strainers and sluicing connections to eliminate the costly and cumbersome resin baskets usually offered for this service.

Replacement strainer baskets, screens, complete strainer assemblies, suppression pool strainers, thermowells and other specialty devices are also provided.





PERMUTIT™ FLOW LIMITING (CAVITATING) VENTURIS, AND MULTI-ORIFICE ASSEMBLIES

We offer Permutit™ flow limiting (cavitation) venturis for limiting flows in critical lines where a sudden decrease in downstream pressure (due to rupture etc) can occur. These are designed for choke flow conditions at a maximum predefined flow rate. Due to the unique inlet curve profile and a recovery cone, erosion under these conditions is limited to such an extent on the critical surfaces that the flow characteristics, and mechanical integrity is not affected. These units can be tested at actual site conditions where required to authenticate the design. Evoqua Water Technologies has compiled a history of such designs, enabling us to test these at lower pressures in the testing lab, and accurately predict limiting flows from the test data. Low pressure test is less expensive. These devices are also used as flow control devices at lower normal operating flow rates.

Evoqua also offers multi-orifice designs that will perform the same function as cavitating venturis. The predictability of the limiting flow, pressure drop is not as accurate as a cavitating venturi, but it can be used where there is flexibility in the design requirements. These assemblies are designed with a number of orifices in series such that cavitation does not occur at any stage. The number of the orifices needed is calculated for each design requirement. In the multi-orifice design a removable orifice can be added so that the performance can be fine tuned at site or lab, for same accuracy as an cavitating venturi.

Construction

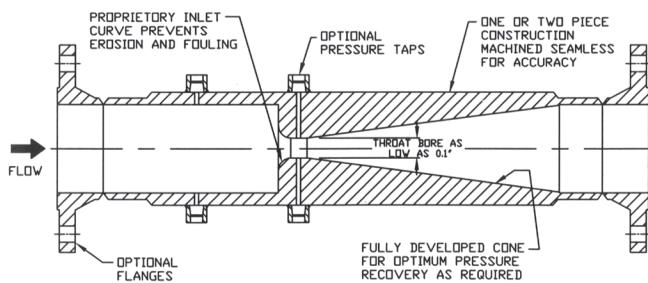
The venturis and the orifices are generally provided in various grades of stainless steel, but other materials can be provided as required. These can be welded in line or provided with flanged connections. The removable orifice is provided with flanged ends.

Quality Control

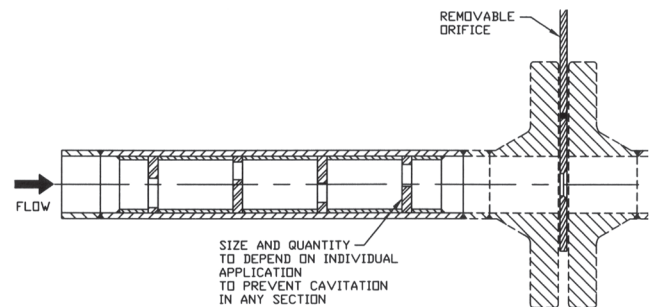
We have been the trusted source for all grades of nuclear and commercial demineralizers for many years. Our capabilities include dissimilar metal welding and fabrication to ANSI and RDT specifications. We meet the requirements of the ASME Codes and 10CFR50, Appendix B through our stringent quality assurance program.

The Advantage

As the leader in the water treatment industry, Evoqua Water Technologies has the greatest depth of personnel and technological resources to overcome any challenge. We offer the widest variety of specialty products for the power generating industry, including many custom components. Please contact us for additional information about your specific requirements.



Cavitating Venturi



Multi-orifice Assembly

Advantages

Cavitating design venturis:

- Uncalibrated accuracy up to $\pm 5\%$ of pressure or flow rate
- Actual characteristics can be determined by full pressure test in lab
- Less susceptible to wear and erosion
- Erosion does not affect design or performance
- No moving parts to wear or breakdown such as in pressure reducing valves etc
- Shorter lengths, can be fit into existing pipelines
- Meets wide variety of flow and application requirements due to custom design

Multi-orifice designs:

- Low cost
- Removable orifice available to fine tune design
- Highest quality design and manufacturing available for both designs to meet requirements of ASME, 10CFR50, Appendix B, ANSI B31.1, seismic and natural frequency requirements

