ISO 5167 DIFFERENTIAL-PRESSURE PRIMARY ELEMENTS

Flow Nozzle
Product & Selection Guide

ISA 1932 · Long-radius · Integrated steam metering · Weld-in construction

Integrated Flow Nozzle Meter for Steam Service

Supply envelope	Calibration route	Reference basis
DN50-DN600	DN300-DN600 flow calibrated	ISO 5167-1 / ISO 5167-3

*Nozzle type, material, pressure code, operating temperature and project design apply.

1. Product Overview

A flow nozzle is a differential-pressure primary element with a smooth converging inlet and a controlled throat. The fluid accelerates through the nozzle, static pressure falls, and the measured differential pressure is converted to flow using the applicable discharge coefficient, diameter ratio, fluid density and, for gases or steam, the nozzle expansibility factor.

Shizhong supplies ISA 1932 and long-radius nozzle elements as integrated, weld-in or flanged meter runs. The rounded profile is mechanically robust and more resistant to sharp-edge wear than a thin orifice plate, making the nozzle a strong candidate for clean steam, feedwater, gas and liquid duties with high velocity, pressure or temperature.

Standards boundary

ISO 5167-3:2022 applies with ISO 5167-1:2022 to full-pipe, single-phase, subsonic and non-pulsating flow. Geometry, size, beta ratio, Reynolds number, roughness, pressure taps and installation must all satisfy the selected nozzle family.

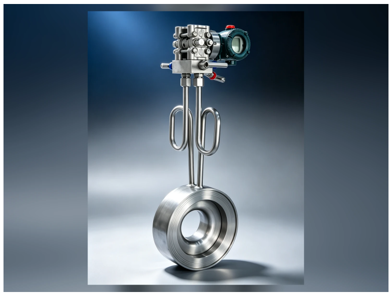
Why engineers select a flow nozzle

- Stable rounded inlet geometry for demanding velocity and temperature conditions.
- DN50-DN300 is within the LG type-approval scope; DN300-DN600 is individually flow calibrated.
- Weld-in, flanged and integrated transmitter arrangements for different piping and maintenance strategies.
- High-pressure and high-temperature materials selected to the project piping code and inspection plan.
- Typical 10:1 flow turndown with a correctly selected differential-pressure transmitter.

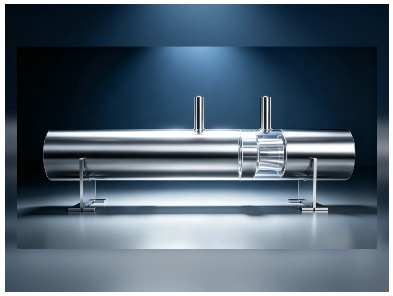
Typical applications

Service	Selection reason
Main / reheated steam	Robust primary element for high-temperature, high-velocity clean steam
Boiler feedwater	Stable geometry for high-pressure liquid flow
Desuperheating water	Compact primary element for controlled water injection duties
Performance testing	Repeatable geometry with a documented calculation or calibration basis

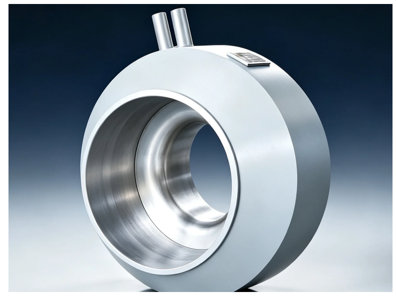
2. Product Configurations



Integrated steam-service assembly



Long-radius nozzle meter run



Weld-in nozzle primary element

Integrated Flow Nozzle Meter for Steam Service

Combines the nozzle primary element, pressure connections, manifold, differential-pressure transmitter and steam impulse arrangement. Factory integration reduces field interfaces, but the final condensate-leg elevation, orientation and thermal layout remain site-engineering responsibilities.

Long-Radius Flow Nozzle Meter Run

Uses a quarter-ellipse inlet profile and D / D-and-one-half pressure tapping. It is supplied as a spool for power-service duties, with pipe material, weld procedure, NDE and pressure testing specified for the design pressure and temperature.

Weld-In Flow Nozzle Primary Element

A compact pressure-boundary arrangement for permanent integration into high-pressure piping. The approved drawing controls bore, concentricity, tapping geometry, weld preparation, heat treatment and inspection requirements.

Image note

Photographs illustrate product configurations. Final dimensions, transmitter arrangement, materials and pressure connections are confirmed on the project drawing.

3. ISO 5167-3:2022 Nozzle Families

The product name 'flow nozzle' is not one universal geometry. ISO 5167-3 defines several nozzle families, each with its own profile, pressure-tap arrangement, operating envelope, discharge-coefficient equation and uncertainty. Shizhong's primary website offering is summarized below.