Design Features

- Cavitating venturis offered in sizes 2" through 6" for weld-in or flange mounting
- Cavitating venturis are available with throat tap sets
- Recovery cones designed for individual pressure recovery conditions
- Accuracy of $\pm 5\%$ to pressure or Flow conditions
- Multi-orifice designs are available as weld-in or flanged
- Flanged removable orifice, included in the multi-orifice design

PERMUTIT™ FLOW NOZZLES FOR ACCURATE MEASUREMENT OF FLUID FLOW

Permutit™ flow nozzles offer accurate measurement and flow control through the use of differential pressure. While we offer all three of the differential pressure-producing devices used within the power industry (flow nozzles, venturis and orifice plates), Permutit flow nozzles are the most versatile devices. They measure the rate that fluids flow under pressure in closed piping systems. Their accuracy and pressure drop/recovery characteristics are far superior to orifice plates. While their characteristics do not equal that of venturi tubes, their excellent performance in maintaining stable/accurate flow rates, overall system performance and affordable cost make them an effective alternative for many system control points.

Applications

Permutit flow nozzles accurately measure liquid, gas or steam flows in all types of boiler piping systems. They are used in a wide range of boilers, from low pressure to supercritical, and in both fossil and nuclear fueled power plants.

Construction

Depending upon size, Permutit flow nozzles are machined from either forgings or centrifugal castings and surfaces are available to 4 RMS. Materials of construction include:

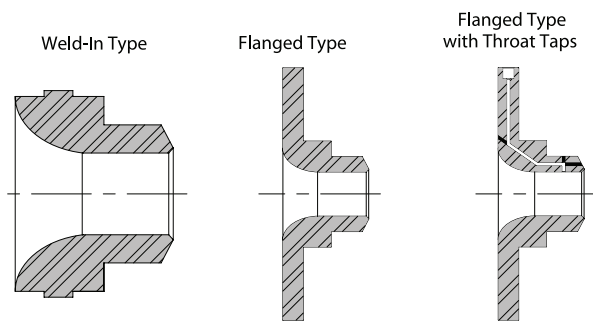
- Carbon steel
- Series 300 stainless steel
- Monel
- Copper-Nickel
- Titanium

Quality Control

We have been the trusted source for all grades of nuclear and commercial flow nozzles and other components for many years. Our capabilities include dissimilar metal welding and fabrication to ANSI and RDT specifications. We meet the requirements of the ASME Codes and 10CFR50, Appendix B, through our stringent quality assurance program.

The Advantage

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Advantages

- Flow coefficient accurate to ± 0.25 when calibrated
- Lower cost than venturi tubes
- Less susceptible to wear than orifice plates
- Lower pressure differential and higher recoveries than orifice plates
- Meets wide variety of size, flow and application requirements
- Highest quality design and manufacturing available to ASME PTC-6 requirements and 10CFR50, Appendix B, ANSI B31.1

Design Features

- Permutit flow nozzles are offered in a wide range of standard sizes for either weld-in or flange mounting
- Nozzles can use either pipe line pressure connections or throat taps
- A wide variety of custom nozzle configurations are available to meet special requirements
- Standard nozzles provide accuracy of $\pm 0.5\%$ when uncalibrated and $\pm 0.25\%$ when calibrated

PERMUTIT™ FLOW STRAIGHTENERS TO CORRECT FLOW PROFILE FOR ACCURATE FLOW MEASUREMENT

The Permutit™ flow straightener has a unique and exclusive design to provide flow profile correction within minimal straight pipe lengths. This combination offers the most flexible installation at a fraction of the cost of ordinary flow straighteners. When installed in existing pipelines, flow straighteners can actually improve flow meter performance.

Uses

Flow straighteners are used to correct the flow distortions that cause inaccurate flow meter readings. The accuracy of the flow meter is dependent upon the flow profile of the fluid as it passes into and through the measuring device. The pipe layout, pipe fittings, expanders and strainers cause distortions in the flow profile. Such distortions can be eliminated by providing an adequate length of straight pipe before the meter or by the use of flow straighteners.

Applications

Permutit flow straighteners are used in liquid, gas or steam applications in virtually all types of closed pressure piping where flow profile correction is required. They can be installed in new or existing systems to ensure accurate flow metering. Appropriate for a wide range of boilers, from low pressure to supercritical, they are utilized in both fossil fueled and nuclear power plants.