Item	ISA 1932 nozzle	Long-radius nozzle
Pipe diameter D	50-500 mm	50-630 mm
Diameter ratio beta	0.30-0.80	0.20-0.80
ReD lower limit	7x10^4 for beta<0.44; 2x10^4 for beta>=0.44	1x10^4
ReD upper limit	1x10^7	1x10^7
Pressure taps	Corner taps	D and D/2 taps
Relative Cd uncertainty	0.8% for beta<=0.60; (2beta-0.4)% above 0.60	2.0% uncalibrated
Typical fit	Standards-based steam, gas and liquid measurement	Power-service and demanding high-pressure meter runs

Do not mix families

An ISA 1932 name cannot be combined with long-radius dimensions, D and D/2 taps or the long-radius discharge-coefficient equation. The approved calculation and drawing must identify one complete geometry basis.

Other ISO 5167-3 devices

- Throat-tapped nozzles and Venturi nozzles are separate standard geometries with different limits and coefficient treatment.
- A Venturi nozzle adds a diffuser and therefore has a different downstream tapping location and lower pressure loss than a similar nozzle.
- Operation outside an ISO envelope requires a documented alternative basis and normally an individual calibration.

Manufacturing controls that matter

- Inlet profile radius, throat diameter, throat length and surface finish.
- Pressure-tap position, diameter, edge quality and freedom from burrs.
- Meter-run bore, roughness, circularity, concentricity and absence of weld or gasket intrusion.

4. Measurement Principle and Accuracy Language

For an applicable standard nozzle, the mass-flow relationship is based on conservation of mass and energy. The calculation is iterative because Reynolds number depends on flow, while the discharge coefficient may depend on Reynolds number and beta ratio.

Mass-flow relationship

qm = C x epsilon x (pi d^2 / 4) x sqrt[2 x differential pressure x upstream density / (1 - beta^4)]

Symbol	Meaning
qm	Mass flow rate
C	Discharge coefficient for the selected nozzle family
beta = d/D	Nozzle throat-to-upstream-pipe diameter ratio
epsilon	Expansibility factor for compressible fluids; nozzle treatment differs from the orifice-plate formula
d / D	Nozzle throat diameter / upstream meter-run bore at operating conditions
Delta p	Differential pressure between the prescribed pressure taps
rho1	Upstream fluid density at operating conditions

Accuracy terminology

A project target such as +/-0.5% to +/-1.0% of rate can apply to an engineered or calibrated meter system. It must not be presented as the universal uncalibrated ISO value. Total installed uncertainty includes the primary-element coefficient, differential-pressure measurement, density and fluid properties, dimensions, pressure and temperature compensation, piping and commissioning.

Calibration decision

DN300-DN600 is individually flow calibrated. Within DN50-DN300, use the approved ISO calculation and verification route unless the customer or project requires complete-system calibration.

5. Selection Guide

Decision item	Engineering information required
Fluid	Phase, composition, density, viscosity, compressibility, corrosion, erosion, solids and moisture
Flow range	Minimum, normal and maximum mass or volume flow with reference conditions
Line	Nominal size, actual bore, schedule, material, roughness and available straight run
Pressure / temperature	Minimum, normal, maximum and design values, including start-up and upset conditions
Performance	System accuracy or Cd uncertainty target, turndown and allowable pressure loss
Nozzle family	ISA 1932 or long-radius, with its complete ISO geometry and tapping basis
Instrumentation	DP range, static-pressure rating, manifold, compensation and communications
Compliance	Piping code, welding, NDE, pressure test, calibration, material certificates and data book

Nozzle versus standard orifice plate

Criterion	Flow nozzle	Standard orifice plate
Inlet geometry	Rounded, robust profile	Sharp upstream edge
Wear sensitivity	Less dependent on a sharp edge	Edge condition is a critical inspection point
High-temperature duty	Often preferred for severe clean steam service	Possible with suitable design, but edge durability must be reviewed
Initial cost	Higher; precision profile or forged meter run	Lower; plate is simple and replaceable
Range changes	Usually require new nozzle/meter run	Plate replacement is comparatively simple

Fluid boundary

The source material mentions dirty media, but ISO 5167 is a single-phase standard. Solids-bearing, wet-steam, two-phase, flashing, cavitating or pulsating service needs a separate technology and calibration review.

6. Pressure and -196 to 600 C Temperature Design

The ISO flow correlation does not replace pressure-equipment or piping design. For power and petrochemical service, the meter run must be engineered as a pressure boundary for the actual material, pressure, temperature, cyclic duty and inspection class.

Design area	Review items
Materials	304/316L stainless steel, Cr-Mo steel or project-specific high-temperature alloy; confirm corrosion and creep basis
Pressure capability	Project-specific; final rating follows the selected piping code, material, wall thickness, connection and design conditions
Temperature capability	-196 to 600 C; the project matches material, pressure class, seals and instrumentation to the combined pressure-temperature duty
Welding	Qualified WPS/PQR, welder qualification, joint design, preheat, PWHT and hardness controls where required
Inspection	Dimensional inspection, surface condition, material traceability, NDE and pressure testing to the purchase specification
Instrumentation	Static-pressure and temperature ratings for transmitter, manifold, valves, impulse lines and seals

Steam impulse system

- Use matched positive and negative impulse lines with equal condensate-leg elevation.
- Keep both sides under similar thermal conditions and route with a continuous, controlled slope.
- Provide safe isolation, equalization, drain/vent and freeze protection as required by the site standard.
- Confirm transmitter static-pressure rating, overpressure protection and zero procedure at operating pressure.