Quality Control

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The Advantage

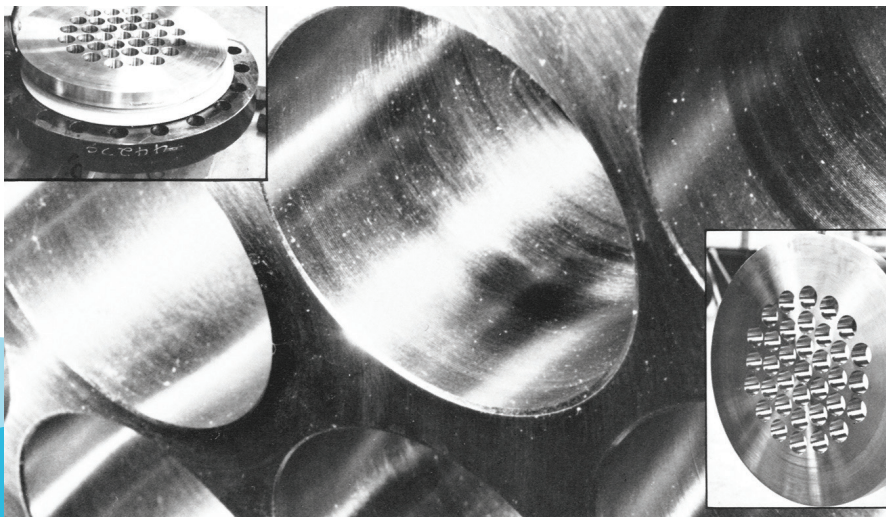
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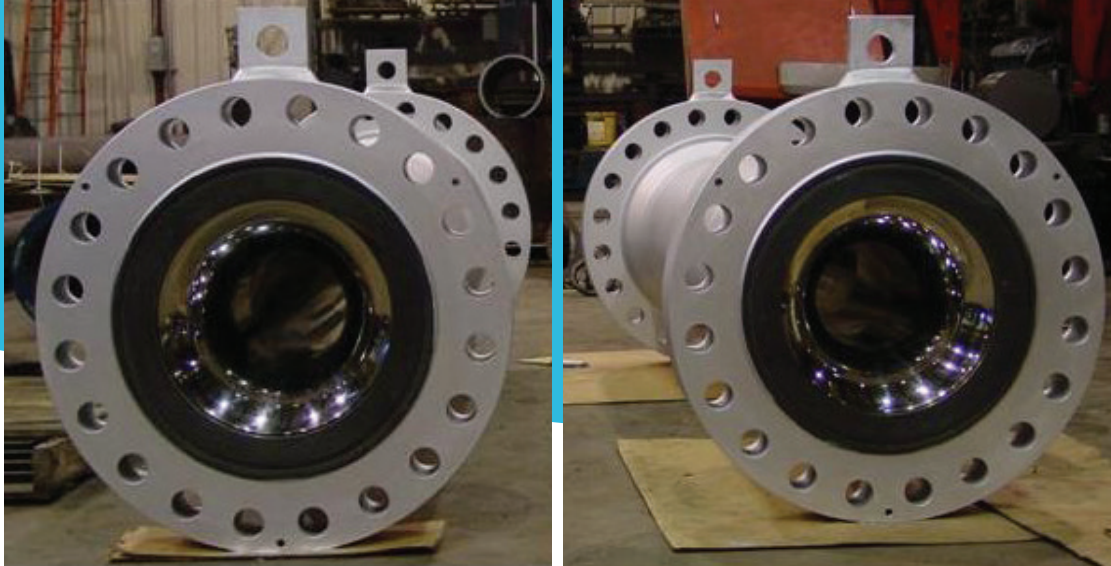
Design Features

Permutit PFP flow straighteners feature a perforated plate design with a symmetrical layout of holes clustered more densely at the center than at the perimeter. This unique design pattern re-establishes the normal turbulent flow velocity profile for a fluid passing through it. Offered in weld-in or flange mounted design, they are available in a range of standard sizes from 6" to 24" diameter with larger units on request. All variations such as length, pressure ratings and materials are available.

Advantages

- **Highly Effective** – corrects rapidly for both unsymmetrical and spiral flow distortions
- **Low Cost** – compact design with simple, rugged construction and ease of installation
- **Less Piping** – uses significantly shorter straight pipe runs than conventional types (requires only 11 pipe diameters upstream and 4 diameters downstream)
- **Low Pressure Loss** – 75% lower pressure drop than conventional perforated plate flow straighteners and 41% lower pressure drop than ASME tube types
- **Versatile** – developed for use with venturi meters, flow nozzles and orifice plates and may also be used with vortex, turbine and pitot type meters





FEEDWATER FLOW METER INSPECTIONS

Over time and with continual usage, your feedwater Flow meters may not be operating at the accuracy level as originally calibrated when first installed. Various causes such as erosion, physical damage, corrosion fouling etc may have altered the flow characteristics of the meter.

Adjustments for the measured flows may have been done by utilizing various instrument loop correction factors, and or comparing it to other devices and using the adjusted flow coefficients based on such measurements, it is extremely important to inspect the flow meter tubes and its components for any deterioration of surfaces tap sets and or physical damage. As you probably are well aware the correction factors s you maybe using may cause both either an increased or decreased flow, from that being recorded by utilizing such correction factors.

Evoqua Water Technologies offers their services for the feedwater meter Inspection during your scheduled outage,when access to the flow meter is available. This will enable you to pinpoint any deficiencies and or corrective action that may be possible.

The staff available for the inspection is highly qualified, with extensive experience in the manufacture and design of the meters. Records, drawings, data for the meters as provided is available inmost cases which makes each inspection highly specific.

Review of Flow Measurement Data:

At the convenience of the plant, this would be done prior to inspection, at site and or by correspondence.

- History and trends of flow measurement, and perceived errors
- Comparison of trend between multiple meters installed in line
- Review installation differences between multiple meters
- Use of tap sets, whether all the tap sets are, connected, averaged or not in use
- Correction factors in use, and source where they are derived from
- Develop a decision tree, for planned activities
- Provide recommended cleaning procedure

Physical Inspection:

- Upstream, downstream pipe inspection
- Flow straightener - view and inspect welds, obstructions etc.
- View signs of erosion, and or deposits, and any distinct patterns of corrosion / erosion
- Check for leaks in venturi section to tap connections.
- Check for damage to inlet profile of venturi
- Critical view of tap holes, signs of edge deterioration, depressions or protrusion of taps into pipe wall etc.
- Presence of burrs, foreign objects etc, in and around the taps
- Review uniformity of clearances between the venturi and pipe walls
- Flange and gasket sealing surfaces, check for damage

In order to do the physical visual inspection, various instrumentation should be available at hand, usually available at site, such as high powered borescope / videoscope with HD video capture, vacuum gauges, corrosion erosion profile meters etc.

Comprehensive Report

- Outlining all the observations.
- Summary and recommendations.
- Independent review of the inspection report and recommendations by an independent expert or lab.

The Advantage

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PERMUTIT™ ORIFICE PLATES FOR EFFICIENT MEASUREMENT OF FLUID FLOW

Permutit™ orifice plates are the simplest and most economical differential pressure-producing device to measure fluid flow under pressure in closed piping systems. Accurate to $\pm 1\%$, Permutit orifice plates are the less expensive alternative to either flow nozzles or venturi tubes. When measurement tolerances are within their accuracy coefficient range, orifice plates are a practical choice for system control points.

Applications

Permutit orifice plates measure liquids, gas or steam in virtually all closed pressure piping systems. Utilized in both fossil fueled and nuclear powered steam/electric generating plants, they are particularly applicable for a wide range of boiler applications from low pressure to supercritical.

Construction

Permutit orifice plates are machined from plate. Surface finishes range from 125 RMS to #4 commercial grade. Depending upon your application, materials of construction can include:

- Carbon steel
- Series 300 stainless steel
- Monel
- Copper-Nickel

Quality Control

We have been the trusted source for all grades of nuclear components for many years. Our capabilities include dissimilar metal welding and fabrication to ANSI and RDT specifications. We meet the requirements of the ASME Codes and 10CFR50, Appendix B through our stringent quality assurance program.

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Advantages

- Accuracy of $\pm 1.0\%$ over Beta ratios from 0.2 - 0.7
- Lower cost than flow nozzles
- Versatile design for a wide variety of application, size and flow requirements
- Highly flexible and can be provided in piping sections built in accordance with 10CFR50, Appendix B, ANSI B31.1 (complete with all Q.A. documentation)

Design Features

- Permutit™ orifice plates are offered in concentric, eccentric or multi-hole designs and either paddle or ring type configurations
- Available in a full range of sizes, they can be installed in pipes from 1/2" to 36" nominal diameters
- They are designed to ASME and ISA Standards and can be supplied with ANSI 300# orifice flanges or within a meter run
- All variations of length, pressure rating, couplings and materials are available



VENTURI ELEMENTS AND FEEDWATER FLOW METERS INSERTION TYPE PERMUTUBE SERIES

Permutit™ venturi elements offer unsurpassed accuracy combined with the lowest pressure drop of all differential pressure-producing devices. Used for measuring fluid flows under pressure in closed piping systems, our permutube series venturi elements offer an inherent accuracy of 0.5% when uncalibrated and 0.25% when calibrated. At beta ratios of 0.5 and above, pressure loss is approximately 10% for reduced operating costs and head requirements. This combination makes Permutit venturi elements the preferred choice for measure and control points in all power generation systems.