Safety

Never loosen a meter-run, manifold, transmitter or impulse-line connection while it is pressurized or at an unsafe temperature. Follow the site's isolation, depressurization, drainage and lockout/tagout procedure.

7. Installation Requirements

Piping and primary element

- Install in the marked flow direction and keep the nozzle concentric and perpendicular to the meter-run axis.
- Maintain a full pipe and avoid locations that trap gas in liquid service or retain liquid in gas service.
- Select upstream and downstream straight run from ISO 5167-3 Table 3 for the actual beta ratio and disturbance combination.
- Do not replace the standard table with one universal value such as 10D, 20D or 30D.
- Locate throttling/control valves downstream where practical and document elbows, tees, reducers and valve orientation.
- Inspect the adjacent bore for steps, ovality, excessive roughness, weld intrusion, scale, deposits or gasket protrusion.

Pressure taps and impulse lines

- Keep pressure taps clean, square and free from burrs; do not enlarge them during maintenance.
- Route positive and negative impulse lines together, as short as practical and with continuous slope.
- For liquids, prevent trapped gas; for gases, prevent condensate pockets; for steam, maintain equal condensate heads.
- Leak-test every fitting, valve and manifold connection before transmitter zeroing.
- Protect against plugging, corrosion, freezing and vibration according to the process risk.

Installation evidence

The final data book should record actual upstream fittings, orientation, separation distance, beta ratio, bore condition and pressure-tap arrangement. If the layout cannot meet the standard, use engineering review or calibration.

8. Commissioning and Maintenance

Commissioning sequence

- Confirm tag, approved calculation, drawing, materials, pressure class, flow direction and nozzle family.
- Inspect the inlet profile, throat and pressure taps for damage, deposits or fabrication debris.
- Flush or blow the line before exposing the primary element to full flow.
- Pressure-test the assembly and verify that both impulse paths are open and leak-free.
- Equalize the manifold, apply stable static pressure and perform the transmitter zero check.
- Open positive and negative isolation valves in the approved sequence, then close the equalizing valve.
- Verify DP range, square-root extraction, engineering units, damping and compensation inputs.
- Record normal-flow DP, pressure, temperature, density and transmitter diagnostics as the baseline.

Troubleshooting

Symptom	Likely causes	Checks
Flow reads low	Positive-line leak/blockage, density error, oversized DP range	Leak-test, purge, verify fluid state and range
Flow reads high	Negative-line leak/blockage, deposit, wrong density	Inspect negative path, throat and compensation
Unstable reading	Pulsation, two-phase flow, trapped phase, vibration	Review process, impulse routing and damping
Bias grows	Deposits, erosion, tap blockage, zero shift	Compare baseline, inspect geometry/taps and zero

9. Ordering Data and Deliverables

Provide the following data for sizing, engineering review and quotation. Missing process or piping data can produce an unsuitable beta ratio, DP range, material or pressure class.

Data group	Required information
Process	Fluid, composition, phase, solids/moisture, min/normal/max flow, pressure and temperature
Properties	Density, viscosity, compressibility and isentropic exponent where applicable
Piping	Nominal size, schedule, actual bore, material, connection and applicable piping code
Performance	Accuracy or Cd uncertainty target, turndown, DP range and allowable pressure loss
Installation	Available straight run and nearby elbows, tees, reducers, valves or branches
Instrumentation	DP transmitter, static-pressure rating, manifold, compensation and protocol
Quality	Calibration, NDE, pressure test, material certificates, inspection plan and data book

Typical deliverables

- Engineering calculation with bore, beta ratio, Reynolds range, coefficient and DP range.
- General-arrangement drawing with dimensions, flow direction, pressure taps, materials and connections.
- Critical-dimensional and surface-condition inspection record.
- Material traceability, NDE and pressure-test records as specified.
- Installation, impulse-line, commissioning and maintenance guidance.

10. References, Contact and Document Status

Primary references

ISO 5167-3:2022 - Measurement of fluid flow by means of pressure differential devices inserted in circular-section conduits running full - Part 3: Nozzles and Venturi nozzles.

Official ISO record: https://www.iso.org/standard/84845.html

ISO 5167-1:2022 - General principles and requirements for differential-pressure devices in full circular conduits.

Official ISO record: https://www.iso.org/standard/79179.html

GB/T 2624.3 - Nozzles and Venturi nozzles; project edition and local legal status to be confirmed.

Copyright and control

This guide paraphrases engineering requirements and does not reproduce the purchased ISO standard. The controlled standard, approved project specification, calculation and drawing govern the order.

Contact

Jinan Shizhong Automation Instruments Co., Ltd.

7036 Jingshi West Road, Jinan, Shandong, China 250022

Email: info@shizhongflow.com

Website: https://www.shizhongflow.com

Office: +86-531-82909656 | Mobile / WhatsApp: +86-188-0531-6689

Document status

Product-selection and application reference only. It does not replace the approved project calculation, drawing, purchase specification, calibration certificate or site safety procedure. Final specifications and performance commitments are confirmed per order.