Applications

Venturi elements precisely measure gas, steam or liquid flows in virtually all closed pressure piping systems. Utilized in both fossil fuel and nuclear powered steam/ electric generating plants, they are ideal for high-pressure and supercritical boiler systems, including feedwater and recirculation loops.

Construction

Permutit venturi elements are machined from either forgings or centrifugal castings and surface finishes are available up to 4 RMS. Depending upon your application, materials of construction can include:

- Carbon steel
- Series 300 stainless steel
- Monel
- Copper-Nickel
- Titanium

Features

Venturi elements are offered in a wide range of beta ratios to meet your specific performance requirements. They can be manufactured in a wide variety of materials and supplied with an averaging annulus for use in all types of fluid measurement systems. Pressure connections can be either single high-low or multiple high-low sets. Elements can be either factory installed in a pipe length or supplied separately for on-site installation by others.

Quality Control

Evoqua Water Technologies has been the trusted source for all grades of nuclear and commercial venturi elements for many years. Our capabilities include dissimilar metal welding and fabrication to ANSI and RDT specifications. We meet the requirements of the ASME Codes and 10CFR50, Appendix B through our stringent quality assurance program.

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Advantages

- **Low Permanent Pressure Loss** – approximately 10% at beta ratio 0.5 and above
- **Low Pumping Costs** – resulting from low-pressure loss
- **Highly Flexible** – meets a wide variety of size, flow and application requirements
- **Rugged Design** – limited only by the pressure limitations of the pipe in which they are installed
- **Highest Quality** – can be designed and manufactured to ASME codes, ASME PTC-6 requirements and 10CFR50, Appendix B and ANSI B31.1

Design Features

- Permutit flow venturis are offered in a wide range of standard sizes for either weld-in or flange mounting
- A wide variety of custom sizes and styles are available to meet special requirements
- Low permanent loss - approximately 10%
- Special proprietary inlet profile available for low fouling
- Standard nozzles provide accuracy of $\pm 0.5\%$ when uncalibrated and $\pm 0.25\%$ when calibrated
- Feedwater flow meters are provided complete with flow straighteners, factory installed in pipe and calibrated



PERMUTIT™ XP AND NS SERIES NON-REGENERABLE DEMINERALIZERS

Permutit™ versatile XP and NS series non-regenerable demineralizers offer simple, high performance within a small footprint. They are available in Type 316 stainless steel in either ASME Code or Non-Code designs. Standard sizes include 10", 16" and 30" diameters with 15" and 28" diameters available as special orders.

Applications

The XP series models are ideal for decontaminating water containing soluble radioactive isotopes, where construction to ASME code specifications is not required.

For more stringent radioactive water applications, the NS series models meet the requirements of the ASME Codes and 10CFR50 and 10CFR21.

NS series demineralizers are widely used for nuclear service. Each unit has resin retention strainers and sluicing connections to eliminate the costly and cumbersome resin baskets usually offered for this service.

Quality Control

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Advantages

- **Compact** – units fit easily into small spaces
- **Low Cost** – standard XP series units are available from stock
- **Easily Transportable** – these demineralizers can be easily transported from one location to another
- **Versatile** – units are available for cation or anion exchange or mixed bed demineralization
- **Simple Installation** – shipped complete, these demineralizers are easy to handle and designed for quick removal and replacement

Design Features

- **Inlet and Outlet Distributors** – with our exclusive design, the stainless steel strainers ensure resin retention
- **Sluicing Connections** – these connections facilitate rapid resin removal and replacement
- **Durable Construction Materials** – stainless steel or baked phenolic lined carbon steel pressure vessels ensure long-term, reliable operation
- **Removable Cover Assembly** – positive bolt closure assembly offers easy access to the interior of the vessel
- **Lifting Lugs** – all vessels are equipped with lifting lugs to facilitate handling



181 Thorn Hill Road, Warrendale, PA 15086

+1 (866) 926-8420 (toll-free) +1 (978) 614-7233 (toll) www.evoqua.com

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